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Assessing the Impact of Rising Sea Levels on Travel and Tourism in APEC Economies

APEC Tourism Working Group

December 2023

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Executive Summary

Introduction

In many Asia-Pacific economies, tourism is a leading source of export earnings, generating jobs and supporting livelihoods primarily in small and medium sized enterprises (SMEs). Tourism development in the region is often concentrated along coastlines due to many travelers' desire to experience beach and ocean environments in addition to other destination amenities. These same coastal areas are also increasingly affected by natural disasters such as frequent typhoons, record-breaking rainfall events, and sea level rise, all attributable to climate change.

Despite many Asia-Pacific economies' efforts to increase the resilience of their infrastructure to such risks, the tourism SMEs operating within them, which account for 99% of all tourism enterprises in the region, remain vulnerable to the effects of climate change because they have limited human and financial resources to cope with them. In addition, tourism SMEs cannot place the sole burden of preparedness and responses on local governments since the latter will be primarily focused on protecting infrastructure, such as airports, roadways, and hospitals, in low-lying areas when disasters occur. Therefore, it is imperative to identify feasible strategies that tourism SMEs can independently implement to prepare for, manage, and recover from sea level rise and major storm events.

The purpose of this report is to aid such preparations by: (1) summarizing and sharing information on the effects of sea level rise and extreme storm events on tourism SMEs in APEC economies, and (2) identifying and communicating innovative tools and best practices that tourism SMEs can learn to lessen the disruptions caused by sea level rise and extreme storm events. The means to these ends were: (1) an extensive literature review that identified the best practices of tourism SMEs in mitigating and adapting to sea level rise, (2) a survey of the members of APEC's Tourism, Emergency Preparedness, Small and Medium Enterprises, and Ocean and Fisheries Working Groups to determine their understanding of climate change impacts and what tourism SMEs in their economies were doing to deal with such impacts, and (3) summaries of technical approaches and case studies of best practices in the APEC region for adapting to, and mitigating, the ill-effects of sea level rise and extreme storms.

Literature Review

The literature review confirmed that sea levels are continuing to rise at an accelerating rate. Though a retreat from popular low-lying areas due to sea level rise and storm surges is inevitable, cost-effective actions that tourism SMEs can independently take to reduce expected damages and costs in time and money from flooding and storm events are available, including these described by the Intergovernmental Panel on Climate Change:

- **Protection**, which reduces coastal risk and impacts by blocking the intrusion of seawater and extreme winds into coastal areas through such means as dikes, seawalls, storm surge barriers, breakwaters, and beach-dune systems;
- **Advance**, which creates new land by building seawards (e.g., reclamation of new land above sea levels or planting vegetation to support natural accretion of land);

- **Ecosystem-based adaptation**, which combines the benefits of protection and advance strategies based on the conservation and restoration of ecosystems such as reefs and coastal vegetation;
- **Accommodation**, which includes a diverse set of biophysical and institutional responses to reduce the vulnerability of coastal residents, human activities, ecosystems, and the built environment (e.g., raising buildings, planting salt tolerant crops, insurance and early warning systems for extreme sea level events); and
- **Retreat**, which reduces exposure to coastal hazards by moving people, assets, and human activities out of exposed coastal areas.

Results of Survey of APEC Working Group Members

The survey of APEC Working Group members was conducted in November and December 2022. Of the 84 members contacted, 51 (60.7%) completed at least some portion of the questionnaire. However, only 20 (23.8%) completed it in its entirety.

Respondents were asked to indicate their perception of the short-term (one to five years) risks that nine negative impacts of climate change had on tourism SMEs in their economies, on a scale from 1 ("low risk") to 5 ("high risk"). Respondents were also queried about the long-term (six or more years) risks that the same nine negative impacts of climate change had on tourism SMEs in their economies, on the same scale. In most cases, respondents perceived higher short-term and long-term risks to be associated with chronic impacts, such as harm to fisheries and coastal ecosystems, than with episodic impacts, such as extreme storms and waves. In addition, respondents were more concerned about how climate change would harm the tourism SMEs in their economies in the distant, as opposed to the near, future.

Respondents were also asked to indicate how frequently five responses to sea level rise, such as "retreating from coastlines when beach erosion requires," were applied in their economies, on a scale from 1 ("not used at all") to 5 ("universally used"). The highest mean responses were for "building sea walls" and "preserving/planting mangroves as a natural defense".

Respondents were asked to indicate how well tourism-related entities in their economies were prepared for, coping with, and recovering from the negative impacts of climate change. This was measured by asking respondents to rate their economy's fitness with respect to 15 abilities, such as the "ability of lodging SMEs to provide back-up sources of drinking water after major flooding or a major storm event," on a scale from 1 ("poor") to 5 ("excellent"). With the exception of only one ability in the list, the mean score on this scale were below the midpoint of the scale (i.e., 3.0), indicating a widespread perception that tourism-related entities were not dealing well with the negative impacts of climate change.

In response to the question, "What do you feel are the best ways for government policy makers and destination managers in your economy to incorporate resiliency into tourism planning and development?", four respondents articulated the need to work closely with stakeholders, and another described the potential role of entrepreneurship training.

Best Practices Case Studies and Technical Approaches

To help delay the effects of sea level rise and reduce its disruptive effects, six best practices cases and two technical approaches were studied to serve as a catalog of options that tourism SMEs and destinations can mix and match and adapt to their own locations. To enhance this adaptability, the cases and technical approaches by design represent a wide range of existing and emerging practices, including those employed by traditional tourism SMEs (Babcock Ranch, USA and Magnums Unique Accommodation Airlie Beach, Australia), a tourism "social enterprise" that uses its profits to fund social programs (Wanderlust Indonesia), communities (Kampung Tua Bakau Serip and Budo Tourism Villages, Indonesia), an entire region of an economy (Quintana Roo, Mexico), and architectural and engineering approaches (floating overwater resorts and engineered reef structures). Each of the case studies were either nominated by authorities or identified through the principal investigators' search efforts as tourism SMEs or destinations that had successfully mitigated and adapted to sea level rise. The search efforts included requests for nominations from: (1) members of the APEC Tourism Working Group, over 3,600 tourism academics globally through the Tourism Research and Information Network electronic bulletin board, (3) alumni and advisory board members of the School of Travel Industry Management at the University of Hawai'i at Mānoa, which has large and active alumni associations across the Asia-Pacific region, and (4) academic colleagues throughout the region who work in climate change, sea level rise, and coastal conservation.

Notwithstanding the great diversity in the cases and approaches studied, four broad themes in them emerged: (1) the important role that environmental preservation can play in shielding coastal zones from the adverse effects of sea level rise and extreme storms, (2) the need for leadership in meeting the challenge of these environmental changes, (3) the significant contribution that technology can make in meeting this challenge, and (4) the importance of educating people about climate change, sea level rise, and disaster preparedness.

Conclusions

The results of this study revealed that few tourism SMEs are preparing for sea level rise and major storm events in any significant way, essentially leaving the effort up to local and domestic-level governments. This may be due to: (1) the daily challenges of managing tourism businesses in today's competitive environment, (2) the fact that building resistance to sea level rise in the face of inevitable retreat might appear to many tourism SMEs to be fruitless and beyond their financial capabilities, and (3) the difficulty of obtaining sea level rise estimates for specific areas, exemplified by the fact that 75% of respondents to our survey affirmed that "data on sea level rise, extreme storms, and sea level events, and associated impacts, are unavailable or inadequate in your economy." Since it is obviously impossible to prepare for what one cannot imagine, more and better data on climate change phenomena are clearly essential.

The widespread perception among survey respondents that tourism-related entities were not prepared for, coping with, and recovering from the negative impacts of climate change highlights a need for education on the seriousness of such impacts and action to mitigate them. University outreach and government technical assistance programs can provide this education, preferably in a collaborative mode.

The results of the best practices cases and technical approaches studied highlight the importance of: (1) promptly expanding the preservation of remaining natural areas before they are lost to development; (2) nurturing leadership capabilities in homes and schools, socially recognizing it when it is deserved, and following and emulating it when it is clearly discernible; (3) governments actively encouraging the development and application of climate change adaptation technologies through grants, tax subsidies, demonstration projects, and education and training programs, and (4) governments supporting programs to better inform people about climate change, sea level rise, and extreme storms, and how to protect themselves from the associated risks, through grant and instructor training programs. Overall, the cases and technical approaches studied illustrate the fact that adapting the tourism industry in APEC economies to sea level rise is not an insurmountable challenge, but it will require planned, adequately funded, and systematically executed action along the lines articulated above.

Introduction

In many Asia-Pacific economies, tourism is a leading source of export earnings, generating jobs and supporting livelihoods primarily in small and medium sized enterprises (SMEs).[1] Tourism development in the region is often concentrated along coastlines due to many travelers' desire to experience beach and ocean environments in addition to other destination amenities. These same coastal areas are also increasingly affected by natural disasters such as frequent typhoons, record-breaking rainfall events, and sea level rise, all attributable to climate change[2], contributing to the fact that the Asia-Pacific region accounts for over 70% of the world's natural disasters.[3]

Despite many Asia-Pacific economies' efforts to increase the resilience of their infrastructure to such risks, the tourism SMEs operating within them, which account for 99% of all tourism enterprises in the region,[4] remain vulnerable to the effects of climate change because they have limited human and financial resources to cope with them. In addition, tourism SMEs cannot place the sole burden of preparedness and responses on local governments since the latter will be primarily focused on protecting infrastructure, such as airports, roadways, and hospitals, in low-lying areas when disasters occur.[5] Therefore, it is imperative to identify low-cost strategies that tourism enterprises can independently implement to prepare for, manage, and recover from sea level rise and major storm events.

The stakes are high for coastal tourism regions across all APEC economies, where sea level rise and storm events are increasing in frequency and intensity, accelerating beach erosion and degrading natural coastal defenses such as mangroves and coral reefs, all of which will

[1] Asia-Pacific Economic Cooperation. (2023). Policy recommendations for tourism of the future: Regenerative tourism. 11th APEC Tourism Ministerial Meeting. Project TWG 08 2021S. https://www.apec.org/meeting-papers/sectoral-ministerial-meetings/tourism/11th-apec-tourism-ministerial-meeting/policy-recommendations-for-tourism-of-the-future-regenerative-tourism

[2] Asia-Pacific Economic Cooperation. (2022). 2022 APEC Research Center for Typhoon and Society (ACTS) Annual Meeting. APEC Policy Partnership on Science, Technology and Innovation. Project PPSTI 06 2022S. https://aimp2.apec.org/sites/PDB/Lists/Proposals/DispForm.aspx?ID=2968; Asia-Pacific Economic Cooperation. (2022). APEC Climate Symposium 2022 - Enhancing APEC Resilience through AI Applications in Climate Change Adaptation. Project PPSTI 05 2022A. https://aimp2.apec.org/sites/PDB/Lists/Proposals/DispForm.aspx?ID=3057; Asia-Pacific Economic Cooperation. (2021). Raising awareness of tourism crisis management in APEC. Project TWG 07 2021S. https://aimp2.apec.org/sites/PDB/Lists/Proposals/DispForm.aspx?ID=2906

[3] Zhu, L., & Huo, Y. (2023). Project report of demonstration and promotion of energy resilience tool based on solar-powered emergency shelter solutions (SPESS) for natural disaster in APEC. Asia-Pacific Economic Cooperation Energy Working Group. Project EWG 01 2022S. https://www.apec.org/publications/2023/05/project-report-of-demonstration-and-promotion-of-energy-resilience-tool-based-on-solar-powered-emergency-shelter-solutions-(spess)-for-natural-disaster-in-apec

[4] Washington CORE, L.L.C. (2019). SMEs' integration into global value chains in services industries: Tourism sector. Asia-Pacific Economic Cooperation Committee on Trade and Investment. Project CTI 20 2017A. https://www.apec.org/docs/default-source/Publications/2019/8/SMEs-Integration-into-Global-Value-Chains-in-Services-Industries/219_CTI_SMEs-Integration-into-Global-Value-Chains-in-Services-Industries---Tourism-Sector.pdf

[5] *New Zealand Herald.* (2010, 27 September). Building a house by the sea is not a good idea.

diminish tourism demand.[6] Studies reported in the media found that up to 80% of tourists would be unwilling to return to a coastal destination for the same price if coral reefs and beaches are damaged.[7]

Tourism SMEs located inland from coastal zones are not immune to storm impacts, either. Across most of the Asia-Pacific economies, steep terrains adjacent to beaches can be prone to landslides, rockfall, and floods during typhoons and extreme rain events.[8] The range of risk and the science explaining it can become overwhelming, leading the operators of many tourism SMEs to conclude that there is nothing they can do. But much can be done if we start preparing, as opposed to only reacting in times of emergencies.[9] The purpose of this report is to aid such preparations by: (1) summarizing and sharing information on the effects of sea level rise and extreme storm events on tourism SMEs in APEC economies, and (2) identifying and communicating innovative tools and best practices that tourism SMEs can learn to lessen the disruptions caused by sea level rise and extreme storm events.

The report is organized as follows. First, we summarize the processes driving the warming of the environment and the subsequent sea level rise and increasing frequency and intensity of extreme storms. Second, we report on an extensive literature review conducted to identify the best practices of tourism SMEs in mitigating and adapting to sea level rise. This literature review involved searching the APEC publications database and the newspaper and research databases of the Principal Investigators' (P. I.) university. When relevant APEC projects were still in their implementation phases, the P. I. emailed the projects' P. I.s to request relevant information to include in this report. Third, we summarize the results of a survey of the members of APEC's Tourism, Emergency Preparedness, Small and Medium Enterprises, and Ocean and Fisheries Working Groups to determine their understanding of climate change impacts and what tourism SMEs in their economies were doing to deal with such impacts. Lastly, we summarize eight best practices and technical approaches for adapting to, and mitigating, the ill-effects of sea level rise and extreme storms in the APEC region.

[6] *Honolulu Star-Advertiser*. (2014, 27 August). Isles warned of grim future for tourism. https://www.staradvertiser.com/2014/08/27/hawaii-news/isles-warned-of-grim-future-for-tourism/

[7] *Courier Mail*. (2007, 7 April). Hopes sinking for islands.

[8] Tsai, C.-H., & Liu, S.-C. (2017). Slope land disaster risk management in tourism. *Current Issues in Tourism, 20*(7), 759-786.

[9] *Honolulu Star-Advertiser*. (2014, 27 August). Isles warned of grim future for tourism. https://www.staradvertiser.com/2014/08/27/hawaii-news/isles-warned-of-grim-future-for-tourism/

Literature Review

Sea Level Rise and Extreme Storm Events in the Asia-Pacific Region

Sea Level Rise in the Asia-Pacific Region

The research reviewed confirms what scientists have long known: sea levels are continuing to rise at an accelerating rate. According to the Intergovernmental Panel on Climate Change (IPCC), "sea level is committed to rise for centuries to millennia due to continuing deep-ocean warming and ice-sheet melt and will remain elevated for thousands of years."[10] Sea level rise and extreme storm events are already forcing changes in coastal ecosystems and the tourism enterprises that depend on them. The evidence is overwhelming that sea level rise is well underway, requiring urgent action to slow and lessen disruptions to coastal tourism economies by making tourism infrastructure and enterprises more resilient. Though the retreat from popular low-lying areas due to sea level rise and storm surges is inevitable, cost-effective actions that tourism SMEs can independently take to reduce expected damages and costs in time and money in recovering from flooding and storm events are available[11] and summarized below.

Sea level rise is not globally uniform and varies regionally by plus or minus 30% of the global median.[12] Using the U.S. coastline as an example, a U.S. interagency report[13] concluded that sea levels will rise 10 to 12 inches (25 to 30 centimeters) during 2020-2050, which will be as much as the rise measured over the last 100 years (1920-2020). Appendix A provides ranges of sea level trends by economy in the APEC region. This predicted rise, along with warming ocean surface temperatures, will only increase the frequencies and magnitude of coastal flooding and extreme weather events that physically and financially

[10] Intergovernmental Panel on Climate Change. (2021). Summary for Policymakers. In *Climate change 2021: The physical science basis* (pp. 3-32). Contribution of Working Group I to the sixth assessment report of the Intergovernmental Panel on Climate Change. Cambridge University Press. doi:10.1017/9781009157896.001

[11] Intergovernmental Panel on Climate Change. (2019). The ocean and cryosphere in a changing climate: Special report of the Intergovernmental Panel on Climate Change. Cambridge University Press. https://doi.org/10.1017/9781009157964

[12] Ibid.

[13] Sweet, W., Hamlington, B., Kopp, R., Weaver, C., Barnard, P., Bekaert, D., Brooks, W., Craghan, M., Dusek, G., Frederikse, T., Garner, G., Genz, A., Krasting, J., Larour, E., Marcy, D., Marra, J., Obeysekera, J., Osler, M., Pendleton, M., … Zuzak, C. (2022). Global and regional sea level rise scenarios for the United States: Updated mean projections and extreme water level probabilities along U.S. coastlines. NOAA Technical Report NOS 01. National Oceanic and Atmospheric Administration. https://oceanservice.noaa.gov/hazards/sealevelrise/noaa-nos-techrpt01-global-regional-SLR-scenarios-US.pdf

harm tourism SMEs. According to the IPCC,[14] without adaptation of coastal areas, flood damages will increase by 2-3 orders of magnitude by 2100.

Extreme Storm Events in the Asia-Pacific Region

At a workshop supported by APEC[15], Leung[16] summarized the science linking CO_2, global warming, and extreme storm events. It is useful to repeat here, as it precisely explains the underlying causes of storm formations and intensity:

> The earth maintains its thermal equilibrium by emitting radiation that balances the energy absorbed from the sun. Since the dawn of the industrial era, energy consumption and land use change have significantly increased the emission of carbon dioxide (CO_2) to the atmosphere. As a greenhouse gas, CO_2 disturbs the thermal equilibrium of the Earth by reducing the radiation emitted back to space. The increase in net energy absorbed by the earth leads to warming, with potential serious consequences to human society and ecosystem. . . .
>
> A direct effect of the impact of CO_2 is surface warming. As summarized in the Intergovernmental Panel on Climate Change Fifth Assessment Report (IPCC AR5), observations of surface temperature between 1901 and 2012 show surface warming in the entire globe, but warming is larger over land and generally increases in the higher latitudes. To project climate changes in the future, comprehensive earth system models are used to simulate the evolution of
> the atmosphere, land, ocean, and sea ice, following emission scenarios based on socio-economics, energy technology, and land use. From a multi-model ensemble, the global mean surface temperature is projected to increase by 1–4 C degrees by 2100 compared to the present, with uncertainty after the mid-century contributed mainly by uncertainty in greenhouse gas emission scenarios. Accompanying the warming is a reduction of frost days, an increase in tropical nights and heat
> waves, melting of glaciers and mountain snowpack, and sea level rise due to thermal expansion of the ocean and melting of sea ice.
>
> Greenhouse warming also has consequences for precipitation. A warmer atmosphere can hold more moisture evaporated from the surface. This follows

[14] Intergovernmental Panel on Climate Change. (2019). The ocean and cryosphere in a changing climate: Special report of the Intergovernmental Panel on Climate Change. Cambridge University Press. https://doi.org/10.1017/9781009157964

[15] Asia-Pacific Economic Cooperation. (2014). Workshop on the climate change's impact on the oceans and fisheries resources - Ensuring adaptation, food security and sustainability, and mitigation on fisheries including aquaculture. Asia-Pacific Economic Cooperation Oceans and Fisheries Working Group. Project OFWG 02 2014. https://aimp2.apec.org/sites/PDB/Lists/Proposals/DispForm.aspx?ID=1532

[16] Leung, L. R. (2015). Meteorological views about climate change. In A. Umezawa (Ed.), *APEC workshop on the climate change impact on oceans and fisheries resources* (pp. 2-11). APEC project OFWG 02 2014. Asia-Pacific Economic Cooperation.

the Clausius-Clapeyron relationship of about 7% increase in water vapor per each degree of warming. However, this translates to only about 2% increase in global mean precipitation for each degree of warming. This is because globally, precipitation is balanced by surface evaporation, which is limited by the energy input to the surface. Historical records of precipitation show that past changes in precipitation have been more variable spatially than the warming pattern, with both increases and decreases in different regions. The projections of future changes in precipitation generally display a pattern resembling the spatial distribution of precipitation in the current climate. These changes reflect the fact that areas experiencing more precipitation are associated with convergence of atmospheric moisture, such as along the intertropical convergence zone and the tropical western Pacific Ocean, both characterized by strong upward motion or convergence of moist air that produces precipitation. In a warmer climate, moisture convergence would increase as the atmosphere holds more moisture hence increasing precipitation. The opposite can also be inferred for regions currently experiencing dryness or divergence of moisture; that is, in a warmer climate, more moisture will be diverged to reduce precipitation even further. These changes often referred to as "the wet gets wetter", have emerged as a first order global pattern of precipitation changes projected by Earth system models.[17]

On a more regional basis, however, precipitation changes are more complex than what was described above because moisture convergence that produces precipitation can be modified not only by changes in atmospheric moisture, but also changes in the circulation that produces convergence and divergence regionally. By arguments of the energy constraint that limits the global precipitation increase to 2% per degree of warming compared to the 7% increase in moisture per degree of warming, the tropical circulation must weaken for the suite of changes to be self-consistent. Indeed, analysis of climate projections by earth system models shows a weakening of the tropical circulation, leading to a more complex spatial pattern of regional precipitation changes.[18]

The Asian monsoon is associated with major precipitation that affects a large population. As a key feature of the tropical circulation, the Asian monsoon circulation is projected to weaken in the future. However, there are some consensuses by earth system models that the increase in moisture due to warmer temperatures can compensate for the circulation changes to produce a

[17] Held, I. M., & Soden, B. (2006). Robust responses of the hydrological cycle to global warming. *Journal of Climate, 19,* 5686-5699.

[18] Vecchi, G. A., & Soden, B. J. (2007). Global warming and the weakening of the tropical circulation. *Journal of Climate, 20,* 4316-4340.

net increase in summer precipitation.[19,20] During winter, midlatitude regions are influenced by synoptic storms, which are projected to shift poleward,[21] thus enhancing precipitation poleward of the current storm tracks, and reducing precipitation on their southern flank. Lastly, global warming can increase extreme precipitation, as they are produced by storm systems with intense vertical motion that can extract moisture effectively from the moister atmosphere in the future.[22] At the same time, however, global warming is also expected to increase aridity in the dry land margins, as the limited moisture availability over land cannot meet the increased saturation vapor deficit in a warmer climate.[23]

The aforementioned changes in temperature and regional and global water cycle must be considered in adaptation planning to improve societal resilience to climate change. With respect to the oceans, sea level rise is a direct consequence of warmer temperatures, and changes in precipitation can alter ocean salinity,[24] with implications to ocean circulation and thermal structure that influence marine ecosystems.

Climate scientists have also shown evidence that rising sea levels and storm surges are not the only threat to coastal communities. Coined the bathtub effect, rising sea levels underestimate by 35-54% other ways in which sea level rise can inundate land with water. The mechanism is rising sea levels, combined with beach erosion impact drainage of low-lying areas, which in turn raise ground water levels. Over time, traditionally dry low-lying areas become progressively wetter in areas that can be well away from a shoreline.[25] Figure 1 depicts the process. The same research documents that sea level rise, king tides, and major storm events can also retard the flow of rain runoff into rivers and eventually the ocean, further exacerbating inland flooding.

[19] Kitoh, A., Endo, H., Kumar, K. K., Cavalcanti, I. F. A., Goswami, P., & Zhou, T. (2013). Monsoons in a changing world: A regional perspective in a global context. *Journal of Geophysics Research, 118*, 3053-3065.

[20] Mei, R. M., Ashfaq, M., Rastogi, D., Leung, L. R., & Dominguez, F. (2015). Dominating controls for wetter South Asian summer monsoon in the twenty-first century. *Journal of Climate, 28*, 3400-3419.

[21] Lu, J., Vecchi, G. A., & Reichler, T. (2007). Expansion of the Hadley cell under global warming. *Geophysics Research Letters, 34*, L06805.

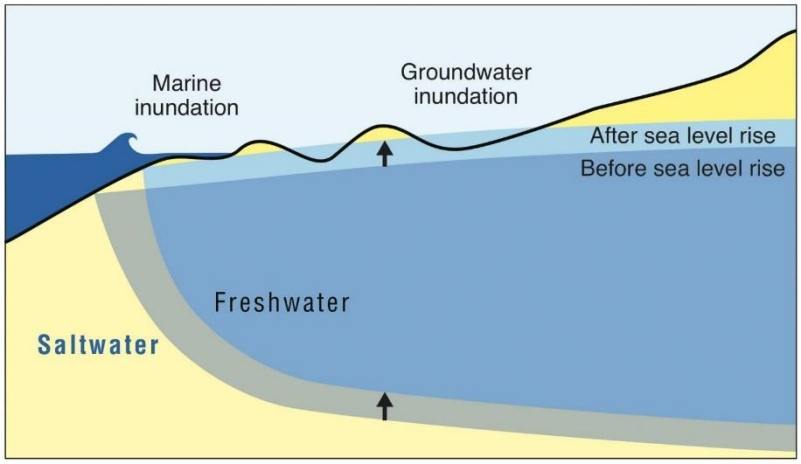
[22] O'Gorman, P. A., & Schneider, T. (2009). The physical basis for increase in precipitation extremes in simulations of 21st-century climate change. *Proceedings of the National Academy of Science, 106*(35), 14773–14777. https://doi.org/10.1073/pnas.0907610106

[23] Sherwood, S., & Fu, Q. (2014). A drier future? *Science, 343*, 737-739.

