UC GIS Week
Thursday, November 21, 2024
1 PM – 2 MM
Ecology: Seed Collection, Desert Fires, and Tropical Lagoons

Sessions:

Welcome everyone to the next to last session of UC GIS Week. Can't believe it's here already.

This session promises to be another great one just like the ones we've had up till now. The theme is ecology and we have sessions on presentations on seed collection, desert fires and tropical lagoons. So I'm looking forward to all of those. Those will each be about 15 minutes long. We'll save questions until the end after all speakers have gone, but you are welcome to put your questions in the chat at any time. And then we can get to discussions at the last several minutes of this hour. So yeah, and I hope you've enjoyed the other sessions if you've had a chance. We have a mapathon that's still gonna go on for the rest of the week. And we also have a Slack channel for you to join and a gallery to look at. So lots of things to help everybody celebrate UC GIS Week.

But without any further ado, I think we'll get going with Clancy McConnell from UC Davis and Clancy when you're ready. Take it away.

I can seed clearly now: A GIS triage protocol for prioritizing areas for seed collection efforts

Speaker: Clancy McConnell – UC Davis

Abstract:

Climate change and wildfire are increasing, stressing limited reforestation seed supplies. Tree stands at low elevation and southern latitudes with hot conditions are potentially both at the highest risk and contain the most climate change-adapted seeds. We present a partially-automated GIS framework to guide seed scouting for tree species in California. Its intended use is to identify areas at the highest risk of extirpation and with the least representation in CalFire's current seedbank.

We begin by creating new, highly-accurate species range maps (see my other presentation this week) and intersecting each with “seed zones and elevation bands” (SZEBs), used for cataloging the state’s seed lots and reforestation efforts. Next, we combined place-based climate change exposure, processed using principal components analysis in RStudio, and potential wildfire intensity indices to rank-order risk each SZEB’s range area. We combined three measures of priority for CalFire’s nursery operations—current inventory, target seed supplies, and areas of high seed demand—as an operational priority ranking, and combined this metric with the two SZEB risk metrics to identify overall scouting priority areas. We used summed road length in each SZEB as a measure of accessibility, but precise seed survey routes and annual assessments of seed production could provide more comprehensive information about accessibility over time.

The outputs from this workflow are then combined with outputs from the climate-adapted seed tool (CAST), which helps identify optimal climate-adapted seed mixtures by SZEB, and the mast inference and prediction tool (MASTIF), which attempts to predict optimal seed production seasons, to inform seed scouting and reforestation. The applied use of this framework is already underway in the state of California.

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Yeah, thank you.

Hi, I'm Clancy. I'm a postdoc at UC Davis. And I am gonna be presenting the sort of the second half of the big project that I'm working on right now. Some of you might've attended a talk I gave earlier this week about range map building. And that is where I'm gonna pick up at the end of that. So the first half is sort of building the range maps. And then today we're showing you the rest of what we're doing.

I spent a little bit of time thinking about, okay, what do I want to do for the title of this talk? And I came up with all kinds of cheesy titles and this is what I landed on. But I think it puts it all in a nutshell.

And that is that we're prioritizing areas to collect seeds for reforestation, primarily reforestation after fire. So I'll try to give you the synopsis of that today.

So our forests are under a lot of pressure. A lot of people are pretty aware of it. Even if you just live in California, you know, wildfires, they've been in the news, been all in the air the last four or five years. Even actually back to 2017, we've had some pretty major fires that have affected people.

Fire suppression has enhanced that. We've got bark beetle infestations, localized droughts, statewide droughts. The list goes on and on. So our forests are under a lot of pressure and it's not just conifer forests. We're dealing with diseases, sudden oak death along the coast range in Tan Oak and Bay Laurel, a whole bunch of species. So our trees are under pressure, our forests are under pressure and we need to reforest. And the way that that's done currently is first, you'd send a team out. This would be from perhaps a state agency like CAL FIRE that would go out and survey where the optimal sites are for collecting seeds. This might be where there are a lot of really good productive seeds from trees. They try to enhance diversity they collect in by elevation and seed zone to ensure that there's local adaptation. And then it runs through the rest of the process where those seeds are stored until they're needed and then they're grown. And that's sort of the process right now and it's a little bit antiquated. We still use this process to collect and store and grow seeds, but as far as how we prioritize areas for restoration and how we use seed from different areas, that process is changing. And one of the reasons that we need to change that process is because of climate change. We can't any longer just think about, even if you're a traditional ecologist, we can't anymore just think about taking localized seed. We have to think about pulling seeds from areas that are perhaps a little bit more drought adapted. Even in one species, this is ponderosa pine in the image in the upper right.

Its historic range has already retracted a certain amount. This is based off of real vegetation data just over the last 90 years. In 90 years, we've already moved up slope. A couple of elevation bands is pretty worrying and we're already past the,

we're not just gonna break the Paris Accord. We're actually emitting more carbon now than we've ever emitted as an entire planet. And we're surpassing the worst representative concentration pathway, the 8.5.

Climate change is gonna be severe is the point. We've already seen significant change. So we need to do something about this. And we need to really ask ourselves, what can we do to help tree species adapt? What can we do to make sure our forests are robust, resilient, healthy in the future? And there are a couple of ways we can do that.

