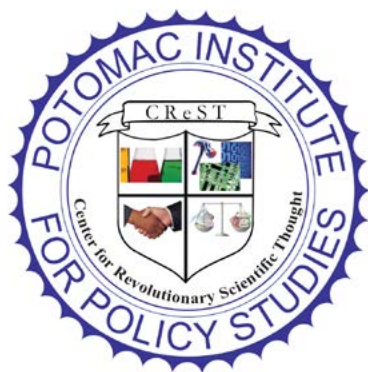


CReST SEMINAR

CLIMATE CHANGE IMPACTS IN THE PACIFIC: IMPLICATIONS FOR US ENVIRONMENTAL AND HUMAN SECURITY



FEATURING
DR. VICTORIA KEENER
SEPTEMBER 20, 2013



POTOMAC INSTITUTE FOR
POLICY STUDIES
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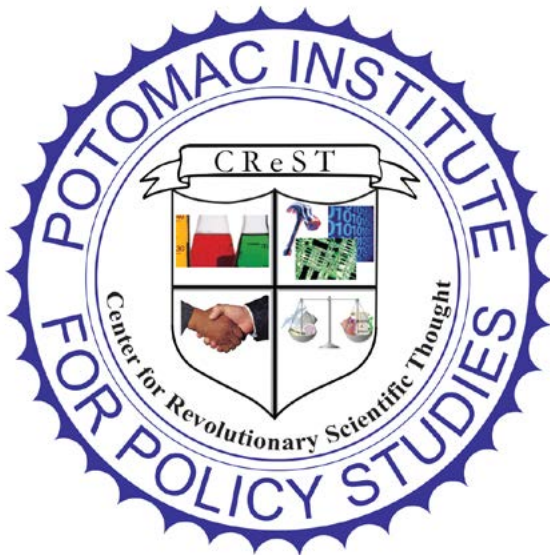
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CReST

The Center for Revolutionary Scientific Thought (CReST) at the Potomac Institute for Policy Studies brings together individuals from a variety of backgrounds to enable a comprehensive outlook of science and technology (S&T) futures from academic and policy perspectives. CReST intends to: 1) develop new ideas, 2) formulate strategies on how to achieve revolutionary gains in S&T, 3) provide a discussion forum to address political, ethical, legal and social issues related to S&T, and 4) inform the public and policymakers about the most pressing issues and concerns regarding the future of S&T.

The CReST mission of solving vital societal problems is enacted through research studies, products, seminars, and conferences designed to address the most trying challenges facing our society.



AGENDA

MODERATOR

MICHAEL S. SWETNAM

CEO and Chairman, Potomac Institute for Policy Studies

FEATURED SPEAKER

DR. VICTORIA KEENER

Scientist, Research Fellow at the East-West Center in Honolulu, Hawaii

OPENING REMARKS

BY MICHAEL S. SWETNAM

Ladies and Gentlemen, I would like to welcome you to the Potomac Institute for Policy Studies. However, it looks like today is full of friends, colleagues, and associates so I want to thank you all for coming. I think you are going to like our presentation today.

For the few people who have not been to one of our events before, the Potomac Institute for Policy Studies is a non-profit organization in the DC area that focuses on science and technology policy. We believe we should be deriving our policy from sound science and good understanding of the technology. Our political and policy decisions should be based on rationality and science. Science and technology policies are helping our policy makers decide how to help fund, direct, and guide the development of technology for the betterment of mankind. Here at the Potomac Institute, we believe we are a part of that conversation and are helping identify issues for analysis, and develop policy recommendations for both Congress and the administration. We have been successful at this because of forums just like this, where we bring together scientists and policy makers to discuss the pressing issues of our time and how science and technology can inform policy in the nation's capital.

For quite some time, like many in the science and technology policy world, we have been thinking about and have been involved in the discussion of the effect and implications of global climate change. There is still a lot of debate on what is causing global climate change but there is very little rational debate left that global climate change is happening. As it comes upon us, the implications of global climate change for mankind and the planet's existence should be considered with all seriousness and due haste.

OPENING REMARKS

With that, it is my great pleasure to have with us a scientist who has studied this issue. She has been involved by traveling to the places that are being affected by global climate change and speaking with the people who will be affected by it. By examining the effects on their lives we can see how it could potentially affect all of our lives. This is the 3rd seminar we have had in the last few years relating to climate change and its impact on not just national security but as a global security issue and I am absolutely sure this will not be our last.

With that, I turn the introduction of our speaker over to our Chief of Staff, Kathryn Schiller Wurster, who is also a member of our Center for Revolutionary Scientific Thought here at the Potomac Institute and is involved in a lot of this analysis and recommendation to Congress. She has been our Chief of Staff here for the last year and is why we have this great new space and why we are operating better, because they took the reins away from me and gave them to her.

SEMINAR TRANSCRIPT

Introduction: Kathryn Schiller Wurster, Chief of Staff of the Potomac Institute for Policy Studies

Thank you all for being here. Dr. Victoria Keener is a research fellow at the East-West Center in Honolulu, HI. She is the lead principal investigator of the Pacific Regional Integrated Science and Assessment Program, which is funded by The National Oceanic and Atmospheric Administration (NOAA). She is here today to talk to us about the Pacific Island Regional Climate Assessment Report that is about to come out and she is also my dear friend. Thank you for being here, Victoria.

Dr. Victoria Keener: Thank you for inviting me here today and thank you to Kathryn for setting this all up. It is always thrilling to be able to grow up with someone and then later in life be able to cross our professional lives and work together. As Kathryn said, my main grant in Hawaii is a NOAA grant, the Pacific RISA (Regional Integrated Science and Assessment). The purpose of the grant is to take an integrated look not only horizontally but also vertically at the issue of climate change. It is horizontal because we integrate both the physical and social sciences, on the effects of climate change and vertically in that we conduct use-inspired science. We work with stakeholder and policy makers in the region in every step of the process. We co-develop our research plans so instead of doing science in a room and coming out with peer reviewed journal articles and hoping someone just picks it up; we are really working with decision makers to insure that the information is usable by them, that it is something they want and can use, and it fits in with their mandate. We strive to build a relationship with them where they really trust our work to help them make good policy decisions. So, that is a little bit about our grant.

Under that, I am also a research fellow at the East-West Center. The East-West Center is a NGO research center, which does research, education, and seminars. Its main goal was really to be a link between the mainland US and the Asia and Pacific Region. The main part of my talk today will be about my work on the Pacific Island Regional Climate Assessment Report, which is going to be a part of the larger National Assessment on Climate Change that will be released by the White House in 2014.

The key issues that I am going to address are several fold and they will reappear over the course of the presentation. The first is going to be disaster preparedness. In the Pacific Island region there are a lot of natural disasters. Usually, these are managed by the Pacific Command. There was recently a large drought in the Marshall Island at the beginning of this year and Pacific Command helped by delivering food and water to them. These kinds of issues are going to pop up more and more as sea levels continue to rise, especially in the Western Pacific where sea levels are the highest.

In terms of national security, Pacific Command has the largest purview of all of the command areas and is based in Honolulu. While most of the area they cover is ocean, they have a wide variety of human and environmental security issues they have to look at. This includes food and water security – so climate change will play a large part in their duties. The impacts on food and water security due to climate change will be several fold. Not only things like precipitation pattern changes and sea level rise, but also wave over-wash salting over the land as well as damage underneath, reducing the fresh water tables leaving less water for drinking or crop irrigation.

We have to consider immigration and its effect on national security. Most people don't know that we have a lot of freely associated

states in the area and where these people will go when there states are no longer inhabitable. A lot of them will come to Hawaii as it makes sense for them both culturally and in terms of island culture. We are going to have a lot of climate migrants in the future.

Now, the work that we are doing for the National Climate Assessment was mandated by Congress by the US Global Change Research Act of 1990. Every 4 years a report to Congress must be given summarizing the climate science investments in the US and incorporating them into a larger context to look at vulnerabilities. Things like economic opportunities, mitigation and adaptation strategies, gaps in assessment and research and integrating from both an academic and interagency perspective – different issues that are coming up.

As it has happened because of politics and funding there have only been two assessments done since 1990. One of them was done in 2001 and the other was done in 2007. The one that is due out in March 2014 is going to be the largest one made to date. They have really tried to involve and inform decision makers at a large scale to help them prioritize their science investments regarding climate change.

