Intro:

You're listening to Making Waves, fresh ideas and freshwater science. Making waves is a bimonthly podcast where we discuss new ideas and fresh water science and why they matter to you. Making waves is brought to you with support by the society for freshwater science, Arizona State University School of Life Sciences and the University of Washington School of Aquatic and Fishery Sciences.

Eric Moody:

This is Eric Moody with the Making Waves podcast. I'm joined this month by Dr. Sapna Sharma, who is an associate professor at York University in Canada. Thanks for joining me.

Sapna Sharma:

Thank you for having me on your program.

Eric Moody:

A lot of your research has focused on climate change and how it's affecting lakes and in particular, I've done some really interesting work lately on ice cover and lakes and how the duration of ice cover is changing. Before we get into that kind of research, I wanted to just start by asking you if you could talk a little bit about what happens with some of these lakes and colder areas that freeze over. I know a lot of people that I talk to, now that I've lived in Arizona, they don't really know much about lakes freezing over. It's sort of an unusual phenomenon. So could you just talk a little bit about how lakes freeze over and why this is important?

Sapna Sharma:

Sure. So where I'm from in Toronto, we actually ... lakes not freezing over is a weird occurrence. So it's kind of a nice contrast from where you are and where I am. Basically what happens in the winter when temperatures dip below freezing for a while, the lake freezes. So as a limnologist, what we're interested in, and particularly in what respect to climate science is the date that the lake freezes in the winter and then the date that the ice melts off the lake in the spring. The reason we're interested in that is because it can sort of give us an idea of climate change. In winter ice cover is important for, in many aspects ecologically, but also culturally. Culturally it's important and socioeconomically in terms of ice fishing, skating, and recreational activities. For example, living in Canada, we sort of think of winter as being cold.

Sapna Sharma:

Unlike snow on the ground ecologically it seems as if winter ice cover may be a major force in determining characteristics of summer lake warming trends. So this is a recent publication that we conducted with a global link temperature collaboration and we found that the presence of ice cover was actually one of the most important factors on identifying how fast the lake warms and ice covered lakes warm twice as fast as non ice covered lakes, but they're also important in determining productivity. So how productive is a lake? How does that influence nutrient cycling and chlorophyll levels and fish behavior. For example, under the ice in the winter.

Eric Moody:

What are some sources of variation in the duration of ice cover among years?

Sapna Sharma:

So there are three major things that we look for when we look at variation in duration of the timing of ice seasonality. First is weather, so local weather things simple as air temperatures, is it cold enough, precipitation, cloud covers, snow, wind events and solar radiation can all be correlated to ice break up through their influences with climate and lake ice. The second major driver that we've found, and many other studies have found too, that are correlated to lake ice is large scale climate drivers. These include the Southern Oscillation Indices, the North Atlantic oscillation, solar sunspots and the Quasi-Biennial oscillation and all the lower scale climate drivers have been attributed to lake ice break up in the spring. And that's because of their large scale influence on climate. And then the third thing we've found, so once we account for local weather, these oscillations through large scale climate drivers, we found in many lakes that there tends to be the linear trend in the data that we're attributing to climate change.

Eric Moody:

You've argued that the timing and duration advice cover is particularly sensitive to climate change. Is that because of these complex effects of various climatic cycles or are there other factors causing that?

Sapna Sharma:

That's exactly right. So it's like the complex relationship between these large scale climate drivers, but also the local climate and local weather sort of interacting together to influence lake ice.

Eric Moody:

So if something changes somewhere along the way, there could be a lot of complex interactions?

Sapna Sharma:

It seems that way.

Eric Moody:

Yeah. So you've done some really interesting work looking at longterm trends in ice cover. One of the things that's particularly impressed me is some of these data sets that you work with that date back over 500 years. Could you talk a little bit about what these data sets are and how you found them?

