Is recorded, and the recording will be published later online on our Yale Center on Climate Change website. And during the seminar, if you have any questions, please feel free to type in your questions in the chat box. So without further ado, Pablo, welcome.

Thank you Kai, and thank you for the audience for being here. Thank you for the invitation for me, it’s an honor to be sharing the information that we have from different research projects, and sharing with people outside of Puerto Rico. Please let me know when you can see my screen as not duplicated. Can you see it well? Yes. Okay, perfect. Thank you, Kai. Let me move this out of here, and also let me minimize this. So again, thank you for the invitation. I am Pablo Mendez-Lazaro, I’m an Associate Professor at the University of Puerto Rico Medical Science Campus. I’ve been working at their environmental health department for 13 years. I’m a geographer by background, but then I switched right there, interdisciplinary research and graduate school on Marine science and climate change.
I can have a little bit of flexibility when changing from one topic to another. In this case, I’m gonna be talking about atmospheric conditions that are impacting or affecting public health and what kind of research we’re doing in Puerto Rico, mainly with Saharan dust.

Basically we do have two research projects that are funded by NASA, NASA ROSES, which is also their health and air quality program. The first one is a research project that we submitted back in 2017. We have been working with three different working groups.

We proposed to use the early warning system to develop early warning system using satellites information around bay stations, and also to quantify the impacts mainly on respiratory diseases on Puerto Rico. I’m gonna be speaking about a little bit of what is Saharan dust? Most of you probably are aware of the Godzilla dust event that occurred in 2020, but for those of you that are not aware, I’m gonna be explaining a little bit. What is Saharan dust, and this is an analysis in Puerto Rico. So to do that, we proposed three different working groups, and for ones which was the responsible of working
0:02:39.77 -> 0:02:43.49 on analyzing the intrinsic relationship into the dust
0:02:43.49 -> 0:02:44.93 and public health,
0:02:45.99 -> 0:02:48.34 using different methods and approach.
0:02:48.34 -> 0:02:51.14 Qualitative analysis but also quantitative analysis
0:02:51.14 -> 0:02:53.08 using secondary databases.
0:02:53.08 -> 0:02:54.707 The second one, the second working group
0:02:54.707 -> 0:02:57.71 was the one responsible of analyzing,
0:02:57.71 -> 0:03:00 we call it atmospheric forcing and air quality.
0:03:00 -> 0:03:01.65 And these ones were the one responsible
0:03:01.65 -> 0:03:03.928 of analyzing and doing the characterization
0:03:03.928 -> 0:03:06.09 of the dust using ground based stations,
0:03:06.09 -> 0:03:08.683 but also diesel particular matter.
0:03:08.683 -> 0:03:11.98 And you will ask, “Okay, so why diesel particular matter?”
0:03:11.98 -> 0:03:13.49 Because in our case we believe that,
0:03:13.49 -> 0:03:16.18 not in our case, I think that all of us agree,
0:03:16.18 -> 0:03:18.37 I’m preaching to the choir in this case but
0:03:18.37 -> 0:03:21.5 natural sources of air pollution are interacting
0:03:21.5 -> 0:03:24.203 with anthropogenic sources of air pollution.
0:03:24.203 -> 0:03:26.72 And one of the main sources of air pollution in Puerto Rico
0:03:26.72 -> 0:03:29.88 could be considered diesel particular matter,
0:03:29.88 -> 0:03:31.19 the anthropogenic sources, right?
0:03:31.19 -> 0:03:34.2 And one of the main natural sources of air pollution
0:03:34.2 -> 0:03:35.28 are the dust that are coming
0:03:35.28 -> 0:03:37.23 from the other side of the Atlantic.
0:03:37.23 -> 0:03:39.08 So we were wondering as well,
0:03:39.08 -> 0:03:43.27 what could happen if both of these aerosols
0:03:43.27 -> 0:03:47.43 and pollutants get together
0:03:47.43 -> 0:03:49.9 and how the conditions in the air quality
0:03:49.9 -> 0:03:54.42 can get deteriorated because of the simultaneous events.
And the third working group is the one that we call decision, support tool, computation, and visualization. And this one is the working group that is responsible of developing the early warning system in collaboration with the National Weather Service, the office in San Juan and the Department of Health. So we call it like a, it’s like a co-design, it’s a human design center approach where we are working directly with any users, to see how can we help them to improve decision making for these kind of hazards. And how to protect the population when this threat is arriving to the Caribbean. Mainly as again, we started with Puerto Rico, but this kind of tool could be scalable to the rest of the Caribbean, because what we're using are satellite information and this information is available for the whole region. So to do that, I first built a team, a multidisciplinary team, this is who we are. A multidisciplinary team of epidemiologists, dermatologists, people from remote sensing, chemistry, atmospheric science and climatology. All of us working together to do this kind of research and developing early warning system for the Caribbean region. And what is this Saharan dust? So in the case of the Caribbean and the Sahara,
This is our aerosols and mineral dust that are coming mainly from the Saharan desert. The Sahara desert is one of the biggest deserts worldwide, and it can provide over 20 billions of tons that can reach into the Americas. When I’m saying the Americas, not only to the Caribbean region, because it depends on what season of the year. South America can be impacted by this dust coming from Africa, but also North America and the Caribbean region. In the Caribbean, these events are associated with increase on excessive risk of emergency room visits and hospitalizations related to respiratory diseases. This has been observed in Granada, Guadalupe, Martinique and in Puerto Rico as well.