The area we worked on was the Pacific Island Region. This is a freely downloadable assessment that was released at the end of year 2012. It is about 200 pages and it provides context as a regional technical input to about 10 chapters in the national assessment. The aims of the Pacific Islands Regional Climate Assessment (PIRCA) were to assess the current state of knowledge of the region, impacts and adaptive capacity in the aid of decision makers. The participants were government agencies, non-government agencies, businesses, community groups, watershed partnerships, academia and NGOs. We brought everyone together for conferences and seminars, literature reviews, workshops, and working together with different scientists toward a consensus on the key trends and problems relating to climate science. Our final product was the technical

input (PIRCA), the chapter in the National Assessment and we also conducted two forums – one of them was in Honolulu in December of 2012 and the other was in Fiji allowing us to work with our international partners that took place in January of 2013.

So the PIRCA in context has three main technical areas, fresh water sustainability and drought, coast inundation and sea level rising, and aquatic and terrestrial ecosystems.

Under these overarching bubbles, we considered the impacts of the science on things like agriculture or different sectors like business and considered their adaptive capacity. This includes the opportunities and constraints on different islands' and countries' policy and governmental limitations, the role of their institutions, and impacts on their communities.

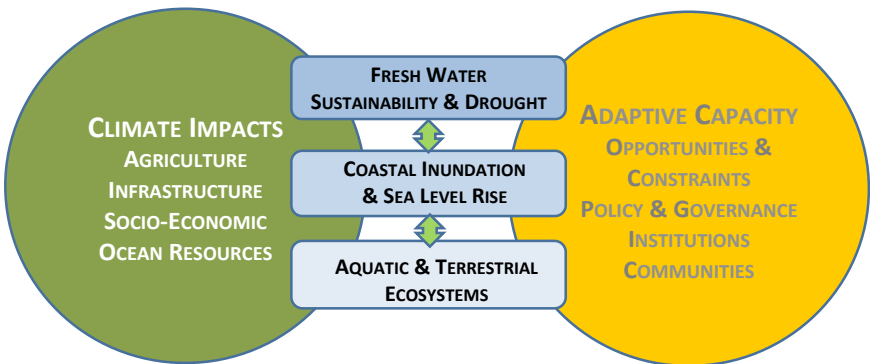


Image courtesy Dr. Victoria Keener.



Image courtesy Dr. Victoria Keener.

We had about 100 collaborators working with us as you can see from the table above. We worked with NOAA, the University of Hawaii, USGS, some other governmental partners, academics, and non-profits and many other organizations not listed here.

To examine a little bit more of the background we can look at this Pacific centered map. A lot of people are not used to a Pacific centered map and on most maps the Pacific Ocean is cut off around Hawaii so you never feel the true size of it.

We split the area into three climatological main regions: the Central North Pacific, which is just the Hawaiian Archipelago; the Western North Pacific region, which includes Guam, Commonwealth of the Mariana Islands, the Republic of Palau, the Federated States of Micronesia, and the Republic of the Marshall Islands; and finally, the South Pacific, the American Samoa. Just to help imagine how big the Pacific Ocean region is, it would take three of the United States to get across the entire ocean.

Looking at the demographics, in terms of US holdings, there are 2,000 islands spread out over millions of square miles of ocean, and

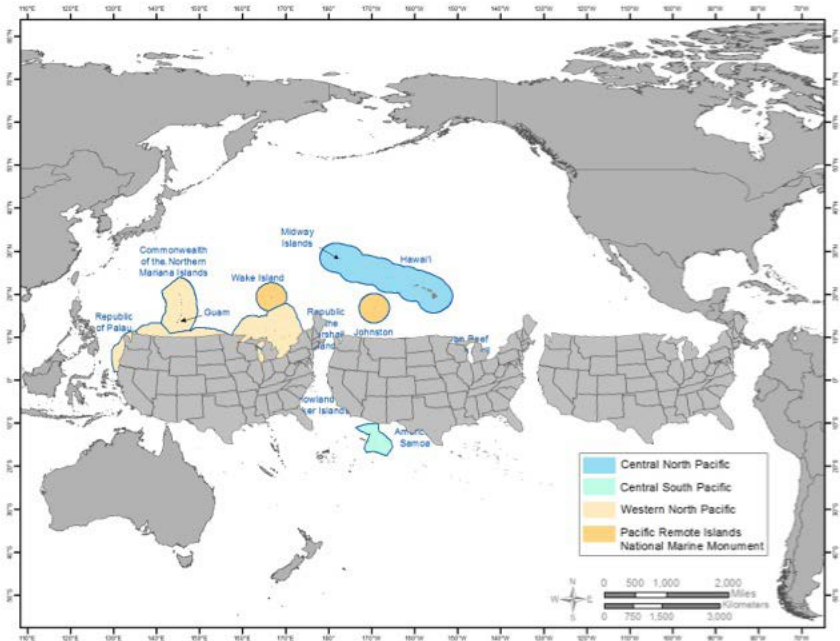


Image courtesy Dr. Victoria Keener.

2 million inhabitants across all islands. Over 50% of the US exclusive economic zones are located here. At least 20 languages are spoken across all of the islands and there is a large military presence. The Pacific Command is located in Honolulu, a large military base in Guam and this base is only going to grow as military personnel move from Okinawa, and finally you have a missile defense system in Republic of the Marshall Islands in Kwajalein. There is also the history in the Marshall Islands with the Bikini Islands and nuclear weapon testing.

Now we can get into the science of climate change and some of the main trends in the climate variables we have been tracking. One of the strengths of this is that, when people are debating climate science, they get worked up on future predictions. I am not going to show you projections but instead just the trends we are seeing. Even if you don't believe in climate change or the causes of climate changes, this shows you the data we are currently seeing spanning the last hundred years.

Now that I have told you about how unique the Pacific Island is; I am going to show you what common elements we are seeing with the rest of the world.

Just like across the globe, Hawaii and the Pacific Region is seeing an increase in the amount of CO² concentrations. Mauna Loa, on the big island of Hawaii, has the longest running record of atmospheric carbon dioxide and is a priceless source of data. This data is only kept alive thanks to a couple of scientists who tirelessly work to string together funding to make sure we have these records continuous so we have eyes on the changes in the atmosphere. All around the world, on average, we are seeing that surface air temperature is rising. Extreme weather events are also changing across the region and the globe. I am not saying they are only increasing. A recent op-ed I read from in the *Washington Post* about extreme events and

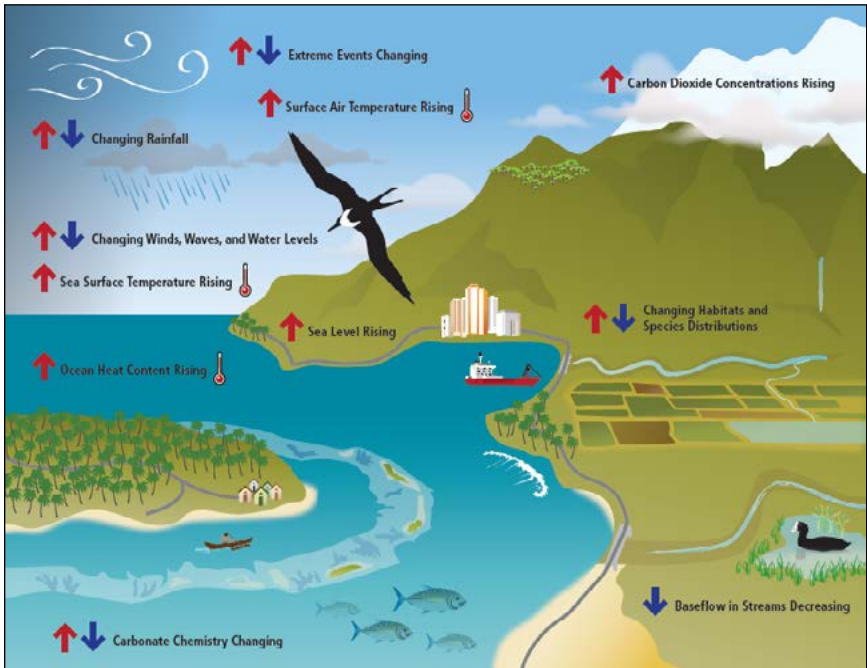


Image courtesy Dr. Victoria Keener.

event attribution regarding climate change is true. Some extreme weather events are going to go up and some are going to go down and we are seeing it on the islands.