The first top part here I just wanna emphasize is focused on adaptation. This is primarily genetic. We can focus our efforts in the parts of ranges that might be most exposed to climate change. And then the second part might be, okay, we're gonna use a site specific mix of seeds. That means we might be pulling seeds from further south, perhaps lower elevation, maybe a little bit more drought adapted, or maybe we need to use some kind of genetically optimal mix of seeds at a certain site. And the science is getting pretty complex on that. And one example is I put it here, it's the CAST tool, Climate Adapted Seed tool. And that does exactly that. It's trying to identify what's the optimal mix for a specific location to reforest. And then the second part, and our project is working on both of these, is like, how can we do this in the most effective way possible? And that is a number of different things. We can focus on areas that are at highest fire risk. That means that it hasn't burned in a long time. There's a lot of fuel load. We can identify those areas. We have data for that. We can also incorporate where we have seed for, and where we don't have seed for. So we're calling that operational priority. We have that data. And we're developing metrics to actually help identify sites that are most accessible to surveyors. That way we're not sending people out where there are no roads or where the terrain is really steep. We wanna send them where it's accessible and it's gonna be the most efficient seed collection crew. And then the last little line there says, okay, maybe we need to send people out during specific years. And anyone who is a botanist in California knows all about masting. We're actually having a masting year for oaks,

a lot of oaks in California where they're producing a bumper crop. It's just a huge crop of seeds. And if we can send people out in years where there's a masting year, a big crop year, that'll be really effective. And so putting all of this together, climate exposure, fire risk, and operational priority, those three primary things, we call that a triage assessment.

I'm gonna skip over this slide, primarily semantics. And the workflow for putting these three things together, number one, we need a really good range map. We need a really good range map in order to do our climate exposure. And that's what I demonstrated on Tuesday. So we'll pick up there. And then the next three steps, we analyze the climate exposure. I'll show you that.

By the zones that we use to collect seed, those are called seed zone elevation bands. Then we assess the exposure. What's the climate exposure? What's the fire risk? And then we add in another layer for our GIS analysis. Where do we need seed? Where don't we have seed for? Where are the areas where we think that we'll need a lot of seed?

Number one, species range map. I left off here on Tuesday. This slide should look familiar. We go through a complicated process to build these really accurate, the most accurate species range maps ever made for California. And we end with this map on the right, this final range map, highly detailed rasterized map. And we put that into principal components analysis using climate models.

These are global climate models and then we downscale them for California.

And forgive me again, I'm actually gonna skip this slide because I think this next one is a little bit more demonstrative. We took that script that was developed about 10 years ago, revamped it, and I'm now testing it on a couple species. One of those is Coast Redwood here. So we have a nice range map for Coast Redwood. That's the red. Say you have about 17,000 acres of historic range. It falls in 148 seed zone elevation band units.

And within that, we sample 100,000 points.

Sample 100,000 points within that. We develop a climate space for that species. That's what the contours are around the points on the chart here on the far left. And all those little red points you see are those that fall outside of the 99th percentile. So we get kind of this core climate, historic climate space for the species. And then we do a place-based climate exposure analysis. That means we're not predicting where the species is gonna end up. We just wanna identify how does the risk change on a cell by cell basis within the existing range? As many people know, trees don't move that fast. They're not gonna move nearly as fast as climate changes. And our jurisdictional boundaries aren't changing. We need to know how to manage the species where they are now. And so that's kind of the idea with this place-based analysis. And then the three charts on the right show our three different times in the future. One is kind of the current period up to 2040, and then a 20-year period, 30-year period, and then a final 30-year end period. And we can see how the climate space changes, or at least how the distribution of that climate space changes over time relative to the historic range. Once we do that, and then I just have it here mapped out, we get an idea of where some of the source spots, some of the sticking points for that species going forward.

You know, because redwood is actually somewhat interesting because we have this climate exposure on the far left in the historic period, and we move to the current period, and we actually have a fair amount of exposure in the top part, in the northern part of the range, and exposure all the way up to about 2070 in the area just south of Monterey. We're kind of thinking that that's likely due to the mid-century drought that's part of the climate model that we're using, that we used for this analysis, which was myROC5. We've since updated that. And then on the far right, we start to identify areas that might serve as climate refugia, specifically here Mendocino County, and then part of Humboldt County.

So once we've done that, we then are able to overlay our seed zone elevation bands. We get an idea of which of those boundaries, because again, those are the formal CAL FIRE boundaries for collecting seeds, are the most exposed, which ones might have the least exposure, and we can start to prioritize that.

I'm actually gonna skip a few of these in the interest of time. I see I just have a few more minutes here. We're doing this for about 21, 20 species right now. That's our current one. The next step after we've done the climate exposure analysis is to put those into the seed zone elevation bands and assess, we pull some of these out.

Pull out some parts of the distribution that are really cold and wet. Those aren't as concerned. We wanna get the riskiest ones, the most exposed.

We pull those out. We also pull out on the bottom here, bottom left. This is burn severity.

