

## Climate Adaptation Planning with Alaska-Based Adaptation Tools

**Katie Poston:** [0:05] Welcome, everyone, from the US Fish and Wildlife Services National Conservation Training Center in Shepherdstown, West Virginia. My name is Katie Poston. I'd like to welcome you to our webinar series held in partnership with the US Geological Survey's National Climate Adaptation Science Center.

[0:24] Today's webinar is titled "Climate Adaptation Planning with Alaska-Based Adaptation Tools." We are excited to have Ryan Toohey, Jeremy Littell, Malinda Chase, and Nancy Fresco with us today. To introduce our presenters today, we have Shawn here. Shawn Carter is from the National Climate Adaptation Science Center. He is a senior scientist.

**Shawn Carter:** [0:49] Thank you. Thanks for joining us today. It's my pleasure to introduce an all-star panel of four speakers.

[0:59] Joining us today for the presentation, we have Dr. Nancy Fresco, who is a research professor at UAF International Arctic Research Center and network coordinator for the Scenarios Network for Alaska and Arctic Planning or SNAP, which focuses on climate change modeling and adaptation.

[1:17] Her work focuses on forging effective collaborations, linking SNAP data to the needs of stakeholders and interpreting the results of complex modeling efforts.

[1:28] We also have Malinda Chase, who is a member, I'm sorry Malinda, can you say the name of your village?

**Malinda Chase:** [1:38] My home village is Anvik, and I am a Deg Hit'an Athabascan.

**Shawn:** [1:44] Thank you. I know I wouldn't have done that justice. That's located at the confluence of the Anvik and Yukon River in interior Alaska.

[1:54] She works as the tribal liaison for the Alaska Climate Adaptation Science Center in Fairbanks, Alaska, and through a partnership with the Aleutian Pribilof Islands Association and is affiliated with the Bureau of Indian Affairs Tribal Resilience Program.

[2:12] She assists tribes in accessing opportunities that increase the capacity and resilience of tribes to prepare for and respond to climate impacts.

[2:21] We also have Dr. Jeremy Littell. He is a climate impact ecologist for the Alaska Climate Adaptation Science Center. With the US Geological Survey, he conducts climate impacts science in a wide range of ecosystems and is an expert on the role of climate change in wildlife, wildfire, mountain ecosystems and resource management.

[2:42] He also works with resource managers and other decision-makers to incorporate climate change information into long-term planning.

[2:50] Finally, we have Ryan Toohey, who's worked for over 20 years in water resources, specializing in interdisciplinary applications of hydrology, water quality, ecosystem services, and governance from the Tropics to Alaska.

[3:05] His current position with the USGS Alaska Climate Adaptation Science Center includes research that involves investigating environmental change, hydrological modeling, and community-based research that integrates indigenous knowledge, social, water, and soil science.

[3:22] Thank you for presenting, everybody, and I'll turn it over to you.

**Ryan Toohey:** [3:28] Great. Thanks, Shawn. Welcome, everybody. Thanks for joining us today. Again, this is part of the Tools You Can Use seminar series and I'd like to thank the National Climate Adaptation Science Center for inviting us to present on some of the work that we're doing up here in Alaska and some of the tools that we're using to do that work.

[3:52] We have a wide variety of tools and we're going to give you a little bit of background on the project.

[3:59] Earlier this year, the Bureau of Indian Affairs funded a tribal resilience project with all the presenters today that basically is focusing on developing capacity with some of our tribes up here, and then assisting with them get more comfortable through how to use some of the tools that are available for adaptation and planning, and in general, these resources that are available.

[4:37] It's a very community-based project. We had a number of different tribes apply to be part of the project, and then several were selected based on funding and geographic locations. We had kind of a first live workshop last April and then we've done the majority of our village visits.

[5:05] I'm going to pass it over to Malinda here and she's going to talk a little bit more about the project design and some of the communities that we're working with.

[5:13] Thanks again for joining us, and Malinda, go ahead and take it away.

**Malinda:** [5:17] [greeting]. Thank you Ryan and thank you for definitely all of you who are making this webinar happen today, especially with our guest participants.