Some specific situations we are seeing in the region are related to base flow in our streams that is decreasing. Base flow refers to the ground water component to stream flow. No matter what people are taking from the surface water, we can always see the trends by looking at the base flow, which would remain undisturbed. For a state like Hawaii that gets 99% of its potable water from this, it has severe implications in terms of water sustainability, even without taking into account climate change.

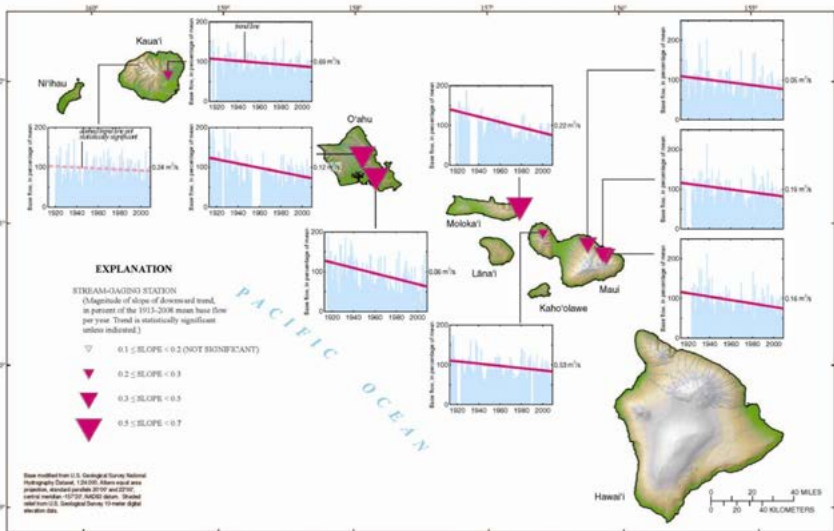
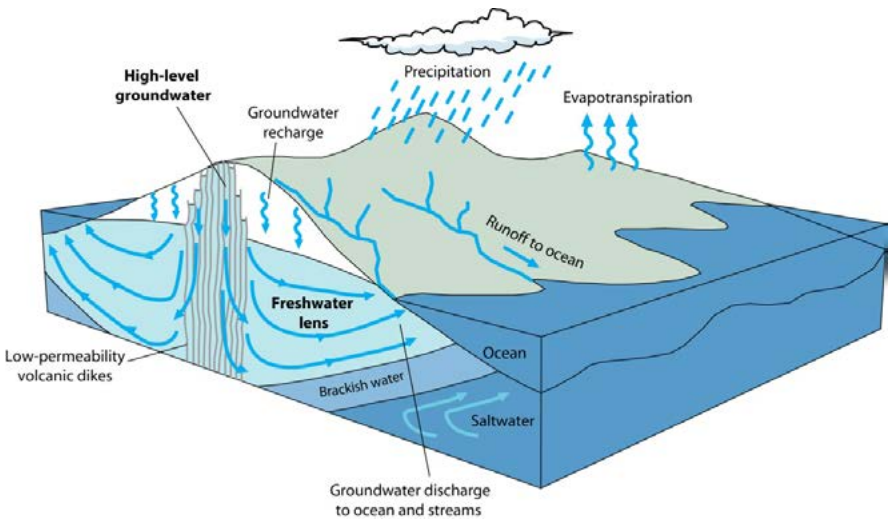


Image courtesy Dr. Victoria Keener.

We are also seeing a change in habitats and species' distributions. As it warms further up or down the mountains, species are moving to escape increasing temperatures and the carbonate chemistry in the reefs is changing, which is affecting the reef ecosystem and the coral life.

In terms of our fresh water resources, the island ecosystems have limited and fragile fresh water resources. Islands are much smaller pieces of land; therefore they are more sensitive to stresses than continents. As we look at the cross section of an island's hydrological system, we see that when rain hits the top of the island some of it sinks through the volcanic rock while some runs off. The amount of water that gets past the volcanic rock creates a fresh water lens underlying the island. This is separated from the saltwater by a thin layer of brackish water so there is not much of a barrier protecting the fresh water from the saltwater from the ocean.

As we drill more wells or less precipitation hits the island, the fresh water lens varies either getting thinner or thicker. As we pump more water out we have more of a risk of saltwater intrusion into our irrigation and fresh water supply.



Izuka, 2012.

Another thing that makes climate science difficult in the Pacific region is that we have very high natural climate variability. This does not refer to global warming, rather refers to natural systems such

as the El Niño southern oscillation. You may be familiar with climate phenomena and oscillations, such as El Niño or La Niña. This also refers to the Pacific decadal oscillation, which has a high influence in the region. What we're looking for with global warming systems is a long term trend over time and the climate variability puts noise into that system, making it more difficult to filter out that long term trend.

Finally, something that all of the scientists across differing fields came forward to say was that at this time, as we are experiencing more rapid environmental change than we have ever seen before, getting data and basic monitoring on our environmental variables is more important than ever. We need eyes from the past and in the present to be able to predict things into the future. A lot of federal funding for monitoring is being cut at the point where we need it the most.

So I said that air temperature across the region is rising, across the entire Pacific – the north, the south, the west. The average minimum and maximum air temperature has been rising. We have a record in Hawaii over the last century that shows the rise, and in Micronesia and American Samoa, about the last sixty years. Really what this shows is Hawaii. These stations are revealing that temperature rise has accelerated in the past thirty years. Those are the red bubbles on the graph on the next page.

You are able to see that the last thirty years of data really shows increased rate in temperature rise. What we are also seeing is that when we separate it out into low elevation and high elevation stations – low elevation is in the middle and high elevation is at the bottom – we are seeing a more rapid rise in air temperature at high elevation stations that are about half a mile above sea level. What is important about that is that some of our most fragile and native ecosystems are at the high elevations in Hawaii. Where we have the most endemic species, where we have the most fragile and protected forests that in turn feed the water to the rest of the island, are under the most pressure from rising air temperatures.

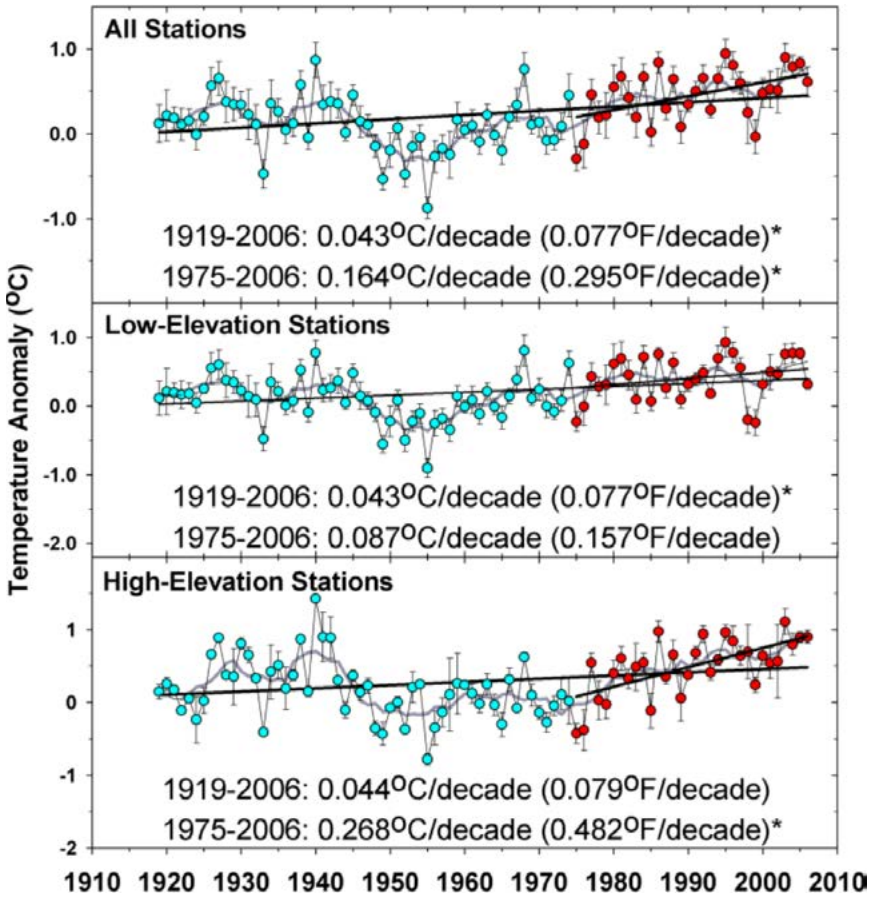
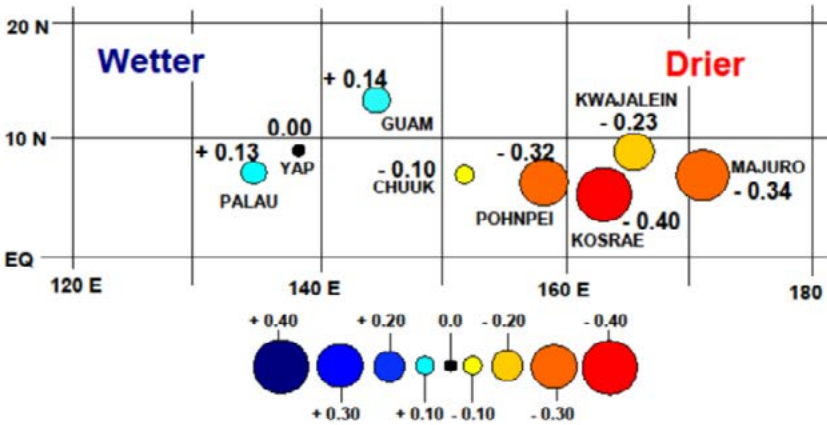


