RESULTS: Breakout groups- NCA4 Engagement Workshop - March 9, 2017

EXTREME EVENTS GROUP

Facilitator: Felix Aponte and Note taker: Nora Alvarez

Question	ROUND #1	ROUND #2
1. Mention observed effects of extreme events due to climate changes	• Fire events like forest fires • Urban floods • Displacement of people due to floods • Displacement of people due to hurricanes • Drought - crop damages • Transportation issues between islands (e.g. Culebra and Vieques) unsafe during extreme events • Pest increase • Heat waves - increase in mortality rates and increase in energy use • Tourism impacted by heat waves • Floods - increases the spread of diseases, increase of mosquitoes • Landslide damages • Flood impact - supply chain of commerce and distribution of food, mobility of people • Extreme events impacts on the energy sector - production can be affected due to wind events - electric infrastructure gets affected	• Diseases in humans (zika, dengue, chikunguya) • Pest diseases - more pests coming in, need to apply more pesticides, more contamination, health issues - chain of effects • Soil erosion - increase due to increase rainfall • Wildlife behavioral changes - Elfin warbler example - competition because of droughts, not enough fruits in the south, Elfin are moving to lower elevations in El Yunque • Phonological changes in crops- germination changes are changing to extreme events. Need to understand how to adapt during extreme events because they mainly depend on irrigation. • Hurricanes increasing in strength. Small changes in hurricanes intensity increase impacts • Heat stress - urban settlements impacts on work industry, outdoor exposure (e.g. Construction) • Increases in wind speed - increases in damage in infrastructure • Accumulation of small events add to create big impacts • Warmer temperature at nights increases humidity, increases mosquitoes • Ports and maritime commerce vulnerability • In island environment, external transportation is key

2. Mention projected effects of extreme events in the next 20-30 years and by the end of the century due to climate changes	• Increase in expenditure in disaster response • More frequent extreme events • Increase in the loss of properties • Increase of poverty • Decrease success of the agricultural sector • Impacts on tourism and economy • Increase impacts on infrastructure (dams, interruption of services, road floods) • US Corps of Engineering design should consider future trends - the current infrastructure is not design for the coming changes • Expecting more flood events • Effects of transportation in Saint Thomas (roads) • Relocation of people • Stronger hurricanes but less numbers - consider indirect impacts and cumulative effects • Cold fronts, winter swells coastal erosion is an emerging issue • Insurance rates will go up for everything	• Perception of vulnerability due to extreme events have a big impact on tourism • Perception of increase in impacts of extreme events decreases tourism; same with diseases • Tourism in Caribbean from the total tourism market is only 5%- fluctuations wil have major impacts on tourism • Increases in GMO - temp, pests, water, flooding resistant crops • How planning increasing agriculture should take into consideration extreme events
3. Mention references or resources on this topic that we should be aware of	• USVI Gap Analysis • Vista Dimension - Journal from the Colegio de Ingenieros (topics from water use to energy productions) • Article: Islands in the Sun by Wayne A. • PRCCC - State of the Climate • Urban heat papers by Pablo Mendez et al. • West Indies - Michael Chang and Peterson papers • Wildlife - Elvira Cuevas • CCCCC web site • National Weather Service Reports • El costo de la inacción- Ramón Bueno	• Cariocom • Cepal • State of the drought report • Javidan Rodriguez (now at NSF) - former professor in Mayagüez- Papers on disaster Management • Wayne Arendt study on Elfin Woods Warbler (2014) • Globe Teachers Guide //observer.globe.gov/ • Indigenous Phenology Network • Food and Agriculture COuncil - includes Puerto Rico, declara cuando hay evento extremo