We're gonna not send people to areas where there's been a big fire in the last few years. So we pull out areas that have had high burn severity.

We assess the fire risk by seed zone elevation band, and this map is for ponderosa pine. So where are the areas that might have a high risk fire, or high, sorry, high intensity fire in the future, high risk of a high intensity fire. And that would remove all of the seeds. So we wanna prioritize those areas for collecting seeds. That way we don't lose those seeds for the next 30, 40, 50 years.

And then the last step, we assess operational priority. This is pretty much supply and demand. Again, this is all for ponderosa pine. We haven't gotten this far yet with other species.

And we have a projected demand from low to high, and almost all of the state is pretty high demand. And that's just because we've had so many severe fires. We need a lot of seed. Our current supply from high, gray to none, very low. Again, we have very low seed supply. That's a problem in and of itself. We're able to combine these together into an operational priority graph on the right. We put all this together into combined risk. This is climate and fire, operational priority, supply and demand, and then put that into a combined ranking. And that gives us an idea of where to send people for our seed collection.

So the folks that put this together, led by all the work that I'm building off of, it was led by postdoc Jesse Godfrey. And there's a whole team of folks behind this. I'm in Jim Thorne's lab. And this is funded in part initially by a grant from CAL FIRE. And the grant that I'm on is a climate adaptation seed grant from a university office of the president for the Applied Climate Science Initiative.

And I think that's where I should end off. So thanks.

Thank you, Clancy.

Very interesting talk. Thank you for all of that.

Next up, we have Danelle, who is going to talk to us about the plants in the desert that have been exposed to fire. So Danelle, if you are ready, we're ready for you. Okay, I was just looking for my window, turn on my camera here.

Fire in the Desert: A Study of Yucca Survival in Mojave

Speaker: Danelle Baronia – UC Riverside

Abstract:

Following the 2020 Cima Dome fire, see how the unique vegetation landscape of the Mojave National Preserve has changed over time. California is home to thousands of unique plant and wildlife species that can't be found anywhere else in the world. In effort to protect such amazing biodiversity, Mojave National Preserve is located in Southern California. When the 2020 Cima Dome fire burned 44,000 acres of Joshua tree forest woodland within the Preserve, it had a substantial impact on the ecosystem.

UC Riverside researcher Danelle Baronia will present an interactive StoryMap that showcases a comparison of pre- and post- fire photo documentation of the Cima Dome landscape. She will discuss the results of research from the Sweet Lab studying the recovery and resilience of desert plants, focusing on two species of yucca, the Eastern Joshua tree and banana yucca, within the ecosystem of the Mojave Desert.

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So moving on from talking about fire and ponderosa pine, we can talk about fire in the desert, which is what my project is on. Hi, I'm Danelle Baronia. I'm from UC Riverside within the Center for Conservation Biology's, Dr. Sweet's lab. And this is going to be a story map that we created in collaboration for our project in the Mojave Desert, looking at the vegetation recovery of fire that happened in the Mojave Preserve in 2020.

And I made this story map. The research is by my lab, Dr. Mansweet, Melanie Davis, and Scott Hecox, all from the Sweet Lab, as well as Tasha Ledue from the Granite Mountains Reserve with UC NRS, and Dr. Joseph McAuliffe of the Desert Botanical Garden.

So I wanted to start with just introducing you to the Mojave Desert. As we all know, the California is a huge biodiversity hotspot and things like the Mojave National Preserve are created to protect such amazing biodiversity. It is managed by the National Park Service, and it protects cultural resources from both the past and present of the original indigenous stewards of the land, as well as a wide range of the natural landscapes.

And so I just wanted to do a quick land acknowledgement. We would like to acknowledge and recognize our responsibility to the original and current caretakers of this land, water, and air, the Chambewawee, the Southern Paiute, the Western Chichone, and the Mojave peoples, and all of their ancestors and descendants, past, present, and future. We're very grateful to be able to work on these lands. And so while my colleagues were out on the field, they made a bunch of beautiful observations. We have a Chacawala here, a desert tortoise, and a Desert Marigold Moth on a Desert Marigold.

And so just before we go into it, this should be available in the UC GIS Gallery. If you'd like to follow along, it'll be right here, if someone can jump that into the chat.

And I also have a QR code in case people wanted to follow along or share it with others after the presentation.

But moving on,

so we can look at the Mojave National Preserve and look a little bit closer into the Cima Dome. So that would be around, I wanna say, this area here.

The Cima Dome is a large granite mass that's covered with what's known to be the largest Joshua Tree with land forests in the world. We're going to be looking at the Eastern Joshua Tree, Yaka Yagiriana, and the Banana Yaka Yaka Bekata. And both of these were found in great numbers before the area burned in 2020.

So this is going to be an Eastern Joshua Tree here,

and this is going to be the Banana Yaka.

So the 2020 Dome Fire caused a huge impact on the Cima Dome. It struck when lightning struck on the Dome on August 15, 2020. That fire was around 44,000 acres of land and it lasted about three days until rain and firefighting efforts were able to put out the blaze.