[24] Durack, P. J., Wijffels, S. E., & Matear, R. J. (2012). Ocean salinities reveal strong global water cycle intensification during 1950-2000. *Science,* 336, 455-458.

[25] Anderson, T., Fletcher, C., Barbee, M., Romine, B., Lemmo, S., & Delevaux, J. (2018) Modeling multiple sea level rise stresses reveals up to twice the land at risk compared to strictly passive flooding methods. *Scientific Reports, 8,* 14484. https://doi.org/10.1038/s41598-018-32658-x

Figure 1. Marine and groundwater inundation due to sea level rise.



Source: University of Hawai‘i at Manoa Coastal Geology Group

Best Practices

Options for tourism SMEs to adapt to sea level rise and the accompanying flooding during high tides are limited.[26] However, ignoring the small annual increases of sea level rise will eventually make buildings uninsurable against sea level rise and extreme storms, diminishing coastal property values by up to 80%.[27] Sea level rise also threatens freshwater supplies and systems on which tourism SMEs depend, and if this continues unchecked it will eventually destroy these businesses.[28]

According to the IPCC,[29] unless decision-makers choose to ignore the risk of wave run-up, increased tidal levels, wind forced sea level rise, and seasonal El Niño effects, responses to such risks can include (Figure 2):

1. Advance
2. Protection
3. Retreat
4. Accommodation
5. Ecosystem-based adaption

[26] *Courier Mail*. (2007, 7 April). Hopes sinking for islands.

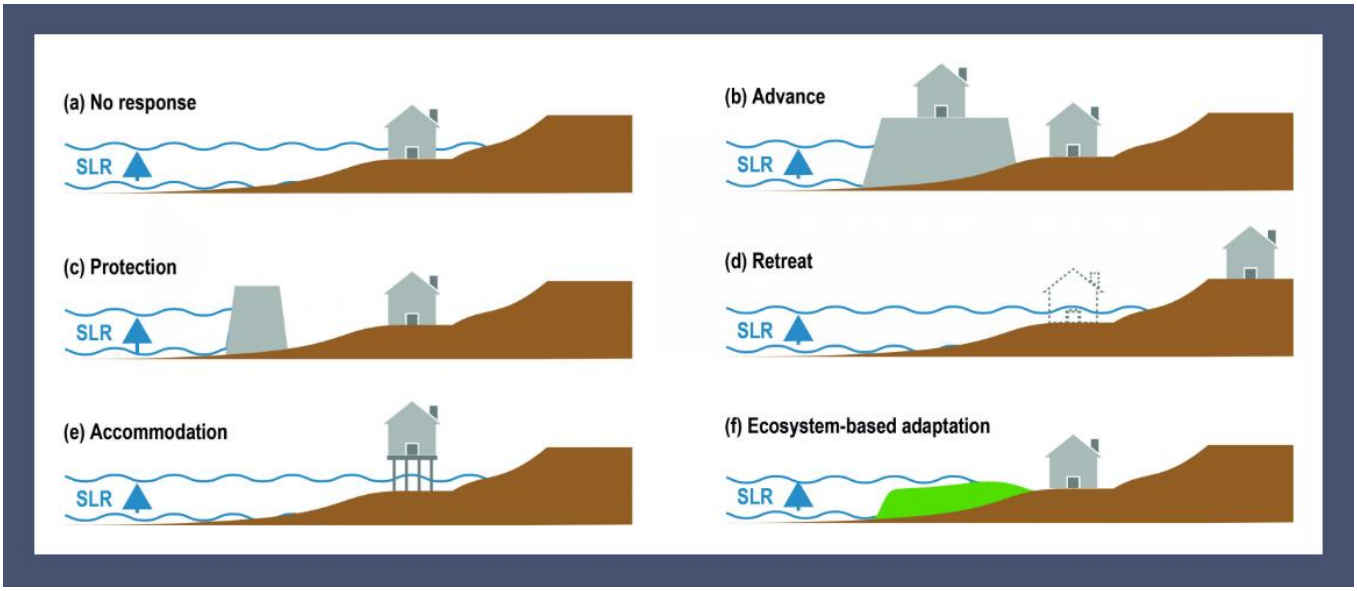
[27] *Herald Sun*. (2007, 11 April). Global warming hits property values.

[28] Phillips, M. R., & Jones, A. L. (2006). Erosion and tourism infrastructure in the coastal zone. *Tourism Management*, *27*(3), 517-524.

[29] Intergovernmental Panel on Climate Change. (2019). The ocean and cryosphere in a changing climate: Special report of the Intergovernmental Panel on Climate Change. Cambridge University Press. https://doi.org/10.1017/9781009157964

Each is discussed in turn below.

Figure 2. Different Types of Responses to Sea Level Rise and Extreme Weather Events.



Source: IPCC [30].

No Response

Understandably, many tourism SMEs assign low priority to the effects of small annual increases in sea level rise on their businesses. Attracting and serving demanding guests; recruiting, motivating, and retaining employees; meeting payroll; controlling costs; and dealing with COVID-19 restrictions present challenges that cannot be ignored. Besides, if, as the IPCC predicts,[31] "sea level is committed to rise for centuries to millennia due to continuing deep-ocean warming and ice-sheet melt and will remain elevated for thousands of years," what can a SME do? Identifying ways to surmount such apathy will require further research. However, education will likely be the key. Tourism SMEs need help, but are not helpless if provided affordable solutions. We contend many will be willing to learn to do what is necessary to preserve their investments of time and resources, which in many cases will finance their retirements and create legacies for their children and communities.

Advance

"Advance" creates new land by building seawards (e.g., reclamation of new land above sea levels or planting vegetation to support natural accretion of land).[32] It can involve reclamation of new land seaward that is raised to protect existing coastal development. Our literature search located no examples of tourism SMEs adopting this approach, possibly due to the high cost of reclaiming and fortifying new land, its impact on the property values of existing

[30] Ibid.

[31] Ibid.

[32] Ibid.

coastal lots, and environmental regulations restricting such development. However, Exhibit 1 portrays an alternative approach to this strategy, in which a seawall is installed offshore, parallel to the shoreline, to absorb the impact of storm- and tide-driven waves, which in essence eliminates coastal erosion. Exhibit 2 is a further variation that allows for better recreational access to the ocean. However, neither approach can mitigate flooding due to sea level rise. In addition, both "advance" approaches negatively impact surfers; when the waves hit the sea walls or groins, the energy refracts into the ocean, causing smaller, weaker breaks for surfers.

Exhibit 1. Seawalls that run offshore parallel to the beach reduce erosion caused by wind and tide driven waves. Waikiki Beach, Hawai'i.

Photo credit: John C. Crotts

Exhibit 2. An alternative "advance" strategy that allows better access to the ocean while reducing the effects of wind driven waves on renourished beaches. Waikiki Beach, Hawai'i.

Photos credit: University of Hawai'i Sea Grant

Protection

"Protection" reduces coastal risk and impacts by blocking the intrusion of seawater and extreme winds into coastal areas through such means as dikes, seawalls, storm surge barriers, breakwaters, and beach-dune systems.[33] This type of response was more commonly encountered in our literature search. One does not have to look too far to see the prevalence of hard and soft barriers to sea level rise and storm surge, such as shoreline seawalls and dikes. Yet building concrete infrastructure such as the seawall portrayed in Exhibit 3 is usually not a practical solution, given it is not only expensive to build and maintain but also accelerates the erosion of beaches and eventually makes the site an isolated island.[34]

Exhibit 3. Shoreline seawall on Waikiki Beach, Hawai'i.

Photo credit: John C. Crotts

Retreat

"Retreat" reduces exposure to coastal hazards by moving people, assets, and human activities out of the exposed coastal area.[35] Coastal lots (or building sites) are expensive and tourism SMEs are often found on relatively small lots. A simple calculation developed by a co-P.I. of this project and currently in the building ordinances of three Hawaiian municipalities may help. Annual sea level rise measures, combined with measurable slope angles of a developable coastal lot, can yield the erosion rate of a shoreline. Often local governments have already produced and made available mean sea level erosion rates for specific coastal

[33] Ibid.

[34] *Canadian Press* (2019, 21 April). Waikiki flood concerns spur push for Hawai'i shore protection.

[35] Intergovernmental Panel on Climate Change. (2019). The ocean and cryosphere in a changing climate: Special report of the Intergovernmental Panel on Climate Change. Cambridge University Press. https://doi.org/10.1017/9781009157964

zones.[36] Multiplying this value by the usable life of a building (e.g., 70 years) yields the distance from a mean high-water mark a building should be placed. In practice, 30 centimeters or more should be added to the derived value to hedge against an increasing rate of sea level rise. If these required setbacks are deemed too costly for a tourism SME seeking to develop a site, the site may need to be passed over since developing it would result in escalating costs of mitigating storm damage and paying higher insurance premiums.[37] If a tourism SME is unable to pass such costs on to tourists, a plan to relocate the business will be needed if the enterprise is to thrive over the long haul.

Accommodation

"Accommodation" includes a diverse set of biophysical and institutional responses to reduce vulnerability of coastal residents, human activities, ecosystems, and the built environment (e.g., raising buildings, planting salt tolerant crops, implementing insurance and early warning systems for extreme sea level events).[38] As portrayed in Figure 2, "accommodation" can involve constructing buildings on sites subject to sea level rise and periodic flooding such that storm surges can pass under buildings. This approach is commonly employed by tourism SMEs. In addition, a number of floating resort developments have been built over calm coastal waters, making them impervious to sea level rise and storm events. However, such developments will likely be too expensive for most tourism SMEs. Practical and lower cost alternatives are available that have been discussed in newspaper articles and documents in the APEC publications databases. For example, tourism SMEs located in areas of frequent coastal flooding and extreme storm events could increase their resilience to storm damage by:

- Locating their electrical junction boxes on the second floor of buildings and moving all electrical outlets on the first floor well above known maximum flood levels;
- Eliminating wood floors of vulnerable buildings with raised, tile-covered concrete slab floors;
- Mounting restaurants' kitchen equipment on wheels so it can be easily moved to secure locations when faced with an extreme storm or flooding event;
- Ensuring restaurants' supplies of fresh food after a disaster by developing and maintaining networks of suppliers that use storm-resistant greenhouses or farms in areas less affected by storm events; and
- Developing flexibility to transition from serving tourists to serving locals to maintain cashflow when tourism demand collapses due to the threat or impact of a major storm event. Tsunamis (and threats of tsunamis) have been shown to cause rapid

[36] Sagoe-Addy, K., & Addo, K. (2013). Effect of predicted sea level rise on tourism facilities along Ghana's Accra coast. *Journal of Coastal Conservation*, *17*(1), 155-166.

[37] *Honolulu Star-Advertiser*. (2014, 27 August). Isles warned of grim future for tourism. https://www.staradvertiser.com/2014/08/27/hawaii-news/isles-warned-of-grim-future-for-tourism/

[38] Intergovernmental Panel on Climate Change. (2019). The ocean and cryosphere in a changing climate: Special report of the Intergovernmental Panel on Climate Change. Cambridge University Press. https://doi.org/10.1017/9781009157964

redistributions of outbound tourists away from impacted destinations,[39] highlighting the need for such flexibility.

Ecosystem-Based Adaptation

"Ecosystem-based adaptation" combines the benefits of "protect "and "advance" strategies based on the conservation and restoration of ecosystems such as reefs and coastal vegetation.[40] For example, the need to retreat from the mean high tide mark can be delayed if dune systems can be preserved or mangrove forests can be planted near shorelines with shallow waters. Though dunes and mangrove forests do not defend against sea level rise, they do control shoreline erosion and the damaging effects of storm driven waves. Similar benefits can result from preserving coral reefs, salt marshes, sea grass meadows, and kelp forests. These natural defenses are more cost effective and resilient than importing large amounts of sand for renourishments.[41] Moreover, those that involve the preservation or restoration of native vegetation have the added advantage of absorbing and storing the carbon associated with carbon emissions.[42]

Exhibit 4. Mangrove forest on Siargao Island, The Philippines. *Photo credit: Envato Elements*

[39] Zhang, H. Q. (2005). Impact of a tsunami on Chinese outbound tourism. *International Journal of Contemporary Hospitality Management, 17*(3), 433-435.

[40] Intergovernmental Panel on Climate Change. (2019). The ocean and cryosphere in a changing climate: Special report of the Intergovernmental Panel on Climate Change. Cambridge University Press. https://doi.org/10.1017/9781009157964

[41] *Irish Times*. (2007, 7 April). Rising seas will wipe resorts off the map.

[42] European Commission. (2009, August). Nature's role in climate change. https://climate.ec.europa.eu/system/files/2016-11/nature_and_climate_change_en.pdf

Narayan et. al.'s global meta-analysis of 69 studies found that, on average, coastal habitats reduced wave heights between 35% and 71%.[43] Coral reefs on average reduced wave heights by 70%, salt-marshes by 72%, mangroves by 31%, and seagrass/kelp beds by 36%.

Research has found that the rate of growth of coral reefs is declining worldwide, while the rate of sea level rise is increasing.[44] This means that the depth above reefs will increase, diminishing the effectiveness of relying solely on this form of ecosystem-based defense.

Other Approaches

In addition to the above five solutions presented by the IPCC,[45] our literature search revealed other promising ways to prepare for, and recover from, major flooding or extreme storm events. In particular, the Senior Vice President of Cendant Hotel Group International offered the following steps that larger tourism enterprises (e.g., hotels and resorts) can take to secure guest safety during an extreme storm event:[46]

- With one's insurance carrier, conduct intensive risk assessments that identify changes in the physical plant that can better protect guests from flooding and extreme storm events;
- Develop and conduct emergency response trainings on how to quickly and efficiently evacuate properties when necessary, and drill staff on them;
- Improve communications between hotels when tourists need to be re-housed to less exposed hotels;
- Place information on emergency procedures in guest rooms;
- Equip hotels with lifesaving devises such as defibrillators; and
- Create duplicate guest lists to help emergency workers identify victims if computer systems fail.

In addition, an APEC-sponsored workshop on flood preparedness[47] offered several relatively cost-effective means to respond to flood disasters. These involved SMEs maintaining:

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[43] Narayan S., Beck, M. W., Reguero, B. G., Losada, I. J., van Wesenbeeck, B., Pontee, N., Sanchirico, J., Ingram, J. C., Lange, G.-M., & Burks-Copes, K. (2016). The effectiveness, costs and coastal protection benefits of natural and nature-based defences. *PLoS ONE, 11*(5), e0154735. https://doi.org/10.1371/journal.pone.0154735

[44] *New Zealand Herald.* (2018, 18 June). Sea-level rise outstripping coral growth, say experts.

[45] Intergovernmental Panel on Climate Change. (2019). The ocean and cryosphere in a changing climate: Special report of the Intergovernmental Panel on Climate Change. Cambridge University Press. https://doi.org/10.1017/9781009157964

[46] Kondraschow, R. (2006). The lessons of a disaster. *Journal of Retail & Leisure Property*, *5*(3), 204-211

[47] Asia-Pacific Economic Cooperation. (2019). Workshop on enhancing participation in flood disaster preparedness through community-based hazard mapping. Asia-Pacific Economic Cooperation Emergency Preparedness Working Group. Project EPWG 02 2019A. https://aimp2.apec.org/sites/PDB/Lists/Proposals/DispForm.aspx?ID=2436

- Engagement with early warning systems further elaborated in APEC report PPSTI 01 2020A[48],
- At least 72 hours of water and food supply for staff and tourist consumption,
- Desalination capabilities in the case of larger tourism enterprises such as hotels and resorts,
- A mode of communication independent of electricity,
- Long lasting battery cell phones with battery power banks,
- Medical kits and medications that stranded guests may need,
- Flashlights or other light sources,
- Evacuation transport,
- Supplies of hygiene and sanitation products for staff and tourists,
- Supplies to entertain children,
- Supplies for the aged or people with special needs,
- Emergency operations plans,
- Evacuation plans, and
- Flood protection measures.

Given the abundant sunlight in most APEC economies, solar power for individual enterprises or micro grids could provide needed electricity during extreme weather events that often damage traditional electrical transmission lines. Designed and installed properly to withstand extreme wind and rain, solar power generation, augmented when necessary with diesel-powered generators, would increase the resilience of tourism SMEs. An APEC-sponsored workshop on solar power[49] provides case studies and contacts for future consultations. Of particular interest are the case studies from Pacific Island economies, most of which are, by definition, in coastal zones.

Survey of APEC Working Group Members

Methods

As mentioned above, we surveyed the members of APEC's Tourism, Emergency Preparedness, Small and Medium Enterprises, and Ocean and Fisheries Working Groups to determine their understanding of sea level rise and what tourism SMEs in their economies were doing to adapt to, and recover from, major flooding and storm events. The survey was administered online using the Qualtrics survey platform. The questionnaire was written in English. However, translated versions were available on request and two respondents requested such assistance. A copy of the questionnaire is provided in Appendix B.

[48] Asia-Pacific Economic Cooperation. (2020). APEC Climate Symposium - Innovations in Climate Communication for Enhancing Human Security to Manage Risks of Climate Extremes. Asia-Pacific Economic Cooperation Policy Partnership on Science, Technology and Innovation. Project PPSTI 01 2020A. https://aimp2.apec.org/sites/PDB/Lists/Proposals/DispForm.aspx?ID=2769

[49] Asia-Pacific Economic Cooperation. (2019). APEC workshop on strategies and successful case studies on solar energy. Asia-Pacific Economic Cooperation Energy Working Group. Project EWG 10 2019A. https://aimp2.apec.org/sites/PDB/Lists/Proposals/DispForm.aspx?ID=2512

Of the 84 members contacted, 51 (60.7%) completed at least some portion of the questionnaire; only 20 (23.8%) completed it in its entirety. Though the low response rate is disappointing, the survey results nevertheless provide useful insights into the awareness of, and the importance given to, sea level rise among members of the aforementioned APEC Working Groups.

Questionnaires were completed from 15 November through 18 December 2022. In the graphics below, "n=" followed by a number refers to the number of respondents that answered a given question, providing the data upon which a reported statistic, such as a mean or percentage, is based. Statistics based on responses from fewer than 10 respondents should be interpreted with caution.

Only descriptive statistics are reported below. Bivariate and multivariate analyses were not possible on account of the paucity of cases.

Results

Basic Characteristics of Respondents

Respondents were asked to "Please indicate which APEC economy you represent." Twenty respondents answered the question. These 20 respondents represented 12 (57.1%) of the 21 APEC economies, specifically Australia; Brunei Darussalam; Chile; China; Indonesia; Japan; Mexico; New Zealand; Peru; Chinese Taipei; the U.S.; and Viet Nam. Peru was represented by four of the respondents to this question; Australia; Chile; China; Indonesia; and Chinese Taipei were each represented by two respondents to this question; and Brunei Darussalam; Japan; Mexico; New Zealand; the U.S.; and Viet Nam were each represented by one respondent to this question.

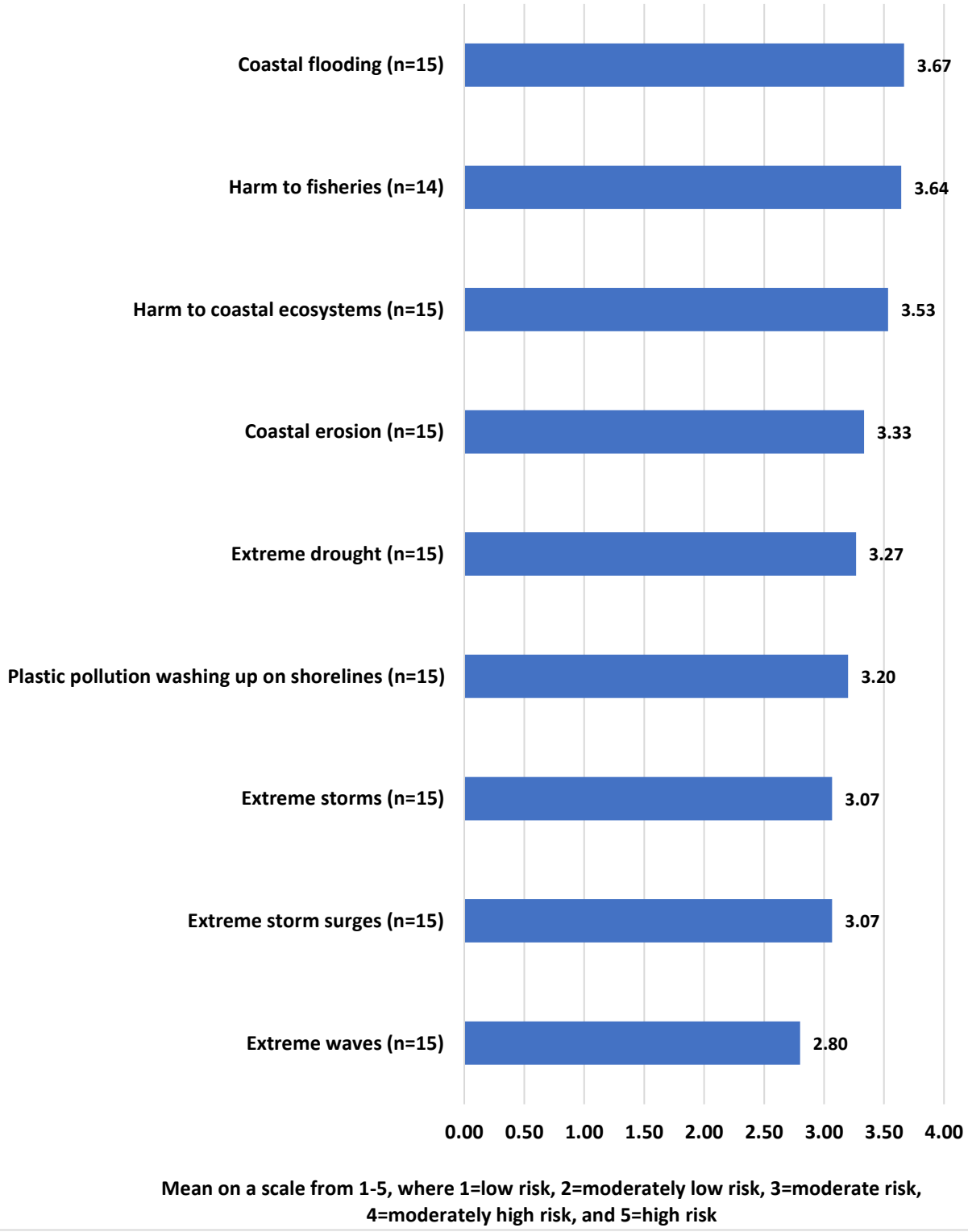
Respondents were also asked to "Please indicate the APEC working group you represent. Twenty respondents answered the question. Among these 20 respondents, 60.0% represented the Tourism Working Group, 20.0% represented the Ocean and Fisheries Working Group, 10.0% represented the Emergency Preparedness Working Group, and 10.0% represented the Small and Medium Sized Enterprises Working Group. All four respondents who stated "Peru" in response to the question on which APEC economy they represented also stated that they represented the Tourism Working Group.

Perceived Risks of Negative Impacts of Climate Change on Tourism SMEs

Perceived Short-Term Risks. Respondents were asked to indicate their perception of the short-term (one to five years) risks that nine negative impacts of climate change had on tourism SMEs in their economies, on a scale from 1-5, where 1 meant "low risk," 2 meant "moderately low risk," 3 meant "moderate risk," 4 meant "moderately high risk," and 5 meant "high risk." The mean perceived risk levels for the nine negative impacts of climate change are shown in Figure 3. The highest means were for coastal flooding (3.67), harm to fisheries (3.64), and harm to coastal ecosystems (3.53), followed by coastal erosion (3.33), extreme drought (3.27), and plastic pollution washing up on shorelines (3.20). The lowest

means were for extreme storms (3.07), extreme storm surges (3.07), and extreme waves (2.80). Thus, in most cases respondents

Figure 3. Perceived short-term (1-5 years) risks of negative impacts of climate change on tourism SMEs in respondents' economies.



Source: Author

perceived higher short-term risks to be associated with chronic impacts, such as harm to fisheries and coastal ecosystems, than with episodic impacts, such as extreme storms and waves.