Well, we were working with this natural source of air pollution affecting public health. All of a sudden it appears, the coronavirus, SARS-CoV-2. So, which is the responsible of the COVID 19 pandemic that we’re suffering. The first cases of COVID 19 in Puerto Rico were registered in March 2020. So very early after the pandemic, and I think that the first cases in Europe were registered in December, 2019, and then it took only a couple of months for the virus to get to the Caribbean region.
And when that happened, we were able to wonder ourselves, "Okay, so we have been working with Saharan dust, and this dust is associated with hospitalization and emergency room visit due to respiratory diseases. So what could happen to this patient or what could happen in the Caribbean, if we are facing two hazards?"

Both are different hazards, but both of them are affecting the same system, the same respiratory disease system. One is air pollution, natural sources of air pollution, and the other one is a virus. But again, both of them are interacting, affecting the same system.

So why we’re doing this? And why we are also including some other environmental factors, okay? Air pollution is being considered like the silent killer. And it’s not only the anthropogenic sources of air pollution, but there’s many other natural resources of air pollution that can exacerbate our health, right?

And it’s been acknowledge by the World Health Organization, but also by the CDC and some others important agencies worldwide. And some other factors that we are considering for example, I’m just gonna be talking about very slightly about the other one that is another climate hazard.
that could be considered a silent killer is extreme heat. And accordingly to the CDC for example, extreme heat, at least in the United States, it can be considered the number one weather related death. So is the one number one responsible for death when we're talking about climate and extreme weather events. So in terms of public health and mortality, when we’re talking about air pollution and extreme heat, both of them are ranking first or second. It depends how do you look at. Both of them are considered number one in terms of impacting and affecting public health. In the left side, what I’m showing is the weather fatalities that occur in the United States and as you can see for example, when we’re talking about weather fatalities, they are not associated with hurricanes they are not associated with floods. Most of them again are associated with heat and extreme heat, right? So these are two very important component because you will see that, right after our result what we’re seeing as preliminary results is that actually both of them are interacting with the pandemic and are exacerbating the conditions in the patients
that are struggling with the virus.

So as I mentioned, this is something

that I think that all of us,

if you’re coming from the Yale School of Public Health

and front of environmental health, most of you are aware.

So there are multiple sources of air pollution

and we have two first categories.

The first one is the anthropogenic sources of air pollution,

which are from transportation for example, airplanes,

ships, trucks, vehicles, whatever,

some others are from the industries.

But also we have natural sources of air pollution,

and this is where we are doing emphasis in our research.

And the natural sources of air pollution

which are from thousand of kilometers away

from the places that are getting affected.

And in our case for example,

we’re talking about natural sources of air pollution

the are five to 7,000 kilometers

away from the Caribbean region.

But actually they have the capacity

to be transported by the trade winds

in some specifics seasons.

And to impact the region

mainly in the Caribbean.

The Saharan dust are mineral dust are not the only one,

and not the only natural sources for pollution.
We can see also some volcanic ashes, and we can see sulfur also from volcanoes. And we have also mold and spores that can be provided by the vegetation in the tropical landscape for example, but there are multiple other sources of air pollution again, that are affecting or are interacting with pollution. What is the Saharan dust? So these are mineral dust particles that can fly literally and can be transported by the trade winds they’re coming from, mainly from the Saharan desert. But also the Sahel desert is another source. Right, because this is the main source of the particles that are getting to the Caribbean. And we’re measuring this as aerosols and aerosol is basically, different small particles that could be liquid or solid that are suspended in the atmospheres. As I mentioned, it could be that of sea salts, volcanic ashes, smoke from fires, biomasses and factory pollution, right? Again, in our case, we are particularly interested in working with this particle that are coming from the other side of the Atlantic. This particle are very important because they provide nutrients to terrestrial ecosystem, but also to ocean ecosystem, so is very important.
But when we’re talking about public health, that’s the negative component. Because in some cases, this particle, they’re coarse, right? So in some cases they’re big enough, but to fly from the other, to be suspended for a long period of time, and to cross all over the Atlantic suspended in the atmosphere, some of this particle are very small in size. And that’s why it could be dangerous for public health, because some of them have the capacity to get inside of your system very deep. And in some cases, because we’re talking about particles that are very small, right?

We have the source, which is in the African continent, in the Northern side, from Sahara and the Sahel. And we need some specific condition for this sediment to get lift by the air, and to be transported by the trade winds, to the other side of the Atlantic. So we need to consider the wind speed, wind direction, and also the conditions that are causing the lift to occur in the Saharan desert, right? So when this, all this planets are aligned, that means that a dust cloud could be transported to the other side of the Atlantic, okay. The main season in the Caribbean of the African dust arriving to our region
are mainly during the Summer, right?

So it’s also interacting with the hottest season in the Caribbean,

and also it’s interacting with the tropical storms.

So you will see that the season start to increase the Saharan dust.

These aerosols arriving to the Caribbean are increasing after May receiving a peak of the season during the months of June.

And then starting to decrease again during July, August and September.

And September is the peak season for the hurricane Caribbean region, in our case.

So the Saharan dust is also, and these aerosols are interacting also with the atmosphere,

which is important because this is dry air.

And in some cases, this Sahara dust also is associated with inhibition of the formation of tropical storms and powerful hurricanes.

We still need to analyze better that kind of information, but the scientists are still wondering how these interactions could be positive, in some cases for hurricane formation in the Caribbean.

These aerosol are also associated with an increase in PM2.5, as I mentioned. Some of them are big, bigger than PM10, for example, but some others could be as small as 2.5 or even smaller.
And that’s why they have the capacity to float and to be suspended in the atmosphere for thousand of kilometers, right?
So when these dust clouds arrive to our region, it’s also increasing the concentration of PM2.5 during this season and it’s associated with the peak events, right?