And so this actually gave us an opportunity to study the recovery of the vegetation within the Mojave National Natural Preserve. So it's generally known that vegetation on the preserve does not readily recover from large and intense wildfires. We're still investigating the fire history, however, it's believed that there are going to be larger, more higher intense, and more constant fires with the frequency of summer monsoonal storms, climate change, and the invasion of non-native grasses.

It's like here we have a photo, the left three, or we have a couple photos, the left three here are going to be Eastern Joshua Trees that were affected by the Cima Dome Fire, and then here on the right is going to be different banana yucca that have been affected by the Cima Dome Fire.

So like I said, we took this as an opportunity to learn. We wanted to know how wildfire influences both the distribution and the composition of the vegetation at the preserve today. We looked at banana yucca, which is known to be widely distributed and common in fire adapted communities, as well as Joshua Trees,

which are known to have a more limited geographic range and lower survivorship after fire.

And so we had a lot of different objectives with this project. We wanted to continue long-term repeat photographs that were taken for this project. We wanted to begin a demographic study for the yucca species and understand yucca survival and fire response to informed management and conservation.

But today we're going to focus on one of those objectives, which was that we were able to create a publicly accessible story map that was for both conservation and science communication.

And so I'm not going to focus too much on this timeline, but it is an interesting way to look at how this project was developed. It actually started all the way in 1992 when Dr. Joseph McCollough was taking photos at the Cima Dome and it was part of his ongoing research in desert plant ecology. So this is one of the first photos that we're taking at one of the sites. It was 2016.

And then after the fire struck, he actually saw that as an opportunity to capture the immediate damage that was caused by the fire. That's 2020. And then after that, he worked in collaboration alongside our lab with UCRCCB to both take photos and also take initial measurements of the Eastern Joshua trees and banana yucca.

So this is one was taken by us in 2022 in the same plot. And this is 2023.

And then just to give you guys a better idea of that drastic change, this is 2016. And this is 2020 immediately after the fire.

So thinking about on the field, I unfortunately was not part of the lab when they first started this project and they were able to go to the field, but there was a couple pieces of data that were taken when they were on the field. They recorded survivorship of the Eastern Joshua trees and banana yucca plants during those surveys. And the way that they recorded that was looking at whether or not the Joshua trees had live parent terminal ends. So these ends here on the tree would be those parent terminal ends, as well as whether they had basal sprouts at the base of the tree. And then for banana yucca, it was to see if they had live rosettes. And so here are a couple of my colleagues and collaborators. They're measuring the height of a Joshua tree that was left badly damaged from the fire.

And so thinking about how we established these plots, we have a map here that shows the perimeter of the burn area. That's the 44,000 acres. And then each red ring here would be a different plot that we established. We took site photos at 19 different sites across the SEMA Dome. And we were able to use an NPS vegetation map that classified our plots according to three different community types. We stratified the landscape using the vegetation map, as well as elevation and proximity to our existing plots. And we use a random point generator to create control plots where we were able to measure unburned vegetation.

And so really the meat of this project and the story map is going to be this map tour that I created. It's a visual transformation that shows all of the photos that were captured of the plots. And it's meant to be used to explore at your own pace. So I'm not going to be able to go through all of it for interest of time right now, but we have these 19 different plots that we established and each of them have photos that are taken across time. So we have pre vegetation photos or pre fire photos,

post fire photos, and then a couple of years after the fire to document the recovery. And then alongside each photo, we also have measurements of the survivorship rate of both the Eastern Joshua Tree and the Banana Yeca. So right now, what I wanted to look at was maybe something that was in the middle of the burn area. So SEMA 06, that's one of our plots.

And this is going to be a photo that Dr. McAuliffe took in 2013. You can see here that pre fire vegetation included Joshua trees here, black brush, we had Banana Yeca. You can see a couple of those individuals here. And ephedra, we had Buckhorn Toya

and just other perennial species. It was very much a lush vegetative landscape. And then we can look at this immediate effect after the fire.

And then throughout the years, this would be fall of 2022 when we took this photo and that's basically when we started our survey recording survivorship. You can actually see some of the Banana Yeca have recovered here in this photo and then 2023 in spring.

And so alongside that, you can see that their present survivorship of the Eastern Joshua tree was 46.5% for this plot. And Banana Yeca had much higher survival, so actually 90.9% survived. And some ways that I would recommend looking through this map tour would definitely be to look one at the different geographic locations of these plots. So we have some that are closer to the edge of the burn. So something like here, SEMA 30, that would be at the roadside at the very edge of the burn versus something that's very much in the middle of the burn. You can also look through it to see maybe the different vegetative communities and just see how maybe those look pre-fire and compare how they were affected by the fire.

So significant findings. Overall, we found significantly higher survival in Banana Yeca, that was 66%.

And that is unsurprising compared to the Eastern Joshua tree, which was only 18% 2.5 years post-fire because we know that they're more common in those fire adaptive communities.

We documented an average of eight surviving Joshua trees per acre and 30 per acre for the Banana Yeca.

And then of all those surviving Joshua trees, only three survived to the branch tips and that actually makes them important to see bearing trees in the short-term future.

And so we are lacking for scarce cover for seedlings and the seed supply to germinate and thrive in the open. So we do recommend that protecting resprouting trees is especially important for this landscape.