[5:32] I'm Malinda Chase, and I was introduced earlier as a tribal liaison at the Alaska Climate Adaptation Science Center. Really, my role is to be a link between the climate science community and our tribes across Alaska.

[5:51] It's quite a challenging position to be in. By that, I say that because we have 229 tribes across Alaska.

[6:03] In my role, when I came on, I really had to look at the situation that many of our tribes are in, having 229 of them across Alaska, we don't have a transportation system that is based on a road system. Most of our tribes are accessible by air or by boat, and we do have some along some of the major road systems.

[6:31] In terms of working with our tribes and providing support that they need for adaptation in an environment that is changing incredibly rapidly and fast, there are definite challenges, particularly with some of the communication that we have.

[6:57] After spending about a year in the position getting my feet on the ground with some of the issues across the state, Ryan and I and the Climate Adaptation Science Center really designed this project looking at how we can support tribes to do a slice of adaptation planning, because we had completed a survey that showed that tribes had gone to training, but were struggling to get some of the planning done.

[7:42] We've looked at how do we design this training that would help to bring them along in understanding some of the tools that were available to them, and then also to support them, not with just doing a training that was in town in an urban area, which much of the training had been designed for them to attend, but also going out to the communities.

[8:22] You'll see here on this map that there were five communities that chose to be a part of this. They self-selected to be part of this project. The title of the project is "Looking Forward, Looking Back - Building Resilience Today."

[8:40] The intent of that really was to look forward at what might be coming down the pipe with the projections and what communities could be looking at in their specific regions.

[8:56] Looking Back is looking back at what are some of the strengths and the knowledge and the history that the community has and the strengths that they have. Building Resilience Today really looks at, how do we help communities access the tools that are available.

[9:24] This presentation today, as Ryan said, is going to cover some of the existing tools. What we're not going to cover is any of the indigenous tools that we are looking at using in the project.

[9:48] In terms of the goals of the project, really it is to increase the knowledge about the warming climate and its impacts in Alaska and across the Arctic, also to raise awareness from the local to global responses.

[10:08] I think this is really important for our population in Alaska. Many of you may know that we don't have a reservation system. We have, actually, one reservation, but we have a system of corporations that are privately-held regional corporations on a lot of our land base.

[10:31] Then we have village corporations that own land at the local level. Then we have tribal governments that provide the governing function.

[10:43] Our system is very different. We operate at all of these scales in a very...How do I say it? We have so many decisions at all of these scales in Alaska for the type of government system that we have. Looking at the impacts and these decisions, we wrapped that into this project management.

[11:15] The other two major goals is to increase the dialogue on local indigenous knowledge in relation to climate change, and then help communities and leadership know of the existing resources and approaches. We designed the project based on a model that really has worked well for Alaska native populations.

[11:45] Again, this has to do with the size of our state. We looked at bringing in the tribal teams of two to three people. We established teams and we really tried to recruit from both the tribal government, the village government, and the city government if there was a city established in each one of those communities.

[12:16] We brought them in to learn about some of the Western science in the first training. Then in between the site visit that we had next out in the communities that Ryan just shared with you that we recently made to four of those communities, in between those visits, we provide support through telephone contact as well as webinars.

[12:46] Finally, we're looking at a third face-to-face, which we're calling training two, back in town, which we'll be going over some of these tools.

[12:55] I will turn it back over to you, Ryan.

**Ryan:** [12:57] OK, great. Thanks, Malinda. As Malinda mentioned, there is a whole other side of this project that we're not really going to talk too much about today. That is the assisting with documenting the local and indigenous knowledge, again, for community planning purposes.

[13:17] We have a number of exercises that we work through with each community to get a lot of that information that we think will be useful for plans, or additional grants, or even public comments.

[13:30] What the next couple of slides are going to show you here is just introduce you to some of the things that these communities experience.

[13:39] I'm going to move back just a couple of slides to look at where we are in the state. Four of these communities are very coastal communities. If you're not from Alaska and you're not familiar with this area, it's a very low-lying area for the most part. Almost all these communities are experiencing coastal erosion and flooding with a lack of sea ice.

