Open learning course: List of training materials (Tourism sector)

Section		Name of materiala	Type	Length
Module 1	**Understanding of risks of climate change impacts on tourism sector**			
	Module 1.1	Risks of climate change impacts on tourism		
		IPCC risk-based conceptual framework and updates of observed and projected climate change in the Pacific	Movie file	14 min.
		Observed and projected climate change in the pacific	Movie file	18 min.
		Observed and projected climate change in the pacific	Movie file	26 min.
		Climate change impact on tourism	Movie file	4 min.
		Lecture slides and notes	PDF	-
	Module 1.2	Basic knowledge of business implication of climate change		
		Basic knowledge of business implication of climate change Part 1	Movie file	21 min.
		Basic knowledge of business implication of climate change Part 2	Movie file	17 min.
		Lecture slides and notes	PDF	-
	Module 1.3	GHG emissions from the tourism sector		
		GHG emissions from the tourism sector	Movie file	11 min.
		Lecture slides and notes	PDF	-
Module 2	**Opportunities of the tourism to respond to climate change**			
	Module 2.1	Possible options for tourism sector to respond to climate change		
		2.1.1 Ecosystems-based approaches: coast, ocean, lake, forest and mountain		
		Ecosystem-based Adaptation (EbA) with a focus on coastal and marine ecosystems, and opportunities to strengthen socioeconomic resilience by mainstreaming ecosystem-based adaptation in the tourism sector	Movie file	21 min.
		Ecosystem-based Adaptation (EbA) with a focus on terrestrial ecosystems	Movie file	14min.
		Ecosystem-based approaches: Coast, Ocean, Lakes, Forest and Mountains - Cases from the Pacific	Movie file	14 min.
		Lecture slides and notes: Coastal and marine	PDF	-
		Lecture slides and notes: Terrestrial	PDF	-
		Lecture slides and notes: Case study	PDF	-
		2.1.2 Resilient and low-carbon infrastructures, facilities and Information management		
		Update on global and regional efforts including Pacific Sustainable Tourism Policy Framework (PSTPF)	Movie file	15 min.
		Opportunities for tourism responses in resilience building and GHG emissions from the aspect of built environment and transport	Movie file	15 min.
		Climate information service	Movie file	14 min.
		Six Senses Fiji- Case study	Movie file	16 min.
		Lecture slides and notes: Low carbon infrastructure and facilities	PDF	-
		Lecture slides and notes: Information service	PDF	-
		Lecture slides and notes: Case study	PDF	-
		2.1.3 Business risk management and recovery		
		Climate-related risks in relation to business activities with examples of a hotel and tourism service	Movie file	19 min.
		Steps to identify and assess climate-related risks; inclusion of outputs of climate-related risk analysis into business strategies and plans; effective structure for managing climate-related risks; and climate-related risks and COVID-19 recovery	Movie file	17 min.
		Lecture slides and notes	PDF	-
	Module 2.2	Enhancing mainstreaming climate change in the national tourism strategy and plan		
		Alignment of National Tourism Policies, Plans & Strategies with tourism climate change frameworks including National Adaptation Plans (NAPs), Joint National Adaptation Plans (JNAPs) & National Determined Contributions (NDC)	Movie file	22 min.
		Lecture slides and notes	PDF	-
Module 3	**Problem and Objective trees and Logical framework**			
	Module 3.1	Theory of change		
		Theory of change	Movie file	13 min.
		Lecture slides and notes	PDF	-
	Module 3.2	Project objectives		
		Project objectives_part1 (1. Introduction, 2. Problem trees, 3. Objectives trees)	Movie file	10 min.
		Project objectives_part2 (4. Logical framework, 5. Summary)	Movie file	12 min.
		Lecture slides and notes	PDF	-
	Module 3.3	Exercise		
		Reference: Mitigation - adaptation performance measures	PDF	-
		Template for exercise_logframe template	Word file	-

CONTENTS

1. Introduction to climate change in the Pacific and IPCC risk-based conceptual framework
2. Observed and projected climate change in the Pacific
   - Observed climate changes
   - Projected climate changes for near- to long-terms
3. Climate change impact on tourism
4. Non-climate factors

CBCRP-PCCC Virtual Training Course

"Climate Resilience of Tourism in the Pacific"

Government of Samoa, SPREP, and JICA

1. Understanding of risks of climate change impacts on tourism

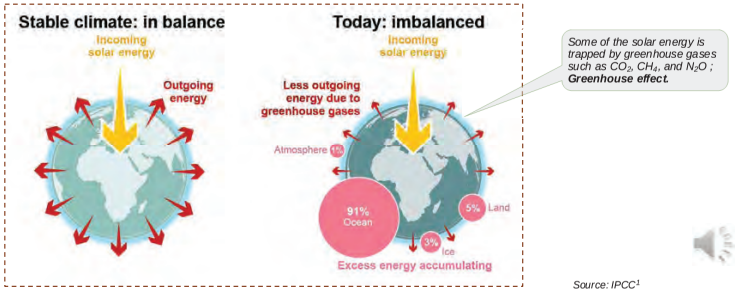
- **IPCC risk-based conceptual framework and updates of observed and projected climate change in the Pacific**

Mr Koji Kuroiwa (Engineering)
JICA Short-term Expert
Overseas Business section, Business Management Department
Japan Weather Association

Introduction to climate change in the Pacific - I

Climate change and the Earth's energy budget

- Earth's climate is largely determined by the Earth's energy budget, i.e., the balance of incoming and outgoing energy.
- Since at least the1970s, less energy is flowing out than is flowing in, which leads to excess energy being absorbed by the ocean, land, ice and atmosphere, with the **ocean absorbing 91%**.



Source: IPCC[1]

1. Introduction to climate change in the Pacific and IPCC risk-based conceptual framework

Narrative Part

1. Roughly, global warming is the main driver of climate change, causing other various changes like heavier rains and more intense storms. In other words, climate change can be described as "global warming and its consequences".
2. Earth's average temperature is determined by the balance between incoming energy from the sun and the outgoing energy emitted back into space. The left panel shows how our planet receives vast amounts of energy every day in the form of sunlight. About a third of the sunlight is reflected back to space, and the rest is absorbed by the ocean, land, ice, and atmosphere. Normally, these incoming and outgoing energies are in balance, the earth's climate is stable, and the temperature remains constant.
3. In recent years, human activities have unbalanced these energy flows. The right panel shows that outgoing energy is less than incoming because part of the solar energy is trapped increasingly by some gasses in the atmosphere and warm the Earth; they are carbon dioxide, methane, and nitrous oxide - the greenhouse effect process and the cause of global warming.
4. Since the 1970s, the excess energy has warmed the ocean and land and melted ice sheets and glaciers. The ocean absorbs as much as 91% of the excess energy, which leads to long-term sea level rise.

Glossary

➢ **Greenhouse gas (GHG)**

Greenhouse gases are those gaseous constituents of the atmosphere, both natural and

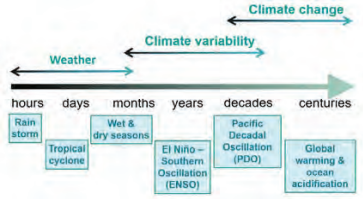
5

Introduction to climate change in the Pacific - III

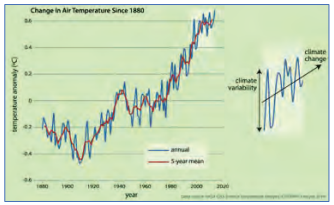
Weather and climate time-scales

- The difference between weather and climate is a matter of time-scale. Climate is sometimes understood as the "average weather" over a long period of time. Climate variability looks at changes that occur within smaller timeframes, such as months, years and decades, and climate change considers changes that occur over a longer period of time, typically over decades or longer.

Illustration of weather/climate time-scales (left) and climate variability/change (right)



Source: PACCSAP



Source: UCAR SciEd

Narrative Part

1. Weather, climate variability and climate change operate on different time scales. Different periods (hours/days/years/centuries) of weather, climate variability, and climate changes are shown on the left panel, including rainstorms that last a couple of hours and tropical cyclones for several days.
2. Weather is highly variable. Climate can be defined as the “average weather” over a long period. The classical period used for describing a climate is “30 years”. While weather is variable, climate also shows variability due to internal and external factors.
3. The right panel shows the change in the surface temperature over the past century and suggests the difference between climate and climate variability. Climate variability occurs over months, years, and decades and are defined by climate patterns such as El-Niño Southern Oscillation (ENSO). Other than ENSO, Pacific Decadal Oscillation (PDO) and Interdecadal Pacific Oscillation (IPO) affect the regional climate over much longer terms on decadal scales.
4. The last category, “climate change”, occurs over decades and centuries and even much longer time scale. A typical example is global warming.

Glossary

- **Warm Pool**

An extensive pool of the world’s warmest water, with temperatures exceeding 28–29° C extending from the central Pacific to the far eastern Indian Ocean.

- **Pacific Decadal Oscillation (PDO)**

The pattern and time series of the first empirical orthogonal function of sea surface temperature over the North Pacific north of 20° N. The PDO broadened to cover the whole Pacific Basin is known as the Inter-decadal Pacific Oscillation. The PDO and IPO exhibit similar temporal evolution.

- **Inter-decadal Pacific Oscillation (IPO)**

A large-scale, long period oscillation that influences climate variability over the Pacific

anthropogenic. Water vapour (H2O), carbon dioxide (CO2), nitrous oxide (N2O), methane (CH4) and ozone (O3) are the primary greenhouse gases in the Earth’s atmosphere. Moreover, there are a number of entirely human-made greenhouse gases in the atmosphere, such as the halocarbons and other chlorine- and bromine containing substances, dealt with under the Montreal Protocol. Beside CO2, N2O and CH4, the Kyoto Protocol deals with the greenhouse gases sulfur hexafluoride (SF6), hydrofluorocarbons (HFCs) and perfluorocarbons (PFCs).

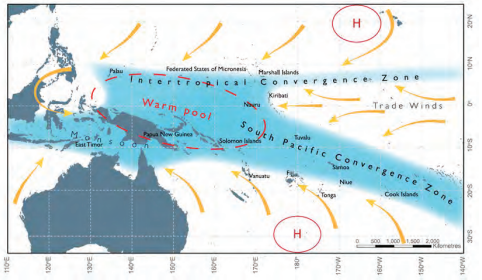
6

Introduction to climate change in the Pacific - II

Large-scale climate features in the W-Pacific

- The South Pacific Convergence Zone (SPCZ), the West Pacific Monsoon (WPM) and the Intertropical Convergence Zone (ITCZ) affect the regional pattern and seasonal cycle in rainfall, winds, tropical cyclone tracks and many other climate aspects of the western tropical Pacific.

Map showing the mean positions of SPCZ, ITCZ and WPM between Nov & Apr



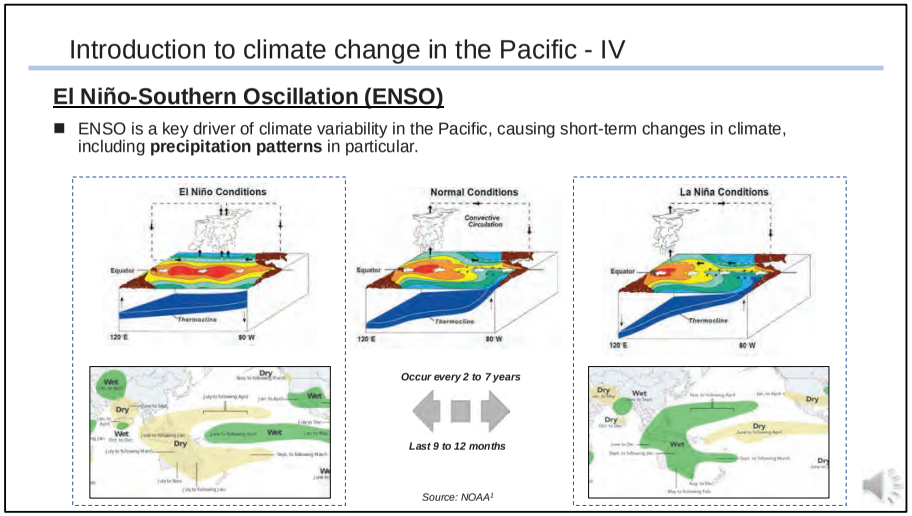
Country	Main features and influences
Cook Islands	SPCZ, sub-tropical highs, trade winds, tropical cyclones, topography
Timor-Leste	WPM, topography
Federated States of Micronesia	ITCZ, WPM, trade winds
Fiji	SPCZ, trade winds, sub-tropical highs, tropical cyclones, topography
Kiribati	ITCZ, SPCZ, trade winds
Marshall Islands	ITCZ, WPM (in some years), tropical cyclones
Nauru	ITCZ, SPCZ, trade winds
Niue	SPCZ, trade winds, sub-tropical highs, tropical cyclones
Palau	WPM, ITCZ, trade winds
Papua New Guinea	WPM, ITCZ, topography
Samoa	SPCZ, trade winds, sub-tropical highs, tropical cyclones, topography
Solomon Islands	SPCZ, WPM, tropical cyclones, topography
Tonga	SPCZ, trade winds, sub-tropical highs, tropical cyclones, topography
Tuvalu	WPM, SPCZ, trade winds, sub-tropical highs, tropical cyclones
Vanuatu	SPCZ, trade winds, sub-tropical highs, tropical cyclones, topography

Source: PACCSAP

Narrative Part

1. The Pacific Ocean covers almost a third of the Earth's surface. It plays an essential role in shaping the climate of the Pacific and the entire globe. The climate of the Pacific is characterized by large-scale climate features and different-sized land masses, which leads to regional variations in climate. At the same time, the El Niño-Southern Oscillation is the source of year-to-year climate variations.
2. The left map shows the average positions of the main features of the regional climate between November and April. The yellow arrows show surface winds; the blue shading represents the bands of rainfall or convergence; the dashed area shows the Pacific Warm Pool, which holds the warmest seawaters in the world. The two rounds stamped by H are high pressures. All these features affect the regional patterns and seasonal cycle of rainfall, winds, tropical cyclone tracks, ocean currents, and many other aspects of the environment of the Pacific.
3. The three extensive bands of large-scale wind convergence are closely associated with rainfall. They are the Intertropical Convergence Zone (ITCZ), the South Pacific Convergence Zone (SPCZ), and the West Pacific Monsoon (WPM).
4. The SPCZ significantly impacts most South Pacific countries, extending from near the Solomon Islands to the east of the Cook Islands. The SPCZ is strongest in the Southern Hemisphere wet season. It stretches across the Pacific just north of the equator and is strongest in the Northern Hemisphere wet season. West Pacific Monsoon is driven by large differences in temperature between the land and the ocean. It moves north to mainland Asia during the Northern Hemisphere summer and south to Australia in the Southern Hemisphere summer. The Monsoon's seasonal arrival usually switches from very dry to very wet conditions.
5. Other aspects of the climate, such as sub-tropical highs, trade winds and tropical cyclones, also impact countries in the Pacific.
6. On larger elevated islands, topography can have a significant effect, so the climate of the key location may not be the same several kilometres away. For example, in Fiji, rainfall is higher in Suva, which is exposed to the southeast trade winds, than in Nadi, which lies on what is predominantly the lee side of the same island. Notable differences in climate also occur within countries that are spread over a

Basin. The IPO operates at a multi-decadal scale, with phases lasting around 20 to 30 years. During the positive phase of the IPO, precipitation is generally higher than normal northeast of the South Pacific Convergence Zone and lower than normal southwest of the SPCZ. Mean sea level pressures are higher than normal to the west of the dateline and lower than normal to the east of the dateline. Due to these pressure differences, there is a southerly flow anomaly during the positive phase of the IPO.



Narrative Part

1. Climate change is a decades-long event and fluctuates in shorter timescales of months to years, which we call climate variability. Various climate features drive the climate of the Pacific.
2. El Niño-Southern Oscillation (ENSO) is a predominant climate variability for the Pacific and significantly affects regional as well as global climate conditions. ENSO refers to the recurrence of two opposite climate episodes, El Niño and La Niña. Southern Oscillation is the term for atmospheric pressure changes between the east and west tropical Pacific, which accompanies El Niño and La Niña, like a seesaw. As a result, ENSO has distinct impacts on precipitation over most Pacific Island countries.
3. The middle panel shows normal ocean and atmospheric conditions over the Pacific. Typically, trade winds take warm water to the west to create Warm Pool in the western equatorial Pacific. As a result, more clouds are formed where the ocean is warm, and more rainfall is brought.
4. When El Niño occurs, which is shown on the left panel, trade winds weaken, and warm water is pushed back toward the east. Meanwhile, South Pacific Convergence Zone (SPCZ) migrates towards the equator. Typically, it results in wetter conditions in the central and eastern equatorial Pacific and drier conditions in the north of the equator and south-west Pacific.
5. In a La Nina (right panel), trade winds strengthen reversely and take the warm water further to the west. It causes opposite changes to El Nino. ITCZ and SPCZ tend to move away from the equator, drier near the equator, while wetter in the north and southwest Pacific.
6. ENSO events occur every 2 to 7 years and last 9 to 12 months. Typically, El Niño occurs more frequently than La Niña, but, in any case, their frequency is quite irregular.

large area, such as the northern and southern Cook Islands.

7. The right table summarizes the main features and influences on the climate in each country. For example, the Cook Islands are typically influenced by SPCZ, sub-tropical highs, trade winds, tropical cyclones and topography. But when we look at other countries in the west of the region, such as Papua New Guinea, they are typically influenced more by the West Pacific monsoon and the ITCZ. The table also shows that topography is a significant factor in impacting the climate of the mountainous islands.

Glossary

➢ **Warm Pool**

An extensive pool of the world's warmest water, with temperatures exceeding 28–29° C extending from the central Pacific to the far eastern Indian Ocean.

➢ **Inter-tropical Convergence Zone (ITCZ)**

The Inter-Tropical Convergence Zone is an equatorial zonal belt of low pressure, strong convection and heavy precipitation near the equator where the northeast trade winds meet the southeast trade winds. This band moves seasonally.

➢ **South Pacific Convergence Zone (SPCZ)**

A band of low-level convergence, cloudiness and precipitation ranging from the west Pacific warm pool south-eastwards towards French Polynesia, which is one of the most significant features of subtropical Southern Hemisphere climate. It shares some characteristics with the ITCZ, but is more extratropical in nature, especially east of the Dateline.

➢ **Monsoon**

A monsoon is a tropical and subtropical seasonal reversal in both the surface winds and associated precipitation, caused by differential heating between a continental-scale land mass and the adjacent ocean. Monsoon rains occur mainly over land in summer.

likely to deteriorate", "area of sand beaches which may be eroded or even lost". Participants are invited to consider other factors for vulnerability and exposure during the self-learning processes. It will provide a useful basics for the discussions in this training course.

Glossary (Definitions at AR5)

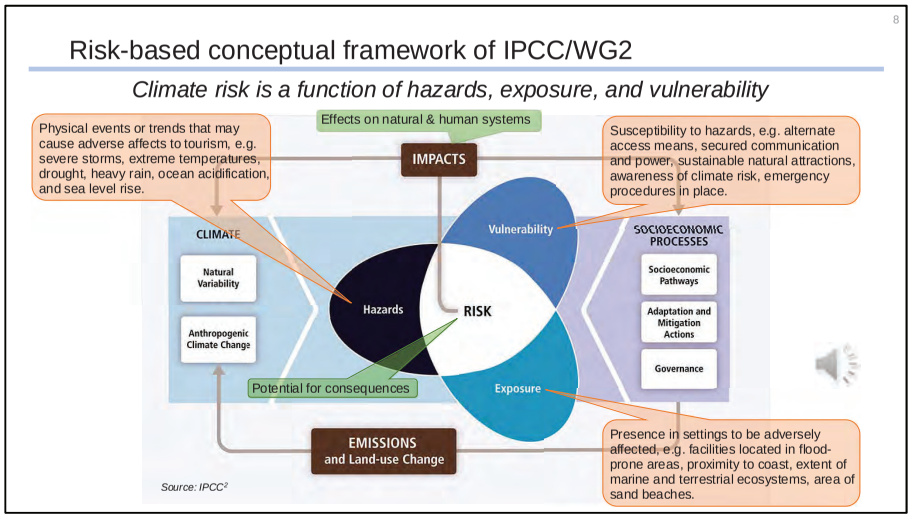
- **Hazard**
  The potential occurrence of a natural or human-induced physical event or trend or physical impact that may cause loss of life, injury, or other health impacts, as well as damage and loss to property, infrastructure, livelihoods, service provision, ecosystems, and environmental resources. In this report, the term *hazard* usually refers to climate-related physical events or trends or their physical impacts.

- **Exposure**
  The presence of people, livelihoods, species or ecosystems, environmental functions, services, and resources, infrastructure, or economic, social, or cultural assets in places and settings that could be adversely affected.

- **Vulnerability**
  The propensity or predisposition to be adversely affected. Vulnerability encompasses a variety of concepts and elements including sensitivity or susceptibility to harm and lack of capacity to cope and adapt.

- **Impacts**
  Effects on natural and human systems. In this report, the term impacts is used primarily to refer to the effects on natural and human systems of extreme weather and climate events and of climate change. Impacts generally refer to effects on lives, livelihoods, health, ecosystems, economies, societies, cultures, services, and infrastructure due to the interaction of climate changes or hazardous climate events occurring within a specific time period and the vulnerability of an exposed society or system. Impacts are also referred to as consequences and outcomes. The impacts of climate change on geophysical systems, including floods, droughts, and sea level rise, are a subset of impacts called physical impacts.

- **Risk**
  The potential for consequences where something of value is at stake and where the outcome is uncertain, recognizing the diversity of values. Risk is often represented as probability of occurrence of hazardous events or trends multiplied by the impacts if these events or trends occur. Risk results from the interaction of vulnerability, exposure, and hazard. In this report, the term risk is used primarily to refer to the risks of climate-change impacts.



Narrative Part

1. Risk-based conceptual framework is a basic scheme for climate risk assessment, which was adopted by IPCC in its 5th Assessment Report (AR5) of Working Group 2. Its fundamental philosophy is that management of Risk is the key to the reduction of climate change impacts. This concept underlies our discussion of adaptation and mitigation options in a series of PCCC training courses, including the present course on "Tourism".
2. There are various factors that determine the rise and fall of Risk. The essence of the AR5's concept is to focus on three main factors of human and natural systems; Hazards, Vulnerability and Exposure. This slide gives a schematic illustration of this concept.
3. The chart in the slide is telling us that Risk emerges from the overlap of Hazards, Vulnerability, and Exposure. And, in order to reduce Risk, we have two approaches; one is to control Hazards, which can be done through changes in emissions, including anthropogenic sources; and the other is to control Vulnerability and Exposure. What we should note here is that both Vulnerability and Exposure develop from many different socio-economic processes, therefore, we can take a wide range of measures to reduce the Vulnerability and Exposure, such as for socio-economic pathways, adaptation and mitigation, and social governance.
4. For reducing the risk of Tourism, it is very important to identify the major components of Hazards, Vulnerability, and Exposure related to the sector. Hazards to Tourism have, for example, "severe storms", "precipitation pattern change", and "sea-level rise", etc.
5. Vulnerability of tourism needs to be considered from different aspects such as accessibility, infrastructure, facilities, attractiveness, knowledge, and even economy. It includes "alternate transportation for tourists in case of traffic disturbances", "stable communication and power for stayers' comfort and security", "sustainable attraction to keep visitors", "awareness of climate risk to increase adaptivity", and "established emergency procedures for the safety of tourists.
6. Exposure includes "location of facilities in areas subject to disasters such as flooding and storm surges", "extent of marine and terrestrial ecosystems which are

Observed Climate Change

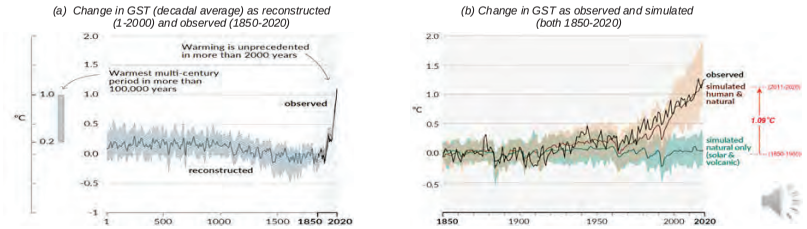
2. Observed and projected climate changes in the Pacific

Observed Climate Change – *Temperature I*

Global surface temperature (GST)

- GST has increased faster since 1970 than in any other 50-year period over at least the **last 2000 years**. *(IPCC[4])*
- It was **1.09°C higher** in 2011-2020 than 1850-1900 with larger increases over land (**1.59°C**) than over the ocean (**0.88°C**). *(IPCC[5])*

Changes in global surface temperature (GST) relative to 1850-1900



Source: IPCC[5]

Narrative Part

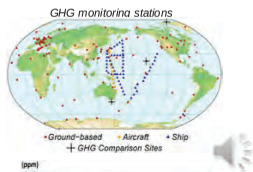
1. In the bottom right panel, the black line shows the record of observations by instruments. Temperatures gradually increased from around 1900 after the industrial revolution and have grown much faster since 1970.
2. The brown line is the model simulations that considered the human drivers such as emission of GHGs and natural drivers such as solar and volcanic activities. The green line also shows the simulation of the temperatures but considers only natural effects. The brown lines coincide with observations and well adjust to reality.
3. The left panel shows the temperature change over the past 2,000 years. For the period before the observation started, temperatures were reconstructed from natural archives, such as tree ring data and sea sediments. A dashed line depicts the latest 70-year change in the right panel. The nearly vertical change shows how drastic the recent temperatures increase was. This panel's left is the estimated warmest temperatures over the past more than 100,000 years. It further endorses that the current warming is a historical incident.
4. These findings and the change of GHGs concentrations shown in the previous slide collectively endorse that global warming is attributed to anthropogenic greenhouse effect.

Observed Climate Change – *GHGs*

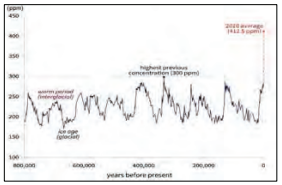
Greenhouse gases (GHGs)

- In 2019, atmospheric CO_2 concentrations were higher than at any time in at least **2 million years**, and concentrations of CH_4 and N_2O were higher than at any time in at least **800,000 years**. *(IPCC[3])*
- Despite a 6% to 7% drop in emissions from reduced activity amid the pandemic, the concentration of GHGs in Earth's atmosphere reached a **new record in 2020.** *(WMO)*

GHG monitoring network (top) and recent concentration of CO_2 (bottom)

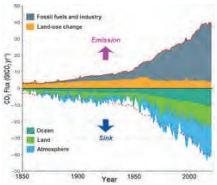


Carbon Dioxide (CO_2) over 800,000 years

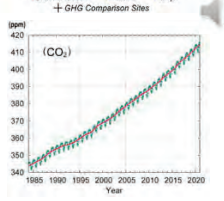


Source: NOAA[2]

Emissions and their partioning



Source: Global carbon project



Source : WMO[1]

Narrative Part

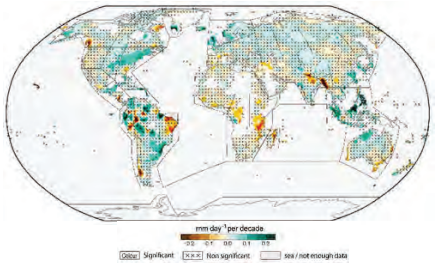
1. Global monitoring of GHGs started in the 1950s, and now carbon dioxide, methane, and nitrous oxide are continuously monitored by the WMO monitoring network (right panel). About 30 ground stations plus aircraft and ships carry out the measurement. Its recent results of CO2 shown in the bottom right panel indicate that the concentration of CO2 has been continually increasing during the last three to four decades. Recently, it has been found that the CO2 concentration reached 412.5 ppm in 2020, the highest ever recorded.
2. The bottom left panel depicts the change in the CO2 concentration over 800,000 years. The CO2 data before the 1950s was derived from the paleo-climate studies of ice core of polar and mountain glaciers and ice caps worldwide. In this long-term graph, the recent 70-year change is shown by the dotted line demonstrating that the recent CO2 increase is just a momentary event over the past 800,000 years. The ice-core data also supported that the present concentrations of Methane and Nitrous Oxide were higher than at any time during this period.
3. The CO2 data for even more ancient times can be given from the deep-sea sediments. Based on those data, IPCC says with high confidence that the latest CO2 concentrations were higher than at any time in at least 2 million years.
4. The middle panel shows the global change of emission and sink of CO2 as well as their sources in the Earth system. In recent years, about 90% of CO2 emissions have come from fossil fuel consumption, and 10% is from land use changes such as deforestation. Meanwhile, 24% of the emitted CO2 is absorbed by the ocean, 32% by land, such as forests, and 45% remains in the atmosphere. From the emission sources, the increase in fossil fuels since the industrial revolution is significant. In terms of the sink, the increase in the ocean is notable, which leads to ocean acidification.
5. The COVID-19 pandemic affects the concentrations of GHGs, and the economic recession was estimated to have reduced carbon emissions by 6 to 7 % during 2020. However, the annual average CO2 concentration in 2020 was found to be about 2.5 ppm more than in 2019. Accordingly, WMO stated that the decrease in CO2 concentration due to COVID-19 is practically indistinguishable.

Observed Climate Change – *Precipitation*

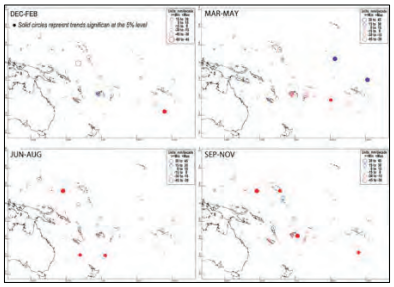
Trends on global and regional scales

- Trends vary spatially and seasonally over Small Island regions in the Pacific. Rainfall has decreased in parts of the Pacific islands poleward of 20° latitude in both hemispheres. However, **trends are not significant** across the globe, including the Pacific. *(IPCC[9])*

Trends of annual precipitation (1961-2015; CRU TS 4.04)



Trends of quarterly precipitation (mm/decade) at PICs (1951-2015; positive (blue) and negative (red))



Sources: IPCC[10] (left), McGree et al. 2019 (right)

Narrative Part

1. Precipitation is a major atmospheric variable, together with temperature. However, compared with temperature, it is much more difficult to find significant changes in precipitation. The left panel shows global trends of annual precipitation over the 55 years from 1961 to 2015. The widespread of x-marks indicates the regions where trends are not significant. A comparison between this chart and that of temperature two slides before demonstrates the difference.
2. The main reasons for the less significance in the precipitation trend analyses are the sparsity and less quality of data, particularly in developing countries, and the large natural variabilities that precipitation has.
3. Nevertheless, some significant increases in land areas are shown in this chart, such as North and South America, Eurasia and northwestern Australia, while decreases are apparent across tropical western and equatorial Africa and southern Asia.
4. Significant trends are not noticeable in the western Pacific region like the global views. Pacific is one of the most data-sparse areas of the world, while interannual and decadal variabilities drive long-term trends in rainfall, as we discussed previously.
5. Four panels on the righthand side depict the findings of regional precipitation trends from the same study in the previous slide. Results are shown in quarterly periods. In the study region, statistically significant annual precipitation trends were only found in the southern subtropics and southwest French Polynesia, both of which are negative. These were associated with negative trends in June to August and from December to February. Significant negative trends were also present from September to November in the north ITCZ and north PNG subregions.
6. Unlike the changes in temperature, which are dominated by background global warming, rainfall patterns in the Pacific are strongly influenced by natural climate variability. Such a regional characteristic makes it difficult to detect rainfall trends.

Observed Climate Change – *Temperature II*

Regional surface temperatures

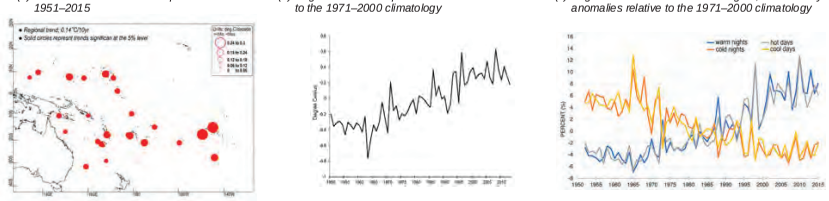
- Warming trends are clearly evident in the small islands, such as those in the Pacific, particularly over the latter half of the 20th century. *(IPCC[7])*
- Significant positive trends ranging from 0.15°C/10yr (1953–2010) to 0.18°C/10yr (1961–2011) are noted in the tropical Western Pacific. *(IPCC[8])*

Recent changes in temperature in the Western Pacific Islands

(a) Trends in annual mean temperature over 1951–2015

(b) Regional mean temperature anomalies relative to the 1971–2000 climatology

(c) Regional amount of warm/cold nights, hot/cool days anomalies relative to the 1971–2000 climatology



Source: McGree et al. 2019

Narrative Part

1. Along with the global mean surface temperatures, warming trends are clear at the Pacific Island countries. In the Southwest Pacific, 2020 was the second or third warmest year, depending on the data sets. The warmest year on record was observed in Southern French Polynesia and Tonga. The warming trends in the region have been examined and endorsed by a couple of climate studies, which suggest increases of roughly 0.15° C to 0.18° C per decade.
2. The left panel shows the results of McGree's study from 1951 to 2015 based on the data from 57 stations. Although regional differences exist, most locations indicate warming trends in annual mean temperatures from 0.06 to 0.30, resulting in a regional average of 0.14. In addition, increases in average temperature were found in all seasons throughout the study period.
3. The middle panel was also given from the McGree's, representing the time change of regional average temperature. A warming trend is clear, particularly during the latter half of the 20th century.
4. The study also revealed significant trends in extreme temperatures in the region. The right panel shows the rates of warm nights and cold nights and hot days and cool days, which were derived from daily maximum and minimum temperatures using a percentile analysis. In addition, it shows the increasing trend of hot days and warm nights, which are grey and blue colors, and the decreasing trend of cool days and cold nights, orange and red.
5. Overall, a widespread increase in mean temperature, fewer cool extremes and more warm extremes are represented from 1951-2015.

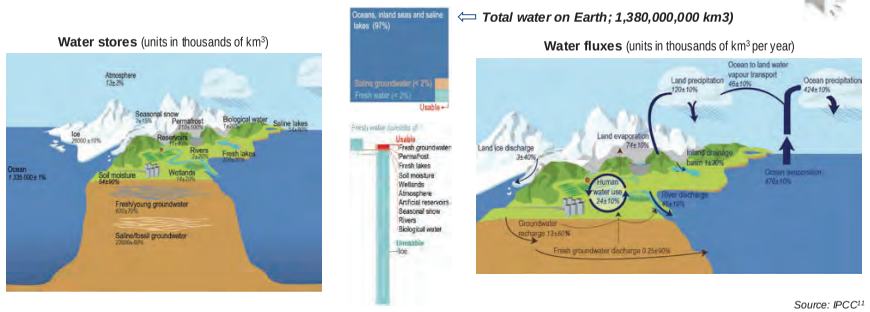
temperature.

7. Discharge of rivers, groundwater, and land ice, as well as water use by human, are also important components of water fluxes. In terms of drinking water and irrigation, recharge and discharge of groundwater is a major contributor in the water fluxes together with precipitation.

359

Global Water Cycle; water stores and fluxes

- Global water cycle is the continuous, naturally occurring movement of water through the climate system from its liquid, solid and gaseous forms among reservoirs of the ocean, atmosphere, cryosphere and land.
- While **saline ocean water accounts for 97%** of all water on Earth, **terrestrial freshwater represents less than 2%** and saline groundwater & lakes 1-2%.



Source: IPCC[11]

Narrative Part

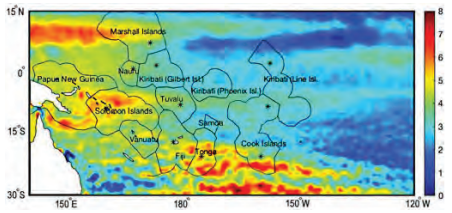
1. This slide shows an overview of the global water cycle in the climate system, including water stores or reservoirs on the left, and water fluxes or movement on the right. The water cycle is a complex system but is very important because it let us know how water reaches us.
2. What are water stores in the water cycle? The major stores of water are the ocean, ice caps, land including underground, and the atmosphere. Among these, the ocean is the primary reservoir storing 97% of all water on Earth, mostly as salt water. Liquid freshwater on land forms surface water such as lakes and rivers, soil moisture and groundwater stores, together accounting for less than 2% of global water.
3. What are water stores in the water cycle? The major stores of water are the ocean, ice caps, land including underground, and the atmosphere. Among these, the ocean is the primary reservoir storing 97% of all water on Earth, mostly as salt water. Liquid freshwater on land forms surface water such as lakes and rivers, soil moisture and groundwater stores, together accounting for less than 2% of global water.
4. Focusing freshwater, ice sheets, glaciers and snowpack account for approximately 96% of all freshwater resources, with less than 4% of freshwater considered easily accessible and available for human society's water resource needs.
5. Meantime, some water moves quickly from one place to another. It is illustrated in the right panel, where the continuous movement of water within the Earth and atmosphere is shown as water fluxes. Water fluxes consist of three major processes, that is “evaporation” where water changes phase from liquid to gas or vapor with solar energy, and “condensation” where water vapor cools and joins together into drops of water and clouds, and “precipitation” where water falls from clouds as rain and snow.
6. The largest component of the global water cycle operates over the ocean, where 85% of evaporation and 77% of precipitation occurs at the ocean-atmosphere interface. Meantime, regional evaporation is rather complex to measure, as it depends on a myriad of localized conditions, including wind speed, humidity, and

Observed Climate Change – *Sea Level Rise II*

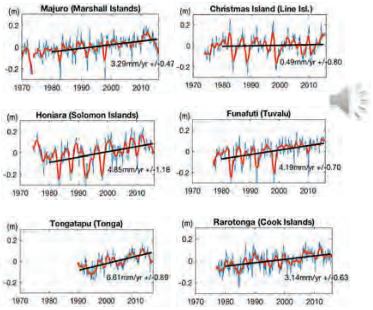
Regional sea level rise

- Across the globe, sea levels rose fastest in the Western Pacific and slowest in the Eastern Pacific over the period 1993–2018. *(IPCC[13])*

Rates of sea level rise from satellite altimetry for 1993-2017 (mm/yr)



Monthly and yearly running average of relative sea level measured at tide gauges for 1977-2017



Source: Aucan, J. 2018

Narrative Part

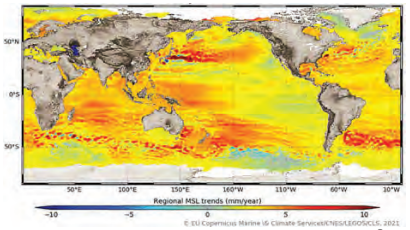
1. Mean sea level can fluctuate over a long period, even for decades. It should be noted that sea level is defined in two different ways: “absolute sea level”, which refers to the sea level as measured from the center of the earth, and “relative sea level”, which refers to the sea level relative to the coastal area of interest. Absolute sea levels have been monitored by satellite altimetry since 1993, while relative sea levels are by tide-gauges which started in the 1960s in the Pacific.
2. Regarding the sea levels in the Pacific, it’s worth noting that satellite altimeters found sea levels rose fastest in the Western Pacific and slowest in the Eastern Pacific from 1993 to 2018, among all basins. This slide presents a recent study which demonstrates this typical trend. The left panel shows calculated rates of the regional sea level rise from 1993 to 2017. During this period, results show a rise in sea level of 3-6 mm/year for the Pacific islands, with notable differences between islands. Some islands in the Western Pacific, such as the Solomon Islands, Papua New Guinea, and the Marshall Islands, have experienced a higher rate of sea level rise (up to 6 mm/year), while other islands further east, such as Samoa and Kiribati are much lower. This difference in sea level rise is attributed to large-scale trends in trade winds.
3. Changes of the relative sea level at some selected stations are shown in the panels on the right. Data measured at tide-gauges combines the measurements of satellite altimeters. All show a rise in relative sea level over the past 30 to 40 years and the varied rates between islands. They also demonstrate inter-annual variability, which is attributed mostly to El-Niño Southern Oscillation.

Observed Climate Change – *Sea Level Rise I*

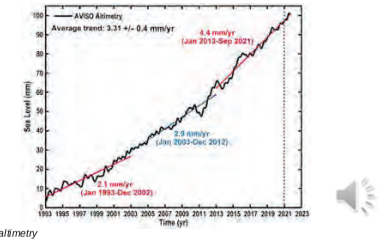
Global mean sea level (GMSL)

- GMSL rose faster in the 20th century than in any prior century over the last three millennia, with a 0.20 m rise over 1901-2018.
- GMSL rise has accelerated since the late 1960s, with an average rate of 2.3 mm/yr over 1971-2018, increasing to 3.7 mm/yr over 2006-2018. *(IPCC[12])*

Regional sea level trend for Jan-1993 to Dec-2020



GMSL evolution for Jan-1993 to Sep-2021



Source: AVISO altimetry

Narrative Part

1. Global mean sea level changes primarily result from ocean warming, leading to the thermal expansion of seawater and land ice melting and adding water to the ocean. As a result, the sea level is continually rising, and it has been found to be accelerating. This has gathered the increasing attention of world scientists.
2. Recent measurements by satellite altimeters revealed that the global mean sea level rise was 2.1 mm per year between 1993 and 2002, 2.9 between 2003 and 12, and 4.4 between 2013 and 21, as shown in the right panel. This rapid step-up was primarily due to the accelerated ice mass loss from glaciers and ice sheets.
3. The regional sea level trends in the left panel demonstrate a considerable variation between the basins. Much of the spatial variation results from natural climate variabilities—such as El Niño and the Pacific Decadal Oscillation—over time scales from months, about a year, to several decades. These climate variations shift surface winds, ocean currents, temperature, and salinity, affecting sea levels. Also accountable are Earth's geological changes, such as changes in Earth's gravity and vertical land motion.
4. The chart shows such variations also in the Pacific. The western tropical Pacific Ocean intensified sea-level rise during the 1990s and 2000s. Ten-year trends exceeded 20 mm yr-1, while sea level trends were negative on the North American west coast.

Glossary

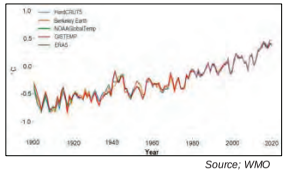
➢ **Altimeter**

Satellites carrying radar altimeters record the surface topography along the satellite’s ground track. They precisely measure a satellite’s height above water, land or ice by timing the interval between the transmission and reception of very short radar pulses. This is the only technology that can measure, systematically and globally, changes in the height of the ocean – and is therefore essential for monitoring sea-level rise. (ESA)

Recent topics in climate observation - (regional)

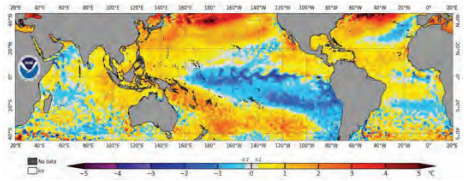
- ✓ In the South-West Pacific region, **2020 was the second or third warmest year** on record.
- ✓ 2020 was **a relatively wet** year over PNG, Solomon Islands, Vanuatu, Fiji, Tonga and Samoa, while many equatorial regions close to IDL were **dry**.
- ✓ PICs were affected straight by the **La Niña** events in 2020-21 and 2021-22. *(On 16 Aug., BoM suggested a 70% chance of a 3rd consecutive La Niña year forming.)*

Area average temperature anomalies from the 1981–2010



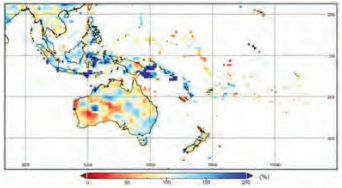
Source; WMO

NOAA Global 5km Satellite Sea Surface Temperature Anomaly on 20 Aug 2022



Source; NOAA

Relative precipitation anomaly in 2020 in reference to 1951-2010

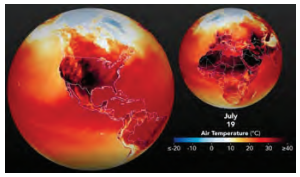


Source; GPCC

Recent topics in climate observation - (global)

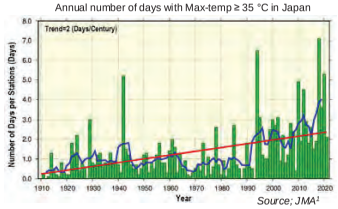
- ✓ Four key climate change indicators – **GHG** concentrations, **sea level rise**, **ocean heat** and ***ocean acidification*** – set **new records in 2021**. *(WMO)*
- ✓ **Over 40°C** was observed in parts of Portugal, Spain, France, US, and UK, which breached the 40°C for the first time. *(WMO)*
- ✓ The frequency of heatwaves **has also been increasing in Japan**. The annual average of the number of days of 35°C or higher for 1992-2021 has been **3.3 times the average** for 1910-1939. *(JMA)*

Daily maximum surface temperature on 19 July 2022



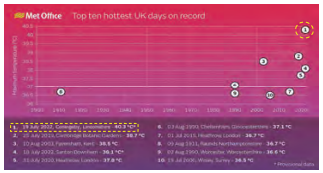
Source; NASA

Annual number of days with Max-temp ≥ 35 °C in Japan



Source; JMA[1]

Top ten hottest UK days on record



Source; Met Office

Narrative Part

1. The 2020 climate report for the Southwest Pacific issued by WMO emphasized that the significant and growing impacts of extreme hydro-meteorological phenomena and tropical cyclones, plus new multi-dimensional threats, pose increasing challenges to communities in the region. Regarding regional averaged temperatures, 2020 was the second or third warmest year on record. The top right panel shows a consistent increase in the regional average temperature has been demonstrated over the past century.
2. In 2020, the Great Barrier Reef suffered a major marine heatwave. In February, sea surface temperatures over the region were 1.2° C above the 1961-1990 average, making it the hottest month on record. Such high temperatures affected the entire GBR, and widespread coral bleaching was reported.
3. The bottom right panel gives an overall regional rainfall condition in 2020. Under the 2020-21 La Nina and the 2021-22 La Nina, relatively wet conditions continued over the region from PNG and Solomon Islands to Fiji and Samoa from 2020 through early 2022, while lower-than-normal rainfall continued in the equatorial region. During these years, Australia suffered frequent floodings, including the 2022 eastern Australia floods, one of the nation's worst recorded flood disasters.
4. The Bureau of Meteorology stated on 16 August that a third consecutive La Niña is likely from late 2022. The latest monitoring of sea surface temperatures (SSTs) shown in the bottom left represents below-average SSTs extending from the eastern to central tropical Pacific and suggests the possible occurrence of La Nina soon.

Narrative Part

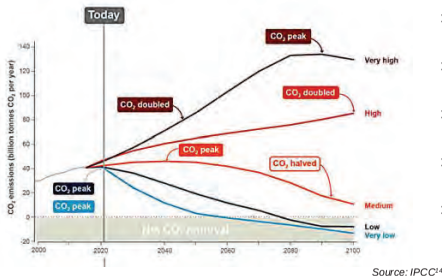
1. Recently, the world climate monitoring system has been observing exceptional weather conditions across the globe. Some of the cases are unprecedented and highly suggestive of accelerating climate change. For example, in 2021, four key climate change indicators set new records. In addition to the record-breaking GHG concentration as well as the accelerating global mean sea level, as shown in the previous slides, scientists have revealed that ocean heat made a record high exceeding the 2020 value and that the ocean surface acidity was at its highest "for at least 26,000 years".
2. In 2022, the world had the third warmest July, with prolonged and intense heat waves affecting the US and parts of Europe and Asia. The top right panel displays a snapshot of the global surface temperatures in July. Nearly 40° C temperatures stand out in the US, Asia and Europe. Despite the weak La Niña, which has a cooling influence, northern hemisphere land masses saw well-above-average temperatures, almost predominantly. Temperatures measuring over 40° C were observed in parts of Portugal, Spain, France, and the UK, which breached 40 degrees for the first time. The World Health Organization witnessed more than 1,700 deaths in Spain and Portugal alone.
3. The top ten hottest days on record in the UK after 1900 are plotted on the bottom right panel. It shows nine out of 10 hottest days have been recorded since 1990, including the 40.3° C on 19 July this year.
4. The Japan Meteorological Agency has also noticed a similar trend over the past hundred years, as shown in the left panel. The number of days of 35° C or higher for 1992-2021, the latest 30-year statistical period, has been 3.3 times the average for 1910-1939, the first statistical period of the Agency. This same trend in the two countries clearly endorses the temperature findings in IPCC AR6.

Projected Climate Change – *GHGs*

Greenhouse gases (emission scenario)

- AR6 considers a set of **five new illustrative emissions scenarios** (Shared Socio-economic Pathways; SSPs). Coupled Model Intercomparison Project Phase 6 (CMIP6) was conducted using these scenarios, and its outcomes served as the main bases of AR6.

New scenarios (SSPs) of annual anthropogenic emission of CO_2 over 2015–2100 (AR6)



- SSP5-8.5
  Very high; Close to RCP*8.5 of AR5. Worst case scenario with no additional climate policy.
- SSP3-7.0
  High; Between RCP8.5 and RCP6.0. Realistic worst-case with continuing CO_2 emission. Would result in serious consequences.
- SSP2-4.5
  Medium; Close to RCP4.5 and later RCP6.0. More consistent with government polices but CO_2 emission remain above zero.
- SSP1-2.6
  Low; Close to RCP2.6. CO_2 emission to plateau and decline after 2025. Temperatures to stay well below 2°C.
- SSP1-1.9
  Very low; No equivalent RCP. Efforts to remove CO_2 needed. Will meet the Paris goal of limiting global warming to 1.5°C.

Source: IPCC[14]

- *Representative Concentration Pathways (**RCPs**) are GHG emission scenarios used in AR5.*

Narrative Part

1. AR6 adopted five new scenarios for GHGs emissions called SSP scenarios instead of 4 RCP scenarios in AR5. The new scenarios represent five different socio-economic pathways. World climate scientists performed simulations of climate change based on these scenarios in the Coupled Model Intercomparison Project--Phase 6 (CMIP6), which formed the basis of AR6. The chart below shows SSP scenarios for CO2. IPCC produced SSP scenarios also for other Green House Gases.
   - SSP/585, the Very high emission scenario, is close to RCP8.5. It assumes no measures will be taken to reduce CO2 emissions. CO2 emissions soar up and double from current levels by 2050.
   - SSP/370, the High scenario, was newly introduced. CO2 emissions double from current levels by 2100.
   - SSP/245, the Medium scenario, is an update to RCP4.5. It assumes that climate protection measures are taken. CO2 emissions remain around current levels until the middle of the century.
   - SSP/126, the low scenario, is a remake of the RCP2.6. CO2 emissions decline to net zero around 2080 and goes into net negative emission.
   - SSP/119, the very low scenario, assumes CO2 emissions declines to net zero around 2050 and then net negative.
2. Roughly, Very high scenario is pessimistic as CO2 emissions are unregulated. And Low and Very low scenarios are optimistic as they require drastic measures to reduce CO2 emissions. The recently released AR6/WG3 report suggests that limiting warming to around 1.5° C requires global greenhouse gas emissions to peak before 2025 at the latest and be reduced by 43% by 2030. The next few years are critical.

Glossary

➢ **Coupled Model Intercomparison Project (CMIP)**

CMIP is a project of the World Climate Research Programme (WCRP)'s Working Group of Coupled Modelling (WGCM). Since 1995, CMIP has coordinated climate model

Projected Climate Change

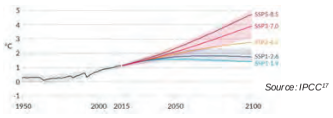
22

Projected Climate Change – *Temperature I*

Global surface temperature (GST)

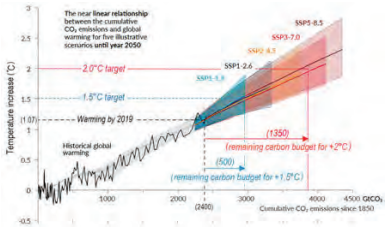
- GST will continue to **increase until at least the mid-century** under all emissions scenarios. *(IPCC[15])*
- It was reaffirmed that there is a **near-linear relationship** between cumulative anthropogenic CO_2 emissions and the global warming they cause. *(IPCC[16])*

GST change relative to 1850-1900



Source: IPCC[17]

GST increase since 1850-1900 (°C) as a function of cumulative CO_2 emissions ($GtCO_2$)



Source: IPCC[18]

Changes in GST under the 5 emissions scenarios

Scenario	Near term (2021-2040)	Mid term (2041-2060)	Long term (2081-2100)
SSP1-1.9	1.5	1.6	1.4
SSP1-2.6	1.5	1.7	1.8
SSP2-4.5	1.5	2.0	2.7
SSP3-7.0	1.5	2.1	3.6
SSP5-8.5	1.6	2.4	4.4

Source: IPCC[19]

Narrative Part

1. This slide shows one of the main outcomes of CMIP6 projections - global surface temperatures. The top left panel shows the projected change of temperatures under all five scenarios. There is a slow turning point during the mid-century, where the trend becomes relatively flat or even starts to decline for Low and Very-low scenarios while continuing to grow for medium and higher scenarios. The difference can be seen more precisely in the table below.
2. The best estimates of the near-term temperatures are 1.5 degrees or higher for all scenarios. It provides new estimates of the chances of crossing the global warming level of 1.5° C in the following decades. The table also shows the significant difference between Very-low and Very-high scenarios in the long term; it is about 3 degrees.
3. More importantly, hot temperatures include heat waves and growing average temperatures. Such extreme events have highly serious impacts and are projected to occur far more frequently in the near future.
4. The right panel shows the near-linear relationship between temperature increase and cumulative CO2 emission until 2050. This diagram shows that the historical cumulative CO2 emissions from 1850 to 2019 were 2400 GtCO2, resulting in global warming of 1.07 degrees. If the emissions continue, Earth will also continue to warm in the same way.
5. This diagram suggests that if we hope to limit the warming to 1.5 degrees, the remaining carbon budget will be about 500 GtCO2. Similarly, for 2.0 degrees, it will be about 1350 GtCO2. So, it gives us an estimate of the allowable amount of additional CO2 emissions for limiting global warming to any target level. In this regard, we should note that the global emissions of GHGs in 2018 were more than 50 GtCO2 in total.

Glossary

➢ **Carbon budget**

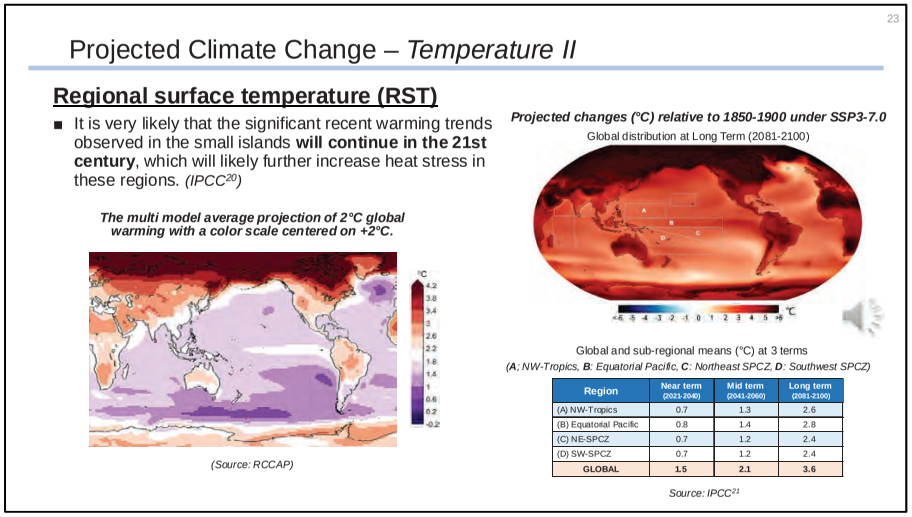
This term refers to three concepts in the literature: (1) an assessment of carbon cycle sources and sinks on a global level, through the synthesis of evidence for fossil fuel and

experiments involving multiple international modeling teams worldwide.

- CMIP has led to a better understanding of past, present and future climate change and variability in a multi-model framework.
- CMIP defines common experiment protocols, forcings and output.
- CMIP has developed in phases, with the simulations of the fifth phase, CMIP5, now completed, and the planning of the sixth phase, i.e. CMIP6, well underway.
- CMIP's central goal is to advance scientific understanding of the Earth system.
- CMIP model simulations have also been regularly assessed as part of the IPCC Climate Assessments Reports and various national assessments.

➢ **Representative Concentration Pathways (RCPs)**

Scenarios that include time series of emissions and concentrations of the full suite of greenhouse gases and aerosols and chemically active gases, as well as land use/land cover (Moss et al., 2008). The word representative signifies that each RCP provides only one of many possible scenarios that would lead to the specific radiative forcing characteristics. The term pathway emphasizes that not only the long-term concentration levels are of interest, but also the trajectory taken over time to reach that outcome. (Moss et al., 2010). For further description of future scenarios, see Box 1.1 of AR5/WG1.



Narrative Part

1. The projected warming over the Pacific Island region is relatively moderate compared with the global-average warming for all emissions scenarios. This is linked to the fact that the oceans are warming at a lower rate than land areas, and this clear trend in the observation part is noted.
2. The top right chart shows the increase of regional temperatures at the end of the 21st century under the high emission scenario. It indicates that warming is clear and almost universal. Looking at the western Pacific, changes are relatively uniform over the region; all are around 2 to 3 degrees.
3. Those of areal means of the four sub-regions; NW Tropics, Equatorial Pacific, NE SPCZ and SW SPCZ; were calculated for each of three terms with AR6-Interactive Atlas, where sub-regions are determined based on the average positions of the ITCZ and SPCZ. The results are listed in the table below. Sure enough, changes are roughly comparable from region to region. If anything, warming is slightly larger in the Equatorial Pacific. Anyhow, the smaller-than-global-average trend in the region is evident. The magnitudes of warming are roughly 50% of the global mean for the near term and 70% for the long term.
4. The left panel depicts the regional temperatures at a 2° C global warming. Changes are shown in a finer and specific color scale centered on plus 2° C. Red indicates the areas hotter than the global average, and purple is cooler than the average. It clearly shows that warming is less than the average across the entire ocean, and it is largely uniform over the western Pacific.

Glossary

➢ **IPCC WGI Interactive Atlas**

The Interactive Atlas regional information supports the assessment done in the AR6-WGI chapters, the Technical Summary (TS) and the Summary for Policymakers (SPM), allowing for flexible temporal and spatial analyses of trends and changes in key atmospheric and oceanic variables, extreme indices and climatic impact-drivers (CIDs), as obtained from several global and regional observational and model simulated datasets used in the report. These analyses are available for a range of historical and

cement emissions, land-use change emissions, ocean and land CO2 sinks, and the resulting atmospheric CO2 growth rate. This is referred to as the global carbon budget; (2) the estimated cumulative amount of global carbon dioxide emissions that that is estimated to limit global surface temperature to a given level above a reference period, taking into account global surface temperature contributions of other GHGs and climate forcers; (3) the distribution of the carbon budget defined under (2) to the regional, national, or sub-national level based on considerations of equity, costs or efficiency.

➢ **Gigatons of Carbon Dioxide (GtCO2)**

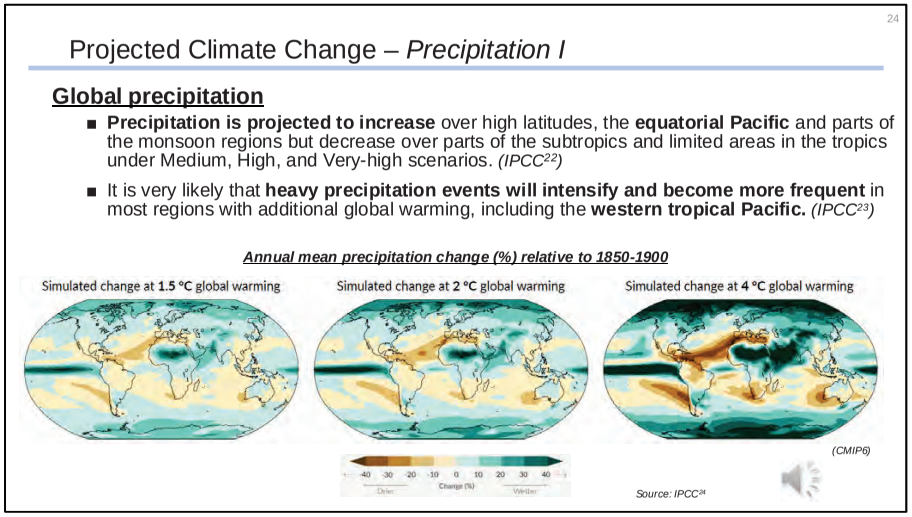
GtCO2 refers to gigaton of carbon dioxide (a gigaton is equal to 1 billion metric tons). GTCO2 (or GtC) is used as the reference unit for the global carbon cycle (Gigaton of carbon = 1 GtC = 1015 grams of carbon. This corresponds to 3.667 GtCO2).

➢ **Carbon cycle**

The term used to describe the flow of carbon (in various forms, e.g., as carbon dioxide (CO2), carbon in biomass, and carbon dissolved in the ocean as carbonate and bicarbonate) through the atmosphere, hydrosphere, terrestrial and marine biosphere and lithosphere.

➢ **Cumulative emissions**

The total amount of emissions released over a specified period of time.