And as you can see, I’m just citing here that the dust, it positively associated with cardiovascular and respiratory conditions in the Caribbean and in this case is related to Puerto Rico, but also is associated with asthma, hospitalization and emergency room visits in children’s, which we are talking about kids in Trinidad and Tobago, Guadalupe and Granada.

So one of the channels that we’re using to identify these aerosols is the aerosol optical depth. The aerosol optical depth is by scattering, the light scattering that we’re receiving using satellite remote sensing and information from different sensors. That I’m gonna be speaking about. And so this is the, they have no maximum units. They can go from zero up to two until now, after we saw with Godzilla.

Zero means that there are no visible particles in the atmosphere that could be identified using these sensors. And the higher the numbers,
0:15:43.05 → 0:15:46.9 it means that a lot of particles are in the atmosphere
0:15:46.9 → 0:15:49.67 are being identified using the satellites
0:15:49.67 → 0:15:53.045 that are floating in the atmosphere, okay?
0:15:53.045 → 0:15:55.1 In terms of the data that we’re using,
0:15:55.1 → 0:15:58.26 as I mentioned, we’re using different sources of data.
0:15:58.26 → 0:15:59.093 So we’re using VIIRS,
0:15:59.093 → 0:16:02.513 which is visible infrared imaging radiometer suite,
0:16:03.367 → 0:16:06.91 and coming out from that sensor we’re using AOD.
0:16:06.91 → 0:16:09.37 AOD again is aerosol optical depth.
0:16:09.37 → 0:16:11.56 Then we have a Scatter Angstrom Exponent.
0:16:11.56 → 0:16:14.56 You see this is an important variable,
0:16:14.56 → 0:16:16.693 because it is associated,
0:16:17.628 → 0:16:21.85 the lower the value with this, the Angstrom Exponent,
0:16:21.85 → 0:16:23.64 it means that the particles
0:16:23.64 → 0:16:26.76 are more associated to be dust, okay?
0:16:26.76 → 0:16:29.18 So it’s a proxy
0:16:29.18 → 0:16:31.24 because when you’re using satellite information,
0:16:31.24 → 0:16:34.95 you are not seeing necessary the distinction between dust
0:16:34.95 → 0:16:36.24 and some other particle
0:16:36.24 → 0:16:38.49 that can be floating in the atmosphere,
0:16:38.49 → 0:16:40.54 as I mentioned with ashes.
0:16:40.54 → 0:16:43.967 But if you look at other kind of signal, for example,
0:16:43.967 → 0:16:46.18 and in this case the Angstrom exponent,
0:16:46.18 → 0:16:49.56 you can have a better idea of what kind of aerosol
0:16:49.56 → 0:16:54.37 is floating in that dust, okay, in that cloud.
0:16:54.37 → 0:16:56.81 So we are using Angstrom exponent
0:16:56.81 → 0:16:58.633 but also mass concentration.
0:16:59.66 → 0:17:01.54 To understand and to see the better,
0:17:01.54 → 0:17:05.07 how this atmospheric variables
0:17:05.07 → 0:17:07.74 are interacting with other environmental factors
nearby the Caribbean region,
we’re also using sea surface temperature
to see how it can influence,
if it have cooling effects over the ocean,
or it has a warming effect over the ocean.
And it’s three case,
it depends on how it’s occurring this dust cloud,
the day, the concentration and the amount of dust
that can be present.
We’re also using MODIS and UTCI, which is from Sentinel.
This is a Universal Thermal Climate Index.
To see again, the interaction
with the occurrence of the Saharan dust
in the Caribbean and the temperatures in our region.
To do that,
we started analyzing daily values since 2012, until 2020.
You have all of the current databases.
There are different satellites
coming from NASA for example,
some of the are geostationary data,
and some others are orbital data.
And where we say geostationary data for example,
to use geostationary data,
it means that it is a satellite or a signal
that is providing you information very frequently,
from the same part of the earth constantly, right?
So like, as it can be with GOES-R, for example,
we’re also using GOES-R to develop the early warning system.
But if you want to understand the trajectory
0:18:39.55 –> 0:18:41.88 of this system for example,
0:18:41.88 –> 0:18:44.05 so then we’re using, for example, VIIRS,
0:18:44.05 –> 0:18:47.18 because VIIRS is a polar orbit and is a satellite
0:18:47.18 –> 0:18:49.26 that is turning around the earth
0:18:49.26 –> 0:18:51.67 and is providing you information
0:18:51.67 –> 0:18:53.72 about what is happening with this aerosols
0:18:53.72 –> 0:18:57.69 and the atmospheric conditions in other places of the world.
0:18:57.69 –> 0:18:59.52 So you can understand what is happening
0:18:59.52 –> 0:19:02 with the source of the dust
0:19:02 –> 0:19:04.36 that are probably coming to your region
0:19:04.36 –> 0:19:05.83 in the next couple of days.
0:19:05.83 –> 0:19:09.66 So we’re using two different formats of information.
0:19:09.66 –> 0:19:11.54 One is geostationary data
0:19:11.54 –> 0:19:13.4 that are coming from GOES-R mainly,
0:19:13.4 –> 0:19:14.94 and the other ones that are coming from VIIRS
0:19:14.94 –> 0:19:18.14 that are orbital information.
0:19:18.14 –> 0:19:19.97 The orbital information has a limitation,
0:19:19.97 –> 0:19:22.54 because for example, in our case, Puerto is very small.
0:19:22.54 –> 0:19:26.1 So it means that the VIIRS is only providing data,
0:19:26.1 –> 0:19:27.853 very accurate data for the region,
0:19:28.76 –> 0:19:31.513 every couple of days, for example.
0:19:31.513 –> 0:19:36.28 It’s not necessarily, it like between five to seven days,
0:19:36.28 –> 0:19:39.85 the interval or the frequency when you can have
0:19:39.85 –> 0:19:42.91 information for aerosols in the Caribbean.
0:19:42.91 –> 0:19:44.91 But if you’re using GOES-R for example,
0:19:44.91 –> 0:19:49.32 GOES-R is providing you aerosol information constantly.
0:19:49.32 –> 0:19:51.22 Well, most of the time there are still,
0:19:51.22 –> 0:19:52.29 there are other limitations,
0:19:52.29 –> 0:19:54.4 but I’m not gonna be speaking about that.
There are other limitation about this geostationary satellite, but it could be providing you very frequent information about the aerosol optical depth in the region. So with all this aerosol we have in place the first experimental decision support tool, this is how we’re calling it in collaboration with the Puerto Rico Department of Health and different 19 organizations, health clinics, and the National Weather Service. It’s been posted in the webpage of CARICOOS, CARICOOS is the Caribbean Coastal Ocean Observing System. And it’s already a platform that is providing meteorological and climate information for Puerto Rico and the US Green Islands. So in this case, we’re making leverage of that existing platform to provide to the audience the information that we’re obtaining in this area. So we are retrieving data from four different regions in Puerto Rico. And this is the four tachometers that we have. We identified the level of risk based on the information that we obtain with the health clinics, with patients and with the secondary data that we analyzed. And based on that impact,
we have the first warning system for level mild, extreme to very extreme conditions in term of air quality, and it depends on the color. And we have four different sites distributed in the most populated region of the island. To provide that information in real time and also we are developing the early warning system, meaning that it will be a forecast to give this information to the general public in advance for them to take precautious actions before this dust is arriving to the Caribbean. So this is our just example of how it looks like. The images are very raw, obviously, but as soon as you get into the webpage, you can use it in your app, and you can see the tachometers providing you in real time information about air quality associated with aerosols. This information had been used also to develop educational materials, and to do outreach with the National Weather Service in Puerto Rico, both in Spanish and English, and being used by the Department of Health. So now as we have like a prototype. As you can see here in October 3rd, 2021, we suffer one of the most recent dust cloud after the Godzilla dust event that occurred in 2020. And most of the agencies that were working with us collaborating, they were using this information to make the population aware of their own healthy conditions.
that we were facing for sensitive group
to take precautious measures.
This is another example done on October seven,
the agency were using our information
to provide the best information as possible
to the general audience and to sensitive groups.
We did a couple of webinars
impacting over 400,000 people in Puerto Rico.
We did it with NASA, with the National Weather Service.
We did it with the (indistinct),
which is a, it’s a science museum in Puerto Rico
that are being responsible of
providing a lot of education and webinars.
So they did most of the outreach,
and we did all of the science to the audience.
So we have already now also
an Air Quality Awareness Week in Puerto Rico,
it’s happening all days, all year, sorry,
and at the beginning of May.
So during the month of May,
we are giving webinars for the general audience
in Spanish and English.
Two different sessions for,
to comply with Puerto Rico because,
in Puerto Rico 98% of the population
are Hispanic and Latino.
And it’s the main, is the principle language
spoken here in Puerto Rico.
Okay, so with that being said,
while we were developing the early warning system and when the first cases of COVID-19 arrived to the Caribbean.