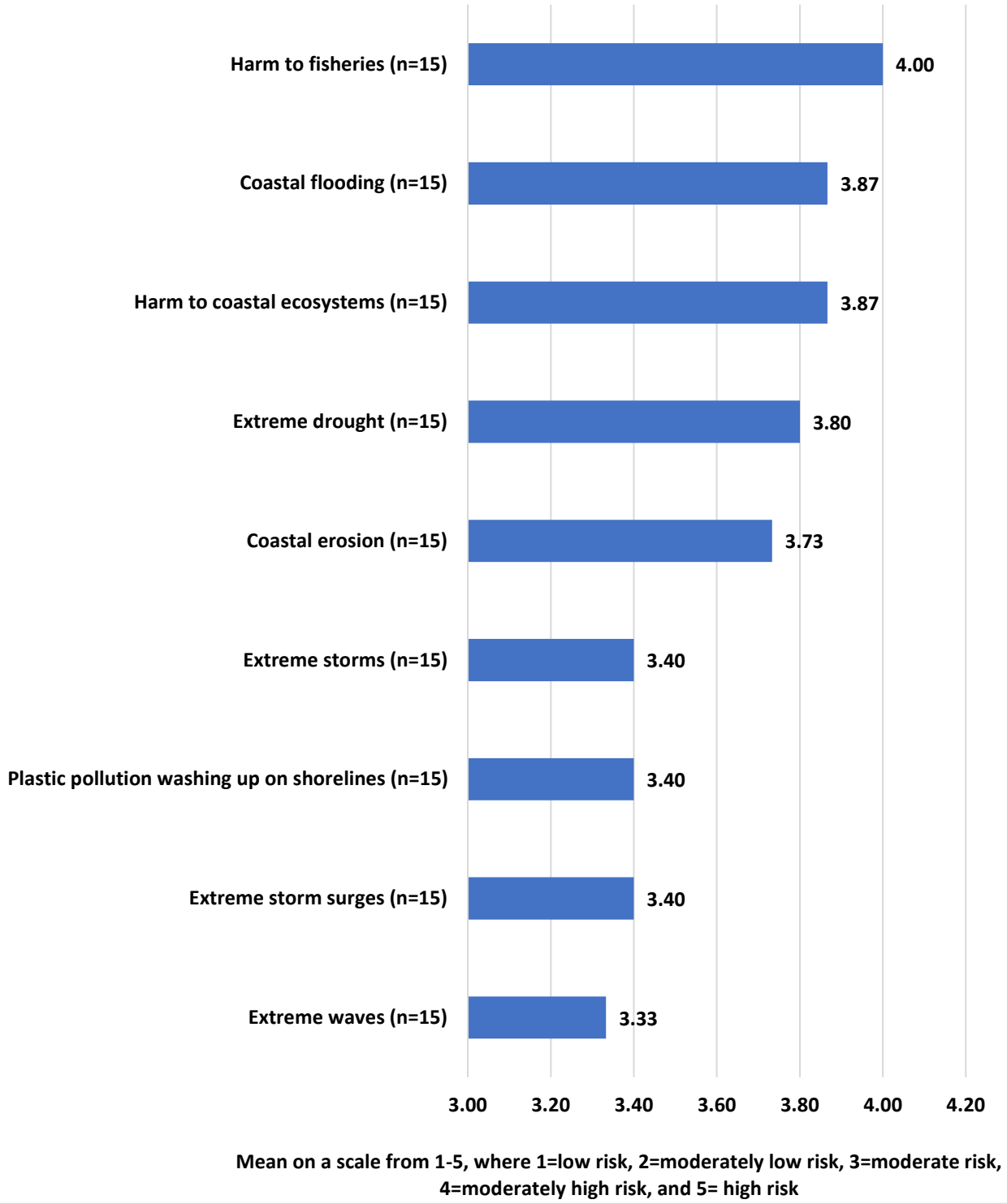
Respondents were given an opportunity to write-in one or two additional negative impacts of climate change and their perceptions of the short-term risks of these impacts. One perceived the "insurability of marine tourism businesses" to be a "high risk" and "damage to infrastructure supporting tourism" to be a "moderately high risk". Another perceived "hot extremes resulting in harm to inland ecosystems, including biodiversity loss, especially of native birds and reptiles diversity, including resident native birds and reptiles" to be a "moderately high risk." Two others separately mentioned the "decline of marine biodiversity" and "illegality in the extraction of resources" but did not indicate their perceptions of the associated risks.

Perceived Long-Term Risks. Respondents were also queried about the long-term (six or more years) risks that the same nine negative impacts of climate change had on tourism SMEs in their economies. The highest means were for harm to fisheries (4.00), coastal flooding (3.87), and harm to coastal ecosystems (3.87), followed by extreme drought (3.80) and coastal erosion (3.73) (Figure 4). The lowest means were for extreme storms (3.40), plastic pollution washing up on shorelines (3.40), extreme storm surges (3.40), and extreme waves (3.33). Thus, as with the perceptions of short-term risks reported above, in most cases respondents perceived higher long-term risks to be associated with chronic impacts, such as harm to fisheries and coastal ecosystems, than with episodic impacts, such as extreme storms and waves.

In addition, in the case of each of the nine perceived negative impacts of climate change on tourism SMEs, the means were higher for the perceived long-term risks of negative climate change impacts than those observed for the perceived short-term risks of negative climate change impacts. This suggests that respondents were more concerned about how climate change would harm the tourism SMEs in their economies in the distant, as opposed to near, future.

Respondents were given an opportunity to write-in one or two additional negative impacts of climate change and their perceptions of the long-term risks of these impacts. The same respondent who perceived the "insurability of marine tourism businesses" to be a "high risk" and "damage to infrastructure supporting tourism" to be a "moderately high risk" in the short-term gave the same responses with respect to the long-term. Likewise, the same respondent who perceived "hot extremes resulting in harm to inland ecosystems, including biodiversity loss, especially of native birds and reptiles diversity, including resident native birds and reptiles" to be a "moderately high risk" in the short-term gave the same response with respect to the long-term. Two others separately mentioned the "decline of marine biodiversity that could affect gastronomy" and "oil exploitation" but did not indicate their perceptions of the associated risks.

Figure 4. Perceived long-term (6+ years) risks of negative impacts of climate change on tourism SMEs in respondents' economies.



Source: Author

Application of Various Responses to Sea Level Rise

Respondents were asked to indicate how frequently six responses to sea level rise, such as "building sea walls" and "beach renourishment by bringing in sand," were applied in their economies, on a scale from 1 to 5, where 1 meant "not used at all," 2 meant "rarely used," 3 meant "occasionally used," 4 meant "widely used," and 5 meant "universally used." Respondents were also given the option to state, "don't know"; such responses were excluded from the analysis.

The means on these scales are portrayed in Figure 5. The highest means were for "building sea walls" (3.40) and "preserving/planting mangroves as a natural defense" (3.18), followed by "retreating from coastlines when beach erosion requires (2.46), "beach renourishment by bringing in sand" (2.44), "avoiding floods by raising buildings onto pilings" (2.42), and "protecting and enhancing dunes as a natural defense" (2.40). The reasons "protecting and enhancing dunes" was a less frequently applied natural defense against sea level rise than "preserving/planting mangroves" as a natural defense would be a useful subject for further research.

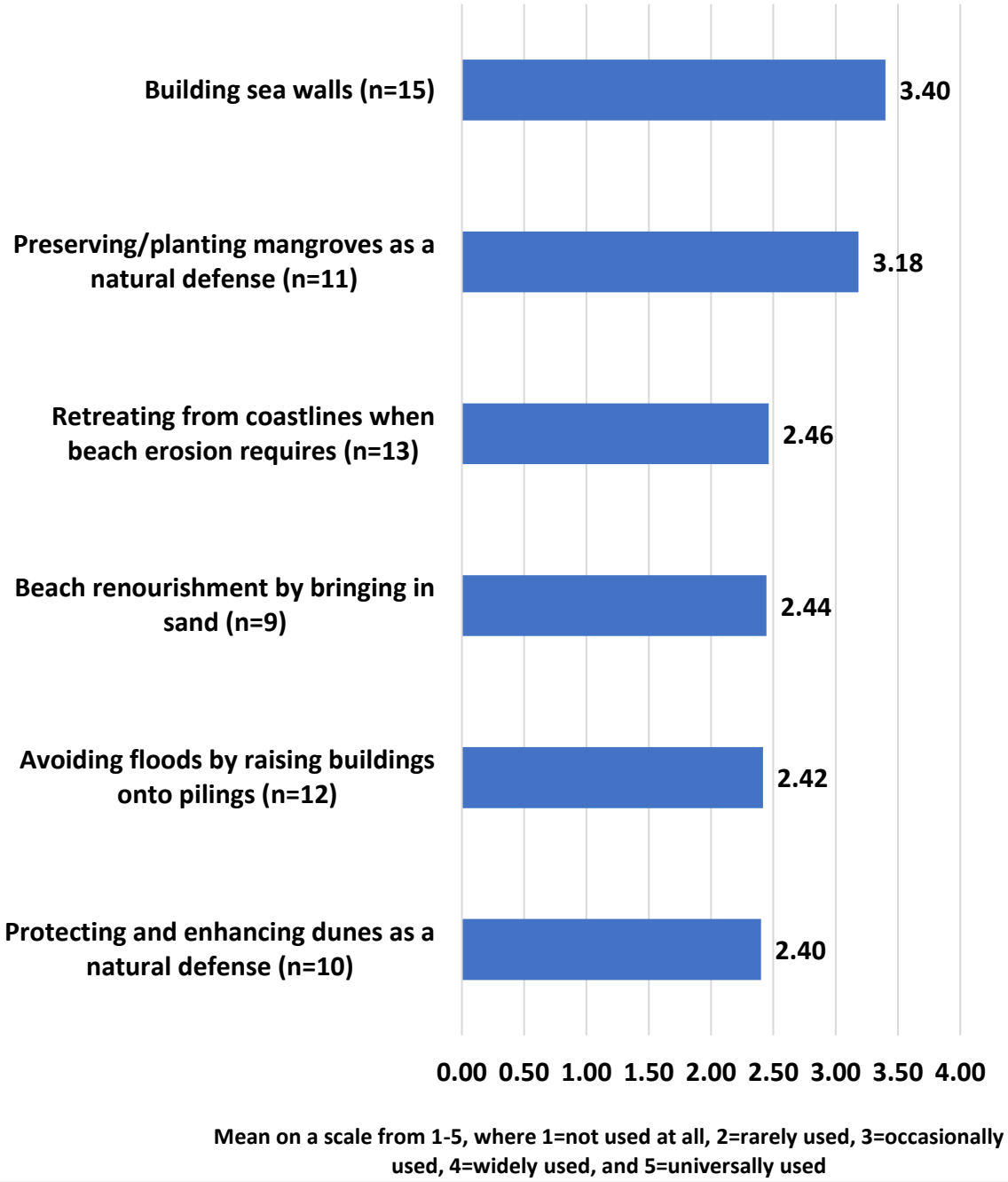
Respondents were given an opportunity to write-in one or two additional responses to sea level rise in their economies. One respondent added "restricting development in coastal erosion areas" to the list of such responses but did not provide a perception of how frequently this was applied in this person's economy.

Abilities of Tourism-Related Entities to Cope with the Negative Impacts of Climate Change

Respondents were asked to indicate how well tourism-related entities in their economies were "prepared for, coping with, and recovering from the negative impacts of climate change." This was measured by asking respondents to rate their economy's fitness with respect to 15 abilities, such as the "ability of distributors to keep delivering fresh food to restaurants after major flooding or a major storm event," on a scale from 1-5, where 1 meant "poor," 2 meant "fair," 3 meant "neutral," 4 meant "good," and 5 meant "excellent." Respondents were also given the option to state, "don't know"; such responses were excluded from the analysis.

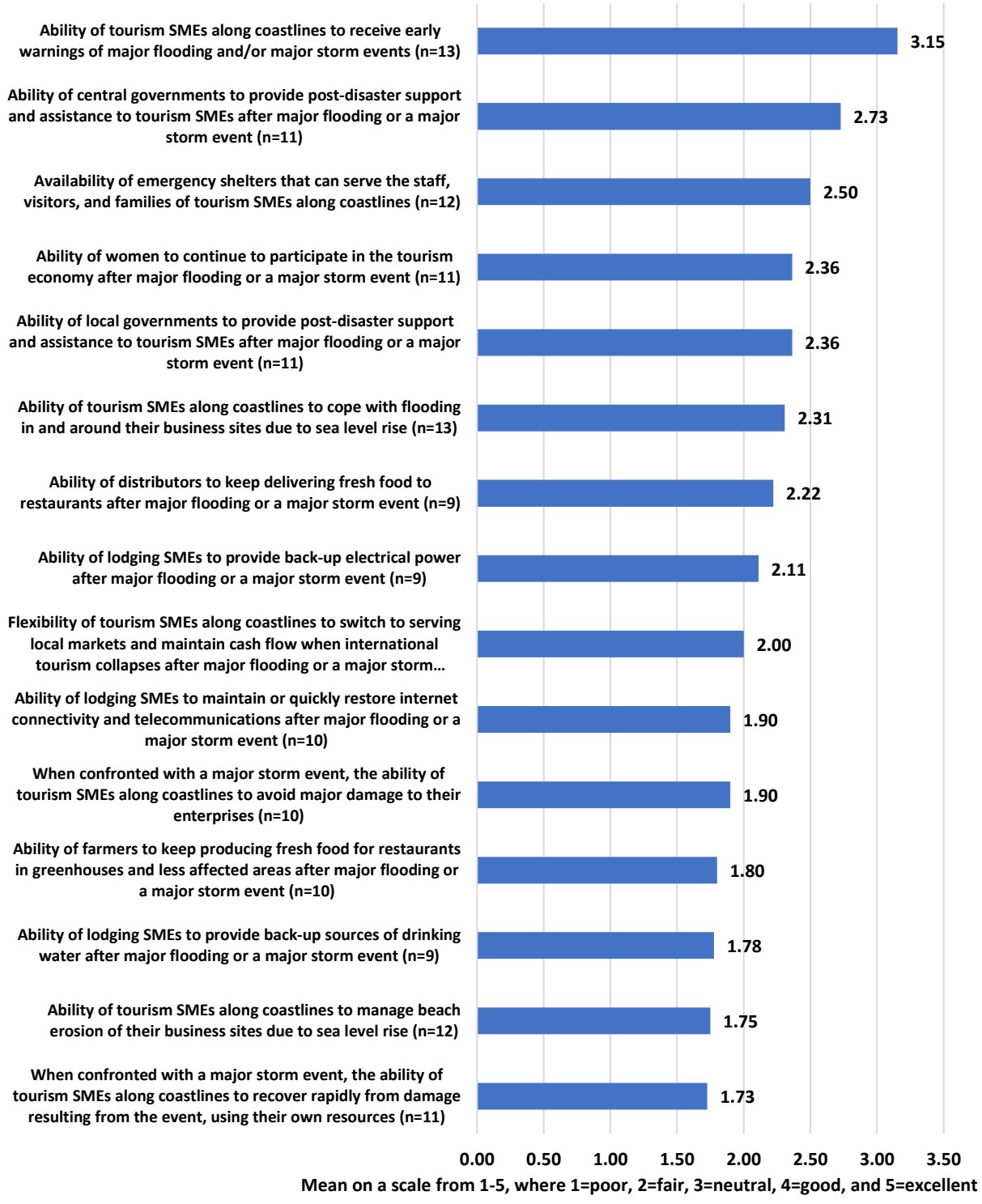
As shown in Figure 6, mean scores on the aforementioned scale were highest for "ability of tourism SMEs along coastlines to receive early warnings of major flooding and/or major storm events" (3.15), followed by "ability of central governments to provide post-disaster support and assistance to tourism SMEs after major flooding or a major storm event" (2.73) and "availability of emergency shelters that can serve the staff, visitors, and families of tourism SMEs along coastlines" (2.50).

Figure 5. Frequency of application of various responses to sea level rise in respondents' economies.



Source: Author

Figure 6. Respondents' perceptions of how well tourism-related entities in their economies are prepared for, coping with, and recovering from the negative impacts of climate change.



Source: Author

Lower mean scores emerged in the case of:

- "ability of women to continue to participate in the tourism economy after major flooding or a major storm event" (2.36),
- "ability of local governments to provide post-disaster support and assistance to tourism SMEs after major flooding or a major storm event" (2.36),
- "ability of tourism SMEs along coastlines to cope with flooding in and around their business sites due to sea level rise" (2.31),
- "ability of distributors to keep delivering fresh food to restaurants after major flooding or a major storm event" (2.22),
- "ability of lodging SMEs to provide back-up electrical power after major flooding or a major storm event" (2.11), and
- "flexibility of tourism SMEs along coastlines to switch to serving local markets and maintain cash flow when international tourism collapses after major flooding or a major storm event" (2.00).

The lowest mean scores emerged in the case of:

- "ability of lodging SMEs to maintain or quickly restore internet connectivity and telecommunications after major flooding or a major storm event" (1.90),
- "when confronted with a major storm event, the ability of tourism SMEs along coastlines to avoid major damage to their enterprises" (1.90),
- "ability of farmers to keep producing fresh food for restaurants in greenhouses and less affected areas after major flooding or a major storm event" (1.80),
- "ability of lodging SMEs to provide back-up sources of drinking water after major flooding or a major storm event" (1.78),
- "ability of tourism SMEs along coastlines to manage beach erosion of their business sites due to sea level rise" (1.75), and
- "when confronted with a major storm event, the ability of tourism SMEs along coastlines to recover rapidly from damage resulting from the event, using their own resources" (1.73).

Only one out of 15 mean scores exceeded 3.00, or "neutral" on the 5-point scale, suggesting that respondents perceived significant room for improvement in tourism-related entities' preparation for, adaptation to, and recovery from, the negative impacts of climate change. A need for additional capacity building is suggested by the particularly low scores for: maintain or quickly restore internet connectivity (1.90), avoid major damage in the case of coastal enterprises confronted with a major storm event (1.90), provide backup sources of drinking water after major flooding or a major storm event (1.78), manage beach erosion due to sea level rise if located along coastlines (1.75), and recover rapidly from damage resulting from a major storm event using their own resources (1.73).

Economy-Specific Efforts Related to Climate Change Adaptation and Mitigation

Respondents were asked a series of five open-ended questions on their economies' efforts to adapt to, and mitigate, climate change. In the case of each question, they were requested to write "don't know" if they had no such information to share. All responses other than "don't know" are reproduced in Appendix C. Selected answers to these questions are reproduced below to give a sense of the range of, and themes in, responses.

Short-Term Efforts. Respondents were asked, "Please describe your economy's planned near-term efforts over the next 1-5 years to minimize or mitigate the negative impacts of sea level rise, extreme storms, and sea level events, including effects on businesses in underserved communities and women-owned businesses." Fourteen respondents answered the question, of which three wrote, "don't know."

Two respondents described domestic government efforts to help communities adapt to, and mitigate, climate change. A respondent from Canada wrote:

> *In 2018, the Government of Canada launched the Disaster Mitigation and Adaptation Fund (DMAF), where it committed CAD2 billion over 10 years to invest in structural and natural infrastructure projects to increase the resilience of communities that are impacted by natural disasters triggered by climate change. Starting in 2021, the DMAF moved to specifically allocate CAD670 million to small-scale project (projects with total eligible costs between CAD1 million and CAD20 million).*

A respondent from Indonesia wrote:

> *The economy has launched the development of climate resilience policies that become the basis for preparing the government's work plan every year and a reference in preparing the National Medium Term Development Plan (RPJMN) 2025-2029 for minimizing the impacts of climate change-related events on communities. In addition, the economy has also prepared and submitted the enhanced Nationally Determined Contribution To UNFCCC, including standpoint on enhanced ambition on adaptation as elaborated in the programs, strategies and actions to achieve economic, social and livelihood, and ecosystem and landscape resilience.*

On a different note, a respondent from Mexico described economy-level government efforts to help tourism-related businesses adapt to, and mitigate, climate change:

> *The Ministry of Tourism of the Government of Mexico implements the ADAPTUR Project, whose purpose is to support companies in the tourism sector to implement measures to adapt to climate change based on ecosystems, to protect natural assets from which the sector benefits, such as beaches, reefs, jungles and biodiversity; and to guarantee the ecosystem services required by the sector. One of the products of this project is the "Guide for Investments Adapted to Climate Change", which aims to provide guidance and provide elements to incorporate the analysis of climate change and the design of adaptation solutions in the conventional and generic process of planning a real estate tourism investment. You can learn more about this project on the following website: https://www.adaptur.mx/ Additionally, the Ministry of Tourism has developed the "Ocean-Based Sustainable Tourism Activities*

> *Strategy", whose main objective is to move towards a sustainable and resilient tourism development model in marine and coastal areas, with its Axis II, called "Leading climate action in tourism", to reduce the vulnerability of populations, infrastructure and ecosystems in marine-coastal areas and make them resilient against the impacts of climate change and natural phenomenon.*

Finally, a respondent from Japan stated that, "*Local governments in Japan are taking steps to curb the negative impacts of sea level rise through climate change countermeasures and the development of action plans to prevent global warming."*

Long-Term Efforts. Respondents were asked, "Please describe your economy's planned long-term efforts over the next six or more years to minimize or mitigate the negative impacts of sea level rise, extreme storms, and sea level events, including effects on businesses in underserved communities and women-owned businesses." Fifteen respondents answered the question, of which four wrote, "don't know."

No discernable themes emerged. A respondent from Canada described how the Canadian government rooted its long-term efforts to adapt to, and mitigate, climate change in the United Nations Sendai Framework:

> *The Government of Canada is one of 187 members signed onto the UN Sendai Framework Global Platform for Disaster Risk Reduction (2015-2030), which provides concrete actions to protect society from risk of disaster. The Emergency Management Strategy for Canada (EM Strategy) builds on the principles articulated in the Sendai Framework in order to establish Federal, Provincial and Territories to strengthen the resilience of Canadian society by 2030. Under the EM Strategy, a key initiative is the National Risk Profile which serves as a domestic-level disaster risk and capability assessment tool. It uses scientific evidence and stakeholder input to create a forward-looking picture of Canada's disaster risks and capabilities in order to strengthen Canadian communities' resilience to disasters, such as floods, wildfires and earthquakes. In future years, the scope will include a broader range of natural hazards.*

A respondent from Mexico described how the Mexican government incorporated criteria for adaptation to climate change in state- and municipal-level tourism policy instruments:

> *One of the great achievements of the ADAPTUR Project was to achieve the incorporation of criteria for adaptation to climate change in tourism policy instruments at the state level and municipal, such as the Tourism Sector Program 2020 - 2024; the Puerto Vallarta Municipal Climate Change Program; the Regulation of Ecology of Tulum, Quintana Roo; the Urban Development Plan in San Miguel de Allende, Guanajuato; the Climate Action Plan in BahÃa de Banderas, among others.*

Other Economy-Specific Efforts. Respondents were asked, "What do you feel are the best ways for tourism SMEs in your economy to mitigate their own risks?" Nine respondents answered the question.

Three respondents wrote that the operators of tourism SMEs must understand the risks in order to mitigate them. As one of them, a respondent from Japan, put it:

> *It is important that many SMEs correctly understand the risks associated with sea level rise and properly prepare to respond before and after the risk occurs. Understanding the possible risks in advance is extremely important to mitigate damage.*

On a different note, a respondent from Indonesia emphasized resilience:

> *Tourism SMEs should have adequate support in finance so they can recover themselves if a disaster happens. Also improve their skills and knowledge and increase their participation and protect their main resources.*

Respondents were asked, "What do you feel are the best ways for government policy makers and destination managers in your economy to incorporate resiliency into tourism planning and development?" Ten respondents answered the question, of which one wrote, "don't know."

Four respondents articulated the need to work closely with stakeholders to incorporate resiliency into tourism planning and development. One respondent from New Zealand wrote:

> *Collaboration and cooperation with local government, local indigenous groups, businesses, workers and residents, along with collaboration across government at the domestic level.*

On a different note, a respondent from Indonesia described how entrepreneurship training could incorporate resiliency into tourism planning and development:

> *The best ways to incorporate resiliency into tourism planning and development are through providing blue economy entrepreneurship training (e.g., green business for youth) can also benefit local communities. Development of blue economy skills in this case is very important to achieve sustainable tourism. This will strengthen the capacity of workers and employers in the tourism industry as well as other relevant stakeholders involved to understand and respond effectively to challenging global climate change for destinations in the tourism sector especially for coastal and marine ecotourism.*

Data on Climate Change Phenomena Used in Respondents' Economies

Types of Data Used. Respondents were asked to "Please describe the data and indicators currently used in your economy to measure and monitor sea level rise, extreme

storms, and sea level events." Fourteen respondents answered the question, of which nine wrote, "don't know," suggesting a need for greater awareness of these information resources.

No discernable themes emerged. A respondent from Canada listed the following websites containing relevant data used to measure and monitor sea level rise, extreme storms, and sea level events, all of which are excellent sources of highly applicable data that can serve as a model for other economies:

- *Canadian Drought Monitor (https://open.canada.ca/data/en/dataset/292646cd-619f-4200-afb1-8b2c52f984a2)*
- *Real-Time Hydrometric Data (https://wateroffice.ec.gc.ca/mainmenu/real_time_data_index_e.html)*
- *Public Weather Alerts for Canada (https://weather.gc.ca/warnings/index_e.html)*

A respondent from Indonesia described the use of IPCC data for measurement and monitoring purposes:

> *The Fifth Assessment Report (AR5) of the Intergovernmental Panel on Climate Change (IPCC), providing estimates of future temperature and precipitation. Four Representative Concentration Pathways (i.e. RCP2.6, RCP4.5, RCP6.0, and RCP8.5) were selected and defined by their total radiative forcing (cumulative measure of GHG emissions from all sources) pathway and level by 2100. In this analysis RCP2.6 and RCP8.5, the extremes of low and high emissions pathways, are the primary focus; RCP2.6 represents a very strong mitigation scenario, whereas RCP8.5 assumes business-as-usual scenario. For Indonesia, these models show a consistent warming trend for all emissions scenarios. However, the projections in rainfall are less certain and vary by both RCP scenarios as well as models. Projected precipitation trends do show a likely increase in rainfall for western and southern areas and a reduction in rainfall for the southern islands; an increase in intensity for extreme rainfall events. Global mean sea-level rise was estimated in the range of 0.44-0.74 meters (m) by the end of the 21st century by the IPCC's Fifth Assessment Report.*

A respondent from New Zealand described the use of satellite data for measurement and monitoring purposes:

> *The government has released location specific sea-level rise projections out to the year 2300 for every 2 kilometres of coast. The sea around our economy rose on average by 1.7mm per year from 1900 to 2008. Data and indicators used to display this include maps, case studies, and measurement of vertical land movement. Vertical land movement is measured using global positioning satellite technology and synthetic aperture radar systems mounted on Earth orbiting satellites. The government publishes extreme wind and rain measurements and computer modelling.*

Availability and Adequacy of Data in Respondents' Economies. When queried, "Are you aware if your economy's government makes measures of annual sea level rise available to the public?", 45.9% answered in the affirmative.