Sapna Sharma:

Sure. So the data sets that you're referring to, there's two in particular. There's one from Japan a lake in Japan called Lake Suwa. Its record extends back to 1442 and I'll talk a little bit about how the data was collected. The second is the Torne River in Scandinavia and Finland. That dataset goes back to 1693 and my collaborator Dr. John Magnuson from the University of Wisconsin Madison actually came across these data sets. He was hosting a workshop in the 1990s on lake and river ice and he invited collaborators from around the world. His request was can you bring data sets from your country to our meeting? It was held in Trout Lake in Wisconsin. So to his great surprise, a colleague from Japan brought this over 550 year record and then a colleague from Finland brought this over a 300 year record to this meeting.

Sapna Sharma:

From then, they've made this data public through the National Snow and Ice Data Center and then we can start analyzing it further. But the stories about how these data sets were started being collected is really interesting to me of our Lake Susa. So this lake is in the Japanese Alps and there's a shrine that's located on the lake. The shrine belongs to Shinto priest and Shinto monks and they were really interested in knowing the date that the lake froze because there was this ridge called the Potawatomi that was formed on the ice. The reason they were interested was because their legend, the Shinto legend said that on this lake there once was a god and goddess that lived together in a shrine, but they got into a disagreement and the goddess moved out, moved to the other side of the lake and built herself, her own tribe.

Sapna Sharma:

But then every winter when the lake froze, the god would cross with this dragon and visit the goddess is to ask for forgiveness. The Shinto priest would celebrate this event because the god left the omiwatari, the ridge behind when he crossed the lake. So they would have a purification ceremony that would last several days and they'd celebrate this event and use it to forecast harvest, rice harvest. They found actually, interestingly the years when the Lake does not freeze and the omiwatari was not pregnant, they have very poor rice harvest and those seem to have been correlated with some of the major famines through Japanese history. But they kept all these records and they kept them on rice paper. [inaudible 00:08:18] went to Japan in the 2000s and he met with the priest and gathered all this data through the rice paper records. And even now we work with translators who communicate with the current Shinto priest to get even the latest data. Which is really cool because the Torne river dataset, it was started by Finnish merchants.

Sapna Sharma:

There was a guy who was just interested in knowing when the river ice would melt because it was such a spectacular site. He would record each year when it would melt and there were actually like seven years missing in his record and that was because he had to at leave Finland to escape the Russians that were invading. Then he came back and he kept making the record and then other people started making records and this town where they were maintaining the record, it turned out that they had a newspaper in this town. That helped because then you could keep track of the newspapers when the spectacular event of the river melting happened.

Sapna Sharma:

And now they have these ice breakup guessing competitions where they will get up to the second when the river melts and the Finnish kept really meticulous records of all the different people who recorded the river ice breakup. So you can go back and those records are available and actually seeing all the written documentation of when the river melted. Which is pretty cool because that gives you a sense of climate. But also it gives you a sense of human history because you know all these days like an ice river records go back through centuries.

Eric Moody:

Right. It's amazing to me, not just that people started recording this information so long ago, but that it's survived for such a long amount of time too.

Sapna Sharma:

They started the records and they maintain them through ... like the Shinto records have been maintained through 15 generations of priests being there. There's some dates in the middle of the Japanese records that are missing. They still recorded whether the lake froze or not, and whether there was not much Potawatomi present but they didn't record the date that it happened. I think there might've been some sort of ruling from the emperor who didn't want this information recorded. And so there was a time where they didn't keep as meticulous notes for the Japanese record, but it was still kind of interesting. Another problem we ran into with these datasets was the problem with a calendar change, which I would have never predicted. So the calendar changed from the lunar calendar to a good Gregorian calendar. In Scandinavia they dealt with it pretty systematically. It wasn't straightforward. Their rubric of figuring out converting the dates between the two calendars, but it was just erratic and it was the same throughout the country. Whereas in Japan it wasn't clear.

Sapna Sharma:

Each shrine changed their calendar on their own schedule and they didn't have to follow systematic rules. And so that kind of made it difficult for us when the calendar date changed to actually be sure about in the Shinto shrine when they switched from Lunar to Gregorian. I want rules they used to make the switch. That was a very unexpected problem encountered. So we needed to talk to climate scientists, but also we needed to talk to people who spoke the native language. So we ended up having really different challenges than you might experience working with current ecological data.