Image courtesy Dr. Victoria Keener.

We also see precipitation and drought patterns changing across the region.

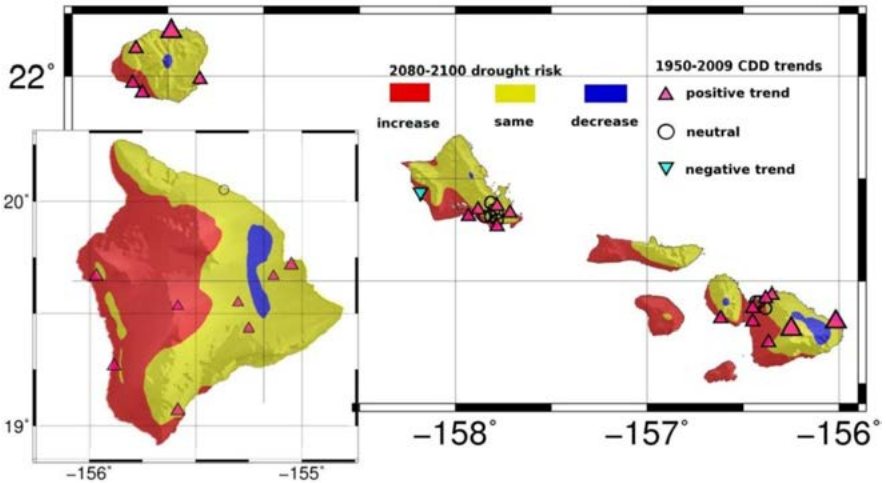
The following is data from Micronesia from 1950-2010, and it's showing trends in precipitation. In east Micronesia, the trends are showing that islands have been getting significantly drier over the past sixty years. The size of the bubble and the color – the more red it is, the bigger the drying trend.



Modified and updated from Guard & Lander.

In west Micronesia, we do not see much of a trend so far. There is not much of a trend, or it is getting insignificantly wetter. What we can also see, as I said previously, we have had this really bad drought in the northern Atolls and the Republic of the Marshall Islands beginning in 2013. It is really playing out and you can see these trends happening more and more. We have to deliver more aid, more water and there are more issues with food security. Of course, it's very expensive to ship food and water out there. So we are going to see these trends continuing throughout the future.

We also see these trends in Hawaii. In the past thirty years, annual precipitation across the entire state on average has decreased significantly. All Hawaiian Islands have experienced greater numbers of consecutive dry days, the days in which it does not rain, which is a measure of drought in the islands, and fewer days of intense rainfall. In our region, we are seeing that storms are predicted to become more intense. However, we are going to get fewer of them. The following figure overlays trends in the past of consecutive dry days, shown by the triangles. So, increasing trends in drought are indicated by large red triangles, and the color maps that is overlaying it is actually a project of looking into the future about what we are expecting to see at the end of the century in terms of drought risk.



PIRCA 2012, Courtesy Oliver Elison Timm.

For the Hawaiian Islands, in most cases the leeward sides of many of the islands are expected to increase in drought risk. There are very few areas, indicated by the blue, mostly at the tops of the mountains on the windward sides of Kauai, and the very middle. The wettest place on earth are the regions where drought risk is expected to decrease.

As previously mentioned, base flow in Hawaiian streams is also decreasing significantly. Again, base flow refers to that ground water component of stream flow. A wonderful USGS research study by the Pacific Islands Water Research Center in Honolulu examined this amazing record of 100 years of stream flow data. As a hydroclimatologist, I will tell you that it is extremely rare to have a stream flow record that long. For my dissertation, I was working with 25 to 30 years of stream flow data. We have this great record because there is a very long history of sugar cane agriculture. The sugar cane farmers in Hawaii kept very good records. As sugar cane industry has decreased, we have been losing those stations, not only weather stations and climate stations, but stream flow gauges, as well.

The USGS has not been able to recapture them all with adequate federal funding. So really, these most important, long-term records that can give us the best view of trends and projections into the future are becoming more scarce. On eight out of nine century-long, long term stream gauges in the Hawaiian Islands, base flow has decreased from 20 to 70 percent in the last century or so, which is very concerning.

Something we have also all heard about is globally average sea-level is rising. Since the 1990s, global average sea-level rise has been about 0.13 inches per year, which may not sound like something to be concerned about until you realize that it is twice the estimated rate for the 20th century as a whole. This figure is showing global average sea-level rising in a range of projections on what they are expecting: the lowest in blue, down at about 0.2 meters and the highest at about 2.0 meters. This is extrapolated out to 2100. These climate model projections are for a 6 to 24 inch in global sea-level average rise by the end of the century.

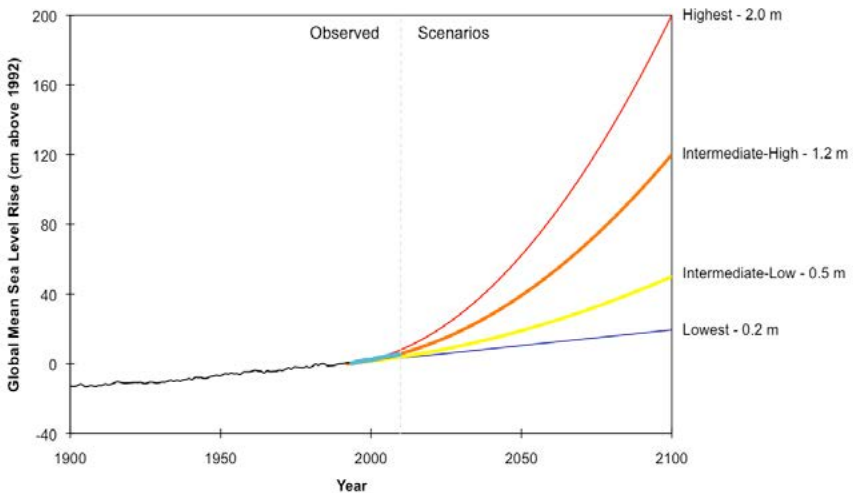


Image courtesy Dr. Victoria Keener.

This also has regional implications because we know that sea-level rise is non-uniform and non-steady. Although they talk about the global rate with everything rising, it is not equal everywhere. So, this is actually data reflecting sea-level rise trends for the past 15 years, globally. Red and orange, warm colors on that map, indicate the highest areas of sea-level rise in the world. Something that should pop out at you right away is that although there are bits and pieces of red around that map, the western Pacific has experienced the highest rates of sea-level rise in the world in the past 15 years. That's actually a natural trend. We are in a very strong trade wind period right now and what that means is that the trade winds are actually pushing the water naturally from the east to the west, and it is all piling up in the western Pacific Ocean.