So as I mentioned at the beginning, the Saharan dust is associated with accessories of emergency room visits, hospitalization, and in some cases, partially attributable to death. They partially attributable that doesn’t mean that you are dying because of the Saharan dust, but with some other comorbidities and some other interactions, you might be suffering for exacerbations and you are most likely to die.

In March 13th, 2020, NASA opened another call for proposal requesting to work with the COVID-19, it was a rapid assessment. So we wasn’t expected an extreme event of dust as it happened during the Summer of 2020. But since we were already working with the Saharan dust for more years, we had this project, but we have been working on it for five years or more. So we were wondering what could happen if we have an extreme dust cloud event getting to the Caribbean, deteriorating the air quality, and also having a lot of cases with COVID-19, right?
So if already the Saharan dust is associated with an increase in the demand of healthcare facilities, what could happen is we were seeing the news in other places of the world where the hospitals were collapsing because they didn’t have the capacity to provide the services to the patients, right? So we were wondering when we were submitting this proposal, what could happen if both of them are simultaneously occurring in the same time, right?

As I mentioned, when we submit the proposal, it was in April, 2020, just a couple of weeks after the first cases of COVID-19 reported in Puerto Rico. By that time, we were not expecting to have Godzilla dust event. And for those of you that are not aware, Godzilla was a dust cloud that arrived to the Caribbean region. And we stayed under unhealthy conditions due to air quality for more than three days in the Caribbean region, so it was a little bit overwhelming. (laughs) So what we did is that we design a couple of instrument to work with physicians, with patients,
and to better understandable vulnerabilities. We design a couple of qualitative instrument because we believe that working in public health, that the qualitative instrument could be richer in some cases, because they can provide you information about various vulnerability risk perception about how the people are working with this risk.