4. Mention adaptation success stories for addressing risk that can be highlighted	• Caguas Bairoa 25 - Demolición y re localización de viviendas por inundaciones • European Union - insurance scheme to extreme events • Cano Martin Pena Project • Water from in Saint Johns (Torruellas project - coral reefs) • Restoration for Coastal Projection • Drought Protocol	• Crisis induces collaboration - examples among farmers in Cidra • Where small-scale collaboration occurs - learning from them • Cenepol for drought - meat industry • Youth environmental netwokr in Caribbean • Dominique youth and climate project - combining traditional knowledge
5. What are the emerging issues and research gaps on this topic	• More research needed on winter swells impacts • Cost of inaction research • Public education and outreach	• Investigate germination cycle changes due to extreme events • Accumulative impacts of smaller events • Dough, temperature stress, and wind resistant crop varieties • Bird migrations are being observed to the south - need to study these patterns and the impacts on tourism • Gender role in disaster risk management and respond • Need to gather traditional knowledge - for food production and traditional medicine • Education and Awareness • Cultural Practices • Need Multi-hazard Approach - how to manage multiple events (e.g. Drought followed by floods)

FRESHWATER RESOURCES GROUP

Facilitator: Eric Harmsen and Note taker: Nora Alvarez

Question	ALL ANSWERS
1. How have freshwater resources been	• Increase in total dissolved solids (TDS) in groundwater (about 200 mg/l in 1970, to 400 mg/l in 1970s and 1980s, to 800 mg/l current. In the Northeast, TDS is 1000- 2000 mg/l in comparison to 200 mg/l in the 1970s. A cause of this may be pumping wells for water supply.

affected by climate change?	• Saturated thickness in the North 200 - 250 ft, but what percent might be due to climate change? • Well salinization. • One participant noted that during the 2014- 2016 drought be received an inquiry from the media asking why reservoirs could not be constructed in high elevated mountain areas which he had not experienced before. • Coastal springs decreasing. • Less than 10 percent rain recharge to aquifers. • Need water management programs that consider aquifer recharge. • Southern Caribbean issues with fires. • Saline intrusion- in future drought events, saline intrusion may become a more prevalent issue (ex: Toa Baja is drier than it has been in the last 15 years). • Well extraction will increase with droughts. • Excess recharge from surface irrigation. • Recharge rate very low. • Floods have affected freshwater resources. • Animal communities migrating. • New diseases emerging in water. • If minimum flow is lacking, the aquatic biota will suffer.
2. How are freshwater resources projected to change by the end of the century?	• Reduced water available due to less rainfall. • Extreme events increase. • We need to keep seasonality in mind. • Aquifer can be recharged during extreme events. • After a dry period, water may mostly run off due to the seal in soil surface. • Groundwater recharge decreases, groundwater component in rivers will be lacking, base flow will decrease (although we do not have a handle on base flow and seasonality). • Seasons are changing. • As rain patterns change, it will be more difficult to harvest rain. • Water infrastructure continues to age. • Treatment costs will increase. • USVI households rely on rainwater and with changing rainfall patterns, this will become more difficult. Lack of understanding of existing resources (groundwater, etc) is another challenge. • River outflow changes coastal beaches. Change in river flow affect aquatic habitat. • As populations move to higher elevated areas due to sea level rise, they may affect freshwater resources and contaminate water.
3. Mention references or resources on this topic that	• Hydrology of the Southcoast - Sigfredo Torres 2016 • NOAA resources • Water budget for El Yunque - University of Georgia • Climate Change in Puerto RIco - Azad • Harmsen - Water Use Management in Puerto Rico (Ag water management) • Emerging Issues Small Scale Agriculture