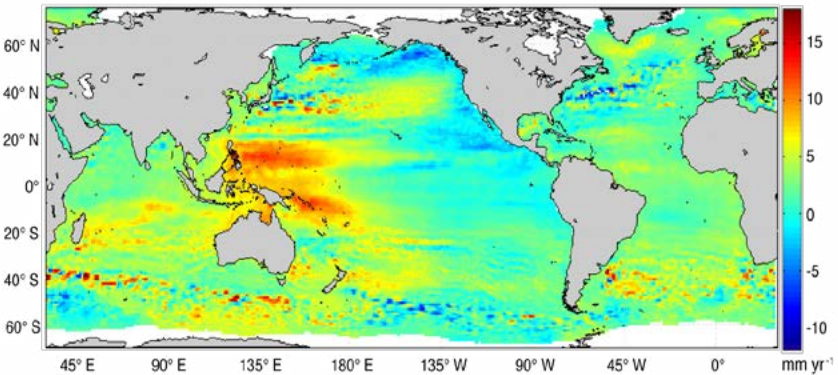
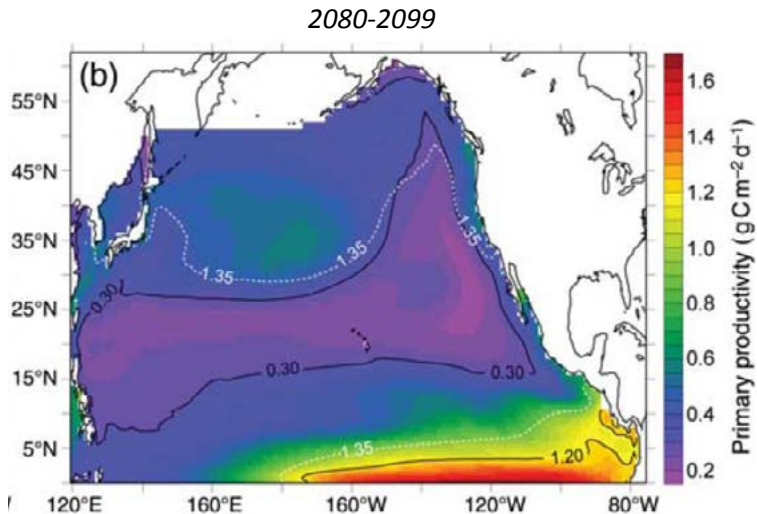


Image courtesy Dr. Victoria Keener.

While we are in this regime of strong trade winds, the western islands, the Atolls – that are at most risk anyway because they are only a couple feet above sea level – are really getting the brunt of that impact. They are being affected more than the rest of the world and the other islands. This increases stress on them because now not only are they dealing with the global rise that is happening incrementally but also this natural rise putting extra stress on them.

As I just said, increasing average sea level means more frequent extreme sea levels. These extreme sea level events occur when high tides combine with non-tidal events, such as a storm or wave overwash event. It not only affects things like coastal infrastructure, houses, and military installations but also ecosystems. For example, on the Midway Islands, there are some of the largest populations of ground-nesting birds, like albatross. There was a king tide event in 2009 that wiped out about 40% of the breeding population of black-footed albatross on the islands. What we are seeing is that these increased coastal inundation events are going to threaten communities and wildlife, and this is only going to worsen.

We also know that the distribution of regional, coastal, and pelagic fisheries is going to shift in the future. For a region which one of the main economic support is fisheries and fishing, both subsistence and trade, we know that this is going to have a huge impact. What we see is not only changing ocean temperatures in the region, but that is going to affect the base of the food chain at the most basic



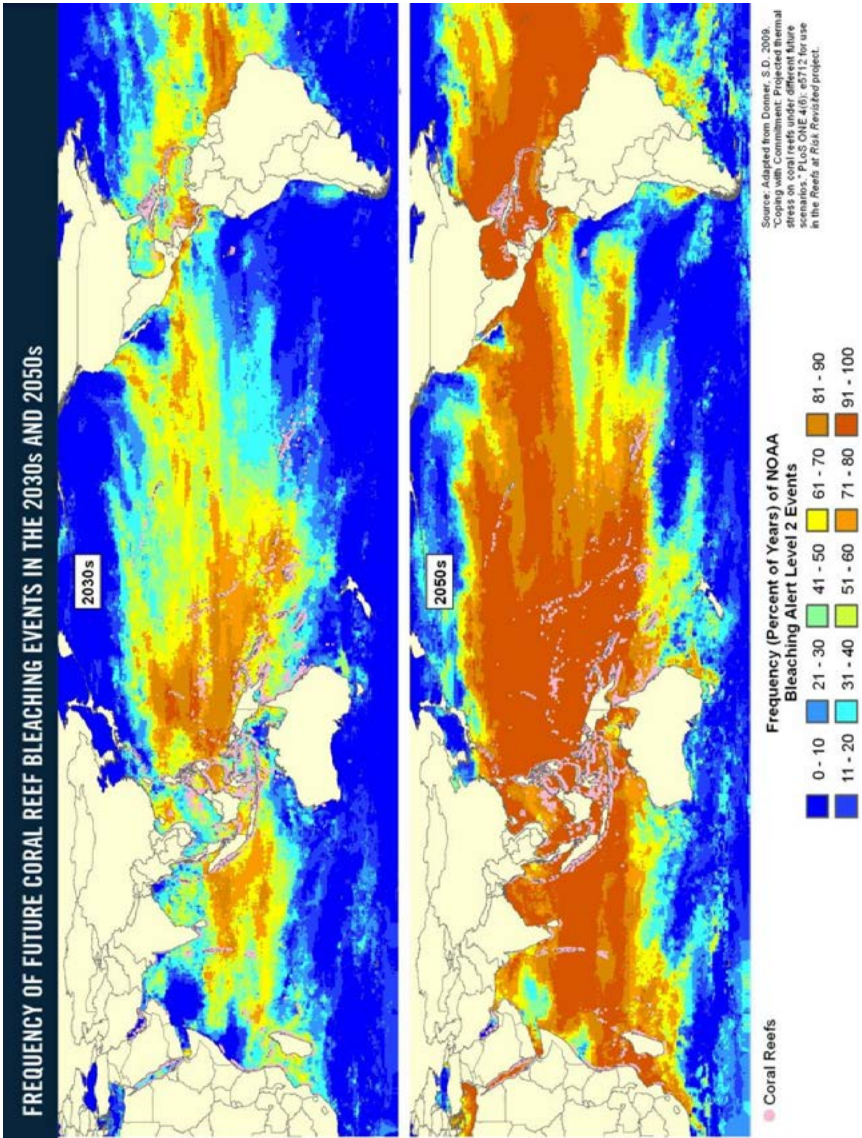
Projected changes in primary production, From Polovina et al., 2011.

level. What we see on the right are projected changes in primary production, so again that very base of the food chain, which is going to dictate where the large groups of fish go in the future.

We know some countries are going to prosper from these shifts and that some will suffer. We do not know exactly where those fish are going to go yet. Models show that there is going to be increased primary production in the central Pacific and then decreased in the northern and southern Pacific. We do not know exactly what this means yet, so this is a question that everyone is very eager to address. Again, this projection is for the end of this century.

The figure to the right is a sobering image, one that always gets me down every time I show it. The threats to coral reefs within the region include both rises in ocean temperature, which cause bleaching events, and increased acidification, which results from increased carbon dioxide in the atmosphere and impacts how corals can build their skeletons. By 2050, it is predicted that many coral reefs will bleach on an annual basis. On the top, this map is showing annual reef bleaching projecting in the 2030s. Of course, the oranges and reds are the percentages. That dark red that you see at the bottom in the 2050s projects that most of the reef regions in the world should be bleaching annually by about 2050. That is not to say the reef ecosystems cannot recover from bleaching events, but if it happens every single year, it severely inhibits their resiliency. These are going to be impacted more and more into the future and we are seeing that. These projections, in case you are interested, are based on the Intergovernmental Panel on Climate Change A1B Scenario, which is basically the business as usual: what we are doing now if we keep doing it into the future. This is what is projected for coral reefs.

Now I'm going to back out of the science and bring it back down to a more general level: the implications that climate change has for the Pacific community and for the world in these cross-cutting issues. As we talked about at first, disaster preparedness for the re-



Future reef bleaching frequency based on IPCC A1b (business as usual) emissions scenarios, Burke et al., 2011; data adapted from Donner, 2009.

gion is a huge issue. The Pacific region is very spread out – which is not unique to the region, but strongly affects our ability to address disasters, includ things like backfill and staff backfill. Many times on US-affiliated islands, someone will leave a position and there is no one to take it over. No one is trained. It will stay open for years and thus it has a lot of implications for disaster management. There is also high turnover since there are few opportunities, which makes people leave. Not much institutional knowledge gets passed on. Also within the region, contextual and cultural competencies vary. Some kinds of regional efforts to help with this include climate-based early warning systems to help predict things like infectious diseases, which are expected to change under different future climate conditions, food and water conditions and shortages. In terms of drought impacts, for example, it is difficult to get mobile RO units to desalinate water out to people who need it. One of the main things we find helps to increase disaster awareness is to increase communication across agencies, states, and countries, and for people to really have an environment in which collaboration is enabled and rewarded. Interagency collaboration and cross-coordination are considered a good thing.