So we recruited more than 55 physicians and over 100 patients to work with them. We recruited more than 55 physicians and over 100 patients to work with them. We also made a couple of memorandums of understanding and agreement with different clinics in order to receive medical records information, because not only understanding the number of cases that are getting into the hospital, but how these patients conditions could be exacerbated with the Saharan dust. And also we started to analyze the whole cost excess mortality, island wide, not only in some places, in interacting with the environmental factors. So this is like only a graphic showing when the first cases of COVID 19 arrive to Puerto Rico and to the Caribbean, and then how we suffered Godzilla dust event. The bigger the number in the right axis,
As you can see are aerosol optical depth.
It means that the most extreme values we observe for aerosols and these particles arriving to the Caribbean.
It was a dust cloud huge enough that is almost covered all the Caribbean sea together, all of the lesser and fields, and also from Puerto Rico to Trinidad and Tobago.
It was big enough, but also with a lot of concentration, higher values were observed during that time.
In the central part of the graphic, what we’re seeing here is that the black line are representing the years of 2020, the different months.
And as you can see, it’s marked a record for aerosol optical depth in our region.
And again, Puerto Rico stayed for over three days with unhealthy conditions due to this Saharan dust PM2.5.
And the bars, what we’re seeing here are the number of cases that had been registered of COVID-19 and hospitalizations in some places of Puerto Rico, right?
This is only a graphic.
I’m not making any kind of assumption with the graphic.
This is just to show you the patterns that were observed during that Summer.
The lines are aerosol optical depth,
the bars are hospital admissions.
So in all places of Puerto Rico,
as I mentioned in all our four tachometers,
you can see the Godzilla dust event marking a record
as never occurred in the last decades,
or even prior to the decade.
Satellite information, the one that we’re using
is only going back until 2012,
but you using ground based station you can go as back
as probably 20 to 30 years before from now.
And it was also a record
for this dust event in the Caribbean.
These are only pictures for you
can see how the visibility decreases so much
in some places of Puerto Rico.
In the right side,
we’re are seeing the Southwest of Puerto Rico,
this is Guánica bay.
And on top of it, you can see the day before
the arrival of the Godzilla dust event
and then very early at 9:00 AM in the morning.
So the visibility decrease up to three miles only
in most of the island,
when the visibility in Puerto Rico is mostly 20 to 21 miles.
So you can imagine that the deterioration in air quality
that had happened.
So working with the physicians, most of them agree
that there were the severity of the symptom
of the patient of COVID 19
could be most likely to be exacerbated because of the dust clouds. And when we were working with the patient, some of them were telling that they were more sensitive to these aerosols after being confirmed with COVID-19. So they were more sensitive after surviving the COVID-19 than they used to be before having COVID 19. So in somehow it means that nowadays they’re most sensitive. We also did another survey where we were lucky because we have 1500 participants that work with us provide a lot of information. Most of them were female, so we need to highlight that. So that’s important to say, between 25 to 44 years old, but something very important is that, almost 65% of the population had at least one chronic conditions, and those individuals with at least one comorbidity are 14.37 more likely to need medical services when they are facing the Saharan dust in Puerto Rico. And this is what happened, for example, with the Godzilla dust event. Most of the people that participate, 90% of them are indicating the Saharan dust is affecting both their family members, but also their own health status. So not only the participants, but also they consider that in their family members are also getting affected by this atmospheric conditions.
Asthma is important because most of the respondent and the participants that participated saying that 65% had only one chronic condition, but asthma was the most reported condition. Another important issue is that apparently these symptoms are mild to level to not that heavy or not that complicated because only 12%, only 12% of the 1500 that participated that were saying that the Saharan dust is affecting the health, of their family members and the own health, only 12% are seeking medical attention. So meaning that the impact on health of the Saharan dust is not necessarily need to be something that at least with this cases, right, that is gonna be saturating all of the hospital and clinics, but only 12% are gonna be visiting or are getting, their symptoms are so complicated, they need medical attention. To continue working with public health data, we are requesting the medical records in six different health clinics. So nowaday, we have 1200 medical records, the clinics provide this information in paper, so we are now doing the data entry. That’s why we are requesting a no cost extension, to analyze this part of the project. And we requested all of the information.
from the first month once the COVID 19 get to Puerto Rico after one year after completely, right?