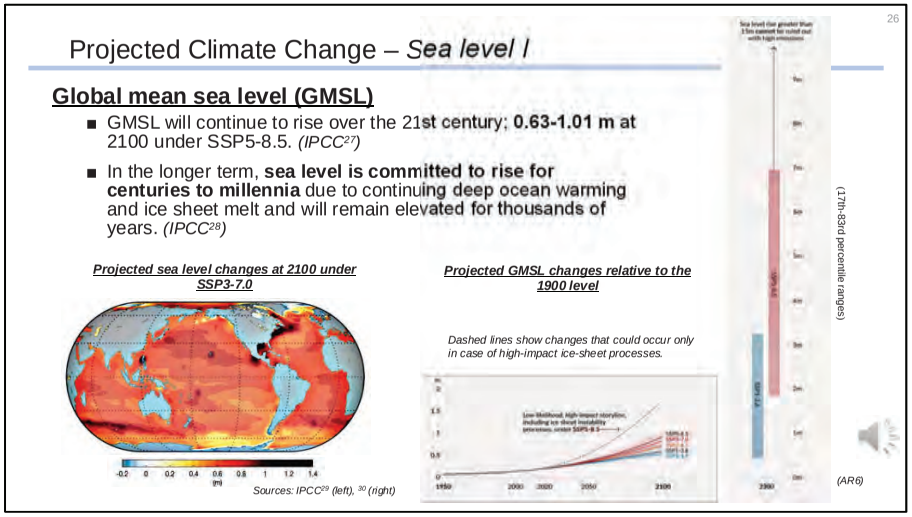


Narrative Part

1. Precipitation has a unique characteristic as it represents opposite changing trends over time and space. Roughly, its contrast will become more significant between dry regions and wet regions and between the dry season and rainy seasons. A warmer climate will intensify very wet and dry weather, with implications for increasing flooding or drought.
2. The three maps on this slide show projected changes in annual mean precipitation for a global warming of 1.5 degrees on the left, 2 degrees in the middle, and 4 degrees on the right. The projection of global precipitation is roughly a half-and-half mixture of positive and negative trends. This is the crucial difference with the projection of temperatures. Precipitation will increase over high latitudes, the equatorial Pacific and parts of the monsoon regions but decrease over parts of the dry subtropical regions and in limited areas of the tropics. Models generally agree that precipitation, when it once occurs, will become more intense. Unlike average annual precipitation, almost the entire world is expected to see an increase in extreme precipitation along with global warming. Also, it's worth noting that rainfall variability related to the El Nino-Southern Oscillation (ENSO) is projected to be amplified by the second half of the 21st century under the Medium and higher scenarios.

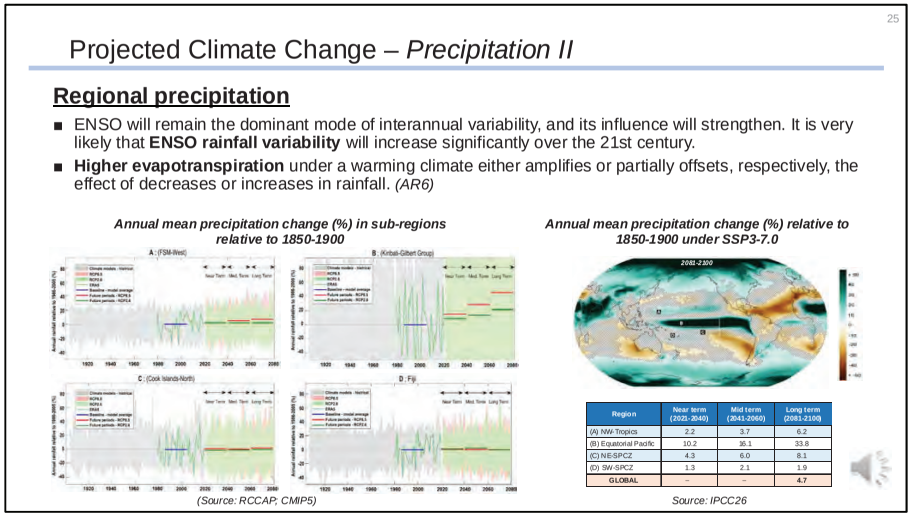
365

future periods and emissions scenarios or warming levels. A description of the datasets, temporal and spatial scales and dimensions of analysis, as well as the representation of robustness and uncertainty (Cross-chapter Box Atlas.1) are introduced in Atlas.1.



Narrative Part

1. Projections of sea level rise under five scenarios are given in the two panels in the middle and on the right. The left shows that sea level rise will reach nearly 1 meter at 2100 and then approach 2 meters at 2150 under Very-high scenario. The vertical graph on the right shows further projections for 2300 under Very-low and Very-high scenarios. Sea levels rise will be 0.5 to 3 meters for Very-Low scenario and 2 to 7 meters for Very-high scenario.
2. Interesting to note in these charts is another storyline indicated by the broken lines. Although it is not included in the projections under five scenarios but suggests that, in case the ice-sheets become highly unstable, in Antarctica in particular, sea level rise could present quite a different storyline. It is shown by the dashed curve here; along this line, sea level rise could be 2 meters at 2100 and 5 meters at 2150. Further, at 2300, the sea level could rise by 15 meters or more.
3. Another point is that even if global temperatures peak by the end of this century, it will continue for centuries or even millennia to come, as the oceans, glaciers and ice sheets take time to reach an equilibrium state (or steady state, in other words). We are only at the starting line of the long-lasting sea level rise to come.
4. The global map on the left shows a snapshot of the rising regional sea levels under the high-emission scenario. Although it shows some regional trends, sea level rise should be recognized as a universal trend across the globe.



Region	Near term (2021-2040)	Mid term (2041-2060)	Long term (2081-2100)
(A) NW-Tropics	2.2	3.7	6.2
(B) Equatorial Pacific	10.2	16.1	33.8
(C) NE-SPCZ	4.3	6.0	8.1
(D) SW-SPCZ	1.3	2.1	1.9
GLOBAL	–	–	4.7

Narrative Part

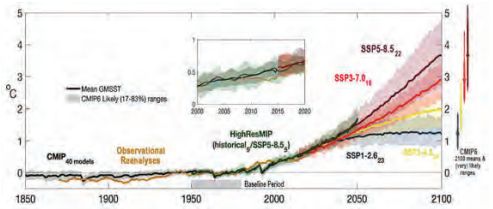
1. In the western tropical Pacific, increases in annual mean rainfall will stand out near the SPCZ and ITCZ.
2. However, as suggested earlier, it is rather challenging to find clear trends in the projection of precipitation changes in contrast to temperature. While the models used by scientists generally agree on how different parts of the Earth will warm, there is much less agreement about where and how precipitation will change. Such difficulties are even more on smaller scales.
3. This is mainly because of the complexity of the water cycle that we saw in the earlier slide. In addition, the scarcity of data, as well as the year-to-year variability of precipitation, is also highly challenging. These hurdles significantly increase uncertainty in model simulations.
4. Still, there were some findings in SMIP5 and 6. The right map is the projection with SMIP6. The models' average shows significant increases in precipitation in the equatorial Pacific, as suggested earlier. Yet, we note again that much of the Pacific region is hatched in the map, meaning the model agreement is low over a wide range.
5. Areal means of the projection were sought for the four sub-regions with the Interactive Atlas, the same as for temperatures in the earlier slide. The results are listed in the table below. Notable increases are shown in the Equatorial Pacific, while other sub-regions are rather flat.
6. Four panels on the left are time-series charts of multi-model means from RCCAP by SMIP5. Each represents the respective subregions. They show the same trend as SMIP6 but are relatively underestimated. In either case, we should note that those projections are just the mid-points of different results from different models with significant uncertainties.

Projected Climate Change – *Sea surface temperature (SST)*

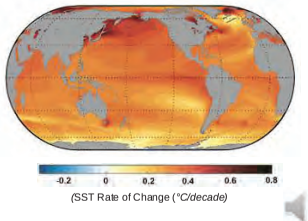
Global mean SST

- Past GHG emissions since 1750 have committed the global ocean to future warming. Over the rest of the 21st century, likely ocean warming ranges from **2–4 (SSP1-2.6) to 4–8 times (SSP5-8.5)** the 1971–2018 change. *(IPCC[32])*

Global mean (SST); modern history and model projections to 2100



SSP5-8.5 CMIP Change Rate (2005-2100)



(SST Rate of Change (*°C/decade)*

Source: IPCC[33]

Narrative Part

1. The global ocean has warmed since 1970 and has taken up more than 90% of the excess heat in the climate system, as we have learned in the earlier slide. Regionally, tropical oceans, including the western Pacific, have been warming faster than other regions since 1950.
2. As shown in the left panel, this ocean warming trend is consistent through the 21st century, except for the very-low emission scenario. The right panel shows the SST changes with time. Under the Very-high scenario, ocean warming could range from 4 to 8 times the 1971-2018 temperatures.
3. Notably, the warming of the ocean is irreversible on centennial to millennial time scales. It is also worth noting that the warming will lead to extreme heat conditions across the basins. Marine heatwaves will become more frequent, and the largest increases will be found in the tropical ocean, especially over the western Pacific.

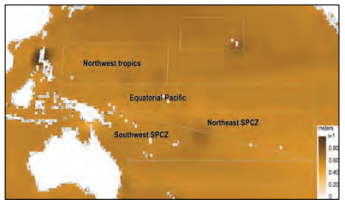
Projected Climate Change – *Sea level II*

Regional sea levels

- Relative sea-level rise (RSLR) is very likely to continue in the tropical Pacific, where regional-mean RSLR will be **0.4–1.0m** for 2081–2100 (relative to 1995–2014) under the high-emission scenario.
- Even a **5-10 cm** additional SLR will **double flooding frequency** in much of the tropical Pacific.

CMIP6-SLR projection relative to 1995–2014 under SSP3-7.0 for Near-, Mid-, and Long-Terms

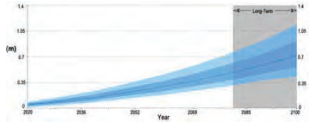
Projection of SLR for 2081-2100



Sub-regional projections of median RSLR (m) for three terms

	N-Term (2021-2040)	M-Term (2041-2060)	L-Term (2081-2100)
NW-Tropics	0.1 [0.0-0.2]	0.2 [0.1-0.4]	0.7 [0.4-1.0]
EQ-Pacific	0.1 [0.0-0.2]	0.2 [0.1-0.3]	0.6 [0.4-0.9]
NE-SPCZ	0.1 [0.0-0.2]	0.2 [0.1-0.3]	0.6 [0.4-0.9]
SW-SPCZ	0.1 [0.0-0.2]	0.2 [0.1-0.4]	0.6 [0.4-0.9]

Time-series projection of the sub-regional mean for the Equatorial Pacific



Source: IPCC[31]

Narrative Part

1. In consideration of the sea level change on a global scale in the previous slide, we should narrow the focus on the Pacific region. Again, AR6's Interactive Atlas was used to see the results of CMIP6 for the sub-regions under the high-emission scenario. As shown in the top table's multi-model averages for three terms and the time-series projection in the bottom chart, you can see that regional sea-levels will be 0.4-1.0m higher than in 1995-2014 in the long term. Also, together with the projected unique pattern in the long-term on the left, it is clear that differences between the regions are minimal—about 0.1m for the near-term and 0.6m for the long-term.
2. Interestingly, the magnitude of regional sea-level rise projections by models has gradually increased over the past decade, along with global projections. For example, sea-level rise in the western tropical Pacific was projected to be 0.26 to 0.82 m by 2100 under the very high emission scenario in the PCCSP report in 2011. Further, we should note that extreme sea-level events are projected to be more intense and frequent. For example, AR6 estimated that even a small amount of sea-level rise, say 5 to 10cm, could increase the frequency of flooding in the tropical Pacific as early as 2030.

Projected Climate Change – *Tropical Cyclone (TC) I*

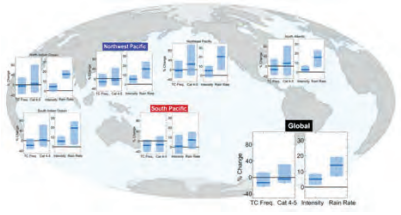
TC projection on the global scale for a 2°C global warming *(AR6)*

- Average peak TC wind speeds
- Proportion of category 4-5 TCs
- Average & Max rain rates associated with TCs
- Peak wind speeds of the most intense TCs

→ **Increase** *(all high confidence)*

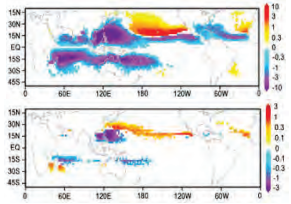
- Frequency of all TCs ----------→ **Decrease or unchanged** *(medium confidence)*

Regional TC projections for a 2 °C global warming



(Source: Knutson et al, 2019)

Projected frequency of TCs of all categories (top) and category 4-5 (bottom) for a 4 °C warming.



(Source: Yoshida et al, 2017)

Narrative Part

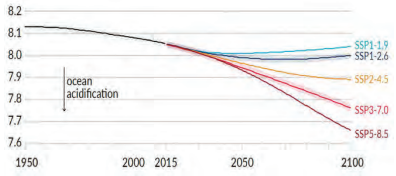
1. This slide presents the results of two recent studies on tropical cyclones. One is shown in the left map by Knutson et al., indicating the future status under 2 degrees warming, and the other is the two panels on the right by Yoshida et al., showing the projected TC frequencies of all categories on the top and 4-5 categories in the bottom.
2. Regarding tropical cyclones, confidence is low in identifying their long-term trends, such as frequency or intensity, due to changes in the technology used to collect best-track data. In addition, for projection, the simulation capabilities of global models are still challenging. However, recent studies, including those in this slide, suggested several essential features.
3. In summary, mainly from the Knutson's and AR6, average peak TC wind speeds and the proportion of Category 4-5 TCs will very likely increase globally with warming. However, over the western North Pacific, the frequency of Category 4-5 TCs will likely increase in limited regions. This trend in the western North Pacific is suggested in the bottom panel of Yoshida's. Also, average TC rain rates will likely increase with warming, and, finally, the frequency of TCs overall categories will decrease or remain unchanged.
4. Although degrees of some changes are different between the basins, tendencies are less similar for all seven basins, including NW and SW Pacific.

Projected Climate Change – *Acidification*

Acidification

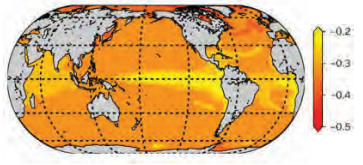
- Upper ocean stratification, ocean acidification and ocean deoxygenation **will continue to increase in the 21st century**, at rates dependent on future emissions. *(IPCC[34])*

Change in global ocean surface pH based on CMIP6 model simulations



Source: IPCC[35]

Change in ocean surface pH for 2081-2100 relative to 1986-2005 under RCP8.5



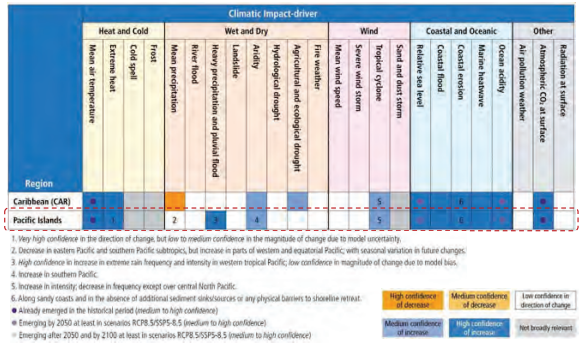
Source: Japan Meteorological Agency

Narrative Part

1. Sea water is becoming more acidic across the entire ocean. Along with sea surface temperatures, this acidification trend will continue all through this century under medium or higher emission scenarios. Please take a look at the left panel. Under the Very-high scenario, the ocean pH will reach around 7.7 or less at the end of the century, which is about 0.4 units lower than the present value. Globally, acidification will be faster over the Equatorial Pacific, as shown in the right panel.

Overall assessment of climatic impact-driver (CID) in SIDS

Summary of confidence in direction of projected change in climatic impact-drivers (CIDs) in the small islands.



Population living in small islands that may be exposed to coastal inundation by 2100 under RCP4.5

Percentage of current population in selected small islands occupying vulnerable land (the number of people on land that may be exposed to coastal inundation; either by permanently falling below MHHW, or temporarily falling below the local annual flood height) in 2100 under an RCP4.5 scenario.

Source: IPCC[36] (left), [37] (right)

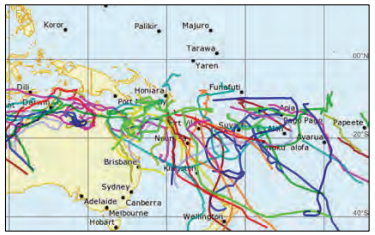
Narrative Part

1. In AR6, WGI has introduced the term “climatic impact-drivers”. A climatic impact-driver or CID refers to a long-term condition or an extreme event that directly affects society or ecosystems.
2. The table on this slide shows the regional assessment of CIDs change in the small islands of the Pacific and the Caribbean for mid-century under RCP4.5, the medium scenario. They are most relevant to small islands and will lead to “hazards” in the five primary domains, i.e., (1) “Heat and Cold”, (2) “Wet and Dry”, (3) “Wind”, (4) “Coastal and Oceanic”, and (5) “Other”.
3. The table assesses each CID by representing the confidence in its projected change and thereby suggests the level of confidence which is determined by the existence of robust evidence and model agreement. So, it will help identify the drivers of greater significance to the region. The level of confidence is indicated by the orange colour for decrease, blue for increase, white for no significant trend, and grey for not applicable.
4. Regarding “Heat and Cold”, “Mean air temperature”, and “Extreme heat” are identified as “High confidence of increase”. It suggests significant recent warming trends will continue in the 21st century with an increase in intensity and frequency of temperature extremes, particularly in the Pacific. So, a considerable increase in heat stress will be inevitable.
5. There are many white squares found in “Wet and Dry”. It is mainly because of the complexity of the global water cycle, scarcity of regional datasets, and complex climate variability of the regions. Nonetheless, high confidence is solely given to the increase of “Heavy precipitation and pluvial flood” in the Pacific. It reflects the increase in frequency and intensity of extreme rainfall events in the western tropical Pacific in the 21st century, even for the Low emission scenario. Meanwhile, the increase in “Aridity” is classified with medium confidence for the southern Pacific.
6. For Wind, again, many are in white due to the scarcity of data. Regarding “Tropical cyclones”, the Pacific region will generally face fewer but more intense storms, as we saw in the previous slides. However, we should note that there is a large variance between regions.

Projected Climate Change – *Tropical Cyclone (TC) II*

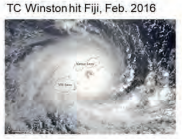
TC projections on the regional scale for S-Pacific *(by RCCAP based on Knutson’s)*

- Average TC intensity will increase; *(mid to high confidence)*
- Frequency of category 4-5 TCs will change; *(low confidence)*
- TC rainfall rates will increase; *(mid to high confidence)*
- Sea level rise will increase TC-related storm surge events; *(high confidence)*
- Frequency of all TCs will decrease; *(high confidence)*



✓ ***All TC tracks during the six seasons from 2012/13 to 2017/18***

TC Winston hit Fiji, Feb. 2016



Source: Southern Hemisphere Tropical Cyclone Data Portal

Narrative Part

1. Compared with the assessment of TC projections on a global scale, it is much more difficult to discuss it for a specific basin, including the South Pacific. It is partly because of the limited ability of climate models to simulate various climate features and variabilities that influence tropical cyclones, such as ENSO and the SPCZ activity.
2. This slide summarizes the regional assessment by RCCAP for the South Pacific. Assessment is made based on Knutson’s and therefore has a lot of commonalities with the global assessment in the previous slide.
3. Points to be underlined are; 1) a clear view that TC frequency will decrease, and 2) an increase of TC-related storm surge is emphasized. Sea level rise will lead to a higher impact of storm surges. It needs to be considered with the projection of more intense TC rainfalls because it could cause the combined effect of storm surge and river flooding in coastal areas.

3. Climate Change Impact on tourism

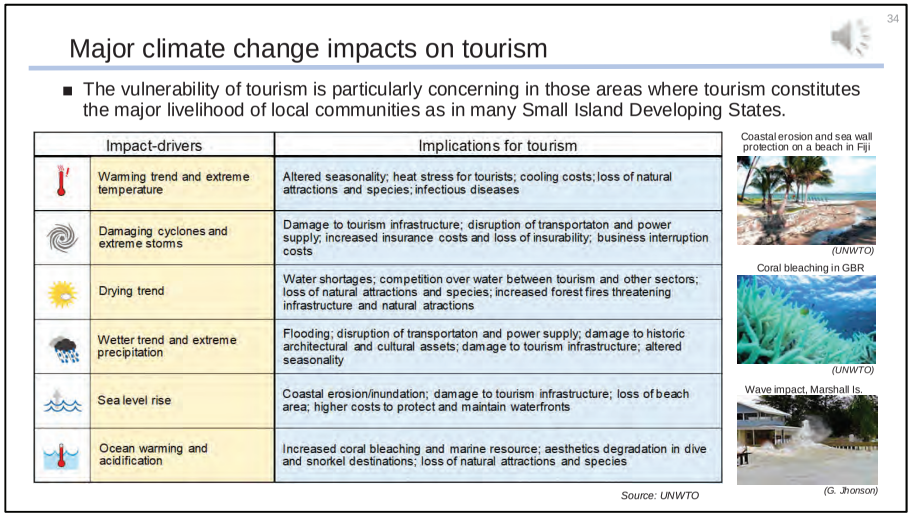
7. Regarding the “Coastal and Oceanic”, it is notable that all the drivers are categorized as “High confidence of increase”, including acidification, heatwave, sea level, coastal flood and erosion, and sea level rise. In particular, the effect of sea-level rise is considered to continue to be a major threat to small islands and atolls, as it exacerbates the impacts, coupled with storm surges and swells. Projections indicate that shoreline retreat will occur over most of the Pacific and Caribbean small islands throughout the 21st century.
8. The chart on the right illustrates the impact of coastal inundation on small islands. It represents the potential effect of the percentage of the population that may be exposed to coastal inundation. It considers not only environmental but also political and socioeconomic factors and demonstrates the vulnerability of an island to sea level rise. As shown here, it is noteworthy that the islands in the Pacific are far more vulnerable than those of other regions, including the Caribbean.

Glossary

- **Climatic impact-driver (CID)**

Climatic impact-drivers (CIDs) are physical climate system conditions (e.g., means, events, extremes) that affect an element of society or ecosystems. Depending on system tolerance, CIDs and their changes can be detrimental, beneficial, neutral or a mixture of each across interacting system elements and regions. See also Risk, Hazard and Impacts (consequences, outcomes).

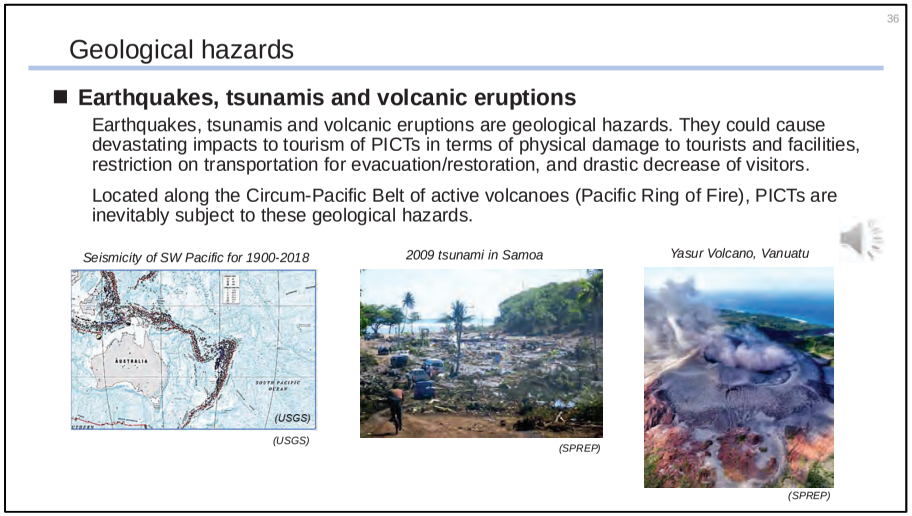
For the Pacific region, the climate itself is a principal resource for tourism and often represents the primary attraction. Adequate climatic conditions are key for all types of tourism activities. Considering that tourism in the Pacific is affected by diverse climate change impacts, as discussed so far, this region may be one of the most vulnerable tourist destinations in the world in regard to climate change.



Narrative Part

1. The impacts of climate change on tourism are highly complex as the interface between climate and tourism is multi-faceted. Tourist destinations and tourism operators are affected by climate variability, and change in a number of ways. Meanwhile, local communities are also affected if their livelihoods depend heavily on tourism.
2. The major types of projected impacts of climate change on the tourism sector are outlined in the table of this slide. An increase in temperature will bring more hot days and an increased cost for cooling. It may change seasonality and cause redirection of destinations and change of travel period. Degradation of tourist attractions is also anticipated. Adverse effects on health through heat stress and skin cancer will emerge as an issue.
3. Regarding the impact of intense storms, including cyclones, damage to infrastructures and transportation is raised first. An increase in disastrous situations will provoke insecurity and insurance costs and will demand additional emergency preparedness.
4. The drying trend will lead directly to insecurity of water and food supply and may result in competition with other sectors. Similar to the temperature increase, the loss of tourist attractions will be problematic. Forest fires will become more frequent and extensive.
5. An increase in precipitation and heavier rainfalls will affect infrastructures, transportation, and power supply. The deterioration of tourist attractions will also progress further. They have much in common with storms in terms of destructive impacts.
6. Sea level rise will affect tourism in many ways. The most serious are those occurring in coastal areas, including erosion and inundation, as it exacerbates storm surges and sea waves. Protective measures will become vital to sustaining the facilities and beaches. Sea level rise will also affect tourist attractions, particularly coral reefs.
7. Ocean warming and acidification are crucial factors for the degradation of marine ecosystems, along with sea level rise. Both are the main drivers of coral bleaching.

34



Narrative Part

1. Non-climate hazards are defined as the hazards that are out of the relation to climate change. Careful consideration of adaptation programs and project proposals requires a clear recognition of the difference between climate-related hazards and non-climate-related. Typical factors that could have serious physical impact on tourism are geological hazards.
2. Geological hazards such as earthquakes, tsunamis, and volcanic eruptions are some of the most devastating natural events on Earth. Unfortunately, these are very common phenomena for many of the Pacific Islands, as the islands are located around the active volcanic zone called Pacific Ring of Fire. Naturally, Pacific has a vast collection of volcanic islands. As we all know, impacts of geological hazards are often catastrophic and take place in a moment.
3. Erupted volcanic ash often causes a serious trouble to aviation. One such case in the South Pacific occurred in 2018. In August 2021, a large eruption of a submarine volcano affected the sea traffic and fisheries in Japan with huge amount of pumice stones over a broad area of more than a thousand kilometers around.

Glossary

- **Pacific Ring of Fire**

Most earthquakes and volcanic eruptions do not strike randomly but occur in specific areas, such as along plate boundaries. One such area is the circum-Pacific Ring of Fire, where the Pacific Plate meets many surrounding tectonic plates. The Ring of Fire is the most seismically and volcanically active zone in the world. (USGS)

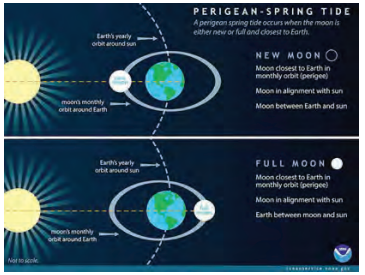
References

1. IPCC Fifth Assessment Report (AR5) and Sixth Assessment Report (AR6): https://www.ipcc.ch/reports/
   - [1]: WGI AR6; FAQ 7.1, Figure1
   - [2]: WGII AR5; Figure SPM.1
   - [3]: WGI AR6; SPM-9 (A.2.1)
   - [4]: WGI AR6; SPM-9 (A.2.2)
   - [5]: WGI AR6; SPM-5 (A.1.2)
   - [6]: WGI AR6; Figure SPM.1
   - [7]: WGI AR6; Chapter 12-87, lines 27-28
   - [8]: WGI AR6; Atlas-93, lines 53-54
   - [9]: WGI AR6; Regional fact sheet - Small Islands
   - [10]: WGI AR6; Atlas-175, Figure Atlas.11
   - [11]: WGI AR6; Chapter 9-8, lines 32-33
   - [12]: WGI AR6; Chapter 9-8, lines 34-35
   - [13]: WGI AR6; Chapter 9-8, lines 42-43
   - [14]: WGI AR6; Infographic TS.1
   - [15]: WGI AR6; SPM-17 B.1
   - [16]: WGI AR6; SPM-36 D.1.1
   - [17]: WGI AR6; Figure SPM.8 a)
   - [18]: WGI AR6; Table SPM.1
   - [19]: WGI AR6; Figure SPM.10
   - [20]: WGI AR6; Chapter 12-88, lines 3-4
   - [21]: WGI Interactive Atlas; CMIP6 projections
   - [22]: WGI AR6; SPM-25, B.3.1
   - [23]: WGI AR6; SPM-20, B.2.4
   - [24]: WGI AR6; Figure SPM.5 c)
   - [25]: WGI AR6; Chapter 12-88, lines 20-21
   - [26]: WGI Interactive Atlas; CMIP6 projections
   - [27]: WGI AR6; SPM-28, B.5.3
   - [28]: WGI AR6; SPM-28, B.5.4
   - [29]: WGI AR6; Figure 9.28 (d)
   - [30]: WGI AR6; Figure SPM.8 d)-middle, e)-right
   - [31]: WGI Interactive Atlas; CMIP6 projections
   - [32]: WGI AR6; SPM-28, B.5.1
   - [33]: WGI AR6; Figure 9.3 (a)-left, (d)-right
   - [34]: WGI AR6; SPM-28, B.5.1
   - [35]: WGI AR6; Figure SPM.8 c)
   - [36]: WGI AR6; Table 12.9
   - [37]: WGII AR6; Figure 15.3
2. Pacific-Australia Climate Change Science and Adaptation Planning Program (PACCSAP): http://www.bom.gov.au/climate/pacific/index-pacific.shtml
3. UCAR Center for Science Education (SciEd): https://scied.ucar.edu/
4. National Oceanic and Atmospheric Administration (NOAA)
   - [1]: https://www.pmel.noaa.gov/elnino/what-is-el-nino
   - [2]: https://www.climate.gov/climatedashboard
   - [3]: https://coralreefwatch.noaa.gov/product/5km/index_5km_ssta.php
5. Global Carbon Project (GCP): https://www.globalcarbonproject.org/
6. World Meteorological Organization (WMO)
   - [1]: https://library.wmo.int/index.php?lvl=notice_display&id=22080#.Yu-dA3bP1aQ
   - [2]: https://public.wmo.int/en/media/press-release/climate-change-increases-threats-south-west-pacific
7. National Aeronautics and Space Administration (NASA): https://earthobservatory.nasa.gov/images/150152/a-july-of-extremes
8. Met Office: https://www.metoffice.gov.uk/
9. McGree, S. et al., 2019: Recent Changes in Mean and Extreme Temperature and Precipitation in the Western Pacific 10 Islands.
10. AVISO altimetry: https://www.aviso.altimetry.fr/en/home.html
11. Aucan, J. 2018: Effects of Climate Change on Sea Levels and Inundation Relevant to the Pacific Islands.
12. Regional Climate Consortium for Asia and the Pacific (RCCAP) portal: https://www.rccap.org/
13. Japan Meteorological Agency:
   - [1]: https://www.data.jma.go.jp/cpdinfo/cgi/2020/pdf/cc2020_shousai.pdf, p-28
   - [2]: https://www.data.jma.go.jp/cpdinfo/cgi/2020/pdf/cc2020_shousai.pdf, p-197
14. Knutson, T. et al., 2019: Tropical Cyclones and Climate Change Assessment: Part I: Detection and Attribution.
15. Knutson, T. et al., 2020: Tropical Cyclones and Climate Change Assessment: Part II: Projected Response to Anthropogenic Warming.
16. Yoshida, K. et al., 2017: Future Changes in Tropical Cyclone Activity in High-Resolution Large-Ensemble Simulations.
17. Southern Hemisphere Tropical Cyclone Data Portal: http://www.bom.gov.au/cyclone/tropical-cyclone-knowledge-centre/history/tracks/

Astronomical event

■ King tide

A king tide is a non-scientific term used to describe the astronomical highest high-tide and lowest low-tide events of the year. King tides occur during a perigean spring tide which occurs when the moon is either new or full and closest to the Earth. Therefore, they are regular and predictable events and reoccur multiple times a year.



Schematic illustration of the relationship between the occurrence of King Tides and the relative positions of the moon and the sun.

- ✓ *The moon is at its closest point to the Earth in its monthly orbit, and the gravitational pull is stronger.*
- ✓ *When the sun, the moon and the Earth are in alignment, it means that the sun and moon's individual gravitational pulls work together, producing the highest high tides of the year, or the King Tides.*

(Source: NOAA)

Narrative Part

1. King tide is a well-known phenomenon in the Pacific but is often recognized incorrectly. King Tides (or the highest high tides of the year) are a unique coastal hazard. They are astronomical phenomena. Therefore, the timing of these extreme water level events can be predicted. They are not byproducts of climate change.
2. King Tides occur during a perigean spring tide at the time of the new and full moon. A new or full moon must co-occur when the Moon is closest to Earth in its elliptical orbit. So, a King Tide can be reworded as an extreme spring tide, which is more academic wording.
3. Along with the rising sea levels, the impacts of King Tide will become more serious. They may be windows for us to see what the future sea level will look like along our coastlines.

Contents

I. Climate Change and Business Activities
- Relation between climate change and business activities
- Climate-related risks and opportunities on business activities
- GHG emissions from business activities

II. Why we have to worry about impacts of climate change?
- Physical risks on business activities
- What are benefits of identifying and assessing physical risks?
- Background: Promotion of evaluation and disclosure of climate-related risks
- Background: SMEs activities on climate-related risks

III. How climate change could impact tourism business?
- Examples of physical risks on tourism business
- Observed impacts of climate change on tourism sector in the Pacific

CBCRP-PCCC Virtual Training Course

“Enhancing Climate Resilience in Tourism in the Pacific ”

Government of Samoa, SPREP and JICA

1. Understanding of risks of climate change impacts on tourism sector
1.2. Basic knowledge of business implication of climate change

Mr. Yasuki Shirakawa
JICA Short-term Expert
ALMEC Corporation

GHG emissions from business activities

Many companies have started estimating GHG emissions from their activities according to international/domestic guidelines.

Emissions across the value chain

Source: GHG Protocol: Corporate Value Chain (Scope 3) Accounting and Reporting Standard. WRI and WBCSD.

Scope 1 and 2 are important to estimate in the first step!

- **Scope 1: Direct GHG emissions**
  Emissions from sources that are owned or controlled by the company, e.g, combustion in owned boilers, vehicles, etc.
- **Scope 2: Electricity indirect GHG emissions**
  Emissions from the generation of purchased electricity consumed by the company. Scope 2 emissions physically occur at the facility where electricity is generated.

4

GHG emissions from business activities

In order to reduce GHG emissions from business activities, many companies in the world have started estimating GHG emissions from their activities according to international/domestic guidelines.
One of these guidelines is the GHG Protocol which provides sets of standards and guidance such as:

- Standards
  - A Corporate Accounting and Reporting Standard
  - Corporate Value Chain (Scope 3) Accounting and Reporting Standard
  - Product Life Cycle Accounting and Reporting Standard
  - The GHG Protocol for Project Accounting
- Guidance
  - GHG Protocol Scope 2 Guidance
  - Technical Guidance for Calculating Scope 3 Emissions
  - GHG Protocol Agricultural Guidance

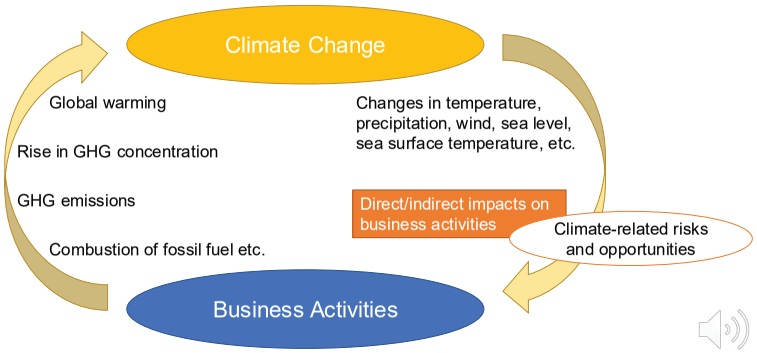
Recently, many of the climate-related disclosure programmes such as TCFD, CDP, PCAF requires to estimate the supply chain, the value chain emissions including Scope1, Scope2 and Scope 3 emissions.
The definitions of these emissions scopes are as follows.

- Scope 1: Direct GHG emissions
  - Emissions from sources that are owned or controlled by the company, e.g, combustion in owned boilers, vehicles, etc.
- Scope 2: Electricity indirect GHG emissions
  - Emissions from the generation of purchased electricity consumed by the company. Scope 2 emissions physically occur at the facility where electricity is generated.

Relation between climate change and business activities

Business activities affect the climate by emitting greenhouse gases (GHGs).

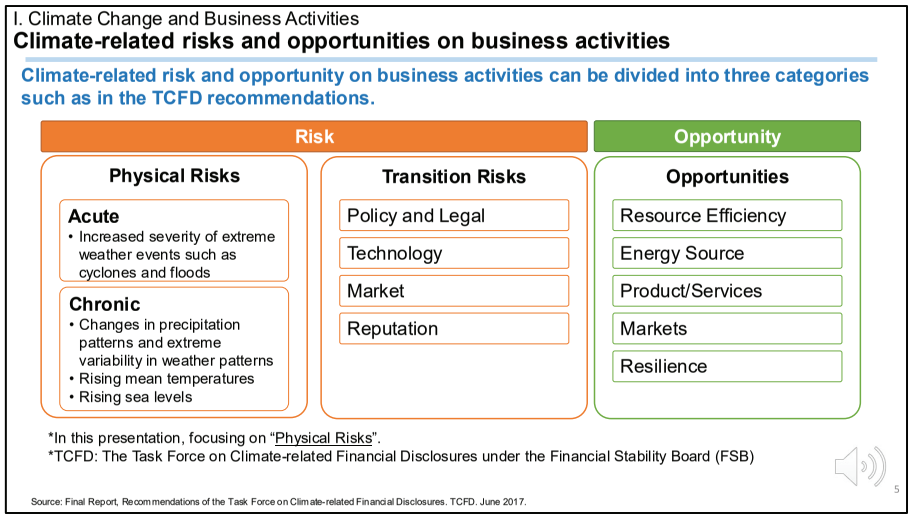
Climate change impacts business activities.



3

Relation between climate change and business activities.

Business activities and climate change are closely related with each other.
Business activities are one of the important sources of GHG emissions through, for example, combustion of fossil fuels and use of electricity at offices, facilities and transportation. It is one cause of the rise in atmospheric GHG concentration which leads to climate change.
On the other hand, climate change has potential to impact business activities directly and indirectly.
Changes in temperature, precipitation, wind, sea level, sea surface temperature or other changes in climate will bring broad rage of impacts to business activities.
As well as reducing GHGs emissions associated with your business, it is important to understand how climate change could bring impact on your business and to prepare for it.



Climate-related risks and opportunities on business activities

Climate-related risk and opportunity on business activities can be divided into three categories as defined in the TCFD recommendations.

The Financial Stability Board established the Task Force on Climate-related Financial Disclosures (TCFD) to develop recommendations for more effective climate-related disclosures for companies.

The definitions of climate-related risk and opportunity in the TCFD recommendation are as follows:

- Physical Risk: Physical risks resulting from climate change can be event driven (acute) or longer-term shifts (chronic) in climate patterns. Physical risks may have financial implications for organizations, such as direct damage to assets and indirect impacts from supply chain disruption. Organizations' financial performance may also be affected by changes in water availability, sourcing, and quality; food security; and extreme temperature changes affecting organizations' premises, operations, supply chain, transport needs, and employee safety.
    - Acute Risk: Acute physical risks refer to those that are event-driven, including increased severity of extreme weather events, such as cyclones, hurricanes, or floods.
    - Chronic Risk: Chronic physical risks refer to longer-term shifts in climate patterns (e.g., sustained higher temperatures) that may cause sea level rise or chronic heat waves.
- Transition Risk: Transitioning to a lower-carbon economy may entail extensive policy, legal, technology, and market changes to address mitigation and adaptation requirements related to climate change. Depending on the nature, speed, and focus of these changes, transition risks may pose varying levels of financial and reputational risk to organizations.
- Opportunity: Efforts to mitigate and adapt to climate change also

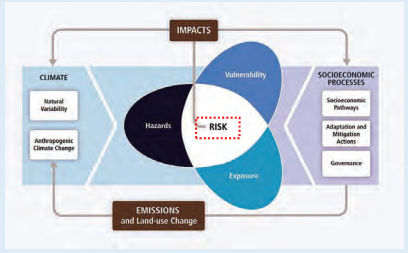
- Scope 3: Other indirect GHG emissions
    - All other indirect emissions. A consequence of the activities of the company, but occur from sources not owned or controlled by the company. e.g. production of purchased materials and use of sold products.

I. Climate Change and Business Activities

Definition of "risk" in IPCC and business/financial literature

IPCC

- Risk results from **the interaction of "vulnerability", "exposure" and "hazard"**.



Source: IPCC AR5 WG2

Business and financial literature

such as in the TCFD Recommendation

- **Physical risk**: risks arising from climate change impacts and climate-related hazards.
- "Physical risk" relates to those derived from the interaction of hazard, exposure, vulnerability framework, but **the focus is often exclusively on changes in the hazard rather than exposure or vulnerability**.

(examples of physical risks: see slide four on "Acute" and "Chronic" risks)

- The way that the risk concept is used in the (business), finance and investment literature is often but not always consistent with the IPCC definition.

Source: The concept of risk in the IPCC Sixth Assessment Report: a summary of cross-Working Group discussions, Guidance for IPCC authors, 4 September 2020, IPCC.

6

Definition of "risk" in IPCC and business/financial literature

First of all, explain definition of the word "risk" in the IPCC and recent business/financial literatures such as the TCFD recommendation.
The way that the risk concept is used in the business/financial literature is often but not always consistent with the IPCC definition.

As already explained in the previous lectures, the IPCC defines "risk" as:
"The potential for consequences where something of value is at stake and where the outcome is uncertain, recognizing the diversity of values. Risk is often represented as probability of occurrence of hazardous events or trends multiplied by the impacts if these events or trends occur. Risk results from the interaction of vulnerability, exposure, and hazard." as shown in the figure in this slide.

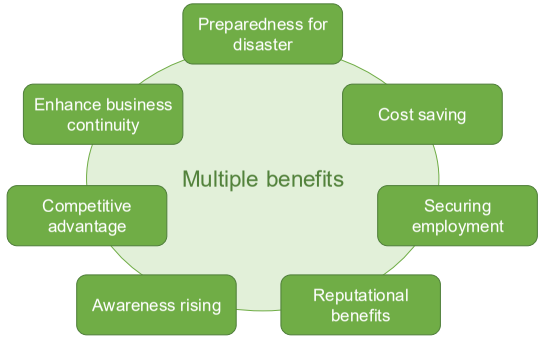
On the other hand, in business/financial literatures, they usually do not use the terms "hazard, exposure and vulnerability", but simply use the terms "risk" and "impact".
According to "The concept of risk in the IPCC Sixth Assessment Report", the term "physical risk" is closely related to risks arising from climate change impacts and climate-related hazards. "Physical risk" relates to those derived from the interaction of hazard, exposure, vulnerability framework, but the focus of this literature is often exclusively on changes in the hazard rather than exposure or vulnerability. Physical risks involve risks from climate change including risk to facilities and infrastructure, impact on operations, water and raw material availability and supply chain disruptions.

produce opportunities for organizations, for example, through resource efficiency and cost savings, the adoption of low-emission energy sources, the development of new products and services, access to new markets, and building resilience along the supply chain. Climate-related opportunities will vary depending on the region, market, and industry in which an organization operates.

In this presentation, focus on "physical risks", considering the importance of physical risks in tourism sector of PICs and the objectives of the training program.

What are benefits of identifying and assessing physical risks?

Multiple benefits to strengthen your business strategies and activities.



What are benefits of identifying and assessing physical risks?

It is challenging for the private sector to identify and assess physical risks of climate change.

However, once you can identify and assess these risks as well as impacts of climate change, you can enjoy multiple benefits and strengthen your business strategies and activities.

The figure shows one of the examples of these benefits.

- Preparedness for disaster: Since climate change may bring adverse impacts on your business through river/costal flood, forest fire and others, if you identify these risks in advance and prepare well for it, you can reduce these adverse impacts.
- Cost saving: Make more informed investment decisions by understanding how current and future climate risks will impact your business's operational performance. This will allow you to manage or lower costs in the long-term. It can also potentially help reduce insurance costs and borrowing costs into the future.*
- Enhance business continuity: Address your business's exposure to climate risks and you will give your business a better chance to continue to operate and meet customer demands, while minimising the degree and duration of any extreme weather related disruption. *
- Securing employment: Well preparedness for climate change impacts and its recovery can contribute to secure employment.
- Competitive advantage: Finding ways to reduce costs, or more effectively managing climate risks. *
- Reputational benefits: Demonstrate to your customers and shareholders that the impacts of climate change are being managed. This will increase investor confidence and boost your business's reputation. *
- Awareness rising: The process of discussing on climate-related risks with the

Physical risks on business activities

Physical risks may have financial impacts for business activities, such as direct damage to assets and indirect impacts from supply chain disruption.

Examples of physical risks and its potential financial impacts

Type	Climate-Related Risks[2]	Potential Financial Impacts
Physical Risks	Acute – Increased severity of extreme weather events such as cyclones and floods Chronic – Changes in precipitation patterns and extreme variability in weather patterns – Rising mean temperatures – Rising sea levels	– Reduced revenue from decreased production capacity (e.g., transport difficulties, supply chain interruptions) – Reduced revenue and higher costs from negative impacts on workforce (e.g., health, safety, absenteeism) – Write-offs and early retirement of existing assets (e.g., damage to property and assets in "high-risk" locations) – Increased operating costs (e.g., inadequate water supply for hydroelectric plants or to cool nuclear and fossil fuel plants) – Increased capital costs (e.g., damage to facilities) – Reduced revenues from lower sales/output – Increased insurance premiums and potential for reduced availability of insurance on assets in "high-risk" locations

Source: Final Report, Recommendations of the Task Force on Climate-related Financial Disclosures. TCFD. June 2017.

Physical risks on business activities

We have to worry about impacts of climate change, because physical risks may have financial impacts on business activities, such as direct damage to assets and indirect impacts from supply chain disruption.

Financial impacts involve impacts on initial costs, operating costs and revenue.

As similar as the concept of disaster risk management or business continuity plan, preparedness enhances resilience of your company. It is important to identify physical risks and potential impacts on your business before it occurs.

The table shows examples of potential financial impacts of physical risks in general.

"Increased severity of extreme weather events such as cyclones and floods" may have potential to increase capital costs such as damage to facilities, as well as to reduce revenues from lower sales/outputs.

"Changes in precipitation patterns and extreme variability in weather patterns" and "Rising mean temperature" may have potential to reduce revenue and higher costs from negative impacts on workforce (e.g., health, safety).

II. Why we have to worry about impacts of climate change?

Background: Promotion of evaluation and disclosure of climate-related risks

Under the framework of TCFD, companies are recommended to evaluate and disclose climate-related risks and opportunities.

- TCFD developed voluntary, consistent climate-related financial disclosures that are recommended to be adopted by all organizations.
- TCFD structured its recommendations around four thematic areas that represent core elements of how organizations operate: governance, strategy, risk management, and metrics and targets. (Fig.1)
- It recommends to evaluate and disclose financial impacts (risks and opportunities) of climate change. (Fig.2)
- Currently, more than 2,600 companies in the world support the TCFD recommendation.

Fig.1 Core elements of recommended climate-related disclosures by TCFD

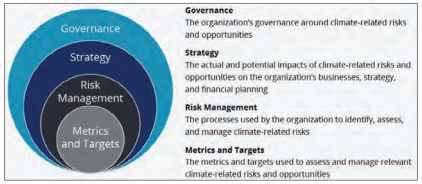


Fig.2 Climate-related risks, opportunities, and financial impact by TCFD

Source: Final Report, Recommendations of the Task Force on Climate-related Financial Disclosures. TCFD. June 2017.

9

Background: Promotion of evaluation and disclosure of climate-related risks

Private companies start trying to identify and evaluate climate-related risks and opportunities, specifically along with the TCFD recommendation.
For your reference, this slide shows outline of the TCFD recommendation.

TCFD developed voluntary, consistent climate-related financial disclosures that are recommended to be adopted by all organizations.
TCFD structured its recommendations around four thematic areas that represent core elements of how organizations operate: governance, strategy, risk management, and metrics and targets. (Fig.1)
TCFD recommends to evaluate and disclose financial impacts (risks and opportunities) of climate change. For example, assessing impacts on revenues, expenditures, assets and capital, and reflect to the cash flow statement and the balance sheet and so on. (Fig.2)
Currently, more than 2,600 companies in the world support the TCFD recommendation, and started identifying, evaluating and disclosing climate-related risks and opportunities.

management and your colleague can rise awareness on climate change and contribute for well preparedness.

*Climate Change Risk Management Tool For Small Businesses In Queensland. Queensland Government.

CBCRP-PCCC & SPTO Virtual Training Course

"Enhancing Climate Resilience in Tourism in the Pacific"

Government of Samoa, SPREP, SPTO and JICA

Module 1. Understanding Risks of Climate Change impacts on the Tourism Sector

1.3 Greenhouse Gas Emissions from the Tourism Sector

Vanda Faasoa – Chan Ting
Pacific NDC Technical Advisor
Secretariat of the Pacific Regional Environment Programme (SPREP)
(vandac@sprep.org)

Talofa! Malo e lelei! Taloha ni! Konnichiwa! My name is Vanda Faasoa – Chan Ting, currently the Pacific NDC Hub Technical Advisor based here at SPREP. I have been fortunate enough to be one of the presenters for Module 1 – Understanding Risks of Climate Change Impacts on the Tourism Sector. Section 1.3 specifically is what my presentation will focus on – Greenhouse Gas Emissions from the Tourism Sector: Mitigation perspective

II. Why we have to worry about impacts of climate change?

Background: SMEs activities on climate-related risks

SMEs (small and medium-sized enterprises) are particularly vulnerable to climate change.

- SMEs are often significantly vulnerable to climate change, because of lack of information, limited budget and human resources to tackle climate change and business continuity, heavily affected by number of customers/tourists.
- Zurich Insurance Group's (Zurich) Annual Global SME Survey reported:
  - ✓78% of SMEs surveyed expected risks associated with climate change to have a significant effect on their business.
  - ✓36% of SMEs considered material damage as likely to be the most critical risk to business due to climate change.
  - ✓The survey, which polled 2,600 SMEs in 13 countries in Europe, the Americas and Asia Pacific.

  Source: Potential effect on business of small and medium enterprises (SMEs) due to climate change in 2016 Global survey report. Zurich Insurance Group. November, 2016.
- Tools and guidelines for SMEs to tackle with climate-related risks have been prepared by the governments/ local governments.

Source: Climate Change Risk Management Tool For Small Businesses In Queensland. Queensland Government

10

Background: SMEs activities on climate-related risks

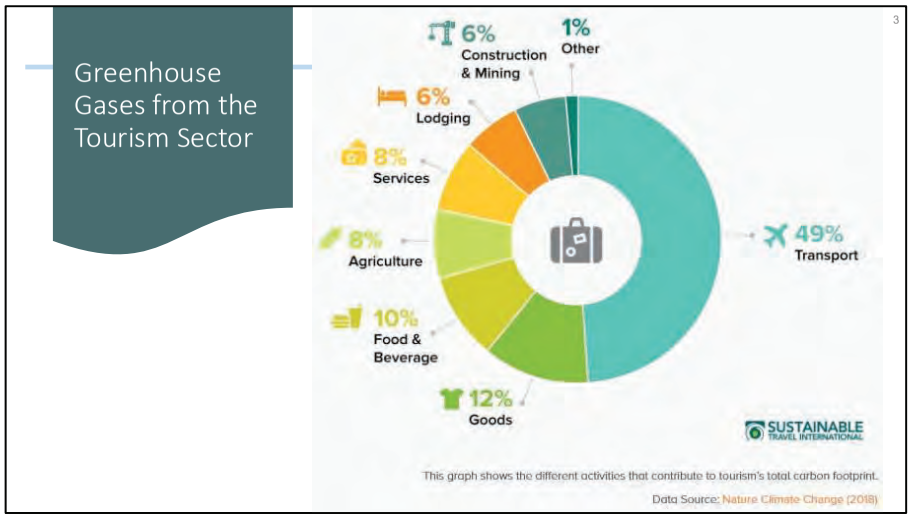
It is often mentioned that SMEs (small and medium-sized enterprises) are particularly vulnerable to climate change.
The reasons are: lack of information, limited budget and human resources to tackle climate change and business continuity, and often heavily affected by number of customers/tourists.

For example, Zurich Insurance Group's (Zurich) Annual Global SME Survey reported that:

- ✓ 78% of SMEs surveyed expected risks associated with climate change to have a significant effect on their business.
- ✓ 36% of SMEs considered material damage as likely to be the most critical risk to business due to climate change.
- ✓ The survey, which polled 2,600 SMEs in 13 countries in Europe, the Americas and Asia Pacific.

Tools and guidelines for SMEs to tackle with climate-related risks have been prepared by the governments/ local governments.
"Climate Change Risk Management Tool For Small Businesses In Queensland" is one of the examples.
The tool provides simple and practical step by step methods to conduct climate change risk management, such as:
- a checklist for rapid climate change risk screening;
- a checklist for climate change risk management assessment and action plan development.

Even though identifying and assessing climate-related risks is challenging for SMEs, they can use these tools to prepare for climate-related impacts.



To set the scene, this was the norm before COVID-19 brought the world to a stop. As shown by the pie graph, 50% of global emissions from the global tourism sector obviously was from the combination of all the various modes of transport used by the travelling tourists. In the context of the Pacific, this can be relatively higher due to the geographical location of SIDS and how the islands are scattered across the Pacific ocean. So if 8% of the world's total GHG emissions is from the Tourism Sector then that means 4% is from the tourism sector transport alone – which is quite high! So what can we do to reduce these GHG emissions?

Structure of my presentation will be as shown on the slide – a snapshot of the global greenhouse gas emissions before we take a dive into the new NDC submissions from the Pacific region then narrowing down into the mitigation activities included in these enhanced NDC submissions to ensure the Pacific region remains an attractive tourist destination.

Sectors in Pacific Enhanced NDCs

5

- Energy
  - ✓ Electricity generation and transmission
  - ✓ Land transport
  - ✓ Maritime transport
  - ✓ Cooking and lighting
  - ✓ Tourism
- Agriculture, Forestry and Other Land Uses (AFOLU)
- Waste
- Oceans

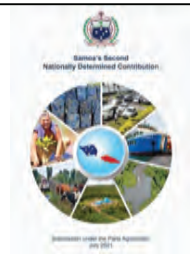
The main sectors included in the 8 enhanced NDCs submitted are Energy, AFOLU (Agriculture, Forestry and Other Land Uses), Waste and Oceans. The sectors are then broken down into subsectors as seen from the Energy Sector. Most of the first round of NDCs from the Pacific focused on electricity generation from renewable energy sources. However, other subsectors have now been included such as transport, both land and maritime. There is currently an electric mobility policy being developed by our colleagues at Pacific Centre of Renewable Energy and Energy Efficiency to facilitate the provision of an enabling environment for an electrified land transport system around the region. Maritime transport involves the use of new and more energy efficient vessels for inter-island transportation. Also under the Energy sector is the energy consumed for cooking and lighting. The Enhanced NDC by Samoa also has Tourism under the Energy Sector mainly due to the fact that the country aims to achieve GHG emission reductions from the Tourism Sector via improvements in the energy usage within the sector.
Other sectors listed – AFOLU, Waste and Oceans, though not mentioned specifically in the NDC documents, but the activities identified have linkages to the Tourism Sector. Under Oceans and Marine for example, the replanting and rehabilitation of mangroves shall produce healthier coral reefs and assist in managing sea level rise along the coastline. More efficient waste strategies in managing waste on the islands can go a long way in ensuring that the environment is clean and healthy for both locals and tourists, an example is the use of biogas systems. Under the AFOLU sector, tourists can be encouraged to plant trees to offset the carbon emissions as a result of their travels to the islands.

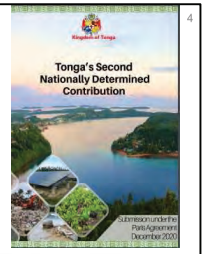
382

Pacific Enhanced NDCs

4

- Fiji
- Nauru
- Papua New Guinea (PNG)
- Republic of the Marshall Islands (RMI)
- Samoa
- Solomon Islands
- Tonga
- Vanuatu





Pacific Small Island Developing States (PSIDS) have always been great leaders in the climate change space. Even with Nationally Determined Contributions (NDCs), the small islands continue to make very ambitious commitments in terms of their greenhouse gas emission reduction pledges, firstly in 2015 at COP21 in Paris, and again in Glasgow during COP26. Eight of the PSIDS listed on the slide have again submitted their NDCs which are even more ambitious than the ones submitted in the first round. In addition, these NDCs have also included adaptation and the scope of activities has expanded into other sectors other than Energy / Electricity generation from renewable energy sources as per initial submissions in Paris.

Case in the Pacific - SAMOA

7

- To reduce GHG emissions from the Tourism Sector, Samoa aims to improve the energy efficiency within the sector by upgrading the existing facilities to more energy efficient electrical appliances;
- Energy Audits have started with some of the accommodation providers which will then provide them with recommendations on avenues to reduce their consumption and in turn reduces their GHG emissions.
- Also included in Samoa's enhanced NDC are other activities which shall assist in maintaining its strength as a tourist destination:
  - replanting and rehabilitation of mangroves around the islands to combat coral bleaching and ocean acidification
  - more waste strategies to reduce the volumes at the landfill (e.g. biogas, recycling, etc)
  - 100% renewable electricity

As mentioned in the previous slide, Samoa was the only Pacific SIDS to have identified the tourism sector specifically. Before the sector can identify which sector stakeholders to assist with in terms of Energy Efficiency, energy audits need to be carried out in order to accurately identify areas where GHG emission reductions can be achieved from. Currently, a consultant has been hired to carry out energy audits with some of the major accommodation providers in the tourism sector. Simultaneously, other mitigating activities have already been implemented in selected communities.

Tourism Sector in NDCs

6

- Only SAMOA specifically has the Tourism Sector as one of the sectors in their Enhanced NDC;
- Though it is not in black and white, but all other countries have committed to implementing various mitigation activities which shall maintain / boost their respective tourism industries indirectly:
  - ❖ utilizing renewable energy sources for electricity production
  - ❖ waste treatment strategies
  - ❖ tree-planting initiatives
  - ❖ mangrove replanting and rehabilitation
  - ❖ more energy efficiency with transport (land and maritime)

The only Enhanced NDC to have identified the Tourism Sector in print is Samoa's. However, more information on that on the next slide but though it was not in printed form for the other seven NDCs, the NDC mitigation activities outlined above all directly benefit the Tourism Sector because they will all contribute to a "green healthy environment" for the islands with "healthy marine ecosystems".

Reference materials

9

- UNFCCC NDC Registry

(https://www4.unfccc.int/sites/NDCStaging/Pages/Home.aspx)

- Wolf, F., Filho, W.L., Singh, P., Scherle, N., Reiser, D., Telesford, J., Miljkovic, I.B., Havea, P.H., Li, C., Surroop, D., Kovaleva, M. Influences of Climate Change on Tourism Development in Small Pacific Island States. *Sustainability* ***2021****, 13, 4223.*

https://www.mdpi.com/2071-1050/13/8/4223/pdf

- World Tourism Organization & International Transport Forum (2019), *Transport-related CO2 Emissions of the Tourism Sector – Modelling Results*, UNWTO, Madrid

(https://www.e-unwto.org/doi/epdf/10.18111/9789284416660)

- Sustainable Travel International

(https://sustainabletravel.org/issues/carbon-footprint-tourism/)

Please write down the script of your explanation what you are going to speak in your narration for this slide.

Summary for the Presentation

8

- The tourism sector is one of the key pillars of national development in the Pacific island states;
- Most of the GHG emissions from the Tourism Sector is via air travel given the Pacific destination being isolated from other major countries geographically;
- Pacific NDCs do not pinpoint the Tourism Sector except for the one submitted by Samoa which aims to reduce GHG emissions by enhancing energy efficiency in the sector;
- Mitigation activities being implemented across the Pacific such as mangrove replanting, utilization of renewable energy, energy audits, etc shall indirectly contribute to maintaining a Tourism Industry ready to welcome tourists once borders open.

Self-explanatory.

CONTENT

1. Ecosystem-based Adaptation (EbA) to climate change, and a focus on coastal and marine ecosystems

2. Mainstreaming ecosystem-based adaptation in the tourism sector: opportunities to strengthen socioeconomic resilience

2

Broadly speaking my presentation is split into two parts:

- The first one aims at providing some basic definitions and explain what is ecosystem-based adaptation (or EbA) to climate change, with the particular focus on coastal and marine ecosystems.
- The second part will showcase and highlight how designing and mainstreaming ecosystem-based adaptation strategies can lead to more resilient and sustainable development processes, including for the tourism industry, as outlined in the new Pacific Sustainable Tourism Policy Framework.

385

1

CBCRP-PCCC & SPTO Virtual Training Course

"Enhancing Climate Resilience in Tourism in the Pacific"

Government of Samoa, SPREP, SPTO and JICA

Module 2. Opportunities of the tourism to respond to climate change

2.1.1 Ecosystem-based approaches: marine, coastal and terrestrial

Nicolas Rocle | Marine Conservation and Management Specialist
SPREP ; nicolasr.ext@sprep.org

Talofa lava all, greetings from Apia, Samoa and welcome in this sub-module dedicated to the links between Ecosystem-based approaches and climate resilience of the tourism sector.
My name is Nicolas Rocle, I'm a Marine Conservation and Management Specialist at SPREP, the Secretariat of the Pacific Regional Environment Programme, based in Samoa.
The purpose of my presentation is to give you an overview of why and how ecosystem-based adaptation can be a relevant strategy to build climate resilience in the long-term and to enhance adaptive capacities of the tourism sector to face climate change impacts.
I will focus here on the coastal and marine ecosystem component, as another colleague will focus on the terrestrial or catchment component. This is due to our respective expertise areas, however as I'm going to explain as soon as we talk about ecosystem-based approach we must have a global view of the entire interactions between the land and the sea.

Ecosystem-based adaptation: what is it (for)?

"Ecosystem-based adaptation (EbA) integrates the use of biodiversity and ecosystem services into an overall strategy to adapt to the adverse impacts of climate change. Ecosystem-based adaptation uses the **sustainable management, conservation, and restoration of ecosystems** to provide services that enable people **to adapt to both current climate variability and long-term change**."