[14:10] Especially over the last couple of years, communities like Kotlik, for example, have had some pretty devastating floods within the past five years and multiple floods. This is giving you a window into some of these communities.

[14:26] A number of these communities have permafrost degradation. You can see in this photo in the top-left corner some cracking in the road right next to...A lot of these communities put their utilities above ground because there is so much freeze-thaw.

[14:42] If they were underground that would just cause even more problems, so they're on these elevated...They're very similar to the Alaska Pipeline except not on as grand of a scale.

[14:54] These are recent photos from when we were there in August and September. You can see there is some remnant flooding. Some of that flooding, again, combined with permafrost degradation leads to...This is a big fuel tank that has tipped over and is now on its side. Again, some kind of remnant flooding depression storage there. Almost all these communities have their houses up on jacks.

[15:25] As I mentioned, these are very coastal communities and there is a lot of permafrost degradation and a lot of thaw throughout the area. Literally, as we've been talking to the communities, folks are having to jack up their houses from sinking into the tundra.

[15:42] We've heard reports as high as two to four times this summer now, which is somewhat of a new...I guess that frequency is new.

[15:52] If you look down here in this bottom-right corner, it's Jeremy Littell standing right there, and you can see that's actually some wild permafrost in action. That's from beneath some of these other photos here where you can see with coastal erosion, so they increased in storminess and that lack of sea ice is exposing these coasts.

[16:18] Permafrost is degrading at the same time, and so it's making them very susceptible to coastal erosion. Then on the other side here, we have some river erosion.

[16:29] Well, you can't see that great in this photo. There is actually a bunch of small rip-rap through here which was meant to stabilize the bank, but that was done a number of years ago and is essentially being washed away from some of the action.

[16:44] These are just some more photos of the coastal erosion and riverine erosion that's happening in the communities. The communities are having to sandbag certain places, which is of some utility but definitely not all.

[16:58] This photo here, this is actually the water plant and if you can see the concrete footings here in front of the doors are slanting downward and actually lifting up from the ground.

[17:12] What this translates to is some additional public health hazards with more people tripping and falling down steps, and doors are crooked and causing some other public health impacts beyond structural damage to the buildings.

[17:28] Another good photo of this is in the right-hand corner here, where you can see that a lot of these telephone poles...The windmill is fairly straight, but if you look at telephone poles compared to the windmill, again, you have a lot of these impacts that are just affecting some pretty important infrastructure.

[17:48] This particular community has built a sewage lagoon about 12 years ago. A sewage lagoon and a landfill, and they are currently in the process of having to relocate those sewage lagoons and the landfills because of the extreme amounts of coastal erosion that they've had.

[18:09] Finally, this last picture is in one of our communities. Participants there shows them going through a subsistence seasonal calendar. Again, we're not going to talk too much about that today. I will pass it back over to Malinda here.

**Malinda:** [18:23] I'm going to show you a couple of brief videos that really demonstrate some of the condition of the land that folks in Southwest Alaska and our communities are dealing with.

[18:38] Again, Jeremy mentioned that this is just a recent trip within a little over the last month. Up in the left-hand corner, you see some of our community team members there, along with Ryan and Jeremy.

[18:54] We went out to an active layer site where the community has been monitoring the active layer over the last 10 years. This community is really fortunate to have some of their environmental staff that have been in their position that long to see some of the changes. While we were out that morning, I was fortunate enough to get some great video.

[19:25] These are real short. I would like to share them with you. There is sound on one of them, and they may be showing a little bit slow on your side. I'll show you this middle one here, which is a picture of Jeremy and Philomena here.

[20:09] [pause]

**Malinda:** [20:09] You could see that was methane that's being released. That was a common happening out there when he would pull that probe out. Definitely, it is happening. There is [inaudible] happening.

[20:29] This next video, you will see another demonstration of what folks locally are dealing with.

[20:36] [pause]

**Malinda:** [20:54] They look like they were having a good time, which they were. At the same time, it was very telling in terms of what people are dealing with locally when they're thinking about adaptation and addressing these issues for their housing and for some of those issues that Ryan laid out.