We also know that climate change is going to impact the security environment and the roles and structure of the military. I've listed here some of the coastal assets of the military that are vulnerable to climate change impacts in the Pacific. These include, but are not limited to:

- Training and testing lands, which are mainly coastal – although on an island you could argue that everything is coastal
- Navigation channels
- Piers, docks, roads, bridges
- Important communication and data centers for the military
- Office and residential building for servicemen

- Fuel tanks, distribution lines
- Water treatment and supply lines, both for the military and for delivering to vulnerable populations in disaster times
- Electricity systems, many of which are underwater
- Shoreline buffers, barrier islands, coastal wetlands, all these in terms of ecosystem services
- On a larger level, habitat for protected species

The military is starting to look at a lot of things such as technology performance vulnerabilities and conducting risk assessments in terms of climate change impacts on their military infrastructure. For example, the SERDP program, DOD's Strategic Environmental Research Defense Program, has just funded us to do a several year project beginning in February 2014 to look at the vulnerability of military infrastructure on the island of Guam to climate change impacts on their freshwater resources, especially considering the buildup. The military is taking an active interest, but also in terms of regional conflict with changes in food and water security and the migration of people from low islands to high islands, from different countries all over the region. At the right is a picture of a test missile being fired from Kwajalein Atoll. I think the average elevation of Kwajalein is three or four feet above sea level, so obviously that missile system is highly vulnerable.



Missile firing from Kwajalein Atoll, RMI.

There are also, as I have mentioned, food and water security impacts for the people across the region. Drought and flooding both destroy crops and impact freshwater supplies. The picture below is a terra field in the state of Chuuk in the Federated States of Micronesia after a wave over-wash event.

This results in the narrowing of the freshwater lens and the narrowing of the ocean water, coupled with these wave over-wash events. They are getting hammered on both ends by these impacts to the agriculture on the island. They do not have that much land to begin with, so they need to protect it. When we talk to people about the kinds of decisions that they are having, the most basic questions they always ask are, In the future how much water is going to be available? Where is it going to be? When is it going to be there? So, for example in Maui, we have a project working with the water department, city planners, the county of Maui planners, and the state commission on water resources to examine impacts of climate change on security of freshwater in the future. We use dif-



Image courtesy Dr. Victoria Keener.

ferent climate scenarios in the future to investigate different management and climate impacts on freshwater resources. One of the main questions we want to answer is: Are our policies adequately adaptive for managing freshwater into the future under climate change conditions? In Hawaii, some of the work has shown that we do have a water law base, but it is not always put into practice adequately or maintained, so we have been looking at ways to make it more responsive to climate issues.

One of the other things is that climate change will force human migration. An interesting thing about climate migrants, which is now the preferred term for refugees from climate change, is that there is no single legal entity that covers climate migrants in the world. For example in a violent conflict, say from a war, there are international rules that govern what type of rights people receive when they leave their country. However, for climate migrants – people that are forced to leave their countries because the entire coastline is no longer inhabitable – there are no international laws by which they are governed. We are already seeing displaced populations of people, having to basically work on their own. For example, the Carteret Islanders in the south Pacific have been displaced from their islands because they cannot grow anything, it is salted at this point and it is uninhabitable. These populations have been migrating over the past few years to the main islands of Papua New Guinea. Basically, migrants get in trucks and beg from village to village to be accepted into those communities. They are getting no support from their governments or the international community on how to do that. The projections of global climate migrants in 2050 range from 25 million to 1 showing that there is a range of uncertainty in that estimate. Of course the numbers are much smaller. There are fewer people and only a couple of million are expected, up to 1.4 million, for climate-induced migration. One of the interesting things is that unlike many others in the world, many Pacific Islanders will not be able to migrate domestically. For example, if you are in Miami, Florida and it gets overrun and no longer inhabitable, you just move up to Tampa or Gainesville. There is some place you can go, even within your state, that is still fine. But, if your en-

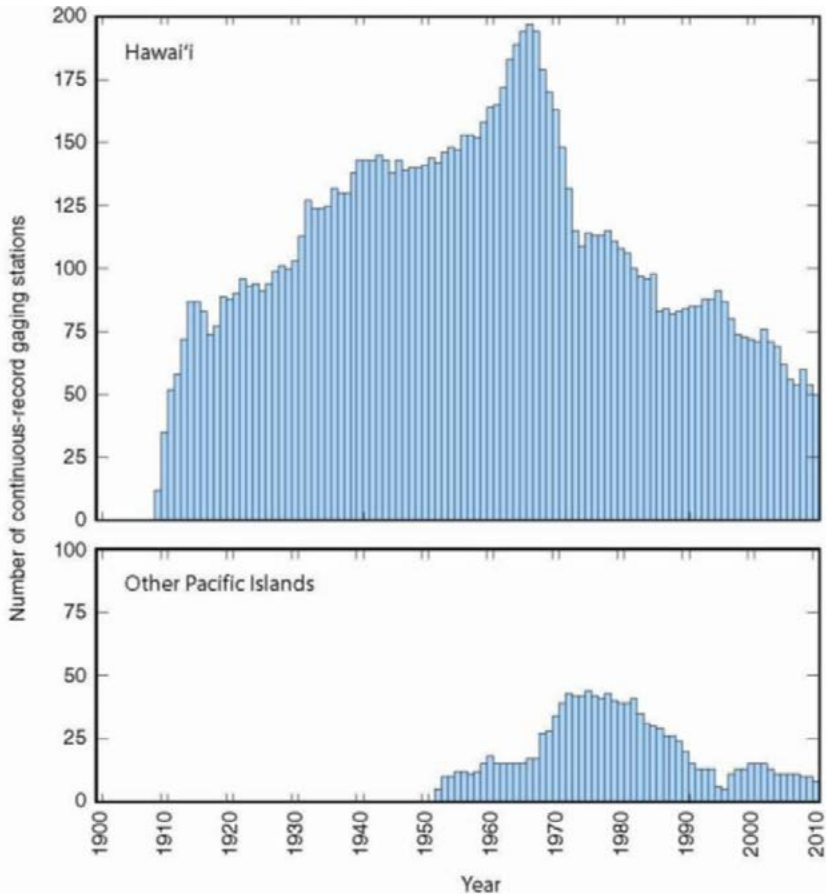
tire country is only a few feet above sea level like many of these Atoll Nations, what does that mean for you?

The ability to assess future climate change in meaningful detail is at risk without this data to both observing what is going on now and calibrated models to project it in the future.

The figure on page 31 shows the number of stream gauges maintained by the USGS in Honolulu from about 1910 to 2010. With the rise of sugarcane agriculture in Hawaii we saw a lot more. Then in the late 1960s early 1970s, we really started to see this drop off in available stream gauges. At a peak of about 200 gauges mid-century, we are now down to fewer than 50 stations across the state. In other Pacific Islands with streams we see a very similar trend except they have had many fewer sensors from the beginning.

Of course, these are very complicated, well thought out monitoring systems that are not cheap to install but that do give us wonderful data. One of the take home messages that we have found, not only for the national climate assessment but in our Pacific RISA work, and also in our work with the East-West Center and the regional organizations, is that we need partnerships between scientists and decision makers at all levels of the decision making process to really make a difference. Whether it is at the community, regional, or global levels – we need them all. The Pacific Islands face these multidimensional problems, not to say that other places do not, but it is very important in our region to realize that neither science nor management alone can adequately address climate change in the region.

One of our main resources has been Ms. Olai Uludong who is the lead negotiator for the UNFCCC (United Nations Framework Convention on Climate Change), representing the Alliance of Small Island States (AOSIS). She has been a tireless advocate and our link to the international level of Pacific Islands and climate. Finally, one of our new collaborative efforts that sprung out of some of



Number of streamgages, USGS Pacific Islands Water Science Center, 2011.

this work is a new regional environmental security group called the Climate, Environment and Security in the Asia Pacific Region (CESPAR), which convened after the climate assessment work was done, as we saw a gap in our own research. Discussion topics so far have included water, security, drought, military infrastructure, disaster response, and early warning. We have been focusing on drought thus far but we have been getting more members into it. So far we have people from US Pacific Command Representatives,

of course Admiral Locklear, the chief of Pacific Command back in March of this year, I believe. He said that climate change was the greatest threat to the Asia Pacific region in the future. Also included are members from the East-West Center, the Center for Asia and Pacific Security Studies, which is a DoD research group in Hawaii, and many state and federal agencies. We see this type of collaborative working group as a way in which we can really extend our reach into the environmental security and human security world.