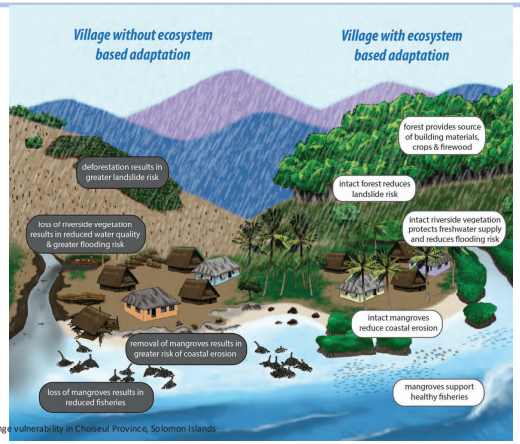
CONNECTING BIODIVERSITY AND CLIMATE CHANGE MITIGATION AND ADAPTATION- Report of the Second Ad Hoc Technical Expert Group on Biodiversity and Climate Change under the Convention on Biological Diversity (CBD)

Here is a definition of Ecosystem-based Adaptation, from a Technical Expert Group under the Convention on Biological Diversity.

Tourism in the Pacific facing climate change

Most islands in atoll nations, such as in this aerial view of Jaluit in the Marshall Islands, are as little as two meters above sea level and threatened by climate change. (Photo: Giff Johnson)

As a start I won't go back over the various current or expected impacts of climate change, but simply reminding, as you know very well, of the extent to which tourism - whatever its form, location and business plan - depends on the goods and services provided by ecosystems. Thus, the rise in sea level, the warming and acidification of waters, the increase in the severity of storms or cyclones, but also the salinization of some lands or water tables, are all phenomena that will inevitably affect the tourism industry and many other economic sectors.



Ecosystem-based adaptation and climate change vulnerability in Choiseul Province, Solomon Islands
Synthesis report

Coastal and intertidal ecosystems such as mangroves, seagrass and coastal vegetation needs to be able to move with changing conditions. Inappropriately designed hard infrastructure can upset the temporal migration of these ecosystems leading to their degradation and loss of services

Ecosystem-based adaptation: what is it (for)?

The objective of ecosystem-based adaptation is to maintain the health and functioning of ecosystems in order to optimise their climate and socio-economic resilience benefits.

ACTIONS INCLUDE:

- Addressing the drivers of ecosystem degradation
- Conservation and restoration measures
- Green/blue infrastructures and engineering
- Financial incentives
- Spatial planning and coordinated governance

FIGURE 1 Ecosystem-based Adaptation (EbA) interventions integrate services from biodiversity and ecosystems, benefits for people and climate change adaptation responses, in the context of sustainable development (adapted from Midgley et al., 2012)

Climate adaptation and resilience based on healthy ecosystems are the guiding principles of EbA.
This can include different actions and measures:

- Addressing the drivers of ecosystem degradation
- Conservation and restoration measures
- Green/blue infrastructures and engineering
- Financial incentives
- Spatial planning and coordinated governance

EbA and Nature-based Solutions

8

(i) Ecosystem restoration approaches:
- Ecological restoration: *Control of invasive species, Re-introduction of native species…*
- Ecological engineering: *Creation of artificial ecosystems, Re-vegetation for erosion control…*

(ii) Issue-specific ecosystem-related approaches:
- **Ecosystem-based adaptation** and mitigation
- Ecosystem-based disaster risk reduction

(iii) Infrastructure-related approaches:
- Natural and green infrastructure: e.g. *reefs or mangroves*

(iv) Ecosystem-based management approaches:
- Integrated coastal zone management
- Integrated water resources management

(v) Ecosystem protection approaches:
- Area-based conservation approaches
- Protected area management

Here is another way of presenting the broad spectrum of which challenges can be addressed through Nature-based solutions and approaches.
The graph shows for example that NbS and Ecosystem-based approaches can address or be part of:
- Disaster Risk Reduction
- Climate Change Mitigation
- Environmental Management
- Climate Change Adaptation: basically we can say that Ecosystem-based Adaptation is the use of Nature-based Solutions to adapt to climate change

388

EbA and Nature-based Solutions

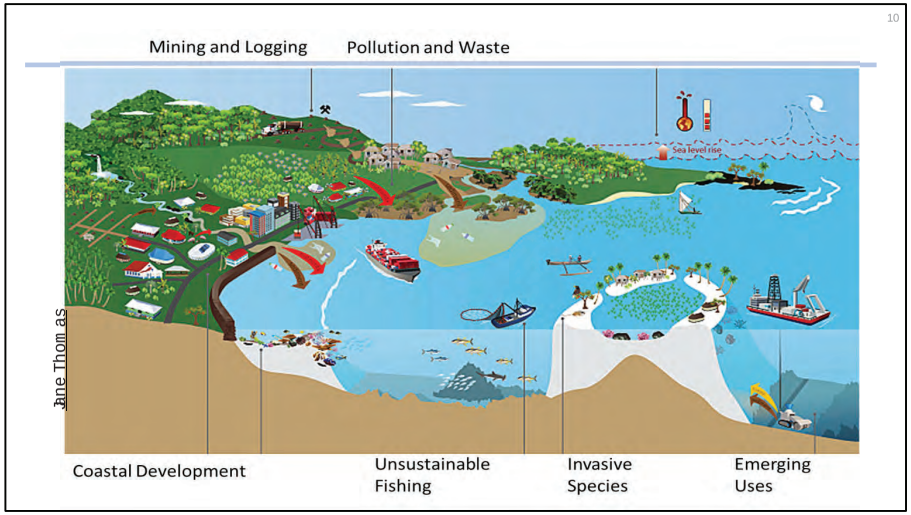
7

Nature-based Solutions:

"*Actions to protect, sustainably manage and restore natural or modified ecosystems that address societal challenges effectively and adaptively*"

(IUCN)

Here I would like to provide quick clarification between two terms which are often used in the same way,namely EbA and NbS .
NbS is a broad concept developed by IUCN and other organizations in the last 10 years to describe the different actions that seek *to protect, sustainably manage and restore natural or modified ecosystems that address societal challenges effectively and adaptively.*
NbS are also focused on building and relying on ecosystems in order to provide co-benefits for both the ecosystems themselves AND human well-being.



EbM recognises that the main current drivers of ecosystem degradation are related to unsustainable development processes
On this image for example poor agricultural practices that lead to accelerated soil erosion could also be added. Pollution includes agro-chemicals that end up in waterways.

For island systems and when we think about coastal and marine sustainable management, this graph highlights some of the main threats and pressures that impact coastal and marine ecosystems. Of course, the main drivers can be addressed further to a diagnosis or environmental impact assessment, but considering the full range of factors that hinder ecosystem services or resilience has led to integrated or systemic approaches, among them are Integrated Coastal Zone Management, Ridge to Reef approach… So Ecosystem-based Management is the key principle supporting such approaches as it recognises and takes into account the biophysical and chemical interactions and effects among different components of an ecosystem.

EbA *vs* Ecosystem-based Management

9

- Ecosystem-based management (EbM) is an integrated management approach that recognizes the full array of interactions within an ecosystem, including humans, rather than considering single issues, species, or ecosystem services in isolation.

- ECOSYSTEM-BASED MANAGEMENT INCLUDES THE FOLLOWING CORE CHARACTERISTICS:
  - Place-based (ecologic criteria)
  - Cross-sectoral
  - Adaptive and flexible
  - Proactive
  - Inclusive and collaborative

Source: NOAA

9

Ecosystem-based Management is an integrated management approach relying on the interactions within an entire ecosystem that includes human beings and activities. This differs from management approach that rely more on administrative boundaries, pre-existing institutional competencies, or economic sectors, etc. Among the core characteristics are the following:

Place-based with geographic areas defined by ecological criteria
Cross-sectoral, considering interactions between sectors of human activity
Adaptive and flexible, responsive to monitoring and research results
Proactive, incorporating trade-offs to manage the marine and coastal environments
Inclusive and collaborative, encourages participation from all levels of government, indigenous peoples, stakeholders…

WHY EbA for tourism resilience?

12

=> Maintaining healthy and optimally functioning ecosystems is a key climate adaptation strategy

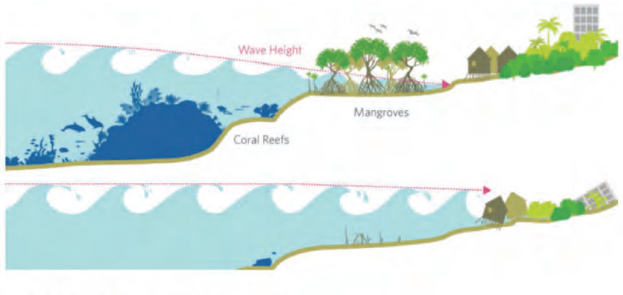


Figure 1: **Coastal ecosystems mitigating risks.**
Source: **Losada et al. 2018**

EXAMPLE: Healthy coral reefs, seagrass, mangroves and coastal vegetation attenuate wave energy which helps **protect shorelines** during storm events, so there are extremely important for **every tourism infrastructure and facility**.

WHY EbA for tourism resilience?

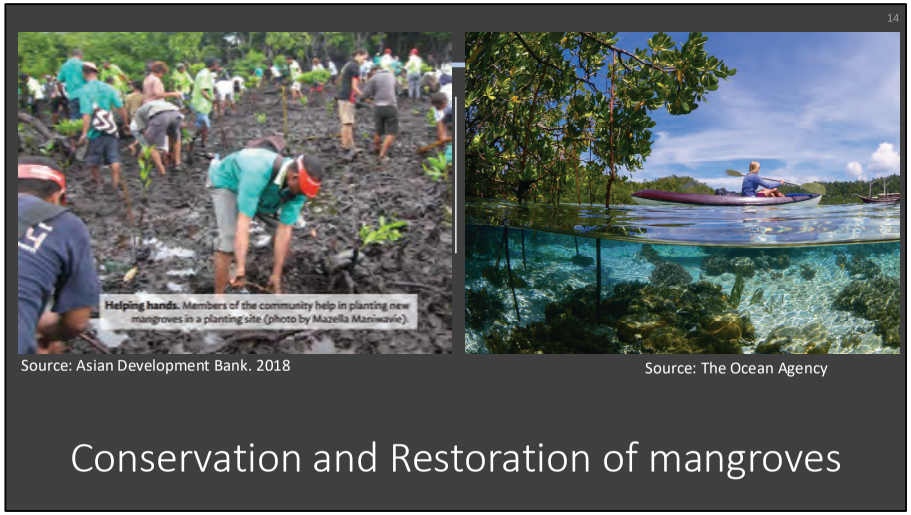
11

Ecosystems support sustainable livelihoods and economies in many ways:

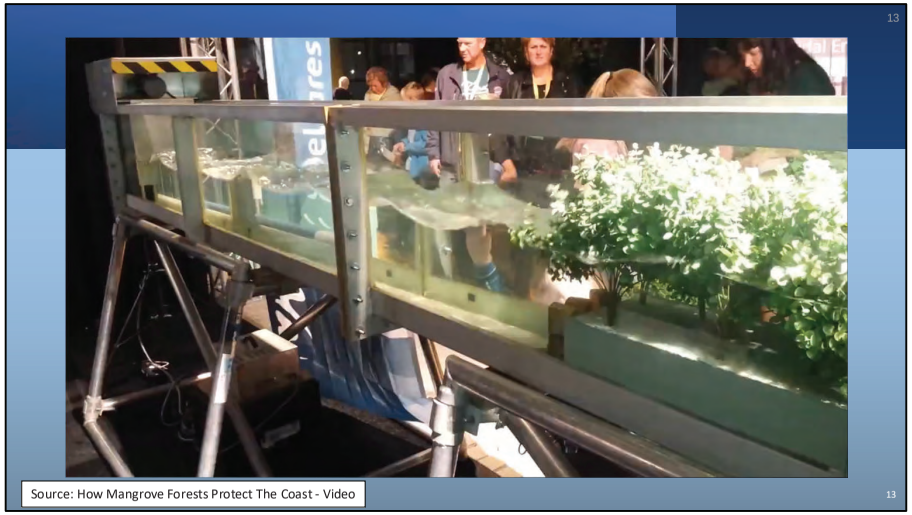
- **Provisioning services**; e.g. fish, seafood, fibre, construction materials, fuel, etc.
- **Regulating services**; e.g. flood control, climate regulation, pest control, maintaining stable coastlines, pollination, carbon sequestration
- **Support services**; e.g. hydrological cycle, soil formation, nutrient cycling, primary production
- **Cultural services**; e.g. spiritual, recreational, aesthetic, educational

Ecosystems are therefore critical components of community health, economic development, well-being and… resilience to climate change

Here is a view of the main services that ecosystems provide, divised into four broad categories. I've highlighted in red those that are specifically relevant for tourism, but of course all the other services contribute in one way or another to the whole range of goods and services that benefit to tourism and recreational activities.



Mangrove (re)planting benefits from community involvment, existing expertise and guidelines, support of public authorities, etc.



Related to that, have a look at this video showing a modeling and demonstration pilot of how mangrove forests can reduce wave energy, erosion, and storm surge water levels, and by doing so mitigate coastal flooding. This is particularly relevant in the context of climate change, as coastal flooding and erosion are predicted to increase in severity as sea levels rise.

As such, this is a good demo to realize how nature can protect shorelines and all the coastal infrastructures and activities where mangroves can grow and be restored.

Video links : How Mangrove Forests Protect The Coast. Youtube. Posted Nov 23, 2016.
https://jpn01.safelinks.protection.outlook.com/?url=https%3A%2F%2Fwww.youtube.com%2Fwatch%3Fv%3DaoMrLYJOdA4&data=05%7C01%7Chanh.tran%40ss.pacific.co.jp%7C25c3b668373843719dd708da86464f47%7C1436d58992e54e3ba67a1e65a9b1ba02%7C0%7C0%7C637969933785620211%7CUnknown%7CTWFpbGZsb3d8eyJWIjoiMC4wLjAwMDAiLCJQIjoiV2luMzIiLCJBTiI6Ik1haWwiLCJXVCI6Mn0%3D%7C3000%7C%7C%7C&sdata=kov%2FSngBax1wNZwnBv8VnSJKxKxxy4A0lhEnrnXv5Gs%3D&reserved=0

Source : University of Hawai'i

"In light of the importance of the tourism industry in SIDS, ***beach nourishment schemes*** *and* ***inventory of beach replenishment deposits and their sustainability*** *should be ensured as a matter of priority."*

(High Level Panel discussion "Climate resilient transport infrastructure for sustainable trade, tourism and development in SIDS" 10 December 2019 - UNFCCC COP 25 Madrid)

Here I would like to focus on a key issue that are facing a lot of tourism infrastructures and facilities, namely coastal erosion. As most of the tourism infrastructures in Small Island States are located along the shoreline, such as hotels, resorts, etc. this is a very issue that will be more and more important given sea-level rise an reduction of sand resources.

As interfaces between the land and the sea, shorelines are extremely dynamic and should be able to keep moving function of wheather and marine conditions to be resilient to storm events, sea level rise, etc. However many projects are still subject to hard construction, such as seawalls, groins, etc. But what this photo shows in a way is that such building structures can amplify erosion processes and often lead to the reduction or disappearance of beaches, which are the main natural capital of many tourist destinations.

This statement coming from a panel discussion on transport, trade and tourism in SIDS during the COP 25 in Madrid is of particular importance, to assess resources and what are the best options to sustainably manage beaches and shorelines.

WHY EbA for tourism resilience?

15

Ecosystems can also **contribute directly to island economies** creating jobs and sustainable incomes

EXAMPLE 1: Tourism spend in Fiji in 2019 was just under USD1.5bil, 40% of GDP and employing 120,000 people (33% of the workforce).

EXAMPLE 2: Commercial fisheries contributed USD1bil to Kiribati in 2013.

More recently attempts have been made to attach a value to the **non-direct economic benefits of Ecosystem Goods and Services**:

EXAMPLE 1: Annual value of marine ecosystem services in Fiji valued at USD1.7bill in 2014 (excluding tourism and fisheries)

EXAMPLE 2: Annual value of coastal protection from ecosystems in Tonga is USD19mil, greater than inshore-and off-shore fisheries combined (USD8.3mil)

The diversity and high quality of Fiji's coastal and marine ecosystems is the main drawcard for tourists, as illustrated here in these figures.

Recognising the value of ecosystem services for coastal protection and tourism can help assessing different EbA options through cost-benefit analyses, for example between "green" and "grey" infrastructures, as highlighted in the following slide.

WHY EbA for tourism resilience?

- **Living breakwaters/artificial reefs can support tourism and recreation**

✓ Where living breakwaters/artificial reefs provide habitat for marine life, they are a potential source of revenue from scuba diving (Seaman 2002; Harris 2009; Sutton and Bushnell 2007).

- **Managed realignment and coastal set-backs can support tourism and recreation**

✓ The ecotourism and recreational value of natural habitats can be increased as a result of managed realignment and coastal set-backs due to the provision of open spaces and access to the shoreline (Linham and Nicholls 2010; Luisetti et al. 2011; Fletcher et al. 2013)

(UNEP, 2016)

Here are two broad examples of adaptation options using hybrid solutions to deal with shoreline management and coastal erosion.

- The first one – living breakwaters and artificial reefs – emphasises how such blue/grey infrastructures can provide habitat for marine life, shoreline protection but also source of revenue for activities like scuba diving and snorkelling.
- The second one is of growing recognition at the international level and in different countries, that is managed realignment and coastal set-back where assets and infrastructures are at risk (now or at mid to long-term). Allowing new spaces and access to shoreline can offer new recreational value for natural habitats and ecotourism.

Green/grey infrastructures

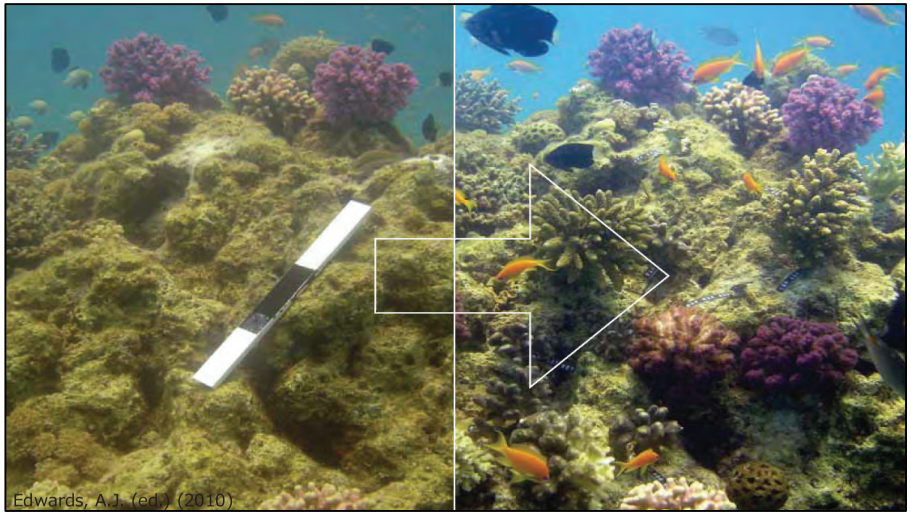
Engineering Challenge	'Grey' Infrastructure Solution	'Green' Infrastructure Solution	Example of a 'Hybrid' Solution
Urban stormwater & flood management	• Retrofitted / enhanced urban storm-water drainage systems • Engineered flood protection	• Green roofs • Urban gardens and green spaces • Riparian and wetland vegetation restoration, creation & management	Uptake of green roofs, bioswales & raingardens to regulate stormwater runoff & reduce flows to drainage system
Coastal flooding, storm surge, sea level rise & erosion	• Seawalls, dykes, permanent artificial walls and temporary storm barriers • Improved drainage systems	• Conservation, management, restoration, or creation of: • Coral reefs (including the use of artificial substrate) • Oyster reef • Seagrass • Coastal wetlands; mangroves & salt marsh • Sand dunes & beaches	Restoring / conserving mangroves belts that support sea dykes as a first line of defence to reduce flood risk and erosion.

Source: Green-Gray Infrastructure (conservation.org)

Grey infrastructure is a loose term to describe engineering projects that use man-made materials such as concrete and steel.
Green infrastructure is a loose term to describe engineering projects that use predominantly plants and ecosystem services to perform the engineering function.

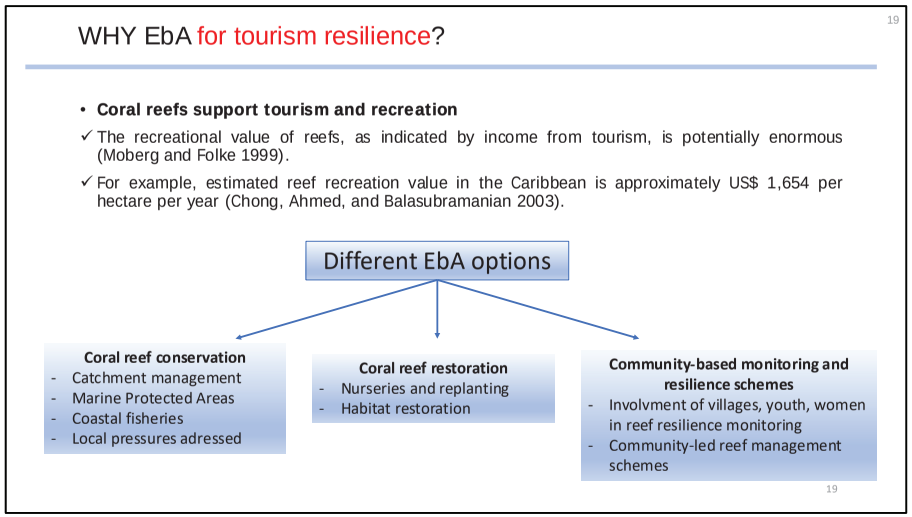
These are not exclusive from each other, for example where ecosystems only can't provide sufficient benefits or when there is need to think more in terms of long-term adaptation pathways, there is rather a growing recognition of "hybrid solutions" combining "green" and "grey" infrastructures, or "soft" and "hard" solutions. You can have a view in a programme run by Conservation International which is called Green/grey infrastructures: "Green-gray" infrastructure mixes the conservation and restoration of nature (including natural coastal buffers such as mangroves and seagrasses) with conventional approaches (such as concrete dams and seawalls). Green-Gray Infrastructure (conservation.org)

An example of mangrove restoration is illustrated below.



Coral reef restoration is of growing interest given the already destroyed or poor coral areas in some parts of the world. This restoration process needs some good knowledge and methodology, active buy-in of communities and different initiatives are observed under the leadership of individuals, villages, ministries, but also tourist operators and businesses (ex. private resorts in Samoa).

However active reef restoration should be viewed as just one option within a broader integrated coastal management plan. It is not an alternative to management and unless the causes of reef degradation are under control, active restoration will ultimately fail.



Focusing more on coral reefs, we know how huge is the recreational and touristic value of coral reefs, so here are a few examples of EbA options that can be considered by tourists operators in partnerships with local communities, public authorities and other stakeholders…

- Coral reef conservation are measures that address the threats that impact coral reefs
- Community-based monitoring and resilience schemes is of great importance to engage new sustainable practices around reefs and to implement the adaptive management I was talking about for achieving an ecosystem-based approach.
- I'm going in more details on coral reef restoration in the following slide

Other case studies are included in general guidelines for managers and decision makers, please have a look at reports produced by ICRI (International Coral Reef Initiative) or other partners:
[Coral Reef Restoration Guidelines – ICRI (icriforum.org)]

Case studies

Transplantation of coral colonies to create new patch reefs on Funafuti Atoll (Tuvalu)

Transplantation of corals to a traditional no-fishing area affected by coral bleaching (Moturiki Island, Fiji)

[see Edwards, A.J. (ed.) (2010). Reef Rehabilitation Manual. Coral Reef Targeted Research & Capacity Building for Management Program: St Lucia, Australia]

In this slide are two case studies of coral restoration projects in the Pacific, one on coral transplantation on Funafuti Atoll, Tuvalu, and the other on Moturiki Island, Fiji.

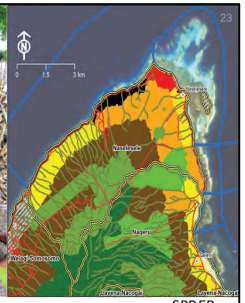
- Systems in place for regular monitoring
- Capacity building and equipping
- Adaptive management

Sustainable financing

- Incentives
- Link with private sector
- Payment for ecosystem services

Key success factors

- Participatory research
- Participatory and spatial planning
- Effective governance arrangements
- Adaptive management
- Monitoring
- Sustainable financing



SPREP

Here are some “takeaways” about some of the key success factors in such EbA projects:

Participatory research

- roles that ecosystems play in supporting community resilience
- status and trends in ecosystem condition = ability to continue providing services
- drivers of degradation
- local experiences and projections for climate change
- potential impacts on ecosystems and their services

Participatory planning

- Identification of key problems and problem analysis
- Identifying range of appropriate interventions/options
- Establishing criteria and screening options
- Development of an EbA implementation plan

Spatial planning

- Establishing appropriate planning boundaries (e.g. watershed, land-seascape, R2R)
- Factoring in ecosystem connectivity (e.g. R2R, MPA networks)
- Marine Spatial Planning – zoning of different land and sea uses
- Spatial modeling to identify socio-ecological linkages

Management

- Integration with local level governance systems
- Nested – governance spans local to national levels
- Multi-sector
- Private sector support
- Clear roles and responsibilities and reporting mechanisms
- Capacity building

Monitoring

- Identification of appropriate social and ecological indicators

Pacific Sustainable Tourism Policy Framework

25

"We will focus our efforts to diversify and strengthen the resilience of the tourism economy, to better prepare for future shocks, to address long standing structural weaknesses (…)"

Pacific 2030 Sustainable Tourism Policy Framework

To do so, it outlines a number of goals and actions, and insists on a key point that I would like to develop before finishing this presentation: namely the link between diversification of the tourism economy and the resilience of this industry. To be able to face global changes and challenges, such as climate change but also global pandemics, the diversification of resources and offers on which tourism relies on seems to me really important.

Pacific Sustainable Tourism Policy Framework

24

"By 2030 we are empowered by, and benefitting from tourism that is resilient, prosperous and inclusive. It improves the wellbeing of our communities and protects, restores and promotes our cultures, islands and ocean ecosystems".

The Pacific 2030 Sustainable Tourism Policy Framework has been released in April 2021 and supports the main vision which is described here.
This vision emphasizes very well the key role of protecting and restoring island and ocean ecosystems to sustain cultures, wellbeing and tourism in the Pacific.

Diversification processes for a resilient tourism

27

Marine Protected Areas can contribute to diversified livelihoods

- MPAs can also help people build their resilience by offering alternative sources of livelihoods and income. Tourism is often promoted in MPAs in the form of snorkelling, diving, wildlife viewing, cultural or eco-tourism in order to create employment and generate revenue (Leisher et al. 2007).

- "*If well managed, MPAs have great potential to contribute to EBA as they can lead to increased food security, wealth and household assets, and levels of employment (particularly from tourism), diversified livelihoods [...]*". (UNEP, 2016)

27

As an example of how synergies can be found between biodiversity conservation and tourism diversification.
More specifically Marine Protected Areas have the potential to offer new or singular forms of tourism: broadly speaking we can call that eco-tourism, including activities such as snorkelling, diving, wildilfe viewing, also linked to the cultural values and habits that co-evolve with those marine ecosystems.
Coral reef restoration, presented earlier, can also be part of an overall strategy of protecting and restoring coastal and marine ecosystems to help building new forms of tourism involving local communities, public authorities together with tourism stakeholders and businesses.
This is finally part of what we call sustainable Blue Economy (following slide).

Diversification processes for a resilient tourism

26

"People living in coastal communities are often dependent on natural resources and ecosystem services for their livelihoods, particularly fisheries, agriculture and eco-tourism [...].

Since ecosystem-based livelihoods are often linked to community values, culture, and identity (Marshall et al. 2013), EBA measures must be formed from community-led processes that identify **areas where diversification could strengthen, rather than hinder, community resilience** (Adger et al. 2012; Tanner et al. 2015).

[...]

Other potential livelihood strategies include exploiting more climate-resilient natural resources and ecosystem services in a sustainable manner through promotion of ecotourism or value-added processing of natural products, for instance." (UNEP, 2016)

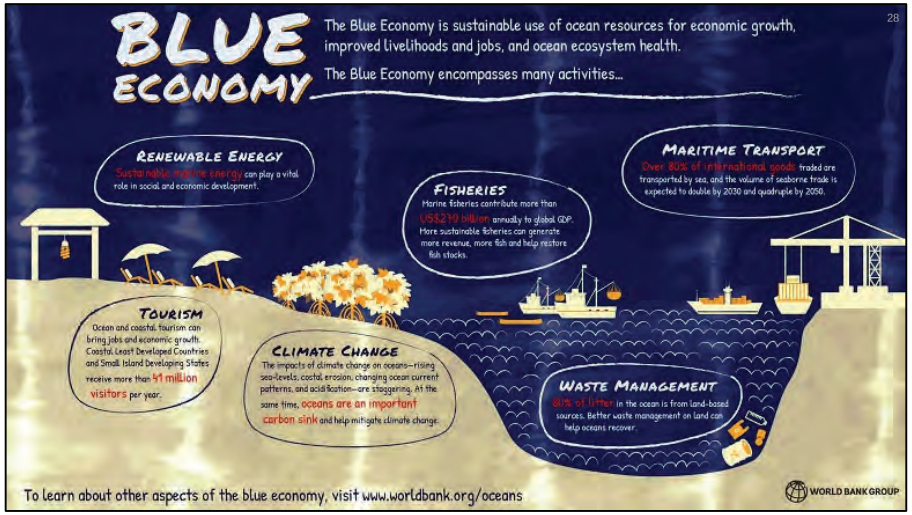
26

These statements from a UNEP report in 2016 also insist on the process of diversification to strenghten community resilience.

Summary of the presentation

29

- Ecosystem-based Adaptation:
  - Focus on ecological, social and economic connectivity => Strengthening integration and coordination between land and sea resource management agencies
  - Managing for uncertainty => monitoring and adaptive management
  - Prioritise ecosystem services that build resilience to (and mitigate) climate change
  - Maximise co-benefits for environment and human activities
  - Requires community buy-in and active participation
- Mainstream EbA and related concepts like *EbM*, *Ridge to Reef*, *Blue Economy*, *Marine Spatial Planning* into climate change and sustainable development and (touristic) sector policies
- EbA can provide a range of opportunities to both strengthen ecosystem and tourism resilience by diversifying touristic activities and business models relying on coastal and marine ecosystems.



28

As exposed here in this picture from the World Bank group, (sustainable) Blue Economy is all the activities that sustainably use ocean resources for economic development, improved livelihoods and jobs, and ocean ecosystem health.

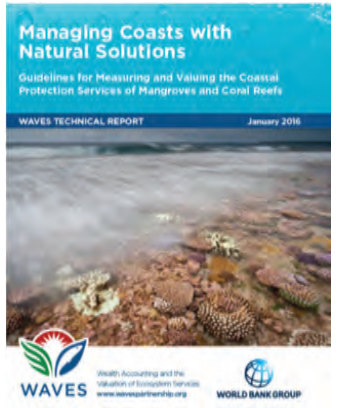
In the past few years, a growing number of countries have formulated, or are formulating, their national Blue Economy strategies and road maps, to diversify their economic base to further include ocean and coastal goods and services.

Reference materials

- What is Ecosystem-Based Management (noaa.gov)
- Nature-based Solutions | IUCN
- Green-Gray Infrastructure (conservation.org)
- Pacific-Sustainable-Tourism-Policy-Framework.pdf (southpacificislands.travel)
- https://reefresilience.org/case-studies/south-pacific-restoration/
- Coral Reef Restoration Guidelines – ICRI (icriforum.org)
- UNEP, 2016. *Options for Ecosystem-based Adaptation (EBA) in Coastal Environments: A Guide for environmental managers and planners*. UNEP, Nairobi
- World Bank, 2016. *Managing Coasts with Natural Solutions: Guidelines for Measuring and Valuing the Coastal Protection Services of Mangroves and Coral Reefs*.

Just providing here a list of references, some of them have been used to build this presentation.
I hope this has been useful for you and look forward to exchanging with you during live session and Q&A.
Thank you for your attention.

Existing resources on coastal EbA activities



30

Many resources and guidelines exist on EbA topics, and on coastal and marine EBA as well. Here are just a couple of examples of the numerous resources that exist on coastal and marine EbA approaches. There are also a number of webistes and databases dedicated to EbA.
Please free to contact us if you are interested to know more about these resources and dedicated platforms.

CONTENTS

1. Introduction
2. Ecosystem – based Approaches as a solution
3. Why EbA for terrestrial tourism resilience
4. Ecosystem-based Adaptation – benefits
5. EbA impact on terrestrial tourism sector
6. Sustainable tourism sector – building EbA interactions
7. Summary of the presentation
8. Reference materials

In this presentation, I will introduce the topic by discussing some of the climate change challenges faced by the terrestrial tourism segment and presenting that Nature based or Ecosystem based approaches as one of a solution. I will then continue to discuss the broader picture of EbA and why this is important to build tourism resilience. In addition, I will then discuss some of the benefits that EbA can offer the tourism sector and the impact EbA will have to the terrestrial tourism sector. Furthermore, before I present the summary and the reference materials, I will discuss EbA building blocks that can offer some sustainability confidence to the terrestrial tourism sector.

SPREP PACIFIC TOURISM ORGANISATION JICA

CBCRP-PCCC & SPTO Virtual Training Course

"Enhancing Climate Resilience in Tourism in the Pacific"

Government of Samoa, SPREP, SPTO and JICA

Module 2. Opportunities of the tourism to respond to climate change

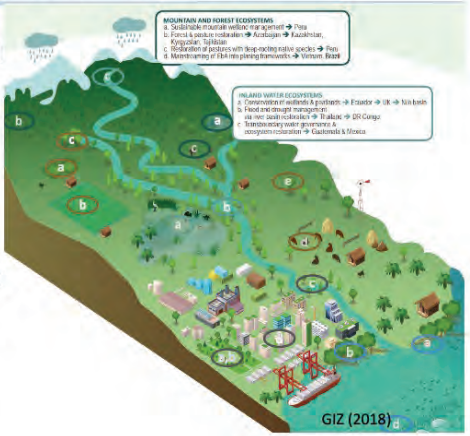
2.1.1 Ecosystem-based approaches: focus on terrestrial ecosystems

Semi Qamese | Monitoring and Evaluation Officer, Intra ACP GCCA+ PACRES Project
SPREP
semiq@sprep.org

Talofa lava and bula vinaka all, greetings from Apia, Samoa and welcome to this session on Ecosystem-based approaches of the tourism sector, a continuation of the marine and coastal components covered by Nicolas Rocle.
My name is Semi Qamese. I am a Monitoring and Evaluation Officer of the Intra-ACP GCCA+ Pacific Adaptation to Climate Change and Resilience Building (PACRES), based at the Secretariat of the Pacific Regional Environment Programme in Samoa.
The purpose of my presentation is to provide EbA option as an opportunity for the tourism sector to respond to impacts of climate change. I will focus on the terrestrial or catchment component of EbA approaches.

Ecosystem – based Approaches as a solution

- Healthy and intact ecosystems (rich in natural and socio-cultural values) provide important services for human well being, hence strategically using and promoting these important ecosystem properties to make nature and humans more resilient to climate change is referred to as Ecosystem-based Adaptation (EbA).



You may have heard many definitions of EbA, but I would like to put it this way "Healthy and intact ecosystems (rich in natural and socio-cultural values) provide important services for human well being, hence strategically using and promoting these important ecosystem properties to make nature and humans more resilient to climate change is referred to as Ecosystem-based Adaptation (EbA)". The picture on the right indicates some of the likely EbA options that can be implemented inland. These will be discussed in the next slide.

Introduction

- Challenges of the Tourism sector – Terrestrial
  - Severe storms and flooding
  - Hotter temperatures
  - Increased droughts
  - Decline in water supply
  - Loss of terrestrial species
  - Food shortage
  - Health risks
  - Poverty and displacement

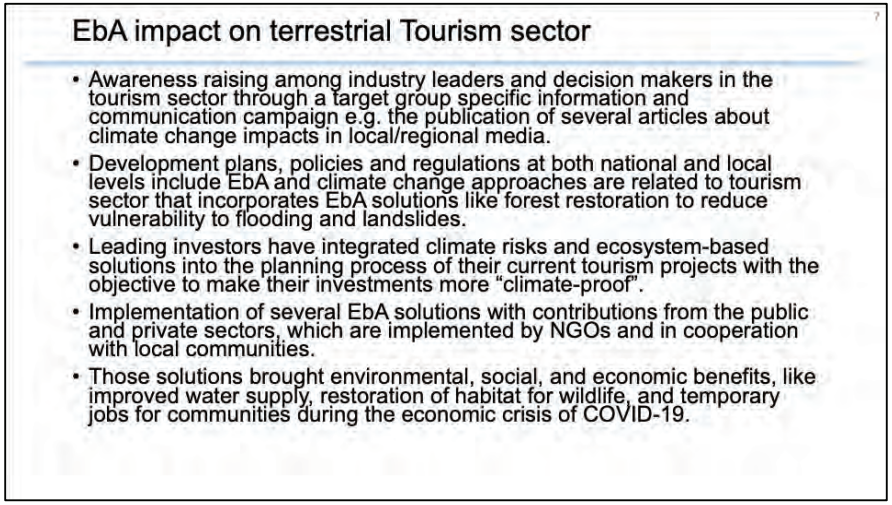
  Please also review learning materials of Module 1
- Terrestrial tourism segment is vulnerable to climate change
- Nature-based and Ecosystem-based approaches as solutions

Climate change represents the most important existential threat to the Pacific, and it will exacerbate other challenges already affecting the region. There is consensus among researchers about the detrimental impact of climate change to the terrestrial ecosystems, and the inland based tourism sector will not be spared. Adaptation of the sector to an uncertain future is required, hence tourism decision makers ought to under forecasted changes and how best to build resilience to it. Historically, we have been faced with severe storms and flash floods, temperatures are hotter, more droughts experienced- disrupt inland navigation by reducing water levels, water supplies both surface and underground declines– impact local community and leads to social conflicts, loss of terrestrial and inland water species, with the changes in weather patterns food crops may not be adapting well and we may face food shortage, there is increase on the prevalence of water and air borne diseases and of cause may push certain part of the population to poverty and human displacement. The terrestrial segment will be impacted and more vulnerable to further impacts of climate change. With that said, Nature-based and / or Ecosystem based approaches can offer some solutions to cushion the impact of climate change and build more resilience to this sector.

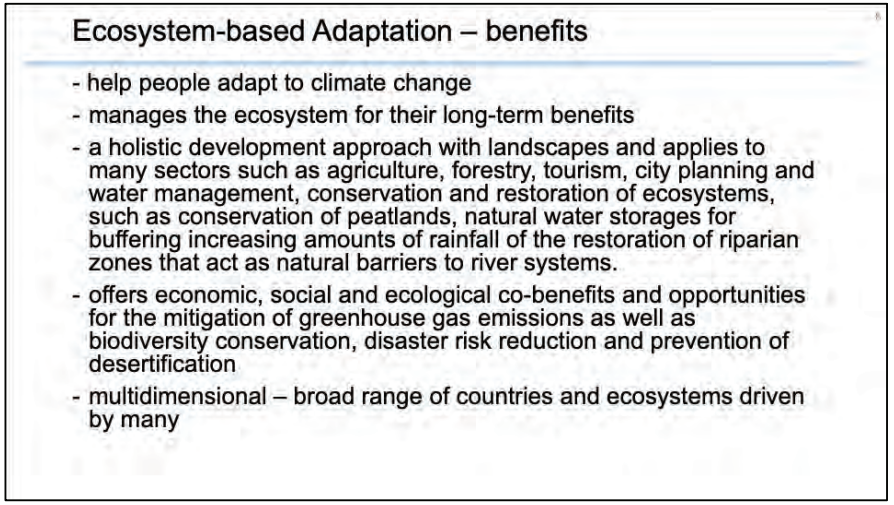
EbA solutions are applied examples of successful processes or approaches to solve a specific challenge related to climate change. They address current and future climate change impacts (e.g. floods, droughts, storms) that are often experienced in the terrestrial areas on human wellbeing through a sustainable management of ecosystems and the services they provide - with a proven impact.

In this slide, these are some of the examples of why we need to do in EbA in terrestrial areas and in-land areas. We can look at it from the urbern-perspective ecosystems where we can see rooftop farming for heat wave buffering. We can also look at a green façade for heat wave buffering on a particular kind of building, for example a Public Administration Building. We can even do green aeration corridors. We can improve flood protection and recreational opportunities like landscaping. We can also look at stormwater management and how we can regenerate urban areas. Secondly, we can look at river, wetland and inland water ecosystems so how best we can manage them. Sustainable mountain wetland management is some of the things that can be done. We can also look at conservation of wetlands & peatlands. We can look at flood and drought management via river basin restoration and or Riverbank stabilisation. We can also look at transboundary water governance and ecosystem restoration. We can even include DRR and apply ecosystem-based disaster risk reduction. This can be integrated into Water Resource Management. Under the agricultural and dryland ecosystems, we can look at some of the examples such as building resilient management of water and soil resources. We can build resilient livelihoods through eco-restoration and sustainable natural resources management. We can even develop sustainable landscapes in grasslands. We can use trees to adapt to prolonged winter and dry seasons. We can have a look at food security and disaster resilience through sustainable drylands management. Lastly but not least, we can also look at Mountain, grassland and forest ecosystems. We can do reforestation in one area that has been deforested. We can also look at riparian zone rehabilitation. In general, we can mainstream EbA into planning frameworks, which can be applied generally across the board.

5



In this slide, we need to look at the impact that EbA will have on the rest of the tourism sector. So once we go into a practice or implement some of the EbA options. This raises awareness among industry leaders and among decision makers in the tourism sector. We are targeting more specifically a larger group with specific information and a communication campaign. So we can look at some of the publications of several articles about climate change impacts in local or regional media. In the process having EbA can drive stakeholders to development plans, policies and regulations at national and local levels that include EbA within those plans and that include climate change approaches related to the tourism sector in those plans and policies. Then, incorporating some of the EbA solutions like forest restoration to reduce vulnerability to flooding and landslides. These are some of the things that can be incorporated within the plan or policy. In addition, information on EbA can also be provided to leading investors so they can integrate climate risks and ecosystem-based solutions into the planning process of their current tourism projects with the objective to make their investments more "climate-proof". Furthermore, implementation of several EbA solutions with contributions from the public and private sectors can be implemented by NGOs or any other parties that are active in that space. This can be done in cooperation with local communities. Last but not least, those solutions brought environmental, social, and economic benefits, like improved water supply, restoration of habitat for wildlife, and temporary jobs for communities during the economic crisis of COVID-19.



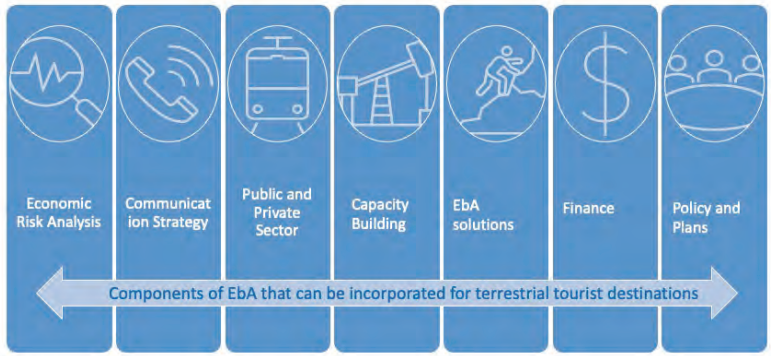
There are many benefits of EbA but here are some of the benefits of these that could be applicable in terrestrial areas, catchment areas or inland areas. It helps people to adapt to climate change. In the process it manages the ecosystem for their long-term benefits but if you look at it from a broader scale, it's a holistic development approach with landscapes and this can be applied across many sectors. We know there is an agriculture sector, forestry sector and tourism sector, but other elements are city planning and water management, conservation and restoration of ecosystems, such as conservation of peatlands, natural water storages for buffering increasing amounts of rainfall of the restoration of riparian zones that act as natural barriers to river systems. In such cases we can also include the livelihood of all the people in, where it can offer economic, social and ecological co-benefits and this gives the opportunity for the mitigation of greenhouse gas emissions as well as biodiversity conservation. In the process we can also have disaster risk reduction and prevention of desertification. The other benefit is looking at from "multidimensional", which means looking at from a broader range. The things can be done in a particular country, which can be replicated in another country so if you look at it from this perspective, this can be driven in many ways.

Summary of the presentation

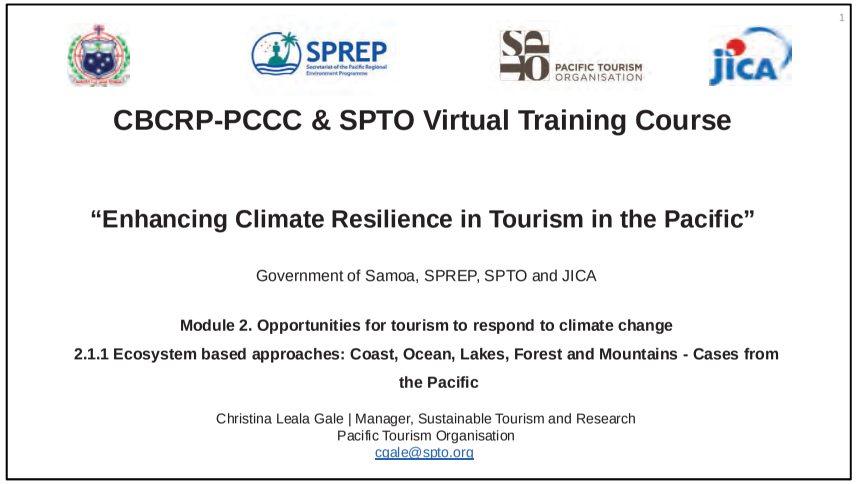
- EbA solutions respond to challenges natural conservation, sustainable development and human wellbeing and contribute to maintaining or improving the health of biodiversity, ecosystems and the services they provide
- EbA provide a successful approach to problem solving in the tourism sector
- EbA have an impact relevant to achieving SDGs, climate change, disaster rick reduction and Aichi targets and other global policy agendas
- EbA promote ecological, economic and/or social benefits to the tourism sector
- Building EbA interactions for sustainable tourism sector have the potential for adaptation, replication or upscaling in other geographic, social or sectorial contexts

In summary, EbA solutions respond to challenges such as natural conservation, sustainable development and human wellbeing and contribute to maintaining or improving the health of biodiversity, ecosystems and the services they provide. EbA provides a successful approach to problem solving in the tourism sector. EbA has an impact relevant to achieving not only the policies and strategies of the tourism sector but achieving the SDGs, climate change, disaster risk reduction and Aichi targets and other global policy agendas of any particular country. EbA promotes ecological, economic and/or social benefits for the tourism sector. Building EbA interactions for the sustainable tourism sector has the potential for adaptation, replication or upscaling in other geographic, social or sectorial contexts.

Sustainable Tourism sector – building EbA interactions



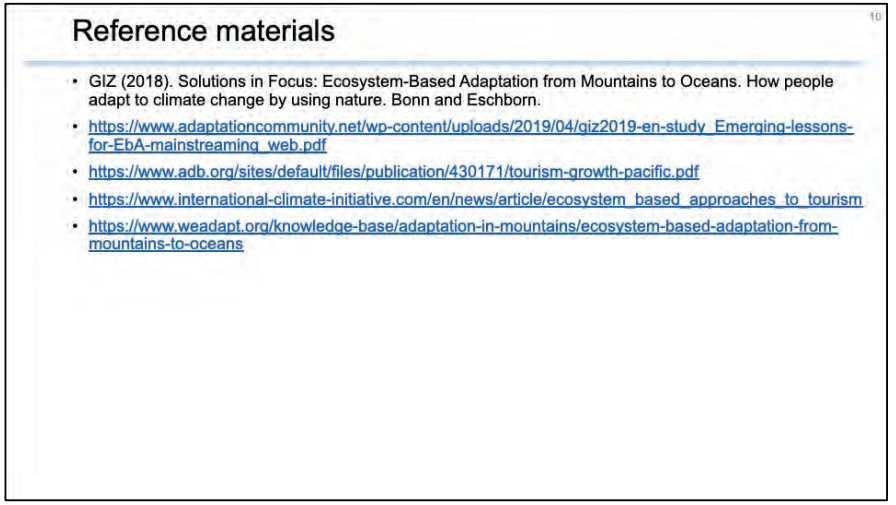
In this slide, we are going to look at having EbA interactions of building these EbA directions will provide some sense of sustainability to the tourism sector. We are going to look at the components of EbA and how this can be incorporated into tourism and make sure we can achieve a form of susta11inability. Moving towards a sustainable tourism sector provides a platform for systematic exchange of knowledge and experiences between the tourism sector and governments, institutions and practitioners, and communicate lessons learnt to climate negotiators and the wider international community of practice. How do these blocks interact? It is better to understand the situation. You need to understand the attitude, and capacities of the main target audience in this case, the tourism sector. An analysis needs to be conducted, which delivers input for communication and capacity building strategy at the same time. In addition, an economic risk assessment needs to be conducted to quantify the costs of climate change for tourism destinations and to put a price-tag on climate. The next step is to strengthen cooperation structures through creating trust between public and private actors. During this period, a communication strategy is executed to raise public awareness of climate change risks, meanwhile a capacity building strategy with focus on the development of policies and EbA solutions is implemented. On the national and subnational levels, support needs to be provided to the development of new tourism policies which include climate change and EbA criteria. All of the above led to the planning and implementation of EbA measures, which can be funded by the public and private sectors and implemented by civil society organizations and local communities. This strengthens the ability of decision makers in the tourism sector to mainstream ecosystem-based adaptation into policy and planning processes.



Talofa Lava and Pacific Greetings dear participants.

Welcome to Module 2 on Opportunities for tourism to respond to climate change. We will be specifically covering 2.1.1 on Case Studies or examples from the Pacific region on Ecosystem based approaches to climate change covering areas from the coast to the mountains.

It is a pleasure to be contributing to the Training on Enhancing climate resilience in tourism in the Pacific. My name is Christina Leala Gale and I am the Sustainable Tourism Manager at the Pacific Tourism Organisation in Suva. I look forward to engaging with you further at the end of the lecture and should you have any questions please feel free to ask me then or email me directly.



Here is provided a list of references. Please feel free to contact us if you are interested in such resources. Thank you for your attention.

1. Regenerative responses

- ✓ Reef restoration e.g. coral planting, giant clam reseeding
- ✓ Mangrove replanting
- ✓ Reforestation e.g. Tree planting and carbon offsetting, replanting native trees
- ✓ Conservation of wetlands, coastal areas
- ✓ Support Marine Protected Areas management

Guest activity programme, Corporate Social Responsibility, Business Values and Strategy

So let's get right into it. Regenerative responses.

From the outset, I would like to acknowledge that tourism is a double-edged sword. As a resource intensive sector, it has detrimental impacts to the natural and built environment of a destination, place or country. If planned well, tourism can be a force for good.

In light of the Pacific Sustainable Tourism Policy Framework, which was prepared by SPTO and its 20 Member Countries in 2021 and endorsed by the Council of Tourism Ministers in October of the same year, Goal 4 on Healthy Islands and Oceans highlights that the ocean-climate-biodiversity nexus requires the protection of all, without priority. A decline in ocean/marine habitat health and species abundance directly affects communities, food security and livelihood options for many of us in the Pacific.

Now, how can tourism respond to climate change, or what are some ecosystem based approaches to building the climate resilience capacity of the tourism sector?

Over the years, the important role of tourism in restoring the environment and ecosystems has been increasingly recognised. Regenerative types of tourism activities are not new to the Pacific as we have noted for instance that tourism businesses, governments through the National Tourism Organisations and partners collaborating on reef restoration programmes, mangrove planting, reforestation of native trees, promoting the conservation of wetlands, coastal areas and marine protected areas amongst others. These are mostly done through guest activity programmes, the implementation of corporate social responsibility commitments or embedded in the ethos and sustainability strategies of businesses.

Uprising Beach Resort in Fiji for example and its mangrove planning partnership with NGO Mangroves for Fiji has helped with planting over 5 hectares of mangroves as part of their carbon offsetting initiative.

Content

Summary of Presentation

1. Regenerative responses
2. Market segmentation
3. Waste management
4. Research and data
5. Policy
6. Capacity
7. Key Takeaways
8. Reference Materials

So in terms of content, this presentation focuses on highlighting examples of Ecosystem based approaches to climate change that are already practiced in the tourism sector across the Pacific region. To help with understanding the examples, I thought to take a different approach in grouping the examples of responses according to the listing here. I will conclude the presentation with some reflections. Additional materials are also provided for further reference.

Coastal and coral reef restoration at Leleuvia Island Resort Fiji

alpha1952

Leleuvia

I have just spent the most enjoyable and relaxing time I have had in years . On Leleuvia Island Resort Fiji an ECO FRIENDLY ISLAND with an abundance of fish and sea bird life due to the amazing reef restoration programme designed by the ECO conscious management and staff of the Island and it's surrounding reef's. Having visited many Island reefs around the world it is truly encouraging to see such an abundance of fish and a live healthy coral reef. It is a credit to all involved the young Fijian men and women doing their training and education in Marine Biology and Diplomas in Tourism. I was overwhelmed by the fresh genuine traditional Fijian hospitality of Management and staff. Traditionally and Eco friendly built structures / Bures with a very convenient modern and efficient living style. Leleuvia is a watermans paradise with wind coming from one angle or another and beautiful lagoon within the reef also a good lefthand surf break ... Colin Philps and his partner Lee Anne have created a truly beautiful positive peaceful sustainable environment for all who visit Leleuvia to enjoy and leave with a peaceful and restful peace of mind as I know I did .. A credit to you both. Will see you again soon. Loloma to you all... Ken Lucas..... .. .

To further highlight the example, I have extracted here, feedback from a guest which is testament to the hard work of the late Colin Philp, the Leleuvia Island Resort team and its partners including the Uto ni Yalo Trust and the University of the South Pacific who have been collaborating on marine research over the years . It is a joint effort to support research and evidence-based decision and policy making in driving the sustainable development agenda forward through tourism.

Regenerative responses

©Fiji Marriott Momi Bay

©Leleuvia Island Resort

The two photos on the left are from the mangrove planting and giant clam reseeding programme at the Fiji Marriott Resort, at Momi Bay and the image on the right is taken at Leleuvia Island Resort where we can see the outcome of its reef restoration programme

2. Market segmentation responses

- ✓ Ecotourism/nature based tourism
- ✓ Agritourism movement – e.g. Vanuatu
- ✓ Dark Sky Accreditation in Niue – air and light pollution
- ✓ Adventure tourism – hiking (Talanoa Treks in Fiji and Snow Pass Tours PNG)

The second ecosystem based approach for responses to ensuring climate resilience in the tourism sector is market segmentation.

Recognising the unique cultural, natural and geographical features and characteristics of each island country, market segmentation ensures ecosystem-based responses are effectively planned, implemented and financed. In this way, actions are targeted focusing on a specific visitor profile and supplier needs in the value chain.

Examples listed include ecotourism or nature based tourism which are quite popular in the Pacific islands.

Recently, we have seen a very strong Agritourism movement in the Pacific with Vanuatu leading the way in terms of agritourism policy, industry support and coordination.

Niue's Dark Sky experience in an interesting initiative aiming at the protection of Niue's air and night skies from light pollution and helps with reducing green house gas emissions.

Adventure tourism on the other hand, in the form of hiking, trekking and bird watching are popular low impact, educational experiences in the highlands of Papua New Guinea, Fiji and Vanuatu and other countries.

Regenerative responses

- ✓ National Parks – recreation, education and conservation opportunity
- ✓ Tourism site management can contribute to protection of water sources
- ✓ Underwater cultural heritage protection
- ✓ Revival of traditional navigation and sea transportation for inter-island travel

Other examples of regenerative types of tourism responses include the opportunity available through National Parks/ Reserves designations. Such sites are ideal for tourism sites which in turn contribute to their preservation, ongoing maintenance and educational value provided. The Lake Lanuto'o National Park on the top right image is a popular adventure site on Upolu Island in Samoa for visitors and locals alike. It is home to a range of endemic bird and plant species and is a very important water source for the capital Apia and surrounding villages.

On the other hand, tourism promotes the revival of traditional knowledge, art, tangible and intangible heritage through opportunities such as traditional navigation and sustainable sea transportation activities as can be seen in several countries including Fiji, Marshall Islands, Federated States of Micronesia and French Polynesia amongst others.

3. Waste management responses

- ✓ Waste water management at tourist facilities, better standards
- ✓ Composting using food waste e.g. Leleuvia Island Resort Fiji
- ✓ Waste sorting and recycling
- ✓ Plastic waste recycling
- ✓ Greener cleaning chemicals
- ✓ Beach clean ups

As a waste generating sector, tourism needs to step up its efforts in waste management now and into the future.

Lifting the standard of compliance and committing to best practices in waste rejection, recycling, repurposing and other levels of interventions in the waste hierarchy will go a long way in supporting our ecosystems to withstand climate impacts in the years to come.

Market segmentation responses

- ✓ Diving - opportunity for learning and taking part in marine conservation
- ✓ Marine tourism – social and environmental engagement
- ✓ Geoparks – a new opportunity for marine and terrestrial tourism

In terms of other market segments, diving and marine tourism provide learning and conservation opportunities for both visitors and host communities.

An emerging market segment which, if properly planned and developed, could derive multiple benefits in terms of climate resilience is Heritage Tourism focusing on Geoparks or Geotourism. I have included in the additional resources a link to the interesting Preliminary Feasibility study report that SPTO, SPC and UNESCO have recently completed for Fiji, Tuvalu, Samoa and Vanuatu. This should definitely be an interesting read for you.

5. Policy responses

- ✓ Legislative framework
- ✓ Environmental Impact Assessment Guidelines for Coastal Tourism
- ✓ Climate Change Adaptation Strategies E.g. Samoa National Tourism Climate Change Adaptation Strategy
- ✓ Development Consent
- ✓ Standards and Guidelines
- ✓ Sustainable Tourism Policies

Lets now move on to Policy responses.

For tourism to successfully take an ecosystem based approach to climate resilience, a robust policy and legislative framework needs to be in place. The absence of which could result in disappointing and costly outcomes of unsustainable tourism.

It is therefore important to ensure that policy responses are inclusive and responsive to climate resilience needs. In fact they should lay the foundation for multi-stakeholder actions and collaboration. Environmental Impact Assessment Guidelines, and Development Consents play an important role for starting tourism development right.

Listed here are examples of relevant legislative and policy frameworks available. These range from EIA Guidelines, national tourism climate change adaptation strategies as we can see for Samoa, standards and sustainable tourism policies.

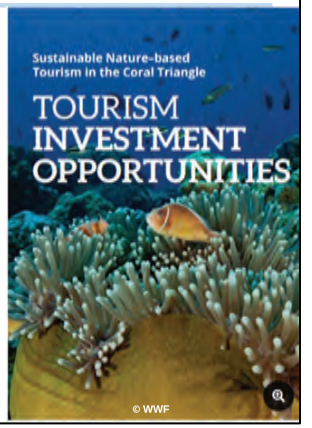
While national EIA guidelines are common, a regional EIA Guidelines for Coastal Tourism Development in the Pacific Island Countries and Territories was launched by SPREP and SPTO in 2018 to support tourism industries in countries where national EIA Guidelines do not exist.

Vanuatu, Samoa, Cook Islands, Niue, Tonga and Kiribati have standards at the sector level. In terms of dedicated Sustainable Tourism Policies, Cook Islands, Vanuatu, Niue and Kiribati have these in place. Fiji and Tuvalu on the other hand are in the process of developing their Sustainable Tourism Policies.

Having these policy instruments in place, will strengthen ecosystem based responses for enhancing climate resilience in the tourism sector in the long run.

4. Research and data responses

- ✓ Valuation of ecosystem tourism services in Fiji
- ✓ Coral Triangle Initiative – Investment Opportunities Asessment in PNG, Solomon Islands and Timor Leste
- ✓ Carrying Capacity Assessment in Niue
- ✓ Whale watching data collection by Oma Tafua in Niue and SPREP and Ministry of Tourism in Tonga
- ✓ Monitoring frameworks and indicators



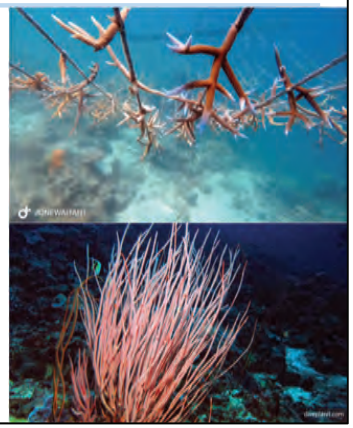
Central to any ecosystem based approach to climate resilience building is research and data.

For tourism, research and data responses are essential in making meaningful impact on the ground. This slide outlines the importance of responsible and responsive research to planning and building a climate resilient tourism sector. Examples of different research and data related responses are listed for your reference.

Moving forward, more partnerships in this space are required. You can also refer to the link provided on the 2021 Pacific Islands Tourism Research Symposium where interesting related research on ecosystem based approaches have been shared.

Key Takeaways: Ecosystem based responses from tourism

1. Climate response needs to address the time scale differences between predictions and short term tourism cycles
2. Multi-layer, multi-stakeholder partnerships need strengthening
3. Mainstream climate consideration across sectors
4. Ecosystem based approaches to climate resilience requires public-private-community collaboration
5. Communities and the environment need to be at the centre of tourism development and recovery



In closing off this presentation these are some key reflections from me:

1. Research has rightly pointed out that climate responses need to address the time scale factors. Climate predictions look at the long term, however, tourism operators on a short term cycle. The practicality of predictions and anticipated implications on the daily operations in tourism needs to be addressed. Perhaps this could be a good conversation to have between the scientific experts and tourism practitioners.

2. For tourism to do better in ecosystem based approaches to enhancing climate resilience, the need for partnerships at all layers and levels need to strengthening, be given serious attention and resourcing.

3. Climate change is not an issue for specific sectors, ministries or groups. It is everyone's business as our lives and livelihoods are on the line if we don't act now. Climate change need to be embedded in tourism policies at sector level and most importantly at business and community level. It is also key for those leading the charge on climate change to seriously consider the value and role of tourism in addressing climate change. I would like to see the Glasgow Declaration which I will discuss in detail in the next unit as a platform for engaging more effectively with tourism.

4. Public-private-community partnerships are essential in increasing ecosystem based approaches to enhancing climate resilience in tourism.

5. Lastly, never losing sight of the people and environment is key and they should continue to be at center of tourism development and recovery moving forward.