[21:19] Some of these communities are on a boardwalk system, and they may or may not have a gravel source. If they're on a boardwalk system, over some of the land that is in this condition and is thawing incredibly fast, the permafrost is.

[21:40] They are dealing with multiple issues, particularly, looking at potentially how do they relocate when in the summer months their land may be in this condition, or in the winter months when we have increased precipitation and other issues that they're addressing.

[22:05] Some of the community takeaways for this particular project are really helping the community leadership team come away with a common understanding about future projections so that they are all on the same page when they are looking at major decisions in front of them.

[22:29] Also, helping them to pull together a synthesis document really focusing on what they want to cover and what they see are important issues for their decision in making an adaptation.

[22:48] This could be including our traditional land use map that covers their area and the potential projections on that area, as well as listing out what are some of the key wildlife, and marine and fish mammals, and plants that the community relies on, given our mixed economy here in Alaska, especially many of our communities are heavily reliant on subsistence.

[23:19] Then also, what is it that the community really wants to take forward as they're looking at issues of potential relocation or addressing a decline in some of our subsistence resources. Then finally, what are the environmental or climate projections that the community wants to include.

[23:43] I just really want to stress that as our communities are looking at these significant and heavy decisions in front of them, it's very significant to transfer and document the knowledge we have on our land. It's not only going to assist future generations and help them as they address some of these issues with some of the projections that we're looking at.

[24:18] It also is significant for relocation and potentially to help communities in conversations that they may need to have at an inner tribal level and looking at future land negotiations, as well as, how are we going to plan forward around our fish and our game, and some of the impacts that we're having on the experience that our game and our wildlife are going through right now.

[24:51] Many of you may have seen on the news that we've had fish die off and other marine mammals die off, and so this kind of knowledge is incredibly important as we are making those decisions forward.

[25:07] Then really, how does the community look at both what they're bringing in in terms of their traditional and past knowledge and integrate that and work with the projections in planning forward. I will turn this back over to now Jeremy.

**Jeremy Littell:** [25:24] Thanks, Malinda. In our work with these communities, one of the things that we do not yet have a tool for, but which we get asked for all the time, is more specific information about what impacts and what changes might be expected in those communities and the regions around them on which they depend for subsistence, resources, and transport, and all kinds of other things that you and I take for granted.

[25:50] If we just went with basic climate data that's available to us, many of these communities in Alaska don't have a long-term climate record, and so we're forced to put it in context of someplace that does.

[26:01] In this region, one of the communities that we use frequently is Bethel which has a fairly long climate record. If we look at the region of Western Alaska and the Yukon Delta that we're dealing with in this project, it's warming at over two and a half times the rate of the whole planet. We can look at data that we have for this and put that into context.

[26:24] It's no surprise to the people that live in these communities that the climate change there is occurring faster because they're experiencing it in ways that people expect in other places to experience it in the future.

[26:37] By the 2050s, the average temperature annually is likely to increase by an additional seven to eight degrees Fahrenheit in this region. By the time you add those two together, that's like going from a glacial to an interglacial period, but you're doing it in a century rather than millennia.

[26:54] The rate of change is really, really fast, and it's hard to impress upon people who don't live there just how quick that is. We expect an increase in precipitation, roughly 10 to 15 percent on average by the 2050s.

[27:08] Especially in the summertime, that's not enough to offset the increase in temperature, and so you have an increased fire season and things like that. Also, the increase in temperatures have

fundamental changes in the hydrologic cycle that have more to do with the impact on the snow season, permafrost, and the amount of snowpack that's available for streamflow in the Spring.

[27:30] In these communities, also the frozen river ice and sea ice are really, really important for access in the cold season, the winter, to resources. It's a fundamental aspect of their transportation system, and so smaller changes in temperature have pretty profound changes for the cryosphere that have large impacts in those communities.

[27:53] There is a regional story that we can tell from data that we have on hand at the Climate Adaptation Science Center and with our colleagues at ACAP, and Nancy is going to show you some of the more specific tools available in a minute.

[28:06] Before we do that though, I want to talk about how these dialogues in the communities that we've had paralleled some of the other stakeholder dialogues that we've had and where we might be going in terms of tools.