Respondents were also asked, "Do you feel that data on sea level rise, extreme storms, and sea level events, and associated impacts, are unavailable or inadequate in your economy?" Among the 16 respondents who responded, 75.0% answered in the affirmative. Respondents who did so were asked which type(s) of data were unavailable or inadequate. Among the eight respondents who answered the question, 25.9% indicated data on sea level rise, 18.5% indicated data on extreme storms, 25.9% indicated data on sea level events, and 29.6% indicated data on associated impacts.

Climate Change and Women-Owned Businesses

Respondents were also asked two open-ended questions on the impacts of sea level rise, extreme storms, and sea level events on women-owned tourism SMEs. In the case of each such question they were requested to write "don't know" if they had no such information to share. All responses other than "don't know" are reproduced in Appendix C. Selected answers to these questions are reproduced below to give a sense of the range of, and themes in, responses.

The first question asked, "What are the specific needs and responses of women-owned tourism SMEs with regard to sea level rise, extreme storms, and sea level events?" Ten respondents answered the question, of which six wrote, "don't know."

No discernable themes emerged. One respondent from Indonesia wrote,

> *The women-owned tourism SMEs needs to improve their resilience in terms of finances, capital, and resources and also improve their skills and knowledge to anticipate climate-related events to business and tourism SMEs*.

The second question asked, "How does sea level rise, extreme storms, and sea level effects affect women's participation in the economy?" Nine respondents answered the question, of which three wrote, "don't know."

Three respondents wrote that systemic social injustice regarding the treatment of women in the workplace made them especially vulnerable to the effects of climate change. A respondent from Peru wrote:

> *Increase in time, distance and cost overruns for access to drinking water for the supply of community tourism; increase and/or maintenance of economic, social and political gaps; search for part-time work or commercial activities due to loss of tourist resources and/or tourist structures; segregation of women to the domestic space and unpaid care because they do not have job opportunities; increase*

in productive activities and unpaid domestic work or care due to the emigration of men and the loss of the tourist resource; difficulty to overcome conditions of poverty; greater inability to ensure family subsistence; limited or no participation in decision making.

A respondent from New Zealand wrote:

Women are more likely to be underemployed, earn less per hour, and do more unpaid work. Extreme weather events and economic transitions are more likely to affect women due to these limitations.

A respondent from Chile wrote:

This type of phenomenon negatively affects the participation of women in the economy, which is why the number of employed women in the economy decreases in a greater proportion than men.

All four of the above quotes indicate that the writers felt that women were especially vulnerable to the negative impacts of climate change, and would benefit from programs to enhance the resiliency and sustainability of their businesses.

Best Practices Case Studies and Technical Approaches

Climate research has documented that sea levels are rising with increasing speed, with disruptive economic effects due in part to the high premiums paid for coastal locations. Thus, tourism SMEs and destinations clearly could benefit from delaying the effects of sea level rise and reducing its disruptive effects as much as possible.

To aid this process, the following is a series of best practices case studies of tourism SMEs and destinations, as well as some technical approaches, in response to the threat of sea level rise and extreme storms. The "technical approaches" are included to communicate what could be done, beyond what currently is being done, in the APEC region to meet these challenges.

Each of the case studies were either nominated by authorities or identified through the principal investigators' search efforts as tourism SMEs or destinations that had successfully mitigated and adapted to sea level rise. The search efforts included requests for nominations from:

1. Members of the APEC Tourism Working Group (TWG).
2. Over 3,600 tourism researchers and educators globally through an email distribution listserv known as "TRINET" (Tourism Research and Information Network), developed and managed by the School of Travel Industry Management (TIM) at the University of Hawai‘i at Mānoa,
3. Alumni and advisory board members of the TIM School, which has large and active alumni associations across the Asia-Pacific region, and
4. Colleagues at the University of Hawai‘i and universities throughout the region who work in climate change, sea level rise, and coastal conservation.

The project did not afford an opportunity to field check the information provided. However, this information is from trusted sources such as TWG members, the entity studied, tourism educators, and information gleaned from the entity's website or reputable news media. They show that these entities are most often using a combination of methods to build resilience in the face of rising sea levels and more frequent extreme storm events in the coastal zone.

Many of the researchers interviewed said that all solutions – though temporary – must be site-specific. In other words, no one size will fit all. With this said, the best practices and technical approaches described below are intended to serve as a catalog of options that can be mixed and matched and adapted to other locations. To enhance this adaptability, the cases by design represent a wide range of existing and emerging practices, including those employed by traditional SMEs, a "social enterprise", i.e., a business that uses its profits to fund social programs,[50] communities, an entire region of an economy, and architectural and engineering approaches.

Best Practices Case Studies

Babcock Ranch, Florida, United States: Adaptation and Restored Ecosystems

Babcock Ranch is a 17,000-acre residential and second home community located 12 miles inland from the coastal city of Fort Myers, Florida. It serves as a model for other residential and second home communities, as well as large resort complexes.

At an elevation averaging 30 feet above sea level, the community weathered Hurricane Ian (Category 5) in 2022 without the major damage and loss of power that obliterated much of the surrounding region. The source of its resilience is three-fold.

First, the development is guided by a long and well-tested literature on surface water best management practices, including Blick et al.,[51] Martin et al.,[52] and Petit-Boix et al.[53] Roughly half of the total footprint of the development is dedicated to greenways, parks, and lakes, with an active trail system through ecosystems preserved and restored from what was previously pastureland and rock mining operations. The layouts of the town and neighborhoods are designed to channel water from extreme rain events away from homes and businesses down specific street corridors to greenways, lakes, and wetlands to increase flood control and

[50] Corporate Finance Institute. (2023). Social enterprise. https://corporatefinanceinstitute.com/resources/esg/social-enterprise/

[51] Blick, S. A., Kelly, F., & Skupien, J. J. (2004). New Jersey stormwater best management practices manual. New Jersey Department of Environmental Protection.

[52] Martin, C., Ruperd, Y., & Legret, M. (2007). Urban stormwater drainage management: The development of a multicriteria decision aid approach for best management practices. *European Journal of Operational Research*, *181*(1), 338-349. https://doi.org/10.1016/j.ejor.2006.06.019

[53] Petit-Boix, A., Arahuetes, A., Josa, A., Rieradevall, J., & Gabarrell, X. (2017). Are we preventing flood damage eco-efficiently? An integrated method applied to post-disaster emergency actions. *Science of the Total Environment*, 580, 873-881. https://doi.org/10.1016/j.scitotenv.2016.12.034

reduce damage to buildings or landscapes. Native tree and planted landscapes add to resilience using, where needed, 100% of reclaimed water for irrigation.

Exhibit 5. A natural area in Babcock Ranch.

Photo credit: Babcock Ranch

Second, Babcock Ranch builds upon the experience of other smart cities by embodying all facets of sustainability. Homes are built to the highest standards of wind resistance, currently selling at market prices of USD200,000 to USD1.5 million.

Lastly, the development is totally solar powered, producing more electricity than it consumes, again withstanding a Category 5 hurricane in 2022 with no damage. The solar energy center includes a 10-megawatt battery storage facility, the largest solar-plus storage project operating in the U.S.[54]

[54] For more information, visit https://babcockranch.com/ and https://babcockranch.com/a-resilient-community-designed-to-weather-any-storm/

Exhibit 6. Solar energy generation at Babcock Ranch.

Photo credit: Babcock Ranch

Magnums Unique Accommodation Airlie Beach, Australia: Resilience of Business Model, Market Flexibility, and Transformation of Core Product

Magnums Unique Accommodation Airlie Beach (previously Magnums Backpackers and "Magnums" hereinafter) is located in the coastal town of Airlie Beach in the Whitsundays region of Queensland, Australia. It has been operating for over 32 years. Airlie Beach suffers from seasonal cyclones that annually run from November to March. Thus, this tourism SME has undertaken various measures to prepare for, and mitigate, the impacts of these disasters.

Exhibit 7. Magnums Unique Accommodation Airlie Beach in Australia.

Photos credit: Magnums Unique Accommodation Airlie Beach

The owner, Ms. Elizabeth Hackett, has adapted to this uncertain environment in many ways. Four key practices she believes are crucial in building business resilience to major storm events are highlighted below.

First, an adequate **contingency fund** is crucial to being prepared for a crisis since it helps the business to recover quickly. Magnums was able to reopen only 11 days after the Cyclone Debbie, a Category 5 cyclone that hit the region in 2017. As a local accommodations

provider, their fast reopen contributed significantly to the resilience of the local tourism community. They have now developed a more structured contingency fund plan to ensure a minimum 6-month running cost to cover all operation-related spending, including labor retention. This has enabled them to not rely solely on government funding or insurance coverage.

Second, **tenured employees** are a core soft resource to mitigate the impacts of crisis, because they have higher embeddedness in the business and are equipped with strong local knowledge of both business procedures and operations. Hence, Magnums believes that maintaining a workforce during a crisis is important for fast recovery and long-term resilience. Magnums also increased their salaries and provided flexible work arrangements to retain these employees. Staff training and continuing education is also part of Magnums' key priorities in managing employees' expectations and supporting their long-term career development. They are also very supportive in encouraging staff to attend regional webinars/seminars held by local tourism organizations. They have written a handbook on crisis procedures that is used in staff training. The priority placed on tenuring and training employees has resulted in 85% of their 33 staff members having worked for them for over five years, with half of them working for over 10 years, and four for over 20 years.

Exhibit 8. Front desk at Magnums

Photo credit: Magnums Unique Accommodation Airlie Beach

Third, **business model development**. Magnums is Eco Certified for Nature Tourism and an Accredited Business for Sustainable Tourism. These certifications are fee-based, with an annual fee of AUD1,600 for eco certification. These credentials assure customers that they provide products in a natural area that minimally impact the environment.

Exhibit 9. Recognitions received by Magnums.

Source: Magnums Unique Accommodation Airlie Beach

The company's activities have also enabled them to diversify their business operation mode and be adaptive in crisis seasons. They have recently transformed from a backpacker-style accommodation to the equivalent of a 3.5-star accommodation. This has enabled them to adapt (revert) to different markets during crises and implement social distancing and other protocols during the COVID-19 pandemic.

Fourth, **industry transformation in the region** through the ground-breaking Whitsunday Skyway Project, a cableway that will link Airlie Beach's main street with a scenic mountain-top development behind Magnums.[55] The development will include mountain bike trails, an interpretive center, food service, and adventure activities like rope courses for youths. Since the local tourism industry heavily relies on water-based activities, the SMEs and the region in general are vulnerable to extreme storm events and associated storm surges, beach erosion, water pollution, and damage to coral reefs and fish habitat. This project will create more inland entertainment and leisure activities for tourists during cyclone seasons, help maintain existing tourism employment levels, and create 140 full-time equivalent jobs and 591 indirect jobs, making the local tourism industry more cyclone-resilient. Ms. Hackett proposed the project after Cyclone Debbie, and has been actively engaged in its advancement.[56]

Exhibit 10. The Whitsunday Skyway project has been in the works since Cyclone Debbie, and if approvals are obtained, could be developed in 18 – 24 months.

Photo credit: Mackay and Whitsunday Life

Quintana Roo, Mexico: Sustainability Through the Preservation and Restoration of Nature

Quintana Roo is a Mexican state on the eastern side of the Yucatán Peninsula that contains the renowned Cancún mass tourism destination and the long beaches and all-inclusive resorts of the adjacent Riviera Maya coastline. The state provides a replicable example of how tourism involving contact with nature can be a viable economic engine when a mass tourist destination is juxtaposed with nearby natural areas attractive to those who seek such contact,

[55] https://www.mackayandwhitsundaylife.com/article/exclusive-skyway-project-on-the-horizon

[56] For more information, visit Magnums' website at https://magnums.com.au/ or contact Ms. Hackett at elizabethhackett@aatgroup.com.au

and, by extension, how preserving and restoring coastal natural areas can be a viable adaptation to sea level rise. Because much of the tourism involving contact with nature occurs in natural areas, this case demonstrates that the preservation and restoration of nature in coastal zones can not only provide important environmental benefits but also, by supporting nature-based tourism and the local fishing industry, support the livelihoods of residents of surrounding areas.

Exhibit 11. A natural area in the coastal zone of Quintana Roo.

Photo credit: Lonely Planet

Environmental preservation in Quintana Roo has mainly taken the form of protected areas where construction and resource extraction are prohibited, environmental restoration has mainly taken the form of insurance-funded rebuilding of damaged coral reefs, and both have yielded important socioeconomic benefits. Each is discussed in turn below.

Environmental Preservation in Quintana Roo. Quintana Roo contains 19 federally-recognized protected natural areas that collectively contain 6,557 square kilometers of land and 63,837 square kilometers of marine area.[57] The terrestrial protected areas, and the terrestrial portions of hybrid marine and terrestrial protected areas, constitute 14.7 percent of Quintana Roo's total land area.

Two of the four mainly coastal protected areas in Quintana Roo, comprising 98.9% of the land area of these four preserves, were established in the 1980s,[58, 59] before rising sea levels became an issue of widespread public concern. It therefore cannot be assumed that their creation was part of a planned adaptation to these changing environmental conditions. The existence of these areas nevertheless constitutes an effective defense against rising sea levels, and other coastal destinations can reap the same benefits Quintana Roo experiences from its

[57] México Comisión Nacional de Áreas Naturales Protegidas. (2023). Listado de las Áreas Naturales Protegidas de México. [Data set]. http://sig.conanp.gob.mx/website/pagsig/listanp/

[58] Ibid.

[59] Protected Planet. (2023). World Database on Protected Areas. https://www.protectedplanet.net/en/thematic-areas/wdpa?tab=WDPA

protected areas by establishing such areas along their coasts and/or working to better protect areas that have already been established.

These benefits include: absorbing toxic substances in seawater and carbon dioxide in the atmosphere; preventing shoreline erosion; providing critical habitat for commercial fisheries and endangered species; purifying water before its discharge into the ocean; absorbing excess seawater from hurricanes, floods, and tsunamis; serving as living laboratories for research and education; and providing venues for educational and appreciative ecotourism experiences that economically benefit nearby communities. As an alternative to developing beachfront resorts, preserving nature in coastal areas has the added advantage of precluding replenishment of such resorts' beaches as they erode from rising sea levels. Such replenishment involves hauling sand from the ocean floor to the shoreline, a controversial and exorbitantly expensive process that can severely damage the reefs that provide habitat for commercial fisheries.[60]

In 2022, Quintana Roo received an estimated 19.6 million visitors,[61] many of whom were attracted to Cancun and the Riviera Maya. This large visitor base provides a ready market for nature-based tourism experiences in Quintana Roo. Currently, Tripadvisor[62] lists 125 commercial tours providing such experiences in the state as either a focus or component of the tour. Many of these tours take visitors to one or more of the State's protected areas. Tourists who connect with nature independently of these tours of course create additional demand for experiences in protected areas. Some tours include a strong educational component, such as a visit to the Síijil Noh Há ecotourism center, where visitors hear a biologist speak on ecological issues, including climate change, carbon footprint, and the extent to which trees capture carbon.[63]

By far the largest protected area in Quintana Roo is the 5,281-square kilometer Sian Ka'an Biosphere Reserve, a coastal area that contains tropical forests, mangroves, and marshes, as well as a large marine section intersected by a barrier reef. It provides habitat for more than 300 species of birds and many terrestrial and marine vertebrates, including manatees, jaguars,

[60] Riker, M. (2023, 27 April). Hawai'i is giving Maui resorts their money back instead of helping shore up a shrinking beach. *Honolulu Civil Beat*. https://www.civilbeat.org/2023/04/hawaii-is-giving-a-maui-hotel-its-money-back-instead-of-helping-shore-up-a-shrinking-beach/

[61] *Cancun Sun*. (2023, 5 February). Mexican Caribbean preparing for the biggest year on record for tourist arrivals. https://thecancunsun.com/mexican-caribbean-preparing-for-the-biggest-year-on-record-for-tourist-arrivals/

[62] Tripadvisor. (2023). Eco tours in Quintana Roo. https://www.tripadvisor.com/Attractions-g1575485-Activities-c61-t216-oa120-Quintana_Roo_Yucatan_Peninsula.html

[63] Co'ox Mayab. (2023). Exploring the Caminos Sagrados (Sacred Ways) of Maya Ka'an – Experiences exchange. Síijil Noh Há. https://cooxmayab.com/exploring-the-caminos-sagrados-sacred-ways-of-maya-kaan-experiences-exchange/

and two species of endangered sea turtle.[64, 65] The Reserve contains 120 kilometers of coastline, or about 55% of the entire coastline of the State.[66, 67] The Amigos de Sian Ka'an (Friends of Sian Ka'an) organization provides technical assistance and training to Mayan communities involved with ecotourism and assists the federal Secretariat of Environment and Natural Resources with natural resource management and environmental education.[68]

The Reserve contains three large core zones open only to scientists. Low-impact economic activities, such as commercial fishing, and sustainable development, occur in a buffer zone. About 2,000 people reside in the Reserve, mostly in the coastal zone, especially in two fishing villages.[69]

In addition to protected areas, the natural environment in Quintana Roo is preserved to a lesser but significant degree at The St. Regis Kanai, Riviera Maya, one of the newest resorts on the Riviera Maya. As shown in Exhibit 12, the resort is suspended above a mangrove forest on stilts, and elevated boardwalks connecting the curved buildings of the complex make guests feel surrounded by nature and provide ocean views from nearly every vantage point.[70] The resort was designed by Mexican architectural firm Edmonds International.[71]

[64] Centro Ecologico Sian Ka'an. (2023). About Sian Ka'an. Sian Ka'an facts. http://www.cesiak.org/aboutsiankaan.htm

[65] United Nations Educational, Scientific and Cultural Organization. (2023). World Heritage Convention. Sian Ka'an. https://whc.unesco.org/en/list/410/

[66] Centro Ecologico Sian Ka'an. (2023). About Sian Ka'an. Sian Ka'an facts. http://www.cesiak.org/aboutsiankaan.htm

[67] Valdes, C. (1988). Regional-level coastal management in Mexico: A proposal for Quintana Roo. Research report submitted to Marine Resource Management Program, College of Oceanography, Oregon State University. https://ir.library.oregonstate.edu/downloads/br86b7893

[68] Wikipedia. (2023). Sian Ka'an Biosphere Reserve. https://en.wikipedia.org/wiki/Sian_Ka%CA%BCan_Biosphere_Reserve

[69] Centro Ecologico Sian Ka'an. (2023). About Sian Ka'an. Sian Ka'an facts. http://www.cesiak.org/aboutsiankaan.htm

[70] Lev-Tov, D. (2023, 5 June). I just visited the newest luxury resort in Cancun, and it has walkways suspended over a forest, a multi-tiered pool, and 2 miles of beach. *Travel+Leisure*. https://www.travelandleisure.com/st-regis-kanai-riviera-maya-mexico-review-7508556

[71] Ibid.

Exhibit 12. Aerial view of the St. Regis Kanai, Riviera Maya.

Photo credit: Tripadvisor.com

In addition to the benefits listed above for coastal natural areas in general, the preservation of mangrove forests in this and other ways is extremely important because such forests play an increasingly vital role in defending coastlines from the ill-effects of sea-level rise. This is because: (1) wind and swell waves are rapidly reduced as they pass through mangroves, lessening wave damage during storms; (2) wide mangrove belts can effectively reduce tsunami heights, diminishing loss of life and property damage in areas behind mangroves, as well as the flooding impacts of storm surges, significantly reducing flood extent in low lying areas; (3) narrower mangrove belts can reduce wind speed, the impact of waves on top of the surge, and flooding impact to some degree; and (4) the dense roots of mangroves can help to bind and build soils by retarding water flows, encouraging deposition of sediments, and reducing erosion.[72]

Insurance-Funded Environmental Restoration in Quintana Roo. A healthy coral reef can reduce up to 97% of a wave's energy before it hits the shore, diminishing the effects of storm surges and daily erosion. However, coral reefs can be damaged by severe storms, especially if they have already been weakened by pollution, bleaching, disease, overfishing, and/or development. To ensure the continued benefits of coral reefs, in 2019 a public-private partnership, including the Quintana Roo government, tourism representatives, and The Nature Conservancy (TNC), purchased an insurance policy to protect the coral reef off the coast of Puerto Morelos in the Riviera Maya, the first-ever insurance policy of its kind. The same year, TNC and project partners in Mexico trained and formed post-storm response

[72] Spalding, M., McIvor, A., Tonneijck, F. H., Tol, S., & van Eijk, P. (2014). *Mangroves for coastal defence: Guidelines for coastal managers & policy makers*. Wetlands International and The Nature Conservancy.

teams called Reef Brigades to complement the insurance by providing capacity to quickly repair storm-damaged reefs.[73]

When Hurricane Delta struck the Caribbean coast of Mexico in 2020, the Brigades stabilized large- and medium-size coral colonies. In the first 11 days, they collected more than 8,000 coral fragments broken by the hurricane, and planted them in the reef, substantially enhancing the recovery process. Moreover, the insurance policy was triggered, paying nearly USD850,000 to expand the post-storm response and fund large-scale repair efforts on the reef. This was the first time that funding from an insurance policy was used to restore a damaged reef.[74] Currently, TNC is working to replicate the model pioneered in Quintana Roo around the globe and investigate whether other ecosystems, such as coastal mangroves[75] and wetlands, could benefit from a similar approach, and whether other risks to ecosystems could be covered.

Socioeconomic Benefits of Environmental Preservation and Restoration in Quintana Roo. Environmental preservation and restoration in Quintana Roo have yielded important socioeconomic benefits. The preservation and restoration of natural areas provide tourists with the education, relaxation, inspiration, exercise, and adventure resulting from contact with nature, and ensures fishers that habitat for commercial fisheries will be protected from silt and contaminants in shoreline runoff. This starkly contrasts with the situation in Jamaica, only about a thousand kilometers to the east, where pollution of seawater from the poorly planned and managed construction and operation of massive resorts decimated offshore marine life and severely harmed the local fishing industry and glass-bottom tour boat operations.[76]

Healthy fisheries ensure that the fishing industry will continue to provide restaurants and grocery stores with fresh, native fish, the consumption of which contributes to the sense of place tourists seek. The opportunity to observe fishers unloading their catches further contributes to this sense of place. The fishers, in turn, benefit from tourism, which increases demand for their catches, and enables them to supplement their incomes by transporting tourists by boat to reefs and lagoons.[77]

Overall, a symbiotic relationship is apparent between environmental preservation and restoration in the coastal zone and sustainable development in the form of commercial fishing and nature-based tourism. Environmental preservation and restoration provide the natural

[73] The Nature Conservancy. (2022). Insuring nature to ensure a resilient future. https://www.nature.org/en-us/what-we-do/our-insights/perspectives/insuring-nature-to-ensure-a-resilient-future/

[74] Ibid.

[75] The Nature Conservancy. (2020). Could insuring mangroves save them—and protect coastal communities? https://www.nature.org/en-us/what-we-do/our-insights/perspectives/three-things-insuring-mangrove-forests/

[76] Figueroa, E., & McCauley, D. (Directors). (2009). *Jamaica for sale*. [Film]. Vagabond Media and Jamaica Environment Trust.

[77] Centro Ecologico Sian Ka'an. (2023). About Sian Ka'an. Sian Ka'an facts. http://www.cesiak.org/aboutsiankaan.htm

resource base requisite to preserve the habitat for commercial fisheries and to attract nature-based tourists. The perpetuation of fishers' catches and sales of fish, and the expenditures of tourists, in turn, help to sustain residents' livelihoods, making it feasible to keep coastal natural areas intact.

Wanderlust Indonesia, Indonesia: Educational and Community Assistance Through a Social Enterprise

Wanderlust Indonesia[78] is a social enterprise that organizes and guides community-based, custom tours for businesses, educational groups, nonprofit organizations, and private individuals and groups in Indonesia. These tours include educational and volunteer experiences conducted in collaboration with community members, including planting mangroves, planting and regenerating coral reefs, and conducting community-based, "farm to cup" coffee tourism and educational tours with the Barokah Coffee Shelter, a coffee roastery that roasts Indonesian specialty coffee sourced from local farmers. Wanderlust's tours contribute to the sustainability of the areas they visit and minimize their environmental impacts on these areas by: (1) educating residents about the value of tourism and hiring them to serve as transport providers, tour guides, homestay hosts, souvenir vendors, food providers, etc.; (2) partnering with stakeholders in some destinations to create community development projects based on community needs, such as library development and waste management programs; and (3) avoiding the use of single-use plastic bottles, bags, and cutlery, in part by asking visitors to bring their own reusable water bottles and providing water refill stations in homestays and attractions.