7. Capacity responses

- ✓ Community education and awareness
- ✓ Public awareness and advocacy
- ✓ Human resources development programes e.g. training and mentoring support
- ✓ Technology to support rsource efficiency e.g. in energy and water consumption
- ✓ Multi-stakeholder partnerships

I now would like to take you through the last grouping of examples where we can see ecosystem based approaches to enhancing climate resilience in the tourism sector.

Despite strong advocacy and ongoing effort on climate change, there are notable gaps in tourism stakeholders from Government to community, in fully understanding and appreciating how tourism contributes to climate change and how it is impacted by climate change.

It is therefore important to have renewed focus at all levels to support relevant capacity related responses whether it be through community education, public awareness, skills development and training of stakeholders, introduction of the right technologies required and forging partnerships to support these efforts. The goal is for the tourism sector stakeholders, regardless of where you stand, to fully recognise that everyone has a role to play in tackling climate change. Given the cross cutting nature of tourism, it must also be seen as an important vehicle in addressing climate change particularly when we are wishing to reach the most vulnerable and marginalized in our communities.

CONTACT:

Please feel free to contact me for further information:

Christina Leala Gale
Sustainable Tourism Manager
Pacific Tourism Organisation
Private Mail Bag
Suva, Fiji
cgale@spto.org
www.southpacificislands.travel
Telephone: +679 3304177

Should you need to contact me, please feel free. That's my email address and contact information. I'm also happy to engage with you further in the discussion that follows this presentation.

For now thank you very much for the opportunity and Faafetai Tele Lava.

Reference Materials and Additional Resources

- Pacific Sustainable Tourism Policy Framework 2030
- Pacific Sustainable Tourism Policy Framework Video
- Glasgow Declaration
- https://www.conservation.org/projects/new-caledonia-home-of-the-worlds-second-largest-marine-park
- EIA Guidelines for Coastal Tourism Development in the Pacific
- Coral Triangle Initiative: Nature based tourism investment prospectus
- Pacific Ecotourism Recovery Initiative: Preliminary Feasibility Study of Geopark Potential in the Pacific
- Pacific Islands Tourism Research Symposium Resources 2021

I have provided in this presentation as well, some reference materials and additional resources to help you with your learning post training.

Contents

Summary of Presentation

1. **Update on global efforts**
   - UNWTO – One Planet Network
   - Climate Action
2. **Update on regional efforts**
   - Past Initiatives
   - Pacific 2030: A Sustainable Tourism Policy Framework
   - Key Policy Interventions
   - Stakeholder Group Actions
3. **Component 1: Built environment:** Opportunities for tourism responses in resilience building and GHG emission reduction
   - Accommodation
   - Facilities
   - Information Management
4. **Component 2: Transport:** Opportunities for tourism responses in resilience building and GHG emission reduction
   - Air Transport
   - Sea Transport
   - Land Transport
5. **Recommendations**
6. **Reference Materials and Additional Resources**

We will start off the lecture with a brief update on global efforts by the United Nations World Tourism Organisation as our lead international partner where we will discuss two programmes of interest, the One Planet Network and the Climate Action Programme respectively.

I will then share a brief update on regional efforts in the Pacific, highlighting what has been done to date including the Pacific 2030 Sustainable Tourism Policy Framework and what that entails for key stakeholder groups.

The next part of the lecture will discuss examples of practical opportunities where tourism can contribute to resilience building and greenhouse gas emission reduction in the built environment specifically within the accommodation, facilities and information management aspects of tourism.

Then we move on to the same for the transport sector where we will discuss air, sea and land transport.

The lecture will conclude with recommendations for the tourism sector. Reference materials as well as additional resources are provided for further reference.

The information shared in this presentation is drawn from a tourism practitioner lens as the scientific perspective on the topic has been covered by the relevant experts earlier on.

CBCRP-PCCC & SPTO Virtual Training Course

"Enhancing Climate Resilience in Tourism in the Pacific"

Government of Samoa, SPREP, SPTO and JICA

Module 2. Opportunities for tourism to respond to climate change

2.1.2 Resilient and low-carbon infrastructures, facilities and Information management

Christina Leala Gale | Manager, Sustainable Tourism and Research
Pacific Tourism Organisation
cgale@spto.org

Talofa Lava and Pacific Greetings dear participants.

Welcome to Module 2 on Opportunities for tourism to respond to climate change. We will be covering topic 2.1.2 Resilient and low carbon infrastructures, facilities and information management in relation to the built environment and the area of transport.

I am privileged to be contributing to this module for the Training on Enhancing climate resilience in tourism in the Pacific. So welcome once again. My name is Christina Leala Gale, I am the Sustainable Tourism and Research Manager at the Pacific Tourism Organisation in Suva Fiji. I look forward to engaging with you further and should you have any questions please feel free to ask at the end of the lecture.

Accelerating Climate Action

1. **Glasgow Declaration at COP26**

- Urgent global call for commitment to a decade of climate action in tourism
- Commitment to at least halve emissions over the next decade and reach NET ZERO emissions before 2050
- Over 300 signatories with **FSM and SPTO** are the first Pacific signatories

2. **How can tourism stakeholders contribute?**

- Develop new or update existing Climate Action Plans & report publicly within 12 months of signing to:

Measure Decarbonise Regenerate Collaborate and Finance

Glasgow Declaration Climate Action in Tourism

FSM President H.E. Panuelo delivers the Pacific commitment at COP26
Photo credit: Christina Leala Gale

In accelerating climate action, the Glasgow Declaration was officially launched at the COP26 UN Climate Change Conference. It proposes a coordinated plan for tourism to support the global commitment to cut emissions by 2030 and achieve net zero by 2050 and requests signatories to make tangible commitments around planning, measuring and reporting.

According to UNWTO/ITF latest research, released in December 2019 at UNFCCC COP25, CO^2 emissions from tourism are forecasted to increase by 25% by 2030 from 2016 levels, against the current ambition scenario. Therefore, the need to scale up climate action in tourism remains urgent as emissions could rapidly rebound once operations restart and, ultimately, the cost of inaction with regards to climate will be in the long run larger than the cost of any other crisis

The signatories of the **Glasgow Declaration on Climate Action in Tourism** are committing to act now and accelerate climate action which are aligned with **5 pathways** defined in the Declaration namely to **measure, decarbonize, regenerate, collaborate, finance.**

Among 300 signatories mobilized at the launch, the Federated States of Micronesia was the first Pacific Island Country to sign up to the declaration. His Excellency President Panuelo delivered his country's aspirations and spoke on behalf of the Pacific Island Countries and SPTO, conveying our support, calling on more countries in the Pacific to sign up to the Declaration.

1. Update on global efforts

United Nations World Tourism Organisation

- One Planet Network – Sustainable Tourism Programme
- Research e.g. 2019 Emissions Report
- Partnerships
- Training
- Awareness
- Climate Action Advocacy and Projects

So let's dive straight into it.

The United Nations World Tourism Organisation (UNWTO) is the leading international organisation in the field of tourism. UNWTO promotes tourism as a driver of economic growth, inclusive development and environmental sustainability and offers leadership and support to the sector in advancing knowledge and tourism worldwide.

The One Planet Sustainable Tourism Programme aims to accelerate sustainable consumption and production (SCP) in tourism policies and practices to address the challenges of pollution, biodiversity loss and climate change. It supports the transition towards a circular economy as a pathway for the sustainable development of tourism. Through its work, the One Planet Sustainable Tourism Programme aims to advance the implementation of Sustainable Development Goal (SDG) 12 and deliver progress through related goals such as SDG13, SDG14 and SDG15, respectively, on climate action and the protection of marine and terrestrial ecosystems. The programme was launched in February 2015, with over 150 participating organisations. The UNWTO delivers support through partnerships, capacity development, education and advocacy campaigns.

PACIFIC 2030 - a Sustainable Tourism Policy Framework

Despite the numerous benefits provided by tourism, it came at a cost to the Pacific. Pre-pandemic, the environmental pressures tourism created weren't always properly managed. It placed pressure on our limited resources and infrastructure, irreversibly impacted our fragile island ecosystems, and affected the wellbeing of our local communities.

In October 2021 the Council of Tourism Ministers endorsed the Pacific Sustainable Tourism Policy Framework which embodies the collective aspirations of the Pacific Island tourism stakeholders and the shared vision in planning for a prosperous, inclusive and resilient tourism industry. The goals, policies and actions in the Framework apply to all tourism stakeholders and cater for countries throughout the Pacific that have advanced sustainable tourism practices in addition to those countries with emerging tourism industries who are in the early stages of sector planning and development.

The Pacific Sustainable Tourism Policy Framework demonstrates our commitment to the global imperative to protect our planet and its people. Putting biodiversity, climate, the protection and restoration of the environment and the social and economic wellbeing of Pacific communities at the heart of this Framework.

A small change like switching to energy-efficient LED light bulbs might seem insignificant in isolation, but multiplied by thousands of businesses across the Pacific, these small steps all start to add up to a much bigger potential positive impact. Goal 4 prioritises building resilience to climate change and transitioning to a low emission, resource efficient sector.

2. Update on regional efforts in the Pacific

Past Initiatives

- Environmental Management Guidelines for Small Hotels and Resorts, Tourism Council of the South Pacific, 1998
- Making Small Hotels and Resorts Environmentally Sustainable: A Simple Checklist for Fiji Operators, 2003 Fiji Integrated Coastal Management Project
- Energy Efficiency Guidelines for Hotels in the Pacific, 2015, IIEC
- Introduction to Energy Efficiency and Renewable Energy for Hotels in Fiji, with applications to Pacific island countries, 2016, SPC, GIZ
- Pacific Sustainable Tourism Policy Framework, 2021, SPTO

Now in terms of a regional update from the Pacific, much work has been done in the area of development planning and research. The Tourism Council of the South Pacific (the former name of SPTO) developed a set of Environmental Management Guidelines for Small Hotels and Resorts in 1998. This work also included Renewable Energy and Energy Efficiency guidelines and tips, which are still applicable to date.

The Government of Fiji in 2003 then built on this work and developed a Checklist for making Small Hotels and Resorts Environmentally Sustainable.

Other related initiatives included the Asian Development Bank funded Energy Efficiency Guidelines for Hotels in 2015 and the E-book on Energy Efficiency and Renewable Energy for Hotels in Fiji which was jointly developed by SPC and GIZ in 2016.

These past initiatives reveal the importance for the tourist accommodation sector to shift to renewable energy sources.

For SPTO, the establishment of its Sustainable Tourism Programme in 2017 is testament of the intentional commitment of its 20 Member Countries to ensuring that tourism in the Pacific aligns with the global Sustainable Development Agenda the PARIS Agreement, the SAMOA Pathway, regional and national priorities. As such, the Pacific Sustainable Tourism Policy Framework provided a clear pathway for advancing sustainable tourism planning and development.

Priority 8. Build resilience to Climate Change and Transition to a Low Emission, Resource Efficient Sector

Key Policy Interventions

1. All tourism activity must comply with sound sustainability standards and principles
2. Government must strengthen policy and regulatory frameworks
3. The tourism industry must be committed to resource efficiency and emission reduction
4. Mobilise resources for programmes that support private investment in low carbon development
5. Promote research and innovation
6. Measure, Decarbonize, Regenerate, Collaborate, Finance to accelerate and co-ordinate climate action

Let's now look into key policy interventions:

There is a need to support the implementation of regional strategies associated with resource management and emissions reduction and adoption of Pacific sustainable tourism standards to improve resource efficiency.

All tourism activity must comply with sound sustainability principles and standards in the way it is developed and operated. This applies to building location, design, use of materials, use of energy and water, waste management and sourcing of supplies.

To manage tourism's contribution and adaptation to climate change, governments need to set a helpful regulatory context, facilitating and inspiring better decision-making, creating market demand through sustainable public procurement, and supporting research and innovation.

The tourism sector is encouraged to commit to reducing and continuously improving its use of energy, water and other non-renewable and emissions generating resources used to transport and deliver services and experiences to visitors throughout the entire tourism value chain according to the context of their destination

The tourism sector is encouraged to reducing the volume of plastics, food and other forms of solid waste and sewerage waste generated in delivering tourism services and experiences.

Align plans with five pathways of the Glasgow Declaration to measure and report on mitigation efforts

Climate & disaster resilience embedded in planning, development and operation of tourism

Tourism contributes to greenhouse gas emissions through waste generation, fossil fuels used in a range of activities including accommodation and the transport sector. The development of low emission infrastructure to support tourism investment is critical for the region, and appropriate mitigation and adaptation measures to respond to climatic events will be crucial to sustain this industry.

In accelerating climate action across the Pacific region, it is crucial for the tourism sector to recognise that it has a significant role to play in both protecting and building its adaptation capacity to cope with impacts, but also in reducing its negative contribution by cutting its carbon emissions.

Goal 4 outlines the key outcomes as well as Performance Indicators to guide regional and national level actions. Considering the cross cutting nature of tourism, outcomes outlined support the sector's contribution to meeting the Sustainable Development Goals.

Priority 8. Build resilience to Climate Change and Transition to a Low Emission, Resource Efficient Sector

National Actions

1. Strengthen coverage of climate change in the country's tourism policy and destination development strategy
2. Develop and implement policies and actions in climate change mitigation and adaptation
3. Support the implementation of Energy Management Plans in tourist accommodations
4. The need for tourism industry to reduce consumption and production of resources is identified in the relevant destination and individual site and resource management strategies and action plans
5. Encourage behavioural changes at a business level to support the use of clean energy (through fiscal policy incentives) such as solar power, wind energy and biofuels in tourism activities
6. Provide industry with guidelines for efficient resource use, financial incentives to invest in clean technologies, sustainability certification/accreditation programs, industry awards and preferential marketing incentives to encourage and support industry to transition to more sustainable operations.

At national level, regardless of where each country stands on the development spectrum, there is opportunity and flexibility within the policy framework to contribute. Governments, private sector and national partners can consider:

- Mainstreaming climate change and strengthening coverage of climate change considerations in the country's tourism policy and destination development strategy is important.
- The development and implementation of climate change mitigation and adaptation policies need to be prioritised.
- Energy Management Plans in tourist accommodations must be developed and implemented.
- Specific actions towards managing sustainable consumption across the industry must be encouraged and followed through with support.
- Support for promoting behavioural change at business level for transitioning to cleaner energy
- Guidelines for resource efficiency and support programmes for accessing technology and enhancing market opportunities need to be provided to the industry.

Priority 8. Build resilience to Climate Change and Transition to a Low Emission, Resource Efficient Sector

Regional Actions: SPTO

1. Develop and implement a regional Climate Action Plan and report on the Glasgow Declaration
2. Implement the Pacific Sustainable Tourism Policy Framework
3. Provide technical capacity building in climate change
4. Share best practices/guidelines in coastal protection, low carbon development, renewable energy and energy efficiency
5. Provide information and facilitate access to green financing for climate adaptation and carbon emissions reduction.
6. Leverage partnerships with other organisations and partners for renewable energy support and low or zero emissions technology.

At regional level, it is important for SPTO to build on existing partnerships with the UNWTO and commit to the development of the Climate Action Plan per the Glasgow Declaration. This will set the pace for Member Countries and the wider industry.

Through the Pacific Sustainable Tourism Leadership Statement of Commitment, roll out the implementation phase for the Pacific Sustainable Tourism Policy Framework.

Work with partners in delivering technical capacity building in climate change in relation to tourism planning, development and operations and sustainable production and consumption.

Ensure that best practices/guidelines in coastal protection, low carbon development, renewable energy and energy efficiency, water supply and management and addressing impacts of climate change and tourism development are widely shared amongst stakeholders.

Facilitate access to green financing for climate adaptation and carbon emissions reduction and share information with stakeholders.

Leverage partnerships for renewable energy support and low or zero emissions technology with other organisations and partners.

Component 1: Built environment: Opportunities for tourism to respond to resilience building and GHG emission reduction

So, we will now look into component one, which is what are some of the opportunities for tourism to respond to climate resilience and lower emission contribution from the tourism sector through the built environments lens.

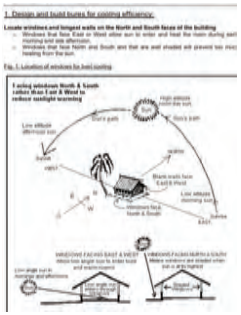
Priority 8. Build resilience to Climate Change and Transition to a Low Emission, Resource Efficient Sector

Development Partner Actions

- Finance green technology and clean energy investments such as solar power, wind energy and biofuels in tourism activities.
- Mobilise funding for green investments and support the industry to transition to more sustainable operating practices.
- Mobile financing to stimulate low-emissions technologies and climate resilient development

The role of development partners particularly donors, international finance institutions, regional and international organisations is crucial in mobilizing financial resources for:

• improving access to green technology and clean energy investments such as solar power, wind energy and biofuels in tourism activities.
•Supporting the industry in transitioning to more sustainable operating practices
•stimulating investment in low-emissions technologies and climate resilient development



Bure design in Fiji
Photo Credit: Fiji Integrated Coastal Management Project

Beach fale example in Samoa
Photo credit: Satuiatua Beach Resort and www.samoa.travel

Two examples are the Bure design in Fiji and the Beach Fale design in Samoa. These two concepts both promote more cooling efficiency, offers a unique experience for visitors and saves costs.

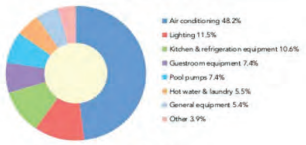
The Bure Design in this photo can be found in the Checklist for Small Hotels and Resorts in Fiji.

The Beach Fale design in Samoa is also part of the country's Beach Fale Accommodation Standards.

Accommodation

The pie chart below shows where and how electricity is commonly used in a typical hotel in a tropical environment.

Figure 1: Electricity use and percentage of overall energy consumption for a typical hotel in the tropics.



Source: IRENA 2014.

1. Promote the use of natural ventilation
2. Use fans and energy efficient air conditioning
3. Promote use of traditional building designs

Considering that the Accommodation Sector is the second largest sub-sector of the tourism industry in terms of carbon emissions according to UNWTO, it is important to consider, simple actions that can be practiced in the Pacific with the objective of reducing the sector's carbon footprint:

1. Our tropical climate allows for the use of natural ventilation and this must be promoted throughout the accommodation sector.
2. Since air conditioning contributes the highest portion to electricity usage, ensure that fans and energy efficient air conditioning are used.
3. Consider the use of traditional building designs from around the Pacific.

Tourism Facilities

1. Kitchen, Bar, Dining, Meeting Facilities: buy/use energy efficient equipment including heating and cooling facilities
2. Public spaces: use natural lighting or energy efficient lighting and promote use of natural ventilation
3. Standby generator to be operated only when needed
4. Standard Operating Procedures and regular training of staff

Energy labeling key to ensuring efficiency


Photo credit: Nukubati Island Resort

In terms of tourism facilities the purchase and use energy efficient equipment, appliances and heating and cooling facilities can be cost-saving and at the same reduce carbon emissions for businesses.

Energy Efficiency labeling provides guidance for decision making.

Facilities and public places like accommodation, can benefit from natural ventilation and energy efficient lighting.

Some hotels use green energy supply for day to day operations where feasible and the standby generator is only operated when needed. This is especially true when the weather is bad and there is excessive rainy days.

Training for staff in monitoring efforts and following Standard Operating Procedures is a good way of getting staff involved in the process.

Accommodation

4. Transition to greener energy supply e.g. use of solar power, wind etc.
5. Invest in smart energy saving solutions such as key cards or mobile phone apps
6. Make the most of daylight and light fittings
7. Turn off lights when unused, train staff to monitor

Nukubati Island Resort, Fiji 100% solar and wind powered
Photo credit: Nukubati Island Resort

Key cards


Mobile phone controlled lights and air conditions
Photo credit: dormakaba

Shifting to greener energy supply is a great long term goal. Nukubati Island Resort in Fiji is pioneering in this area where it is 100 percent powered by solar. It has also installed wind energy. Please refer to the Nukubati website for further information.

Where feasible, invest in innovative and smart energy saving solutions such as the use of key cards which are common in the Pacific region.

In other parts of the world, the use of mobile phone applications are becoming popular. Technological innovation could provide opportunities if funded and supported for the Pacific.

Never under-estimate the value of encouraging turning off lights and mobilizing staff in supporting the monitoring of these efforts on a day to day basis.

Information Management

Governments/Destination Management

1. Promote partnerships for research into low-carbon tourism
2. Develop supportive policies and emission indicators to track progress
3. Promote benefits of low-carbon tourism development with the industry and advocate for resources and incentives to support industry transition
4. Provide guidelines for tourism operators on how to transition to low-carbon tourism development

So when we look at the role of governments and destination management organisations, it is vital that they communicate information to different partners in ways that will inspire change and action. Research in low carbon tourism for instance need to be communicated clearly and made accessible

Our policies are required to be developed and shaped in ways that is easy for all our stakeholders to understand including our indicators. We cannot measure something don't understand what we find very difficult to understand. So we need to make that process and make those indicators user-friendly.

How we communicate the benefits of low-carbon tourism development within the industry is key when we advocate for additional resources to support our industry in transitioning to lower emissions.

Tailoring information to private sector needs aids decision making and buy in.

Information Management

Guests/Visitors/Clients

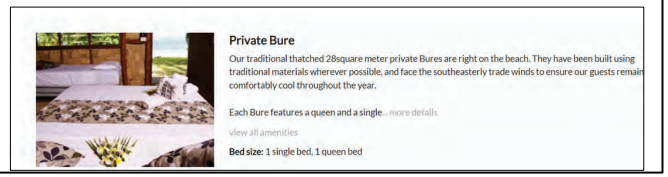
- Educational content to garner support from visitors on business sustainability values via compendium, room signage, digital content (TV), public areas, activities board etc.

Businesses/Industry

- Train employees and inspire behaviour change and have clear Standard Operating Procedures
- Awards and incentives to be tied to sustainability initiatives
- Procurement and Finance teams to be well trained and informed of sustainability initiatives
- Promotional content for the business to reflect actions and avoid green washing

Example of in-room reminder signage
Photo credit: https://www.ciohnsonsignco.com/plaques---miscellaneous.html

Example of communication on website
Photo credit: Leleuvia Island Resort, Fiji



Information Management plays a central role in effecting change. Recognising that we are dealing with a diverse range of stakeholder groups from guests, to employees, business owners to policy makers for instance, it is imperative that attention is given to communicating information on climate resilience and energy saving actions on a regular basis.

For information targeted towards guests or clients, the use of signage (in room or throughout strategic locations) are needed. Some use guest information packs or compendiums and some have used digital content via TV or mobile phones.
At business level, inspiring behaviour change amongst owners, managers and staff is a good investment in the long term sustainability of greener practices. When we engage staff members, we can change behavior it's easier to get across to our guests.

Awards and incentives are needed to boost employee and business performance. These need to be aligned with sustainability initiatives.

Getting our Finance teams on board is also very important because at the end of the day, their jobs need to go beyond the maximizing revenue and reducing losses aspects. But rather, look at the long-term cost effectiveness of the immediate investment options.

Marketing opportunities can be harnessed through the promotion of energy saving initiatives of the business. A good example here from Leleuvia Island Resort in Fiji gives the visitors early insights and builds their trust in the offering and the sustainabililty values of the business.

Air transportation

1. **Global level:** Commitment to greener technology, innovation and energy options

2. **Destination level:**

- Commit to holistic carbon-offsetting initiatives such as reforestation
- Involve airlines, visitors and industry in destination efforts by linking with environment and forestry sectors
- Educate and raise awareness on the importance of reducing emissions
- Publicly report on emission reduction progress
- Monitor fuel consumption and report on progress

From the outset, highlight for us, the importance of the three areas that we are touching here.

Carbon emissions by the aviation industry is a critical issue for the Pacific and airlines servicing the region will need to be encouraged to ensure their commitment to the Cleaner Pacific 2025 Strategy and other environmental policies allow for carbon offset programmes that support climate change mitigation programmes in the Pacific.

We have very little influencing power here. However we have a significant role to play in amplifying advocacy for greater commitment to greener, technology, innovation and fuel options for airlines servicing the Pacific region.

And at destination level, we need to be committing to holistic carbon offsetting initiatives for airline companies and involving wider stakeholders in such programmes including reforestation initiatives and others.

Educate and promote awareness around the importance of why we are reducing emissions again publicly report and be transparent about that whole process in terms of our consumption levels and how far are we progressing or not.

Component 2: Transport - Opportunities for tourism to respond to resilience building and GHG emission reduction

So the next part of the presentation, we will discuss the transport sector considerations and what opportunities exist for tourism to respond.

Land transportation

1. **Global level:** Commitment to greener technology, innovation and energy options for vehicles

2. Destination level

- Land transport policies to promote shift to greener and cleaner options
- Industry commitment to greener land transport services for guests
- Commit to holistic carbon-offsetting initiatives at destination
- Educate and raise awareness on the importance of reducing emissions
- Monitor fuel consumption and report on progress

And lastly land transport again, advocacy around greener options greener technology, innovation in energy options for land transport especially vehicles in the Pacific region.

At destination level, how can we influence different policies or greener policies of government and similarly, to what we have covered before industry commitment to carbon offsetting, holistic approaches monitoring as well as education and awareness.

Sea transportation

1. **Global level:** Cruise companies commitment to greener technology, innovation and energy options

2. Destination level

- Promote partnerships with cruise liners with credible sustainability policies
- Explore the shift to expedition cruises, yachting and other more sustainable options of cruise sector development
- Commit to holistic carbon-offsetting initiatives at destination
- Educate and raise awareness on the importance of reducing emissions
- Promote tourism experiences using traditional sea transport including sailing, canoeing etc.
- Monitor fuel consumption and report publicly on progress

In the area of sea transportation, we can advocate for change in the way cruise liners are designed in terms of innovation, technology and fuel options.

At destination level, we will be able to deliver more when we are influencing the types of cruise sector development we want.

We can shift the vision of the country and the vision of the sector to greener options by exploring the benefits of switching to expedition cruises or yachting, more sustainable options for cruise development that increases yield and minimizes impact on the environment and host communities.

Again, commitment to holistic, approaches to carbon offsetting for the cruise sector.

Education, awareness, bringing our communities on board because they interact directly with the cruise visitors. So that's very key, when we're looking at this particular aspect of transportation.

One area to strengthen in the Pacific tourism offering is the promotion of traditional navigation practices, sea transport, including sailing, canoeing etc. which can be both adventurous and educational.

Recommendations

1. Climate and disaster resilience must be embedded in the planning, development and operation of tourism.
2. Secure partnerships to access green and blue financing for sector transformation
3. Accelerate actions for reduction of electricity use, water use, solid waste generation and GHG emissions
4. Collaborate with global, regional, national, industry and community stakeholders to support climate action in tourism
5. Set up the Pacific Sustainable Tourism Indicator Framework to support measurement of tourism sector progress
6. Link tourism sector emission targets to Nationally Determined Contributions of country

We need to ensure that we embed climate and disaster resilience consideration into the way we plan, develop and manage tourism on a daily basis.

We need Partnerships. Without Partnerships we cannot access green financing. We cannot bring everyone together.

We need to accelerate reduction in electricity use, in water use, in solid waste we generate as well as greenhouse gas emissions. So it's a holistic way of managing and using resources.

Collaborate, collaborate, collaborate. That's key because without collaboration we cannot achieve our aspirations as a sector.

We need to set up the indicator framework that will support us in monitoring our performance, through the Pacific Tourism Statistics Strategy.

And lastly. it's quite important to advocate for better ways of linking tourism sector emission targets to our NDCs or the nationally determined contributions of our countries. This will give tourism a better appreciation of collective measurement and reporting as well as valuing that we are on the same pathway.

Recommendations

We've come to the last part of the presentation, where we look into key recommendations and what are some of the key takeaways for us based on this module.

Recommendations

DECARBONISE

- Set and deliver targets aligned with climate science to accelerate tourism's decarbonisation.
- Offset but complement with real reductions.

REGENERATE

- Restore and protect ecosystems
- Support affected and at-risk communities in resilience building, adaptation and disaster response.
- Help visitors and host communities experience better balance with nature.

Decarbonise
Decarbonisation requires us to set and deliver targets that are aligned with the climate science in terms of accelerating decarbonisation of the tourism sector from transport to accommodation, to activities food and drinks and waste management. And that we have to ensure that whilst we are offsetting, we need to also be making real progress in terms of emission reductions. ,

Regenerate
The Pacific needs to promote as much as possible, regenerative types of tourism where we restore and protect our oceans and island ecosystems because without our natural resources, there is no tourism and so need to safeguard biodiversity, food security and water supply

Protecting our at-risk communities who are dependent on tourism by building their capacity, finding programs that can support them in better disaster response and ensure that we bring our visitors and host communities together to experience a better balance with nature.

Recommendations

MEASURE

- Measure the tourism sector's carbon footprint by setting up regional and national sustainability indicators in line with the Pacific Tourism Statistics Strategy and the Pacific Sustainable Tourism Policy Framework
- Measure and disclose all travel and tourism-related emissions.
- Ensure our methodologies and tools are aligned to UNFCCC-relevant guidelines on measurement, reporting and verification, and that they are transparent and accessible.

In closing I would like to re-emphasize our global commitment through the Glasgow Declaration, the pathways provide us with important platforms of engagement in moving forward.

Yes. We need to measure tourism's carbon footprint by making sure that we have our indicators in place through the Sustainable Tourism Policy framework and the Statistics Strategy for the region and that should be translated down into concrete actions at country level.

Measure and disclose all our travel and tourism related emissions, but also at the same time, strengthen collaboration with UNWTO and partners in aligning our indicators and methodologies in measuring our carbon footprint to the guidelines of the UNFCCC so we are continuously finding better ways of reporting on our commitments.

Reference Materials and Additional Resources

- Pacific Sustainable Tourism Policy Framework 2030
- Pacific Sustainable Tourism Policy Framework Video
- Pacific Sustainable Tourism Statistics Strategy
- Glasgow Declaration
- Transport-related CO2 Emissions of the Tourism Sector – Modelling Results (e-unwto.org)
- Tourism's Carbon Emissions Measured in Landmark Report Launched at COP25
- https://www.e-unwto.org/doi/pdf/10.18111/9789284412341
- Making Small Hotels and Resorts Sustainable: A Simple Checklist for Fiji Operators
- Renewable Energy Opportunities for Islands Tourism
- Introduction to Renewable Energy and Energy Reduction in Hotels in Fiji with applications to the Pacific islands

I have provided in this presentation as well, reference materials and additional resources to help you with your learning post training.

Recommendations

COLLABORATE

- Share evidence of risks and solutions with all stakeholders and our guests, and work together to ensure our plans are as effective and coordinated as possible.
- Strengthen governance and capacity for action at all levels, including national and sub-national authorities, civil society, large companies and SMEs, vulnerable groups, local communities and visitors.

FINANCE

- Ensure organisational resources and capacity are sufficient to meet objectives set out in climate plans, including the financing of training, research and implementation of effective fiscal and policy tools where appropriate to accelerate transition.

Collaborate
Collaboration means sharing information about our journey, the risks we face and the solutions that can work with all our partners and stakeholders including our visitors and guests.

Strengthen governance and capacity for action at all levels, including national and sub-national authorities, civil society, large companies and SMEs, vulnerable groups, local communities and visitors.

Finance
In terms of financing, it means ensuring resources including funding, capacities and capabilities are well resources to help the tourism sector in meeting our objectives and accelerating action.

I would like to close off this topic with the quotation from Secretary General of UNWTO who said in 2020 "Sustainability must no longer be a niche part of tourism, but it must be the new norm for every part of our sector"

CONTACT:

Please feel free to contact me for further information:

Christina Leala Gale
Sustainable Tourism and Research Manager
Pacific Tourism Organisation
Private Mail Bag
Suva, Fiji
cgale@spto.org
www.southpacificislands.travel
Telephone: +679 3304177

Should you need to contact me, please feel free. That's my email address and contact information. I'm also happy to engage with you further in the discussion that follows this presentation.

Faafetai Tele Lava. Thank you very much for the opportunity.

The content of my presentation will touch on what, why, where, when and how to access weather and climate information. I will also present on some of the communication and knowledge products as well as synergies and partnership opportunities between tourism sector and national meteorological services – which is the main custodian of weather, climate and climate change science information.

CBCRP-PCCC Virtual Training Course

"Enhancing Climate Resilience in Tourism in the Pacific"

Module 2. Possible Options for Tourism sector to respond to Climate Change

2.1.2 Climate Information Service

Azarel Maiai | COSPPac Capacity Development Officer
Pacific Met. Desk Partnership, Climate Change Resilience
Secretariat of the Regional Environment Programme (SPREP)

Talofa, my name is Azarel Maiai – SPREP Climate and Ocean Support Programme (COSPPac) Capacity Development Officer and I will be presenting on 2.1.2 Climate Information Services.

Weather and Climate Information Services (CIS)

Weather and Climate are intertwined with our Pacific island countries sustainable and economic development. Take for example in Tonga, about18.1% of the population were affected by storms, translating into a 17.4% reduction of the GDP according to **Nurse et.al** (2014).

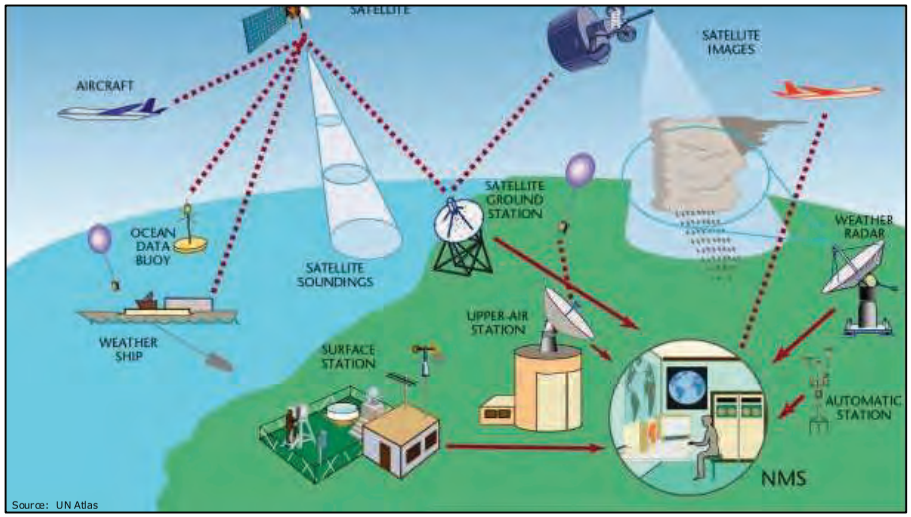
Weather and Climate-related factors play a crucial role in the selection of tourist destinations, and in determining the season, the time of travel and length of stay. Climate Change can also impact tourism activities that can be differentiated according to environmental, socio-cultural and economic dimensions.

Learning outcomes:

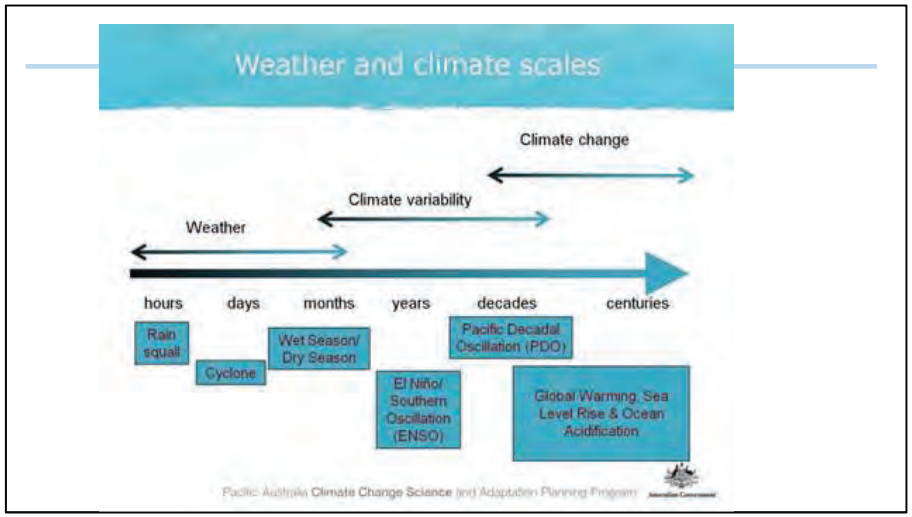
- Enhance understanding of weather and climate information and services;
- Understand weather and climate prediction and associated risks;
- Acquire knowledge on impacts of weather and climate on tourism sectors;
- Ability to identify partnership opportunities and synergies between local national meteorological services and tourism sector.

Take away messages and anticipated key outcomes are to:

- Enhance understanding of weather and climate information and services;
- Understand weather and climate prediction and associated risks;
- Acquire knowledge on impacts of weather and climate on tourism sectors;
- Ability to identify partnership opportunities and synergies between local national meteorological services and tourism sector.



National Meteorological and Hydrological Services work around the clock to monitor the state of the **atmosphere and ocean using land-based and space based instruments to collect data.** This data will be used to for preparation of vital weather and climate information worldwide. Almost all of the Pacific islands have national meteorological services that provide a range of services from weather information (tropical cyclones, extreme weather, storms surge), climate (la Nina, wet and dry season forecast), whilst some national met services have geo-hazards divisions that monitor volcanoes or tsunamis activities, most if not all national met services provide climate change information on projections, sea level rise, coral bleaching), as well as research support for universities and research students.



So, what is weather and Climate. The terms weather, climate and climate change are often used interchangeably. There is a clear difference between weather, climate variability and climate change

Weather vs. Climate; Natural Variability vs. Climate Change

Weather describes current atmospheric conditions, such as rainfall, temperature, and wind speed, at a particular place and time. It changes from day to day.

Climate is the average (or 'normal') pattern of weather for a particular place over several decades.

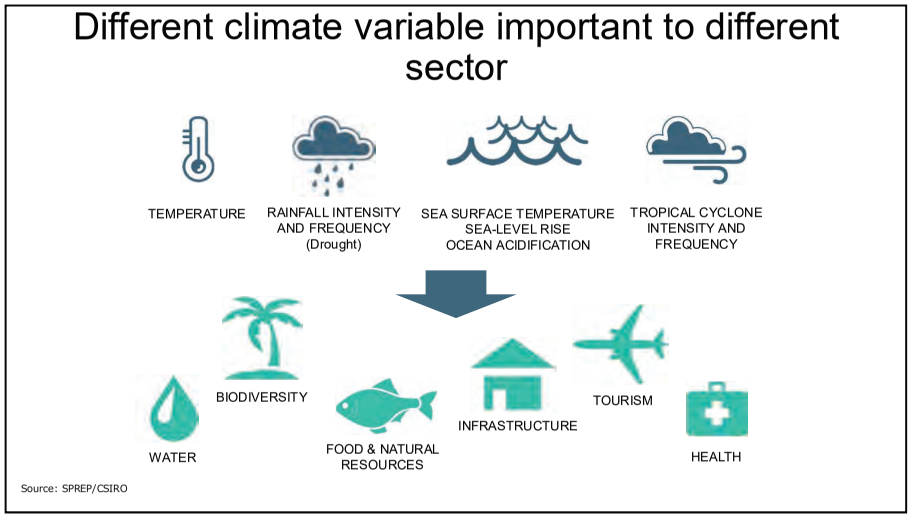
Climate variability is referred to the natural variation of the earths climate system over temporal and spatial scales. Variability may be due to ***natural internal processes*** within the climate system (internal variability), or due to variations in ***anthropogenic*** external forcing (external variability).

Climate Change: Climate change refers to any change in climate over time, whether due to natural variability or as a result of human activity.

United Nations Framework Convention on Climate Change (UNFCCC) , which defines "climate change" as: "a change of climate which is attributed directly or indirectly to **human activity** that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods."

One way to understand the difference between weather, climate variability and climate change is to think about how they operate on different time scales.

The big arrow in ***Figure 1*** refers to different periods of time – days, months, years, decades and centuries. We can see here that weather refers to hours, days; climate refers to months, years and decades, and climate change refers to decades and centuries. **Examples** of weather are rainstorms that might last one or two hours and tropical cyclones that may last days. Climate variability can be defined by climate patterns such as the El-Niño Southern Oscillation and climate change refers to things which happen over centuries, like global warming and coral bleaching.

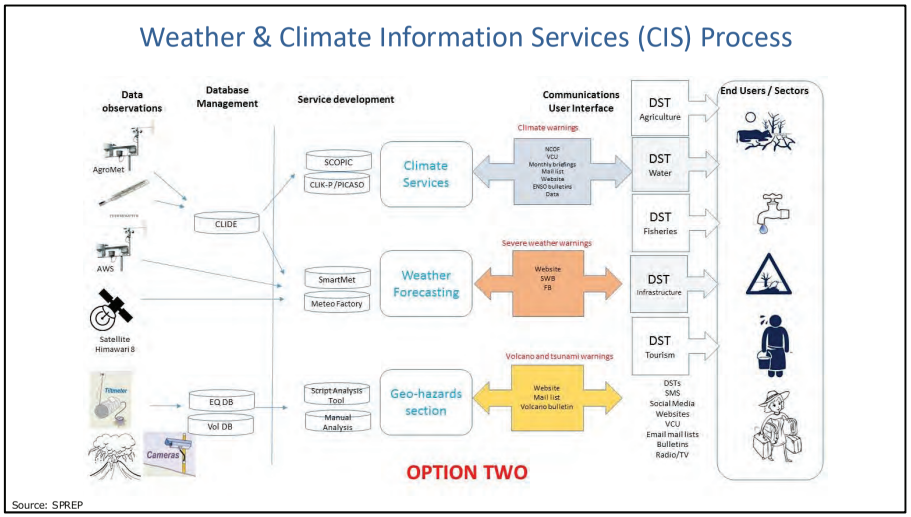


So there are different climate variables that are monitored and analysed by Met Services like temperature, rainfall, sea surface temperature etc that influence and affect sectors:

For example,

- Rainfall data is important to hydro services which subsequently affect water supplies for drinking. For tourism it will affect water supplies to hotels, swimming pools and outdoor activities etc
- Rainfall and temperature data is important to predict likely outbreak of vector-borne diseases (e.g Zika, Malaria) which might defer travel of tourists to certain areas.
- Sea surface temperature is important for the Fisheries sector which can influence tuna migration and algae bloom etc
- Tropical cyclones and extreme weather bulletin are essential for all sectors to prepare and respond should there be a looming hazards.

It is important that you talk with your NMS so they understand your need and develop products that are useful to for you and arrange a focal point to get more climate information on a regular basis.



Following the collection of data from land-based and space-based instruments as demonstrated in previous slide, your national meteorological services stores, analyze and quality control the data collected, then develop products like weather and climate bulletin that is communicate either as warning, advisory or normal based on the analysis. In some instances the information and data is tailored for different sectors like agriculture, water, fisheries, infrastructure, tourism and general public using a decision support tool.

In some meteorological services, tailoring information for sector might not be available so please contact your met services for more information and support in that regard.

Examples of Socio-economic impacts of climate change on tourism (Source Grimm, 2016)

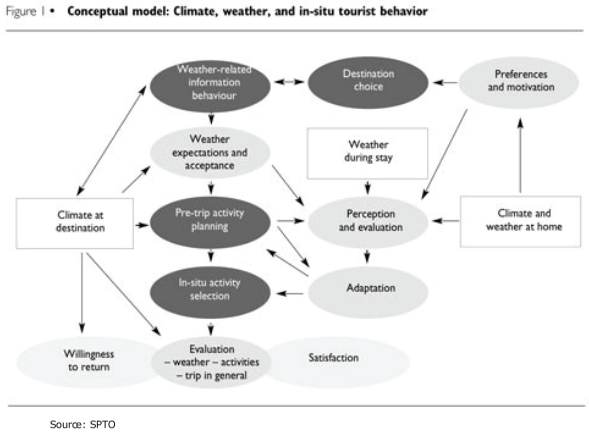
Impacts	Consequences	Challenges
Influence of temperature increase on supply and demand		
Reduction of appropriate period of sun exposure; Thermal stress; Increase in incidence of skin cancer	Redirection of demand to other potential destinations. e.g., conservation units;	Promote low-carbon activity;
	Adaptation of travel period;	Offer destinations of nature all year round;
	Fragmentation of holiday period with reduction in stay;	Promote actions and run campaigns on sun protection
	Poor quality of experience	
Influence of sea-level rise on geographical space, supply and agents		
Degradation of beaches; Bleaching of corals; Coastal erosion; Destruction of mangroves; Destruction of waterfront infrastructure	Decrease in sand space for leisure	Promote mitigation and adaptation actions and initiatives;
	Impacts on freshwater reserve;	Plan and order use and territorial occupation of the seaside;
	High cost of waterfront restoration	Implementation of coastal engineering works

Looking at the impacts of climate change on tourism:

Key factors like temperature and sea level rise has impacts on supply and demand for tourism. Impacts like increase in temperature will increase in incidence of skin cancer which subsequently mean redirection of demand (tourist) to other potential destinations. Or SLR will degrade beaches which consequently decrease sand space for leisure and high cost of waterfront restoration.

To look closely, at the impacts of climate change on tourism, we will highlight impacts through the peer-reviewed paper on "***Influences of Climate Change on Tourism Development in Small Pacific Island States***" which provides us with examples of socio-economic impacts of climate change on tourism sector according to Grimm (2016).

Source: **Grimm, I.J. Mudanças** Climáticas e o Tu-rismo: Estratégias de Adaptação e Mitigação. Ph.D. Thesis, Universidade Federal do Paraná, Curitiba, Brazil, 2016; 250p



Climate and weather at home

climate at destination and climate during stay

are key factors influencing travel decisions and satisfaction, comfort safety

Source: SPTO presentation at Fiji first NCOF.

To look closely at the key factors influencing travel decision, satisfaction, comfort and safety of tourists are:

- Climate and Weather at home (for example: some might choose to escape winter and move to the tropics)
- Climate at destination (wet season or dry season)
- Climate during stay

firm commitment of the sector is yet to be seen due to lacking international mitigation measures.

- Benefits from reductions in CO2 emissions from tourism need to be weighed against the substantial economic losses caused by lack of revenue from tourism, which thousands of people depend on.

Influence of extreme events on geographical space, demand, supply and agents		
Destruction of tourism infrastructure; Road blockades; Interruption of media Services; Changes in hydrologic cycle	Real estate speculation;	Foster new, more sustainable destinations;
	Contamination, spread of diseases;	Promote actions and run campaigns informing about protection and rational use of resources;
	Lack of drinking water;	New investments, technologies and marketing strategies;
	High cost of recovery;	Create plans, actions, develop strategies to deal with consequences of extreme events
	Low capacity for emergency care (rescue, evacuation, medical services);	Implement warning measures that anticipate occurrences of extreme events
	Unavailability of emergency accommodation, counseling and assistance to victims;	Implement measures to mitigate risk and protect local inhabitants and tourists
	Increase in price of trips;	
	Insecurity;	
	Poor quality of experience;	
	Consumer distrust	

For Pacific islands countries experiencing firsthand extreme events (like tropical cyclones) which impacts on infrastructure and interrupts essential services which are all too common in our region. For tourism sector this setbacks in high-cost in recovery and pose further challenges with insurance claims.

Source: **Grimm, I.J. Mudanças** Climáticas e o Tu-rismo: Estratégias de Adaptação e Mitigação. Ph.D. Thesis, Universidade Federal do Paraná, Curitiba, Brazil, 2016; 250p

Key recommendations (Wolf.et al, 2021)

- Tourism-related CO2 emissions will continue to drive anthropogenic climate change, from which SIDS, particularly those that are vulnerable, will suffer, and island nations remain in a quandary as to how to alleviate the harmful environmental effects of tourism-related GHG emissions whilst maintaining an attractive tourist destination.

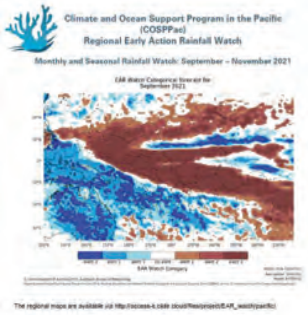
- Tourism represents an indispensable pillar of national income in Pacific SIDS, securing local livelihoods, yet the socio-economic effects of the global pandemic underscore the fatal dependency on the sector whose abrupt decline severely endangers national development and well-being.

- Climate impacts and related changes in tourism demand may lead to a shrinking tourism sector, with severe implications for sustainable national development and well-being, as revealed by the case studies of Tonga and the Solomon Islands that provide evidence of reduced touristic attractiveness of these island destinations.

- The global pandemic may serve to push the tourism sector towards more sustainability in terms of redesigning offers and reducing its carbon footprint, but a

Regional Early Action Rainfall Watch

■**Purpose**: To provide the Pacific Red Cross Regional Branch with simplified division-scale seasonal rainfall outlooks and rainfall status information on a monthly basis for disaster risk reduction purposes. Local Red Cross agencies are encouraged to contact their National Meteorological Services for further information.



Rainfall Status: as of 30 November 2021

Alert Level	3-month period
Seriously wet (90%)	Palau, FSM (C), PNG (S), Solomon Is. (W), Vanuatu (N)
Near or wetter than normal	FSM (P, K), PNG (M, Is.), Solomon Is. (E), Vanuatu (S), Fiji (C, N), Kiribati (E), Niue, Cook Islands (All)
Warning (25%)	Solomon Is. (C), Fiji (W, E)
Seriously dry (10%)	FSM (Y), Kiribati (W)
Severely dry (5%)	Samoa
Status not available	Marshall Is., PNG (H), Kiribati (C), Tuvalu (All), Fiji (R)

Source: SPREP, BoM, SPC COSPPac Project

There are two types of EAR Watch:
1: Regional: provides a general outlook for all the 12 countries looking three months ahead on whether they will experience drought or more wetter conditions. This information is mostly tailored for Pacific Red Cross Regional Branch.

2: National: provides the rainfall status and outlook looking at a specific period identified by your national met services and respective sectors. It also provides information for water, agriculture, health, tourism, infrastructure and Energy sector with the purpose to trigger early responses to any drought or wetter conditions.

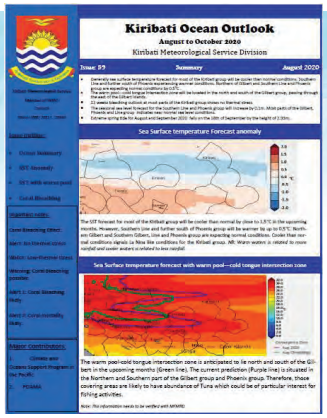
435

COSPPac Early Action Rainfall Watch (EAR Watch)

So how can the tourism sector cope with changing climate and extreme events. In the next couple of slides I will display few products and services that might be useful. But I encourage you to contact your NMS for more information.

To start: the COSPPac Early Action Rainfall Watch (EAR Watch) is an Australian funded monthly product that is specifically developed for disaster managers to respond to extreme rainfall or deficiency in rainfall (such as droughts).

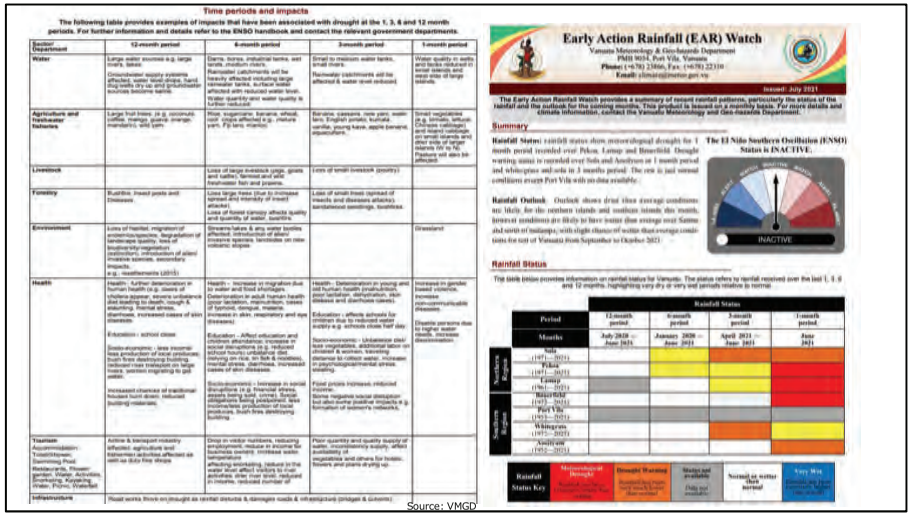
Ocean Bulletin Examples: Kiribati and Vanuatu



Source: Kiribati Website and VMGD

There are also National Ocean Outlook bulletin which provide useful information on coral bleaching, sea level, ENSO status, Sea Surface Temperature.

This bulletin is available is in, Kiribati, Fiji, Vanuatu, Solomon Islands, Tuvalu and RMI



Source: VMGD

This is an example of a National EAR Watch for Vanuatu which showcase impacts associated with 1, 3, 6 and 12 month period within the different sector as already mentioned.

National EAR Watch are available in Kiribati, Fiji, Samoa, Tuvalu, PNG, Solomon Islands, Vanuatu, and will be extended to other countries in the near future.

Opportunities & Partnerships

- Strengthen engagements by developing/co-designing projects between NMHS & Tourism sector
- Exchange of information
- Co-develop and tailoring of products
- Identifying focal points for NMHS and Tourism
- Share facilities to monitor and collect data and information
- Sign agreements

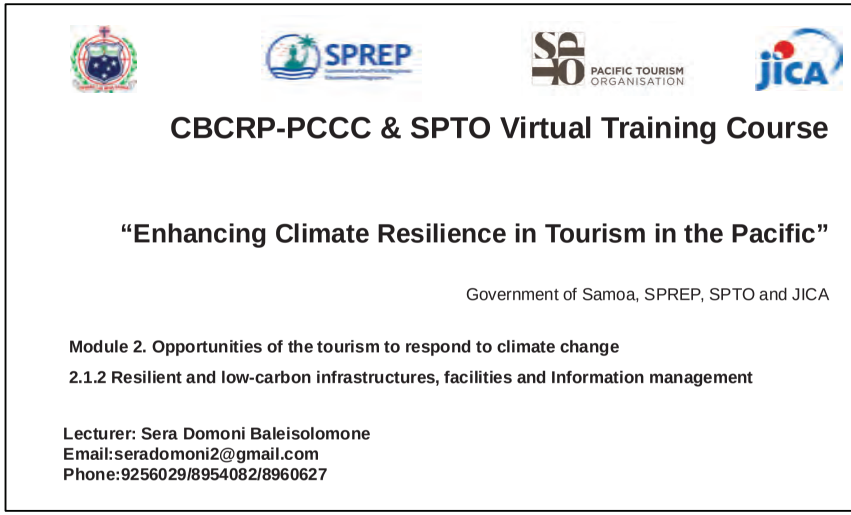
437

OCEAN PORTAL

http://oceanportal.spc.int/portal/ocean.html

The COSPPac SPC is hosting the Pacific Ocean Portal which is **an interactive website for visualizing and accessing historical, real-time and predictive ocean data categorized by marine applications** on an integrated and user-friendly platform.

http://oceanportal.spc.int/portal/ocean.html



1. Welcome everyone to this Virtual Training Course of "Enhancing Climate Resilience in Tourism in the Pacific. Module 2. Opportunities of the Tourism to respond to climate change
2. Today on Module 2.1.2 Resilient and low –carbon infrastructure, facilities and Information management we look at one Fiji's newest luxury chain of hotel that has taken the lead on Sustainable Tourism – Six Senses Fiji.

438

Summary of the presentation

- Enhance understanding of weather and climate information and services;
- Understand weather and climate prediction and associated risks;
- Acquire knowledge on impacts of weather and climate on tourism sectors;
- Ability to identify partnership opportunities and synergies between local national meteorological services and tourism sector.

1. Background: We touch base on the birth of the idea of sustainability
2. Sustainability Initiatives: What are some of the sustainability initiatives used by Six Senses as a brand
3. Brand result: What have the Six Senses brand achieved so far
4. Way forward: we look at what is the way forward in terms of sustainability for the Six Senses brand.
5. Overall summary

1. During this course we will focus on Six Sense Fiji and all its sustainable practises, initiatives that has put this luxury hotel brand on the top list of Sustainable Tourism worldwide.
2. We will also look at brand results, what the Six Senses brand has achieved so far in terms of sustainability.
3. Last but not list, what are the way forward in Sustainable Tourism for Six Senses as a brand.

SUSTAINABILITY INITIATIVES

I. SOLAR POWER GENERATION

- Producing energy usually creates pollution and is the biggest cause of global warming. At Six Senses Fiji several steps have been taken to reduce energy usage and to ensure use of renewable energy wherever possible.
- Six Senses Fiji is proud to have an award ,providing all our winning state of art reticulated off grid solar and TESLA battery mini grid, providing all our power needs, including heating our waters.
- This makes this system the largest off grid power system currently operating in the South Pacific Region.

1. Producing energy usually creates pollution and is the biggest cause of global warming. At Six Senses Fiji several steps have been taken to reduce energy usage and to ensure use of renewable energy wherever possible.
2.Six Senses Fiji is proud to have an award ,providing all our winning state of art reticulated off grid solar and Tesla battery mini grid, providing all our power needs, including heating our waters.
3. This makes this system the largest off grid power system currently operating in the South Pacific Region.
4. Any excess power is used for the desalination plant. This is when sea water is drawn from the sea to be processed into drinkable water.

440

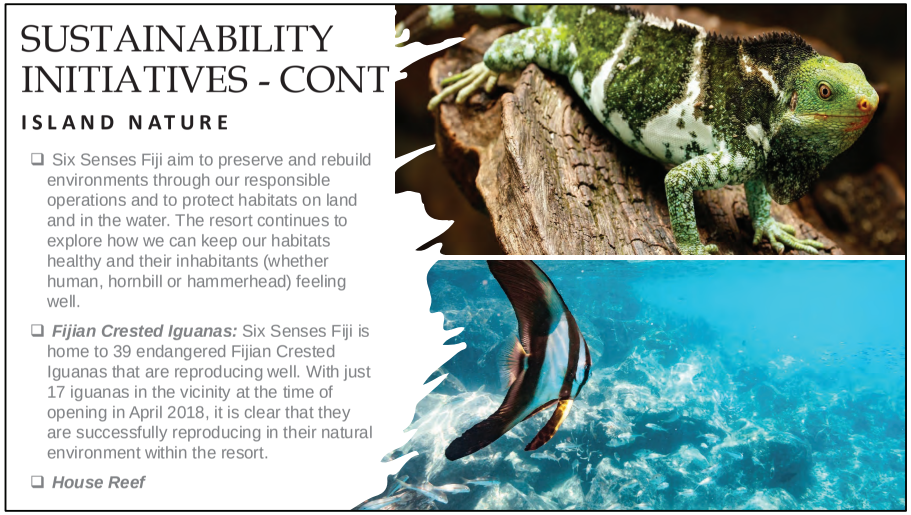
BACKGROUND

- From the, beginning in 1995, Six Senses quickly became recognized as the hospitality industry's pioneer of sustainable practice, demonstrating that taking responsibility for the environment is the core of the resorts vision and values.
- "Sustainability is not something that we do; it is who we are! We have been loud and passionate supporters for the last two decades. It is more than social responsibility and good business, it runs through our rivers and the sea, you can taste it in our food, it powers our resort through solar energy and overall, just shapes decisions"
- Six Senses Sustainability is not about sacrifice; rather it is a celebration of abundance. The unique environments, culture and experiences shared with the guest are not meant to be experienced just once. Sustainability ensures that future generations can enjoy the nature and beauty of our environment in years to come.
- Being environmentally friendly and socially responsible can be successfully wedded to uncompromisingly gorgeous hideaways. Located on Malolo Island, surrounded by crystal clear waters and offering a picture-perfect white sandy beach, Six Senses Fiji is ideal for ocean enthusiasts looking for their own piece of tropical paradise, whilst maintaining their commitment to the environment at the same time.
- Consistent with the commitment of the Six Senses group, Six Senses Fiji invites guests to share responsibility to offset their carbon footprint and care for the eco system in which we develop and operate.

1. From the, beginning in 1995, Six Senses quickly became recognized as the hospitality industry's pioneer of sustainable practice, demonstrating that taking responsibility for the environment is the core of the resorts vision and values.
2. Sustainability is not something that we do; it is who we are! We have been loud and passionate supporters for the last two decades, long before it was considered fashionable. Its not a token of phrase, it's the very core of everything we do
3. Six Senses Sustainability is not about sacrifice; rather it is a celebration of abundance. The unique environments, culture and experiences shared with the guest are not meant to be experienced just once. Sustainability ensures that future generations can enjoy the nature and beauty of our environment in years to come.

4. For us, being environmentally friendly and socially responsible can be successfully wedded to uncompromisingly gorgeous hideaways. Empty of waste, toxins and plastic, and full of spirituality, celebration and joy.
Located on Malolo Island, the largest of the Mamanuca Islands, surrounded by crystal clear waters and offering a picture-perfect white sandy beach for guests, Six Senses Fiji is ideal for ocean enthusiasts looking for their own piece of tropical paradise, whilst maintaining their commitment to the environment at the same time.
5. Consistent with the commitment of the Six Senses group, Six Senses Fiji invites guests to share responsibility to offset their carbon footprint.

1. There are few tips that the resort uses to minimize the use of electricity around the resort.
2. The use of Lutron system, when guest exits the room and forgets to turn off power points, lights or air condition, within 15 minutes, power shuts down on its own.
3. Replacement of wide blade ceiling fans with orbital ceiling fans. Orbital fan requires less energy than the long blade ones.
4. Shut down all AC in staff areas during low occupancy i.e. if majority work through the day, shut down AC from 07:00 am until 16:00 Hrs. however engineer to determine if this is possible and test to ensure the resort does not experience " in rush " current loads at start-up which may be more costly.
5. Ensure during low season that "wine cellars "are emptied of certain wines to be stored in typical kitchen cooler to shut down heavy load AC in wine cellars.