As a summary for people who may be interested in policy, there are two main take home messages that we got from representatives in the region: resource allocation and leadership. With regard to resource allocation, our main message was to help build climate-resilient communities. This means not putting off actions that will only help your community today or waiting for better information to come out later. Having uncertainty in scientific information is no excuse not to take action now. I will just hammer it home again to support monitoring: rebuild, upgrade, and expand the network of systems we already have. Something that scientists in our group like to say is, “Monitoring is not sexy science;” people do not like to fund it. It does not have immediate payoffs but it is extremely necessary for all research. Support integrated research because it is problem focused, it works with people making decisions on the ground and is iterative, flexible, and adaptive.

In my program where physical scientists and social scientists work together on problems, it is the kind of integrated research that can help. In terms of leadership, we have seen that partnerships with creative solutions are very helpful within the region. Also it is important to have a person (the champion) in an organization that really has both the breadth of knowledge and the reach to make a difference. In most of our projects, if you do not find the champion within the group that you are working with, it is not going to go far. Finally, if you want to download the PIRCA reports (a freely available 200 page assessment report that we did), a series of case studies or regional stories about impacts on different sectors, or just an 8 page executive summary, they are available

at <http://www.eastwestcenter.org/PIRCA>. Feel free to contact the four main editors of the report or any of us for more information on statistics, papers, citations, and whatever you are interested in.

QUESTIONS & ANSWERS

Question: Could you tell us a little bit more about your team, the people you work with, how big the team is, and the data you work with?

Answer: I am the head of the core PI's in which I majored in Agricultural and Biological Engineering. Our two main collaborators are the Water Resources Research Center at the University of Hawaii (hydrologists) and the International Pacific Research Center (climatologists and meteorologists), which are also at the University of Hawaii. The climate group does the global down scaling which involves taking global climate models and putting them into an island scale so we can get regional- and island-level projections for the future. We then put those into water budgets for the islands and specific groups who look at climate change and effects on water resources. One of my colleagues is a decision scientist with a background in psychology; she is one of the social scientists. We also have another community psychologist in our group. We partner heavily in the region with the USGS, which is where we get much of our data. The Pacific Islands Climate Change Cooperative is a Landscape Conservation Cooperative (LCC), which is a DOI funded center. The DOI also has new climate science centers, which they are rolling out in all regions of the United States. In terms of the RISA program, generally NOAA has eleven RISA's which are regionally based and scattered around the United States. There is not one for this region but there is one for the Urban Northeast, which is centered at Columbia University, one in the Southeast which is centered at the University of Florida, and another one in the Carolinas.

Question: Can you talk a little bit about what some of the islands are doing to adapt?

Answer: In Fiji, I know a group that is translating climate change terms, which often do not exist in many other languages around the region, into understandable terms so that people living in the region have verbiage to discuss what they are seeing and how to adapt. A group called the Micronesian Conservation Trust (MCT) has a project they call the climate change flip chart, which is a community-based project. They visit and talk to villages and people, mapping out the decisions people are making and put climate cycles on top of that. They map out when the elders have seen droughts and floods in the past and how that corresponds to the change in climate systems. Two organizations in the region are SCOPIC (from Australia) and PEAC (from the National Weather Service in Honolulu). They have monthly conference calls of all local meteorological service directors. This is one of the main topics to work on – communication. It is very unique to have these high level directors to call in once a month and talk about what they are seeing across such a vast region like the Pacific. They discuss participation trends, sea-level trends, etc. They then compare and validate these across the region. There have been climate change field schools all across the South Pacific. For example, Vanuatu has done a lot with honeybee management, climate change conditions, and traditional environmental knowledge. They talk to people to find out what they recognized from the past and how they can incorporate that into adaptation for the future. Other things include infrastructure in Hawaii, where they have used climate information to redo landfill construction. In Chuuk and FSM they are raising the airport runway based on projections of the sea level rise and modeling sea level to see how it is going to affect holdings on multiple islands. There are seasonal predictions being made. In Hawaii, one of the big things is the climate adaption bill that was passed last year mandating that agencies start taking climate change into account when they conduct their planning.

Question: Very early in your presentation during the freshwater stream based flow data monitoring centers section you said that you had 200 of them and it has reduced to 50. What does it cost? What are locals doing to increase stream gauging with the decrease in federal budget?

Answer: First of all, it is a cost share program. The USGS maintains and collects all the data but the initial setup is a cost share and I think it is about \$40,000 per partner to put in one stream gauge. This pays for all of the monitoring into the future. It truly seems like “a drop in the bucket” in terms of some of the things we are spending money on. In terms of what people are doing on the islands to measure stream flow it does seem expensive, especially for people that do not have the money to get that level of gauging in. People have been using different methods of improvising and measuring flow. The problem with that is, that it is not directly comparable to USGS records because it is done in a different way, on a different timescale, and in different locations. So they are creating new records but they are not as well maintained or set up, and are not comparable with the longer records, in many cases.

Question: Does USGS see the requirement to increase stream monitoring in Hawaii and if they do, have they been budgeting for it or not?

Answer: Yes, they have been but they have been cut drastically.

Question: Is it too late for mitigation? Are we dealing with impacts and the only thing left to do is adapt in a lot of these communities?

Answer: In terms of encouraging climate resilient communities, we are saying that if it is a win-win situation, if you are making things better off in a specific community, while simultaneously adapting for future climate conditions, Then it is a no-brainer – you should

go in that route. In the island communities, for example Oli and UNFCCC, the small island states have been very vocal in not doing adaptation up until very recently because they wanted to push for mitigation funds. The amount of emissions that Pacific islands contribute, in terms of CO2 and greenhouse gas emissions, to the global climate scheme is miniscule. Yet many of these islands are getting some of the most severe impacts and will be getting a lot of the impacts in the near future. So internationally and from the UN perspective they have taken the stance of mitigation only. They do not want to talk about adaptation. We are not going to talk about the fact that some day we will no longer be able to live here – you are going to make it okay, this is your fault. But at this point they are starting to talk about adaptation because it is eminent.

Question: Are there groups in the region that are looking holistically at the impacts of human migration on invasive species within the island?

Answer: I do not know if there is one group that is looking specifically at that. In Hawaii, we have a very active USDA invasive program that tries to keep as many plants and animals out of Hawaii that don't belong. Oahu is a lost cause but many of the other islands are pretty pristine and fairly good. In terms of how we split up different kinds of duties in our region, my group the Pacific Research, mainly deals with fresh water issues on climate. The PICCC (Pacific Island Climate Change Cooperative), a DOI initiative, mainly focuses on ecosystems and NOAA on the coastal services center the Pacific climate information systems (PACIS) take a lot of the sea level rise and coastal inundation issues and of course we are all on each other's committees and we go to each other's meeting and we talk very closely about what we are doing. But in terms of human migration on invasive, I do not think there has been very much work done.

Question: In terms of collaboration and internationally within the region, have there been road blocks with other governments?

Answer: Of course. A lot of the islands in the region and their governments are very keen to address climate change both from a funding issue and from an adaptation issue and to the future. It is a very collaborative region, and I do not just say that without statistics to back it up. We actually have a social network project going on right now of climate change professionals within the US affiliated islands. We finished a survey, and the network is now over 1,000 people from US affiliated islands and Hawaii. The connectivity, as in the six degrees of Kevin Bacon, the average node length is three people. So to get from one person to any other person in that 1,000 person climate network is only a chain of three people, which is very high connectivity. In terms of government, we had some trouble in Fiji. Because of the military regime a lot of our NOAA colleagues were not able to travel there for the climate forum, we did. There are some further issues as in they do want to work together but in some cases governments are just not allowed to work with other governments. The East-West center where I work is an NGO, so it was created as a place of diplomacy and meeting where say, the US could not meet with North Korea in the US but they could meet in the East-West center in a non-government building.

Question: Are there groups thinking about the international implications of climate migrants?