And so here we have a photo, it's an example of a resprouted tree that's happened 2.5 years after the SEMA dome fire. So it's a bit of hope in that story. So looking to the future, we're not really done with this project yet. It's very important for us to understand how vulnerable species respond to the fires. And we are working with land managers at NPS to understand what to expect following the 2020 SEMA dome fire. We see signs of promise as we see trees resprout and we are hoping that all of this information can help guide those active planting efforts under way at the Mojave National Preserve. We're also looking into things like whether burnt severity affected, whether or not a tree would recover post-fire as well as whether the height of a Joshua tree has, is affected by,

can affect their survivorship after the fire. And so this is actually a photo that we have of a flowering Eastern Joshua tree that was within the plot area. So there are some signs of hope.

And then so thinking about this as a science communication tool, we wanted to also provide other resources that users can look at. So we have this video that we've embedded that's created by NPS that looks more at the SEMA dome fire. You can watch it and basically understand

more about what they're doing on the park end as well as see more footage of the fire. They also have an article that they've published and we've included our lab website in which we share more about what we do with conservation, applied ecology and a bunch of free resources that our lab creates for outreach and education.

And so just acknowledgments and credits. I created this story map. The research, like I said, was done by my lab and in collaboration with Tashla doo and Dr. Joseph McAuliffe. And we also want to thank Dr. Deborah Houston and the staff at the Mojave National Preserve. We want to thank other collaborators such as Dr. Clay Noss, Dr. Sydney Glassman and Dr. Fabiola Polito Chavez.

And this work was permitted and funded by the National Park Service within the Mojave National Preserve.

And I think that'll be it for me.

Thanks very much, Danelle. Yeah. Yeah, great presentation. Thank you.

Yeah, so we have one more to go before we have time for questions at the end and that will be from Christian John.

So Christian, whenever you're ready.

Nearshore nutrient regimes link land use to tropical lagoon microbial communities

Speaker: Christian John - UC Santa Barbara

Abstract:

Coral reefs provide coastal protection, subsidize food, and harbor biodiversity in coastal waters of tropical islands around the globe. Corals are sensitive to rising ocean temperatures, but other anthropogenic factors such as nutrient pollution (via, e.g., fertilizer runoff) interact with warming to impact coral bleaching. Here, we describe the results of a multiyear monitoring effort to uncover how terrestrial factors impact the nutrient dynamics and microbial communities in lagoons of Moorea, French Polynesia. We combine in situ field sampling, remote sensing techniques, and geospatial analyses to connect watershed parameters on land with biotic variability in lagoons. We show that reefs that are close to shore and downstream of large, human-impacted watersheds have higher water column nutrients, and that algae samples in these sites have similarly elevated nutrient concentrations. Furthermore, nearshore, “fringing reef” habitats are home to unique microbial communities not found in lagoon sites that are more isolated from terrestrial human influences. This work demonstrates the importance of land-sea connections for coral reef ecology, and hints at broader pathways by which human impacts may drive change in tropical marine ecosystems.

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Oh, you're muted.

Of course I'm muted. All right, we're good to go. We're good. Super.

Hi everybody, I'm Christian. Thanks for having me here today. I'm gonna be sharing some work that I've been doing with my postdoc research out of the Burkepile Lab at UC Santa Barbara and with the Moorea Coral Reef Long-term Ecological Research Station.

So my background is in terrestrial ecology and I actually got hired for this job because I had experience working with remote sensing data and they were looking for someone to come work with a bunch of marine biologists to help unpack some of the land-sea connections that are occurring in Mo'orea where they have this long-term ecology research going on. And so Mo'orea is an island in the South Pacific. It's right next to Tahiti, which is the larger island that you can see on the right here. Mo'orea on the left is, it's a smaller island, but it's very well studied in terms of its coral reef ecology. So there's a UC owned research station there called the Gump Research Station and it's kind of on the North shore of the island. It's highlighted with the star up here. And that is where I get to go twice a year to do marine biology research.

From the North shore of the island, this is kind of what the lagoons look like. So there's this area between the shore of the island and the reef crest where the waves are breaking. And it's generally one to two meters deep water with a thriving coral reef community, lots of fish.

And very important for the people there, obviously it provides coastal protection, but it's also providing food subsidies

and it's culturally and spiritually very important as well.

But as you can see that everything that's in this lagoon scene is downstream of something on land. And there's a huge variety of different land uses across the island of Mo'orea. And so that's what we're gonna be talking about today. So I'll start out talking just a little bit about the land use and the climate on the island and how those are related to chemistry of the rivers. And then I'll link that more broadly to the nutrients and microbial communities that we're finding in the lagoon waters.

So to start off with land use, I've been working with a bunch of really amazing fine scale satellite data. So I get to work with the Worldview2 satellite images, which are, they're like one and a half meter pixels. They're super, super fine scale. And the products are so fine scale in fact that we have to correct for terrain when we're doing anything with repeated imaging because the mountains on the island are so steep that small differences in where the satellite is oriented

make a really big difference for how pixels appear in sort of a flattened image.