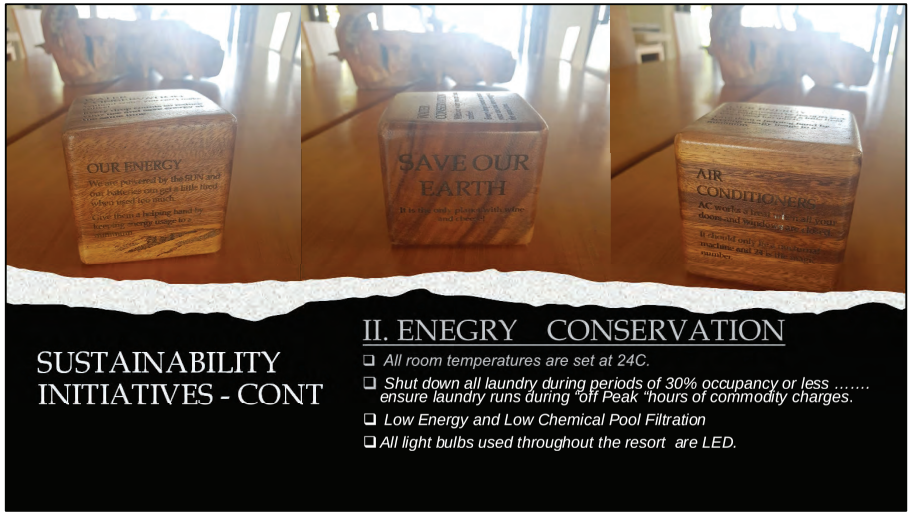


1. We aim to preserve and rebuild environments through our responsible operations and to protect habitats on land and in the water. We continue to explore how we can keep our habitats healthy and their inhabitants (whether human, hornbill or hammerhead) feeling well.
2. Fijian Crested Iguana

Six Senses Fiji is home to 39 Fijian Crested iguanas, a critically endangered native species with less than 5,000 remaining in the world. With just 17 iguanas in the vicinity at the time of opening in April 2018, it is clear that they are successfully reproducing in their natural environment within the resort. We make every effort to ensure that these special residents are safe and that their habitat, between the villas and our spa, remains as it was found. This section of the resort is called the Iguana Reserve and as guests walk along the winding boardwalk through the trees, they may be able to catch a glimpse of one of the friendly fellas.

3. House Reef

The coral nursery in our protected bay is home to a number of underwater species, including giant clams and a house reef turtle. Planting of the garden began 5 years ago, and has continued over the years to create a wonderful underwater world straight off our beach. The house reef is an ongoing project with the aim to give nature a helping hand in creating a happy and healthy coral garden.



1. *Air condition; As a standard, all room temperatures are set at 76 F(24C) prior to guest arrival and is equipped with a sensor to automatically switch off the air-conditioning once the doors are opened.*
2. *Shut down all laundry during periods of 30% occupancy or less ……. ensure laundry runs during "off Peak "hours of commodity charges.*
3. *By monitoring the energy and chemicals used for the pools, the resort ensures low environmental impact.*
4. *All light bulbs used throughout the resort are LED; to ensure the highest level of LED efficiency and minimization of power usage.*

SUSTAINABILITY INITIATIVES - CONT

FARM TO FORK

- Our produce is grown in, not flown in so come and get your hands dirty foraging for clean food! By cultivating own produce on site, the idea is to drastically reduce our carbon footprint and ensure organic harvest to be used in our restaurants.
- ***Cluckingham Palace***

Nothing beats eggs for breakfast, especially when they are fresh, plucked from the coop that very morning. Six Senses Fiji's chicken coop is home to over 100 hens and roosters who produce happy, healthy eggs for use throughout the resort's restaurants.

- ***Honeybees***
- ***Mushroom Hut***

1. Our produce is grown in, not flown in so come and get your hands dirty foraging for clean food! By cultivating our own produce on site we drastically reduce our carbon footprint and ensure organic harvest to be used in our restaurants.

2. Cluckingham Palace

Nothing beats eggs for breakfast, especially when they are fresh, plucked from the coop that very morning. Cluckingham Palace is Six Senses Fiji's chicken coop where over 100 hens and roosters roam, relax and produce happy, healthy eggs for use throughout the resort's restaurants. For an interactive experience, guests can make their way to Cluckingham and select their own goods for frying up in the kitchen.

3. Honey Bees

It is estimated that one third of the foods we consume each day relies on pollination mainly by bees, meaning they are an integral species for our environment. Six Senses Fiji aims to keep this species protected and active with a beehive area located near the chicken coop. Fresh honey and honeycomb is produced and used throughout the resorts restaurants.

4. Mushroom Hut

Most of us love to relax in the sunshine and take in the warmth on our skins, however mushrooms aren't so keen. For them to grow well they need a cool and dark environment, which is why Six Senses Fiji has created a Mushroom Hut, giving them exactly the conditions they need to grow tasty and well.

SUSTAINABILITY INITIATIVES - CONT

FARM TO FORK

- When it comes to food, activities extend beyond dining outlets. All properties source fresh ingredients grown in an onsite organic gardens as part of our Eat With Six Senses approach to food and drink.
- ***The Garden***

Everyone wants to keep produce as local as possible at Six Senses Fiji and what better way than by growing fresh produce? The Garden produces fresh herbs, fruits and vegetables for use in the resort restaurants, bars, spa and Alchemy Bar.

- ***Local Fisherman***

All fish consumed at the resort are sourced from local fishermen

1. When it comes to food, our activities extend beyond our dining outlets. All properties source fresh ingredients grown in our onsite organic gardens as part of our Eat With Six Senses approach to food and drink.

2. The Garden

Everyone wants to keep produce as local as possible at Six Senses Fiji and what better way than by growing fresh produce? The Garden produces fresh herbs, fruits and vegetables for use in the resort restaurants, bars, spa and Alchemy Bar.

3. Local Fisherman

All fish consumed at the resort are sourced from local fishermen.

SUSTAINABILITY INITIATIVES - CONT

LOCAL RESPONSIBILITY

- *Our knowledge of the best fishing holes, diving spots, underground and pop-up events is founded on our local relationships. After all, we could not hope to care for you if we did not first care for our people, families and communities we are part of.*

- ***Supporting Local***

Six Senses Fiji has collaborated with Rise Beyond the Reef in order to improve the local economy. This NGO works with women in remote communities teaching them to create marketable goods, in the form of small homewares and crafts, using traditional skills.

- ***Social Responsibility***

Six Senses Fiji is committed to employing locally, with a large percentage of the hosts being of Fijian nationality.

1. Our knowledge of the best fishing holes, diving spots, underground and pop-up events is founded on our local relationships. After all, we could not hope to care for you if we did not first care for our people, families and communities we are part of.

2. *Local Produce*

Six Senses Fiji has collaborated with Rise Beyond the Reef in order to improve the local economy. This NGO works with women in remote communities teaching them to create marketable goods, in the form of small homewares and crafts, using traditional skills. These goods are used in the villas and restaurants and can be found on offer in the resort boutique. The profit from these products goes into alleviating poverty in the communities.

3.Social Responsibility

Six Senses Fiji is committed to employing locally, with a large percentage of the hosts being of Fijian nationality. The resort offers internships to high-performing students and work experience opportunities for university undergraduates majoring in tourism.

SUSTAINABILITY INITIATIVES CONT

SUSTAINABLE BEVERAGES

- *Sustainability really is ingrained in everything we do here at Six Senses Fiji … even down to the water you drink and the cocktails you enjoy!*

- ***Water Bottling Plant:*** *Water is produced and bottle on site*

- ***Homemade Tonics***

Created with pride, tonics, ginger beers and probiotics use fresh ingredients from The Garden. By making mixers onsite, energy consumption is reduced along with pollution and plastic waste that comes from importing goods.

Sustainability really is ingrained in everything we do here at Six Senses Fiji … even down to the water you drink and the cocktails you enjoy!

Water Bottling Plant

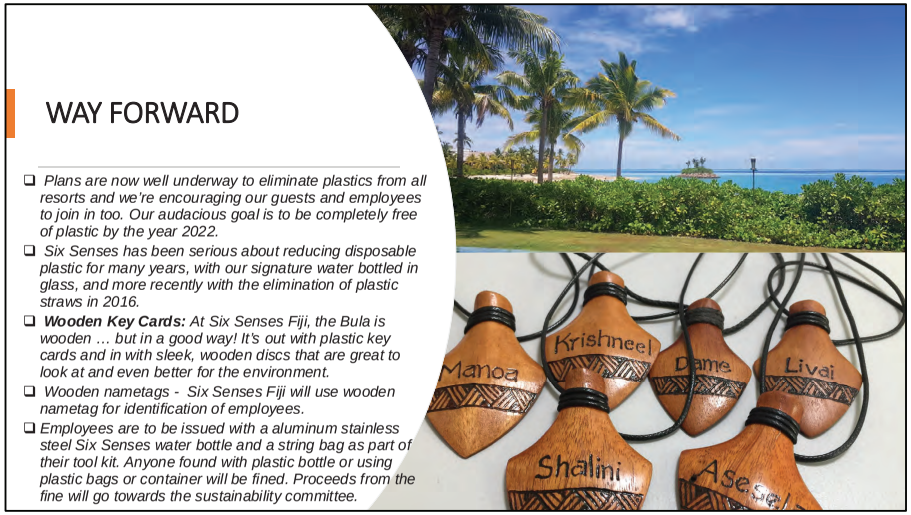
As in all Six Senses resorts, still drinking water at Six Senses Fiji is produced and bottled on-site. Drinking water is treated to the highest international standards, purified, mineralized and bottled in Six Senses glass bottles. Water is not imported to reduce greenhouse gas emissions and in support of zero waste.

Homemade Tonics

Homemade mixers are a groundbreaking feature at Six Senses Fiji and offer sustainability right down to evening cocktails. Created with pride, tonics, ginger beers and probiotics use fresh ingredients from The Garden. By making mixers onsite, energy consumption is reduced along with pollution and plastic waste that comes from importing goods.

1. 22 percent of solid waste diverted from landfills.
2. 28,126 kWh generated renewable electricity increase.
3. 74,765 kilograms of organic fruit and vegetables grown for guests and communities
4. 109,000 free-range organic eggs contributed from happy Six Senses hens compared to 73,000 in 2018
5. Sponsored projects in 2019 totaled USD 626,641 through resorts Sustainability Funds.

1. 1,802,794 glass water bottles replaced disposable plastic bottles.
2. 3,48 kWh energy consumption decrease per occupied room in 2019.
3. 3,549 meaningful local jobs created.
4. 191,822 kilograms of compost and natural fertilizer given back to the earth.
5. 65 kgs scrubs for spas by repurposing natural ingredients from the garden.



1. *Plans are now well underway to eliminate plastics from all resorts and we're encouraging our guests and employees to join in too. Our audacious goal is to be completely free of plastic by the year 2022.*
2. *Six Senses has been serious about reducing disposable plastic for many years, with our signature water bottled in glass, and more recently with the elimination of plastic straws in 2016.*
3. ***Wooden Key Cards:** At Six Senses Fiji, the Bula is wooden … but in a good way! It's out with plastic key cards and in with sleek, wooden discs that are great to look at and even better for the environment.*
4. *Wooden nametags - Six Senses Fiji will use wooden nametag for identification of employees.*
5. *Employees are to be issued with a aluminum stainless steel Six Senses water bottle and a string bag as part of their tool kit. Anyone found with plastic bottle or using plastic bags or container will be fined. Proceeds from the fine will go towards the sustainability committee.*

Acknowledgement and Reference

- I'd like to thank all management and host of Six Senses Fiji especially those that working as part of the skeleton team in December of 2021 for the tremendous support that enable me to put this training materials together.
- All materials used were sourced from the approval of the Six Senses Fiji Management Team.

SUMMARY

- At Six Senses we care for the environment and the people in it too. Taking care of the environment gives a sense of belonging which brings back to the vision of the resort " Reconnecting with themselves, others and the world around them"

CBCRP-PCCC Virtual Training Course

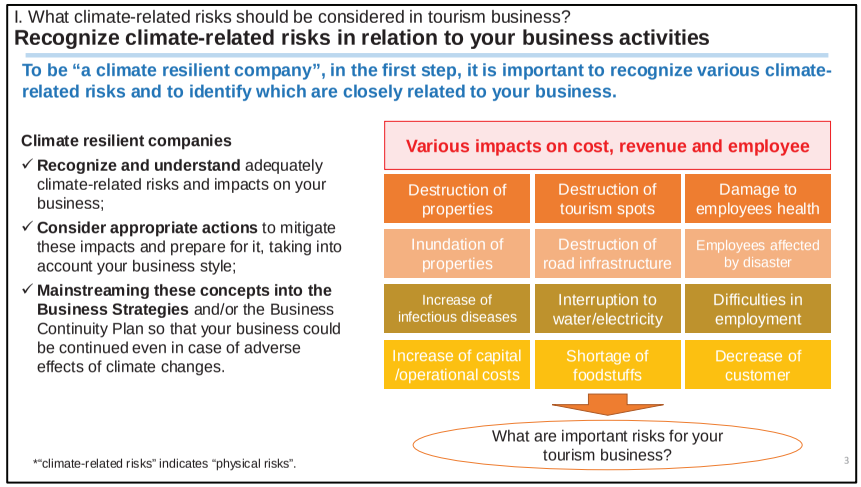
“Enhancing Climate Resilience in Tourism in the Pacific ”

Government of Samoa, SPREP, SPTO and JICA

2. Opportunities of the tourism to respond to climate change
2.1.3 Business risk management and recovery

Mr. Yasuki Shirakawa
JICA Short-term Expert
ALMEC Corporation

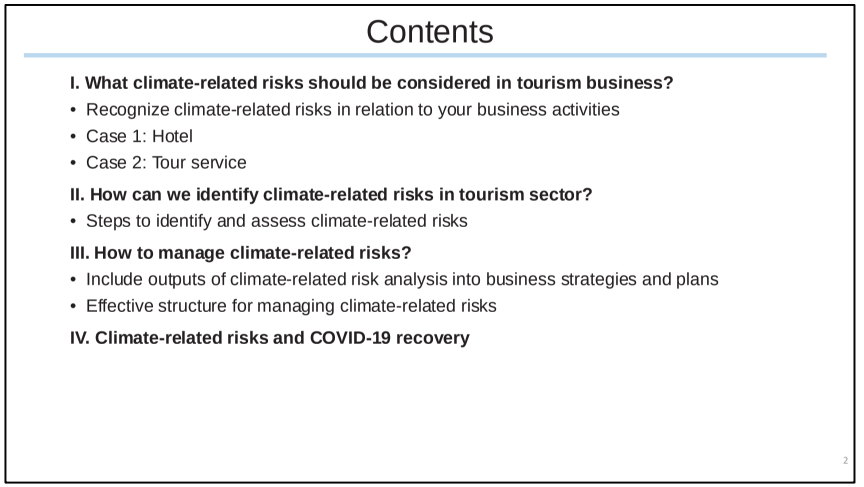
THANK YOU AND VINAKA VAKALEVU

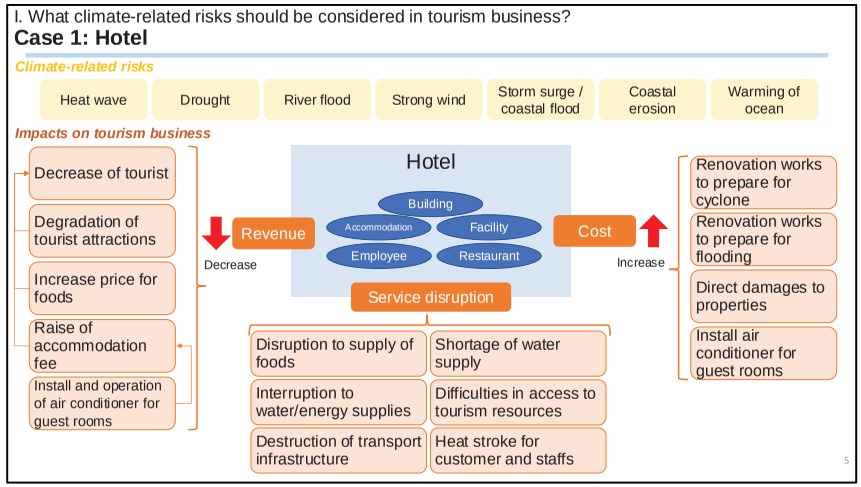


Recognize climate-related risks in relation to your business activities

As explained in the previous lectures, climate change is already having impacts on business activities and is projected to be more severe.
In order to continue and develop your business under such circumstances, it is needed to realize “a climate resilient company”.
What does the term “climate resilient company” means?
It can be defined as a company which:
- recognize and understand adequately climate-related risks and impacts on your business;
- consider appropriate actions to mitigate these impacts and prepare for it, taking into account your business style;
- mainstreaming these concepts into the Business Strategies and/or the Business Continuity Plan so that your business could be continued even in case of adverse effects of climate changes.

In the first step to realize “climate resilient company”, it is important to recognized various climate related risks which are described in the module 1.2 and to identify which are closely related to your business.
The figure in the right hand side shows some of expected impacts of these risks.
Such as, destruction of properties/tourism spots/road infrastructure, damage to employees health, interruption to water/electricity, decrease of customer.
All of these would have adverse impacts on cost, revenue and employee, therefore it is important to understand which would be relevant to your business.





I. What climate-related risks should be considered in tourism business?
Case 1: Hotel

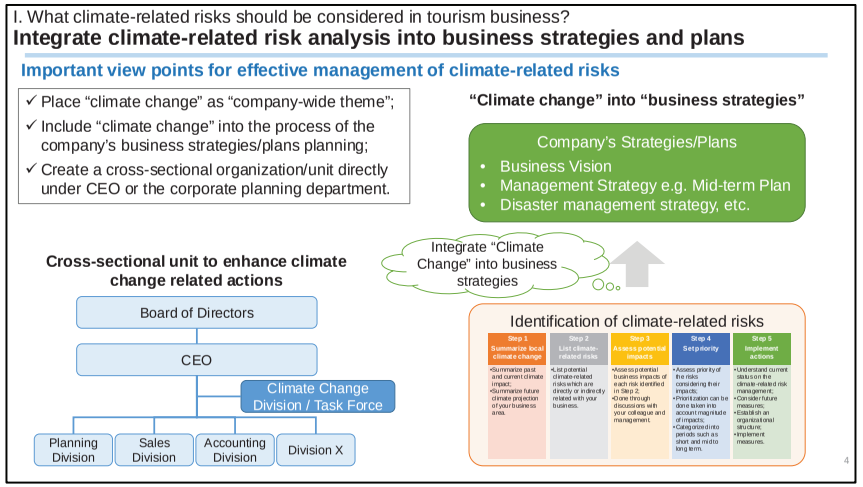
How climate-related risks impact on tourism businesses?
As an example, this slide shows potential impacts of the risks on accommodation businesses in PICs.
When we assess impacts of climate-related risks on business activities, we can consider impacts on cost, revenue and service disruption.

Accommodation businesses have very wide range of activities. They own buildings, facilities, restaurants and employees. Besides, they are depending on tourists, energy supply networks and supply chain of foods or goods.
All of these would have potential to be affected by climate-related risks directly or indirectly.
For example,
cost for buildings and facilities would be increased, for example, because of:
- renovation works to prepare for cyclone/flooding;
- direct damages to properties by cyclone/flooding;
- installation of air conditioner for guest rooms under hotter temperature and extremes.

Revenue would be decreased because of decrease of tourists.
Tourists may avoid visiting because of degradation of tourism attractions and increase cost of their stay.
Under hotter weather, the hotel will need to install and operate air conditioners for guest rooms and it will lead to raise of accommodation fee.

Service disruption may happen because of, for example:
- destruction of transport infrastructure;
- interruption to water/energy supplies;
- Heat stroke for customer and staffs, etc.

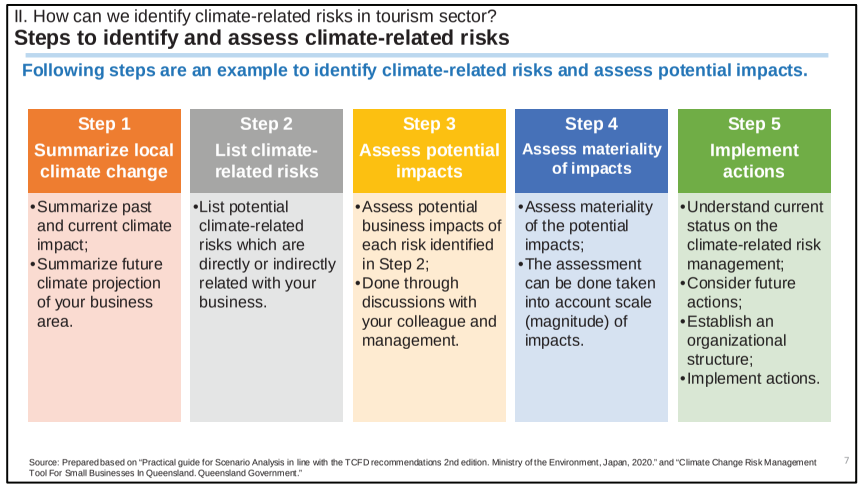
This is just an general example of accommodation businesses, and it is needed to consider your company's characteristics and local situation.



Integrate climate-related risk analysis into business strategies and plans

After recognizing and understanding the risks related to your business and impacts of these risks, an important view point is to integrate these analysis into your company's business strategies and plans.
Some of important aspects for a company to effectively manage climate-related risks are:
- place "climate change" as "company-wide theme";
- include "climate change" into the process of the company's business strategies/plans planning;
- create a cross-sectional organization/unit directly under CEO or the corporate planning department.

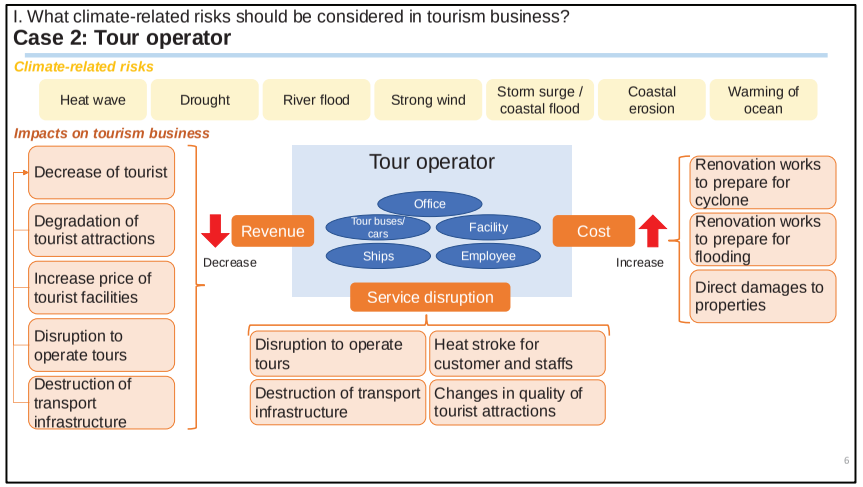
Climate change would have wide range of impacts on your company, and it is not the simple issues to be tackled by one division/department.
It should be placed as "company-wide theme" under leadership of the CEO, and set up a cross-sectional unit or division to enhance actions to climate change.
Another important aspect is to integrate the outputs of identified climate-related risks into your company's business vision, management strategy and disaster management strategy, etc.



II. How can we identify climate-related risks in tourism sector?
Steps to identify and assess climate-related risks

Now let us consider how to identify climate-related risks in tourism sector.
This slide shows an example of steps to identify climate-related risks and assess potential impacts.

We have five steps and the outline is:
In the Step 1, summarize past and current climate impact as well as future climate projection of your business area. Here, you need to summarize and understand climate characteristics of the area where your company is located.
Step 2; take into account the result of Step 1, list potential climate-related risks which are directly or indirectly related with your business.
Step 3; assess potential business impacts of each risk identified in Step 2. Discussions with your colleague and management would be needed to assess the impacts.
Step 4; next assess materiality of the potential impacts raised in Step 3. Scale (magnitude) of each impact is considered to assess the materiality.
Step 5; understand current status on the climate-related risk management, and consider future actions. Establish necessary organizational structures to take the actions, then implement these actions.



I. What climate-related risks should be considered in tourism business?
Case 2: Tour operator

This slide shows an example of potential impacts of the risks on tour operators in PICs.
Again, when we assess impacts of climate-related risks on business activities, we can consider impacts on cost, revenue and service disruption.

Tour operators own offices, facilities, cars/ships and employees. Of course, their businesses are dependent on number of tourists.
All of these would have potential to be affected by climate-related risks.
For example,
cost for buildings and facilities would be increased, for example, because of:
- renovation works to prepare for cyclone/flooding;
- direct damages to properties by cyclone/flooding.

Revenue would be decreased because of decrease of tourists.
Tourists may be avoid visiting because of degradation of attractions and increase cost of their stay.
Tour operators would face with occasions to stop their services, because of costal/river flood, strong wind and heat wave, and it leads to the decrease of tourists.

Service disruption (disruption to operate tours) may happen by, for example:
- destruction of transport infrastructure;
- changes in quality of tourist attractions;
- heat stroke for customer and staffs.

II. How can we identify climate-related risks in tourism sector?
Step 1　Summarize local climate change

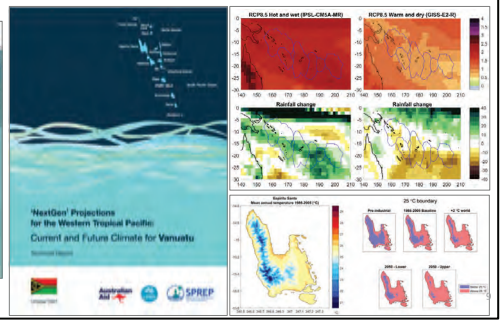
Summarize future climate projection on your business area:
Example of data sources

- Please refer to the module 1.1, "2. Observed and projected climate change in the Pacific" for more information.

An example of information on future climate projection
RCCAP: Regional Climate Consortium for Asia and the Pacific

Source: Regional Climate Consortium for Asia and the Pacific
https://www.rccap.org/climate-change-update-for-the-pacific/

An example of RCCAP future climate projection: Case of Vanuatu



II. How can we identify climate-related risks in tourism sector?
Step 1　Summarize local climate change

As to regional projections targeting on each country in the PICs, there are not as many studies as global projections.
This is an helpful example of the future climate projection for the Pacific provided by RCCAP (Regional Climate Consortium for Asia and the Pacific).
The latest information about climate change for 14 Pacific countries and Timor-Leste is available in a set of technical reports produced by Australia's Commonwealth Scientific and Industrial Research Organisation (CSIRO) and the Secretariat of the Pacific Regional Environment Programme (SPREP).
https://www.rccap.org/climate-change-update-for-the-pacific/

In that website, you can find the country reports which contains, for example;
- historical and projected temperature;
- historical and projected rainfall;
- Tropical cyclones, extreme rainfall and sea level projections
- Standardised scenario analysis.

II. How can we identify climate-related risks in tourism sector?
Step 1　Summarize local climate change

Summarize past and current climate impact on your business area.

Why?

- If your area has been impacted by a climate hazard in the past and your business has been negatively affected, but you have not taken any actions yet, you have some existing climate related risks to your business.

How to summarize?

- Identify impacts that your business had suffered in the past, such as impacts to properties, staff, customer and supply chain, through local knowledge such as your and your colleagues experiences and past records of weather agencies.

Summarize future climate projection on your business area.

Why?

- Climate change is projected to be more sever in coming future. Appropriate projections should be taken into account for the risk assessment.

How to summarize?

- Using regional climate change projections for your country or surrounding area provided by government/scientific organization or donors.
- Not only changes in climate parameters, but also refer to the studies on local impacts.

An example of checklist for past climate impacts

Source: Climate Change Risk Management Tool For Small Businesses In Queensland. Queensland Government.

8

II. How can we identify climate-related risks in tourism sector?
Step 1　Summarize local climate change

Firstly, why is it necessary to summarize past and current climate impact on your business?
We can assume that, if your area has been impacted by a climate hazard in the past and your business has been negatively affected, but you have not taken any actions yet, you have some existing climate related risks to your business.
There are several ways to identify and summarize impacts that your business had suffered in the past, such as impacts to properties, staff, customer and supply chain.
For example, local knowledge such as your and your colleagues, family's experiences and past records of weather agencies.
The impacts can be summarized using a checklist which is shown in this slide.

Why is it necessary to summarize future climate projection on your business area?
As already provided in the previous lectures, climate is projected to be not as same as current status but to change in coming future. Temperature will rise, sea level will rise, and intensity of tropical cyclones are projected to be more strong.
Appropriate scientific projections should be taken into account for the risk assessment.
It is recommended to summarize it by using regional climate projections for your country or surrounding area which are provided by government/scientific organization or donors. The module 1.1 provides useful examples of the climate change projections, such as outputs of the AR6 (Sixth Assessment Report) of IPCC (Intergovernmental Panel on Climate Change).
Not only changes in climate parameters which are outputs of climate models, but also refer to the studies on local impacts.

II. How can we identify climate-related risks in tourism sector?

Step 3 Assess potential impacts

Assess potential business impacts of each risk identified in Step 2.

- Business impacts: financial impacts such as increase of capital/ operational costs and decrease of revenue.
- **How to assess?**
  - Internal discussions with your colleague and the management;
  - Literature review and information from relevant agencies.

An image of assessing potential impacts on your business (acute risks)

Climate change	Risk	Potential impact	Capital cost	Operational cost	Revenue
Extreme weather event increase (other than cyclone)	Heat wave	• Heat stroke for customer and staffs which may lead to business interruption.			↓
	Drought	• Shortage of water supply which may lead to business interruption.		↑	
		• Disruption to the supply of and price increase of foods for the restaurant which may lead to difficulties in procuring necessary foods.		↑	
	River flood	• Destruction of roads which may lead to business interruption.			↓
Changes in Cyclone	Strong wind	• Damages to properties resulting in increased costs.	↑		
	Storm surge / coastal flood	• Interruption to water/energy supplies which may lead to operation interruption.			↓
		• Damages to tourism spots which may lead to lose customer and revenue.			↓

11

II. How can we identify climate-related risks in tourism sector?
Step 3 Assess potential impacts

After identifying climate-related risks in Step 2, assess how each of risk bring impacts on your business.
In this presentation, business impacts refer to as financial impacts such as increase of capital/ operational costs and decrease of revenue.

This table shows potential impacts of acute risks on tourism businesses.
In the case of the risk of “strong wind” caused by “changes in cyclone”, one of the potential impacts on your business would be “damages to properties resulting in increased costs for the repair”.
The potential impact of “river flood” caused by “extreme weather event increase” would be “destruction of roads which may lead to business interruption” resulting in loss of revenue.
“Drought” may have impact on such as “disruption to the supply of and price increase of foods for the restaurant which may lead to difficulties in procuring necessary foods” resulting in increased operational costs.

These assessments can be done through internal discussions within your company especially involving the management as well as literature review and so on.

II. How can we identify climate-related risks in tourism sector?

Step 2 List climate-related risks

List potential climate-related risks which are directly or indirectly related with your business.

How to list?

- Review reports in relation to climate change;
- Obtain information from relevant agencies;
- Discussion with colleague, experts, stakeholders.

Check relation between climate-related risks and your business.
++: The risk may significantly affect your business
+ : The risk may affect your business
- : The risk may be minor.

Image of listing climate-related risks on your business

Climate-related risk			Relation with your business
Acute	Extreme weather event increase (other than cyclone)	Heat wave	++
		Drought	+
		River flood	-
	Changes in Cyclone	Strong wind	++
		Storm surge / coastal flood	++
Chronic	Average temperature increase	Hotter days	+
		Ocean temperature rise	+
	Rainfall pattern changes	Precipitation increase/decrease	+
	Sea level rise	Coastal erosion	+
		Coastal inundation	++
	Ocean acidification	Changes in ocean acidity	+

10

II. How can we identify climate-related risks in tourism sector?
Step 2 List climate-related risks

Step 2 is to list climate-related risks.
Based on the outputs of Step 1, list potential climate-related risks (only physical risks) which are directly or indirectly related with your business.
First of all, list all the risks even it is minor one, referring to the module 1.1 and 1.2 as well as the result of Step 1, and summarize into a table as shown in this slide.
The risks can be categorized into acute and chronic risks as stated in recent business and financial literatures.
Since climate-related risks are closely related with business types and its activities, when listing and identifying the risks, it is recommended to discuss with your colleague, experts and stakeholders, not only by scientific reports and information of relevant agencies.

After listing the risks, you can evaluate relation between each risk and your business, such as:
++: the risk may significantly affect your business
+ : the risk may affect your business
- : the risk may be minor.

II. How can we identify climate-related risks in tourism sector?
Step 4 Assess materiality of impacts

Assess materiality of business impacts which are analyzed in Step 3.

- **How to assess materiality?**
  - ✓ Compare each impact analyzed in Step 3 from the perspective of the scale of business impact, then categorized into three categories, “large”, “medium” and “small”.
    - ✓ **Large**: Significantly large additional investments and/or operational costs to mitigate impacts will be required. Significantly large amount of revenue losses are projected. Those bring serious financial impacts that hinder business continuity.
    - ✓ **Medium**: Additional investments and/or operational costs to mitigate impacts will be required. Revenue losses are projected.
    - ✓ **Small**: Minor impacts are projected in terms of capital/ operational costs and/or revenue.
  - ✓ These categories are just an example and you can set another criteria using the metrics shown below.

Source: Basic concept of materiality assessment: based on “Practical guide for Scenario Analysis in line with the TCFD recommendations 2nd edition. Ministry of the Environment, Japan, 2020.”

- **What are other metrics for the assessment?**
  - ✓ **Time and duration of the impact**: e.g. expected recovery period of direct damages on facilities, decrease of tourists.
  - ✓ **Cost of business interruption, repairs and upgrades**: e.g. expected costs for damaged facilities, preparedness for the impacts.
  - ✓ **Loss or damage to critical supply chains**: e.g. expected loss or damage to food/ energy supplier.
  - ✓ **Significant unavailability of staff** : e.g. number of unavailable staffs because of transport disruption or direct damages to their residences.
  - ✓ **Lost revenues and/or market shares**: e.g. expected losses of revenues because of decrease of tourists.

Source: Based on “Advancing TCFD guidance on physical climate risks and opportunities. EBRD, 2018.”

13

II. How can we identify climate-related risks in tourism sector?
Step 4 Assess materiality of impacts

In Step 4, assess how large or significant each of identified business impact is.
There are many methodologies and metrics to assess materiality of impacts, and it is not straightforward to conduct these assessments.
This slide shows an simple example of the assessment, and if necessary revise it to fit with the characteristics of your business.

The method is to compare each impact analyzed in Step 3 from the perspective of the scale of business impact, then categorized into three categories, “large”, “medium” and “small”.
For example,
Large: Significantly large additional investments and/or operational costs to mitigate impacts will be required. Significantly large amount of revenue losses are projected. Those bring serious financial impacts that hinder business continuity. For example, high repair costs for heavily damaged building by cyclones.
Medium: Additional investments and/or operational costs to mitigate impacts will be required. Revenue losses are projected. For example, revenue loss by a short interruption of your business by disruption of transport services.
Small: Minor impacts are projected in terms of capital/ operational costs and/or revenue.

These categories are just an example and you can set another criteria using the metrics such as:
Time and duration of the impact: e.g. expected recovery period of direct damages on facilities, decrease of tourists.
Cost of business interruption, repairs and upgrades: e.g. expected costs for damaged facilities, preparedness for the impacts.
Loss or damage to critical supply chains: e.g. expected loss or damage to food/ energy supplier.
Significant unavailability of staff : e.g. number of unavailable staffs because of transport disruption or direct damages to their residences.
Lost revenues and/or market shares: e.g. expected losses of revenues because of decrease of tourists.

II. How can we identify climate-related risks in tourism sector?
Step 3 Assess potential impacts

An image of assessing potential impacts on your business (chronic risks)

Climate change	Risk	Potential impact	Capital cost	Operational cost	Revenue
Average temperature increase	Hotter days	• **Requires cooling facilities for the hotel resulting increased costs.**	↑	↑	
	Ocean temperature rise	• **Negative impacts to coral reef which may lead to lose customer and revenue.**			↓
Rainfall pattern changes	Precipitation increase/decrease	• **Changes of suitable land for vegetable and fruit cultivation which may lead to difficulties in procuring necessary foods.**		↑	
Sea level rise	Coastal erosion	• **Negative impacts to beach and coral reef which may lead to lose customer and revenue.**			↓
Ocean acidification	Changes in ocean acidity	• **Negative impacts to coral reef which may lead to lose customer and revenue.**			↓

12

II. How can we identify climate-related risks in tourism sector?
Step 3 Assess potential impacts

This table shows potential impacts of chronic risks on tourism businesses.
In the case of the risk of “hotter days or extreme temperature”, one of the potential impacts on your business would be “requires cooling facilities for the hotel resulting increased costs”, that lead to increase of investment costs as well as operational electricity costs.
On the other hand, “coastal erosion” will bring “negative impacts to beach and coral reef which may lead to lose customer and revenue”.

These impacts can be assessed in quantitative manner.

II. How can we identify climate-related risks in tourism sector?

Step 5 Implement actions

1. **Understand company's current status on the climate-related risk management**
   Considering the materiality of each climate-related impact which are analyzed in Step 4, it is important to understand the current status on your company's actions to manage these impacts.
2. **Consider future actions for the climate-related risk management**
   Consider practical actions to manage the identified risks.
3. **Establish an organizational structure for the climate-related risk management**
   Establish an organizational structure in your company in order to effectively manage the climate-related risks and promote the actions.
4. **Implement actions**
   Implement the actions to manage the risks under the set organizational structure.

Source: Prepared based on the method proposed in "Practical guide for Scenario Analysis in line with the TCFD recommendations 2nd edition. Ministry of the Environment, Japan, 2020."

15

II. How can we identify climate-related risks in tourism sector?
Step 5 Implement actions

This is the final step.
After finishing technical considerations from Step 1 to Step 4, in this step, it is needed to set up the way to manage and mitigate the impacts, and to implement actions.

First of all, considering the materiality of each climate-related impact which are analyzed in Step 4, it is important to check and understand the current status on your company's actions to manage these impacts. For example, summarize for which risks and impacts your company has already taken actions or planned to implement it, and what are the weak points and strong points in managing the impacts.
Second, consider practical actions to manage the identified risks. Take into account the weak points and strong points on the risk management of your company, you need to develop actions to manage these risks.
Third, establish an organizational structure in your company in order to effectively manage the climate-related risks and promote the actions. Take into account the current structure of risk management, it is recommended to set up an effective organizational structure to conduct actions.
Fourth, implement the actions to manage the risks under the set organizational structure.

II. How can we identify climate-related risks in tourism sector?

Step 4 Assess materiality of impacts

An image of materiality assessment of impacts on your tourism business

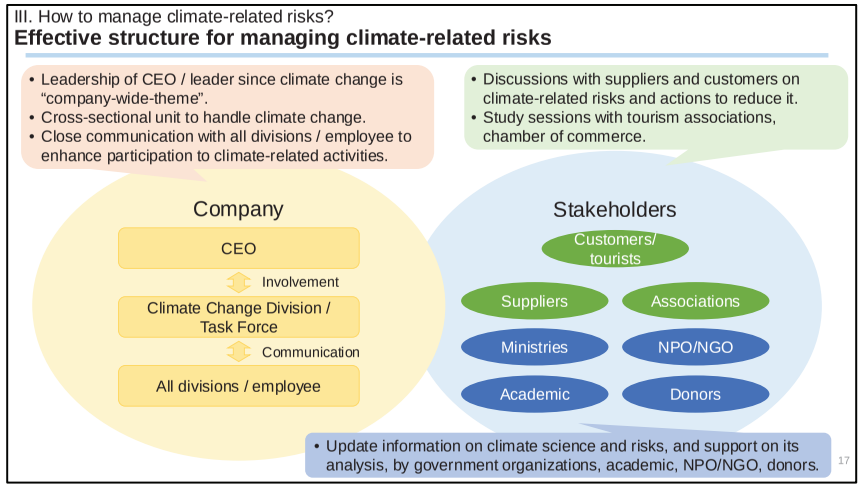
	Climate change	Risk	Potential impact	Capital cost	Operational cost	Revenue	Materiality
Acute	Extreme weather event increase (other than cyclone)	Heat wave	• Heat stroke for customer and staffs which may lead to business interruption.			↓	Medium
		Drought	• Shortage of water supply which may lead to business interruption.		↑		Small
			• Disruption to the supply of and price increase of foods for the restaurant which may lead to difficulties in procuring necessary foods.		↑		Small
		River flood	• Destruction of roads which may lead to business interruption.			↓	Small
	Changes in Cyclone	Strong wind	• Damages to properties resulting in increased costs.	↑			Large
		Storm surge / coastal flood	• Interruption to water/energy supplies which may lead to operation interruption.			↓	Large
			• Damages to tourism spots which may lead to lose customer and revenue.			↓	Large
Chronic	Average temperature increase	Hotter days	• Requires cooling facilities for the hotel resulting increased costs.	↑	↑		Large
		Ocean temperature rise	• Negative impacts to coral reef which may lead to lose customer and revenue.			↓	Medium
	Rainfall pattern changes	Precipitation increase/decrease	• Changes of suitable land for vegetable and fruit cultivation which may lead to difficulties in procuring necessary foods.		↑		Small
	Sea level rise	Coastal erosion	• Negative impacts to beach and coral reef which may lead to lose tourists.			↓	Large
	Ocean acidification	Changes in ocean acidity	• Negative impacts to coral reef which may lead to lose customer and revenue.			↓	Medium

↑: Significantly large negative impact ↑: Negative impact ↑: Minor negative impact

14

II. How can we identify climate-related risks in tourism sector?
Step 4 Assess materiality of impacts

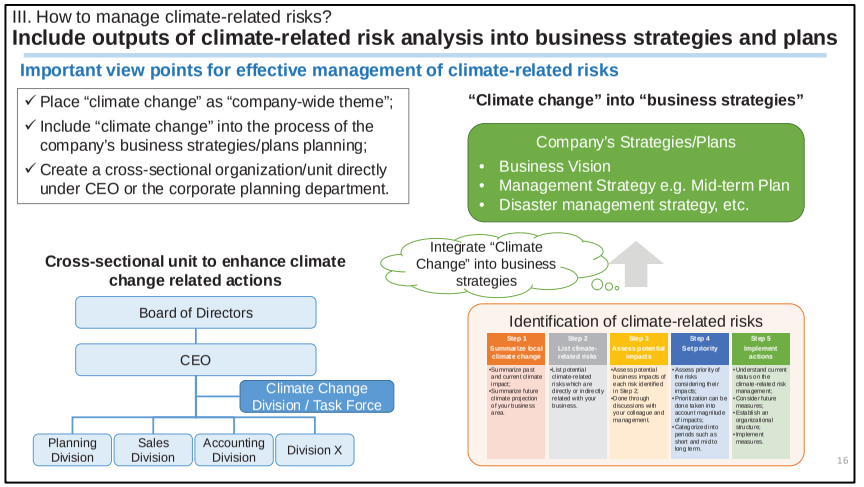
This slide shows an image of materiality assessment of impacts on tourism businesses.
As explained in the previous slide, the materiality can be categorized into "large", "medium" and "small".
All of impacts are assessed and you can understand which of those impacts should be considered in the company's business strategies/plans.



III. How to manage climate-related risks?
Effective structure for managing climate-related risks

Climate change is the matter which is related with tourism businesses in various manner.
It affects their activities in various ways, e.g. directly to assets and properties, and affects indirectly through supply chains etc.
Therefore, it is important to consider in your company that:
- leadership of CEO / leader since climate change is "company-wide-theme";
- cross-sectional unit to handle climate change;
- close communication with all divisions / employee to enhance participation to climate-related activities.

Do not tackle this matter solely by your company, but try to collaborate with the stakeholders since it would be often effective and efficient.
For example,
- update information on climate science and risks, and support on its analysis, by government organizations, academic, NPO/NGO, donors.
- discussions with suppliers and customers on climate-related risks and actions to reduce it.
- study sessions with tourism associations, chamber of commerce.



III. How to manage climate-related risks?
Include outputs of climate-related risk analysis into business strategies and plans

As already explained this slide in the beginning of the module, this is an important concept to manage climate-related risks in your company.
An important view point is to integrate outputs of climate-related risk analysis into your company's business strategies and plans.

Again, climate change would have wide range of impacts on your company, and it is not the issue to be tackled by one division/department.
It should be placed as "company-wide theme" under leadership of the CEO, and set up a cross-sectional unit or division to enhance actions to climate change.
Another important aspect is to integrate the outputs of climate-related risk analysis into your company's business vision, management strategy and disaster management strategy, etc.

References

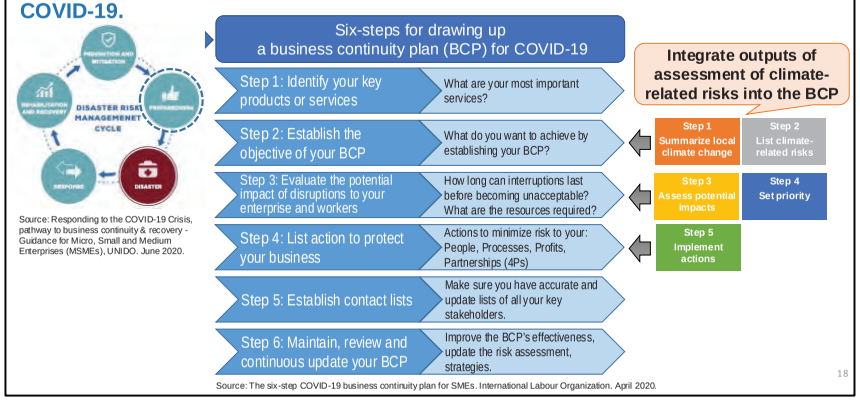
- Adapting to Climate Change using your Business Continuity Management System. BSI (The British Standards Institution) Group.
- Advancing TCFD guidance on physical climate risks and opportunities. EBRD, 2018.
- Climate change risk management options for the tourism sector, IDB.
- Climate Change Risk Management Tool For Small Businesses In Queensland. Queensland Government.
- Final report, recommendations of the Task Force on Climate-related Financial Disclosures. TCFD. June 2017.
- Guidelines on formulation and operation of BCP (Business Continuity Plan) for SMEs. The Small and Medium Enterprise Agency, Japan.
- Impacts of climate change on tourism in the coastal and marine environments of Caribbean Small Island Developing States (SIDS).
- Influences of climate change on tourism development in Small Pacific Island States. F. Wolf et al. 13, Sustainability 2021.
- IPCC, 2014: Summary for policymakers. In: Climate Change 2014: Impacts, Adaptation, and Vulnerability.
- National Tourism Climate Change Adaptation Strategy for Samoa 2012-2017. Samoa Tourism Authority.
- Practical guide for scenario analysis in line with the TCFD recommendations 2nd edition. Ministry of the Environment, Japan, 2020.
- Regional climate consortium for Asia and the Pacific, Climate change update for the Pacific. https://www.rccap.org/
- Responding to the COVID-19 Crisis, pathway to business continuity & recovery - Guidance for Micro, Small and Medium Enterprises (MSMEs), UNIDO. June 2020.
- The six-step COVID-19 business continuity plan for SMEs. International Labour Organization. April 2020.

19

IV. Climate-related risks and COVID-19 recovery

Integrate outputs of assessment of climate-related risks into the BCP

Climate-related risk management can be integrated into a recovery plan / BCP for COVID-19.



Source: Responding to the COVID-19 Crisis, pathway to business continuity & recovery - Guidance for Micro, Small and Medium Enterprises (MSMEs), UNIDO. June 2020.

Source: The six-step COVID-19 business continuity plan for SMEs. International Labour Organization. April 2020.

18

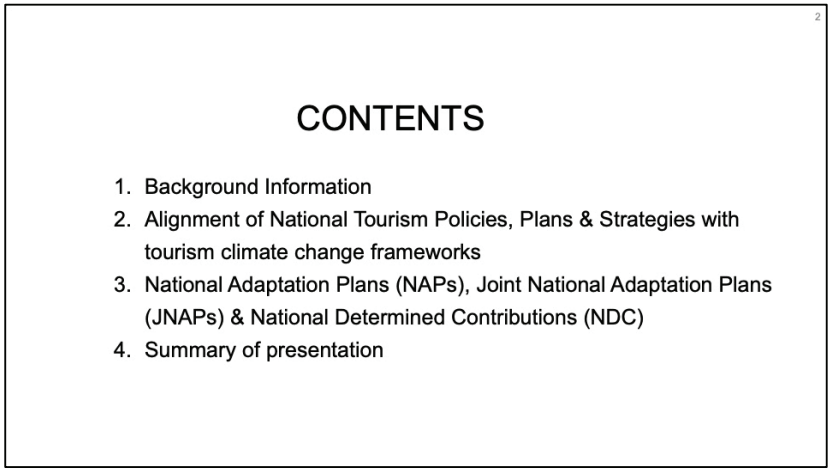
IV. Climate-related risks and COVID-19 recovery

Integrate outputs of assessment of climate-related risks into the BCP

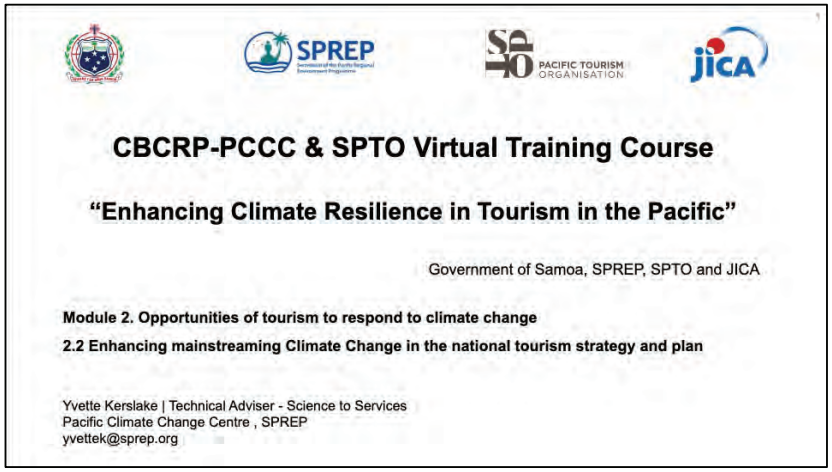
Finally, let us consider on climate-related risks and COVID-19 recovery.
We have still been suffered from the COVID-19, and especially tourism sector in the PICs the damages are very serious.
We need to develop a recovery plan for the COVID-19 and take actions immediately.
In this context, climate-related risk management can be integrated into the recovery plan or BCP (business continuity plan) for the COVID-19.
You can prepare not only for the short term risks, but for mid to long term risks.

BCP is concerned with the element of preparedness in the disaster risk management cycle (the left figure).
The International Organization for Standardization (ISO) has defined a BCP as documented procedures that guide organizations to respond, recover, resume, and restore to a pre-defined level of operation following disruption.
It will be efficient and effective that if you can integrate multiple disasters into a single BCP.

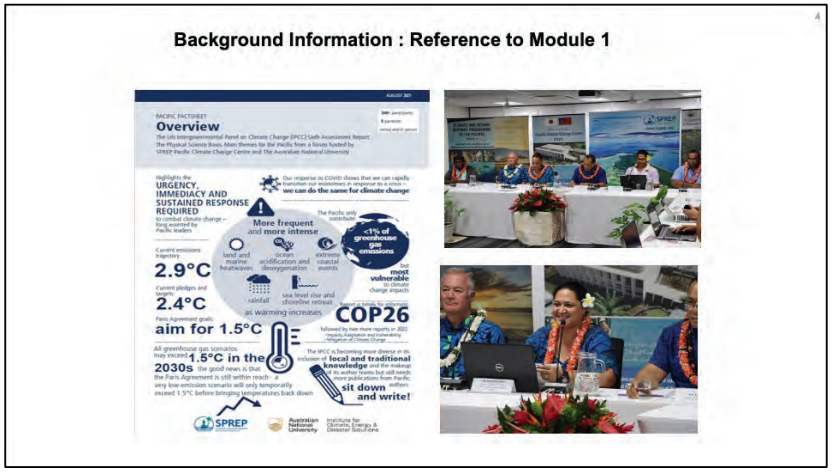
As shown in the middle chart in this slide, the International Labour Organization proposed "Six-steps for drawing up a business continuity plan (BCP) for COVID-19" especially for SMEs.
Pandemics like the COVID-19 are not the only disaster risks that the business sector generally face or presently are facing.
And if you develop a BCP, it is efficient to consider other disaster risks in it, and climate-related risks can be integrated into it.
The outputs of assessments described in the Chapter II and III can be included in the BCP taking into account the time scale of climate change impacts, such as mid to long-term.



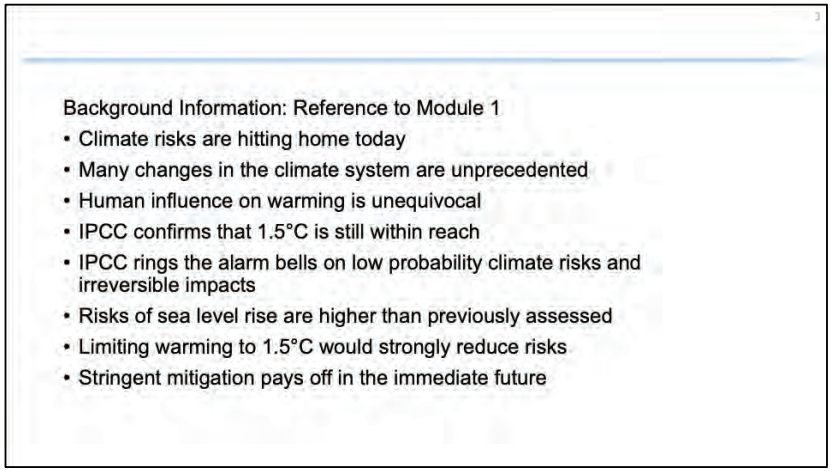
A brief outline of my presentation. I will provide a brief background information on the latest science from the IPCC working group 1 physical science report and then further discuss the alignment of national tourism policies, plans and strategies with tourism climate change frameworks. I will further present on mainstreaming tourism in existing National Adaptation Plans (NAPs), Joint National Adaptation Plans (JNAPs) and Nationally Determined Contribution (NDC) and will conclude with a summary of the presentation.



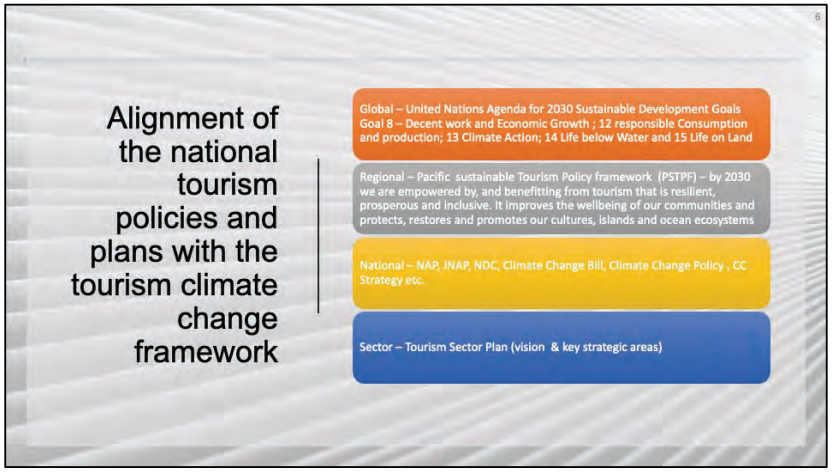
Talofa lava from the Pacific Climate Change Centre. I am Yvette Kerslake, Technical Adviser for science to services of the PCCC and my presentation today for the CBCRP PCCC & SPTO Virtual training course on Enhancing Climate Resilience in Tourism in the Pacific will focus on Module 2.2. Enhancing mainstreaming of Climate Change in the national Tourism strategy and plan.



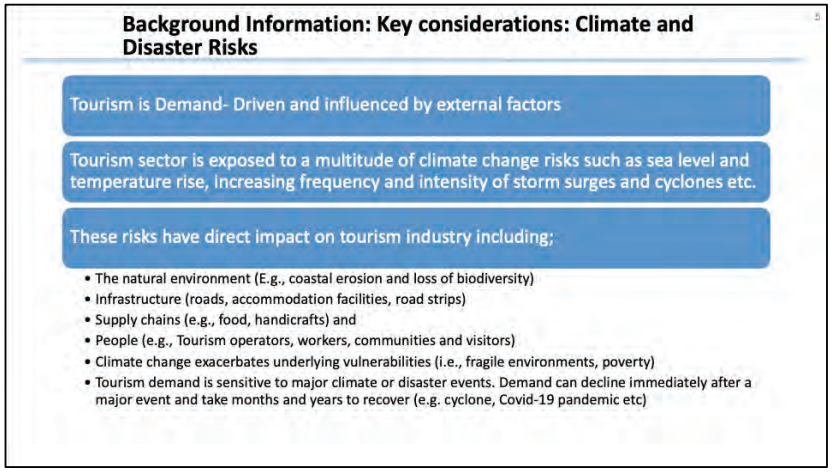
Again with the reference to Module 1, the Pacific Climate Change Centre hosted a Pacific webinar on the latest IPCC 6th Assessment Report. Also I attached the fact sheets as part of the reference materials for this model. But I just wanted to touch once again that the Pacific only contributes to less than 1% of greenhouse gas emissions. But we are the most vulnerable to climate change impacts. This is because due to the recent report there will be more frequent and more intense land and marine heat waves, ocean acidification and deoxygenation. They will be extreme coastal events. There will be rainfall, sea level rise and shoreline retreat as the warming increases. This will also drastically impact the tourism sector. That is why it's very important that we mainstream climate change into tourism policy and plans at the national level.



With reference to Module 1 but also the latest International Panel on Climate Change reports, it is important to note that climate risks are hitting home today. Many changes in the climate system are unprecedented. Human influence on warming is unequivocal. IPCC confirms that 1.5° C is still within reach. The IPCC rings the alarm bells on low probability climate risks and irreversible impacts. This means risks of sea level rise are higher than previously assessed and this will impact the tourism industry. Limiting warming to 1.5° C would strongly reduce these climate risks for us in the Pacific as Small Islands Developing States as we are vulnerable to the impacts of climate change. Stringent mitigation pays off in the immediate future.

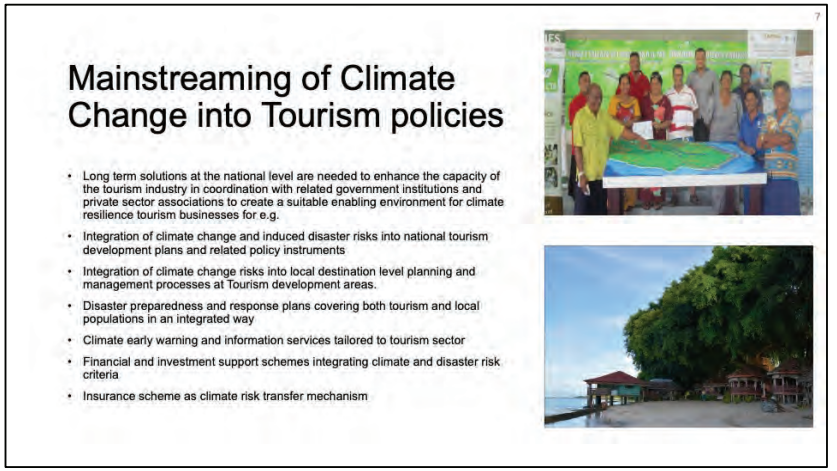


It is therefore crucial for integration of climate change and climate-induced disaster risk into national development policies and plans. In terms of the existing tourism climate change framework, we are looking at a top-bottom approach. What is globally related to the tourism sector? You have the United Nations Agenda for 2030 Sustainable Development Goals. These mandates are for all countries and all our sustainable development goals. The most relevant goals to the tourism sector are Goal 8 - decent work and economic growth, Goal 12 - responsible consumption and production, Goal13 climate action, Goal 14 life below water and Goal 15 life on land. When you look at the regional level, we have the Pacific Sustainable Tourism Policy Framework or well known as the PSTPF. This has a vision by 2030 that we are empowered by and benefiting from tourism that is resilient, prosperous and inclusive. It improves the wellbeing of our communities and protects, restores and promotes our cultures, islands and ocean ecosystems. Therefore we will focus our efforts to diversify and strengthen the resilience of the tourism economy to better prepare for future shocks and to address long-standing structural weaknesses. When we look at the existing tourism frameworks at the national level, you have your national bills or acts, climate change policies and climate change strategy. It is important that tourism is mainstreamed within these existing frameworks. It's also important that globally we are mandated to also provide plans to the United Nations Framework of Climate Change. This is the form of the National Adaptation Plans, the Joint National Adaptation Plans and NDCs. Therefore, bringing it down to the tourism sector, it is important that the tourism industry or the tourism sector also has a sector plan, which clearly aligns its vision and key strategic areas.

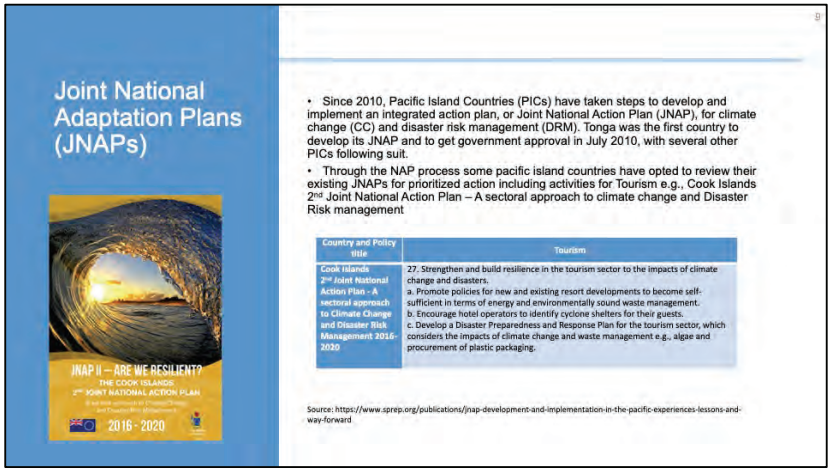


If we look at key considerations in terms of climate and disaster risk, We're all aware based on previous modules that tourism is demand-driven and influenced by external factors. The tourism sector is exposed to a multitude of climate-change risks such a sea level and temperature rise, increase in frequency and intensity of storm surges and cyclones.These risks have direct impact on the tourism industry for example, the natural environment, coastal erosion, the loss of biodiversity. You are looking at infrastructure: roads, accommodation facilities, road strips. You are looking at the supply chain in terms of food security, handicrafts, and also people. It affects us: tourism operators, workers, communities and also the visitors. Climate change exacerbates underlying vulnerability. That is the fragile environment and also in terms of poverty. Tourism demand is sensitive to major climate or disaster events. The demand can decline immediately after a major event and as you all know it takes months and years to recover. For example, most of our Pacific island countries have experienced cyclones and also with the recent COVID-19 pandemic. It impacted the tourism industry and sector as well.