[28:18] We know that the rate of change in different parts of Alaska is different. These are just the change factors for temperature for the 13 climate divisions in the State of Alaska.

[28:30] The numbers that you see in the middle of each of those divisions is the rate of change relative to the global average rate of change. You often hear this figure that Alaska is warming at twice the national average or something like that, so we decided to put a finer point on those numbers.

[28:46] In the southern parts of our region, it's a little faster than the national or global average. As you move further north, those numbers get bigger and bigger. By the time you're on the North Slope, the northern part of the North Slope, it's almost three times the rate of change.

[29:00] Even within Alaska, we have a range of impacts and responses. What is affecting us in the population centers of Juneau, and Anchorage, and Fairbanks, may be quite different than what some of these communities experience.

[29:14] By starting to look at some of the regional responses and the variation in that, we put a finer point on the impacts that we expect.

[29:20] We don't yet have a tool to do this other than some of the community charts which tell the changes that you could experience in each community and allow you to look at some of this. In terms of the impacts on other variables, we of course, have to think about climate model output in the future, and the rate of change in temperature.

[29:40] These are expressed in Fahrenheit, which is often more useful for our stakeholders. The changes in each of these divisions as you move north, you see seven, eight, nine degrees by the end of the 21st century. Those are numbers that are familiar to some people like in the Pacific Northwest, for example, as a high-end scenario.

[29:59] As you move into the interior of Alaska and up towards the North Slope and the Yukon Delta, you're talking 10, 11, 12, even 14 degrees Fahrenheit changed, averaged over something the size of the climate division, some of those locales within those divisions even faster.

[30:14] These are really, really fast changes, and rightfully so, many of the communities and other stakeholders want to know what the specific impacts will be.

[30:23] We have a lot of gridded sciencey information on this that's been developed by us as well as others, but not a lot of specific translation for that, and to-date not very many tools that allow us better access to that.

[30:40] We're having, I guess I would say, an uptick in requests for more specific information. It's not enough to know just what the temperature or precipitation changes will be. People want to know about extremes. They want to know about sub-seasonal changes that are very important to subsistence or to access.

[30:57] An example is high rainfall events. This is from the third National Climate Assessment analyses showing the change in high-rainfall events for this part of Alaska. The frequency of extreme, that is 1 in 20-year events, under a less warming scenario is relatively low.

[31:20] The changes under more warming relative to historical, you go from something that was 1 in 20-year event becomes a 1 to 2 or 3-year event. Really big changes in extreme rainfall, for example.

[31:32] If you look at the Yukon-Kuskokwim Delta there, it's in dark blue. We can start to back up some of this information. Again, we'd like to get more specific.

[31:43] We started to do this for many of these communities. Here's a zoom-in on the Yukon-Kuskokwim Delta. The communities in this project that Malinda was speaking about as well as another one that deals with the middle Kuskokwim and the change in the months of reliable snow, which we've just defined as 70 percent of the precipitation in the winter months falling as snow rather than rain.

[32:07] As you can see, in the southern part of this domain, you get really large decreases in the months of reliable snow. That's because, historically, much of that snow fell relatively near freezing near the coast in the southern part of the delta. As you move north, you retain many of those months of snow.

[32:28] Somewhere on the Y-K Delta is that threshold between mixed rain and snow and snow-dominant winter precipitation. The changes in the future move up north and to the east. These northern communities are more buffered. They only lose a couple months of snow. In all cases, the snow season is getting shorter as we warm.

[32:53] The change in that snowpack contribution to spring melt and to river runoff is also an important feature. The blue colors on this map show you what are basically snow-dominated watersheds. The main event in the hydrologic year is the snowmelt. Other precipitation events contribute relatively minor amounts of runoff compared to the spring snowmelt.

[33:20] The reds and oranges are places where it's transitional, where now, under the future projected change in climate, you get more of a mixed rain and snow hydrology, where in the past, it was historically snow-dominated.

[33:40] We're being able to now map out some of this gridded information community by community, project by project. We're being asked to do it repeatedly. This is one of the places where a tool might be useful.