So I used a bunch of imagery from 2018 and paired this with some data provided by the French government during a 2012 census on land and they had this really fine scale survey of land use.

And I used that for some training data to predict land use on the island more recently. Because it was older vector census data, there was a lot of correcting that needed to be done. There were a lot of houses that no longer existed in 2018. There were a lot of houses that appeared by 2018. So there was a lot of like manual labor that went into the back end of this. But ultimately this is the classification map that we came up with. So this is obviously just one subset of the island.

But you can see the forests, kind of the dense forest in the center of the image is well highlighted.

And the monoculture of pineapple plantations on the east and west side of the images also come out really clearly. We can see the dirt areas got highlighted very obviously as dirt buildings are shown in red and then other various and sundry types of land clearing are in pale green here. We did this classification with a ResNet-50 model in ArcGIS Pro.

There was, let's see, there were like 20 epochs of training. We can talk about the details of that if people want later. But it did have a pretty good accuracy overall. In particular, the model almost always called forested area forest and it almost called, it almost always called buffer and agricultural area, buffered and agricultural area. And so the interest of being kind of granular with our approach, but not too granular, we took the classes that we were really confident about, so forest and basically non forested, and then broke those out and looked at how they looked across the island as a whole.

And so this is what the island looks like. And we're gonna have a little fly by here looking through some different aspects of the island. So right now we're flying up a pool and a who bay, which is on the sort of Northwest side of the island. And you can see around the West side, that there's a lot of forest.

There's not a ton of land clearing and the watersheds are very small and very steep. So you can imagine there's not a ton of opportunity for development. You're not gonna put a house on like a 60 degree slope if there's tropical cyclones that come through once a year.

And coming around the East side, there's some more flatlands in these larger watersheds and there's a little bit more human development. We're gonna see the airport here on the Northeast tip of the island in a second. There, you can see it coming by. And then finally, we'll zoom back into the central caldera of the island through Cook's Bay. And we can see it's quite flat in the center and that's where a lot of the agriculture is taking place. So everything that's highlighted in orange there is some sort of monoculture. It's typically pineapple plantations, but there's some sugar cane as well. And it's gonna switch to regular imagery. So you can see that there's a lot of water in the next regular imagery. So you can see what that looks like as we zoom back out with the total scale of the island.

And so my colleague, Kyle Newman, went out during four different sampling seasons between the beginning of 2018 and the end of 2019. And he collected weekly river samples at 16 different rivers on the island

during the rainiest part and the driest part of the year. So on the right, you can see the seasonal precipitation, the pattern and highlighted in blue and gold are his sampling timeframes.

And so we paired the precipitation data with some river chemistry data that Kyle was collecting to look at how land use impacts different river chemistry attributes. So on the top, we can see dissolved inorganic nitrogen was higher in large cleared watersheds during the rainy season. And on the bottom, we can see total suspended solids were also higher during the rainy season.

So we separated the river chemistry data into more of a community analysis, like you would do with ecology, to look at how different samples are different from each other. And we found that some water samples contained more total suspended solids. So they load more positively on the top right of the graph. And some samples had more dissolved inorganic nitrogen. So they loaded toward the top left of the graph. And we can associate these sampling measurements with continuous environmental variables. And what we found was that recent precipitation, that is precipitation in the last three days alongside cleared land were the most two important environmental variables explaining differences in water chemistry. And so we know that from these results, we can say precipitation, which is seasonal, is really important in moderating terrestrial efflux into the lagoons by way of rivers.

So next, we'll look at some differences in the habitats of the lagoons around the island and how these different terrestrial factors play a role in the nutrients and microbial communities of these nearshore habitats.

So if you got into the water right on shore and started swimming seaward, you would begin by snorkeling over what's called fringing reef. And this is reef that abuts the shoreline. It's generally in very shallow water. It's often pretty silty or sediment rich. It can be hard to see through.

And as you can imagine, it's most immediately impacted by terrestrial factors.

As you go further and further offshore, you'll find yourself in a back reef habitat, which is much more structurally complex. It looks like you're classic, like finding nemosine.

And then you'll hit a certain point where the reef is actually at its shallowest. And this is called the reef crest. It's where waves crash. And the reef crest is broken by reef passes, just like a mountain pass. These are areas where the reef dunks down really deep into the water. Boats can come and go through those. That's also where Olympic surfing happens.

And then finally, beyond the reef crest is the much deeper fore reef. And I've also gotten to do some work on the fore reef as part of this job, but I'm not gonna talk about that today.

So we wanted to understand how these nutrient and microbial communities varied by habitat around the islands of lagoons. And so in 2016, my lab started collecting data from almost 200 sites, visiting site by site. Each day you get to like 11 or 12, you spend a week or two just boating around the island to like that picture in the top right.

It really makes months of fighting with ArcGIS Pro worth it. And so we go around the island and we collect turbinaria samples. Turbinaria are these macroalgae you can see on the bottom right image. They integrate excess nitrogen from the water column. So we use them as an index of long-term nutrient enrichment. We also collect water chemistry samples and water microbial samples.