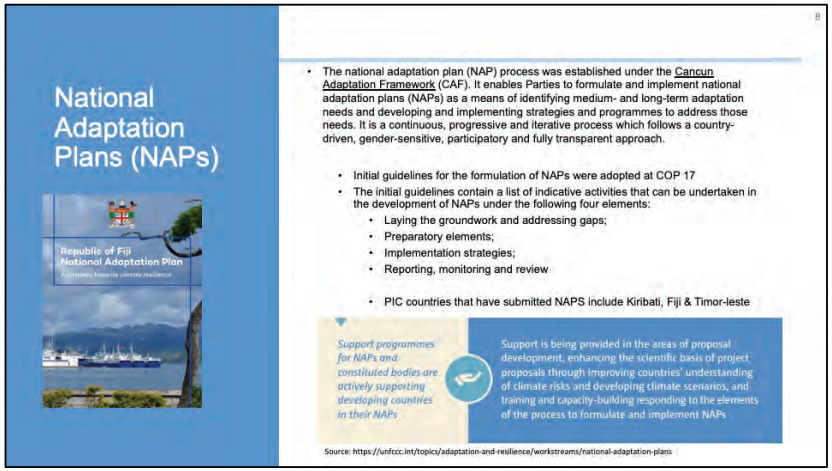
boost the activities in regards to the tourism sector. It's very important that we have financial and investment support schemes integrating climate and disaster risk criteria. This is why it's really important that we mainstream tourism into these national climate change policies and plans because this could also open up opportunities and to mobilize resources for the tourism industries or the tourism sector through different donors, funders and also partnerships that would assist with implementation of this work. Another thing that is very important given COVID-19 and climate, you look at activities for insurance schemes as climate risk transfer mechanisms.



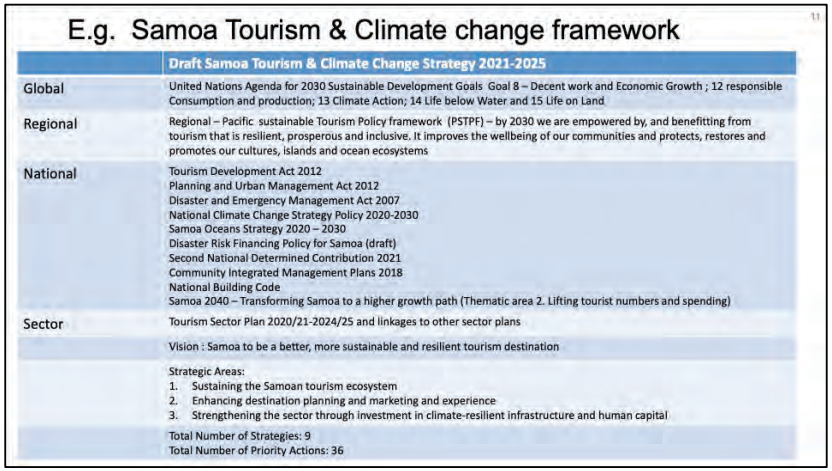
Just to give you some examples of how to mainstream climate change into existing tourism policies. It's important that long-term solutions at the national level are needed to enhance the capacity of the tourism industry in coordination with related government institutions and private sector associations to create a suitable enabling environment for climate resilience tourism businesses. It is therefore important for the integration of climate change and induced disaster risk into national tourism development plans and related policy instruments. As you can see on the right, it is a picture of a tourism development area, which developed a tourism development plan in Samoa. I just wanted to highlight that while they had the tourism development plan in place, it is also important that the communities that support the tourism industry are aware and also understand what this plan is. Through one of the UNDP tourism projects funded through the Global Environment Facility (GEF) we developed three dimensional models as you can see at the top picture. From these models you are clearly able to identify by a bird's eye view all the features and then we map on it the risks and what actions that are needed to do. Through this exercise the people are more aware of the climate risks and also what we have included in these tourism development plans and how these tourism development plans for further if we implemented it would ensure that we are implementing the national climate change policies that these have been integrated into. Other examples are integrating climate change risks into local destination level planning and management processes at tourism development areas. It is also important for disaster preparedness and response plans covering both tourism and local populations in an integrated way. You can also look at climate early warning and information services tailored to the tourism sector. We need to have information about weather and climate to inform tourists. A good example is that if we have climate data we know when a river is flowing or a river is not flowing. We can inform tourists in advance that this river is flowing for them. That would also



Some countries that have opted to use their existing Joint National Adaptation Plans which have taken steps to develop and implement a more integrated and action plan for climate change and disaster risk management. Since 2010, Pacific Island countries have taken steps to develop and implement this Joint National Adaptation Plan for climate change and DRM, and Tonga was the first country to develop its JNAP and get government approval in July 2010 with all the other Pacific Island countries that have followed suit. So through the NAP process, as I have informed before, they have opted to review their JNAPs to prioritize action, including activities for tourism. For example, you have there on the left Cook Islands 2nd Joint National Adaptation Plan, which has a sectoral approach to climate change and disaster risk management. This is also provided in the briefing documents that you have and identified under bullet point 27 for the JNAP for Cook Islands, they included activities for tourism for example strengthen and build resilience on the tourism sector to the impacts of climate change and disasters, promote policies for new and existing resort developments to become self-sufficient in terms of energy and environmentally-sound waste management, encourage hotel operators to identify shelters for their guests and also to develop a disaster preparedness and response plan for the tourism sector which considers the impacts of climate change and waste management. It's also important to note that for the development of these JNAPs, countries usually use resources from the Global Environment Facility, the Green Climate Fund and etc so it's important for the tourism sector, these are usually led by the Climate Change Focal Point when they develop these plans. From the tourism industry, it's very important that you are present in these workshops so in the process for the development of these plans and also that you mainstream these activities but also to ensure that these activities are relevant to the context of tourism and also that it would be implemented once the funds are received.



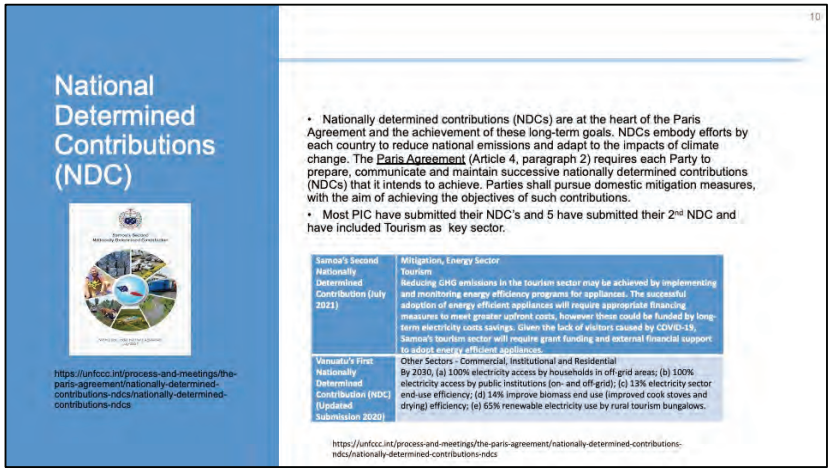
It is important that we also mainstream tourism into your National Adaptation Plans. National Adaptation Plants are a process established under the Cancun Framework. It enables parties to formulate and implement National Adaptation Plans as a means of identifying medium- and long-term adaptation needs and developing and implementing strategies and programmes to address those needs. It is also important to note since being implemented for least developed countries the NAPs have been viewed by other Pacific small island developing states as a means to identify the adaptation needs in the medium and long-term and to develop and implement strategies to address these needs. However, there are challenges in accessing financial resources for NAP formulation and implementation including a concept of GCF Readiness. That's why it's important that Pacific SIDS and also AOSIS have underscored this process. While there was sympathy for difficulties encountered by most parties, they argued there was sufficient support available if countries only requested it. Therefore we need to ensure that more work will be needed to be done in order to give effect to build our capacity into ensuring that not only we develop our National Adaptation Plans but also that the tourism sector is also mainstreamed within this National Adaptation Plan. Just to give example of our Pacific Island countries that have submitted their NAPs are Kiribati, Fiji and Timor Leste and other countries are also following suit. There are support programs for NAPs and constituted bodies that are actively supporting developing countries in their NAPs.



E.g. Samoa Tourism & Climate change framework

	Draft Samoa Tourism & Climate Change Strategy 2021-2025
Global	United Nations Agenda for 2030 Sustainable Development Goals Goal 8 – Decent work and Economic Growth ; 12 responsible Consumption and production; 13 Climate Action; 14 Life below Water and 15 Life on Land
Regional	Regional – Pacific sustainable Tourism Policy framework (PSTPF) – by 2030 we are empowered by, and benefitting from tourism that is resilient, prosperous and inclusive. It improves the wellbeing of our communities and protects, restores and promotes our cultures, islands and ocean ecosystems
National	Tourism Development Act 2012 Planning and Urban Management Act 2012 Disaster and Emergency Management Act 2007 National Climate Change Strategy Policy 2020-2030 Samoa Oceans Strategy 2020 – 2030 Disaster Risk Financing Policy for Samoa (draft) Second National Determined Contribution 2021 Community Integrated Management Plans 2018 National Building Code Samoa 2040 – Transforming Samoa to a higher growth path (Thematic area 2. Lifting tourist numbers and spending)
Sector	Tourism Sector Plan 2020/21-2024/25 and linkages to other sector plans
	Vision : Samoa to be a better, more sustainable and resilient tourism destination
	Strategic Areas: 1. Sustaining the Samoan tourism ecosystem 2. Enhancing destination planning and marketing and experience 3. Strengthening the sector through investment in climate-resilient infrastructure and human capital
	Total Number of Strategies: 9 Total Number of Priority Actions: 36

I just wanted to give you an example of a country Tourism and Climate Change Framework. This one is an example from Samoa note that following this presentation there will be a case study that will go more into detail of the Samoa Tourism Climate Change Framework by the Samoa Tourism Authority so you can see there they have their draft Samoa Tourism Climate Change Strategy and they've identified all the relevant frameworks at the global level that we have already discussed in the previous two slides. At the regional level you have the Pacific Sustainable Tourism Policy and at the National level they've listed their acts, policies and plans related to tourism. Then also they have their Tourism Sector Plan and linkages to other sector plans, they have a vision and then they have strategic areas. For example, sustaining the Samoa Tourism ecosystem, enhancing destination planning and marketing and experience, strengthening the sector through an investment climate resilient infrastructure and human capital. In this, they have a total number of strategies that lead to our strategic areas which is 9 and the number of priority actions is around 36.



National Determined Contributions (NDC)

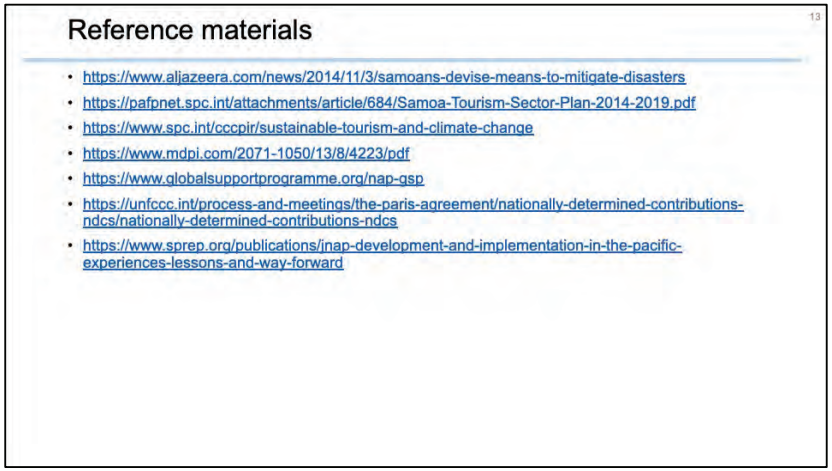
https://unfccc.int/process-and-meetings/the-paris-agreement/nationally-determined-contributions-ndcs/nationally-determined-contributions-ndcs

- Nationally determined contributions (NDCs) are at the heart of the Paris Agreement and the achievement of these long-term goals. NDCs embody efforts by each country to reduce national emissions and adapt to the impacts of climate change. The Paris Agreement (Article 4, paragraph 2) requires each Party to prepare, communicate and maintain successive nationally determined contributions (NDCs) that it intends to achieve. Parties shall pursue domestic mitigation measures, with the aim of achieving the objectives of such contributions.
- Most PIC have submitted their NDC's and 5 have submitted their 2nd NDC and have included Tourism as key sector.

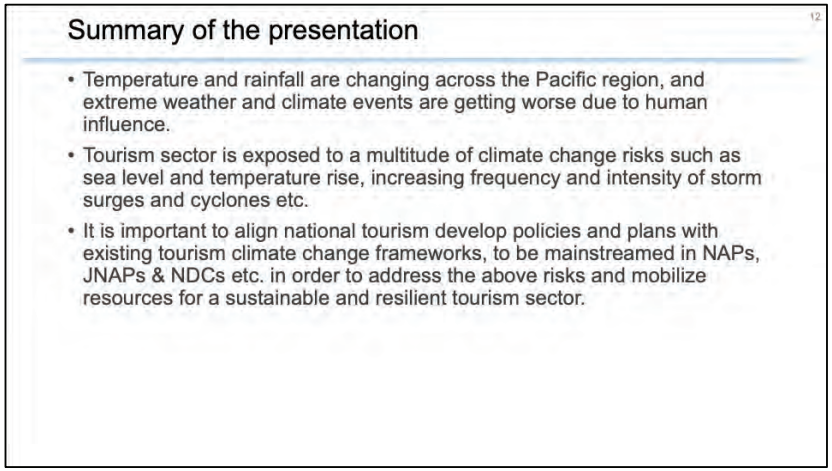
Samoa's Second Nationally Determined Contribution (July 2021)	Mitigation, Energy Sector Tourism Reducing GHG emissions in the tourism sector may be achieved by implementing and monitoring energy efficiency programs for appliances. The successful adoption of energy efficient appliances will require appropriate financing measures to meet greater upfront costs, however these could be funded by long-term electricity costs savings. Given the lack of visitors caused by COVID-19, Samoa's tourism sector will require grant funding and external financial support to adopt energy efficient appliances.
Vanuatu's First Nationally Determined Contribution (NDC) (Updated Submission 2020)	Other Sectors - Commercial, Institutional and Residential By 2030, (a) 100% electricity access by households in off-grid areas; (b) 100% electricity access by public institutions (on- and off-grid); (c) 13% electricity sector end-use efficiency; (d) 14% improve biomass end use (improved cook stoves and drying) efficiency; (e) 65% renewable electricity use by rural tourism bungalows.

https://unfccc.int/process-and-meetings/the-paris-agreement/nationally-determined-contributions-ndcs/nationally-determined-contributions-ndcs

For National Determined Contributions or NDCs, these are at the heart of the Paris Agreement and achievement of these long-term goals. The NDC's embody goals by each country to reduce their national emissions and adapt to the impacts of climate change. The Paris Agreement Article 4 Paragraph 2 requires each party to prepare, communicate and maintain successful National Determined Contribution or NDCs that it intends to achieve. So parties shall pursue domestic mitigation measures with the aim of achieving the objectives of such contributions. Most Pacific Island countries have submitted their NDCs, and 5 to data have submitted their National Determined Contributions and most of these have also included tourism as a key sector. For example, the Samoa National Determined Contribution, the 2nd National NDC also included the Mitigation Energy sector and Tourism and it looked at activities reducing GHG emissions in the Tourism sector may be achieved by implementing and monitoring energy efficient programs for appliances for successful adoption of energy-efficiency appliances will require an appropriate financial measures to meet greater upfront costs. However, these could only be funded by long-term electricity cost savings. Given the lack of visitors caused by COVID-19, Samoa Tourism sector will require grant funding and external financial support to adopt energy efficient appliances. Because Samoa has included this in their 2nd NDC, this is also a way of mobilising resources to implement these activities because the activity has been mainstreamed in the national climate change policy and plan. In regards to just to give an example of Vanuatu's 1st National Determined Contribution, they identify the Tourism sector in their first NDCs and which they also included other sectors, commercial, institutional and residential by 2030 (a) 100% electricity access by households in off-grid areas (b) 100% electricity access by public institutions (on and off grid) (c) 13% electricity sector end-use efficiency (d) 14% improve biomass end-use (improved cook stoves and drying) efficiency and (e) the most important one is that 65% renewable energy use by rural tourism bungalows. So they have identified through this national climate change policy and plan the need for their target. Therefore they would need resources to implement this to benefit the tourism sector.



Please find also reference materials. I have also included Al Jazeera news on a tourism and climate change project that will be interesting to watch on YouTube. Also all the other reference materials that would support your work with this module. With that I'd like to take the opportunity to thank you for listening to this presentation. I hope this will be useful for the implementation of your reports and activity for this module. Fa'afetai tele lava (thank you very much).



To sum up my presentation I discussed the temperature rainfall changing across the Pacific region and extreme weather and climate events are getting worse due to human influence in the background information and then discuss more in regards to the climate and disaster risk that the tourism sector is exposed to multiple climate risk such as sea-level rise and temperature rise, increase in frequency and intensity of storm surges and cyclones. I took you through the different climate change frameworks and the importance of aligning national tourism development policy and plans with existing tourism climate change frameworks and its importance to be mainstreamed in the National Adaptation Plans, the Joint National Adaptation Plans, the NDCs. These are all important in order to address the above risks and mobilize resources for a sustainable and resilient tourism sector.

THEORY OF CHANGE IN DEVELOPING BANKABLE PROJECT PROPOSALS

DR. PETER KING

SENIOR POLICY ADVISOR

INSTITUTE FOR GLOBAL ENVIRONMENTAL STRATEGIES

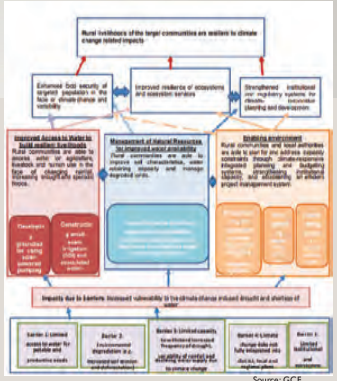
BANGKOK REGIONAL CENTRE

A Theory of Change in developing bankable project proposals.

Thank you

THEORY OF CHANGE

- **SOME COMMON QUESTIONS**
- **What is the difference between a "theory of change" and the "logical framework"?**
- **What are the implementation implications of the theory of change?**
- **Why aren't the climate predictions a required element of the theory of change?**
- **Why is a theory of change best presented as a diagram instead of narrative text?**
- **Who should be involved in developing the theory of change?**



Source: GCF

Now some common questions that are often asked in relation to the theory of change.
Firstly, what is the difference between a theory of change and the logical framework? Often, they appear to be used interchangeably.

What are the implementation implications of a theory of change? Why are climate predictions a required element of the theory of change? And why is the theory of change often best presented as a diagram instead of a narrative text?
And who should be involved in developing the theory of change? Well, we'll try and answer some of those questions as we go through the presentation.

GCF GUIDANCE ON THEORY OF CHANGE

- The project scoping exercise should start with the identification of the climate change problem that the proposed project is aiming to address. This determination will form the starting point and basis for the theory of change diagram, which articulates how the project will address the identified problem.
- The theory of change, despite being called a "theory", is a methodological approach that allows AEs and project developers to design and plan a project by first setting up the long-term project goals and objectives then mapping backwards to identify the necessary preconditions to meeting those goals, the project outcomes and outputs, as well as the assumptions under which the theory of change is developed. In this way, the theory of change clearly articulates how the results chain will cascade from the theory of change statement to the project activities.
- The innovation of the theory of change lies in making the distinction between desired and actual outcomes, as well as in requiring stakeholders to model their desired outcomes before they decide on forms of intervention to achieve those outcomes.

GCF has provided guidance on a theory of change, and this presentation will help to understand exactly what GCF is looking for in relation to theory of change.
Firstly, the project scoping exercise should start with the identification of the climate change problem that the proposed project is aiming to address. Generally, that's done through a problem tree.
This determination will form the starting point and the basis for your theory of change diagram or narrative, which articulates how the project will address the identified problem.
The theory of change, despite being called a theory. is actually a methodological approach that allows accredited entities and project developers to design and plan a project by first setting up the long-term project goals and objectives and then mapping backwards to identify the necessary preconditions and inputs to meeting those goals.
The project outcomes and outputs as well as the assumptions under which the theory of change is developed.
In this way, a theory of change clearly articulates how the results chain will cascade from a theory of change statement to the project activities.
The innovation of the theory of change lies in making the distinction between what is a desired outcome and the actual outcomes, as well as in requiring stakeholders to model their desired outcomes before they decide on the forms of intervention to achieve those outcomes.

The **climate context** provides the scientific underpinning for evidence-based climate action decision-making and the theory of change for all activities funded by GCF. It ensures that the set of causal linkages between the climate and climate impacts/hazards and action and societal benefits is fully grounded in the best available climate data and science. It demonstrates that the proposed interventions advance a national priority related to climate change mitigation and/or adaptation in terms of reducing GHG emissions or improving the resilience of people and communities and should meet at least one of the eight GCF results areas.

The **theory of change** explains to the funder (GCF) why you think your project will work, and why the funder should expect the project to bring about the results you envision for the project. A good theory of change is like the backbone of a well-designed and fundable project proposal. Many proposals are rejected because they don't include a theory of change, or because the theory of change doesn't adequately show how the project moves from problem to solution.

The climate context provides the scientific underpinning for evidence-based climate action, decision making and the theory of change for all activities funded by the GCF. It ensures that the set of causal linkages between the climate and climate impacts or hazards, and action and societal benefits is fully grounded in the best available and most up to date climate data and science.
It demonstrates that the proposed interventions advance a national priority related to climate change mitigation and or adaptation in terms of reducing greenhouse gas emissions or improving the resilience of people and communities and should meet at least one of the eight GCF resolve areas.

The Theory of Change explains to the funder, that is the GCF, why you think your project will work and why the funder should expect the project to bring about the results you envision for the project.

A good theory of change, therefore, is like the backbone of a well designed and fundable project proposal. Many proposals, in fact, are rejected because they don't include a theory of change or because the theory of change doesn't adequately show how the project moves from problem to solution.

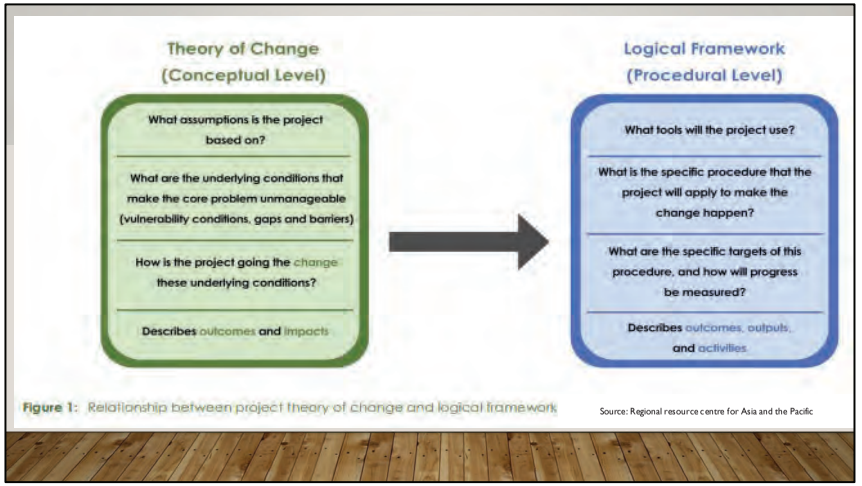


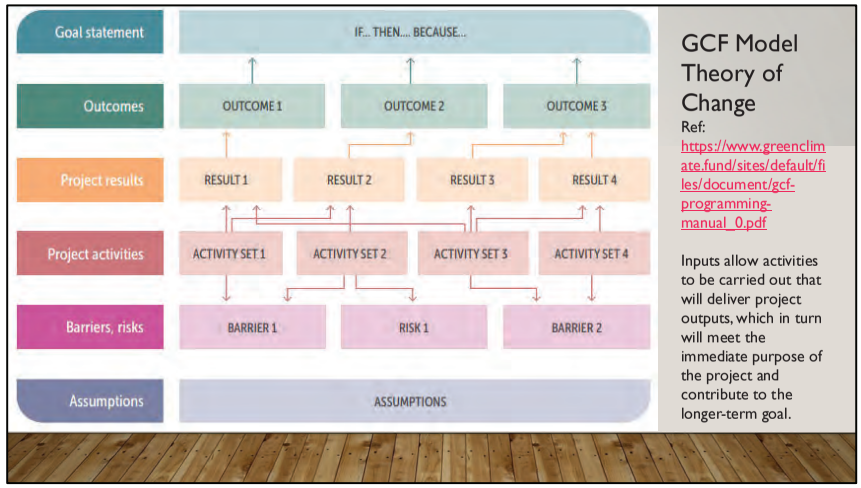
Figure 1: Relationship between project theory of change and logical framework

Source: Regional resource centre for Asia and the Pacific

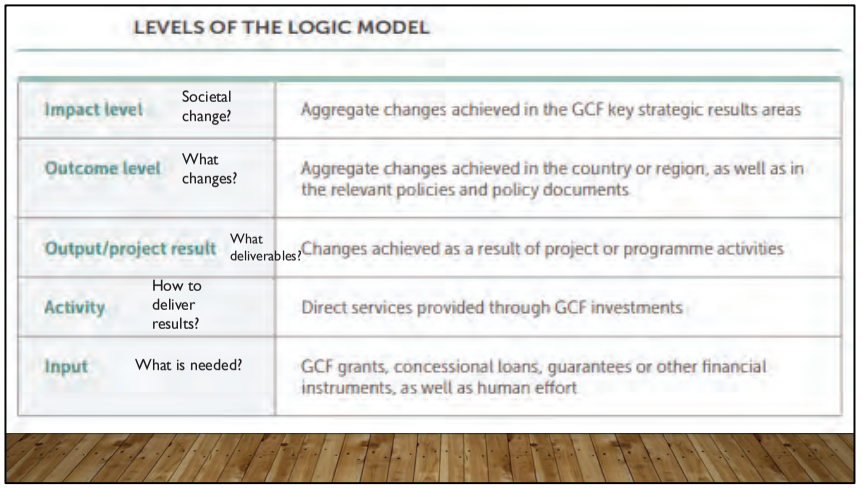
A good way to think about the difference between a theory of change and the logical framework is that the theory of change is essentially at a conceptual level.

So what assumptions is a project based on? What are the underlying conditions that make the core problem currently unmanageable, often through vulnerability assessments or identification of gaps and barriers?

And how is the project going to change these underlying conditions?
It will describe the outcomes and impacts at a high level of the logic chain.
The logical framework, however, is a more procedural arrangement where we look at what tools will a project use, what are the specific procedures that the project will apply to make the change that's desired actually happen?
And what are the specific targets of this procedure and how will progress be measured? And it describes the outcomes, the outputs and activities, as well as the input supports to achieve those activities.

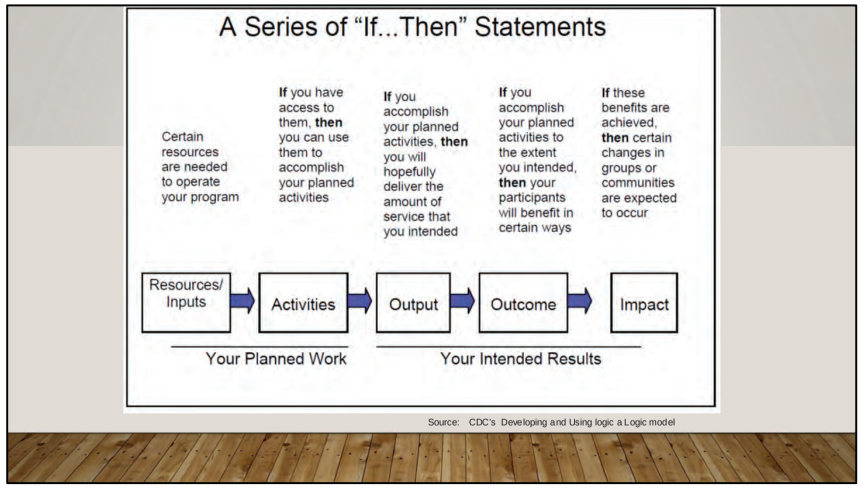


The GCF has provided a standard diagram that is relatively easy to fill in and it basically moves from the understanding of that inputs will allow activities to be carried out that will deliver project outputs which in turn will meet the immediate purpose of the project and contribute to the longer term goal that GCF is trying to achieve through its overarching paradigm shift.
Importantly, the goal statement also operates on a logical basis and says if we carry out activity X then we achieve output Y because we have undertaken a series of inputs.



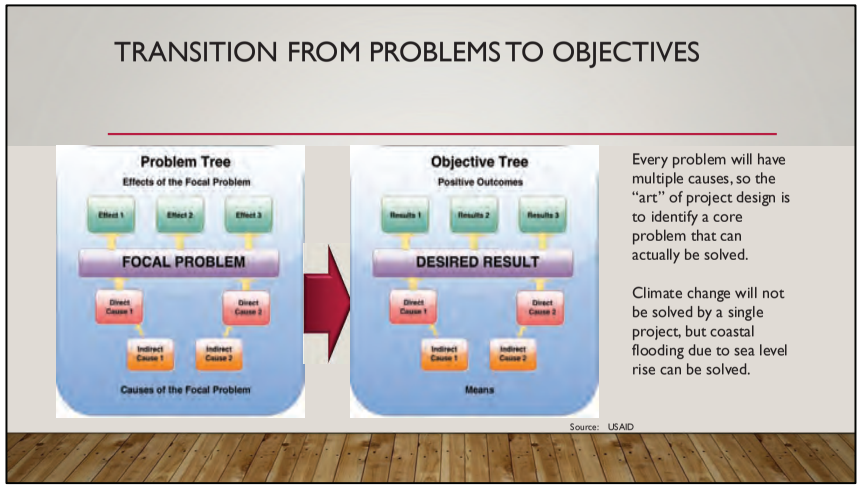
And there are different levels of the logic model that apply in the theory of change. At the impact level, which is the highest level, we're actually looking for societal change. What are the aggregate changes achieved in the GCF key strategic result areas?

At the outcome level, we're asking what changes? What changes are achieved in the country or region or project area, as well as in the relevant policies and policy documents at the national level? At the output or project result level we're really asking what are the tangible deliverables that the project will provide?
What are the changes achieved as a result of a project or programme activities?
At the activity level we're asking the question how do we deliver the results? And these are the direct services provided through GCF investments. And at the input level we ask what is needed to deliver the results?
These can be the GCF grants, concessional loans, guarantees or other financial instruments as well as the human effort that goes into project implementation.



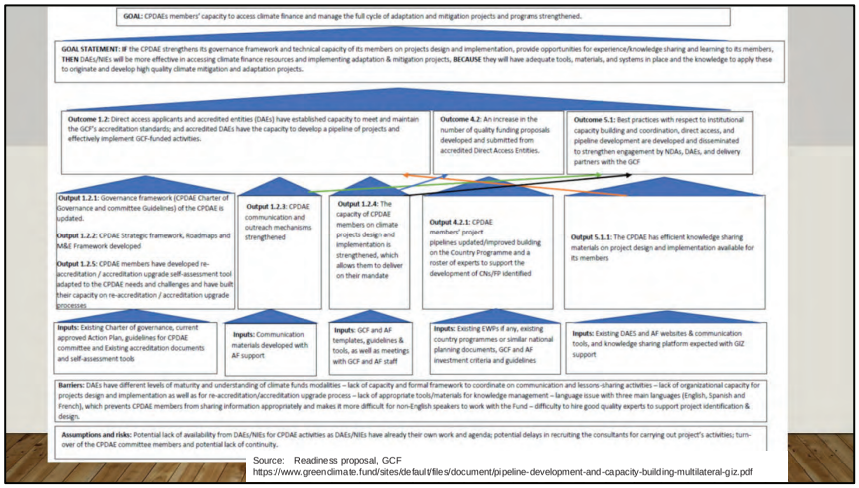
And the logic that underpins the theory of change is that you need certain resources to operate your programme or your project.
These are the inputs and if you have access to these inputs then you can use them to accomplish your planned activities. And if you accomplish your planned activities, then you will hopefully deliver the amount of products and or services that you intended as part of your project design.
And these are the outputs. And if you accomplish your outputs and planned activities to the extent you intended, then your participants or beneficiaries will benefit in certain ways. These are your outcomes.

And if these benefits to the participants and outcomes are achieved, then certain changes in organisations, communities or systems might be expected to occur and contribute to the impact that the GCF is looking for.



Now every problem will have multiple of course.

So the art of project design is to automatically identify a core problem that can actually be solved. Climate change is so enormous and so all encompassing it cannot be solved by a single project. But coastal flooding in a specific area due to sea level rise is something that can be solved through an adaptation project.
So it's really important then to identify a problem which is solvable and then the desired result is something which is actually achievable.



Source: Readiness proposal, GCF
https://www.greenclimate.fund/sites/default/files/document/pipeline-development-and-capacity-building-multilateral-giz.pdf

I won't go through the detail of this particular slide is simply to show the kind of diagrammatic format that the GCF is looking for.
In addition to the narrative type approach for the theory of change.

GOAL	Sustaining community resilience to climate change risks
GOAL STATEMENT	IF communities have access to safe shelter, water and food supplies all year-round and adopt climate resilient practices in their daily lives THEN community resilience can be sustained BECAUSE they are better prepared for climate change risks
RESULTS (Fund level) – defined by GCF	• A1.0 Increased resilience and enhanced livelihoods of the most vulnerable people, communities, and regions • A2.0 Increased resilience of health and well-being, and food and water security • A3.0 Increased resilience of infrastructure and the built environment to climate change
OUTCOMES (Fund level) – defined by GCF	• A5.0 Strengthened institutional and regulatory systems for climate-responsive planning and development • A6.0 Increased generation and use of climate information in decision-making • A7.0 Strengthened adaptive capacity and reduced exposure to climate risks • A8.0 Strengthened awareness of climate threats and risk-reduction processes
RESULTS (Project level) – defined by the project	• An effective island /district and community development and CCDRR plans • Community-driven climate resilient interventions are implemented and sustained • Strengthened capacity of the Local Government and NGOs /CSOs to support community-based adaptation measures • Strengthened leadership in climate change and disaster risk reduction within the Local Government, NGOs /CSOs and the Community • An operational and effective community-based small grants programme

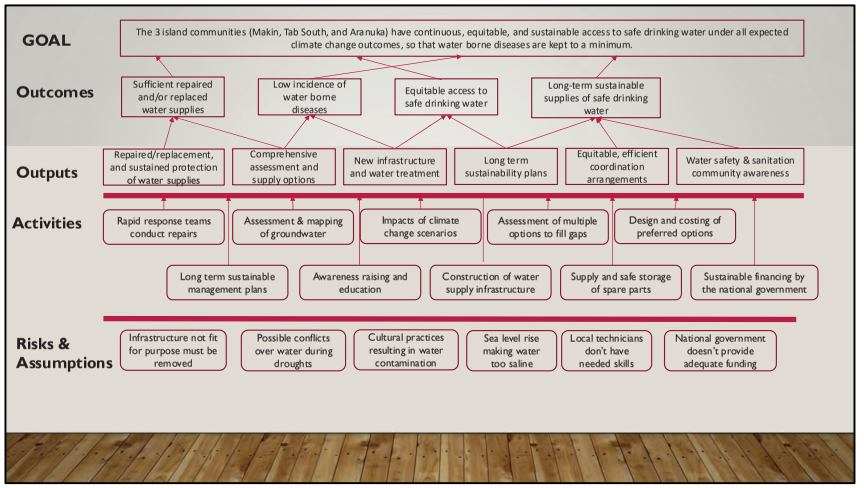
Here is a fairly typical narrative type approach for a theory of change. It starts with an overarching goal which is sustaining community resilience to climate change risks. It has this if then because goal statement if communities have access to safe shelter, water and food supplies all year round and adopt climate resilient practices in their daily lives, then community resilience can be sustained because they're better prepared for any future climate change risks.

And the results which are at the fund level and defined by the GCF are increased resilience and enhanced livelihoods, increased resilience of health and wellbeing, food and water security, increased resilience of infrastructure and the built environment to climate change and these are defined by the GCF and must be reflected in the project design.

Similarly, at the outcome level these are also defined by the GCF and in this case would be a 5.0 through to a 8.0 relating to strengthened institutional and regulatory systems, increased generation and use of climate information, strengthen adaptive capacity and reduced exposure to climate risks and strengthen awareness of climate threats and risk reduction processes.

And the results are actually defined at the project level and are defined by the project proponent and these may be things like an effective island or district and community development with climate change and disaster risk reduction plans. Community driven climate impact interventions are implemented and sustained.
Strengthen capacity of local government and NGOs, strengthen leadership in climate change and DRR within the local government, and an operational and effective community based small grants programme to provide the funding to carry out these interventions.

So I'll leave it there and thank you for your attention. I hope this has given you some insight into what is a theory of change and how important it is in designing a bankable project, particularly for the GCF.



Here is another version, a simpler version of that rather complicated theory of change.
And here you can see that there is a logical connection between the various activities, the intended outputs, the outcomes and the ultimate goal of the project. And below the line there are the risks and assumptions that underpin the project design.

CONTENTS

1. Introduction
2. Problem tree
3. Objective tree
4. Logical framework
5. Summary

CBCRP-PCCC Training Course

“Enhancing Climate Resilience in Tourism in the Pacific”

Government of Samoa, SPREP and JICA

Module 3. Problem and Objective trees and logical framework

3.2 Project objectives

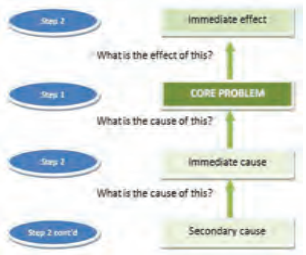
Peter King | Senior Policy Advisor
IGES

Tetsuya Yoshida
JICA Short-term Expert
Oriental Consultants Global, Co., Ltd.

Brainstorming a "Problem Tree"

Starting point: construct a **problem tree** that links causes and effects

1. Define "**core problem**"
   - Displacement due to flooding
   - Water/sanitation deficiencies
2. Identify **direct causes** and **direct effects**
   - Cause- Heavy rains
   - Cause- Overburdened infrastructure
   - Cause- Settlement in flood prone areas
   - Cause- Obstructed drains
   - Effect - Increased vulnerability
   - Effect - Damage to infrastructure
3. Identify **secondary (indirect) causes**
   - Rural-urban migration
   - Lack of planning
   - No responsible lead agency
   - Inadequate urban finance



Source: USAID

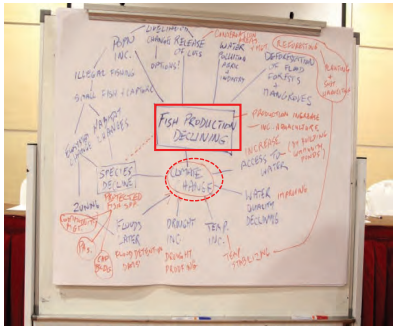
We start off with brainstorming a problem tree. A problem tree is something that links causes and effects. It basically has 3 steps. The first step is to define what is a core problem you're trying to solve. It could be something like displacement due to flooding or it could be water or sanitation deficiencies. Then, you identify the direct causes and the direct effects. The cause of flooding could be heavy rains or could be overburdened infrastructure or it could be settlements in flood-prone areas or obstructed drains. The effect could be an increase of vulnerability of communities or could be damage to roads and other infrastructure.
Then, the third step is to identify the secondary or underlying driving causes. These could be issues like so many people are moving from rural areas to urban areas, could be a lack of urban planning, could be that there is no responsible lead agency driving the process, or it could be that there is inadequate urban finance. The secondary cause leads to the immediate cause. The immediate cause leads to the core problem, and the core problem leads to the immediate effect. That's the logical chain of events that underpins a problem tree.

Introduction

- In formulating *a climate change adaptation/ mitigation project*, the theory of change and the **logical framework** are key elements.
- They are described as tools of logic that connect cause and effect.
- All projects are designed to overcome a problem, but problems may have multiple causes.
- How do we know if we have identified the **core problem** and the **main causes**?
- All projects are intended to achieve a purpose or a goal and if it fails to achieve that end point (or ultimate effect) then the project is regarded as a failure. In the case of climate change adaptation projects, failure may also result in maladaptation.
- This session is intended to help you come to the right decisions that will lead to a convincing logical framework that will guide successful implementation.

In formulating any climate change adaptation project, the theory of change in the logical framework are key elements but what do they really mean? They're described as tools of logic that connect cause and effect but how do we uncover those connections? Now all projects are designed to overcome a specific problem, but problems may have maltiple causes so how do we know if we have identified the core problem and the main causes? Again all projects are intended to achieve a purpose or a goal and if the project fails to achieve that in point or ultimate effect.
Then, the project is regarded as a failure. In the case of adaptation projects, failure may also result in what's called maladaptation or the opposite to what is expected. So, this session is intended to help you come to the right decisions that would lead to a convincing theory of change and a logical framework that will ultimately guide successful implementation.

The problem tree is the “engine” of the project design



Source: USAID

- Involve the project beneficiaries and ask them to brainstorm about what they think the problem is.
- Do not assume you know what the real problem is.
- Do not start from an assumption that climate change is the problem.

Useful tips:
- It is critical to identify the core problem right in formulating a project.
- Avoid including contributing causes in the core problem statement.
- Identify one most important issue as the core problem, and avoid including multiple elements in the core problem (e.g. property damage due to severe floods).

Now the problem tree is really the engine of the project design and it's always advisable to involve the project beneficiaries and ask them to brainstorm about what they think the problem is. As an expert don’t assume you know what the real problem is. You may not have sufficient local knowledge. And don't start from an assumption that climate change is a problem simply because you're preparing a concept note for the GCF. In this particular case that I've shown here where the brainstorming is very messy, the participant started with an assumption that
climate change was the core problem but as the brainstorming progressed it was realized that actually the core problem was a decline in fish productivity and climate change was really just one of multiple causes.

Brainstorming

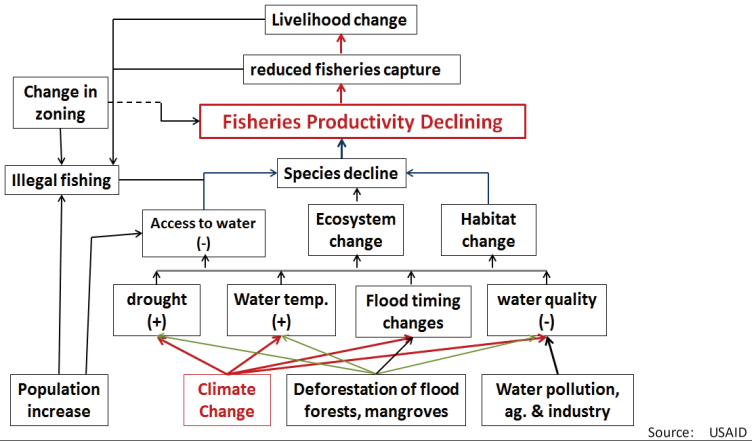
- Break participants into small groups.
- Prepare flipcharts, post-it notes, marker pens, and a table to spread out.

- Step 1. Consider what you think **the main problem** is.
- Step 2. Analyse what is **the main cause** of that main problem.
- Step 3. Check if there is **any other cause** of that direct cause.
- Step 4. Re-arrange all the answers in a tree.
- Step 5. Do the same for the effects, identify the **direct effects** and **indirect effects** of that main problem.

- You will be asked to do the same in an exercise in this training course.

Now to get to the problem tree. The best way of doing this is through brainstorming.
With breaking participants into relatively small groups so that every voice is heard making sure that they're all well equipped with flip charts, post-it notes, marker pens and a table to spread out on. And you start by asking each person what they think the main problem is and write down their answers on a post-it note. In a second-round ask each person what they think is the main cause of that core problem, and in the third round ask if there is any other cause of that direct cause. You rearrange all the answers in the form of a tree with roots and a trunk and some branches, starting off with a consensus on what you believe to be the main or the core problem. Step back from that and check if any key cause has been missed. Now do the same for the effects starting with the direct effects and then possibly secondary or indirect effects.
Now take note of these directions because later on in the course you'll actually be asked to do this in an exercise.

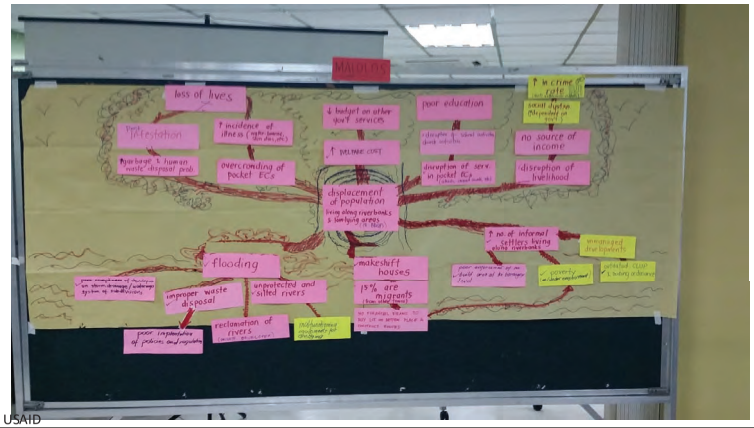
Reorganise the messy brainstorming



Source: USAID

Once you've done that then it's always good to try and reorganize the messy brainstorming approach into something which ultimately could go into a project document and demonstrate some clear thinking in terms of what are the causes, what is the core problem and what are the effects.

Use post-it notes to move things around

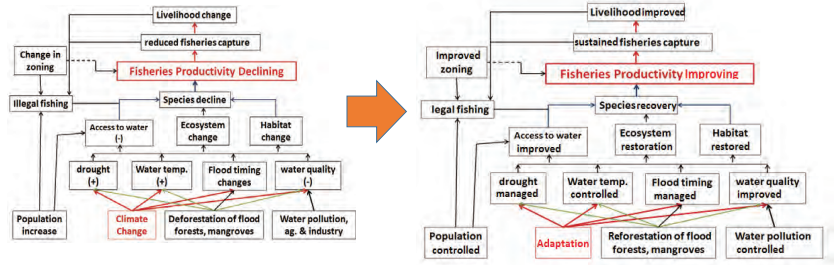


Source: USAID

Now the reason we suggest to use post-it notes is so that you can move things around on the roots and branches of the tree that enables you to organize your thoughts in a more logical fashion.

An Objectives Tree

- Objectives trees transform all problems from your Problem Tree into an objective – Each negative problem will become a positive objective.
- Each cause can be transformed into a possible project activity or component. For example, water pollution control or reforestation could be key activities.

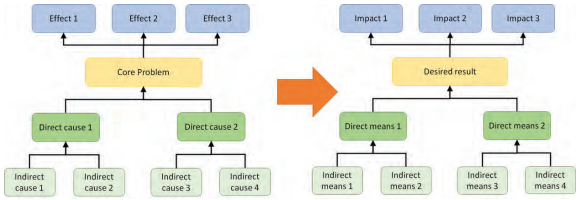


Source: USAID

We come up with an objectives tree by basically transforming all of your problems from your problem tree into an objective. So each negative problem is then turned around to become a positive objective. And note again that climate change might not be the core problem but it could be one of the contributing objectives. Below the core result or project output, each cause can be transformed into a possible project activity or component. For example, in this objectives tree, water pollution control, reforestation or ecosystem restoration could be key activities that ultimately contribute to species recovery and the improvement in fisheries productivity.

476

Transition from Problem tree to Objectives tree



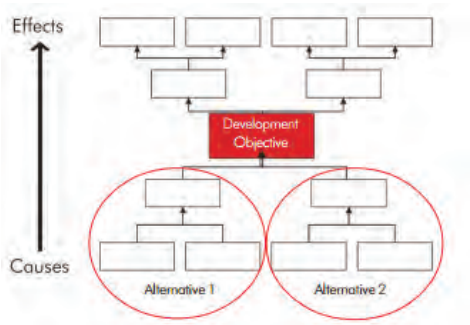
- Every problem will have multiple causes.
- The "art" of project design is to identify a Core Problem that can actually be solved.
- Climate change will not be solved by a single project, but an eroding coastline due to sea level rise can be solved.
- Solving the Core Problem will provide the desired result at the end of the project. This result will contribute to other positive outcomes and long-term impacts.

Tips:
- Problem tree and objectives tree are mirror images of each other – one negative, the other positive.
- The Means you identify in the Objectives Tree will be the basis of Project Activity in your Logical Framework.

Source: USAID

Once we have a problem tree worked out, it's relatively simple to transition from a problem tree to an objectives tree. Every problem will have multiple causes so the art of project design is to firstly identify your core or focal problem that can actually be solved. Climate change is a global problem, it is not going to be solved by a single project but an eroding coastline in a specific location due to the sea level rise can be solved. Now solving the core problem will provide the desired result at the end of the project, but that result in turn will contribute to other positive outcomes and long-term impact beyond the scope of the specific project.

Use the objectives tree to decide on project alternatives



- There may be several alternative ways that a project can contribute to the development objective.
- The objectives tree can help to illustrate these alternative pathways and lead to a consensus on which one shows the most promise for reaching the central development objective.
- In some cases, the objectives tree might highlight the possibility of complementary projects that will combine to reach the central development objective.

Useful tips:
- Direct Causes and Indirect Causes you identified in the Objectives Tree can be the basis of your Logical Framework (transformed as Project Activity and Inputs).
- You can put only the selected Causes in your Logical Framework which are relevant to your project objectives.

Source: ADB

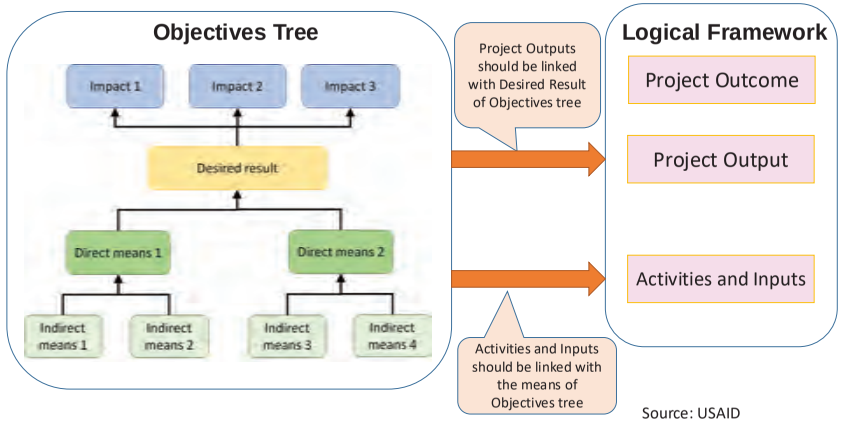
Now we can also use the objectives tree to decide on project alternatives. There are often several alternative ways that a project can contribute to the development objectives. The objectives tree can help you to illustrate these alternative pathways and lead to a consensus on which one shows the most promise for reaching the central development objective. In some cases, the objectives tree might also highlight the possibility of complementary projects that will each combine to reach the central development objective.

Check that no critical cause or effect has been missed

- Once your problem tree and objectives tree have been completed, stand back and discuss if anything has been missed or if a specific cause or effect is too minor to include.
- In the fisheries productivity example, one of the key elements that the brainstorming missed was the lack of capacity in the local compliance and enforcement agency, which was a contributing cause of the water pollution problem, the deforestation problem, and inadequate control of the illegal fishing. This omission could have been because the brainstorming group did not include people outside the government or potential beneficiaries.
- If this capacity issue was not addressed, then the whole project could fail. Later on we will see why the logical framework would have included this as a potential risk or assumption.

Once your problem tree and your objectives tree have been completed, stand back, have them side by side and discuss if anything is being missed or if a specific cause or effect is too minor to include. In the fisheries productivity example, one of the key elements with the brainstorming missed was the lack of capacity in the local compliance and enforcement agency, which was a contributing cause of the water pollution problem, the deforestation problem, and inadequate control of the illegal fishing. This omission could have been because the brainstorming group did not
include people outside the government or potential beneficiaries. Now if this capacity issue was not addressed, then the whole project could fail and later on we'll see why the logical framework would have included this as a potential risk or an assumption.

Develop the Logical Framework from the Objectives Tree



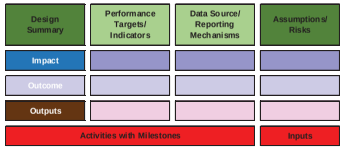
Source: USAID

Going from the objectives tree to the logical framework is a simple process where the means in the objectives tree are basically what becomes the inputs and activities that lead to the end of project outputs, which is the same as the desired result of the objectives tree. The purpose or outcome and the goals or impacts of the extension beyond the project boundary is equivalent to the results both direct and indirect that come from the objectives tree.

478

Logical Framework

- A logical Framework is also called:
  - Project Framework
  - Logframe
  - Project Decision Matrix
  - Results Framework
  - Design and Monitoring Framework
- Standard sections:
  - **Four Columns** – Design Summary (Description), Performance Targets, Monitoring Mechanisms, and Assumptions and Risks;
  - **Five Rows** – Goal, Purpose (Outcome), Outputs, Activities, Inputs.
- Note hierarchical "logical" relationships vertically and horizontally, link all 20 frames.
- **Inputs** allow **activities** to be carried out that will deliver project **outputs**, which in turn will meet the immediate purpose (**outcome**) of the project and contribute to the longer-term **goal**.



Source: ADB

Now turning to the logical framework, sometimes is also called the project framework or shortened to logframe. Sometimes it's called a project decision matrix, a results framework or a design and monitoring framework. These are essentially different terms for the same matrix. There are standard sections. There are four columns: a design summary or description, performance targets, monitoring mechanisms and assumptions and risks. And there are 5 rows: the goal, the purpose sometimes called an outcome, outputs, activities and inputs. So note that there is a hierarchical logical relationship both vertically and horizontally that links together all 20 frames of the logical framework. A way to understand this is that the inputs allow activities to be carried out that will deliver the project outputs, which in turn will meet the immediate purpose of the project and contribute to the longer-term goal.

Logical framework approach of Green Climate Fund (GCF)

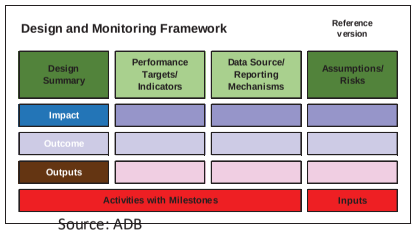
H.1.1. Paradigm Shift Objectives and Impacts at the Fund level[1]						
Paradigm shift objectives						
Increased climate resilient sustainable development	Please elaborate on the paradigm shift objectives to which the project/programme contributes.					
Expected Result	**Indicator**	**Means of Verification (MoV)**	**Baseline**	**Target**		**Assumptions**
				Mid-term (if applicable)	Final	
Fund-level impacts						
Choose appropriate expected results	*Please select relevant GCF indicators from the Fund's performance measurement framework. More than one indicator may be selected per expected impact result.*					

In this Logframe template (version 2.0), GCF specifies the ultimate goal (paradigm shift), fund-level impacts, and core indicators.
In addition to the core indicators, GCF also suggests additional indicators at:
https://www.greenclimate.fund/sites/default/files/document/mitigation-adaptation-performance-measurement.pdf
https://www.greenclimate.fund/document/integrated-results-management-framework

Paradigm shift objective: Increased climate resilient sustainable development
Fund-level impacts (adaptation):
- ✓ 1.0 Increased resilience and enhanced livelihoods of the most vulnerable people, communities, and regions
- ✓ 2.0 Increased resilience of health and wellbeing, and food and water security
- ✓ 3.0 Increased resilience of infrastructure and the built environment to climate change threats
- ✓ 4.0 Improved resilience of ecosystems and ecosystem services

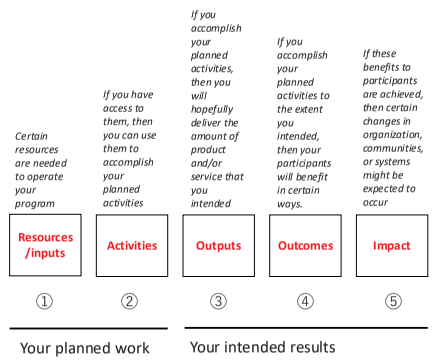
Core indicators (for adaptation): e.g. Total Number of direct and indirect beneficiaries; Number of beneficiaries relative to total population; Number and value of physical assets made more resilient to climate variability and change, considering human benefits (reported where applicable)

Performance targets



Source: ADB

- ➢ To ensure that each design "element" is implemented as planned, performance **targets** are specified, as are the mechanisms for **measuring** these targets – plus the **risks** that could upset achievement are explicitly recognized and assumed to be mitigated (by another project, by the government agency, or by other means).
- ➢ Unmitigated or unforeseen risks could torpedo an otherwise well-developed project.



The way the Green Climate Fund approaches the logical framework is worthwhile getting a better understanding as you will often be involved in looking at this framework. The first thing to note is that the ultimate objective or the impact that is intended is specified as a paradigm shift objective of the GCF. Given that the overall mandate for the GCF is a paradigm shift. In the case of an adaptation project, this is increased climate-resilient sustainable development. The GCF also defines fund level impacts and in the case of an adaptation project, there are basically four of these:
increased resilience and enhanced livelihood with the most vulnerable people, communities and regions, increased resilience of health and well-being and food and water security, increased resilience of infrastructure and the built environment to climate change threats, or improved resilience of ecosystems and ecosystem services. Now for each of these impacts GCF has also indicated a number of core indicators. In the case of an adaptation project, it is the total number of direct and indirect beneficiaries plus the number of beneficiaries relative to the total population.
It could also be the number in value of physical assets made more resilient to climate variability and change considering human benefits where applicable.
Note that GCF specifies the ultimate goal, the fund level impacts and the core indicators. In addition to these core indicators, the GCF also suggests

In relation to performance targets, it's important to ensure that each design element is implemented as planned. So, performance targets are specified as well as the mechanisms for measuring those targets. Then in turn, the risks that could upset achievement are explicitly recognized and assumed to be mitigated either by another project, by the government agency or by other means. Unmitigated or unforeseen risks could actually torpedo an otherwise well-developed project. Another way to think about the logic of the logical framework is that your planned work will consist of the resources and inputs that you have available to operate your program. These contribute to a certain number of activities, so if you have those inputs, you can use them to accomplish your planned activities. These in turn lead to your intended results. Firstly, if you accomplish your planned activities, then you will hopefully deliver the amount of product or service that you intended at the end of the project. If you achieve those outputs, then you may benefit wider outcomes at your national level, at the regional level, or at the global level and if you achieve those outcomes
then you may be able to contribute in some way to much broader impact, such as the Paris agreement for example.

Logical framework approach of GCF (cont.)

H.1.2. Outcomes, Outputs, Activities and Inputs at Project/Programme level

Expected Result	Indicator	Means of Verification (MoV)	Baseline	Target		Assumptions
				Mid-term (if applicable)	Final	
Project/programme outcomes	**Outcomes that contribute to Fund-level impacts**					
Choose expected outcome	*Please select relevant GCF indicators from the Fund's performance measurement framework. More than one indicator may be selected per expected impact result.*					
Specify other expected results						
Specify other expected results						
Project/programme outputs	**Outputs that contribute to outcomes**					
1.						
2.						
3.						
Activities	**Description**		**Inputs**		**Description**	
1.1.			1.1.1.			
1.2.			1.1.2.			
2.1.			1.1.3.			
...			...			

Outcomes (for adaptation):

- 5.0 Strengthened institutional and regulatory systems for climate responsive planning and development
- 6.0 Increased generation and use of climate information in decision-making
- 7.0 Strengthened adaptive capacity and reduced exposure to climate risks
- 8.0 Strengthened awareness of climate threats and risk reduction processes

Outputs, Activities, Inputs:
to be uniquely designed by the project

The latest template of GCF funding proposal and results management framework can be found at:
https://www.greenclimate.fund/document/funding-proposal-template
https://www.greenclimate.fund/document/integrated-results-management-framework

480

Moving further down in the logical framework to the outcomes. The GCF also specifies the outcomes. In the case of adaptation projects, these are again four: strength and institutional and regulatory systems for climate responsive planning and development, increased generation and use of climate information in decision-making, strengthened adaptive capacity and reduced exposure to climate risks, and strengthened awareness of climate threats and risk reduction processes. Then to go one step further down to the project or program outputs. These are left up to the program designer or the project designer to specify. Then you come down to the activities and a description of those and the inputs required to achieve each of those activities and again a description of those and that information then goes into your budget proposal.

Note:
https://www.greenclimate.fund/sites/default/files/document/mitigation-adaptation-performance-measurement.pdf
Please refer to page 9 and 10 of the document “Mitigation and adaptation performance measurement frameworks” for outputs examples of GCF.

additional indicators and there is a website where you can see those additional indicators that you may use in your own project designs.

Note:
https://www.greenclimate.fund/sites/default/files/document/mitigation-adaptation-performance-measurement.pdf
Please refer to page 7 and 8 of the document “Mitigation and adaptation performance measurement frameworks” for details.

addition to the core indicators, GCF also suggests additional indicators for the outcome level while leaving the project output targets and indicators to the project designers.

Summary of this presentation

- All projects are designed to overcome a problem, but problems may have multiple causes, so a **"problem tree"** helps to sort out cause and effect.
- Similarly, all projects are intended to achieve a purpose or a goal and if we fail to achieve that end point (or ultimate effect) then the project is regarded as a failure. An **"objectives tree"** helps to identify the means of achieving a desired result or **output** at the end of a project, as well as indicating the longer-term **outcomes** and impacts that the project can contribute to.
- The **objectives tree** is simply the mirror image of the problem tree, where all negatives are turned into positives. The objectives tree may also highlight alternative pathways to achieve the desired result as well as indicating the possibility of multiple, complementary projects.
- The objectives tree contributes the "bones" of the **logical framework**, which consists of **Four Columns** – Design Summary, Performance Targets, Monitoring Mechanisms, and Assumptions and Risks; and **Five Rows** – Goal, Purpose (Outcome), Outputs, Activities, Inputs.
- Most funding sources require a logical framework (or equivalent) as a crucial part of any project proposal. The Green Climate Fund (GCF) specifies the ultimate goal (paradigm shift), fund-level **impacts**, and core **indicators**. In addition to the core indicators, GCF also suggests additional indicators for the **outcome** level, while leaving the project **output** targets and indicators to the project designers.