Exhibit 13. A Wanderlust Indonesia tour.

Photo credit: Wanderlust Indonesia

In 2015, Wanderlust partnered with KAIPKA Ujung Kulon, an environmental organization, to help residents of Tamanjaya Village, in West Java, develop a community library, educate

[78] https://idwanderlust.net/

local guides on sustainable tourism practices, and conduct informal classes for elementary and high school students in the Village. When the Sunda Strait tsunami struck nearby Ujung Kulon National Park on 22 December 2018, causing the deaths of more than 400 people,[79] Wanderlust organized: crowdfunding campaigns to raise money for the Village, a volunteer program to help heal traumatized residents, an initiative to plant trees near the coastline, and a program to educate community partners about disaster risk mitigation and how the local tourism industry, as one of the principal employers in the Village, could become better prepared for future tsunamis or earthquakes.

In 2019-2021, Wanderlust facilitated an "impact travel experience" supported by a grant from Australia Awards, funded by the Australian Department of Foreign Affairs and Trade.[80] This program educated residents and tourists in the Lembang Fault seismic zone near the tourist destination of Bandung, West Java, about disaster risk management, including mitigating the risks associated with earthquakes in this area and tsunamis in surrounding coastal areas. Several tours to the area educated tour participants about mitigating such risks through storytelling that made science fun.

This project was important because of the massive potential loss from an earthquake in the Lembang Fault seismic zone. Currently, research on the Fault predicts that a colossal earthquake could suddenly occur and unleash tsunamis in surrounding coastal areas, impacting more than a million residents, causing IDR51 trillion of damage, and disrupting a tourist destination that hosts more than five million visitors annually.[81, 82] However, to date limited action has been taken to educate residents and tourism stakeholders about these potential dangers and how to mitigate them.

Overall, Wanderlust Indonesia represents an example of how a social enterprise, through its educational and community assistance programs, and its own sustainable business practices, can help communities adapt to, and recover from, the ill-effects of sea level rise, and benefit society in general.

[79] Dian, A. (2018, 28 December). Deadly tsunami leaves Javan rhinos untouched, but peril persists. *Mongabay: News & Inspiration from Nature's Frontline*. https://news.mongabay.com/2018/12/deadly-tsunami-leaves-javan-rhinos-untouched-but-peril-persists/

[80] Australia Awards. (2023). Australia Awards in Indonesia. https://www.australiaawardsindonesia.org/article/detail/716/291/disaster-mitigation-education-to-local-people-in-sesar-lembang-lembang-fault-through-impact-travel-experience

[81] Daryono, M. R., Natawidjaja, D. H., Sapiie, B., & Cummins, P. (2019). Earthquake geology of the Lembang Fault, West Java, Indonesia. *Tectonophysics*, *751*, 180-191.

[82] Hanifan, A. F. (2017). Inilah yang terjadi saat gempa lembang menghantam Bandung. *Tirto.id* https://tirto.id/inilah-yang-terjadi-saat-gempa-lembang-menghantam-bandung-cyE6.

Kampung Tua Bakau Serip and Budo Tourism Villages, Indonesia: The Benefits of Mangrove Forests

Our final best practices case studies feature two additional entities in Indonesia, each of which is involved in some degree with the preservation, regeneration, and/or management of mangrove forests that provide the significant social, economic, and environmental benefits described above. These case studies illustrate how the preservation, regeneration, and/or management of mangrove forests can be effectively integrated into community-based tourism.

Kampung Tua Bakau Serip Tourism Village. This Tourism Village is located near Batam City in the Riau Islands Province of western Indonesia. The Village provides tourists with an opportunity to observe fascinating cultural patterns and enjoy an adjacent mangrove forest with a beautiful white sandy beach. These resources enable the Village to provide education and beach tourism with a focus on special interest tour packages for nature-based and cultural tourists. It practices community-based tourism designed to engage and empower Village residents in the management of tourism. Visitor facilities include art and cultural stages, seafood restaurants, selfie areas, souvenir shops, WiFi areas, public restrooms, and prayer rooms.

The Village conserves and prominently features the "Mangrove Pandang Tak Jemu", a roughly seven-hectare mangrove forest that serves as a venue for ecotourism experiences and provides the significant social, economic, and environmental benefits discussed earlier. The potential of the forest to attract ecotourists persuaded the community to actively contribute to its conservation and to teach children the importance of carefully preserving and managing such forests. To this end, Village residents regularly involve children in the planting of mangroves.

Overall, the cultural resources of the Village, the adjacent mangrove forest, and sufficient visitor services, combine to make the Village a sustainable destination. In addition, the Village illustrates how the preservation, regeneration, and sound management of mangrove forests can simultaneously generate social, economic, and environmental benefits, including adaptation to sea level rise.[83]

[83] For more information on Kampung Tua Bakau Serip Tourism Village, visit: https://jadesta.kemenparekraf.go.id/desa/kampung_tua_bakau_serip_pokdarwis_pandang_tak_jemu

Exhibit 14. Mangrove Pandang Tak Jemu of Kampung Tua Bakau Serip Tourism Village.

Photo credit: Wonderful Indonesia

Budo Tourism Village. This Tourism Village is located in North Minahasa Regency in northeastern Indonesia. Like many coastal villages in this region, it traditionally depended on small-scale fishing, but after overfishing depleted fish stocks a new focus on tourism as an engine of economic development emerged. A United Nations International Labour Organization (ILO) program is helping the Village diversify into sustainable tourism, providing skills to local entrepreneurs, especially women.[84]

With government support, a dilapidated pier has been renovated, with wooden huts and benches added for tourists, who pay a nominal fee to stroll it and enjoy the view. Visitors can buy local delicacies and drinks at a ticket counter, where orders are prepared and delivered by members of the Village Enterprise Association.[85]

With the support of the ILO and its partners, Budo has increased its income from tourism fivefold and recently won the Indonesia Ministry of Tourism and Creative Economy's Top 50 Village Tourism Award in the digital marketing category. There is interest in building more homestays, and increasing overnight stays, possibly through a marketing campaign to convince foreign tourists from nearby world-class diving destinations to dine and lodge in a typical village rather than a mass tourism destination. The Village Enterprise Association also plans to offer cooking and handicraft classes and fishing trips.[86]

[84] United Nations. (2023, 7 January). UN News. Economic Development. https://news.un.org/en/story/2023/01/1132252

[85] Ibid.

[86] Ibid.

Exhibit 15. Part of Budo Tourism Village.

Photo credit: TribunBatam.id

The Village's tourism offer includes built overwater bungalows, both as a visitor amenity and an adaptation to sea level rise. As explained above, these structures are less vulnerable to sea level rise than shoreline constructions, and in this case enable tourists to view marine life in adjacent reefs and mangrove forests. In addition, the conservation, regeneration, and benign use of such forests have been integrated into its tourism planning and development based on a recognition of the many benefits of mangrove forests listed above. Thus, Budo Tourism Village provides an additional example of how the preservation of mangrove forests, when combined with the provision of adequate visitor services, especially overnight accommodations in the form of built overwater bungalows, can simultaneously support economic development and aid adaptation to sea level rise.[87]

Technical Approaches

Floating Overwater Resorts as an Example of Adaptation

One adaptation to potentially inundated shorelines is to avoid them altogether by providing lodging for tourists in the form of floating overwater bungalows like those at 500 Rai Floating Resort near Phuket, Thailand.[88] Inspired by traditional floating villages in Thailand

[87] For more information on Budo Tourism Village, visit: https://jadesta.kemenparekraf.go.id/desa/budo

[88] Osztonits, S. (2023). 13 Reasons to stay at 500 Rai Floating Resort, Khao Sok National Park near Phuket, known as the 'Jurassic Park of Thailand'. TripCanvas. https://thailand.tripcanvas.co/phuket/500-rai-floating-resort/

and non-motorized houseboats on the lakes of Indian-administered Kashmir, these bungalows float on the water's surface, temporarily tethered to the seabed with anchors less harmful to the ocean floor than the permanent stilts that affix non-floating overwater bungalows to the seabed. To further minimize negative environmental impacts, the structures are built on land with eco-friendly construction materials and then floated into place, and are fully self-contained, obviating the need for sewer or water lines.[89]

Innovations such as 3-D modelling and rust- and salinity-resistant materials have increased the durability of floating overwater bungalows. More recently, the high-tech ocean-innovation company Ocean Builders has developed a futuristic floating bungalow in Panama called the "SeaPod" that harvests rainwater on its roof and operates almost entirely on solar power. Some of this solar power is used to generate a mild electrical current to attract calcium carbonate, the building block of coral, thereby helping to restore coral reefs.[90]

Environmental impact standards add to the general complexity and cost of permitting, building, and maintaining such resorts. Given the cost of permitting, construction, and maintenance, floating overwater bungalows generally must demand high rental prices. A developer can cut some corners by not providing air conditioning, mini bars, etc., but these bungalows will always have to be sold as a luxury product.

Exhibit 17. A floating bungalow in Thailand.

Photo credit: Dersyn Studio Co., Ltd.

[89] Dersyn Studio Company. (2023, 3 August). Sustainable architecture, floating resorts, bungalows and villas. Best practices panel, session II, Asia-Pacific Economic Cooperation senior officials' meeting on assessing the impact of rising sea levels on travel and tourism in APEC economies, Seattle, USA. Project TWG 04 2021A.

[90] Ward, T. (2023, 2 June). Is this floating eco-pod the future of overwater bungalows? *Condé Nast Traveler*. https://www.cntraveler.com/story/floating-seapod-panama-review

Hawai‘i, United States: Human Engineered Adaptations Inspired by Natural Ecosystems

Researchers at the University of Hawai‘i, through its Applied Research Laboratory, Hawai‘i Institute of Marine Biology, and School of Ocean and Earth Science and Technology, in collaboration with other US universities and an ocean-engineering industry partner, are engaged in two major research projects attempting to both mimic and nurture natural ecosystem coastal defenses. Coined as Rapid Resilient Reefs for Coastal Defense (R3D), the team is well into a five-year project designed to build a functioning living breakwater to reduce the wave energy experienced by a shoreline by 90%, realize 35% improvement in coverage of the artificial structure with live coral, and improve live coral survivability at +3 degrees Celsius above current ocean temperatures. Though the effort to develop a prototype system is still in research and development, the project is summarized here for the inspiration and promise it may hold for coastal zones where coral reefs naturally form.

The project can arguably be considered, in essence, an attempt to learn from and mimic how natural coral ecosystems protect coastlines from the damaging effects of waves experienced regularly, as well as extreme storm events. Exhibit 18 shows on the left an engineered sea wall in contrast to a natural fringing reef on the right. Both preserve shorelines from the damaging effects of wave action.

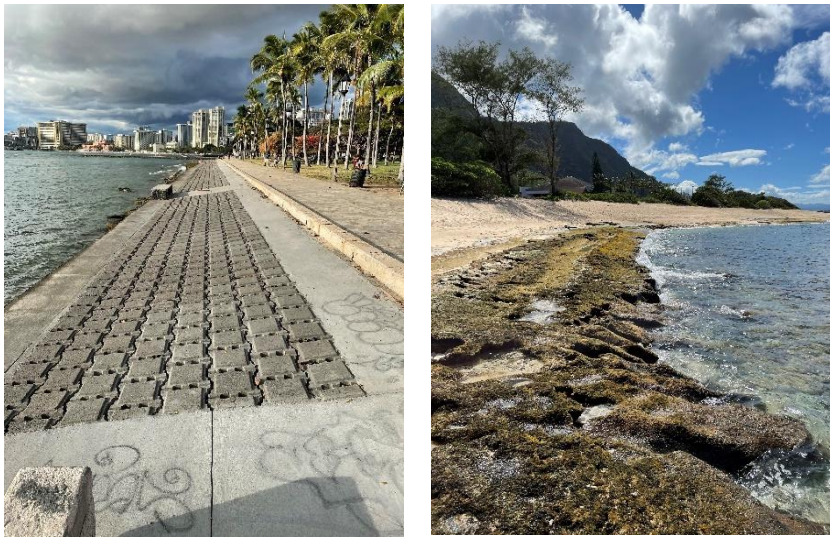


Exhibit 18. An engineered sea wall (l.) and a natural fringing reef (r.)

Photo credit: John C. Crotts

Next, consider the live breakwater reef system depicted in Exhibit 19. The rocks and reefs offshore essentially form a natural submerged sea wall to absorb and neutralize the force of tide and wind driven waves. Closer to shore are intermittently spaced rocks covered with coral that further dissipate the effects of surf eroding shorelines and beaches.

Exhibit 19. A live breakwater reef system.

Photo credit: John C. Crotts

Now consider, in contrast, a visual of an engineered breakwater of R3D that is intended to have the same effect (Exhibit 20). The structures that form the high-point of the reef are placed to reduce most of the incoming wave energy while structures on the horizontal upper surface of the reef reduce residual energy from larger swell events while providing abundant habitat for coral and other reef-supporting life, such as algae-grazing fish and invertebrates.

Many challenges must be mitigated to achieve R3D's targeted goals. First, the design of the engineered reef structures must support water circulation suitable for marine life. The concrete casts of each structure are being designed to mimic water flow around rocks and reefs. Their surfaces also allow for 3D printing of natural chemical and biological cues. Larval coral is also being explored to speed the settlement and growth of a living reef. Second, the structures must attract reef fish. Without algae-grazing fish, reefs cannot flourish. Acoustic recordings of healthy reef sounds, termed acoustic enrichment, are being played back on underwater speakers to attract the species of fish needed to promote live coral growth.

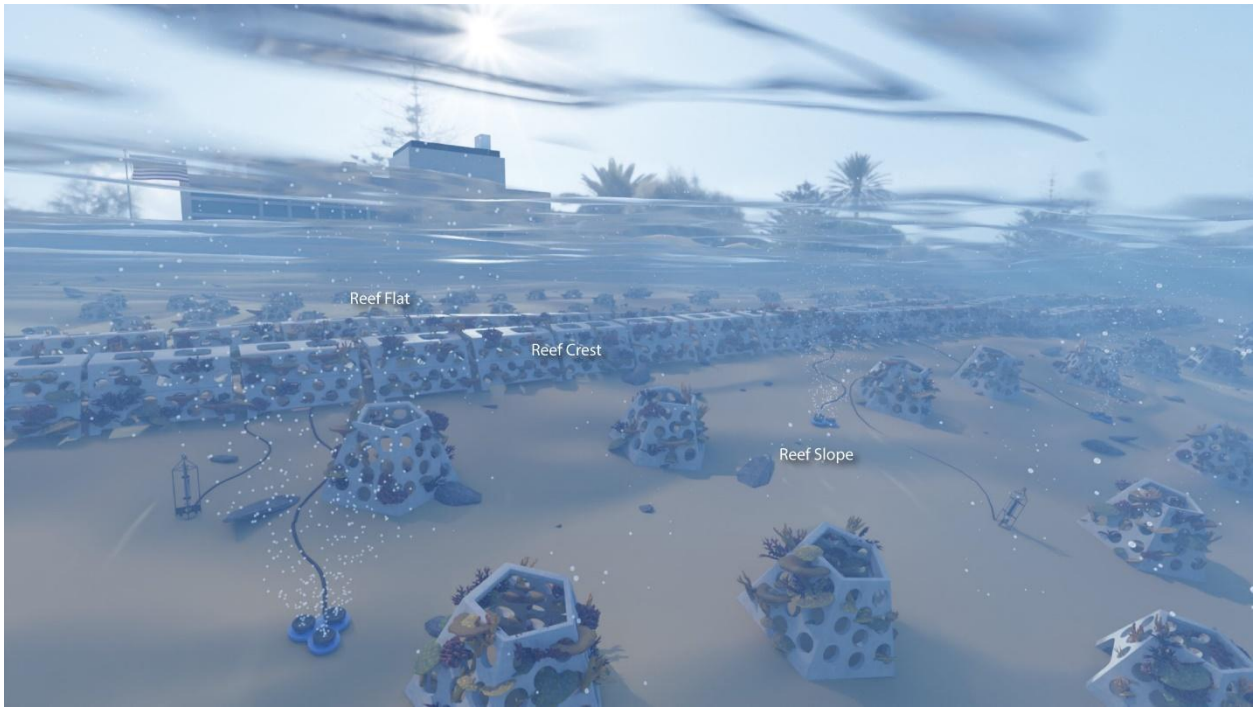


Exhibit 20. Graphic showing engineered reef structures and living coral reef.

Photo credit: School of Ocean and Earth Science and Technology, University of Hawai'i at Manoa

Third, a nascent engineered reef must be able to survive in a warmer climate. Efforts to identify and captively breed heat-resistant coral for future outplanting to these sites are underway. The approach is to identify heat-resistant strands of coral during natural bleaching events that can be bred and propagated in controlled environments and then reintroduced to environments where needed (Exhibit 21).

Photo credit: Joaquin Anico

Photo credit: Coral Reslience Laboratory, HIMB UH

Exhibit 21. Identifying heat-resistant strands of coral during natural bleaching events that can be bred and propagated in controlled environments and then reintroduced to environments where needed.

In summation, the project is designed to quickly build a coastal defense system that by nature, as a living coral reef, can self-repair, adapt to sea-level rise, and is resilient to rising ocean temperatures (Exhibit 22). What has been provided in this overview is where the project currently stands in May 2023. The principal investigator will provide an update of the project on 3 August 2023 at the "APEC Workshop on Assessing the Impact of Rising Sea Levels on Travel and Tourism in APEC Economies" associated with this report.[91]

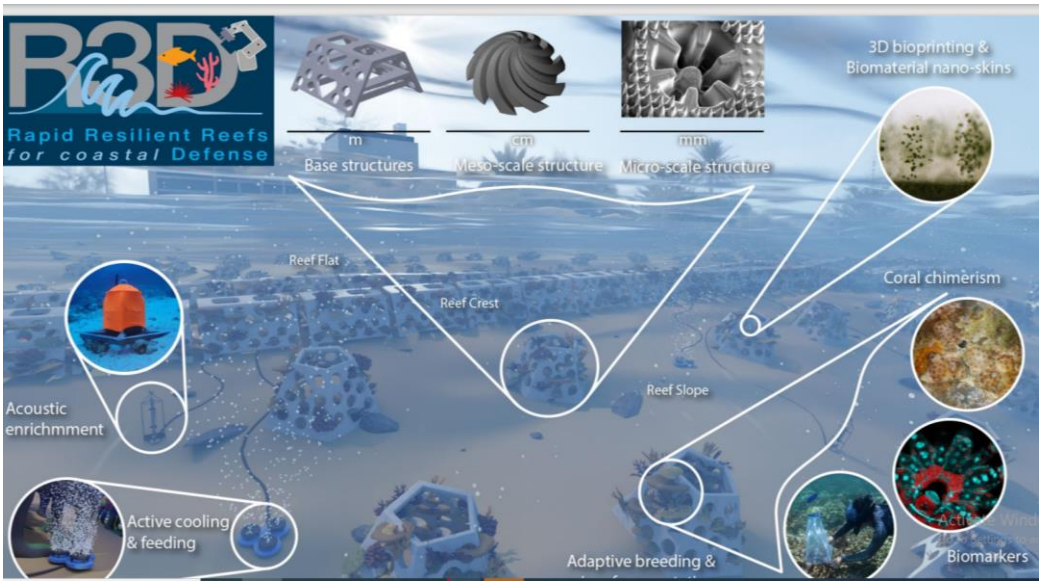


Exhibit 22. Elements of Rapid Resilient Reefs for Coastal Defense.

Photo credit: University of Hawai'i at Manoa R3D

Conclusions

The results of this study revealed that few tourism SMEs are preparing for sea level rise and major storm events in any significant way, essentially leaving the effort up to local and economy-level governments. This may be due to: (1) the daily challenges of managing tourism businesses in today's competitive environment, (2) the fact that building resistance to sea level rise in the face of inevitable retreat might appear to many tourism SMEs to be fruitless and beyond their financial capabilities, and (3) the difficulty of obtaining sea level rise estimates for specific areas, exemplified by the fact that 75% of respondents to our APEC Working Group survey affirmed that "data on sea level rise, extreme storms, and sea level events, and associated impacts, are unavailable or inadequate in your economy." Since it is obviously impossible to prepare for what one cannot imagine, more and better data on climate change phenomena are clearly essential. Hopefully, this report will contributes to the resolution of the last two issues by making sources of data better known and providing examples of cost-effective best practices.

The widespread perception among survey respondents that tourism-related entities were not prepared for, coping with, and recovering from the negative impacts of climate change highlights a need for education on the seriousness of such impacts and action to mitigate

[91] For more information, visit https://www.hawaii.edu/news/2022/06/17/engineered-coral-reef-ecosystem/

them. University outreach and government technical assistance programs can provide this education, preferably in a collaborative mode.

Notwithstanding the great diversity in the best practices cases and technical approaches studied, four broad themes in them are apparent: (1) the important role that environmental preservation can play in shielding coastal zones from the adverse effects of sea level rise and extreme storms, (2) the need for leadership in meeting the challenge of these environmental changes, (3) the significant contribution that technology can make in meeting this challenge, and (4) the importance of educating people about climate change, sea level rise, and disaster preparedness. Amplifications of each follow.

Environmental Protection

By protecting natural areas in their coastal zones, Babcock Ranch, Quintana Roo, and the tourism villages of Kampung Tua Bakau Serip and Budo are defending themselves from the ill-effects of sea level rise and extreme storms. Simultaneously, they are helping to slow climate change as their natural areas remove excess CO_2 from the atmosphere, and providing an amenity for their residents and an attraction for their tourists. Environmental preservation can certainly be expanded across the APEC region, but prompt action is required before remaining natural areas are lost to development.

Leadership

The tourism industry is an inherently complex phenomenon, with multiple, mutually dependent sectors that are significantly influenced by a host of external entities and forces. Consequently, getting anything done in the tourism industry typically requires more collaboration across more organizations than is the case in other industries. Making this collaboration happen, in turn, requires leadership. Elizabeth Hackett's initiation of the Whitsunday Skyway Project to impel the Airlie Beach tourism industry to become more cyclone-resilient, and Wanderlust Indonesia's organizing disaster relief for Tamanjaya Village, exemplify the caliber of leadership necessary to meet the challenge of sea level rise and extreme storms. Such leadership obviously cannot be manufactured, but in the APEC region it can be nurtured in homes and schools, it can be socially recognized when deserved, and it can be followed and emulated when clearly discernible.

Technology

Babcock Ranch's construction of homes using the highest standards of wind resistance and completely powering the development with solar energy; the use of floating overwater bungalows in some places in the APEC region; and the development of engineered reef structures by the University of Hawai'i demonstrate the potential for technology to facilitate adaptation to sea level rise and extreme storms. In the APEC region, governments can actively encourage the development and application of such technology through grants, tax subsidies, demonstration projects, and education and training programs.

Education

The Síijil Noh Há ecotourism center in Quintana Roo educating visitors about the role of natural areas in mitigating climate change, and Wanderlust Indonesia educating residents of West Java communities about disaster risk mitigation and management, exemplify what can be done to better inform people about climate change, sea level rise, and extreme storms, and how to protect themselves from the associated risks. In the APEC region, governments can support education programs such as these through grant and instructor training programs.

Overall, the cases and technical approaches studied illustrate the fact that adapting the tourism industry in APEC economies to sea level rise is not an insurmountable challenge, but it will require planned, adequately funded, and systematically executed action along the lines articulated above.