[33:51] One other thing we've done with a lot of this work is to start summarizing it by watersheds, HUC 12 boundaries, for example.

[33:59] I've gotten users past a lot of the worry about summarizing gridded data projects from pictures, which is difficult and also sets us up to do work in pretty much any set of polygons for which people might want summaries, whether that's management units, different ownerships, and things like that.

[34:15] This is definitely progressing towards a tool-based approach but we don't yet have a user-accessible tool.

[34:22] The Alaska CASC is funding the integrated ecosystem model team that works with us to start developing some of these kinds of summary tools. We're hopeful that that can begin to make this more accessible to more people rather than having us do gridded and watershed summaries.

[34:39] This version is for the same kind of variable for southeast Alaska where we do get a pretty big change towards the end of the century from what were, historically, transitional watersheds mixed rain and snow. You see the green ones in the right-hand panel, those are places where the hydrology has changed to a rain-dominant system rather than one that was mixed rain and snow.

[35:01] Many of the snow-dominated watersheds are moving towards transitional or much less snow-dominated watersheds. That's the progression that we see in the warmer parts of the state like southeast Alaska. We've got a different set of potential impacts here. Southeast Alaska just went through a drought that made some headlines.

[35:21] People don't think of Juneau and Ketchikan as places that experience drought. It turns out that they do and that the dependence of local communities on water resources is higher than others might have guessed.

[35:34] There's more vulnerability there than we initially expected. We're expecting a much-increased attention on these kinds of impacts as well.

[35:44] With that, I'll turn it over to Nancy who has some information on some of the tools that have been developed that are more user-accessible.

**Katie:** [35:52] It looks like Nancy's not connected, as far as her sound.

**Ryan:** [35:58] Hey. This is Ryan. Maybe while they're doing that, we'll skip to the end here and talk about a different tool that's been developed while we're waiting to figure out the technical difficulties with Nancy.

[36:11] One of the other tool that the Alaska CASC developed with the Northwest Boreal Landscape Conservation Cooperative and ARLIS, which is our local state-wide library system

and database is this thing that we call the Northwest Boreal Science and Management Research Tool or SMRT. One of the things is I moved up to Alaska about 10 years ago.

[36:45] From that time, I've done a lot of work with communities. Northwest Boreal is very interested in making more information accessible to communities. We went through the development of this tool. A vision of it is that we wanted it to have a large number of documents that were curated in one place. Our librarians from ARLIS were wonderful.

[37:11] We basically curated land-use management plans, scientific articles, and then a lot of the theses and dissertations in one place all the way back to 2000. The land-use management plans went beyond that. A lot of our work in Alaska has tried to focus on these trans-boundary datasets so that we don't have to stop research at the Alaska-Yukon border.

[37:46] Finally, a lot of our work is you go out to these communities. They have very limited Internet connectivity. They definitely have experienced a lot of researchers blazing in and blazing out of these communities, getting what they need and then not doing a great job of follow-up with the community.

[38:11] What we wanted to be able to do is say, "OK, if you're from a small community in Alaska, you can just draw a box on a map and start to see relevant studies and land-use management plans."

[38:26] We were able to create this with Data Basin and the work that we did. We created a dataset of, I think it was about 7,000 articles, land-use management plans, and thesis, and dissertations.

[38:40] We had a team of interns that went in and geo-located all of those. We used Google Earth to draw polygons of what they are around.

[38:50] What this enables us to do is you can search by text, you can search by a place-based location, or you can do a combination of both.

[38:57] This is a quick example. We did a search for links over this area around Whitehorse and Haines Junction. Then you end up with a fairly good, relevant dataset that has a variety of different publications here. You can see the footprint that it refers to. If you are looking for something more larger-scale or smaller-scale, you can sort through your results based on that.

**Jeremy:** [39:25] Nancy's here.

**Nancy Fresco:** [39:26] I'm here in Malinda's office.

**Ryan:** [39:27] Perfect. All right, then we'll pass it over to you, Nancy.

**Nancy:** [39:31] The goal here is not to blind people with too many numbers but to introduce some of the more accessible tools that we've been trying to create. It's great having a lot of people on the line because we'd love to get feedback as to usefulness, the utility of these tools, of course, for this project but in general.