To summarize, all projects are designed to overcome a specific problem but problems may have multiple causes, so a problem tree helps to sort out cause and effect.
Similarly, all projects are intended to achieve a purpose or a goal and if we fail to achieve that endpoint or ultimate effect then the project is regarded as a failure. An objectives tree helps to identify the means of achieving a desired result or output at the end of a project as well as indicating the longer-term outcomes and impacts that the project can contribute to in some small way. The objectives tree is simply the mirror image of the problem tree where all of the negatives of the problem tree are turned into positives. The objectives tree also highlights alternative pathways to achieve the desired result of the project as well as indicating the possibility of multiple complementary projects to achieve the core objective. The objectives tree contributes
the bones of the logical framework which consists of 4 columns: a design summary, performance targets, monitoring mechanisms and assumptions and risks, and 5 rows: goal purpose, output activities and inputs giving a total of 20 elements that need to be filled in. Now most funding sources require a logical framework or its equivalent as a crucial part of any project proposal. The Green Climate Fund specifies the ultimate goal, that is a paradigm shift, the fund level impacts, which they have pre-defined and the core indicators. In

18

Reference materials related to GCF

Please note that the below information is as of December 2022 therefore the link to the reference will might be changed.

If the link does not work, please visit the GCF web site (https://www.greenclimate.fund/).

Mitigation and adaptation performance measurement frameworks:

https://www.greenclimate.fund/document/mitigation-and-adaptation-performance-measurement-frameworks

Integrated results management framework:

https://www.greenclimate.fund/document/integrated-results-management-framework

Funding Proposal template:

https://www.greenclimate.fund/document/funding-proposal-template

GCF Programming Manual:

https://www.greenclimate.fund/sites/default/files/document/gcf-programming-manual_0.pdf

Readiness proposal:

https://www.greenclimate.fund/sites/default/files/document/pipeline-development-and-capacity-building-multilateral-giz.pdf

Open learning course: List of training materials (Health sector)

Section		Name of materials	Type	Length
Module 1	**Understanding of risks of climate change impacts on human health and health services, and GHG emission from health services**			
	Module 1.1	Risk of climate change impacts		
		IPCC risk-based conceptual framework and updates of observed and projected climate change in the Pacific	Movie file	14 min.
		Observed and projected climate change in the pacific	Movie file	18 min.
		Observed and projected climate change in the pacific	Movie file	26 min.
		Climate change impact on Health	Movie file	12 min.
		Lecture slides and notes	PDF	-
		Cases of climate change impacts on human health and health services in the Pacific	Movie file	10 min.
		Lecture slides and notes	PDF	-
	Module 1.2	Vulnerability and adaptation assessment		
		Vulnerability and adaptation assessment of health care facilities in the context of climate change		
		Vulnerability and adaptation assessment guidelines	Movie file	5 min.
		Comprehensive steps in conducting and adaptation assessment	Movie file	3 min.
		Checklist to assess vulnerabilities in health care facilities in the contexts of climate change	Movie file	13 min.
		Checklist for assessing vulnerabilities to Flood	Movie file	9 min.
		Lecture slides and notes	PDF	-
		Cases of vulnerability and adaptation assessment in the Pacific	Movie file	8 min.
		Lecture slides and notes	PDF	-
		Climate risk assessment of health facilities in Samoa	Movie file	13 min.
		Lecture slides and notes	PDF	-
	Module 1.3	GHG emissions from health services		
		Health service activities, Scope of greenhouse gas emission, Carbon footprint of health, and Opportunities to reduce health care carbon emission	Movie file	25 min.
		Lecture slides and notes	PDF	-
Module 2	**Climate adaptation and mitigation options of health systems**			
	Module 2.1	Health workforce: surveillance, assessment, risk communication and planning		
		Surveillance for outbreak prediction and response		
		Part 1	Movie file	13 min.
		Part 2	Movie file	25 min.
		Lecture slides and notes	PDF	-
		Forecasting outbreaks		
		Part 1	Movie file	13 min.
		Part 2	Movie file	12 min.
		Part 3	Movie file	20 min.
		Lecture slides and notes	PDF	-
		The WHO-Spatio-temporal EWARS		
		Part 1	Movie file	70 min.
		Part 2	Movie file	66 min.
		Lecture slides and notes	PDF	-
		The WHO-Spatio-temporal EAWRS Framework: Risk Mapping		
		Part 1	Movie file	38 min.
		Part 2	Movie file	26 min.
		Lecture slides and notes	PDF	-
	Module 2.2	Facilities and Infrastructures		
		Building, energy and water		
		Health systems building blocks and service activities	Movie file	10 min.
		Goals of climate resilience and environmental sustainability: energy use; infrastructure, technology and products; and water and waste	Movie file	25 min.
		Lecture slides and notes	PDF	-
		Cases in the Pacific: Assessment and improvement of health facilities in Fiji	Movie file	21 min.
		Lecture slides and notes	PDF	-
	Module 2.3	Policies and regulations		
		Overview of the United Nations Framework Convention on Climate Change, Paris Agreement, Nationally Determined Contribution and National Adaptation Plan	Movie file	26 min.
		Lecture slides and notes	PDF	-
		Quality Criteria for Health National Adaptation Plan	Movie file	41 min.
		Lecture slides and notes	PDF	-
Module 3	**Problem and Objective trees and Logical framework**			
	Module 3.1	Theory of change		
		Theory of change	Movie file	13 min.
		Lecture slides and notes	PDF	-
	Module 3.2	Project objectives		
		Project objectives_part1 (1. Introduction, 2. Problem trees, 3. Objectives trees)	Movie file	10 min.
		Project objectives_part2 (4. Logical framework, 5. Summary)	Movie file	12 min.
		Lecture slides and notes	PDF	-
	Module 3.3	Exercise		
		Reference: Mitigation - adaptation performance measures	PDF	-
		Template for exercise_logframe template	Word file	-

CONTENTS

1. Introduction to climate change in the Pacific and IPCC risk-based conceptual framework
2. Observed and projected climate change in the Pacific
   - Observed climate changes
   - Projected climate changes for near- to long-terms
3. Climate change impact on health
4. Non-climate factors

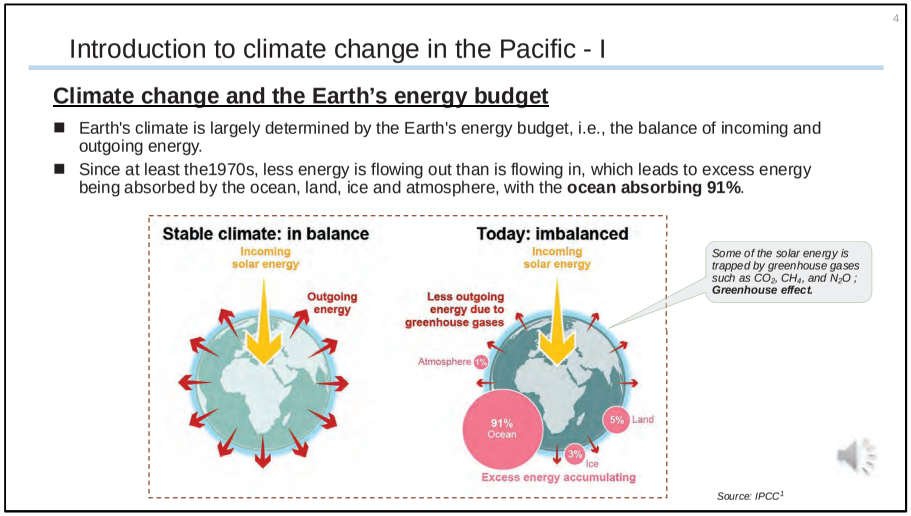
CBCRP-PCCC Virtual Training Course

Health Systems and Climate Change:
Enhancing Resilient and Low-carbon Development in the Pacific

Government of Samoa, SPREP, and JICA

1. **Understanding of risks of climate change impacts on human health and health services, and GHG emission from health services**
   - **IPCC risk-based conceptual framework and updates of observed and projected climate change in the Pacific**

Mr Koji Kuroiwa (Engineering)
JICA Short-term Expert
Overseas Business section, Business Management Department
Japan Weather Association



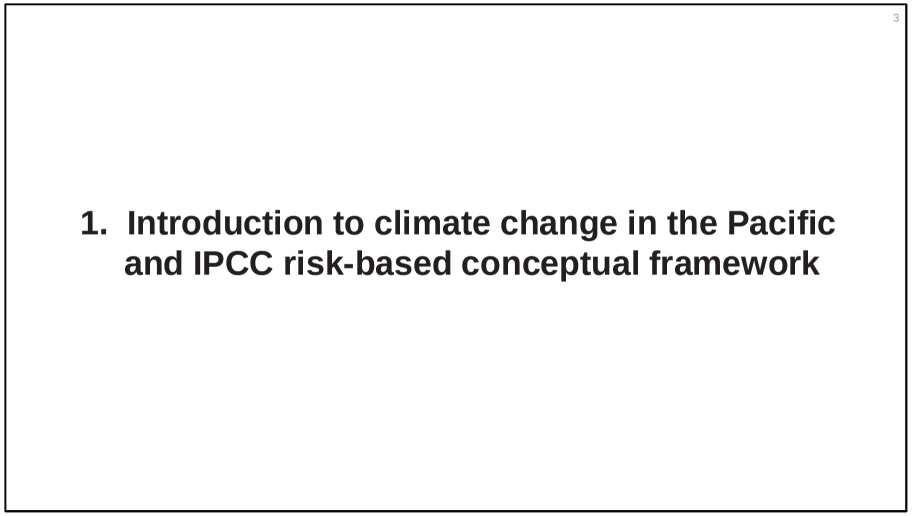
Narrative Part

1. Roughly, global warming is the main driver of climate change, causing other various changes like heavier rains and more intense storms. In other words, climate change can be described as "global warming and its consequences".
2. Earth's average temperature is determined by the balance between incoming energy from the sun and the outgoing energy emitted back into space. The left panel shows how our planet receives vast amounts of energy every day in the form of sunlight. About a third of the sunlight is reflected back to space, and the rest is absorbed by the ocean, land, ice, and atmosphere. Normally, these incoming and outgoing energies are in balance, the earth's climate is stable, and the temperature remains constant.
3. In recent years, human activities have unbalanced these energy flows. The right panel shows that outgoing energy is less than incoming because part of the solar energy is trapped increasingly by some gasses in the atmosphere and warm the Earth; they are carbon dioxide, methane, and nitrous oxide - the greenhouse effect process and the cause of global warming.
4. Since the 1970s, the excess energy has warmed the ocean and land and melted ice sheets and glaciers. The ocean absorbs as much as 91% of the excess energy, which leads to long-term sea level rise.

Glossary

➢ **Greenhouse gas (GHG)**

Greenhouse gases are those gaseous constituents of the atmosphere, both natural and anthropogenic. Water vapour (H2O), carbon dioxide (CO2), nitrous oxide (N2O), methane (CH4) and ozone (O3) are the primary greenhouse gases in the Earth's atmosphere. Moreover, there are a number of entirely human-made greenhouse gases in the atmosphere, such as the halocarbons and other chlorine- and bromine containing substances, dealt with under the Montreal Protocol. Beside CO2, N2O and CH4, the Kyoto Protocol deals with the greenhouse gases sulfur hexafluoride (SF6), hydrofluorocarbons (HFCs) and perfluorocarbons (PFCs).



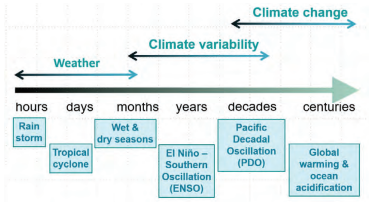
years. During the positive phase of the IPO, precipitation is generally higher than normal northeast of the South Pacific Convergence Zone and lower than normal southwest of the SPCZ. Mean sea level pressures are higher than normal to the west of the dateline and lower than normal to the east of the dateline. Due to these pressure differences, there is a southerly flow anomaly during the positive phase of the IPO.

Introduction to climate change in the Pacific - III

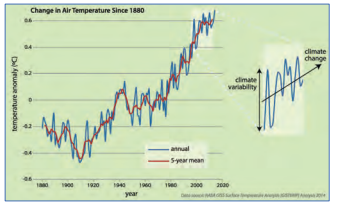
Weather and climate time-scales

- The difference between weather and climate is a matter of time-scale. Climate is sometimes understood as the "average weather" over a long period of time. Climate variability looks at changes that occur within smaller timeframes, such as months, years and decades, and climate change considers changes that occur over a longer period of time, typically over decades or longer.

Illustration of weather/climate time-scales (left) and climate variability/change (right)



Source: PACCSAP



Source: UCAR SciEd

Narrative Part

1. Weather, climate variability and climate change operate on different time scales. Different periods (hours/days/years/centuries) of weather, climate variability, and climate changes are shown on the left panel, including rainstorms that last a couple of hours and tropical cyclones for several days.
2. Weather is highly variable. Climate can be defined as the “average weather” over a long period. The classical period used for describing a climate is “30 years”. While weather is variable, climate also shows variability due to internal and external factors.
3. The right panel shows the change in the surface temperature over the past century and suggests the difference between climate and climate variability. Climate variability occurs over months, years, and decades and are defined by climate patterns such as El-Niño Southern Oscillation (ENSO). Other than ENSO, Pacific Decadal Oscillation (PDO) and Interdecadal Pacific Oscillation (IPO) affect the regional climate over much longer terms on decadal scales.
4. The last category, “climate change”, occurs over decades and centuries and even much longer time scale. A typical example is global warming.

Glossary

➢ **Warm Pool**

An extensive pool of the world’s warmest water, with temperatures exceeding 28–29° C extending from the central Pacific to the far eastern Indian Ocean.

➢ **Pacific Decadal Oscillation (PDO)**

The pattern and time series of the first empirical orthogonal function of sea surface temperature over the North Pacific north of 20° N. The PDO broadened to cover the whole Pacific Basin is known as the Inter-decadal Pacific Oscillation. The PDO and IPO exhibit similar temporal evolution.

➢ **Inter-decadal Pacific Oscillation (IPO)**

A large-scale, long period oscillation that influences climate variability over the Pacific Basin. The IPO operates at a multi-decadal scale, with phases lasting around 20 to 30

7. The right table summarizes the main features and influences on the climate in each country. For example, the Cook Islands are typically influenced by SPCZ, sub-tropical highs, trade winds, tropical cyclones and topography. But when we look at other countries in the west of the region, such as Papua New Guinea, they are typically influenced more by the West Pacific monsoon and the ITCZ. The table also shows that topography is a significant factor in impacting the climate of the mountainous islands.

Glossary

➢ **Warm Pool**

An extensive pool of the world's warmest water, with temperatures exceeding 28–29° C extending from the central Pacific to the far eastern Indian Ocean.

➢ **Inter-tropical Convergence Zone (ITCZ)**

The Inter-Tropical Convergence Zone is an equatorial zonal belt of low pressure, strong convection and heavy precipitation near the equator where the northeast trade winds meet the southeast trade winds. This band moves seasonally.

➢ **South Pacific Convergence Zone (SPCZ)**

A band of low-level convergence, cloudiness and precipitation ranging from the west Pacific warm pool south-eastwards towards French Polynesia, which is one of the most significant features of subtropical Southern Hemisphere climate. It shares some characteristics with the ITCZ, but is more extratropical in nature, especially east of the Dateline.

➢ **Monsoon**

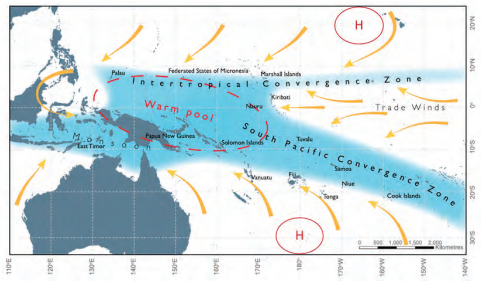
A monsoon is a tropical and subtropical seasonal reversal in both the surface winds and associated precipitation, caused by differential heating between a continental-scale land mass and the adjacent ocean. Monsoon rains occur mainly over land in summer.

Introduction to climate change in the Pacific - II

Large-scale climate features in the W-Pacific

- The South Pacific Convergence Zone (SPCZ), the West Pacific Monsoon (WPM) and the Intertropical Convergence Zone (ITCZ) affect the regional pattern and seasonal cycle in rainfall, winds, tropical cyclone tracks and many other climate aspects of the western tropical Pacific.

Map showing the mean positions of SPCZ, ITCZ and WPM between Nov & Apr

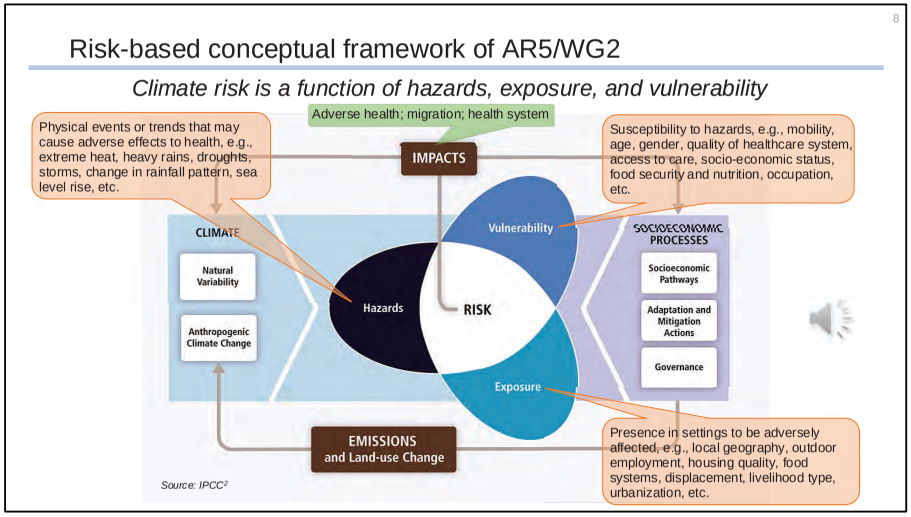


Country	Main features and influences
Cook Islands	SPCZ, sub-tropical highs, trade winds, tropical cyclones, topography
Timor Leste	WPM, topography
Federated States of Micronesia	ITCZ, WPM, trade winds
Fiji	SPCZ, trade winds, sub-tropical highs, tropical cyclones, topography
Kiribati	ITCZ, SPCZ, trade winds
Marshall Islands	ITCZ, WPM (in some years), tropical cyclones
Nauru	ITCZ, SPCZ, trade winds
Niue	SPCZ, trade winds, sub-tropical highs, tropical cyclones
Palau	WPM, ITCZ, trade winds
Papua New Guinea	WPM, ITCZ, topography
Samoa	SPCZ, trade winds, sub-tropical highs, tropical cyclones, topography
Solomon Islands	SPCZ, WPM, tropical cyclones, topography
Tonga	SPCZ, trade winds, sub-tropical highs, tropical cyclones, topography
Tuvalu	WPM, SPCZ, trade winds, sub-tropical highs, tropical cyclones
Vanuatu	SPCZ, trade winds, sub-tropical highs, tropical cyclones, topography

Source: PACCSAP

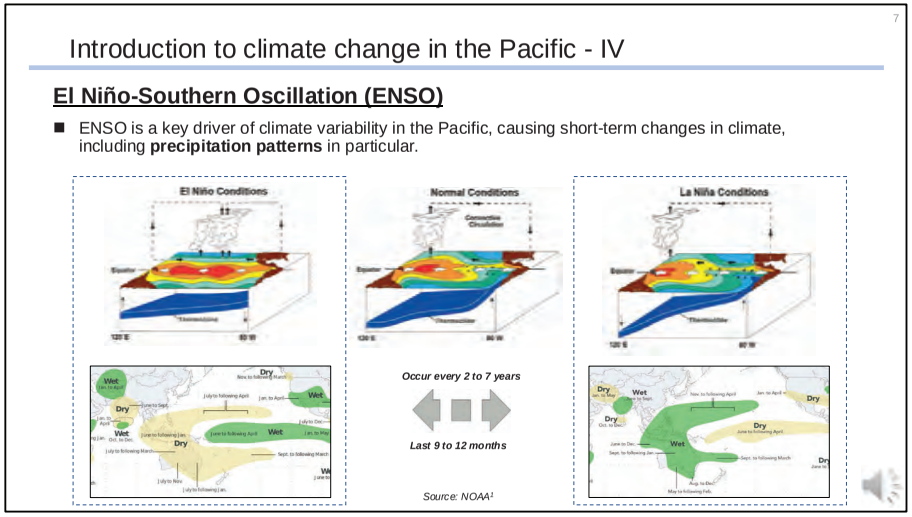
Narrative Part

1. The Pacific Ocean covers almost a third of the Earth's surface. It plays an essential role in shaping the climate of the Pacific and the entire globe. The climate of the Pacific is characterized by large-scale climate features and different-sized land masses, which leads to regional variations in climate. At the same time, the El Niño-Southern Oscillation is the source of year-to-year climate variations.
2. The left map shows the average positions of the main features of the regional climate between November and April. The yellow arrows show surface winds; the blue shading represents the bands of rainfall or convergence; the dashed area shows the Pacific Warm Pool, which holds the warmest seawaters in the world. The two rounds stamped by H are high pressures. All these features affect the regional patterns and seasonal cycle of rainfall, winds, tropical cyclone tracks, ocean currents, and many other aspects of the environment of the Pacific.
3. The three extensive bands of large-scale wind convergence are closely associated with rainfall. They are the Intertropical Convergence Zone (ITCZ), the South Pacific Convergence Zone (SPCZ), and the West Pacific Monsoon (WPM).
4. The SPCZ significantly impacts most South Pacific countries, extending from near the Solomon Islands to the east of the Cook Islands. The SPCZ is strongest in the Southern Hemisphere wet season. It stretches across the Pacific just north of the equator and is strongest in the Northern Hemisphere wet season. West Pacific Monsoon is driven by large differences in temperature between the land and the ocean. It moves north to mainland Asia during the Northern Hemisphere summer and south to Australia in the Southern Hemisphere summer. The Monsoon's seasonal arrival usually switches from very dry to very wet conditions.
5. Other aspects of the climate, such as sub-tropical highs, trade winds and tropical cyclones, also impact countries in the Pacific.
6. On larger elevated islands, topography can have a significant effect, so the climate of the key location may not be the same several kilometres away. For example, in Fiji, rainfall is higher in Suva, which is exposed to the southeast trade winds, than in Nadi, which lies on what is predominantly the lee side of the same island. Notable differences in climate also occur within countries that are spread over a large area, such as the northern and southern Cook Islands.



Narrative Part

1. Risk-based conceptual framework is a basic scheme for climate risk assessment, which IPCC Working Group-2 (WGII) adopted in its 5th Assessment Report (AR5). Its fundamental philosophy is that risk management is the key to reducing climate change impacts. This concept underlies the discussion of adaptation and mitigation options in a series of PCCC training courses.
2. Various factors determine the rise and fall of Risk. The essence of the AR5's concept is to focus on three main factors of human and natural systems: Hazards, Vulnerability and Exposure
3. Risk emerges from the overlap of Hazards, Vulnerability, and Exposure. There are two approaches to reducing Risk; one is to control Hazards, which can be done through changes in emissions, including anthropogenic sources, and the other is to manage Vulnerability and Exposure. It should be noted that vulnerability and Exposure develop from many different socio-economic processes, and therefore, a wide range of measures to reduce Vulnerability and Exposure can be taken, such as through socio-economic pathways, adaptation and mitigation, and social governance.
4. For the reduction of Risk to Health, it is vital to identify the significant components of Hazards, Vulnerability, and Exposure related to this sector. Some examples are indicated in balloons in the chart: Hazards to Health include "extreme heat", "heavy rains", "droughts", and "storms"; Vulnerability includes: "mobility" e.g., a capacity to move away from hazards, "age" and "gender" in terms of susceptibility, such as children and the elderly, "quality of health system" including accessibility to preventive and curative health services, and "socio-economic status" like income and education that could aggravate or alleviate the effect of climate change; Exposure includes "local geography", e.g., coastal areas subject to inundation and storm tides, "outdoor employment" that is directly affected by the adverse impact of heat stress, "housing quality" such as structural issues that could increase risk of injuries and inadequate sanitation, a poor "food system" with low accessibility and consumption of unhealthy food is a major cause of health problems.



Narrative Part

1. Climate change is a decades-long event and fluctuates in shorter timescales of months to years, which we call climate variability. Various climate features drive the climate of the Pacific.
2. El Niño-Southern Oscillation (ENSO) is a predominant climate variability for the Pacific and significantly affects regional as well as global climate conditions. ENSO refers to the recurrence of two opposite climate episodes, El Niño and La Niña. Southern Oscillation is the term for atmospheric pressure changes between the east and west tropical Pacific, which accompanies El Niño and La Niña, like a seesaw. As a result, ENSO has distinct impacts on precipitation over most Pacific Island countries.
3. The middle panel shows normal ocean and atmospheric conditions over the Pacific. Typically, trade winds take warm water to the west to create Warm Pool in the western equatorial Pacific. As a result, more clouds are formed where the ocean is warm, and more rainfall is brought.
4. When El Niño occurs, which is shown on the left panel, trade winds weaken, and warm water is pushed back toward the east. Meanwhile, South Pacific Convergence Zone (SPCZ) migrates towards the equator. Typically, it results in wetter conditions in the central and eastern equatorial Pacific and drier conditions in the north of the equator and south-west Pacific.
5. In a La Nina (right panel), trade winds strengthen reversely and take the warm water further to the west. It causes opposite changes to El Nino. ITCZ and SPCZ tend to move away from the equator, drier near the equator, while wetter in the north and southwest Pacific.
6. ENSO events occur every 2 to 7 years and last 9 to 12 months. Typically, El Niño occurs more frequently than La Niña, but, in any case, their frequency is quite irregular.

9

2. Observed and projected climate changes in the Pacific

489

5. Vulnerability and Exposure in the Health Sector have both direct and indirect pathways. Consideration of different factors for Vulnerability and Exposure will provide valuable basics for this training course discussion.

Glossary (Definitions at AR5)

- **Hazard**
  The potential occurrence of a natural or human-induced physical event or trend or physical impact that may cause loss of life, injury, or other health impacts, as well as damage and loss to property, infrastructure, livelihoods, service provision, ecosystems, and environmental resources. In this report, the term *hazard* usually refers to climate-related physical events or trends or their physical impacts.

- **Exposure**
  The presence of people, livelihoods, species or ecosystems, environmental functions, services, and resources, infrastructure, or economic, social, or cultural assets in places and settings that could be adversely affected.

- **Vulnerability**
  The propensity or predisposition to be adversely affected. Vulnerability encompasses a variety of concepts and elements including sensitivity or susceptibility to harm and lack of capacity to cope and adapt.

- **Impacts**
  Effects on natural and human systems. In this report, the term impacts is used primarily to refer to the effects on natural and human systems of extreme weather and climate events and of climate change. Impacts generally refer to effects on lives, livelihoods, health, ecosystems, economies, societies, cultures, services, and infrastructure due to the interaction of climate changes or hazardous climate events occurring within a specific time period and the vulnerability of an exposed society or system. Impacts are also referred to as consequences and outcomes. The impacts of climate change on geophysical systems, including floods, droughts, and sea level rise, are a subset of impacts called physical impacts.

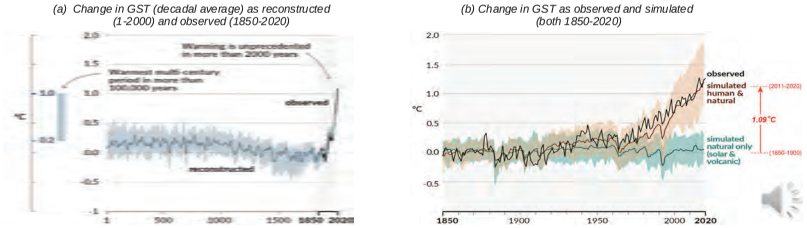
- **Risk**
  The potential for consequences where something of value is at stake and where the outcome is uncertain, recognizing the diversity of values. Risk is often represented as probability of occurrence of hazardous events or trends multiplied by the impacts if these events or trends occur. Risk results from the interaction of vulnerability, exposure, and hazard. In this report, the term risk is used primarily to refer to the risks of climate-change impacts.

Observed Climate Change – *Temperature I*

Global surface temperature (GST)

- GST has increased faster since 1970 than in any other 50-year period over at least the **last 2000 years**. *(IPCC[4])*
- It was **1.09°C higher** in 2011-2020 than 1850-1900 with larger increases over land (**1.59°C**) than over the ocean (**0.88°C**). *(IPCC[5])*

Changes in global surface temperature (GST) relative to 1850-1900



Source: IPCC[6]

Narrative Part

1. In the bottom right panel, the black line shows the record of observations by instruments. Temperatures gradually increased from around 1900 after the industrial revolution and have grown much faster since 1970.
2. The brown line is the model simulations that considered the human drivers such as emission of GHGs and natural drivers such as solar and volcanic activities. The green line also shows the simulation of the temperatures but considers only natural effects. The brown lines coincide with observations and well adjust to reality.
3. The left panel shows the temperature change over the past 2,000 years. For the period before the observation started, temperatures were reconstructed from natural archives, such as tree ring data and sea sediments. A dashed line depicts the latest 70-year change in the right panel. The nearly vertical change shows how drastic the recent temperatures increase was. This panel's left is the estimated warmest temperatures over the past more than 100,000 years. It further endorses that the current warming is a historical incident.
4. These findings and the change of GHGs concentrations shown in the previous slide collectively endorse that global warming is attributed to anthropogenic greenhouse effect.

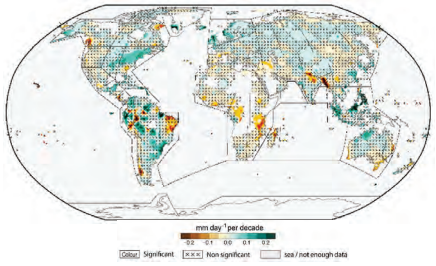
Observed Climate Change

Observed Climate Change – *Precipitation*

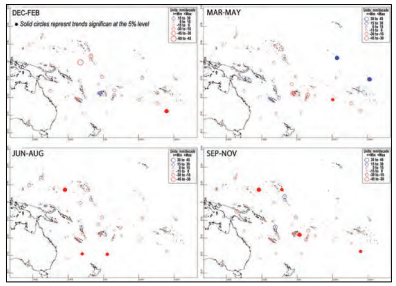
Trends on global and regional scales

- Trends vary spatially and seasonally over Small Island regions in the Pacific. Rainfall has decreased in parts of the Pacific islands poleward of 20° latitude in both hemispheres. However, **trends are not significant** across the globe, including the Pacific. *(IPCC[9])*

Trends of annual precipitation (1961-2015; CRU TS 4.04)



Trends of quarterly precipitation (mm/decade) at PICs (1951-2015; positive (blue) and negative (red))



Sources: IPCC[10] (left), McGree et al. 2019 (right)

Narrative Part

1. Precipitation is a major atmospheric variable, together with temperature. However, compared with temperature, it is much more difficult to find significant changes in precipitation. The left panel shows global trends of annual precipitation over the 55 years from 1961 to 2015. The widespread of x-marks indicates the regions where trends are not significant. A comparison between this chart and that of temperature two slides before demonstrates the difference.
2. The main reasons for the less significance in the precipitation trend analyses are the sparsity and less quality of data, particularly in developing countries, and the large natural variabilities that precipitation has.
3. Nevertheless, some significant increases in land areas are shown in this chart, such as North and South America, Eurasia and northwestern Australia, while decreases are apparent across tropical western and equatorial Africa and southern Asia.
4. Significant trends are not noticeable in the western Pacific region like the global views. Pacific is one of the most data-sparse areas of the world, while interannual and decadal variabilities drive long-term trends in rainfall, as we discussed previously.
5. Four panels on the righthand side depict the findings of regional precipitation trends from the same study in the previous slide. Results are shown in quarterly periods. In the study region, statistically significant annual precipitation trends were only found in the southern subtropics and southwest French Polynesia, both of which are negative. These were associated with negative trends in June to August and from December to February. Significant negative trends were also present from September to November in the north ITCZ and north PNG subregions.
6. Unlike the changes in temperature, which are dominated by background global warming, rainfall patterns in the Pacific are strongly influenced by natural climate variability. Such a regional characteristic makes it difficult to detect rainfall trends.

Observed Climate Change – *Temperature II*

Regional surface temperatures

- Warming trends are clearly evident in the small islands, such as those in the Pacific, particularly over the latter half of the 20th century. *(IPCC[7])*
- Significant positive trends ranging from 0.15°C/10yr (1953–2010) to 0.18°C/10yr (1961–2011) are noted in the tropical Western Pacific. *(IPCC[8])*

Recent changes in temperature in the Western Pacific Islands

(a) Trends in annual mean temperature over 1951–2015

(b) Regional mean temperature anomalies relative to the 1971–2000 climatology

(c) Regional amount of warm/cold nights, hot/cool days anomalies relative to the 1971–2000 climatology

Source: McGree et al. 2019

Narrative Part

1. Along with the global mean surface temperatures, warming trends are clear at the Pacific Island countries. In the Southwest Pacific, 2020 was the second or third warmest year, depending on the data sets. The warmest year on record was observed in Southern French Polynesia and Tonga. The warming trends in the region have been examined and endorsed by a couple of climate studies, which suggest increases of roughly 0.15° C to 0.18° C per decade.
2. The left panel shows the results of McGree's study from 1951 to 2015 based on the data from 57 stations. Although regional differences exist, most locations indicate warming trends in annual mean temperatures from 0.06 to 0.30, resulting in a regional average of 0.14. In addition, increases in average temperature were found in all seasons throughout the study period.
3. The middle panel was also given from the McGree's, representing the time change of regional average temperature. A warming trend is clear, particularly during the latter half of the 20th century.
4. The study also revealed significant trends in extreme temperatures in the region. The right panel shows the rates of warm nights and cold nights and hot days and cool days, which were derived from daily maximum and minimum temperatures using a percentile analysis. In addition, it shows the increasing trend of hot days and warm nights, which are grey and blue colors, and the decreasing trend of cool days and cold nights, orange and red.
5. Overall, a widespread increase in mean temperature, fewer cool extremes and more warm extremes are represented from 1951-2015.

7. Discharge of rivers, groundwater, and land ice, as well as water use by human, are also important components of water fluxes. In terms of drinking water and irrigation, recharge and discharge of groundwater is a major contributor in the water fluxes together with precipitation.

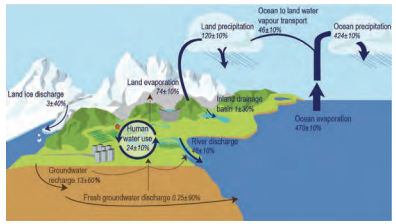
Global Water Cycle; water stores and fluxes

- Global water cycle is the continuous, naturally occurring movement of water through the climate system from its liquid, solid and gaseous forms among reservoirs of the ocean, atmosphere, cryosphere and land.
- While **saline ocean water accounts for 97%** of all water on Earth, **terrestrial freshwater represents less than 2%** and saline groundwater & lakes 1-2%.

⇦ ***Total water on Earth; 1,380,000,000 km3)***

Water stores (units in thousands of km^3)

Water fluxes (units in thousands of km^3 per year)



Source: IPCC[11]

Narrative Part

1. This slide shows an overview of the global water cycle in the climate system, including water stores or reservoirs on the left, and water fluxes or movement on the right. The water cycle is a complex system but is very important because it let us know how water reaches us.
2. What are water stores in the water cycle? The major stores of water are the ocean, ice caps, land including underground, and the atmosphere. Among these, the ocean is the primary reservoir storing 97% of all water on Earth, mostly as salt water. Liquid freshwater on land forms surface water such as lakes and rivers, soil moisture and groundwater stores, together accounting for less than 2% of global water.
3. What are water stores in the water cycle? The major stores of water are the ocean, ice caps, land including underground, and the atmosphere. Among these, the ocean is the primary reservoir storing 97% of all water on Earth, mostly as salt water. Liquid freshwater on land forms surface water such as lakes and rivers, soil moisture and groundwater stores, together accounting for less than 2% of global water.
4. Focusing freshwater, ice sheets, glaciers and snowpack account for approximately 96% of all freshwater resources, with less than 4% of freshwater considered easily accessible and available for human society's water resource needs.
5. Meantime, some water moves quickly from one place to another. It is illustrated in the right panel, where the continuous movement of water within the Earth and atmosphere is shown as water fluxes. Water fluxes consist of three major processes, that is “evaporation” where water changes phase from liquid to gas or vapor with solar energy, and “condensation” where water vapor cools and joins together into drops of water and clouds, and “precipitation” where water falls from clouds as rain and snow.
6. The largest component of the global water cycle operates over the ocean, where 85% of evaporation and 77% of precipitation occurs at the ocean-atmosphere interface. Meantime, regional evaporation is rather complex to measure, as it depends on a myriad of localized conditions, including wind speed, humidity, and temperature.

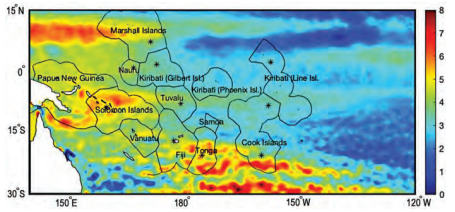
16

Observed Climate Change – *Sea Level Rise II*

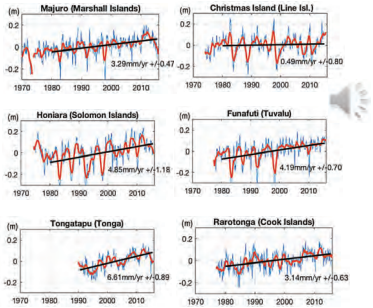
Regional sea level rise

- Across the globe, sea levels rose fastest in the Western Pacific and slowest in the Eastern Pacific over the period 1993–2018. *(IPCC[13])*

Rates of sea level rise from satellite altimetry for 1993-2017 (mm/yr)



Monthly and yearly running average of relative sea level measured at tide gauges for 1977-2017



Source: Aucan, J. 2018

Narrative Part

1. Mean sea level can fluctuate over a long period, even for decades. It should be noted that sea level is defined in two different ways: “absolute sea level”, which refers to the sea level as measured from the center of the earth, and “relative sea level”, which refers to the sea level relative to the coastal area of interest. Absolute sea levels have been monitored by satellite altimetry since 1993, while relative sea levels are by tide-gauges which started in the 1960s in the Pacific.
2. Regarding the sea levels in the Pacific, it’s worth noting that satellite altimeters found sea levels rose fastest in the Western Pacific and slowest in the Eastern Pacific from 1993 to 2018, among all basins. This slide presents a recent study which demonstrates this typical trend. The left panel shows calculated rates of the regional sea level rise from 1993 to 2017. During this period, results show a rise in sea level of 3-6 mm/year for the Pacific islands, with notable differences between islands. Some islands in the Western Pacific, such as the Solomon Islands, Papua New Guinea, and the Marshall Islands, have experienced a higher rate of sea level rise (up to 6 mm/year), while other islands further east, such as Samoa and Kiribati are much lower. This difference in sea level rise is attributed to large-scale trends in trade winds.
3. Changes of the relative sea level at some selected stations are shown in the panels on the right. Data measured at tide-gauges combines the measurements of satellite altimeters. All show a rise in relative sea level over the past 30 to 40 years and the varied rates between islands. They also demonstrate inter-annual variability, which is attributed mostly to El-Niño Southern Oscillation.

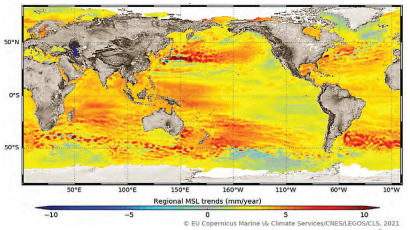
15

Observed Climate Change – *Sea Level Rise I*

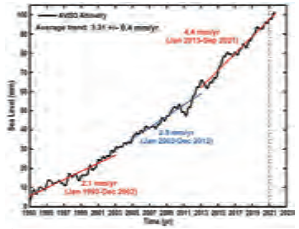
Global mean sea level (GMSL)

- GMSL rose faster in the 20th century than in any prior century over the last three millennia, with a 0.20 m rise over 1901-2018.
- GMSL rise has accelerated since the late 1960s, with an average rate of 2.3 mm/yr over 1971-2018, increasing to 3.7 mm/yr over 2006-2018. *(IPCC[12])*

Regional sea level trend for Jan-1993 to Dec-2020



GMSL evolution for Jan-1993 to Sep-2021



Source: AVISO altimetry

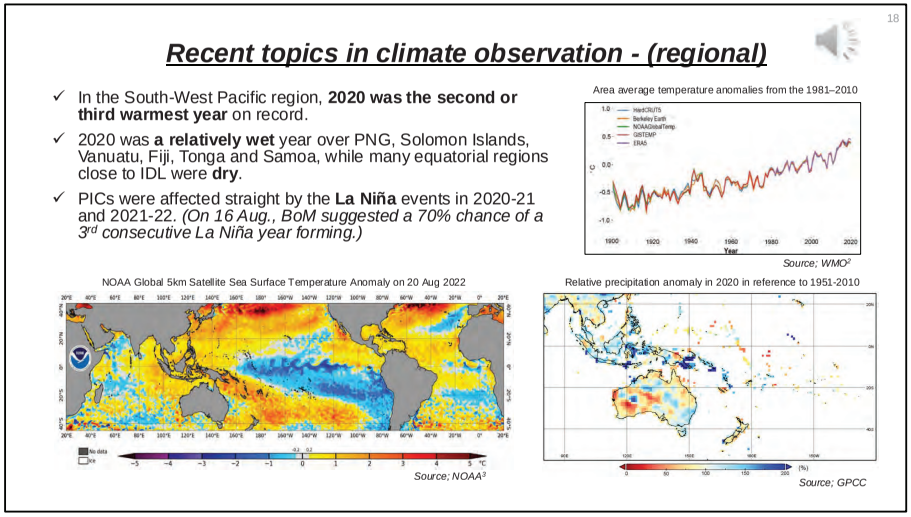
Narrative Part

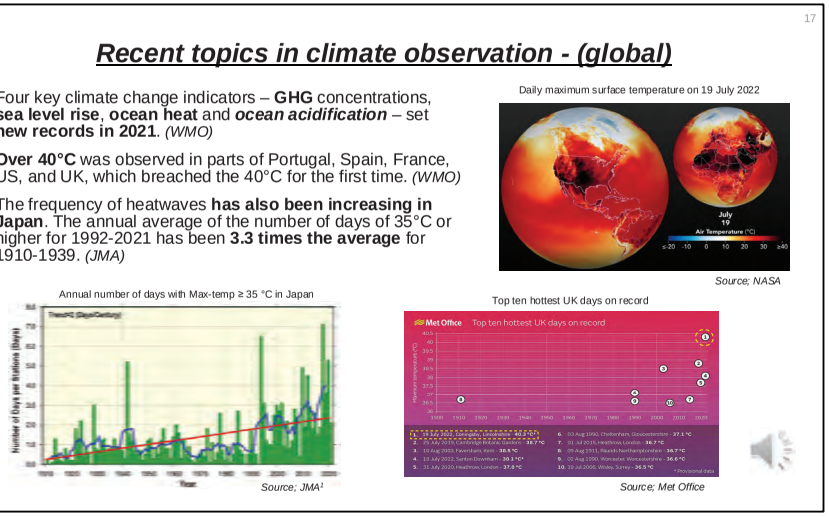
1. Global mean sea level changes primarily result from ocean warming, leading to the thermal expansion of seawater and land ice melting and adding water to the ocean. As a result, the sea level is continually rising, and it has been found to be accelerating. This has gathered the increasing attention of world scientists.
2. Recent measurements by satellite altimeters revealed that the global mean sea level rise was 2.1 mm per year between 1993 and 2002, 2.9 between 2003 and 12, and 4.4 between 2013 and 21, as shown in the right panel. This rapid step-up was primarily due to the accelerated ice mass loss from glaciers and ice sheets.
3. The regional sea level trends in the left panel demonstrate a considerable variation between the basins. Much of the spatial variation results from natural climate variabilities—such as El Niño and the Pacific Decadal Oscillation—over time scales from months, about a year, to several decades. These climate variations shift surface winds, ocean currents, temperature, and salinity, affecting sea levels. Also accountable are Earth's geological changes, such as changes in Earth's gravity and vertical land motion.
4. The chart shows such variations also in the Pacific. The western tropical Pacific Ocean intensified sea-level rise during the 1990s and 2000s. Ten-year trends exceeded 20 mm yr-1, while sea level trends were negative on the North American west coast.

Glossary

➢ **Altimeter**

Satellites carrying radar altimeters record the surface topography along the satellite’s ground track. They precisely measure a satellite’s height above water, land or ice by timing the interval between the transmission and reception of very short radar pulses. This is the only technology that can measure, systematically and globally, changes in the height of the ocean – and is therefore essential for monitoring sea-level rise. (ESA)





Narrative Part

1. The 2020 climate report for the Southwest Pacific issued by WMO emphasized that the significant and growing impacts of extreme hydro-meteorological phenomena and tropical cyclones, plus new multi-dimensional threats, pose increasing challenges to communities in the region. Regarding regional averaged temperatures, 2020 was the second or third warmest year on record. The top right panel shows a consistent increase in the regional average temperature has been demonstrated over the past century.
2. In 2020, the Great Barrier Reef suffered a major marine heatwave. In February, sea surface temperatures over the region were 1.2° C above the 1961-1990 average, making it the hottest month on record. Such high temperatures affected the entire GBR, and widespread coral bleaching was reported.
3. The bottom right panel gives an overall regional rainfall condition in 2020. Under the 2020-21 La Nina and the 2021-22 La Nina, relatively wet conditions continued over the region from PNG and Solomon Islands to Fiji and Samoa from 2020 through early 2022, while lower-than-normal rainfall continued in the equatorial region. During these years, Australia suffered frequent floodings, including the 2022 eastern Australia floods, one of the nation's worst recorded flood disasters.
4. The Bureau of Meteorology stated on 16 August that a third consecutive La Niña is likely from late 2022. The latest monitoring of sea surface temperatures (SSTs) shown in the bottom left represents below-average SSTs extending from the eastern to central tropical Pacific and suggests the possible occurrence of La Nina soon.

Narrative Part

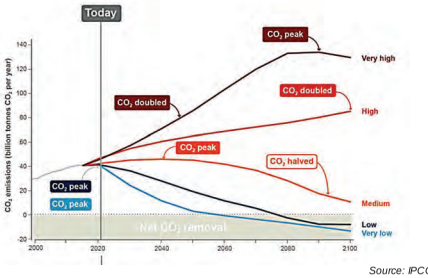
1. Recently, the world climate monitoring system has been observing exceptional weather conditions across the globe. Some of the cases are unprecedented and highly suggestive of accelerating climate change. For example, in 2021, four key climate change indicators set new records. In addition to the record-breaking GHG concentration as well as the accelerating global mean sea level, as shown in the previous slides, scientists have revealed that ocean heat made a record high exceeding the 2020 value and that the ocean surface acidity was at its highest "for at least 26,000 years".
2. In 2022, the world had the third warmest July, with prolonged and intense heat waves affecting the US and parts of Europe and Asia. The top right panel displays a snapshot of the global surface temperatures in July. Nearly 40° C temperatures stand out in the US, Asia and Europe. Despite the weak La Niña, which has a cooling influence, northern hemisphere land masses saw well-above-average temperatures, almost predominantly. Temperatures measuring over 40° C were observed in parts of Portugal, Spain, France, and the UK, which breached 40 degrees for the first time. The World Health Organization witnessed more than 1,700 deaths in Spain and Portugal alone.
3. The top ten hottest days on record in the UK after 1900 are plotted on the bottom right panel. It shows nine out of 10 hottest days have been recorded since 1990, including the 40.3° C on 19 July this year.
4. The Japan Meteorological Agency has also noticed a similar trend over the past hundred years, as shown in the left panel. The number of days of 35° C or higher for 1992-2021, the latest 30-year statistical period, has been 3.3 times the average for 1910-1939, the first statistical period of the Agency. This same trend in the two countries clearly endorses the temperature findings in IPCC AR6.

Projected Climate Change – *GHGs*

Greenhouse gases (emission scenario)

- AR6 considers a set of **five new illustrative emissions scenarios** (Shared Socio-economic Pathways; SSPs). Coupled Model Intercomparison Project Phase 6 (CMIP6) was conducted using these scenarios, and its outcomes served as the main bases of AR6.

New scenarios (SSPs) of annual anthropogenic emission of CO_2 over 2015–2100 (AR6)



- SSP5-8.5
  Very high; Close to RCP*8.5 of AR5. Worst case scenario with no additional climate policy.
- SSP3-7.0
  High; Between RCP8.5 and RCP6.0. Realistic worst-case with continuing CO_2 emission. Would result in serious consequences.
- SSP2-4.5
  Medium; Close to RCP4.5 and later RCP6.0. More consistent with government polices but CO_2 emission remain above zero.
- SSP1-2.6
  Low; Close to RCP2.6. CO_2 emission to plateau and decline after 2025. Temperatures to stay well below 2°C.
- SSP1-1.9
  Very low; No equivalent RCP. Efforts to remove CO_2 needed. Will meet the Paris goal of limiting global warming to 1.5°C.

Source: IPCC[14]

- *Representative Concentration Pathways (**RCPs**) are GHG emission scenarios used in AR5.*

Projected Climate Change

Narrative Part

1. AR6 adopted five new scenarios for GHGs emissions called SSP scenarios instead of 4 RCP scenarios in AR5. The new scenarios represent five different socio-economic pathways. World climate scientists performed simulations of climate change based on these scenarios in the Coupled Model Intercomparison Project--Phase 6 (CMIP6), which formed the basis of AR6. The chart below shows SSP scenarios for CO2. IPCC produced SSP scenarios also for other Green House Gases.
   - SSP/585, the Very high emission scenario, is close to RCP8.5. It assumes no measures will be taken to reduce CO2 emissions. CO2 emissions soar up and double from current levels by 2050.
   - SSP/370, the High scenario, was newly introduced. CO2 emissions double from current levels by 2100.
   - SSP/245, the Medium scenario, is an update to RCP4.5. It assumes that climate protection measures are taken. CO2 emissions remain around current levels until the middle of the century.
   - SSP/126, the low scenario, is a remake of the RCP2.6. CO2 emissions decline to net zero around 2080 and goes into net negative emission.
   - SSP/119, the very low scenario, assumes CO2 emissions declines to net zero around 2050 and then net negative.
2. Roughly, Very high scenario is pessimistic as CO2 emissions are unregulated. And Low and Very low scenarios are optimistic as they require drastic measures to reduce CO2 emissions. The recently released AR6/WG3 report suggests that limiting warming to around 1.5° C requires global greenhouse gas emissions to peak before 2025 at the latest and be reduced by 43% by 2030. The next few years are critical.

Glossary

➢ **Coupled Model Intercomparison Project (CMIP)**

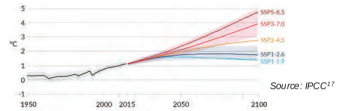
CMIP is a project of the World Climate Research Programme (WCRP)'s Working Group of Coupled Modelling (WGCM). Since 1995, CMIP has coordinated climate model experiments involving multiple international modeling teams worldwide.

Projected Climate Change – *Temperature I*

Global surface temperature (GST)

- GST will continue to **increase until at least the mid-century** under all emissions scenarios. *(IPCC[15])*
- It was reaffirmed that there is a **near-linear relationship** between cumulative anthropogenic CO_2 emissions and the global warming they cause. *(IPCC[16])*

GST change relative to 1850-1900



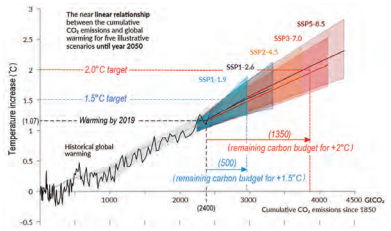
Source: IPCC[17]

Changes in GST under the 5 emissions scenarios

Scenario	Near term (2021-2040)	Mid term (2041-2060)	Long term (2081-2100)
SSP1-1.9	1.5	1.6	1.4
SSP1-2.6	1.5	1.7	1.8
SSP2-4.5	1.5	2.0	2.7
SSP3-7.0	1.5	2.1	3.6
SSP5-8.5	1.6	2.4	4.4

Source: IPCC[18]

GST increase since 1850-1900 (°C) as a function of cumulative CO_2 emissions ($GtCO_2$)



Source: IPCC[19]

Narrative Part

1. This slide shows one of the main outcomes of CMIP6 projections - global surface temperatures. The top left panel shows the projected change of temperatures under all five scenarios. There is a slow turning point during the mid-century, where the trend becomes relatively flat or even starts to decline for Low and Very-low scenarios while continuing to grow for medium and higher scenarios. The difference can be seen more precisely in the table below.
2. The best estimates of the near-term temperatures are 1.5 degrees or higher for all scenarios. It provides new estimates of the chances of crossing the global warming level of 1.5° C in the following decades. The table also shows the significant difference between Very-low and Very-high scenarios in the long term; it is about 3 degrees.
3. More importantly, hot temperatures include heat waves and growing average temperatures. Such extreme events have highly serious impacts and are projected to occur far more frequently in the near future.
4. The right panel shows the near-linear relationship between temperature increase and cumulative CO2 emission until 2050. This diagram shows that the historical cumulative CO2 emissions from 1850 to 2019 were 2400 GtCO2, resulting in global warming of 1.07 degrees. If the emissions continue, Earth will also continue to warm in the same way.
5. This diagram suggests that if we hope to limit the warming to 1.5 degrees, the remaining carbon budget will be about 500 GtCO2. Similarly, for 2.0 degrees, it will be about 1350 GtCO2. So, it gives us an estimate of the allowable amount of additional CO2 emissions for limiting global warming to any target level. In this regard, we should note that the global emissions of GHGs in 2018 were more than 50 GtCO2 in total.

Glossary

➢ **Carbon budget**

This term refers to three concepts in the literature: (1) an assessment of carbon cycle sources and sinks on a global level, through the synthesis of evidence for fossil fuel and cement emissions, land-use change emissions, ocean and land CO2 sinks, and the

- CMIP has led to a better understanding of past, present and future climate change and variability in a multi-model framework.
- CMIP defines common experiment protocols, forcings and output.
- CMIP has developed in phases, with the simulations of the fifth phase, CMIP5, now completed, and the planning of the sixth phase, i.e. CMIP6, well underway.
- CMIP's central goal is to advance scientific understanding of the Earth system.
- CMIP model simulations have also been regularly assessed as part of the IPCC Climate Assessments Reports and various national assessments.

➢ **Representative Concentration Pathways (RCPs)**

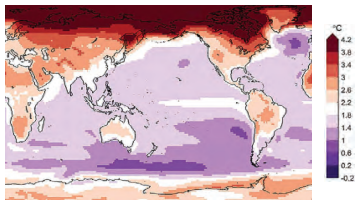
Scenarios that include time series of emissions and concentrations of the full suite of greenhouse gases and aerosols and chemically active gases, as well as land use/land cover (Moss et al., 2008). The word representative signifies that each RCP provides only one of many possible scenarios that would lead to the specific radiative forcing characteristics. The term pathway emphasizes that not only the long-term concentration levels are of interest, but also the trajectory taken over time to reach that outcome. (Moss et al., 2010). For further description of future scenarios, see Box 1.1 of AR5/WG1.

Projected Climate Change – *Temperature II*

Regional surface temperature (RST)

- It is very likely that the significant recent warming trends observed in the small islands **will continue in the 21st century**, which will likely further increase heat stress in these regions. *(IPCC[20])*

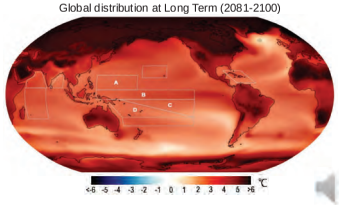
The multi model average projection of 2°C global warming with a color scale centered on +2°C.



Source: RCCAP

Projected changes (°C) relative to 1850-1900 under SSP3-7.0

Global distribution at Long Term (2081-2100)



Global and sub-regional means (°C) at 3 terms

*(**A**: NW-Tropics, **B**: Equatorial Pacific, **C**: Northeast SPCZ, **D**: Southwest SPCZ)*

Region	Near term (2021-2040)	Mid term (2041-2060)	Long term (2081-2100)
(A) NW-Tropics	0.7	1.3	2.6
(B) Equatorial Pacific	0.8	1.4	2.8
(C) NE-SPCZ	0.7	1.2	2.4
(D) SW-SPCZ	0.7	1.2	2.4
GLOBAL	**1.5**	**2.1**	**3.6**

Source: IPCC[21]

Narrative Part

1. The projected warming over the Pacific Island region is relatively moderate compared with the global-average warming for all emissions scenarios. This is linked to the fact that the oceans are warming at a lower rate than land areas, and this clear trend in the observation part is noted.
2. The top right chart shows the increase of regional temperatures at the end of the 21st century under the high emission scenario. It indicates that warming is clear and almost universal. Looking at the western Pacific, changes are relatively uniform over the region; all are around 2 to 3 degrees.
3. Those of areal means of the four sub-regions; NW Tropics, Equatorial Pacific, NE SPCZ and SW SPCZ; were calculated for each of three terms with AR6-Interactive Atlas, where sub-regions are determined based on the average positions of the ITCZ and SPCZ. The results are listed in the table below. Sure enough, changes are roughly comparable from region to region. If anything, warming is slightly larger in the Equatorial Pacific. Anyhow, the smaller-than-global-average trend in the region is evident. The magnitudes of warming are roughly 50% of the global mean for the near term and 70% for the long term.
4. The left panel depicts the regional temperatures at a 2° C global warming. Changes are shown in a finer and specific color scale centered on plus 2° C. Red indicates the areas hotter than the global average, and purple is cooler than the average. It clearly shows that warming is less than the average across the entire ocean, and it is largely uniform over the western Pacific.

Glossary

➢ **IPCC WGI Interactive Atlas**

The Interactive Atlas regional information supports the assessment done in the AR6-WGI chapters, the Technical Summary (TS) and the Summary for Policymakers (SPM), allowing for flexible temporal and spatial analyses of trends and changes in key atmospheric and oceanic variables, extreme indices and climatic impact-drivers (CIDs), as obtained from several global and regional observational and model simulated datasets used in the report. These analyses are available for a range of historical and future periods and emissions scenarios or warming levels. A description of the datasets,

resulting atmospheric CO2 growth rate. This is referred to as the global carbon budget; (2) the estimated cumulative amount of global carbon dioxide emissions that that is estimated to limit global surface temperature to a given level above a reference period, taking into account global surface temperature contributions of other GHGs and climate forcers; (3) the distribution of the carbon budget defined under (2) to the regional, national, or sub-national level based on considerations of equity, costs or efficiency.

➢ **Gigatons of Carbon Dioxide (GtCO2)**

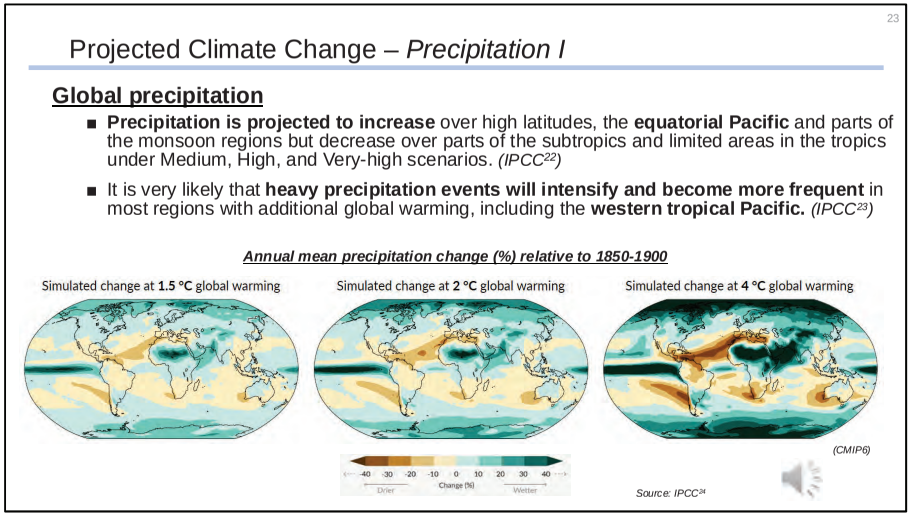
GtCO2 refers to gigaton of carbon dioxide (a gigaton is equal to 1 billion metric tons). GTCO2 (or GtC) is used as the reference unit for the global carbon cycle (Gigaton of carbon = 1 GtC = 1015 grams of carbon. This corresponds to 3.667 GtCO2).

➢ **Carbon cycle**

The term used to describe the flow of carbon (in various forms, e.g., as carbon dioxide (CO2), carbon in biomass, and carbon dissolved in the ocean as carbonate and bicarbonate) through the atmosphere, hydrosphere, terrestrial and marine biosphere and lithosphere.

➢ **Cumulative emissions**

The total amount of emissions released over a specified period of time.



Narrative Part

1. Precipitation has a unique characteristic as it represents opposite changing trends over time and space. Roughly, its contrast will become more significant between dry regions and wet regions and between the dry season and rainy seasons. A warmer climate will intensify very wet and dry weather, with implications for increasing flooding or drought.
2. The three maps on this slide show projected changes in annual mean precipitation for a global warming of 1.5 degrees on the left, 2 degrees in the middle, and 4 degrees on the right. The projection of global precipitation is roughly a half-and-half mixture of positive and negative trends. This is the crucial difference with the projection of temperatures. Precipitation will increase over high latitudes, the equatorial Pacific and parts of the monsoon regions but decrease over parts of the dry subtropical regions and in limited areas of the tropics. Models generally agree that precipitation, when it once occurs, will become more intense. Unlike average annual precipitation, almost the entire world is expected to see an increase in extreme precipitation along with global warming. Also, it's worth noting that rainfall variability related to the El Nino-Southern Oscillation (ENSO) is projected to be amplified by the second half of the 21st century under the Medium and higher scenarios.

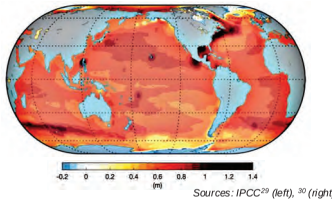
temporal and spatial scales and dimensions of analysis, as well as the representation of robustness and uncertainty (Cross-chapter Box Atlas.1) are introduced in Atlas.1.

Projected Climate Change – *Sea level I*

Global mean sea level (GMSL)

- GMSL will continue to rise over the 21st century; **0.63-1.01 m at** 2100 under SSP5-8.5. *(IPCC[27])*
- In the longer term, **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. *(IPCC[28])*

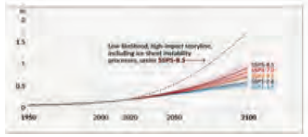
Projected sea level changes at 2100 under SSP3-7.0



Sources: IPCC[29] (left), [30] (right)

Projected GMSL changes relative to the 1900 level

Dashed lines show changes that could occur only in case of high-impact ice-sheet processes.