Appendix A

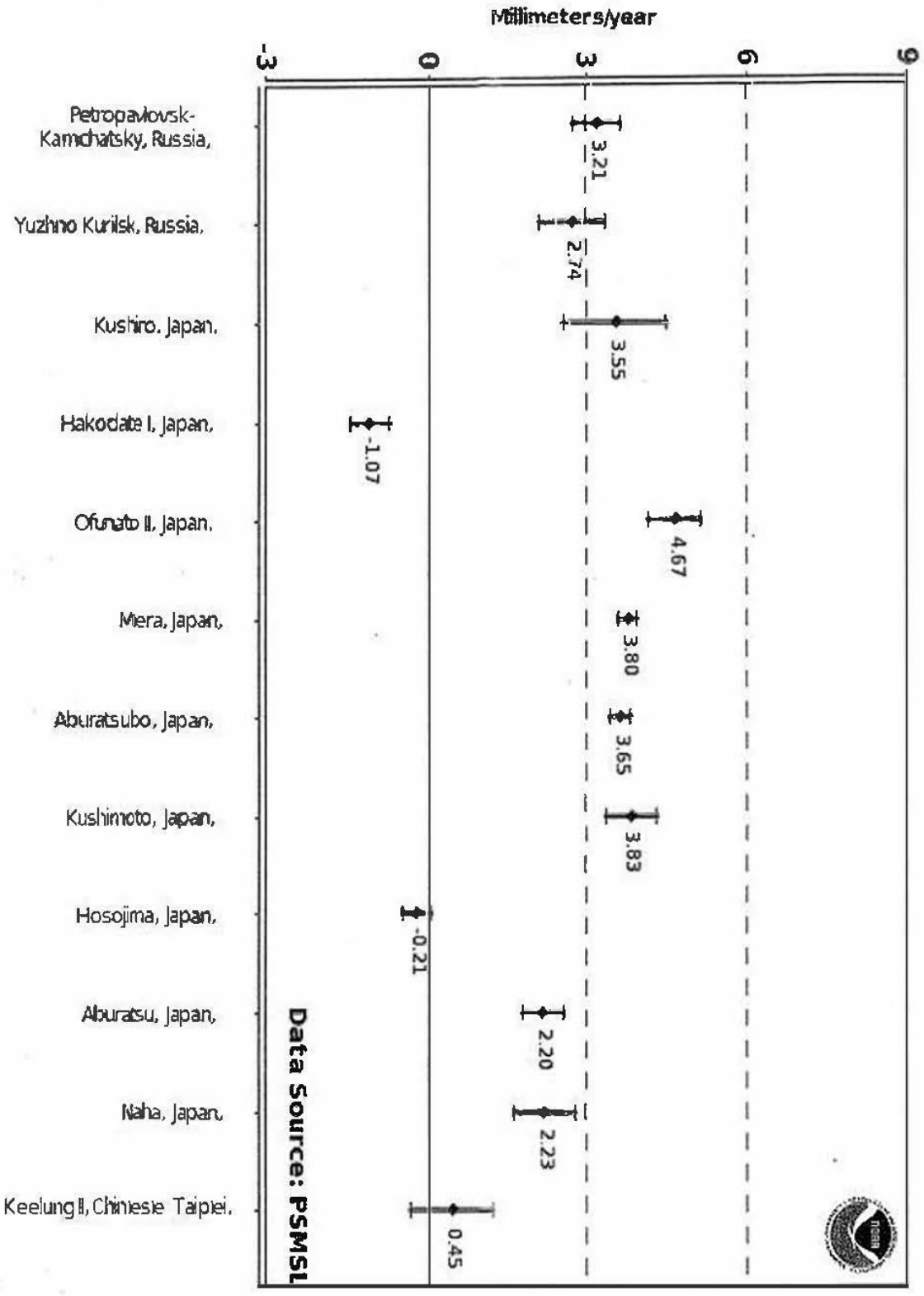
Relative Sea Level Trends by Economy in APEC Region

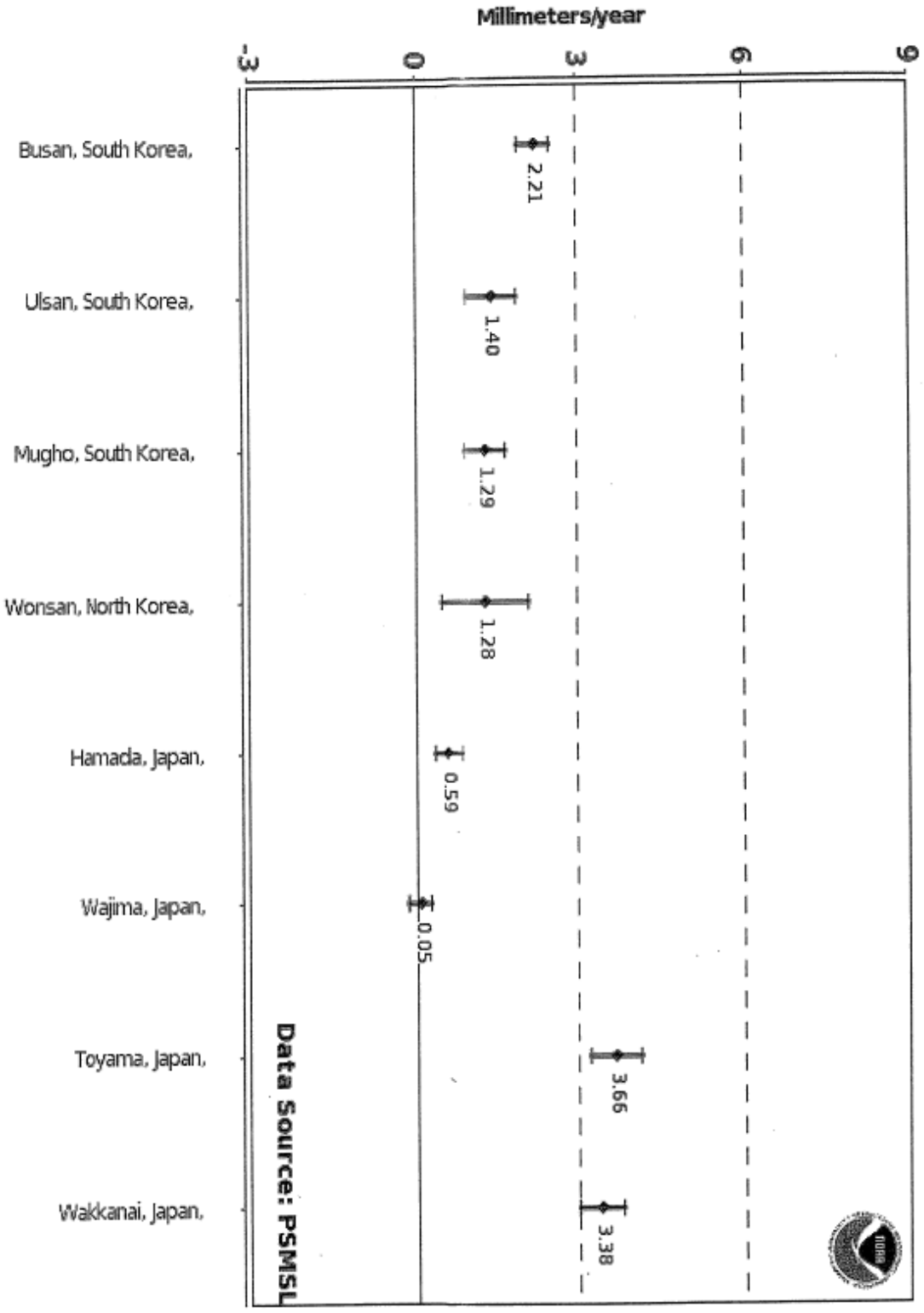
Explanatory Notes

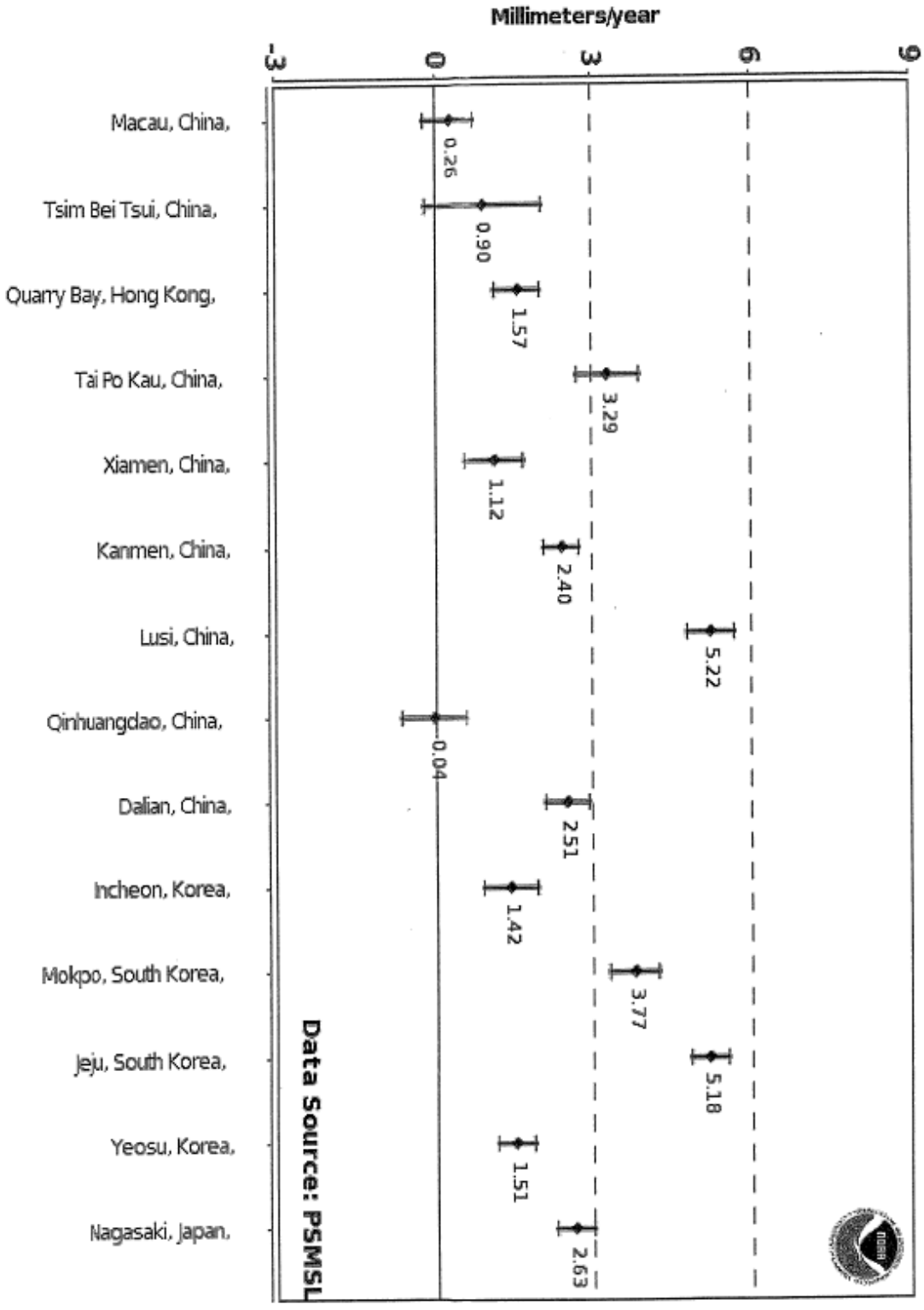
Sea level is primarily measured using tide stations and satellite laser altimeters. Tide stations around the globe measure sea levels in particular locales—the height of the water as measured along the coast relative to a specific point on land. Satellite measurements quantify the average height of the entire ocean. Taken together, these tools document how ocean sea levels are changing over time.

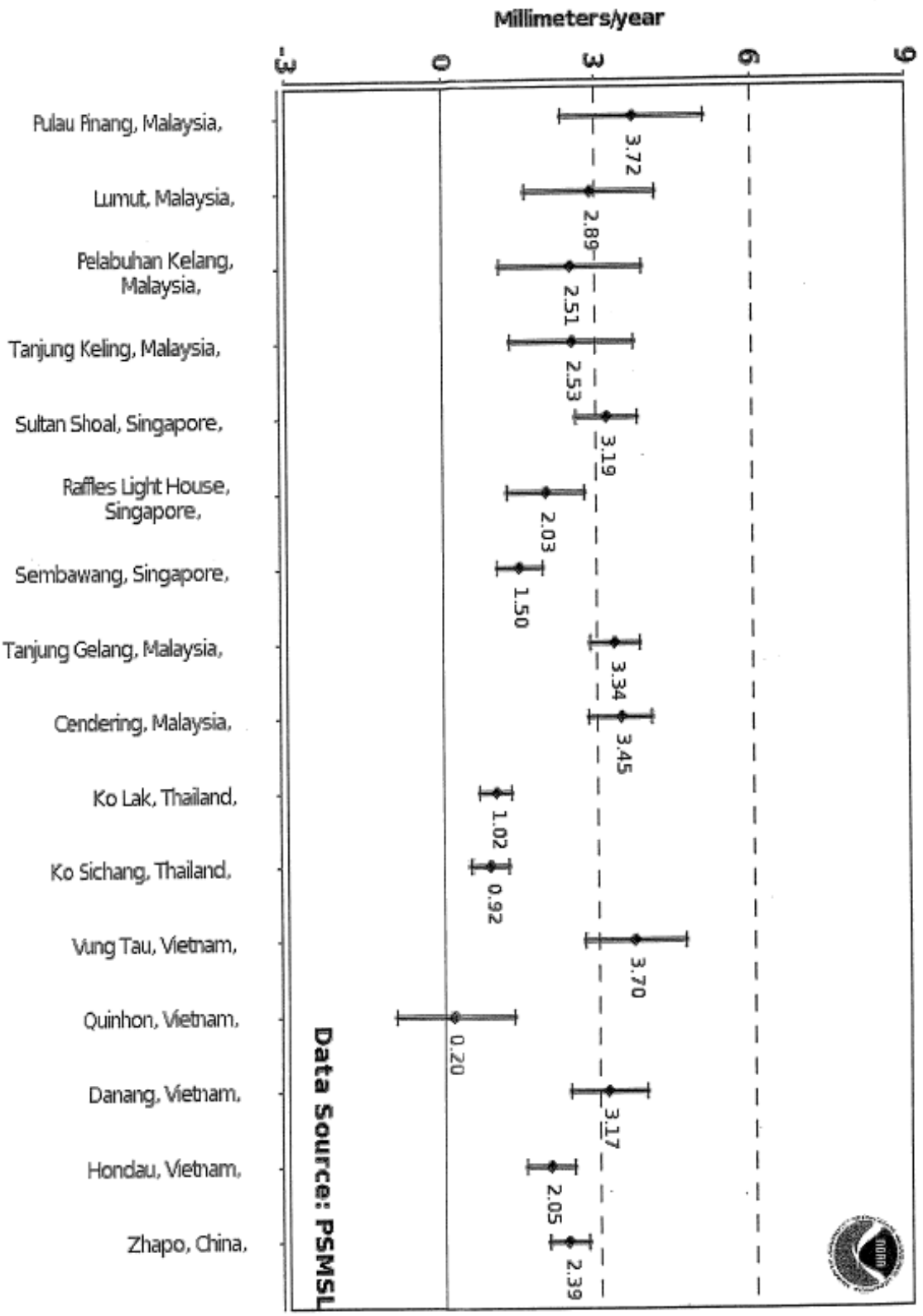
Sea level rise is not globally uniform and varies regionally by plus or minus 30% of the global median (IPCC, 2019). The following graphs compare the 95% confidence intervals of relative sea level rise trends. Trends with the narrowest confidence intervals are based on the longest data sets. Trends with the widest confidence intervals are based on only 30-40 years of data.

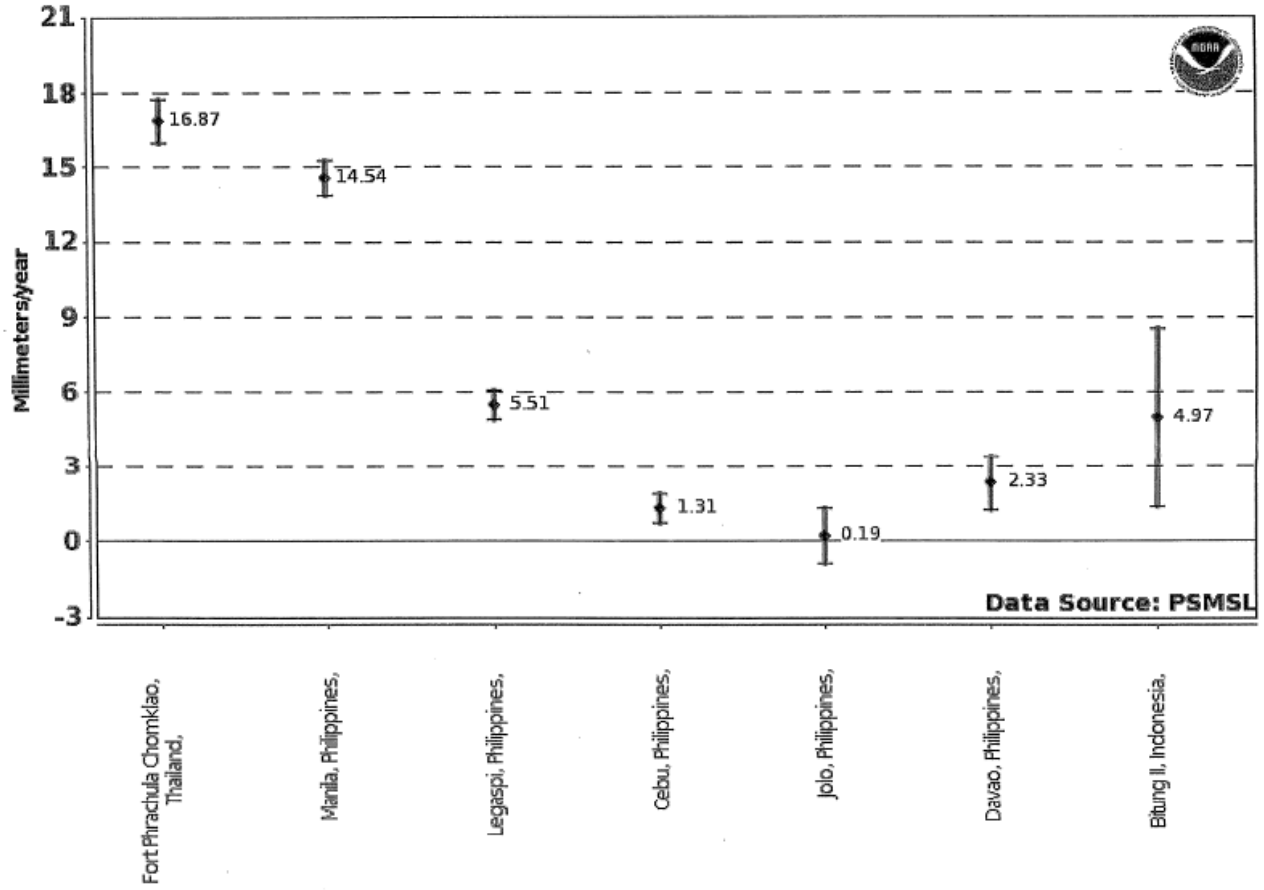
Historical trends for many APEC economies are available from the U.S. National Oceanic and Atmospheric Administration at
https://tidesandcurrents.noaa.gov/sltrends/sltrends_global.html


Millimeters/year
-3
0
3
6
9
Petropavlovsk-Kamchatsky, Russia,
Yuzhno Kurilsk, Russia,
Kushiro, Japan,
Hakodate I, Japan,
Ofunato II, Japan,
Mera, Japan,
Aburatsubo, Japan,
Kushimoto, Japan,
Hosojima, Japan,
Aburatsu, Japan,
Naha, Japan,
Keelung II, Chinese Taipei,
3.21
2.74
3.55
-1.07
4.67
3.80
3.65
3.83
-0.21
2.20
2.23
0.45
Data Source: PSMSL


Millimeters/year
-3
0
3
6
9
Busan, South Korea,
Ulsan, South Korea,
Mugho, South Korea,
Wonsan, North Korea,
Hamada, Japan,
Wajima, Japan,
Toyama, Japan,
Wakkanai, Japan,
2.21
1.40
1.29
1.28
0.59
0.05
3.66
3.38
Data Source: PSMSL


Millimeters/year
-3
0
3
6
9
Macau, China,
Tsim Bei Tsui, China,
Quarry Bay, Hong Kong,
Tai Po Kau, China,
Xiamen, China,
Kanmen, China,
Lusi, China,
Qinhuangdao, China,
Dalian, China,
Incheon, Korea,
Mokpo, South Korea,
Jeju, South Korea,
Yeosu, Korea,
Nagasaki, Japan,
0.26
0.90
1.57
3.29
1.12
2.40
5.22
0.04
2.51
1.42
3.77
5.18
1.51
2.63
Data Source: PSMSL


Millimeters/year
-3
0
3
6
9
Pulau Pinang, Malaysia,
Lumut, Malaysia,
Pelabuhan Kelang, Malaysia,
Tanjung Keling, Malaysia,
Sultan Shoal, Singapore,
Raffles Light House, Singapore,
Sembawang, Singapore,
Tanjung Gelang, Malaysia,
Cendering, Malaysia,
Ko Lak, Thailand,
Ko Sichang, Thailand,
Vung Tau, Vietnam,
Quinhon, Vietnam,
Danang, Vietnam,
Hondau, Vietnam,
Zhapo, China,
3.72
2.89
2.51
2.53
3.19
2.03
1.50
3.34
3.45
1.02
0.92
3.70
0.20
3.17
2.05
2.39
Data Source: PSMSL



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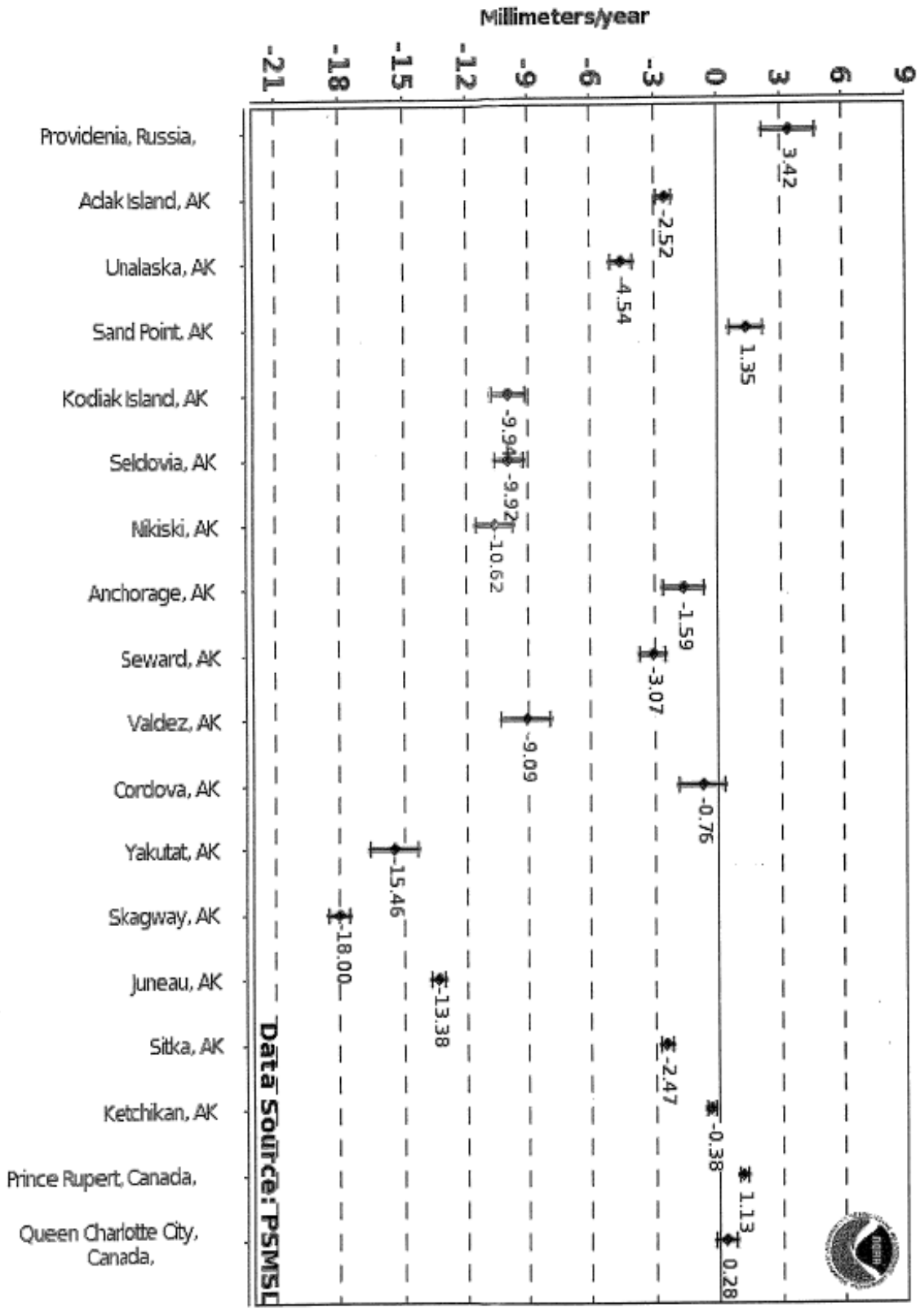
Millimeters/year
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6
3
0
-3
-6
-9
-12
-15
-18
-21
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Adak Island, AK
Unalaska, AK
Sand Point, AK
Kodiak Island, AK
Seldovia, AK
Nikiski, AK
Anchorage, AK
Seward, AK
Valdez, AK
Cordova, AK
Yakutat, AK
Skagway, AK
Juneau, AK
Sitka, AK
Ketchikan, AK
Prince Rupert, Canada,
Queen Charlotte City, Canada,
3.42
-2.52
-4.54
1.35
-9.94
-9.92
-10.62
-1.59
-3.07
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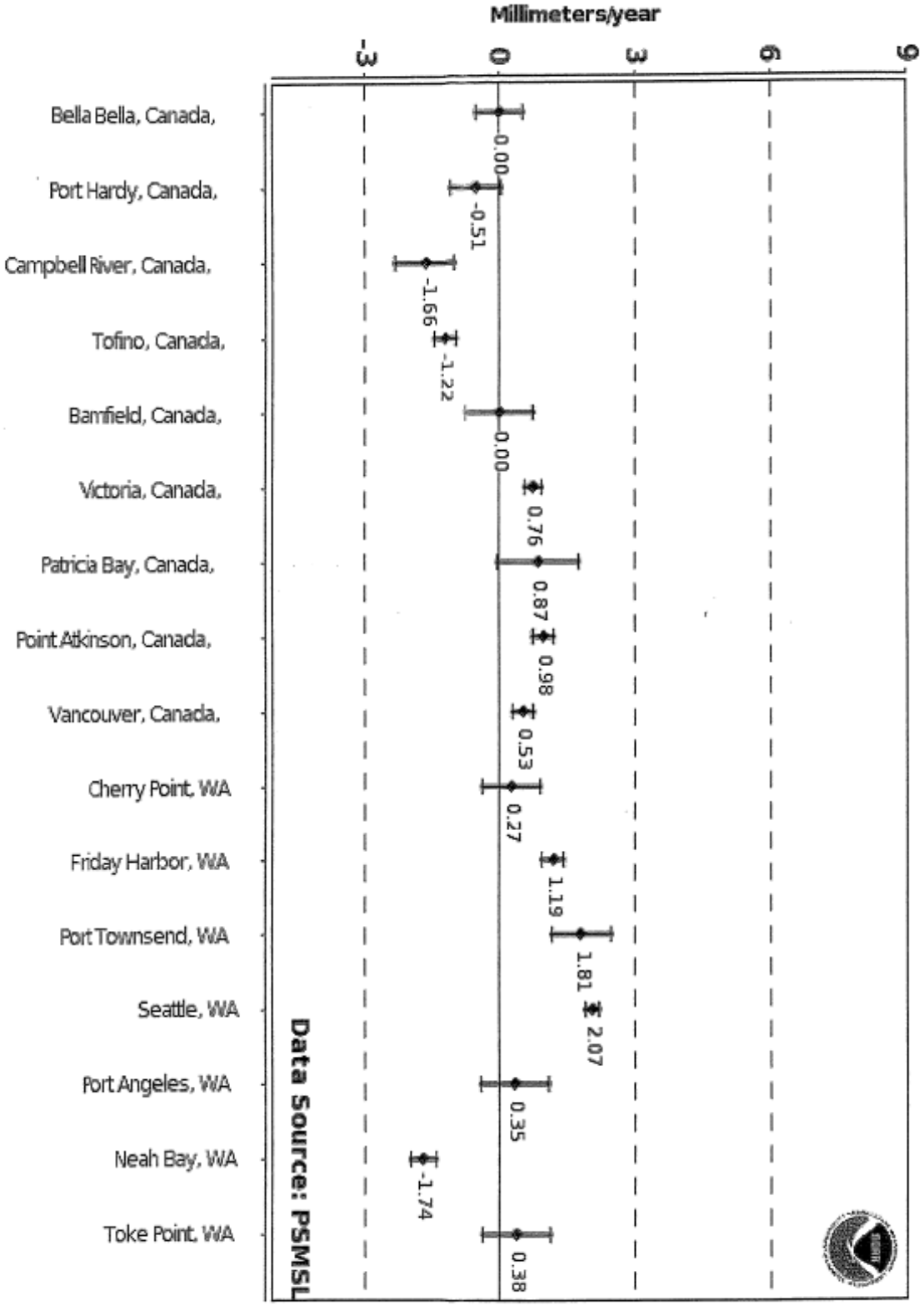
1.13
0.28
Data Source: PSMSL