we should be aware of	• Fernando Quinones - table on AAA operations • Sea Level Rise - Aurelio Mercado • EPA Watershed Laws • Gustavo Martinez - Water Quality and Freshwater Resources • USGS Acuífero del sur y cambios de precipitación • Pablo Méndez Lázaro - cambio en precipitación en Río Piedras • DNER / AAA website - info de embalses y acuíferos • PRAGwater.com - soil moisture and crop stress • Clean Water Act & Clean Air Act • UPRM.edu/courses from Hector Lopez - water usage, layouts for rainwater collection
4. Mention adaptation success stories for addressing risk that can be highlighted	• Success story - IITF rainwater harvesting and permeable pathways. • Success story- USVI requires 3 types of water tubing (roof, toilets, drinking/bathing) as a part of their construction regulations. • Success story - St. John's hotel uses reclaimed water for garden. • Success story- Las Casas de la Selva sustainable forestry project has a wastewater garden. • Success story - Signs on storm water drains in some coastal areas indicate that the water drains directly to the ocean. • Success story - Ventana del mar - new vegetation was planted to avoid sand erosion. • Success story - Use of air conditioning condensation toilet water. • Success story - 2014 - 2016 drought management was a success. • Successful use of cover crops to conserve water - strategic plan was also developed to manage water. • Opportunity - Due to recent PR drought, citizens are more aware of water resources. • Challenge - Water use must be improved because it is ineffective. • Challenges - Need more strategies to capture extreme events. • Challenge - Excessive use of freshwater by PR citizens. • Challenge - Poor will be more impacted by lack of water because they can't afford bottled water and other emergency options.
5. What are the emerging issues and research gaps on this topic	• Agriculture is growing, so the water demand will increase. Future conflict between agriculture and AAA (for domestic water use). • Link between energy, water and food. • Need to communicate to public - like Ariel Lugo's great Caribbean Business article on the drought. Need to increase scientific communication to public • Receiving input from public is also necessary. • There is a lack of communication at the state level. • A need for data on evapotranspiration. • Need for adequate distribution of freshwater. • Glysophate (RoundUp) is used for weed control and it contaminates water because there are no laws to regulate. • AAA does not remove medicine or pesticides.

	• The lack of integration of agencies that work with water resources may dilute their efforts. • Need for public education. • Enforcement needs implementation.

RISING SEA LEVELS & COASTAL EROSION GROUP

Facilitator: Aurelio Mercado and Note taker: Vanessa Marrero

Question	ALL ANSWERS
1.Mencionar los efectos observados del cambio climático en el aumento del nivel del mar y la erosión costera en el Caribe.	• Efectos en las barreras costeras (incluyendo mangles, arrecifes,) • El nivel del mar está aumentando se ha observado una *aceleración más rápida del aumento del nivel del mar de lo esperado. • Pérdida de la costa, en especial de las playas. • Cambios de hábitat costeros (ej. Cabo Rojo) • Impactos en el turismo costero (Sea Sun Sand) • Intrusión salina de los acuíferos • Impacto en las estructuras cercanas a la costa. • Impacto en comunidades pesqueras
2. ¿Cómo se proyecta que el cambio climático afecte nivel del mar y la erosión costera en los próximos 20-30 años y para final del siglo?	• Pérdida de hábitat • Impactos en las especies marinas que están en áreas poco profundas, con una mayor profundidad debido al SLR pudieran afectarse. • Mayores áreas con salinidad en los acuíferos. • Impactos en la salud (aumento en las enfermedades vectoriales) • Impacto en la calidad de vida (bienestar psicológico y recreación) por la pérdida de playas. • Efecto de water logging • Aumento de inundaciones costeras • Inundación del aeropuerto en SJ • Mayores efectos en las marejadas ciclónicas • Impacto de salud, por áreas inundadas aumentan las enfermedades vectoriales y en algunas áreas cercanas a la costa se unen con las aguas residuales (aguas negras)
3. ¿Hay recursos o estudios de casos que debemos tener en cuenta?	• IPCCC • Aurelio – Sea Level Rise around PR • PRCCC