Eric Moody:

Yeah, I've heard a lot of stories about problems people have with their data, but that's a new one for me.

Sapna Sharma:

Yeah, definitely.

Eric Moody:

With these incredible records, what kind of things have you found? Have you found any long term trends in ice cover that could be related to climate change.

Sapna Sharma:

Yeah, so we found several major things. First, we found that climate is warming more rapidly, the industrial revolution. This is something that many people have shown using all sorts of records. That's something that we as scientists all are pretty comfortable with knowing. But the reason that it was important to show with these ice records is that these are one of the few climate datasets that have been collected directly by humans. So actual human observations of longterm data extending before the industrial revolution are extremely rare. And there are some people who don't want to rely on paleo records or modeling inferences. So they question whether climate is actually happening or is it sort of an inference from the techniques that we are using to infer a climate change. And so this was direct human observations collected by people who had no knowledge or interest in climate change.

Sapna Sharma:

I think that was one of our main points for the dissemination of our work for climate science in general. The other things that we found was that in the last 50 to 65 years, climate events are becoming more extreme. The example we used for Lake Susa was whether or not the lake froze or not. In the first 250 years of this dataset, the lake did not freeze three times. Whereas in the last 50 years the lake did not freeze 12 times. In the last 10 years it didn't freeze five times. And so something as simple as does the lake freeze or not can give you an indication of climate warming. And we did account for population and geysers in hot springs in the lake and still regardless of all the sort of extra [inaudible 00:14:29] type, an anthropogenic influences, we found where the climate signal was really directly related to these more exchange events.

Sapna Sharma:

One major thing that we found, that I was particularly interested in, was looking at how large scale climate drivers have changed. As I mentioned this record extends before the industrial revolution. So what we could do was compare what the frequencies of these larger scale climate driver were like before the industrial revolution and after. What we found was that before we had evidence of a lot of short term oscillations and longterm multi-decanal oscillations. For example the ENSO El Nino Southern oscillation or North Atlantic oscillation extended in multi-decanal periods and we have a lot of evidence for that. Whereas since the industrial revolution and particularly in the last half century, all those large scale longterm oscillation seemed to be missing from both time series.

Sapna Sharma:

That I found particularly interesting because it seems to suggest there might be a structural change in these large scale climate drivers. It could make sense because for example, and so is a measurement of sea surface temperatures between two regions. But you sort of think of them as being constant and the fact that those are changing may then have fundamental consequences on many aspects of our climate. And so I think that's an area that would be great for a climate scientist to explore on.

Eric Moody:

So let's get back to some of the issues you mentioned about working with the longterm data. You do a lot of work with different types of very large data sets. Do you see particular challenges to doing work with these kind of large data sets?

Sapna Sharma:

So like you said, I work with different kinds of work datasets. So these were different from what I normally work on as these extend really far back in time. They have their own challenges. Others that I work on, we have a lot of spatial coverage and those present a lot of challenges as well because I think the biggest challenge is quality control. So keeping track of all the data, where they're coming from and what sorts of factors may have been at play in a particular year in a particular state. That can be challenging when you're working and synthesizing such large data sets. But I also find that really interesting because you can learn a lot about a place or the people who kept the records or took measurements from these records.

Eric Moody:

You hear a lot about how we're entering this age of big data and more people are doing research with large data sets like this. Do you think that we'll be able to come up with a streamlined process or is this going to always be a challenge?

Sapna Sharma:

I think that's a good question. So it's a big data world is sort of being streamlined into programming everything. So you write some code and you have so much data and the idea is that this code will pick up on some errors. There are a couple old school people on these teams and we really value looking at the data. Even if you're programming and coding, you've missed a ton of things because there might just be a particular site that's not right or the depth isn't the same, or you know there could be any number of things. For example, calendar change and you might not know about that. Even in the age of big data, I think it's really important to look at your Excel sheets and plotting your data. Just getting a sense of what is actually in there. When you start working in this big data realm and processing a ton of data, it can be easier to miss things.

Eric Moody:

Thanks a lot for joining me then.

Sapna Sharma:

Oh, thank you for your interest in our work.

Outro:

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