Millimeters/year
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0
3
6
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Port Hardy, Canada,
Campbell River, Canada,
Tofino, Canada,
Bamfield, Canada,
Victoria, Canada,
Patricia Bay, Canada,
Point Atkinson, Canada,
Vancouver, Canada,
Cherry Point, WA
Friday Harbor, WA
Port Townsend, WA
Seattle, WA
Port Angeles, WA
Neah Bay, WA
Toke Point, WA
0.00
-0.51
-1.66
-1.22
0.00
0.76
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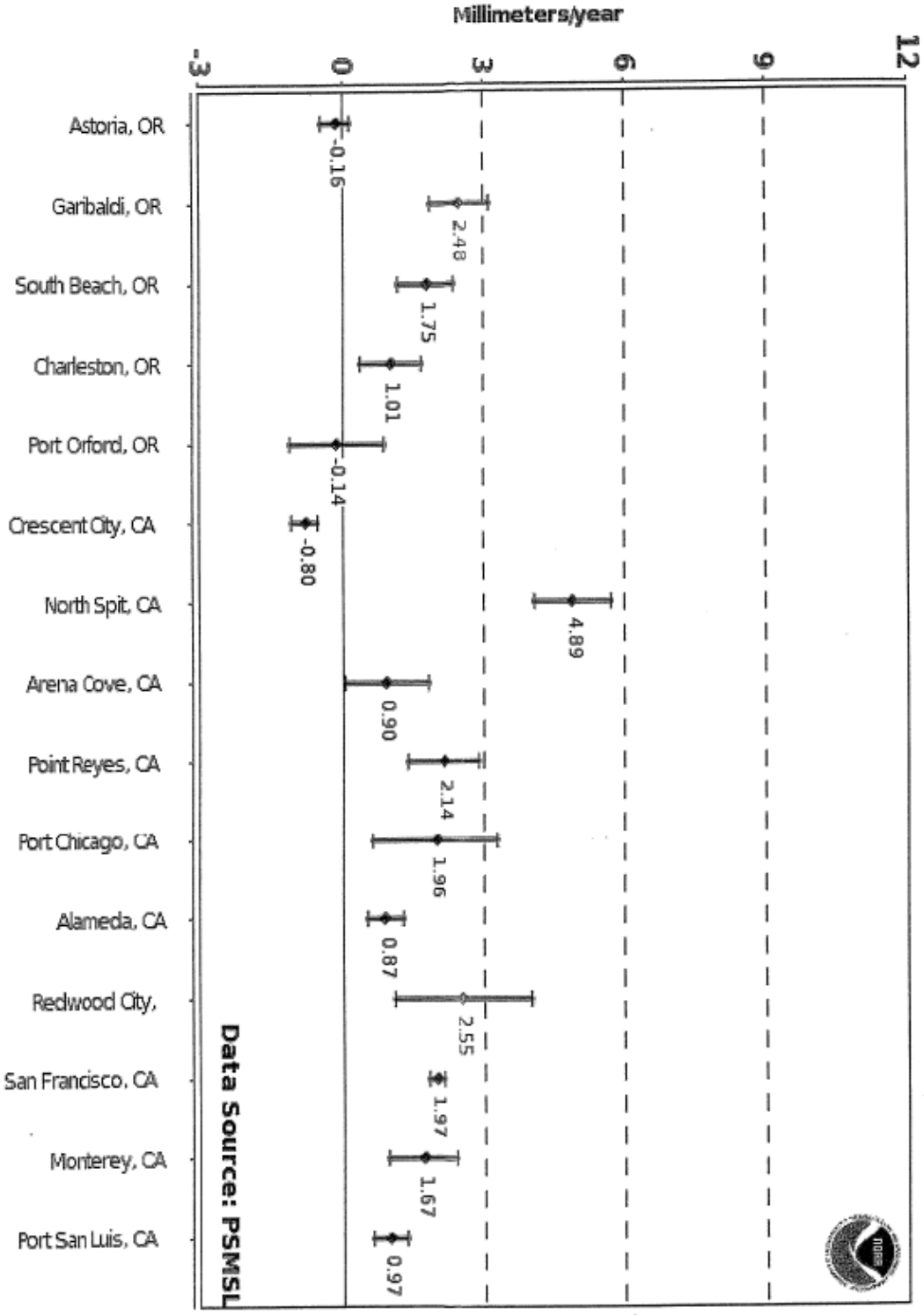
Millimeters/year
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Garibaldi, OR
South Beach, OR
Charleston, OR
Port Orford, OR
Crescent City, CA
North Spit, CA
Arena Cove, CA
Point Reyes, CA
Port Chicago, CA
Alameda, CA
Redwood City,
San Francisco, CA
Monterey, CA
Port San Luis, CA
-0.16
2.48
1.75
1.01
-0.14
-0.80
4.89
0.90
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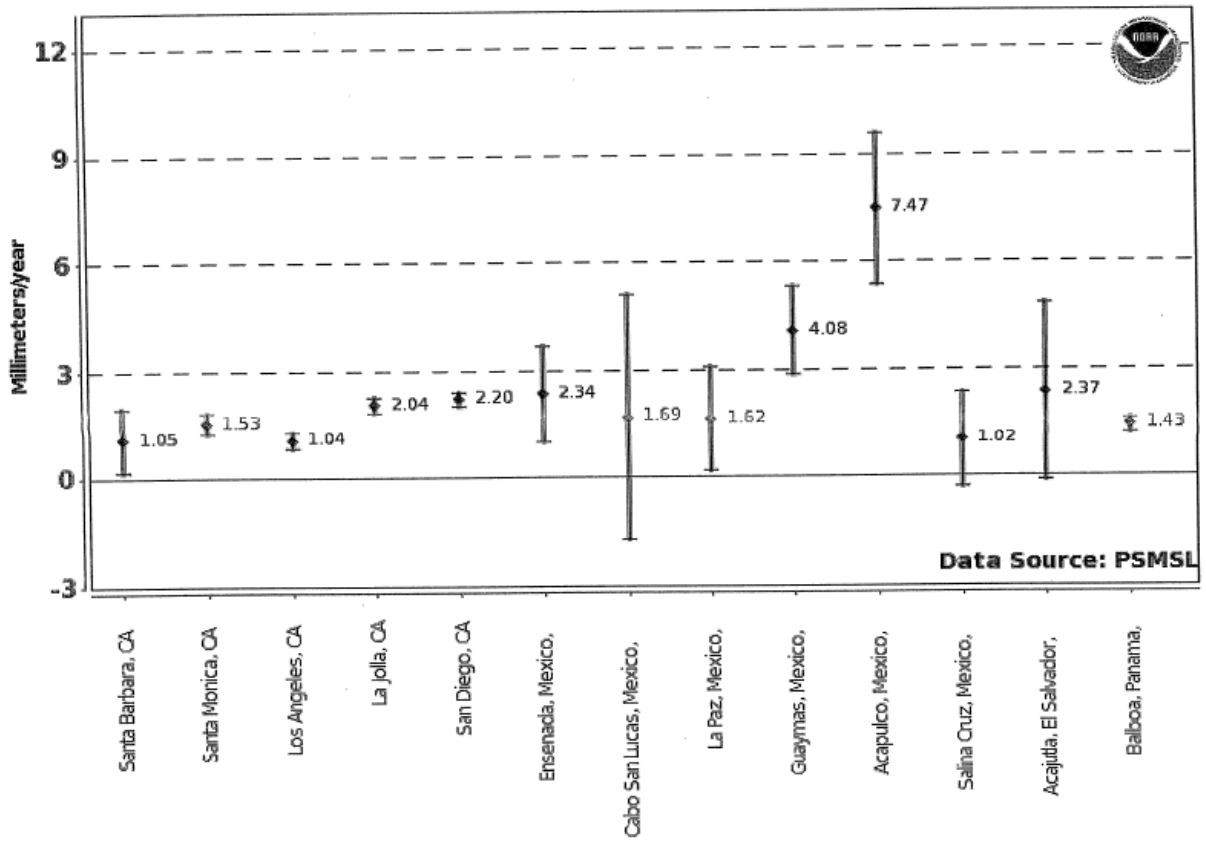
0.87
2.55
1.97
1.67
0.97
Data Source: PSMSL



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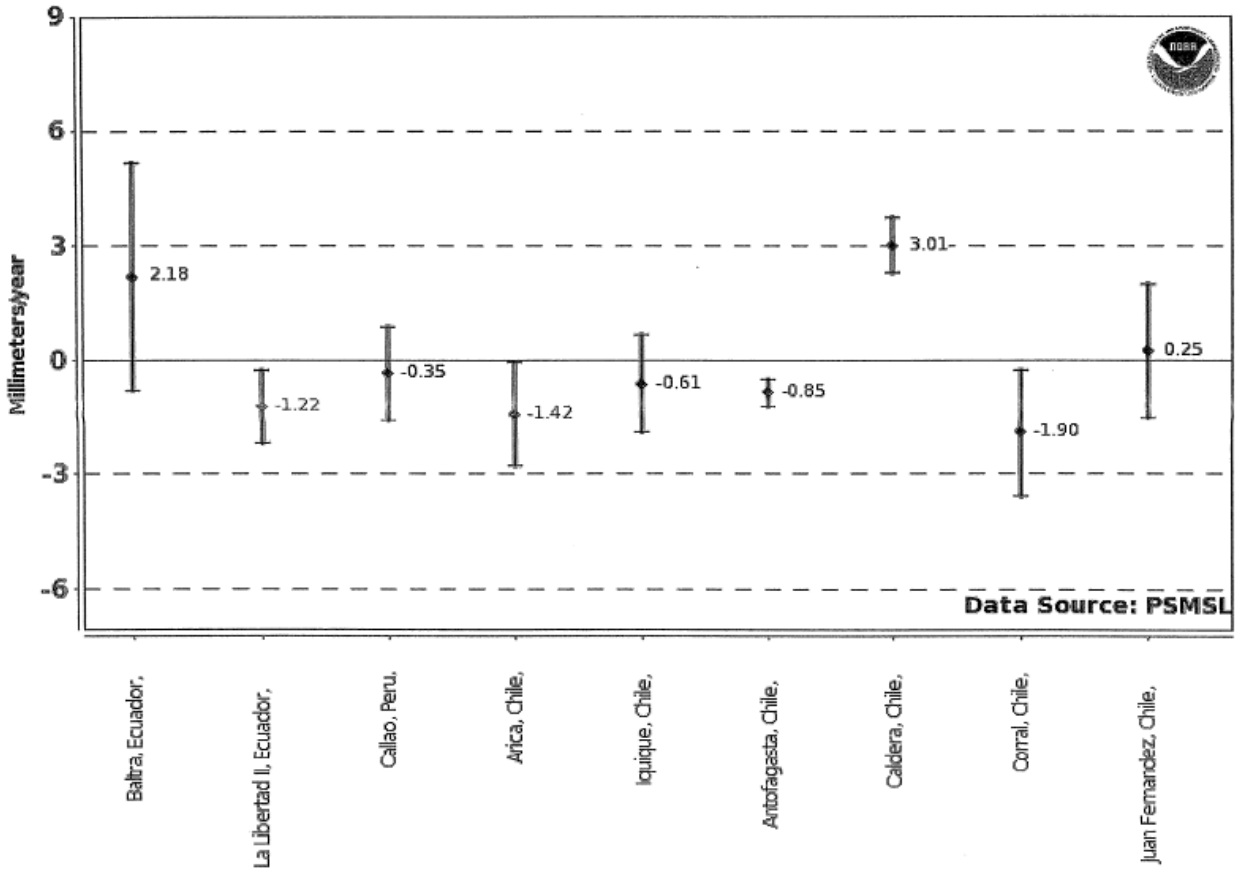

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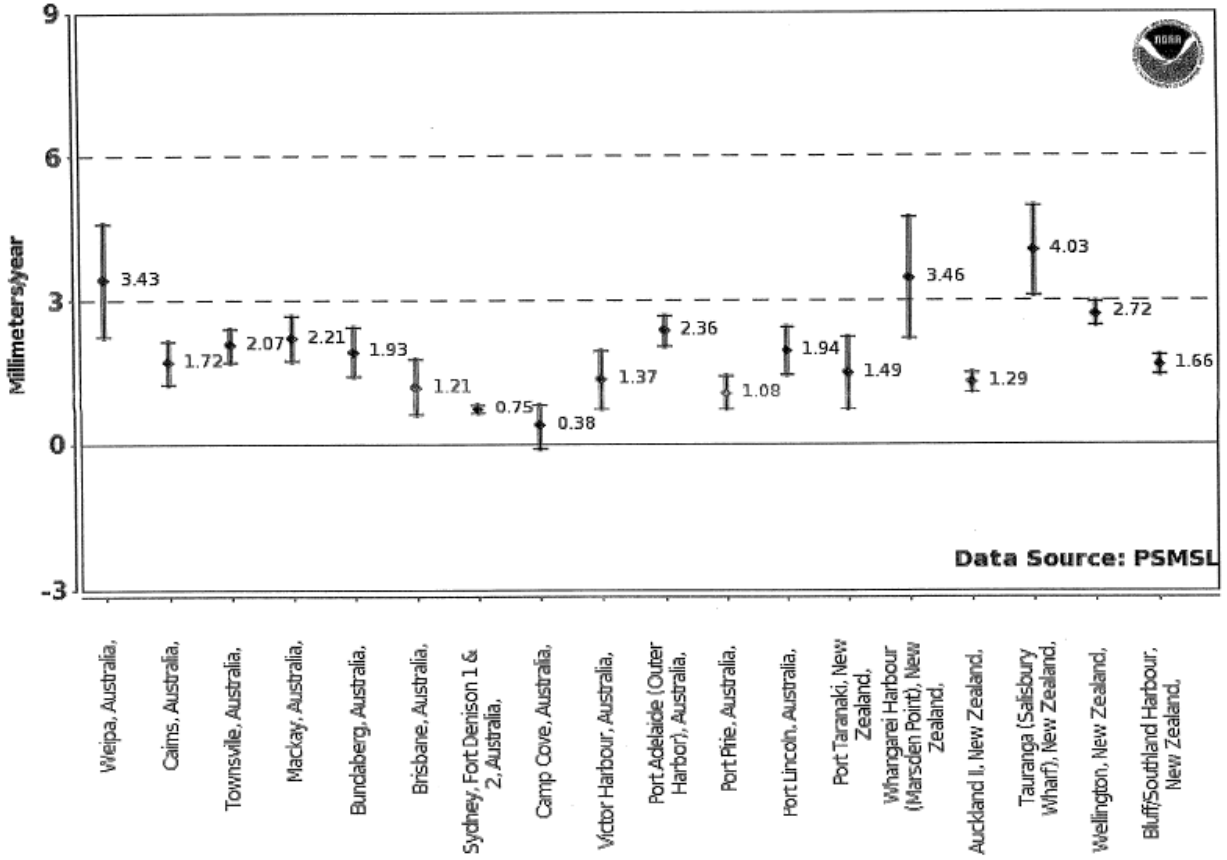

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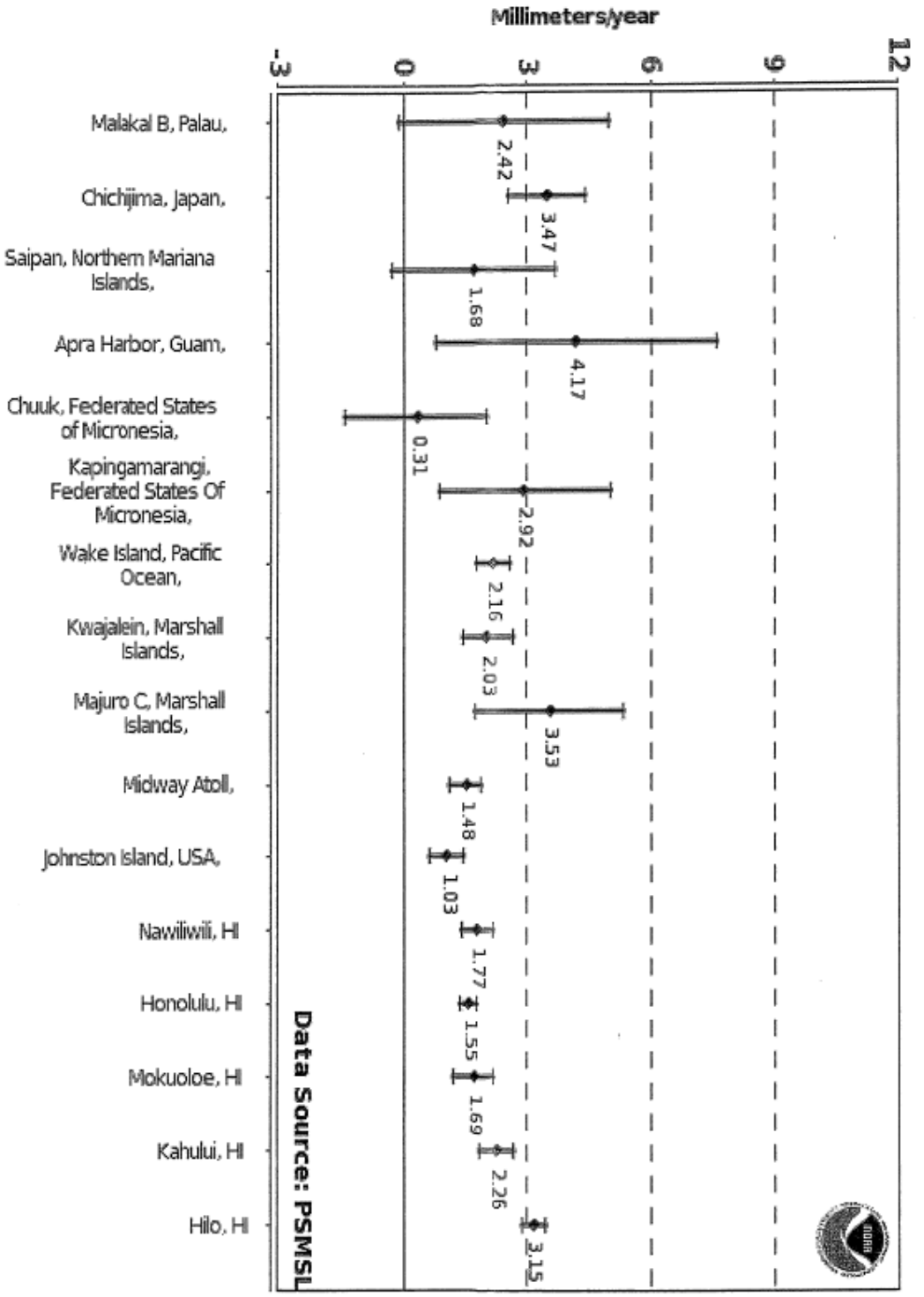
Millimeters/year
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3
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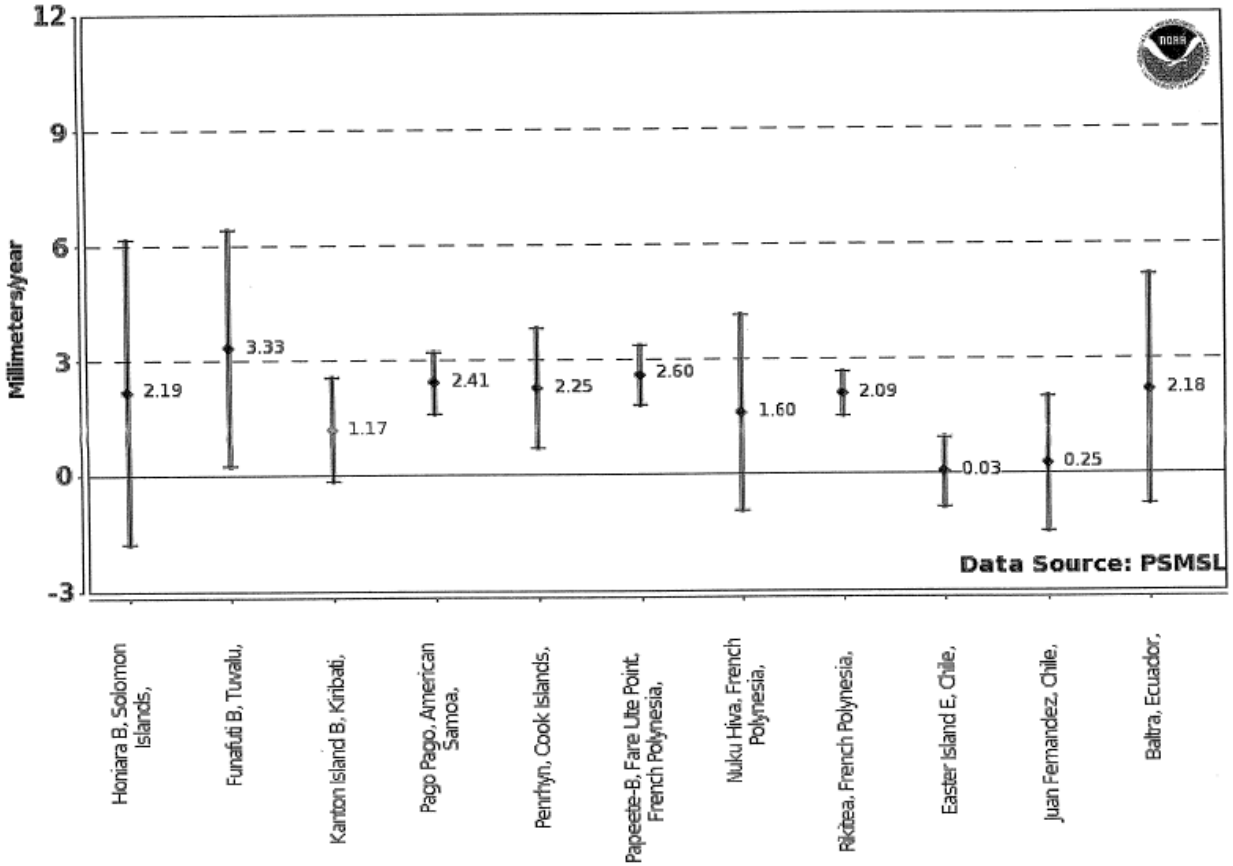
Malakal B, Palau,
2.42
Chichijima, Japan,
3.47
Saipan, Northern Mariana Islands,
1.68
Apra Harbor, Guam,
4.17
Chuuk, Federated States of Micronesia,
0.31
Kapingamarangi, Federated States Of Micronesia,
2.92
Wake Island, Pacific Ocean,
2.16
Kwajalein, Marshall Islands,
2.03
Majuro C, Marshall Islands,
3.53
Midway Atoll,
1.48
Johnston Island, USA,
1.03
Nawiliwili, HI
1.77
Honolulu, HI
1.55
Mokuoloe, HI
1.69
Kahului, HI
2.26
Hilo, HI
3.15
Data Source: PSMSL



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Appendix B

Questionnaire Used in Survey of APEC Working Group Members

Q1. Are you aware if your economy's government makes measures of annual sea level rise available to the public? [ ] Yes [ ] No [ ] Uncertain

Q2. If yes, what is it in centimeters or inches? _____

Q4. Climate change has various negative impacts on tourism SMEs in APEC member economies, including sea level rise, extreme storms, and sea level events. Please indicate your perception of the **short-term (1 to 5 years)** risks each of the following negative impacts of climate change has on tourism SMEs in your economy, on the following scale from low risk to high risk.