[39:51] As other presenters have been saying, the real goal here is to try to connect what people are seeing on the landscape, what they're living on the landscape, and what they will be living into the future with the best modeling that we can possibly put together that's accessible, and meaningful, and connects the actual questions that people have to the things that are a concern to their lives.

[40:17] This first slide is the interface of our SNAP website where you can connect, learn a little more about our research, our modeling, and connect to some of these tools. This next slide is the analysis interface where you can click on one of these icons.

[40:35] I'm going to do a very quick walk-through of some of the tools that we have here, the ones that are pertinent and connected to the work in these communities or that could be. The community charts tool, some people have probably seen this already. It was already mentioned. It's very simple but it's powerful.

[40:57] Any community, any village in Alaska and in parts of western Canada as well can put in the name of their community and immediately generate a graph like this that shows very simply what climate models are saying about the future of temperature and the future of precipitation for that location. Of course, this is modeled data.

[41:21] It's showing historical in grey and it's showing out into the future. Any graph is only as useful as the story it tells. If you look at the graph that's on your screen for Quinhagak, one thing that jumps out when I look at it is the way it's set up. The line going across is at the freezing point, 32 Fahrenheit.

[41:43] You look at how, historically, the month of April on average was below freezing and the month of October in the fall was around freezing. If you look at the future, those months are way above freezing, really thawed.

[42:00] That alone, if you know the landscape, if you're someone who lives in the landscape that tells you a different story about what might be happening there in the future.

[42:10] This next slide, a different model, a different interface on our website. This one's relatively new. Of course, the permafrost issue, that's huge. You've seen slides of people out there measuring it, jumping up and down on it, releasing methane.

[42:29] This is a little less fun and exciting, happens in an office behind a desk. This is obviously a map of Alaska. You can, again, choose a community.

[42:43] Saint Michael is highlighted here. What that means is that the circles you see at the bottom reference Saint Michael. You see you've got a score or a level for things like massive ice and, ultimately, for risk level. You can generate maps. You can look at different risk levels for different variables for different communities.

[43:06] It gives some sense of what kind of change might be in the outlook for the future, which ties back to everything that people are concerned about.

[43:17] This next tool, we've been talking about the effect of extreme days, about what happens when you go above normal thresholds or below normal thresholds. What happens in the really hot, the really cold days?

[43:30] For a long time, we didn't have data to address that because we just had monthly averages, which are useful but don't tell the whole story. Often it's the extremes that affect people's lives.

[43:41] This is a new tool and has a lot of different buttons that you can play around with. It's easy to get lost in, especially if you don't spend a lot of time in front of the computer the way I do.

[43:51] This set-up as it is right now is set up for Nome, which, obviously, is not one of the communities we're looking at directly in this project but it is a coastal community. It's set to look for January for a long time period, across a full-time span and to look at temperature.

[44:13] In this case, temperature is above four Celsius, which is 39 Fahrenheit. It would be the number of days in January where you'd have these really clear thaw levels. It's way above freezing.

[44:30] What you see is the model is saying that those would become much, much more frequent in the future. Another graph that looks similar but you see I've changed the variables.

[44:40] Now we're looking at days in July above 16 Celsius, which is 61 Fahrenheit, hot summer days, really warm, sunny, summery days in July. Again, when you look across the time period, you see those start out pretty rare and the models say they become more and more common.

[45:00] This is the kind of tool that we've been playing around with so that we could tell different stories about what might happen in the future.

[45:07] This next slide, totally different subject once again. This is a different tool. These are all different tools that you can get to from that menu.

[45:15] This is sea ice. This is not a future projection tool. This is something that's data from the past but it's turned into these maps.

[45:27] To me, a picture, a map tells a story in a really clear way. If you're trying to talk to people about change or even convince people that change has occurred and is occurring, these maps are very powerful. This is way, way back in history using data from 150, 170 years ago.