And we see that nutrients are most enriched nearest the shore as we might expect. So the fringing reef habitats in panels B and C here are those near shore ones and they have higher nitrogen in the macroalgae tissue. And they also have the highest water column nitrogen compared to back reef and reef crest sites. Bays are also generally enriched with nitrogen and nitrites because they're where like most of the agriculture is spilling into.

We also see that at the level of the site, our long-term nutrient integrator, turbinaria is generally predictive of water column nutrients.

And so we were interested in asking like, how does nutrient enrichment vary spatially in these lagoons after accounting for some of these factors that we expect to be driving nutrient enrichment? So we regressed the turbinaria nutrients against distance from shore and accounted for that and then took the residual variation from that regression and creaked it to look at where there are nutrient hotspots in the lagoons of Moraya. And so those are shown in brown here. You can see on the west side of the southern tip of the island, there's a really dark brown spot kind of centrally on the east side of the island. There's another and then extending out from the western Poonahue Bay on the north side of the island. These are all places that are generally kind of enriched with nitrogen.

And so we wanted to ask why, why are these places more nutrient rich than others?

And so we took each of our sampling locations

and calculated the shoreline around a hundred meters around the nearest point on shore. And for each sampling location, we were then able to delineate a relevant watershed

and we were able to ask what does the land use in that watershed look like?

And then we broke our lagoon water chemistry data out just like we did with the river chemistry data and found that sites that are enriched with nutrients in the water chemistry data also generally have enriched turbinaria nitrogen, which is kind of that relationship that we showed before, but this is now in multivariate space. And we showed that that is closely associated with cleared area of the upstream watershed and it's negatively associated with distance from shore, which is also something that we had already showed but is now shown in multivariate space.

And finally, we asked how these patterns play out with microbial communities. Microbes are really important not just for like coral wellbeing, they're also important for broader

community or ecosystem level processes and lagoons from decomposition to respiration and lots of important carbon and nitrogen flux systems. And what we found is that the nutrient enrichment that we see in our macroalgae data is super evident in patterns of microbial community diversity. So what I want you specifically to look at here is in the bottom three panels of this slide, there is a lot of overlap amongst the different colored points being our microbial communities, but there are regions where there's only red points. And what that means is that some of these fringing reef sites have novel microbial communities that aren't seen in other waters in the lagoons. And those points are associated with increased nutrients. We know that these are coming from terrestrial sources based on our water column data. And now we're seeing that they're actually important for how microbial communities are distributed across the lagoons as well.

So taken together, these results show that terrestrial factors are important for lagoon water chemistry and microbial communities together.

So in the future, these waters are gonna warm and precipitation forecasts are uncertain for the South Pacific, but they could go either way. But either way, we know precipitation is important for how terrestrial factors are ending up

affecting lagoon ecosystem communities. And so it's gonna be important to see like exactly what plays out in the coming years so we can better predict what's gonna play out in the coming century. So with that, I'd like to thank my lab and lots of colleagues, data providers and funders, and in particular, Kristi Lao from the DREAM Lab at UCSB Library has been so helpful with lots of geospatial stuff. So thanks a lot, Kristi, and everyone else who's shown here. And with that, I'm happy to take any questions.

Thank you, Christian.

Q&A

So let's see if anybody attending has questions for any of our presenters.

I saw that there was one in the chat earlier, but I believe that might've gotten answered.

So the one for Clancy, it looks like...

Clancy answered that. Is there any elaboration that you'd like to make on that? That point?

I suppose I could. I mean, it is a broader question about, and a lot of people are concerned about it, that we're gonna be collecting all these seeds and moving them fast distances and reforesting. So we are determining the future genetic makeup of all of our forests, and it's just inevitable. So we have to adapt or lose them.

Yeah, I had a question that might be just very much coming from a person who doesn't know much about botany. But I was wondering if there's qualities of the seeds from a particular species. Does the quality vary depending on where they're coming from? Whereas a ponderose pine seed, the same, whether you're harvesting it way up north or way down south, that kind of thing. Yeah, that's another good question about seed viability is the term that they use. And I'm not a tree physiologist, but I've heard some folks around me discuss it. And yes, there are populations of each species where there are much more viable seeds in certain areas than others.

For example, I know that Coast Redwood, there are pockets that have highly viable seeds and some pockets have very low viability seeds. And there's not a good reason for it, but they do know that it's based in some of the genetics.

So which makes it even more, that might be a factor, another factor that could be incorporated into prioritizing areas. There's a pocket of highly viable seeds down near Monterey, or sorry, Santa Cruz. And if we lose that pocket in a big fire, that could be a huge blow to reforestation efforts.

Thank you. I see there's a question for Danelle in the chat. I don't know if you've seen it, Danelle. Is there a massive movement to collect all seeds, catalog them, store them for when fires happen? Because it seems they are unfortunately inevitable.

Yes.

So within the Cima Dome Fire area, replanting Joshua trees has been a high priority for the park. There's been seed collecting trips for volunteers. I believe that it's currently ongoing. So if anyone wants to go do those replanting efforts, I definitely recommend looking that up. I believe that they take volunteers just from the public. And they've been able to collect maybe around 500k seeds. It's been funded by the bipartisan infrastructure law. And so yes, that's definitely a huge effort on their parts.