Answer: There are groups, but it is academic. There was recently a conference last year at the Columbia University Law School on island refugees under climate change. The outcome was a lot of working papers but not a lot of action.

Question: What is the level of involvement of native islanders regarding climate migrants?

Answer: One of the things I advocate for when I go to speak at other islands and talk to students is to say, “Go into international law, this is going to affect you in the very near future.” They nod their heads so maybe in a few years we will have an influx of international lawyers from other islands.

Question: In terms of very specific recommendations for both national and international actions and policy to support, are there people working on that?

Answer: I think at the international level there really are people working on policy. For example, the UN framework on climate. The UNFCCC, there are a lot of people working on that type of thing. A problem that we have come across is that a lot of our federal partners whom we work closely with in the region are not allowed to give policy recommendations at that level. So NOAA can inform but they cannot recommend specific policies. We have a lot of trouble getting very specific.

Question: Do you have any interested collaborators that are interested in doing that type of work?

Answer: Yes. In our climate and security networking group that we started, a lot of our collaborators at the Central Asia Pacific Security Studies are interested in moving there with us but that is not my field of expertise. But we do have social scientist and economist and people working at the East-West center and surrounding area who are just starting to look at these things. On a state-level, when it gets more specific, things like passing that climate adaptation bill last year was very big for Hawaii. In terms of concrete actions, that was one. Our lawyer at the East-West center wrote a white paper

that included a series of tools that water managers could use under current Hawaii legislation. So without having to enact new laws, what kind of adaptive capacities were there in current law to adapt to climate change to have sustainability of fresh water in the future? We have actually had four of the twelve tools become implemented into policy. This was only released last year so we are doing great!

Question: What is the involvement of the IPCC?

Answer: The IPCC has its own problems, but I reviewed the new draft of the island chapter this year and I have not seen what it is going into the final, but they are so careful about everything and they do not make recommendations. Their adaptation recommendations are very general.

Comment: Islanders do not like being called “the canary in the coalmine”.

The East-West center does have an office in DC and one of its purposes is to keep our work known because we are so far away. But they are not climate scientists. They are more focused on Asia security so the voice is not strong here from our end.

Question: In the era of open data, is there data that we do not have access to that we need or want?

Answer: All of the data that was used in the Pacific Islands Regional Assessment and any data that is used in the National Climate Assessment, which will be coming out early next year, is all open data by requirement. There has been a lot of work to make sure that data is traceable and accountable. They are building databases on the national climate assessment website to house all of this data that has not been available before. A lot of it is research data that has been done by groups of scientists from specific universities and is proprietary. I have had a very difficult time trying to get

insurance information on disasters, on money spent addressing disasters in Hawaii and the region, and how insurance decisions are made. I need to talk to an economist on how to get that data but I have not had luck with it. However, in regards to scientific data, there is nothing that I have not had access to that I needed. But I may not be the best person to ask because I do not deal with all the information needed.

BIOGRAPHIES

MICHAEL S. SWETNAM

CEO and Chairman, Potomac Institute for Policy Studies



Michael Swetnam assisted in founding the Potomac Institute for Policy Studies in 1994. Since its inception, he has served as Chairman of the Board and currently serves as the Institute's Chief Executive Officer.

He has authored and edited several books and articles including: "Al-Qa'ida: Ten Years After 9/11 and Beyond," co-authored with Yonah Alexander; "Cyber Terrorism and Information Warfare," a four volume set he co-edited; "Usama bin Laden's al-Qaida: Profile of a Terrorist Network," co-authored with Yonah Alexander; "ETA: Profile of a Terrorist Group," co-authored with Yonah Alexander and Herbert M. Levine; and "Best Available Science: Its Evolution, Taxonomy, and Application," co-authored with Dennis K. McBride, A. Alan Moghissi, Betty R. Love and Sorin R. Straja.

Mr. Swetnam is currently a member of the Technical Advisory Group to the United States Senate Select Committee on Intelligence. In this capacity, he provides expert advice to the US Senate on the R&D investment strategy of the US Intelligence Community. He also served on the Defense Science Board (DSB) Task Force on Counterterrorism and the Task Force on Intelligence Support to the War on Terrorism.

From 1990 to 1992, Mr. Swetnam served as a Special Consultant to President Bush's Foreign Intelligence Advisory Board (PFIAB) where he provided expert advice on Intelligence Community issues including budget, community architecture, and major programs. He also assisted in authoring the Board's assessment of Intelligence Community support to Desert Storm/Shield.

Prior to forming the Potomac Institute for Policy Studies, Mr. Swetnam worked in private industry as a Vice President of Engineering at the Pacific-Sierra Research Corporation, Director of Information Processing Systems at GTE, and Manager of Strategic Planning for GTE Government Systems.

Prior to joining GTE, he worked for the Director of Central Intelligence as a Program Monitor on the Intelligence Community Staff (1986-1990). He was responsible for the development and presentation to Congress of the budget of the National Security Agency, and helped develop, monitor and present to Congress the DOE Intelligence Budget. Mr. Swetnam was also assigned as the IC Staff representative to intergovernmental groups that developed the INF and START treaties. He assisted in presenting these treaties to Congress for ratification. Collateral duties included serving as the host to the DCI's Nuclear Intelligence Panel and Co-Chairman of the S&T Requirements Analysis Working Group.

Mr. Swetnam served in the US Navy for 24 years as an active duty and reserve officer, Special Duty Cryptology. He has served in several public and community positions including Northern United Kingdom Scout Master (1984-85); Chairman, Term limits Referendum Committee (1992-93); President (1993) of the Montgomery County Corporate Volunteer Council, Montgomery County Corporate Partnership for Managerial Excellence (1993); and the Maryland Business Roundtable (1993). He is also on the Board of Directors of Space and Defense Systems Inc., Dragon Hawk Entertainment Inc., and the Governing Board of The Potomac Institute of New Zealand.

DR. VICTORIA KEENER

Scientist, Research Fellow at the East-West Center in Honolulu, Hawaii



Dr. Victoria Keener is a Research Fellow at the East-West Center <http://www.eastwestcenter.org> in Honolulu, Hawai'i, and the Lead Principal Investigator of the NOAA sponsored Pacific Regional Integrated Sciences and Assessments (Pacific RISA) program. Dr. Keener received her PhD in 2010 in Agricultural & Biological Engineering from the University of Florida, specializing in hydro climatology and practical applications of climate science for regional decision makers. The Pacific RISA program strives to enhance knowledge and capacity to sustainably manage freshwater resources in Hawai'i and the Pacific Islands. Projects include producing downscaled climate and hydrological projections to estimate future water availability; assessing stakeholders¹ decision-support needs and their capacity to use seasonal forecasts; identifying opportunities for adaptive measures within the existing law and policy framework in Hawai'i; and network analysis of climate professionals in the region. She is the Lead Editor and a Chapter Author for the 2012 Pacific Islands Regional Climate Assessment (PIRCA) report, the regional technical input to the US 2014 National Climate Assessment. <http://www.eastwestcenter.org/events/climate-change-impacts-in-the-pacific-implications-us-environmental-and-human-security>. All PIRCA reports and products are available for download: <http://www.eastwestcenter.org>.

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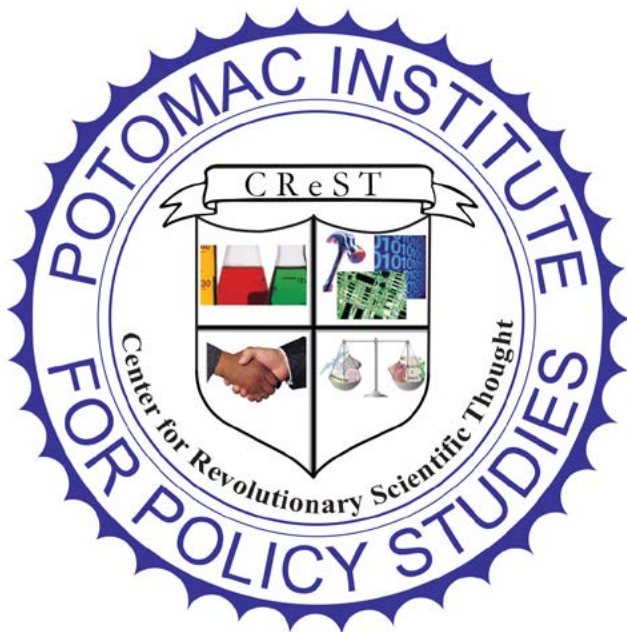
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