Because when it was, when we were planning to end the analysis. We were not that lucky, it took us a lot of time because we were dealing with legal offices (laughs) and a lot of paperwork and memorandums of understanding. But finally, we have this information available. This is the only missing information that we still need to analyze, to better understand, how the patients that were admitted how their conditions were exacerbated by these symptoms. In terms of the databases, I'm gonna be very quickly on this. Most of them are the one that are already mentioned at the beginning, what we were using, mortality, hospital admission, emergency room visits. Environmental factor source are heat index, universal thermal climate index and aerosols, okay? In terms of the hospital admission, this is another graphic. And again, I'm not making another, not assumption about this graphic, but what I would like to show is that as we can see at the very first beginning,
we did suffer a couple of cases of COVID 19 and hospitalization in the six clinics that are participating with us. And then because of the lockdown and the curfew, and all of the restrictions that the government did during that period, we were able to control all of the local transmissions and the infections, and we can see how it went very low. But then all of a sudden, together with the Godzilla dust event, we can see how COVID 19 cases started to increase. I’m not saying again, this is because of the Godzilla dust event, but it is timely associated if you want, (laughs) because both of them occur during the same time and same period, okay. So once the cases started to increase during the Summer, then during the Fall, during the hurricane season, it started to decrease, there was a lot of, couple of curfews and lockdown and government restrictions. And then during the Winter, which it was expected, the COVID 19 cases started to increase again and then restrictions, and we can see it here. And again, I’m not saying that the environmental factors are the only one that are associated
0:36:12.46 –> 0:36:14.81 with COVID 19 transmission and infections,
0:36:14.81 –> 0:36:16.83 we need to consider so many other
0:36:16.83 –> 0:36:18.9 social behaviors and patterns
0:36:19.8 –> 0:36:23.87 that has been confirmed by the scientists
0:36:23.87 –> 0:36:25.11 that are also related
0:36:26.96 –> 0:36:29.093 with the spread of the COVID 19.
0:36:30.09 –> 0:36:31.39 I show already this graphic,
0:36:31.39 –> 0:36:33.1 but it’s just to highlight again,
0:36:33.1 –> 0:36:35.71 that right after the cases,
0:36:35.71 –> 0:36:38.52 when the cases started to rise during the Summer,
0:36:38.52 –> 0:36:41.46 we were also facing the Godzilla dust event
0:36:41.46 –> 0:36:43.17 during the same period.
0:36:43.17 –> 0:36:46.32 Again, I’m not saying that
0:36:46.32 –> 0:36:48.785 it was because of the Saharan dust
0:36:48.785 –> 0:36:51.873 that the COVID 19 cases get so high, okay?
0:36:53.82 –> 0:36:56.49 In case of what we have on the hospital admissions,
0:36:56.49 –> 0:36:59.37 this is our very demographic profiles.
0:36:59.37 –> 0:37:00.66 And in terms of the mortality
0:37:00.66 –> 0:37:03.21 is what I think what is very important.
0:37:03.21 –> 0:37:05.88 So we do have a couple of,
0:37:05.88 –> 0:37:09.15 nine or more different environmental variables.
0:37:09.15 –> 0:37:12.69 We only are analyzing in this case, nine of them,
0:37:12.69 –> 0:37:14.42 the one that we think
0:37:14.42 –> 0:37:17.81 that could be impacting health in Puerto Rico,
0:37:17.81 –> 0:37:21.47 and we build 18 different environmental indices,
0:37:21.47 –> 0:37:25.973 most of them retrieve from the satellites data.
0:37:27.05 –> 0:37:31.7 Since some of them, and both of them are correlated
0:37:31.7 –> 0:37:33.62 because these are atmospheric conditions
0:37:33.62 –> 0:37:35.29 that have a lot of co-linearity,
0:37:35.29 –> 0:37:38.04 so we only kept a couple of them
0:37:39.94 –> 0:37:44 to have a better understanding on how these variables
are associated with mortality in Puerto Rico.

So we started analyzing, we requested daily mortality from the Department of Health in Puerto Rico.

And as you can see here, this is mortality, total mortality.

Non accidental mortality, let me clarify that. This is non accidental mortality.

and we create this table for you to see it, for example.

So since 2015 to 2020, in Puerto mortalities, used to be higher during the Autumn and during the Winter.

still don’t know why,

but this is the patterns that we observe.

As you can see, for the last five years per season, the higher mortality occur in the aftermath of hurricane Maria, not necessarily during hurricane Maria.

Again, not too many people died during landfall, but many people died in the aftermath of hurricane Maria,

weeks and two weeks ago.

So after that,

you can see another record that occurred in 2020, but surprisingly, it didn’t occur in Fall or Winter,

it occurred in Summer.

So it means that it’s associated also with the COVID 19 cases,

again, not attributable 100%
to the cases of COVID, but because of the pandemic, a lot of people were afraid to search for medical attention and a lot of other things that need to be considered making another record for mortality in Puerto Rico during the Summer. Which is weird because over the last five years, this is the only Summer that it marked a record on mortality, this is the first time that we’re seeing this. And we’re wondering also how much this dust cloud event should be exacerbating the conditions, okay? So when we started analyzing mortality, we first starting by saying, “Okay, so we have a seasonality for the Saharan dust arrival to the Caribbean.” So we have Saharan days, for example, and we have non Saharan days. And those non Saharan days are those that are where we are not seeing aerosol optical depth. For example, the threshold that we use is 0.18, I’m not gonna go into the details. (laughs) And the other ones are the days where we can observe 0.18 or values above that for the aerosol optical depth. And we started to see that, for example, even though these aerosols are more associated to the Summer, but we can see a distinction also on mortality due to respiratory conditions without flu cases, because flu in Puerto Rico
has a very marked seasonality as well, and it’s more associated with Winter. So we took flu cases apart, and we take it out of the database and we only analyzed all of the other respiratory condition, and we started seeing some specific results.

Analyzing it with COVID 19, we observed that actually during the Summer, the patients that had COVID 19 were more likely to die, when UTCI, UTCI is universal thermal climate index. This is another indicator to provide information about how is the sensitivity to heat, okay? So your thermal comfort in regard of temperatures, okay? So that is considering wind speed, wind direction, humidity, relative humidity, and air surface temperature, obviously. But it’s an indicator, it’s an index, it’s not an information that is being provided by the National Weather Service, for example, because what they’re providing you is heat index or air surface temperature.

But we are actually seeing and slightly increasing or slightly system higher, right? The mortality, and this is something that we observe during the Summer, which makes a lot of sense, right? We also observe that COVID 19 patients are most likely to die when we do have also other allergens.
that are associated with molds and spores in Puerto Rico.

So that’s another natural source of air pollution, as I mentioned. And also when we had starting adjusting all this analysis per age and per season, we are observing that actually the numbers are continuing to rise and are even higher for COVID-19 mortality, as we could be expected. And again, in this case, we are not considering the vaccine because we close prior to the vaccination period in Puerto Rico, so we close it until March 2021. Vaccine is another story, and vaccination is changing obviously it might change all of these results, and the technology from the medical component, because there are new treatments, there are innovations in medicines, and a lot of other things that are helping for the patient not to die because of the COVID-19.