4. ¿Qué desafíos, oportunidades e historias de éxito para manejo de riesgos pueden ser destacados?	• Florida (re-noutrishment) realimentan las playas • North Carolina – manejo del retroceso (Retreat) • Holanda • Inglaterra • En Puerto Rico – Comunidad Juana Matos, tiene Ecosystem based Adaptation projects. Con la siembra de manglares y restauración de humedales para evitar las inundaciones costeras.
5. ¿Cuáles son los problemas emergentes y / o brechas de investigación en este tema?	• Estudiar el impacto económico y social: • de la reubicación de comunidades (envejecimiento-población vulnerable); • del impacto en los puertos y lo que esto representa en la seguridad alimentaria de PR • Impacto económico en el turismo. Necesidad de diversificar el turismo. • Necesidad de mover infraestructura, tales como: • los pozos que estén a menos de 200 pies de la costa • aeropuerto de SJ • Necesidad de una política pública que atienda estos efectos, ej. Ley de Costas de PR • Necesidad de investigación social y de planificación de usos de terrenos. • Reubicación de comunidades • Inundación de terrenos agrícolas de gran valor ej. Juana Díaz • Enfermedades vectoriales • Cómo afectan las inundaciones molestosas afectan la rutina diaria de las comunidades (ej. Condado, Caño Martín Peña, etc.)ñ que también se suman a las aguas residuales lo cual pudiera afectar la salud

CHANGING OCEANS GROUP

Facilitator: Apurva Dave and Note taker: Amanda Leinberger

Observations: There were not many participants in this group, so this could either be an indicator of lack of presence of pertinent experts or a relative lack of priority (among those present and taking into consideration that among the 5 topics, there was only time to choose 2). So, I want highlight that although, when compared to other groups, there is a lack of information here, as well as a lack of confirmed existing and available data and information on some of these topics, that this does not mean that these issues under are not as important or should not be included in this Caribbean chapter. There is also an overlap between what is included in this group with what other groups are covering, e.g. extreme events and sea level rise. The areas in which this section is unique are coastal ecosystems (such as corals) and also fisheries (displacement and changes in distribution of fish populations and changes in diversity of these ecosystems) and their connection to recreation and tourism.

For observed effects: We looked mainly at climatic stressors such as increased ocean temperatures, increased precipitation, and an increase in extreme events and how these are connected to effects in coastal ecosystems, fisheries, and tourism. Observed effects that we discussed include an increase in diseases, habitat loss, increased acidity, higher sedimentation output, increase in coral mortality, decrease in habitat, harmful algal blooms, and changes in primary production species.

Question	ALL ANSWERS

1. Mention observed effects of climate change on oceans in the Caribbean.	• Increased temperature
	  ○ Increase in diseases
	  ○ Changes in habitat
	  ○ Changes in biodiversity
	• Increased CO2
	• Ocean acidification (Atmospheric Chemistry)
	  ○ Increase in coral mortality
	  ○ Effects on shell-forming organisms
	  ○ Effects on tourism due to coral reef loss
	• Increase in precipitation
	• Higher sediment output
	  ○ Increase in coral mortality
	• Increase in extreme events
	• Higher sediment output
	  ○ Increase in coral mortality

5. What are the emerging issues and/or research gaps on this topic?	When we talk about changes in distribution of marine organisms, those changes of distribution occur in space and time and create complex interactions between the organisms and their environment. Therefore, it is very difficult to understand what the effect is, especially when there are many compounding climatic stressors on organisms. We also highlighted the need for higher resolution hydrodynamic patterns. Also, there is a lack of understanding of sedimentation and pollution effects on corals specific to extreme events. For example, the amount of sedimentation discharged during one week of rainfall vs. one day (sensitivity to increased plumes distributed over shorter vs. longer time intervals). Another gap is the need to understand which coral species are more resilient.

WARMING TEMPERATURES GROUP

Facilitator: Pablo Méndez-Lázaro and Note taker: Sandra Soto

Question	ALL ANSWERS

1. Mention observed effects of warming temperatures	• Effect on habitats and different species:
	  ○ Impact on bird's nest & breeding times
	  ○ the gender of sea turtles changes depending on the temperature of the sand. Higher temperatures - males
	  ○ decreased air quality (indoor & outdoor)

in the Caribbean	• Human health: it has been found that human beings have a "thermal comfort" that is defined by the temperature to which you are exposed 75% of the time. This is why in PR we have less tolerance to higher temperatures, than our grandparents because we live in A.C. systems. This also makes us more sensitive when temperatures increase and mortality rate is higher at lower temperatures.