[45:51] This is January 1850 how much ice there was all around the coast of Alaska. Then, jumping forward to the recent past, seems sort of recent, 1982. You see that the change is not that much from that really, really, super distant past to the much more recent past.

[46:15] Then when you jump forward to January of last year, 2018, you see that's when the change is taking place in these past few decades, January, to January, to January.

[46:28] What that tells us, for thousands of years in history not much change in sea ice. Now, it's really, really changing. Using this same tool, if you pick a different month, now we're looking at November 1982. I was a little kid then.

[46:49] There are certainly people my age or older who remember the 1980s. Change is already taking place but just starting, November 1982 and then November of last year. Huge, huge change. The ice isn't forming yet in that month. That also can tell a story as a picture.

[47:17] Then this last tool, again, totally changing track, different tool. This is an interesting one looking at a lot of factors that affect fire. You can look at, historically, what has happened with fire.

[47:33] This is fire [inaudible] this past summer, 2019 fires. This is not looking at past or future. It's just this past summer. Where were those fires? How big were they? Basic information but all in one place.

[47:50] Here's where you can look at the past and you can see within the same tool. You see I've selected and put a checkmark on the historical fire perimeters from 1940 to 2018.

[48:01] The map changes, shows all the fires that burned in that whole time period. That starts to give you a picture of, historically, how the fires are concentrated across interior Alaska. A lot fewer in these coastal areas that we're thinking about.

[48:18] Then, when I go to this final slide, this is the same tool but I've put a checkmark on future flammability. Of course, this is now modeled. This is trying to model what is likely to happen in the future based on changes in vegetation, changes in temperature, lightning strikes, fire risk, the whole picture.

[48:41] You see some really high fire risk, maybe not all the way on the coastlines but definitely creeping down toward the coast and cropping up in areas that were not historically at huge risk for fires.

[48:55] Again, it's models. It's the stuff that happens in an office, not out on the landscape. It needs to be melded with what local people know and experience about the land.

[49:07] A model by itself doesn't tell you that much. Our hope is that making these tools accessible such that people can look at them, and can share information, and can link it to what they know and experience, that this will be an important part of planning and of trying to prepare and adapt for the future. That's the end of my slides.

**Ryan:** [49:32] Thanks to all presenters. Thanks to the NCASC technical team that helped us do that. We had a fairly successful, fairly complex presentation. A lot of those tools that Nancy was just talking about...

[49:49] We're essentially going to focus on using those tools with the tribes that we're working with to teach them to use those tools and then squeeze that out as much information and put those into some useful documents for the tribes and the communities there.

[50:06] We'll open it up for at least a question or two.

[50:09] Jeremy, did you have something while we wait to see if [inaudible]?

**Jeremy:** [50:11] I did. I thought we should point out that the site in which Bernard and I are surfing the tundra is a site that Ryan had for over 10 years. In the background, you can see him doing real science work.

[50:25] We were just demonstrating the fact that there was a floating mat where there used to be solid ground. This is Ryan's science that he's been sampling for a long time.

**Ryan:** [50:35] Yeah. We've been working on that site with [inaudible]Kala] community and, the Yukon River Inter-Tribal Watershed Council, and some other folks from USGS for 10 years.

[50:47] It's been a pretty dramatic change, especially in Trout Lake, where you've had probably a 30-or-40-percent increase in that active layer, the layer that thaws every year. It's been very impressive and hard to deal with as a community in terms of infrastructure. They have the boardwalks.

**Katie:** [51:04] To Joel's question about, please, remind us how long the projects will run.

**Ryan:** [51:15] This project started in last fall. We're hoping to wrap up in the springtime, about a year and a half. That's the BIA's funding restrictions on that. They may have other opportunities in the future. But for right now, we're trying to compile these synthesis documents of the communities.

[51:40] Then in the springtime, we'll evaluate where to go from there.

**Katie:** [51:45] I want to thank you all, all our presenters and everybody that tuned in today, big thank you to everybody.

**Ryan:** [51:51] Thank you.

**Nancy:** [51:52] Thank you.

**Malinda:** [51:52] Thank you.

**Jeremy:** [51:54] Thank you.

[51:55] [silence]