In terms of other respiratory diseases, we also observe that aerosol optical depth is also associated with the mortality of ischemic heart disease for Puerto Ricans. And also it is consistent even when you are adjusting this per year, per season, per age, and the different adjusting that can be done using the Poisson model assumption.
0:43:41.52 → 0:43:46.08 observations and the regulation analysis that we did.
0:43:46.08 → 0:43:49.35 For further considerations I think that
0:43:49.35 → 0:43:52.61 we are hunger to analyze the medical records
0:43:52.61 → 0:43:54.98 because we are still doing the data entry.
0:43:54.98 → 0:43:58.24 We still have only numbers as I show you
0:43:58.24 → 0:44:02.35 in terms of increases in hospital admissions
0:44:02.35 → 0:44:03.867 and emergency room visits.
0:44:03.867 → 0:44:06.14 And so we were more able to analyze
0:44:06.14 → 0:44:08.467 and to have a better results with mortality.
0:44:08.467 → 0:44:11.17 But mortality is only that is of the eyebrows meaning that
0:44:11.17 → 0:44:15.19 if you are able to identify that mortality
0:44:15.19 → 0:44:18.69 is increasing because of some specific conditions
0:44:18.69 → 0:44:23.22 you might expect that also you might expect to see
0:44:23.22 → 0:44:25.42 a lot of people searching for medical attention,
0:44:25.42 → 0:44:28.72 but are not that fragile to die, for example,
0:44:28.72 → 0:44:30.53 and some others that are getting affected,
0:44:30.53 → 0:44:32.75 but not even considering
0:44:32.75 → 0:44:35.24 to search for medical attention, right?
0:44:35.24 → 0:44:39.77 So these are important findings because for Puerto Rico,
0:44:39.77 → 0:44:42.22 I think that we are not only developing
0:44:42.22 → 0:44:44.61 the early warning system for a hazard
0:44:44.61 → 0:44:47.95 that is deteriorating public health in the region,
0:44:47.95 → 0:44:49.69 but also this is one of the first time
0:44:49.69 → 0:44:52.8 that we can provide evidence that the Saharan dust
0:44:52.8 → 0:44:55.55 is in somehow related with mortality.
0:44:55.55 → 0:44:57.72 As well again, partially attributable.
0:44:57.72 → 0:45:01.08 Something is a statistical analysis,
0:45:01.08 → 0:45:04.65 and some other is that by doing the qualitative analysis,
0:45:04.65 → 0:45:07.08 talking with the physician and with the experts.
with the informants, we might be able to explain better how this hazard is deteriorating the health of their patients. We still have a lot of other questions that need to be answered in order to identify the vulnerable patients and population. I think that it’s important that we are developing early warning system. You need to identify your target population, because this is how exactly, if you are talking about the population that are getting flooded or not. So you need to address your communication, your risk, your advisories to the more sensitive groups in order for them to take precautions before the arrival of this dust cloud. So we will continue working on this and we’ll stop sharing my screen, and I’ll be happy to answer whatever question you may have. Thank you so much for the wonderful presentation Pablo. And just a reminder to the audience that if you have any questions, please do put them in the chat box. And well, for this seminar, we have 19 students attending, and we actually have already collected some of the questions from the students. So while the audience is putting their questions in the chat box,
we are to start with two questions from students. Actually, there are two types of questions the students are mostly interested in. The first one is actually, Pablo you show us how to distangle the interactions between the dust and COVID and the all the environmental factors. So many students actually are wondering how to control for confounding factors like from human behavior. Like people may spend more time in doors during the Saharan dust. That’s a pretty good question. With the data that we have from mortality and medical records, it’s a little bit complicated. The only way that I will say that it will be useful to receive more accurate information in that regard will be by doing interviews. One on one interviews with the patients, for example, identifying or doing focus group directly with all of them. That’s another way on how can you measure exposure, right? Well not measure, but at least having a proxy on the exposure for Saharan dust. So yes, it was complicated because during this Godzilla dust event, we were struggling with COVID 19. One of the recommendations already in Puerto Rico,
and I think that is also in the United States as well happen

is that the agency were telling,

were suggesting the population to open the windows and doors

to let the clean air to get in. (laughs)

So, we’d receive a lot of memes

from people that were saying,

"Okay, so if I open the doors and the windows,

then my house will be full of sand. (laughs)

So what do I do?

I cannot open the windows.

I cannot open the doors

because I have an outdoor hazard,

but if I keep it closed,

then if someone bring the virus inside of my house,

I might probably get infected with the virus.”

So yes, it was a little bit not funny,

but a lot of people took it that way.

And you can see a lot of memes that came out

during that season.

Thanks Pablo, yeah, this is very complicated.

And when it gets to real policy recommendations,

I think a lot more research is needed.

I do see another question from Robert Dubrow,

Professor Robert Dubrow is the director,

faculty director of our center.

So he ask, "Is there evidence that climate change

is affecting Saharan dust in the Caribbean?

For example, is there anything known about

what caused the Godzilla dust event?”
And I also wanna mention that this question, it combines with one of the students question that wondering, not just dust, but also other like hurricanes in Puerto Rico, "Does climate change, you know, introduce some additional, these extreme weather events and can they play a role in the COVID prediction in Puerto Rico?" So two separate questions, but kind of related, thank you.

Let me see, how can I address this? And thank you for both questions.

Let me mention something very quickly related to the other one, to the first one. By using masks, one of the recommendations from the CDC, we are unable to minimize the exposure to this dust, right, to these aerosols. So that’s something very important, and we need also to highlight, because most of the people in Puerto Rico are using mask outdoors, even outdoors, right, so that’s important.