2. Mention projected effects of warming temperatures in the next 20-30 years and by the end of the century.	• High uncertainty
	• Impacts on human health:
	  ○ Exposure of general population and workforce (airports, AEMM?).
	  ○ Cardiovascular & cerebrovascular.
	  ○ Increased mortality.
	• Effects on agriculture:
	  ○ Planting and harvest season change. This leads to changes on markets and has economic effects. Demand of products that already is on certain seasons, will have to change.
	  ○ Products are affected, such as milk production due to stress to livestock.
	  ○ More and new pests (shorter life cycle).
	  ○ Higher demand of pesticides.
	  ○ Increased costs of production that won't lead to time of "barbechos".
	  ○ Impact on agricultural productivity due to changes of plant/crop growth rate. Dehydrated soils
	• Impact on tourism: higher temperatures decrease tourisms due to the comfort temperatures of tourists (María Santos mentioned that there is a set range of typical temperatures that tourists seek - 26ºC? - and if you have higher temperatures than that people will stop visiting the country)
	• Impact on businesses because businesses and industries have to increase costs of production, such as the cost of A.C. and electricity. This has a snowball effect and leads to higher costs to do businesses in general.
	• Increase in operational costs of hospitals or keep food refrigerated (hygiene)
	• This will lead to economic problems and will also cause higher standard of living (costo de vida??) and production (e.g. plant nurseries have to control temperatures inside)
	• Social problems:
	  ○ Poor communities are more vulnerable, due to the fact that they don't have the resources to adapt. What are public policies on this respect?
	  ○ Older sector of the population
	• Impact on habitats due to changes on plant growth or animal behavior:
	  ○ changes on bird breeding & nest times
	• Climatic: In PR we will have more Saharan Dust arriving & More intense hurricanes & higher temperatures causes stronger winds

3. Mention references or resources (reports, etc.)	• Pablo & Rafael Méndez (2015) (2016) • Joglar (2016) - about effect of climate change on coquí • Raúl Pérez Rivera - effect on nesting patterns of "golondrinas" due to changes in precipitation because they need to nest on wet season

on this topic that we should be aware of.	• Santos, M. & Méndez, R. (2016) • Mark Jury has publications from 1998 - today • Azad et al. 2016 • CELAC • CCCCC • UN-WTO • WTTO • WMO - WHO Heat Warming Advisory 2015 • USDA - APHIS PPQ Annual Plant Board • Laboratorio Agrológico Estatal (pests, soils) • Journal UPR - Mayagüez - Ciencias Agrarias
4. Mention adaptation success stories for addressing risk that can be highlighted.	• Heat early warning system in tropical arc (Hong Kong, Vietnam) • Planting of trees in areas with livestock • Café bajo sombra • Federal incentive programs (USDA) for sustainable agriculture • agroecology: use mulch • Josco Bravo (Toa Alta) • USVI are looking for plants with better resilience to increased temperatures

5. What are the emerging issues and/or research gaps on this topic?	• Education
	  ○ K-12
	  ○ Add this topic to engineers & architects curriculum
	  ○ patronos
	  ○ general population should be aware of the effect that changing temperatures have on ecosystems
	• Improve design of buildings, houses and structures (this is related to adding this topic to the curriculum of engineers and architects)
	• Cost of inaction
	• How is going to be government intervention?
	  ○ Legislation of climate change
	  ○ research
	  ○ guidelines
	• Adaptation Strategies for Emerging Issues & Risk Vulnerability Assessment
	• Emerging diseases
	• Emerging vector - borne disease
	• Social inequality
	• Integración interagencia
	• Green infrastructure and heat reduction on buildings