And a question I thought of for you is, you touched on it briefly about what might influence survival rates for particular species. Like you said, maybe the height of a Joshua tree had some connection with how well they survived the fire. But I was wondering if there's other things that are being speculated about that we may be explaining.

So we've been looking into that. It's something that we unfortunately haven't been able to incorporate into our story map as of yet, because this data is unpublished and we want to kind of keep that under wraps for a bit until those publications are out there. But in terms of what we have been studying, so for example, like you said, height of a Joshua tree and whether or not that's going to influence its recovery after fire, we found that it doesn't have any effect. However, we have done burn severity measurements for each of the Joshua trees going from zero. So that means that it's hardly affected by the fire at all to six, which meant that the tree trunk was actually hollowed out and felled by the fire. And we have noticed that whether the burn severity, the height of the burn severity as expected,

immediately after the fire, the less likely it is to survive and recover from the fire.

OK, great. And was there a wide variety, like the percentage of survival rate? Anything? Yeah, so... For either of the species?

So it was generally found that the banana yucca were able to survive more readily and recover more readily from the fire. We did find that the Eastern Joshua tree survivorship rates were very similar to other measurements taken with Western Joshua tree survivorship rates. So it does seem to be quite consistent.

Thank you. Thank you.

And then we also have a question for Christian in the chat. I don't know if you were able to see that one, Christian.

Yeah, so someone asked if farmers that use the land are aware of the relationship between land and sea, and specifically because oftentimes populations are aware and may not use the same language, but have generational or ancestral knowledge. And if so, what have they taught us, slash our research team?

And yeah, I mean, in terms of what have people there taught us, I could talk for hours about that. It's just amazing to hear the depth and breadth of knowledge that people there have and could really go on with how that's impacted our research. But to answer the questions most specifically,

yeah, people are very aware of the connection between land and sea, and that's a research priority that people there have asked our research team to explore, because people really want to develop a better understanding of how exactly land use is impacting the lagoons, and not just things like microbial communities, but what that means for fishing and what that means for the corals themselves.

And I think that today I talked at kind of a broad level about, you know, watersheds with a lot of cleared area and those are associated with increased nutrients, but people have different land use practices and those practices are changing by the day.

I think permaculture is becoming an increasingly popular way of producing food. And as you can imagine, that has really big impacts on how water is running off of land. If there's a variety of crops and a diversity of topography versus a wide open field, those have hydrologically very different impacts.

The other thing is we're trying to develop a better understanding of how other economically viable practices could go hand in hand with land use to better control the flow of things from land to sea. So for example, taro is a crop that is a fiber and a food source.

And, you know, planting a row of taro as a buffer between a large field and a river could be really impactful in what runoff does.

And so we're trying to improve our models to understand these really granular effects that, you know, a barrier might have rather than just a broad summary of a watershed.

So that has those have been like research goals that were developed with community guidance and alongside communities.

And yeah, that's been really impactful for how we're doing our work.

Thank you.

I had a question for you, not directly related to your research, but you said at the beginning that this is an island that has been studied quite a bit. And I didn't know if it's all in like the natural sciences that it's been studied or and what's kind of prompted this to be a target for researchers.

Yeah, I think for one, it's amazing.

So it's just really wonderful to go. And I think that there's been an appeal to Western scientists to go to a place that's awesome.

But I think something that's really important here is that

Mireya has been people have lived there for a thousand years and it has been heavily fished for that duration.

And there are other islands in the tropics that have have much less human impact in the sense of fishing because they've been.

They've been occupied for less time. So there's other islands that are way more sharky, for example, but there's less sharks on Mireya. And one of the reasons might be there's just less fish to eat because there's a competing predator. But research really took off there and it's super accessible. You can fly direct from San Francisco or LA to the west coast of Tahiti and then you stay in a hotel one night and the next morning you take a ferry and you're on Mireya.

So it's it's super accessible. It's not like some islands that you have to cruise for six days to get to. And and that makes it very heavily studied. It's also the site of both a French long term research station and a US long term research station. The US one started in in the early thousands, but there have been American researchers on Mireya since I think the 70s. Don't quote me on that, though, but it's been a long time. And the French have been similar.

But like this map behind me is I don't even remember what year it's from, but it's like basically a pirate map. And it has specific depth soundings for all of the lagoons in the sea. It's for all of the lagoons of Mireya because it was such a great place to put a ship because those two predominant bays on the north side of the island are very protected. And so it's it's had a mapped bathymetry for a super long time, really precisely.

And that's been like great jumping off points for for more recent work.

It's wonderful to hear a mention of the older maps. And at a time when we're looking at what GIS can do into the future,

the old cartography was pretty amazing as well. So does anybody else have any questions for any of our presenters?

Well, if not, I think we want to give a one round of virtual applause to everyone who presented today. Really appreciate your time and your efforts.

And thanks to all who joined us today for this presentation. We have one more hour of programming to go that starts in an hour and five minutes. And that topic is going to be GIS for policy, health, transportation and zoning. So I hope if you have the time and are available, you can join us there. So thanks again, everyone. Have a good rest of your day.

Yeah.