Okay, so in terms of climate change, yes, there is evidence that in some cases that the Saharan desert is getting bigger. So that means, that could mean, let me say it like that, that most likely the source of mineral dust could be increasing in terms of tons of sediments that could be lifted by the air. But we need some other kind of conditions.
0:50:36.4 -> 0:50:39.39 to make this dust to arrive to the Caribbean.
0:50:39.39 -> 0:50:40.223 And for example,
0:50:40.223 -> 0:50:42.46 wind directions and wind patterns, right?
0:50:42.46 -> 0:50:44.65 So if you don’t have the wind velocity
0:50:44.65 -> 0:50:47.47 or the capacity to lift dust particles
0:50:47.47 -> 0:50:49.23 to be transported, floating in the atmosphere
0:50:49.23 -> 0:50:52.92 to the other side, it’s another story.
0:50:52.92 -> 0:50:56.38 But yes, the source is increasing in the Saharan desert.
0:50:56.38 -> 0:50:59.22 So it’s mean that it’s getting dryer some places in Africa
0:50:59.22 -> 0:51:01.61 and also to the Southern part of Europe.
0:51:01.61 -> 0:51:03.84 So most likely, again,
0:51:03.84 -> 0:51:07.363 providing more sources of mineral dust to the atmosphere.
0:51:08.34 -> 0:51:11.37 If the trade winds continue to be the same,
0:51:11.37 -> 0:51:15.4 we could say that probably it will increase
0:51:15.4 -> 0:51:17.51 the amount of dust that we are receiving.
0:51:17.51 -> 0:51:20.73 But until now, there is no evidence suggesting
0:51:20.73 -> 0:51:23.88 that we are receiving most dust than ever.
0:51:23.88 -> 0:51:26.6 We do receive a record
0:51:26.6 -> 0:51:29.12 that it was marked by the Godzilla dust event,
0:51:29.12 -> 0:51:33.288 but it’s not marketing a trend, okay?
0:51:33.288 -> 0:51:36.017 In terms of other sources of extreme event,
0:51:36.017 -> 0:51:38.96 for example, yes, hurricane Maria
0:51:38.96 -> 0:51:42.31 devastated millions and millions of trees and vegetation
0:51:42.31 -> 0:51:44.41 and green infrastructure, right?
0:51:44.41 -> 0:51:47.57 So right after hurricane Maria with a lot of humidity,
0:51:47.57 -> 0:51:52.57 we marked another record for mold in Puerto Rico,
0:51:53.19 -> 0:51:55.71 and mold is another natural source of air pollutions
0:51:55.71 -> 0:51:57.17 other allergens, right.
0:51:57.17 -> 0:51:58.11 And that was amazing.
So hurricane Maria switched a little bit
the pattern and the behaviors of these other allergens
that are associated with the vegetation. And so meaning that these powerful extreme events,
have the capacity also to change
how these other allergens are being distributed along the year.

Thanks Pablo, yeah. I just want to mention one of the things that
in terms of the dust, there’s also some researcher in from the European side,
say the Sahara dust also larger in size than the PM2.5, they do bring a lot of health effects
to the respiratory systems. So I think in addition to the COVID work,
your Sahara dust work is also very interesting. I do encourage audience, if you do have questions,
please feel free to put it in the chat box. And if not then in the meantime,
I want to ask a final question from the students. Actually, the students are very excited
about the public health early warning system that you’re creating.
And they’re wondering, you know, you study a lot about the interactions
of these seasonal pattern, the environment factors, and they are wondering, like,
"When you actually put them into the policy recommendations,
what are the, you know,
experience or source you have
and how effective that could be?"
Well, I have two great experience in Puerto Rico,
mainly with the Puerto Rico Department of Health,
because you have two different agencies
that are responsible of working with this, right?
The National Weather Service is the agency responsible of monitoring the weather
and the atmospheric conditions,
but they’re not responsible of issuing any kind of warning
to protect public health,
is this the responsibility of the Department of Health.
So you need that coordination,
one agency to monitor the weather
and to provide that warning for the population.
And the other one to tell the population what to do,
because this is a public health issue, right?
So I started working with them
since the very first beginning.
Both of them were very committed,
wanted to work with us very closely,
and so that’s how we gained that trust.
So now all of us together, we’re working on that.
The recommendations are coming out
from meeting groups that we’re having,
from all of our team,
epidemiologists, physicians
and climate atmospheric scientists,
working with the National Weather Service
and the Department of Health.
And all of them are listed, so once the warnings are posted by the Department of Health, then you will see the list that is the list of actions that you need to do or to follow in the case, if you are as part of the sensitive group.

Thanks Pablo, that’s excellent point. I think we anchor your point that, you know, to deal with the COVID pandemic also climate change, we need a multi department and the collaborations from researchers across and also from different governmental agencies.

There’s a follow up question from Rob, "How far in advance can you predict the levels of Saharan dust in the early warning systems?"

Well, now I suppose that we might, we might have up to 72 hours from now and will be available somewhere between this week and the other one. But for now, if you go into the webpage, you will see is only the real time information. We’re still working on the early component (laughs) to provide the information in advance. So we have this year to continue working completely on the forecasting. Yeah, for 72 hours. We will have it very soon this week or the next week. And we will have one full year to work it with the decision makers and with the community on how to improve it.
To test it.

Yeah, thank you.

Thank you, Pablo.

for the wonderful presentation and very engaged discussion.

And thank you all for joining us today.

I think let’s give the final, like applause to Pablo for the wonderful talk today, and thank you everyone for coming.

Thank you for inviting me.

Happy to be here. Bye everyone.

Thanks Pablo.

Ciao Robert, good to see you.