	Low Risk	Moderately Low Risk	Moderate Risk	Moderately High Risk	High Risk
Coastal erosion	[ ]	[ ]	[ ]	[ ]	[ ]
Coastal flooding	[ ]	[ ]	[ ]	[ ]	[ ]
Plastic pollution washing up on shorelines	[ ]	[ ]	[ ]	[ ]	[ ]
Extreme storms	[ ]	[ ]	[ ]	[ ]	[ ]
Extreme storm surges	[ ]	[ ]	[ ]	[ ]	[ ]
Extreme waves	[ ]	[ ]	[ ]	[ ]	[ ]
Extreme droughts	[ ]	[ ]	[ ]	[ ]	[ ]
Harm to coastal ecosystems	[ ]	[ ]	[ ]	[ ]	[ ]
Harm to fisheries	[ ]	[ ]	[ ]	[ ]	[ ]
Other, please explain	[ ]	[ ]	[ ]	[ ]	[ ]
Other, please explain	[ ]	[ ]	[ ]	[ ]	[ ]

Q5. Please indicate your perception of the **long-term (6+ years)** risks each of the following negative impacts of climate change has on tourism SMEs in your economy, on the following scale from low risk to high risk.

	Low Risk	Moderately Low Risk	Moderate Risk	Moderately High Risk	High Risk
Coastal erosion	[ ]	[ ]	[ ]	[ ]	[ ]
Coastal flooding	[ ]	[ ]	[ ]	[ ]	[ ]
Plastic pollution washing up on shorelines	[ ]	[ ]	[ ]	[ ]	[ ]
Extreme storms	[ ]	[ ]	[ ]	[ ]	[ ]
Extreme storm surges	[ ]	[ ]	[ ]	[ ]	[ ]
Extreme waves	[ ]	[ ]	[ ]	[ ]	[ ]
Extreme drought	[ ]	[ ]	[ ]	[ ]	[ ]
Harm to coastal ecosystems	[ ]	[ ]	[ ]	[ ]	[ ]
Harm to fisheries	[ ]	[ ]	[ ]	[ ]	[ ]
Other, please explain	[ ]	[ ]	[ ]	[ ]	[ ]
Other, please explain	[ ]	[ ]	[ ]	[ ]	[ ]

Q6. Please indicate how frequently the following responses to sea level rise are applied in your economy, on the following scale. If you feel unknowledgeable in making a given assessment, please select "Don't Know".

	Not Used At All	Rarely Used	Occasionally Used	Widely Used	Universally Used	Don't Know
Protecting and enhancing dunes as a natural defense	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
Beach renourishment by bringing in sand	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
Preserving/planting mangroves as a natural defense	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
Building sea walls	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
Avoiding floods by raising buildings onto pilings	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
Retreating from coastlines when beach erosion requires	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
Other, please explain	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
Other, please explain	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]

Q7. Below is a list of statements related to how well tourism SMEs in your economy are prepared for, coping with, and recovering from the negative impacts of climate change. Please indicate your perception of tourism SMEs' ability on each dimension, on the following scale. If you feel unknowledgeable in making a given assessment, please select "Don't Know".

	Poor	Fair	Neutral	Good	Excellent	Don't Know
The ability of tourism SMEs along coastlines to manage beach erosion of their business sites due to sea level rise.	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
The ability of tourism SMEs along coastlines to cope with flooding in and around their business sites due to sea level rise.	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
The ability of tourism SMEs along coastlines to receive early warnings of major flooding or events.	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
The availability of emergency shelters that can serve the staff, visitors, and families of tourism SMEs along coastlines.	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
When confronted with flooding or a major storm event, the ability of tourism SMEs along coastlines to avoid significant damage to their enterprises.	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
When confronted with flooding or a major storm event, the ability of tourism SMEs along coastlines to recover rapidly from resulting damage, using their own resources.	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
The flexibility of tourism SMEs along coastlines to switch to serving local markets and maintain cash flow when international tourism collapses after major flooding or a storm event.	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]

Q8. Below are several additional statements related to how well tourism SMEs in your economy are prepared for, coping with, and recovering from the negative impacts of climate change. Again, please indicate your perception of tourism SMEs' ability on each dimension, on the following scale. If you feel unknowledgeable in making a given assessment, please select "Don't Know".

	Poor	Fair	Neutral	Good	Excellent	Don't Know

The ability of local governments to provide post-disaster support and assistance to tourism SMEs after major flooding or a storm event.	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
The ability of **local governments** to provide post-disaster support and assistance to tourism SMEs after major flooding or a storm event.	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
The ability of **central governments** to provide post-disaster support and assistance to tourism SMEs after major flooding or a storm event.	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
The ability of lodging SMEs to provide back-up electrical power after major flooding or a storm event.	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
The ability of lodging SMEs to provide back-up sources of drinking water after major flooding or a storm event.	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
The ability of lodging SMEs to maintain or quickly restore internet connectivity and telecommunications after major flooding or storm event.	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
The ability of farmers to keep producing fresh food for restaurants in greenhouses and less affected areas after major flooding or a major storm event.	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
The ability of distributors to keep delivering fresh food to restaurants after major flooding or a major storm event.	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
The ability of women to continue to participate in the tourism economy following a natural disaster.	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]

Q9. Please describe your economy's planned near-term efforts over the next 1-5 years to minimize or mitigate the negative impacts of sea level rise, extreme storms, and sea level events, including effects on businesses in underserved communities and women-owned businesses. If you 'Do Not Know', please just input Don't Know in the space below.

Q10. Please describe your economy's planned long-term efforts over the next six or more years to minimize or mitigate the negative impacts of sea level rise, extreme storms, and sea level events, including effects on businesses in underserved communities and women-owned businesses. If you don't know, please just indicated 'Don't Know' in the space below.

Q11. Please describe the data and indicators currently used in your economy to measure and monitor sea level rise, extreme storms, and sea level events. If you don't know, please just wrote in the space below.

Q12. Do you feel that data on sea level rise, extreme storms, and sea level events, and associated impacts, are unavailable or inadequate in your economy?

[ ] Yes [ ] No

Q13. If yes, which type of data are unavailable or inadequate? Check all that apply.

[ ] Sea level rise

[ ] Extreme storms

[ ] Sea level events

[ ] Associated impacts

[ ] Other, please explain

Q14. What are the specific needs and responses of women-owned tourism SMEs with regard to sea level rise, extreme storms, and sea level events? If you don't know, please just wrote in the space below.

Q15. How does sea level rise, extreme storms, and sea level effects affect women's participation in the economy? If you don't know, please just wrote in the space below.

Q16. What do you feel are the best ways for tourism SMEs in your economy to mitigate their own risks? If you don't know, please just wrote in the space below.

Q17. What do you feel are the best ways for government policy makers and destination managers in your economy to incorporate resiliency into tourism planning and development? If you don't know, please just wrote in the space below.

Q18. Please indicate which APEC economy you represent:

- Australia
- Brunei Darussalam
- Canada
- Chile
- China
- Hong Kong, China
- Indonesia
- Japan
- Republic of Korea
- Malaysia
- Mexico
- New Zealand
- Papua New Guinea
- Peru
- Russia
- Singapore
- Chinese Taipei
- Thailand
- The Philippines
- United States
- Viet Nam

Q19. Please indicate the APEC working group you represent.

- Emergency Preparedness
- Ocean and Fisheries
- Small and Medium Sized Enterprises
- Tourism

Q20. Lastly, we are attempting to identify tourism SMEs or destinations in each APEC economy that are effective in preparing for and managing sea level rise and major flooding and storm events. To this end, we ask that you nominate candidates in each of these categories by providing: (1) The name of the tourism SME or destination you wish to nominate, (2) Its website address (if available), (3) The name of the APEC economy, and (4) any and all contact information on the tourism SME or destination, including, the owner's name and email address if applicable.

Q21. In your own words, what has this tourism SME or destination done to make their enterprise or destination better able to cope with and recover from major flooding and storm events or be more resilient to the negative impacts of sea level rise?

Appendix C

Responses to Open-Ended Questions in Survey of

APEC Working Group Members

This appendix presents a complete list of all responses, other than "don't know", to the open-ended questions in the questionnaire used in the survey of APEC Working Group members. Each such response is listed in italics as a separate paragraph, followed by the name of the respondent's economy in brackets.

Question 9. Please describe your economy's planned near-term efforts over the next 1-5 years to minimize or mitigate the negative impacts of sea level rise, extreme storms, and sea level events, including effects on businesses in underserved communities and women-owned businesses.

In 2018, the Government of Canada launched the Disaster Mitigation and Adaptation Fund (DMAF), where it committed CAD2 billion over 10 years to invest in structural and natural infrastructure projects to increase the resilience of communities that are impacted by natural disasters triggered by climate change. Starting in 2021, the DMAF moved to specifically allocate CAD670 million to small-scale project (projects with total eligible costs between CAD1 million and CAD20 million). [Viet Nam]

Through mitigation and adaptation, by actions plans. [Chile]

Development of an action plan for climate change, where matters of actions for the impacts of sea level rise are addressed. [Chile]

The Ministry of Tourism of the Government of Mexico implements the ADAPTUR Project, whose purpose is to support companies in the tourism sector to implement measures to adapt to climate change based on ecosystems, to protect natural assets from which the sector benefits, such as beaches, reefs, jungles and biodiversity; and to guarantee the ecosystem services required by the sector. One of the products of this project is the "Guide for Investments Adapted to Climate Change", which aims to provide guidance and provide elements to incorporate the analysis of climate change and the design of adaptation solutions in the conventional and generic process of planning a real estate tourism investment. You can learn more about this project on the following website: https://www.adaptur.mx/ Additionally, the Ministry of Tourism has developed the "Ocean-Based Tourism Activities Initiative", whose main objective is to move towards a sustainable and resilient tourism development model in marine and coastal areas, with its Axis II, called "Leading climate action in tourism", to reduce the vulnerability of populations, infrastructure and ecosystems in marine-coastal areas and make them resilient against the impacts of climate change and natural phenomenon. [Mexico]

There are both mitigation and adaptation measures being planned and implemented. [Australia]

Local governments in Japan are taking steps to curb the negative impacts of sea level rise through climate change countermeasures and the development of action plans to prevent global warming. [Japan]

Peru is preparing the Nationally Determined Contribution for adaptation and mitigation against climate change in the tourism sector, where short, medium and long-term goals will be determined. Likewise, good environmental practices have been updated, aimed at reducing GHG emissions. [Peru]

The government of our economy has formulated the "2050 Zero Carbon Plan". In line with the Plan, 5 local governments in our 6 major cities have different degrees of legislation to reduce carbon emissions in response to climate change, among which Taipei City is the most complete. [Chinese Taipei]

There are several key domestic adaptation policies, strategies, and plans that has prepared by the economy to address climate change such as National Medium-Term Development Plan 2020-2024, Enhanced Nationally Determined Contribution (NDC) To Paris Climate Agreement, etc. [Indonesia]

The economy has launched the development of climate resilience policies that become the basis for preparing the government's work plan every year and a reference in preparing the National Medium Term Development Plan (RPJMN) 2025-2029 for minimizing the impacts of climate change-related events on communities. In addition, the economy has also prepared and submitted the enhanced Nationally Determined Contribution To UNFCCC, including standpoint on enhanced ambition on adaptation as elaborated in the programs, strategies and actions to achieve economic, social and livelihood, and ecosystem and landscape resilience. [Indonesia]

Businesses and local governments are recommended to develop flexible adaptation plans, rather than relying on a single sea-level rise value or scenario. This is because there is a wide range of possible coastal futures with ongoing sea-level rise, particularly heading into next century. Each regional council must prepare a regional policy statement. Many local authorities have already started to plan for sea-level rise. Some councils have completed coastal hazard assessments and have developed maps showing areas which are expected to be affected over the next 50-100 years. [New Zealand]

Question 10. Please describe your economy's planned long-term efforts over the next six or more years to minimize or mitigate the negative impacts of sea level rise, extreme storms, and sea level events, including effects on businesses in underserved communities and women-owned businesses.

The Government of Canada is one of 187 members signed onto the UN Sendai Framework Global Platform for Disaster Risk Reduction (2015-2030), which provides concrete actions to protect society from risk of disaster. The Emergency Management Strategy for Canada (EM Strategy) builds on the principles articulated in the Sendia Framework in order to establish Federal, Provincial and Territories to strengthen the resilience of Canadian society by 2030. Under the EM Strategy, a key initiative is the National Risk Profile which serves as a domestic disaster risk and capability assessment tool. It uses scientific evidence and stakeholder input to create a forward-looking picture of Canada's disaster risks and capabilities in order to strengthen Canadian communities' resilience to disasters, such as floods, wildfires and earthquakes. In future years, the scope will include a broader range of natural hazards. [Viet Nam]
Adaptation and action plans for different activities. [Chile]

Creation and development of a climate change adaptation plan, where matters of action are addressed to adapt and mitigate the effects of climate change, among which is the rise in sea level. [Chile]

One of the great achievements of the ADAPTUR Project was to achieve the incorporation of criteria for adaptation to climate change in tourism policy instruments at the state level and municipal, such as the Tourism Sector Program 2020 - 2024; the Puerto Vallarta Municipal Climate Change Program; the Regulation of Ecology of Tulum, Questionuintana Roo; the Urban Development Plan in San Miguel de Allende, Guanajuato; the Climate Action Plan in BahÃa de Banderas, among others. [Mexico]

There are both mitigation and adaptation measures being planned and implemented. [Australia]

Peru is preparing the NDC for adaptation and mitigation against climate change in the tourism sector, where short, medium and long-term goals will be determined. [Peru]

In response to rising sea levels caused by global warming, our government continues to elaborate more detailed response plans and through in more budget for the climate emergency. [Chinese Taipei]

The coastal areas are greatly affected by climate change due to the rise in sea-level, and thus the Economy must prepare long-term adaptation strategies to these effects. The Economy has prepared Long Term Strategy for low carbon and climate resilience, and National Long-term Development Plan 2005-2025 to accommodate the climate change impacts. [Indonesia]

The economy has prepared the document of LTS-LCCR 2050, the document presents the carbon-rich economy's sustainable vision beyond the Paris climate targets, and strikes a balance between future emission reduction and economic development. The long-term strategy also outlines Indonesia's goal to reach peak domestic GHG emissions by 2030, with a net sink in the forestry and land use sectors, and to progress further towards net-zero emissions by 2060 or sooner. Similarly, the strategy aims to reduce the economy's potential GDP loss by 3.45% due to climate change in 2050 by enhancing resilience in four basic socio-economic development needs: food, water, energy, and environmental health. [Indonesia]

Question 11. Please describe the data and indicators currently used in your economy to measure and monitor sea level rise, extreme storms, and sea level events.

- *Canadian Drought Monitor (https://open.canada.ca/data/en/dataset/292646cd-619f-4200-afb1-8b2c52f984a2)*
- *Real-Time Hydrometric Data (https://wateroffice.ec.gc.ca/mainmenu/real_time_data_index_e.html)*
- *Public Weather Alerts for Canada (https://weather.gc.ca/warnings/index_e.html)* [Viet Nam]

The Ministry of Tourism of Mexico does not have specific indicators, however, from 2014 to 2018, 25 studies of vulnerability to climate change in tourist destinations were elaborated, which include: vulnerability and risk map, adaptation program, and analysis of the security system and early warnings. The studies make it possible to identify the threats and possible impacts associated with climate change, as well as to locate the most vulnerable areas. In 2018, the World Tourism Organization and the Organization of American States (OAS),

distinguished the vulnerability studies as a case of good practices in the tourism sector to promote sustainable development in Americas. The publication can be consulted at the following link: https://www.e-unwto.org/doi/pdf/10.18111/9789284419937 [Mexico]

We do have some index and data. But I believe our National Science and Technology Center for Disaster Reduction (NSTCDR) has more detailed information. [Chinese Taipei]

The Fifth Assessment Report (AR5) of the Intergovernmental Panel on Climate Change (IPCC), providing estimates of future temperature and precipitation. Four Representative Concentration Pathways (i.e. RCP2.6, RCP4.5, RCP6.0, and RCP8.5) were selected and defined by their total radiative forcing (cumulative measure of GHG emissions from all sources) pathway and level by 2100. In this analysis RCP2.6 and RCP8.5, the extremes of low and high emissions pathways, are the primary focus; RCP2.6 represents a very strong mitigation scenario, whereas RCP8.5 assumes business-as-usual scenario. For Indonesia, these models show a consistent warming trend for all emissions scenarios. However, the projections in rainfall are less certain and vary by both RCP scenarios as well as models. Projected precipitation trends do show a likely increase in rainfall for western and southern areas and a reduction in rainfall for the southern islands; an increase in intensity for extreme rainfall events. Global mean sea-level rise was estimated in the range of 0.44-0.74 meters (m) by the end of the 21st century by the IPCC's Fifth Assessment Report. [Indonesia]

The government has released location specific sea-level rise projections out to the year 2300 for every 2 kilometres of coast. The sea around our economy rose on average by 1.7mm per year from 1900 to 2008. Data and indicators used to display this include maps, case studies, and measurement of vertical land movement. Vertical land movement is measured using global positioning satellite technology and synthetic aperture radar systems mounted on Earth orbiting satellites. The government publishes extreme wind and rain measurements and computer modelling. [New Zealand]

Question 14. What are the specific needs and responses of women-owned tourism SMEs with regard to sea level rise, extreme storms, and sea level events?

Secure source of income. [Chile]

Mechanisms of ecosystemic retribution to conserve the landscape beauty. [Peru]

Should be same as all the tourism industry members. [Chinese Taipei]

The women-owned tourism SMEs needs to improve their resilience in terms of finances, capital, and resources and also improve their skills and knowledge to anticipate climate-related events to business and tourism SMEs. [Indonesia]

Question 15. How does sea level rise, extreme storms, and sea level effects affect women's participation in the economy?

This type of phenomenon negatively affects the participation of women in the economy, which is why the number of employed women in the economy decreases in a greater proportion than men. [Chile]

If women are primary caregivers to dependents and sea level rise, extreme storms, and sea level effects prevent access to school and/or childcare. [Australia]

Increase in time, distance and cost overruns for access to drinking water for the supply of community tourism; increase and/or maintenance of economic, social and political gaps; search for part-time work or commercial activities due to loss of tourist resources and/or tourist structures; segregation of women to the domestic space and unpaid care because they do not have job opportunities; increase in productive activities and unpaid domestic work or care due to the emigration of men and the loss of the tourist resource; difficulty to overcome conditions of poverty; greater inability to ensure family subsistence; limited or no participation in decision making. [Peru]

Should be same as all the tourism industry member. [Chinese Taipei]

The climate-related events will limit their income and decrease the economy. [Indonesia]

Women are more likely to be underemployed, earn less per hour, and do more unpaid work. Extreme weather events and economic transitions are more likely to affect women due to these limitations. [New Zealand]

Question 16. What do you feel are the best ways for tourism SMEs in your economy to mitigate their own risks?

Through mitigating the effects, and planning adaptation. [Chile]

An adequate delivery of information so that they are aware of the risks of adverse events that may occur and how to deal with them. [Chile]

They must be aware of the risks. Identify who must be involved for the actions undertaken to work. Maintain a continuous dialogue with interest groups based on respect for human rights and a gender perspective. [Mexico]

Have well developed business continuity plans in place. [Australia]

It is important that many SMEs correctly understand the risks associated with sea level rise and properly prepare to respond before and after the risk occurs. Understanding the possible risks in advance is extremely important to mitigate damage. [Japan]

Strengthen and implement policies, strategies, programs and projects associated with reducing the risk of the tourist offer in the face of the effects of climate change. [Peru]

Awareness campaigns targeting vulnerable populations. [Peru]

Learn the weather knowledge and watch for the trend in order to plan ahead. [Chinese Taipei]

Tourism SMEs should have adequate support in finance so they can recover themselves if a disaster happens. Also improve their skills and knowledge and increase their participation and protect their main resources. [Indonesia]

Question 17. What do you feel are the best ways for government policy makers and destination managers in your economy to incorporate resiliency into tourism planning and development?

Through working coordinated with the stakeholders. [Chile]

Generating public policies from the territories and considering the spaces with the greatest vulnerability to the effects of climate change, mainly to the effects of rising sea levels. [Chile]

Raise awareness of the risks to which they are vulnerable. Develop technical capabilities. Involvement of key stakeholders. [Mexico]

More readily utilize tourism assets to provide environmental protection services. This will build a degree of responsiveness in the tourism industry and also a well-resourced and plan business continuity option for tourism business following extreme impacts on the environments within which their businesses operate. [Australia]
If the parties involved in the tourism business can share the policies for dealing with possible risks before and after the event, it will be possible to minimize the damage, which will contribute to resiliency. [Japan]

Currently, the state has been developing the necessary tools to deal with events caused by climate change, where the stakeholders involved participate. [Peru]

Somehow transform the invisible climate issues into visible climate issues, so that the stakeholders can see, feel, and encourage them together to deal with weather issues. [Chinese Taipei]

The best ways to incorporate resiliency into tourism planning and development are through providing blue economy entrepreneurship training (e.g., green business for youth) can also benefit local communities. Development of blue economy skills in this case is very important to achieve sustainable tourism. This will strengthen the capacity of workers and employers in the tourism industry as well as other relevant stakeholders involved to understand and respond effectively to challenging global climate change for destinations in the tourism sector especially for coastal and marine ecotourism. [Indonesia]

Collaboration and cooperation with local government, local indigenous groups, businesses, workers and residents, along with collaboration across government at the domestic level. [New Zealand]

Appendix D

Author Profiles

Author Profiles

John C. Crotts, Ph. D.

Dr. John C. Crotts is the incoming Director and Professor of the School of Travel Industry Management at the University of Hawai‘i at Mānoa. Prior to this, he was the founding Chair of the Department Hospitality and Tourism Management at the College of Charleston, a senior lecturer in the Advanced Business Programme on tourism subjects at Otago University, New Zealand, and the Director of the Center for Tourism Research and Development at the University of Florida. His research encompasses the areas of economic psychology, sales and negotiation strategy, and the management of cooperative alliances. He also serves as the North American Editor of *Tourism Management* - the leading journal in the tourism management field. John has published over a 100 academic journal articles involving tourism, demonstrating competency in survey designs and both quantitative and qualitative data analysis. He is an active consultant with both large and small organizations, including most recently Hyatt North America, Starbucks, the South Carolina Ports Authority, Michigan Ports Authority, U.S. Department of Energy, and the Cities of Hampton Roads, VA, Pikesville, KY, Grand Island, LA, and Charleston, SC.

Charles Fletcher, Ph. D.

Dr. Charles “Chip” Fletcher is the Interim Dean of the School of Ocean and Earth Science and Technology at the University of Hawai‘i at Mānoa. He is Chairperson of the Honolulu Climate Change Commission, a prominent public speaker, and a contributor to local and domestic-level media. Chip’s research and teaching focus is on climate change, coastal community resiliency, and natural coastal systems. He has been the principal advisor in funding and awarding over 30 graduate research degrees in Earth and Planetary Sciences, and has received a number of teaching, research, and community service awards.

Daniel M. Spencer, Ph. D.

Dr. Dan Spencer is a Professor in the School of Travel Industry Management at the University of Hawai‘i at Mānoa who specializes in sustainable tourism policy, planning, and management. Prior to joining the School’s faculty in 2010, he was a Senior Research Associate with the Travel, Tourism, and Recreation Resource Center at Michigan State University. His applied and methodological inquiries have appeared in the *Journal of Travel Research*, *Tourism Management*, the *Journal of Leisure Research*, and other serials. He has conducted contract research and outreach projects for the Hawai‘i Tourism Authority; Hawai‘i Sea Grant; the Office of Maunakea Management; the South Dakota Office of Tourism; the South Dakota Department of Game, Fish and Parks; the Sisseton-Wahpeton Sioux Tribe; Black Hills Community Economic Development; Travel Michigan; the Michigan Department of Transportation, and other entities.