(AR6)

Narrative Part

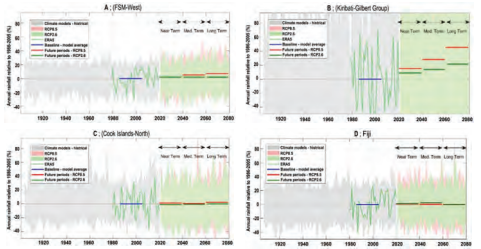
1. Projections of sea level rise under five scenarios are given in the two panels in the middle and on the right. The left shows that sea level rise will reach nearly 1 meter at 2100 and then approach 2 meters at 2150 under Very-high scenario. The vertical graph on the right shows further projections for 2300 under Very-low and Very-high scenarios. Sea levels rise will be 0.5 to 3 meters for Very-Low scenario and 2 to 7 meters for Very-High scenario.
2. Interesting to note in these charts is another storyline indicated by the broken lines. Although it is not included in the projections under five scenarios but suggests that, in case the ice-sheets become highly unstable, in Antarctica in particular, sea level rise could present quite a different storyline. It is shown by the dashed curve here; along this line, sea level rise could be 2 meters at 2100 and 5 meters at 2150. Further, at 2300, the sea level could rise by 15 meters or more.
3. Another point is that even if global temperatures peak by the end of this century, it will continue for centuries or even millennia to come, as the oceans, glaciers and ice sheets take time to reach an equilibrium state (or steady state, in other words). We are only at the starting line of the long-lasting sea level rise to come.
4. The global map on the left shows a snapshot of the rising regional sea levels under the high-emission scenario. Although it shows some regional trends, sea level rise should be recognized as a universal trend across the globe.

Projected Climate Change – *Precipitation II*

Regional precipitation

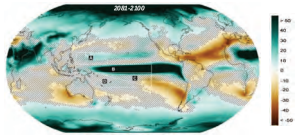
- ENSO will remain the dominant mode of interannual variability, and its influence will strengthen. It is very likely that **ENSO rainfall variability** will increase significantly over the 21st century.
- **Higher evapotranspiration** under a warming climate either amplifies or partially offsets, respectively, the effect of decreases or increases in rainfall. *(IPCC[25])*

Annual mean precipitation change (%) in sub-regions relative to 1850-1900



Source: RCCAP; CMIP5

Annual mean precipitation change (%) relative to 1850-1900 under SSP3-7.0



Region	Near term (2021-2040)	Mid term (2041-2060)	Long term (2081-2100)
(A) NW-Tropics	2.2	3.7	6.2
(B) Equatorial Pacific	10.2	16.1	33.8
(C) NE-SPCZ	4.3	6.0	8.1
(D) SW-SPCZ	1.3	2.1	1.9
GLOBAL	–	–	4.7

Source: IPCC[26]

Narrative Part

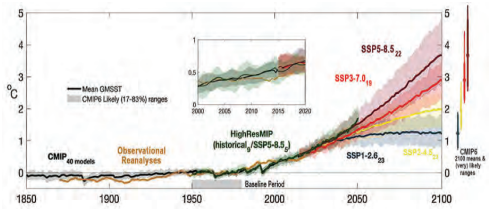
1. In the western tropical Pacific, increases in annual mean rainfall will stand out near the SPCZ and ITCZ.
2. However, as suggested earlier, it is rather challenging to find clear trends in the projection of precipitation changes in contrast to temperature. While the models used by scientists generally agree on how different parts of the Earth will warm, there is much less agreement about where and how precipitation will change. Such difficulties are even more on smaller scales.
3. This is mainly because of the complexity of the water cycle that we saw in the earlier slide. In addition, the scarcity of data, as well as the year-to-year variability of precipitation, is also highly challenging. These hurdles significantly increase uncertainty in model simulations.
4. Still, there were some findings in SMIP5 and 6. The right map is the projection with SMIP6. The models' average shows significant increases in precipitation in the equatorial Pacific, as suggested earlier. Yet, we note again that much of the Pacific region is hatched in the map, meaning the model agreement is low over a wide range.
5. Areal means of the projection were sought for the four sub-regions with the Interactive Atlas, the same as for temperatures in the earlier slide. The results are listed in the table below. Notable increases are shown in the Equatorial Pacific, while other sub-regions are rather flat.
6. Four panels on the left are time-series charts of multi-model means from RCCAP by SMIP5. Each represents the respective subregions. They show the same trend as SMIP6 but are relatively underestimated. In either case, we should note that those projections are just the mid-points of different results from different models with significant uncertainties.

Projected Climate Change – *Sea surface temperature (SST)*

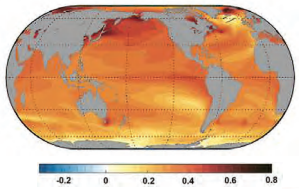
Global mean SST

- Past GHG emissions since 1750 have committed the global ocean to future warming. Over the rest of the 21st century, likely ocean warming ranges from **2–4 (SSP1-2.6) to 4–8 times (SSP5-8.5)** the 1971–2018 change. *(IPCC[32])*

Global mean (SST); modern history and model projections to 2100



SSP5-8.5 CMIP Change Rate (2005-2100)



(SST Rate of Change (°C/decade)

Source: IPCC[33]

Narrative Part

1. The global ocean has warmed since 1970 and has taken up more than 90% of the excess heat in the climate system, as we have learned in the earlier slide. Regionally, tropical oceans, including the western Pacific, have been warming faster than other regions since 1950.
2. As shown in the left panel, this ocean warming trend is consistent through the 21st century, except for the very-low emission scenario. The right panel shows the SST changes with time. Under the Very-high scenario, ocean warming could range from 4 to 8 times the 1971-2018 temperatures.
3. Notably, the warming of the ocean is irreversible on centennial to millennial time scales. It is also worth noting that the warming will lead to extreme heat conditions across the basins. Marine heatwaves will become more frequent, and the largest increases will be found in the tropical ocean, especially over the western Pacific.

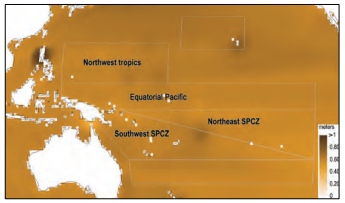
Projected Climate Change – *Sea level II*

Regional sea levels

- Relative sea-level rise (RSLR) is very likely to continue in the tropical Pacific, where regional-mean RSLR will be **0.4–1.0m** for 2081–2100 (relative to 1995–2014) under the high-emission scenario.
- Even a **5-10 cm** additional SLR will **double flooding frequency** in much of the tropical Pacific.

CMIP6-SLR projection relative to 1995–2014 under SSP3-7.0 for Near-, Mid-, and Long-Terms

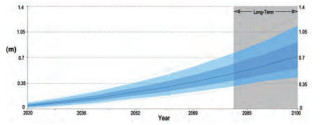
Projection of SLR for 2081-2100



Sub-regional projections of median RSLR (m) for three terms

	N-Term (2021-2040)	M-Term (2041-2060)	L-Term (2081-2100)
NW-Tropics	0.1 [0.0-0.2]	0.2 [0.1-0.4]	0.7 [0.4-1.0]
EQ-Pacific	0.1 [0.0-0.2]	0.2 [0.1-0.3]	0.6 [0.4-0.9]
NE-SPCZ	0.1 [0.0-0.2]	0.2 [0.1-0.3]	0.6 [0.4-0.9]
SW-SPCZ	0.1 [0.0-0.2]	0.2 [0.1-0.4]	0.6 [0.4-0.9]

Time-series projection of the sub-regional mean for the Equatorial Pacific



Source: IPCC[31]

Narrative Part

1. In consideration of the sea level change on a global scale in the previous slide, we should narrow the focus on the Pacific region. Again, AR6's Interactive Atlas was used to see the results of CMIP6 for the sub-regions under the high-emission scenario. As shown in the top table's multi-model averages for three terms and the time-series projection in the bottom chart, you can see that regional sea-levels will be 0.4-1.0m higher than in 1995-2014 in the long term. Also, together with the projected unique pattern in the long-term on the left, it is clear that differences between the regions are minimal—about 0.1m for the near-term and 0.6m for the long-term.
2. Interestingly, the magnitude of regional sea-level rise projections by models has gradually increased over the past decade, along with global projections. For example, sea-level rise in the western tropical Pacific was projected to be 0.26 to 0.82 m by 2100 under the very high emission scenario in the PCCSP report in 2011. Further, we should note that extreme sea-level events are projected to be more intense and frequent. For example, AR6 estimated that even a small amount of sea-level rise, say 5 to 10cm, could increase the frequency of flooding in the tropical Pacific as early as 2030.

Projected Climate Change – *Tropical Cyclone (TC) I*

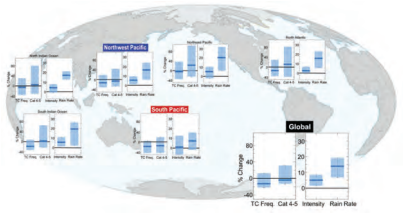
TC projection on the global scale for a 2°C global warming *(AR6)*

- Average peak TC wind speeds
- Proportion of category 4-5 TCs
- Average & Max rain rates associated with TCs
- Peak wind speeds of the most intense TCs

→ **Increase** *(all high confidence)*

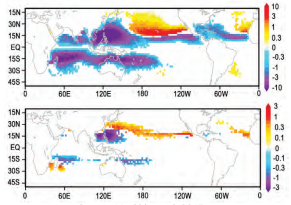
- Frequency of all TCs ----------→ **Decrease or unchanged** *(medium confidence)*

Regional TC projections for a 2 °C global warming



Source: Knutson et al, 2019

Projected frequency of TCs of all categories (top) and category 4-5 (bottom) for a 4 °C warming.



Source: Yoshida et al, 2017

Narrative Part

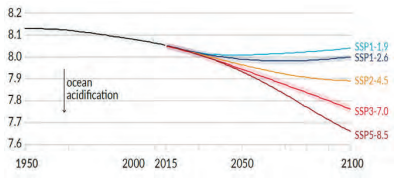
1. This slide presents the results of two recent studies on tropical cyclones. One is shown in the left map by Knutson et al., indicating the future status under 2 degrees warming, and the other is the two panels on the right by Yoshida et al., showing the projected TC frequencies of all categories on the top and 4-5 categories in the bottom.
2. Regarding tropical cyclones, confidence is low in identifying their long-term trends, such as frequency or intensity, due to changes in the technology used to collect best-track data. In addition, for projection, the simulation capabilities of global models are still challenging. However, recent studies, including those in this slide, suggested several essential features.
3. In summary, mainly from the Knutson's and AR6, average peak TC wind speeds and the proportion of Category 4-5 TCs will very likely increase globally with warming. However, over the western North Pacific, the frequency of Category 4-5 TCs will likely increase in limited regions. This trend in the western North Pacific is suggested in the bottom panel of Yoshida's. Also, average TC rain rates will likely increase with warming, and, finally, the frequency of TCs overall categories will decrease or remain unchanged.
4. Although degrees of some changes are different between the basins, tendencies are less similar for all seven basins, including NW and SW Pacific.

Projected Climate Change – *Acidification*

Acidification

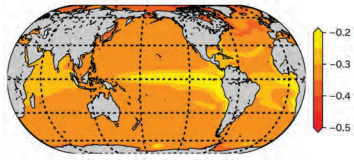
- Upper ocean stratification, ocean acidification and ocean deoxygenation **will continue to increase in the 21st century**, at rates dependent on future emissions. *(IPCC[34])*

Change in global ocean surface pH based on CMIP6 model simulations



Source: IPCC[35]

Change in ocean surface pH for 2081-2100 relative to 1986-2005 under RCP8.5



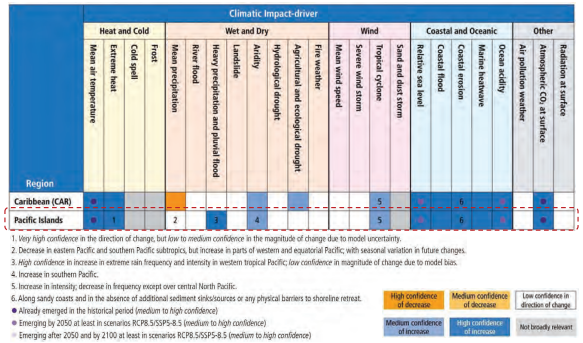
Source: JMA[2]

Narrative Part

1. Sea water is becoming more acidic across the entire ocean. Along with sea surface temperatures, this acidification trend will continue all through this century under medium or higher emission scenarios. Please take a look at the left panel. Under the Very-high scenario, the ocean pH will reach around 7.7 or less at the end of the century, which is about 0.4 units lower than the present value. Globally, acidification will be faster over the Equatorial Pacific, as shown in the right panel.

Overall assessment of climatic impact-driver (CID) in SIDS

Summary of confidence in direction of projected change in climatic impact-drivers (CIDs) in the small islands.



Population living in small islands that may be exposed to coastal inundation by 2100 under RCP4.5

Percentage of current population in selected small islands occupying vulnerable land (the number of people on land that may be exposed to coastal inundation; either by permanently falling below MHHW, or temporarily falling below the local annual flood height) in 2100 under an RCP4.5 scenario.

Source: IPCC[36] (left), [37] (right)

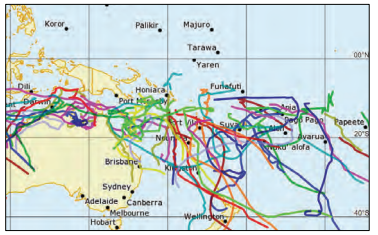
Narrative Part

1. In AR6, WGI has introduced the term “climatic impact-drivers”. A climatic impact-driver or CID refers to a long-term condition or an extreme event that directly affects society or ecosystems.
2. The table on this slide shows the regional assessment of CIDs change in the small islands of the Pacific and the Caribbean for mid-century under RCP4.5, the medium scenario. They are most relevant to small islands and will lead to “hazards” in the five primary domains, i.e., (1) “Heat and Cold”, (2) “Wet and Dry”, (3) “Wind”, (4) “Coastal and Oceanic”, and (5) “Other”.
3. The table assesses each CID by representing the confidence in its projected change and thereby suggests the level of confidence which is determined by the existence of robust evidence and model agreement. So, it will help identify the drivers of greater significance to the region. The level of confidence is indicated by the orange colour for decrease, blue for increase, white for no significant trend, and grey for not applicable.
4. Regarding “Heat and Cold”, “Mean air temperature”, and “Extreme heat” are identified as “High confidence of increase”. It suggests significant recent warming trends will continue in the 21st century with an increase in intensity and frequency of temperature extremes, particularly in the Pacific. So, a considerable increase in heat stress will be inevitable.
5. There are many white squares found in “Wet and Dry”. It is mainly because of the complexity of the global water cycle, scarcity of regional datasets, and complex climate variability of the regions. Nonetheless, high confidence is solely given to the increase of “Heavy precipitation and pluvial flood” in the Pacific. It reflects the increase in frequency and intensity of extreme rainfall events in the western tropical Pacific in the 21st century, even for the Low emission scenario. Meanwhile, the increase in “Aridity” is classified with medium confidence for the southern Pacific.
6. For Wind, again, many are in white due to the scarcity of data. Regarding “Tropical cyclones”, the Pacific region will generally face fewer but more intense storms, as we saw in the previous slides. However, we should note that there is a large variance between regions.
7. Regarding the “Coastal and Oceanic”, it is notable that all the drivers are

Projected Climate Change – *Tropical Cyclone (TC) II*

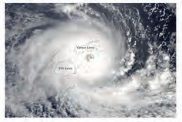
TC projections on the regional scale for S-Pacific *(by RCCAP based on Knutson's)*

- Average TC intensity will increase; *(mid to high confidence)*
- Frequency of category 4-5 TCs will change; *(low confidence)*
- TC rainfall rates will increase; *(mid to high confidence)*
- Sea level rise will increase TC-related storm surge events; *(high confidence)*
- Frequency of all TCs will decrease; *(high confidence)*



✓ ***All TC tracks during the six seasons from 2012/13 to 2017/18***

TC Winston hit Fiji, Feb. 2016



Source: Southern Hemisphere Tropical Cyclone Data Portal

Narrative Part

1. Compared with the assessment of TC projections on a global scale, it is much more difficult to discuss it for a specific basin, including the South Pacific. It is partly because of the limited ability of climate models to simulate various climate features and variabilities that influence tropical cyclones, such as ENSO and the SPCZ activity.
2. This slide summarizes the regional assessment by RCCAP for the South Pacific. Assessment is made based on Knutson’s and therefore has a lot of commonalities with the global assessment in the previous slide.
3. Points to be underlined are; 1) a clear view that TC frequency will decrease, and 2) an increase of TC-related storm surge is emphasized. Sea level rise will lead to a higher impact of storm surges. It needs to be considered with the projection of more intense TC rainfalls because it could cause the combined effect of storm surge and river flooding in coastal areas.

3. Climate Change Impact on Health

categorized as “High confidence of increase”, including acidification, heatwave, sea level, coastal flood and erosion, and sea level rise. In particular, the effect of sea-level rise is considered to continue to be a major threat to small islands and atolls, as it exacerbates the impacts, coupled with storm surges and swells. Projections indicate that shoreline retreat will occur over most of the Pacific and Caribbean small islands throughout the 21st century.

8. The chart on the right illustrates the impact of coastal inundation on small islands. It represents the potential effect of the percentage of the population that may be exposed to coastal inundation. It considers not only environmental but also political and socioeconomic factors and demonstrates the vulnerability of an island to sea level rise. As shown here, it is noteworthy that the islands in the Pacific are far more vulnerable than those of other regions, including the Caribbean.

Glossary

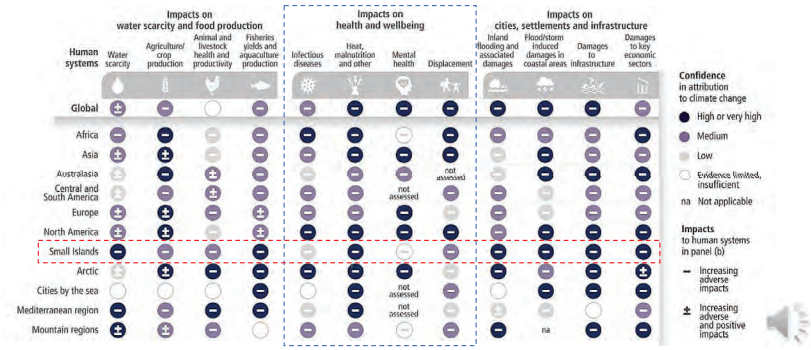
- **Climatic impact-driver (CID)**

Climatic impact-drivers (CIDs) are physical climate system conditions (e.g., means, events, extremes) that affect an element of society or ecosystems. Depending on system tolerance, CIDs and their changes can be detrimental, beneficial, neutral or a mixture of each across interacting system elements and regions. See also Risk, Hazard and Impacts (consequences, outcomes).

iii. Increased diarrheal diseases, including cholera, due to higher temperatures, increased rainfall and flooding.
iv. Mental health challenges such as trauma from extreme weather and climate events.

Observed impacts of climate change on human systems

■ Climate change has already had diverse adverse impacts on human systems, including on ***water security and food production***, ***health and well-being***, and ***cities, settlements and infrastructure***.



Source: IPCC[38]

Narrative Part

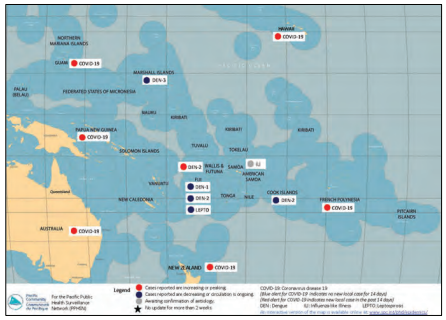
1. Climate change is already having visible effects on the world, and we are now experiencing its impact. It is increasing the frequency and intensity of weather and climate extremes in every region across the globe.
2. This slide presents the assessment of observed climate change impacts on human systems by AR6 WGII, which categorized the systems into three domains, i.e., “water scarcity and food production”, “health and wellbeing”, and “cities, settlements and infrastructure” from region to region, including Small Islands. Each domain is divided into four subdomains, so detailed consideration can be given.
3. For example, in the “Health and wellbeing domain”, ‘Infectious diseases’ include water-borne and vector-borne diseases; ‘Heat, malnutrition and other’ considers human heat-related mortality, labour productivity, harm from wildfire, and nutritional deficiencies; ‘Mental health’ includes impacts from extreme weather events and the effect of cumulative events; ‘Displacement’ assessments refer to the evidence of displacement due to climate and weather extremes.
4. Each assessment is represented by confidence and impact. Here, confidence is indicated in four levels. At the same time, the + and – symbols indicate the direction of observed impacts, with a – denoting an increasingly adverse impact and a ± denoting that both adverse and positive impacts have been observed.
5. Overall, this chart proves that climate change has already had varied adverse impacts on human systems in all regions. Looking at Small Islands, it is noted that the adverse impact is increasing with medium or higher confidence in most of the assessed subdomains, particularly in the “cities, settlements and infrastructure” domain. Regarding “health and well-being”, increasing adverse impacts with relatively high confidence is given to “Heat malnutrition and other” and “Displacement”.
6. In the global assessment of observed impacts, AR6 WGII identified the following with very high confidence.
    i. Human mortality and morbidity due to extreme heat events.
    ii. Increased occurrence of climate-related food-borne and water-borne diseases.

35

Climate-related health risks in SW Pacific

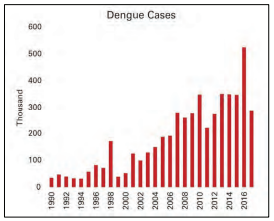
- In the South-West Pacific, malaria and dengue cases have increased in the past two to three decades. In particular, dengue cases have increased rapidly in recent years. *(WMO)*

Epidemic and emerging disease alerts in the Pacific as of 3 November 2020



Source: SPC

Confirmed dengue cases in the South-West Pacific.



Source: WHO

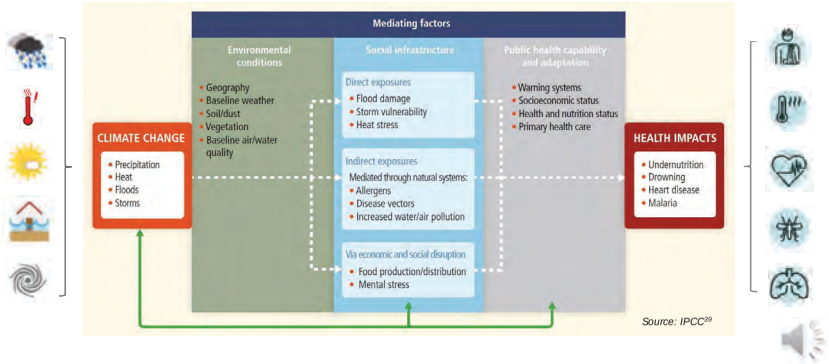
Narrative Part

1. Climate change and extreme weather events are already affecting many sectors of Pacific Island Countries, including transportation, agriculture, ecosystem, and the health and well-being of people. Regarding infectious diseases in the South-West Pacific, it has been found that malaria and dengue have increased in the past two to three decades. In particular, dengue cases have increased rapidly in recent years.
2. Changing rainfall patterns, humidity and temperature, and rapid urbanization contribute to a surge in vector-borne diseases such as dengue.
3. The right panel displays the annual numbers of dengue cases in the SW Pacific from 1990 to 2016. It proves the rapid increase in recent years, particularly for the last dozen years.
4. The left panel is a snapshot of an outbreak case of dengue that occurred from 2019 to 2020. At that time, COVID-19 was gradually increasing in the region. This map was produced by SPC and indicated “epidemic and emerging disease alerts” announced for the island concerned as of 3 November 2020.
5. As of the day, there were about 3800 dengue-like-illness cases, and 1900 confirmed cases reported by the Marshall Islands, 54 cases in Futuna, and about 380 cases in the Cook Islands.

34

How climate change affects health

- Conceptual diagram showing three primary exposure pathways by which climate change affects health.



Source: IPCC[39]

Narrative Part

1. As discussed in the previous slide, climate change affects every aspect of human systems. Its process is complicated and has characteristic differences between sectors. This slide will look at how climate change affects health. So it presents here a diagram indicating the process.
2. Initially, we should note that climate change leads to health impacts through a variety of mediating factors, and at its core are three primary exposure pathways in social infrastructure.
3. First is “direct exposures”, which relate primarily to high-impact factors of climate change such as severe floods, intense storms, and extreme heat. This pathway leads to direct illness, injury, and death.
4. The second is “indirect exposures” through natural systems such as allergens, disease vectors, and environmental pollution, most likely caused by warmer conditions and increased precipitation. Related also are saltwater intrusion from sea level rise.
5. Thirdly, the pathways that are heavily mediated by human systems, such as undernutrition and mental stress. These include, e.g. increased challenges from population displacement, damage to healthcare infrastructure, and heat impact on the workforce.
6. However, exposure pathways are not stereotypical for all populations influenced by local circumstances. The green box indicates the presence of such environmental conditions that need to be considered as background information of the people concerned. It includes environmental factors such as geography, local climate, ecosystem, and terrestrial conditions.
7. Meanwhile, the grey box suggests the eventual health impacts as a result of the three categories of exposure are moderated by the healthcare capacity and socioeconomic conditions of the society concerned, as well as the adaptation measures to be taken.
8. The green arrows indicate that there may be feedback mechanisms between societal infrastructure, public health and adaptation measures, and climate change itself.

Human and natural factors

- The chain of associations from climate change to changing disease patterns can be extremely complex and include many non-climatic factors. Therefore, the severity of impacts will be determined not only by changes in climate but also by concurrent changes in non-climatic factors.
- Non-climate factors that should be considered when assessing the health risks of climate change can be broadly categorized into the following:
  - Overall economic development affecting human well-being (e.g., wealth and distribution of income; efforts to reduce poverty and tackle gender equity; issues around industrial development, pollution, urbanization and population growth; access to adequate nutrition, clean water and sanitation; deforestation;
  - Non-climatic disasters (e.g., volcanic activity, earthquakes and tsunamis);
  - Future improvements in health interventions;
  - Mass migration, conflicts and war.

Source: UNFCCC/CGE Training Materials for Vulnerability and Adaptation Assessment, Chap.8

Deforestation

(SPREP)

Urbanization

(UN HABITAT)

Mass drug administration

(JICA)

Waste disposal

(SPREP)

Hunga Tonga–Hunga Ha'apai

(Tonga Geological Services)

4. Non-climate factors

Narrative Part

1. We have so far learned that health is influenced by many factors, including environmental, socio-economic, and demographic, through highly complex processes. Non-climate factors are closely associated with the cause of influence on health as the significant determinants along with climate-related factors, both having a close relationship. Therefore, to develop effective adaptation programs based on a valid risk and vulnerability assessment, it is crucial to identify the non-climate factors in conjunction with those climate-related.
2. Many significant non-climate factors consist in the socio-economic category. Communities with a lower average income are more at risk than higher income. Population density is closely linked with the transmission and persistence of diseases. Poverty is a major cause of illness and, at the same time, a barrier to accessing health care. Though not visible, outbreaks of infectious diseases, including Ebola, are more likely in areas of deforestation.
3. Obviously, non-climatic disasters, particularly those geological such as volcanic eruptions, earthquakes and tsunamis, are often devastating and catastrophic and responsible for the great loss of life and properties. Located in the circum-pacific belt of active volcanoes, or Pacific Ring of Fire, many Pacific islands are actually frequently affected by geological hazards.
4. Future improvements in health interventions, particularly organizational-level changes such as an increase of skilled health workers and drug availability, will no doubt make communities healthier and more climate resilient.
5. Mass migration or population displacement undermines the provision of medical care and vaccination programs, making infectious diseases harder to deal with and more deadly. Conflicts and wars are caused by political, social, and environmental issues or their combination. They could claim millions of lives in some cases. Like mass migration, conflict creates conditions conducive to infectious diseases through insufficient nutrition, overcrowding, decreased access to clean water, and poor sanitation.

References

1. IPCC Fifth Assessment Report (AR5) and Sixth Assessment Report (AR6): https://www.ipcc.ch/reports/
   - [1]: WGI AR6; FAQ 7.1, Figure1
   - [2]: WGII AR5; Figure SPM.1
   - [3]: WGI AR6; SPM-9 (A.2.1)
   - [4]: WGI AR6; SPM-9 (A.2.2)
   - [5]: WGI AR6; SPM-5 (A.1.2)
   - [6]: WGI AR6; Figure SPM.1
   - [7]: WGI AR6; Chapter 12-87, lines 27-28
   - [8]: WGI AR6; Atlas-93, lines 53-54
   - [9]: WGI AR6; Regional fact sheet - Small Islands
   - [10]: WGI AR6; Atlas-175, Figure Atlas.11
   - [11]: WGI AR6; Figure 8.1
   - [12]: WGI AR6; Chapter 9-8, lines 32-33 & 34-35
   - [13]: WGI AR6; Chapter 9-8, lines 42-43
   - [14]: WGI AR6; Infographic TS.1
   - [15]: WGI AR6; SPM-17 B.1
   - [16]: WGI AR6; SPM-36 D.1.1
   - [17]: WGI AR6; Figure SPM.8 a)
   - [18]: WGI AR6; Table SPM.1
   - [19]: WGI AR6; Figure SPM.10
   - [20]: WGI AR6; Chapter 12-88, lines 3-4
   - [21]: WGI Interactive Atlas; CMIP6 projections
   - [22]: WGI AR6; SPM-25, B.3.1
   - [23]: WGI AR6; SPM-20, B.2.4
   - [24]: WGI AR6; Figure SPM.5 c)
   - [25]: WGI AR6; Chapter 12-88, lines 20-21
   - [26]: WGI Interactive Atlas; CMIP6 projections
   - [27]: WGI AR6; SPM-28, B.5.3
   - [28]: WGI AR6; SPM-28, B.5.4
   - [29]: WGI AR6; Figure 9.28 (d)
   - [30]: WGI AR6; Figure SPM.8 d)-middle, e)-right
   - [31]: WGI Interactive Atlas; CMIP6 projections
   - [32]: WGI AR6; SPM-28, B.5.1
   - [33]: WGI AR6; Figure 9.3 (a)-left, (d)-right
   - [34]: WGI AR6; SPM-28, B.5.1
   - [35]: WGI AR6; Figure SPM.8 c)
   - [36]: WGI AR6; Table 12.9
   - [37]: WGII AR6; Figure 15.3
   - [38]: WGII AR6; Figure SPM.2 (b)
   - [39]: WGII AR5; Figure 11-1
2. Pacific-Australia Climate Change Science and Adaptation Planning Program (PACCSAP): http://www.bom.gov.au/climate/pacific/index-pacific.shtml
3. UCAR Center for Science Education (SciEd): https://scied.ucar.edu/
4. National Oceanic and Atmospheric Administration (NOAA)
   - [1]: https://www.pmel.noaa.gov/elnino/what-is-el-nino
   - [2]: https://www.climate.gov/climatedashboard
   - [3]: https://coralreefwatch.noaa.gov/product/5km/index_5km_ssta.php
5. Global Carbon Project (GCP): https://www.globalcarbonproject.org/
6. World Meteorological Organization (WMO)
   - [1]: https://library.wmo.int/index.php?lvl=notice_display&id=22080#.Yu-dA3bP1aQ
   - [2]: https://public.wmo.int/en/media/press-release/climate-change-increases-threats-south-west-pacific
7. National Aeronautics and Space Administration (NASA): https://earthobservatory.nasa.gov/images/150152/a-july-of-extremes
8. Met Office: https://www.metoffice.gov.uk/
9. McGree, S. et al., 2019: Recent Changes in Mean and Extreme Temperature and Precipitation in the Western Pacific 10 Islands.
10. AVISO altimetry: https://www.aviso.altimetry.fr/en/home.html
11. Aucan, J. 2018: Effects of Climate Change on Sea Levels and Inundation Relevant to the Pacific Islands.
12. Regional Climate Consortium for Asia and the Pacific (RCCAP) portal: https://www.rccap.org/
13. Japan Meteorological Agency:
    - [1]: https://www.data.jma.go.jp/cpdinfo/ccj/2020/pdf/cc2020_shousai.pdf, p-28
    - [2]: https://www.data.jma.go.jp/cpdinfo/ccj/2020/pdf/cc2020_shousai.pdf, p-197
14. Knutson, T. et al., 2019: Tropical Cyclones and Climate Change Assessment: Part I: Detection and Attribution.
15. Knutson, T. et al., 2020: Tropical Cyclones and Climate Change Assessment: Part II: Projected Response to Anthropogenic Warming.
16. Yoshida, K. et al., 2017: Future Changes in Tropical Cyclone Activity in High-Resolution Large-Ensemble Simulations.
17. Southern Hemisphere Tropical Cyclone Data Portal: http://www.bom.gov.au/cyclone/tropical-cyclone-knowledge-centre/history/tracks/
18. UNFCCC/CGE Training Materials for Vulnerability and Adaptation Assessment - Chapter 8 Human Health

507

Glossary

➢ Pacific Ring of Fire

Most earthquakes and volcanic eruptions do not strike randomly but occur in specific areas, such as along plate boundaries. One such area is the circum-Pacific Ring of Fire, where the Pacific Plate meets many surrounding tectonic plates. The Ring of Fire is the most seismically and volcanically active zone in the world. (USGS)

Tropical cyclone Winston 20 February 2016

- Hit Fiji on 20 February 2016
  - National state of emergency 7 March to 29 May
- WHO portable toolkit for an early warning alert and response system (EWARS in a Box) deployed within 24 hours
- Recorded 34,113 cases of nine syndromes among 326,861 consultations in a population of about 900,000
- 48% of cases were influenza-like illnesses
- 583 cases of Zika-like illness (1.7%)
- 2 large outbreaks of viral conjunctivitis (880 cases)

Source: IPCC Sixth Assessment Report, WGII, Chapter 15

3

CBCRP-PCCC Virtual Training Course

Health Systems and Climate Change
Enhancing Resilient and Low-carbon Development in the Pacific

Government of Samoa, SPREP, and JICA

Module 1. Understanding of risks of climate change impacts on human health and health services, and GHG emission from health services

1.1 Risks of climate change impacts

Cases of climate change impacts on human health and health services in the Pacific

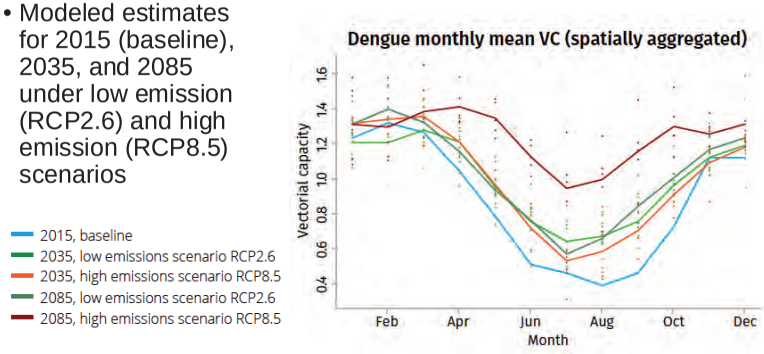
Dr. Kristie Ebi,
Professor, Department of Global Health, University of Washington

1

508

Monthly mean vectorial capacity (VC) for dengue fever in Fiji

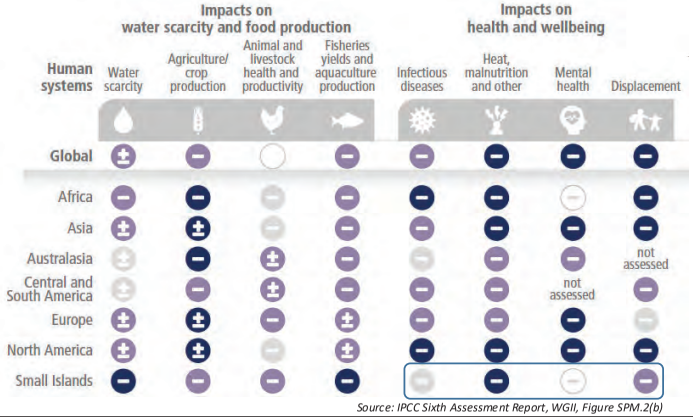
- Modeled estimates for 2015 (baseline), 2035, and 2085 under low emission (RCP2.6) and high emission (RCP8.5) scenarios



Source: WHO Health and Climate change Country Profile 2021: Fiji, Figure 7

4

Observed global and regional impacts of climate change on health and wellbeing



Source: IPCC Sixth Assessment Report, WGII, Figure SPM.2(b)

2

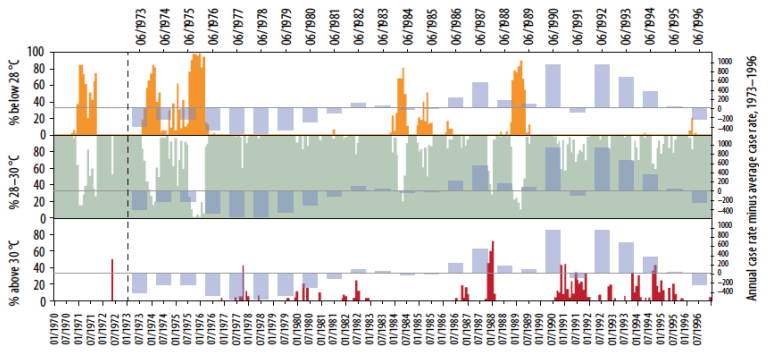
Additional health risks of climate change in the Pacific

- Heat stress
  - Heatwaves are associated with excess hospitalizations and (preventable) mortality
  - Productivity of outdoor workers is reduced on hot days
- Food security
  - Climate-driven changes in the ability to access locally grown food can increase dependence on imported foods, increasing rates of malnutrition and non-communicable diseases
  - By 2050, local food accessibility could be reduced by 3.2% in the Western Pacific, with approximately 300,000 deaths possible
  - 20% projected decline in coral reef fish production by 2050 could exacerbate food insecurity
- Diarrheal diseases from reliance on aquifers and rainwater harvesting, coupled with overcrowding, population growth, and contamination
  - Seasonal rainfall in Kiribati is associated with diarrhea, cholera, and typhoid fever

Source: IPCC Sixth Assessment Report, WGII, Chapter 15

7

Warmer sea surface temperatures coincide with higher rates of ciguatera, Kiribati



Source: WHO Health and Climate change Country Profile 2017: Kiribati, Fig. 2.3.

5

509

Reference

- IPCC Sixth Assessment Report, WGII SPM, https://www.ipcc.ch/report/ar6/wg2/downloads/report/IPCC_AR6_WGII_SummaryForPolicymakers.pdf
- IPCC Sixth Assessment Report, WGII Chapter 15, https://www.ipcc.ch/report/ar6/wg2/downloads/report/IPCC_AR6_WGII_Chapter15.pdf
- WHO Health and Climate change Country Profile 2021: Fiji, https://www.who.int/publications/i/item/WHO-HEP-ECH-CCH-21.01.01
- WHO Health and Climate change Country Profile 2017: Kiribati, https://www.who.int/publications/i/item/health-and-climate-change-country-profile-2017-Kiribati
- Gibson KE, Barnett J, Haslam N, Kaplan I. The mental health impacts of climate change: Findings from a Pacific Island atoll nation. J Anxiety Disord. 2020 Jun;73:102237. doi: 10.1016/j.janxdis.2020.102237. Epub 2020 May 20. PMID: 32485590., https://pubmed.ncbi.nlm.nih.gov/32485590/

8

Mental health impacts of climate change: Tuvalu

- 100 Tuvaluan participants were interviewed to determine the presence of psychological distress and associated impairment attributed to:
  - Local environmental impacts caused or exacerbated by climate change
  - Hearing about climate change and contemplating its future implications
- Results found
  - Distress to both stressors
  - High proportion of participants were experiencing psychological distress at levels that caused them impairment in one or more areas of life

Source: Gibson KE, Barnett J, Haslam N, Kaplan I. The mental health impacts of climate change: Findings from a Pacific Island atoll nation. J Anxiety Disord. 2020 Jun;73:102237. doi: 10.1016/j.janxdis.2020.102237. Epub 2020 May 20. PMID: 32485590.

6

CONTENTS

1. Climate change risks and vulnerability – definitions
2. Existing evidence on climate change impacts on health
3. Vulnerability and Adaptation assessment guidance (WHO, 2021)
4. Steps in conducting vulnerability and adaptation assessment
5. Vulnerability of sub-populations to health impacts of climate change
6. Role of healthcare facilities amid climate change
7. Vulnerability of health facilities – the four components

In this lecture, we shall first talk briefly about the definitions of climate change risks and vulnerability before exploring existing evidence on the health impacts of climate change. We shall then go through the WHO guidelines for conducting vulnerability and adaptation assessment of health systems. Finally, we shall look into WHO checklists for assessing vulnerability and adaptation of healthcare facilities.

510

CBCRP-PCCC Virtual Training Course

Health Systems and Climate Change: Enhancing Resilient and Low-carbon Development in the Pacific

Government of Samoa, SPREP, and JICA

Module 1.2. Vulnerability and adaptation assessment

1.2.1 Vulnerability and adaptation assessment of health care facilities in the context of climate change

Akampumuza Precious (PhD) | JICA Expert
JWA, akampresh@gmail.com

Hello, everyone my name is Precious Akampumuza , I did my Masters and PhD in sustainability science from the UTokyo, and will deliver this training module 1.2 (V&A) as a short term JICA expert. I am happy to be delivering this training and hope that you will find it interesting and informative.

Existing evidence on climate change impacts on health

- Global climate change poses direct and indirect health risks in developing countries
- Mortality and illnesses associated with climate hazards such as heatwaves, flooding and wildfires
- Warmer temperatures linked to increase in vector-born diseases like malaria, dengue, rift valley and yellow fever in previously low rates of infestation (Colón-González et al, 2021).
- Water contamination during floods and water shortage during droughts heighten risk of diarrhea (Bandyopadhyay et al., 2012) and cholera (Trærup et al., 2011).

Let us talk about existing evidence, we are all acutely aware that climate change poses direct and indirect health risks in developing countries. The commonly cited ones include mortality and illnesses associated with climate hazards such as droughts, heatwaves, flooding and wildfires, storms, among others.

Climate change risks and vulnerability - definitions

- Definitions
  - Climate change risk: Likelihood that climate-induced shocks and stresses will adversely impact the functioning of a health care facility.
  - Climate change vulnerability (IPCC): the propensity or predisposition to be adversely affected by a climate risk.
- Preventive measures & policy actions reduce vulnerability; benefit society, and the environment

Climate change risks in the context of healthcare facilities is generally defined as the likelihood that climate-induced shocks and stresses will adversely impact the functioning of a healthcare facility. On the other hand, the IPCC defines climate change vulnerability as the propensity or disposition to be adversely affected by a climate risk. Many societies around the globe face climate change related challenges, but preventive measures and policy actions reduce vulnerability, and hence benefit society, and the environment.

Vulnerability and Adaptation Assessment (WHO, 2021)

Let us talk about V&A assessment (WHO, 2021)

Existing evidence on climate change impacts on health_cont'd

- Children and elderly more vulnerable to climate-induced mortality (Amegah et al., 2016).
- Mental health problems associated with extreme weather events including:
  - Among children (Rother et al., 2020)
  - Among pastoral communities in the Horn of Africa (Cooper et al., 2019)
  - Mental illness violence linked to heatwaves in South Africa (Chersich et al., 2019)
- Direct risks like injury and death due to floods are on the rise (Theron et al., 2022; Mphekgwana, 2022).

More on evidence, the direct risks like injury and death due to floods are on the rise. The most vulnerable groups to climate-induced mortality include children and elderly.

Vulnerability and Adaptation Assessment Guidelines (WHO, 2021)

❖ **V&A assessment could strengthen priority areas of health systems & communities through;-**

1. enhancing service delivery (e.g. during and after climate-related hazards such as severe storms)
2. seeking adequate funding and resource allocations to support health adaptation efforts
3. informing actions to maintain, upgrade, site and build new health infrastructure such as hospitals
4. preparing health workforce by providing information and tools to protect themselves & clients from disasters
5. developing and implementing health information systems to track illnesses, injuries and deaths and to inform early warning systems that protect health
6. working with decision-makers outside the health sector to maximize co-benefits to human health and to health systems from properly designed adaptation and greenhouse gas mitigation measures
7. determining the effectiveness of adaptation options taken by health authorities and partners outside the health sector to support iterative decision-making
8. providing the data and information needed to develop a health adaptation strategy, with high-priority adaptation options and with a monitoring and evaluation plan

Vulnerability and adaptation assessment are a crucial tool for developing an implementing comprehensive health adaptation measures to increase the capacity of health systems to address climate-related risks and improve healthcare service delivery. The information collected from the assessments can be an integral part of developing disease surveillance and tracking mechanisms.

Vulnerability and Adaptation Assessment Guidelines (WHO, 2021)

❖**Rationale: To provide flexible guidance on :**

- conducting a national or subnational V&A assessment of current and future vulnerability to the health risks of climate variability and change
- policies, programmes and capacities of health systems that could increase resilience, taking into account the multiple determinants of climate-sensitive diseases and health outcomes

❖**Resultant information from the V&A assessment informs health policy makers about:**

- the magnitude and pattern of likely health risks attributable to climate change over the short and longer term
- potentially severe or catastrophic impacts to individual health and to health systems when capacity to respond is overwhelmed
- opportunities to collaborate with decision-makers outside the health sector to achieve large health co-benefits from climate action
- potential cost savings and other benefits of implementing such policies and programmes.

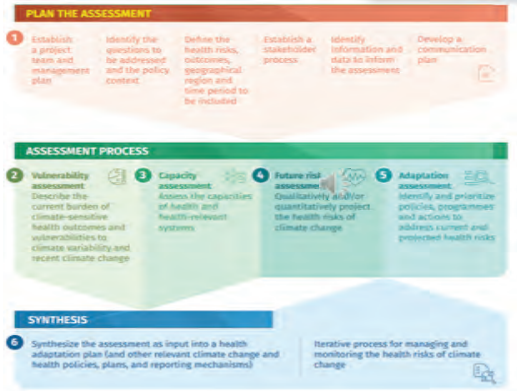
The WHO V&A assessment is meant to guide countries in conducting their own assessments customized to their country contexts, with an ultimate goal of understanding vulnerabilities and designing response and resilience measures.

Comprehensive steps in conducting vulnerability and adaptation assessment

Source: WHO and Health Canada (2021): Climate Change and Health, Vulnerability and Adaptation Assessment

We are now going to go through the detailed steps of conducting a vulnerability and adaptation assessment in the subsequent slides.

Steps in conducting vulnerability and adaptation assessment



Source: WHO and Health Canada (2021): Climate Change and Health, Vulnerability and Adaptation Assessment

The WHO V&A assessment guidelines have six major steps that are categorized into three broad groups. The first step is to properly plan the assessment, followed by conducting the assessment itself. This second part entails conducting a vulnerability assessment to ascertain the current burden of climate-sensitive health outcomes, assessing the capacity of health systems to handle climate-related risks, qualitatively and quantitatively projecting the future risks and conducting an adaptation assessment. The final step is to synthesize the assessment and integrate its findings into health adaptation plans.

Step 1: Getting started – plan the assessment

Step 1A: establish a project team and management plan, including representatives from other departments and ministries

Step 1B: identify the questions to be addressed and the policy context.

Step 1C: define the health risks, outcomes, geographical region and time period that will be the focus of the assessment.

Step 1D: establish a stakeholder process, including populations that could be affected by climate change.

Step 1E: identify information and data to inform the assessment.

Step 1F: develop a communication plan.

Source: WHO and Health Canada (2021): Climate Change and Health, Vulnerability and Adaptation Assessment

The first step of planning the assessment is quite crucial as it is the main determinant of the success of subsequent steps of the assessment. This requires establishing an appropriate team of experts from relevant institutions (e.g. ministries of health), identifying the right set of questions to be asked during the assessment, clearly defining risks to be assessed, identifying stakeholders to be engaged along with a stakeholder engagement plan and developing a communication plan to share resultant data.

Step 2: Vulnerability assessment – describe the current burden of climate sensitive health outcomes and vulnerabilities to climate variability and recent climate change

Step 2A: identify, describe and prioritize key climate-sensitive health outcomes.

Step 2B: analyse the relationships between current and past weather and climate conditions and health outcomes.

Step 2C: identify trends in upstream drivers of climate-sensitive health outcomes and the geographical distribution of risks.

Step 2D: identify vulnerable populations and geographical regions.

Step 2E: document baseline information for monitoring changes in future vulnerability and evaluating adaptation options.

Source: WHO and Health Canada (2021): Climate Change and Health, Vulnerability and Adaptation Assessment

In this second step, it is crucial to identify which climate risks are to be prioritized in order to narrow down the scope of the assessment focusing on the most important health outcomes. This is followed by ascertaining the link between these health outcomes and past and current climate conditions. It is then important to ascertain the drivers of climate-sensitive health outcomes and identifying the groups of people and regions most vulnerable to certain hazards.

Step 3: Capacity assessment – assess the capacity of health and health-relevant systems:

Step 3A: identify the policies, programmes and infrastructure to manage current and future health outcomes.

Step 3B: assess the current capacity of the health system to address the risks of climate sensitive health outcomes.

Step 3C: assess the current actions of other sectors that affect the risks of climate-sensitive health outcomes.

Source: WHO and Health Canada (2021): Climate Change and Health, Vulnerability and Adaptation Assessment

Assessing the capacity of health systems is important in understanding the preparedness (policies and programs) to handle climate-related risks

Step 4: future risk assessment – qualitatively or quantitatively project the health risks of climate change:

Step 4A: describe how current health risks could change under diverse scenarios of climate change and development.

Step 4B: estimate the possible additional burden of adverse health outcomes due to climate change.

Source: WHO and Health Canada (2021): Climate Change and Health, Vulnerability and Adaptation Assessment

While assessing future risks, it is important to keep in mind potential changes in current health risks under different climatic conditions and hence project potential additional health burdens resulting from changing climate

Step 5: adaptation assessment – identify and prioritize policies, programmes and actions to address current and projected health risks

Step 5A: identify additional population health and health care policies and programmes to prevent or reduce projected health burdens.

Step 5B: prioritize health system adaptation policies and programmes to reduce likely future health burdens.

Step 5C: identify human and financial resources for implementation of identified policies and programmes and potential challenges to be addressed.

Step 5D: estimate the costs of action and inaction.

Step 5E: identify actions to reduce the potential health risks and maximize health co-benefits of adaptation and greenhouse gas emission mitigation policies and programmes implemented in other sectors.

Source: WHO and Health Canada (2021): Climate Change and Health, Vulnerability and Adaptation Assessment

Having understood the risks, the fifth step is to ascertain the extent to which health systems can handle observed and/or projected risks. This entails assessing existing policies and programs to reduce vulnerability, identifying human and financial resources, assessing benefits and costs of taking action and maximizing co-benefits of health adaptation

Step 6: synthesize the assessment as input into relevant climate change and health policies, plans and reporting mechanisms:

Step 6A: synthesize the knowledge and understanding gained as input into a health adaptation plan.

Step 6B: establish an iterative process for managing and monitoring the health risks of climate change and climate resilience of health systems.

Source: WHO and Health Canada (2021): Climate Change and Health, Vulnerability and Adaptation Assessment

The final step in the V&A assessment is meant primarily to integrate information gathered from the assessment into health adaptation plans and establishing multi-stakeholder frameworks to continuously monitor health risks resulting from climate change.

Role of healthcare facilities amid climate change

❖**Healthcare facilities play a crucial role of adaptation through:**

1. Treating illnesses and injuries attributable partially to climate-related hazards
2. Caring for patients during and after disasters and
3. Participating in community efforts to adapt to and mitigate climate change

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4276665/

❖**Effective performance depends on availability of:**

1. Skilled and empowered health workforce and decent working conditions
2. Sustainable and safe management of water, sanitation and hygiene (WASH) and health care waste services
3. Sustainable energy services
4. Appropriate infrastructure, technologies, products and processes

Healthcare facilities are at the forefront of fighting against climate-related risks through not only treating illnesses and injuries and caring for patients but also participating in community adaptation programs including awareness-raising campaigns. The ability of healthcare facilities to fulfill this role depends on availability of skilled human resources, sustainable energies and infrastructure and sustainable management of WASH and healthcare waste services

518

Checklists to assess vulnerabilities in health care facilities in the contexts of climate change

This part of the training is devoted to understanding the role played by health facilities in addressing climate-related risks, the vulnerability of healthcare facilities and step-by-step process of assessing vulnerability and adaptation using the WHO (2021) checklists.

Steps in assessing climate vulnerability in a healthcare facility

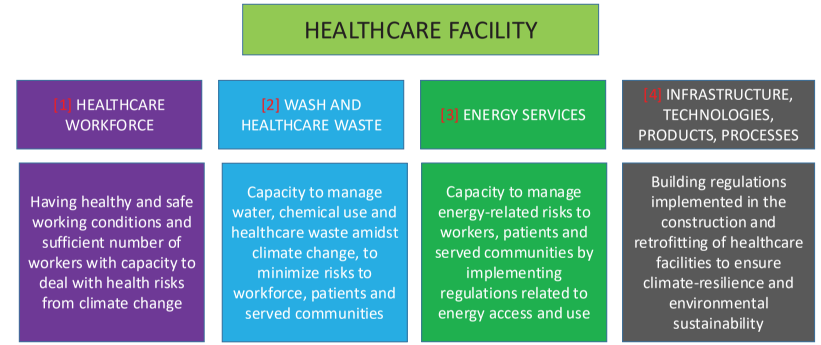
(i) Identify climate hazards of concern

(ii) Assess current vulnerability for each of the hazards, in each of the key components of health care facilities

(iii) Understand potential impacts posed by climate variability and change in each of the key components of health care facilities.

The process of conducting vulnerability and adaptation assessment in healthcare facilities has three main steps. The first step entails identifying climate hazards to which the healthcare facility is likely to be prone. In the second step, vulnerability of the healthcare facility to each of the identified hazards is assessed keeping in mind vulnerability of the four components of healthcare facilities to each hazard. The third and final step is to ascertain potential impacts of each hazard on healthcare work force, energy, WASH and healthcare waste management and infrastructures, technologies, products and processes.

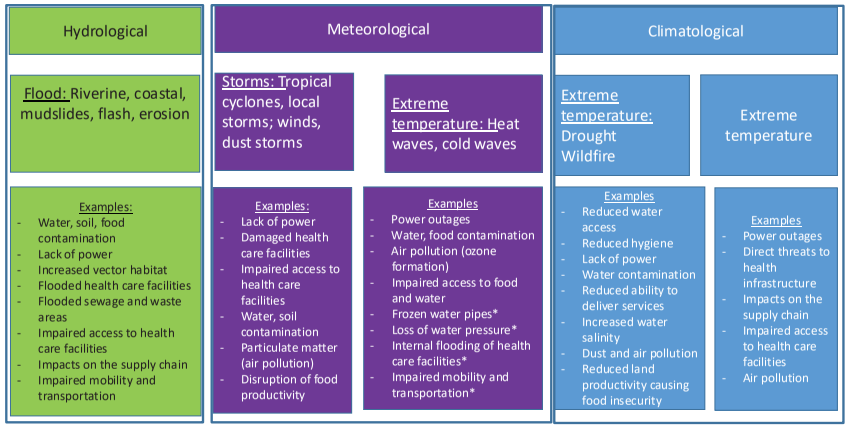
Vulnerability of health facilities – the four components



Source: WHO 2021 Vulnerability Assessment Tool Kit, Table 3

The effective delivery of healthcare services depends on the agility of four components of healthcare facilities, namely; healthcare workforce, WASH and healthcare waste, energy services and infrastructure, technologies, products and processes.

Hydro-meteorological hazards



Hydrometeorological risks relate to hazards emanating from water and heat and are subdivided into three groups. Hydrological risks like floods, riverine and coastal erosion, mudslides, etc. destroy and/or contaminate healthcare services and infrastructure. Meteorological and climatological risks result from storms, extreme temperatures, droughts and wild fires that interrupt power supply, contaminate water and food systems within the healthcare facility.

Step 1: Identify climate hazards of concern

- **First understand which climate-related hazards are of concern to the healthcare facility**
- **Risk magnitude depends on**
  - Current hazards
  - Exposure
  - Vulnerability
- **Hazards are broadly classified into:**
  - Hydro-meteorological hazards
  - Environmental hazards
  - Biological hazards
- **Keep in mind technological and societal dimensions of identified hazards**

While conducting the first step of identifying climate hazards of concern to the healthcare facility, the assessor needs to keep in mind that the magnitude of risks depends on the nature of current hazards, degree of exposure and level of vulnerability. WHO broadly categorizes hazards into hydro-meteorological, environmental and biological hazards. These are described in detail in subsequent slides.

Biological hazards – climate-sensitive diseases

HAZARD TYPE	EXAMPLES OF EXPOSURE PATHWAYS
Airborne diseases	• Respiratory infections • Meningococcal meningitis • Influenza
Waterborne diseases	• Diarrhoeal diseases • Cholera • Typhoid fever
Foodborne diseases	• Hepatitis A • Foodborne microbial hazards
Zoonotic diseases	• Leptospirosis • Hantavirus disease
Vectorborne diseases	• Dengue • Malaria • Chikungunya • Zika • Rift Valley fever • West Nile virus • Lyme disease

Source: WHO (2021) Vulnerability and Adaptation Assessment Checklist

Risks posed by biological hazards include increased incidence of airborne diseases like respiratory infections, meningitis and influenza; water-borne diseases like diarrhea, cholera and typhoid; food-borne diseases like Hepatitis A and microbial hazards; zoonotic diseases like leptospirosis and hantavirus diseases as well as vector-borne diseases like dengue, malaria, chikungunya, rift valley fever, West Nile virus, zika, Lyme disease, etc.

Environmental hazards

Sea level rise	Direct hazard from increased temperature
Recurrent or permanent coastal floods and erosion	-Accelerated growth, transmission, virulence of certain pathogens leading to increased biological hazards -Ozone formation
Examples: - Increased salinity intrusion (water, soil) - Freshwater contamination - Food contamination - Flooded health care facilities - Flooded sewage and waste areas - Impaired access to health care facilities	Examples: - Increased biological hazards - Change in climate-sensitive diseases (increase in health care facility admissions) - Water and food contamination - Air pollution (ozone formation) - Impacts on biodiversity (control of new pathogens) - Threats to building infrastructure from melting permafrost

Risks related to environmental hazards include sea level rise associated with coastal floods and erosion which interrupt the normal flow of clean water and sewage systems. Other environmental change risks include direct hazards from increased temperature which lead to ozone formation and biological hazards like pathogen expansion.

Hypothetical scenario of climate hazards impacts on healthcare facility

CLIMATE HAZARD TYPE	IS A HAZARD OR EXPOSURE PRESENT?	WHAT ARE THE IMPACTS ON THESE AREAS? ● Current observed impacts ◇ Possible impacts with changed conditions			
	Yes/No*	Health workforce	WASH and health care waste	Energy services	Infrastructure, technologies, products, processes
Storm (tropical cyclone)	Yes	●	●	●	●
Flood	Yes	◇	●	●	●
Heatwave	No	◇		◇	
Drought	No	◇	◇		
Wildfire	No			◇	◇
Sea-level rise	Yes	◇	◇		●

**A yes/no categorization is used in this example. In some cases assessments may include the likelihood of occurrence and the intensity of the impact.*

Source: WHO (2021) Vulnerability and Adaptation Assessment Checklist

This hypothetical example illustrates the main hazards of concern to a typical healthcare facility in a small island country. For most island countries, the common hazards are either hydrological or environmental in nature, including storms or tropical cyclones, floods and sea level rise

Other climate-related risks

Climate-sensitive health outcomes	**Noncommunicable diseases and injuries**	• Chronic respiratory diseases • Cardiovascular diseases • Unintentional injuries • Mental health outcomes • Malnutrition • Kidney diseases
Technological (mediated by climate hazards)	Industrial hazards (as a result of a climate hazard such as a storm, flood, or wildfire)	• Chemical spill • Structural collapse • Occupational hazards (health workforce) • Environmental pollution (air, water, soil) • Food contamination • Infrastructure disruption causing: power outages; contamination of water supply, solid waste, wastewater, food and water: communication system failure; medical equipment, products and services, supply system failure; build up of hazardous waste
Societal (mediated by climate hazards)	Displaced populations Famine	• Water and food scarcity • Mental health problems • Protein-energy malnutrition • Conflict and violence

Source: WHO (2021) Vulnerability and Adaptation Assessment Checklist

Other climate-related risks include climate-sensitive health outcomes like noncommunicable diseases and injuries; technological risks exacerbated by climate hazards (chemical spills, structural collapse, occupational hazards, etc.) and societal risks like famine and population displacement.

Assessment areas and objectives under the four components

- To provide safe and quality care in the context of climate change, the interventions can be suggested along the lines of the following four requirements;

1. the health workforce;
2. water, sanitation, hygiene and health care waste management;
3. sustainable energy services; and
4. Infrastructure, technologies and products.

- The assessment areas and objectives under each of the above requirements are categorized into three items

In order to understand the vulnerability of healthcare facilities, a vulnerability and adaptation assessment is needed. The assessment areas and objectives are elaborated in subsequent slides, covering the four healthcare facility components.

523

Step 2: Assessing current vulnerabilities

- Healthcare facilities have preexisting vulnerabilities prior to hazards
- Existing vulnerabilities could increase climate impacts on the four healthcare facility components
- Hazards could occur simultaneously; compounding impacts on healthcare facility
- Hazards could occur simultaneously; compounding impacts on healthcare facility
  - Social
  - Economic
  - Demographic
  - Environmental
  - Institutional
  - Political

Healthcare facilities have existing vulnerabilities which are often worsened by climate change which increases vulnerability of healthcare facilities along their four main components. Climate-related hazards could occur simultaneously with social, economic, demographic, institutional and political risks and ultimately compound the vulnerability of healthcare facilities.

WASH & Waste management _Assessment areas and objectives

- **Monitoring and assessment:**
  - Information regarding water, sanitation, chemical use and health care waste management considering climate-resilience and environmental sustainability for promoting action
- **Risk management:**
  - Strengthened capacity of health care facilities to manage water, sanitation, chemicals and health care waste risks to workers, patients and served communities, by including assessments of climate-resilience and environmental sustainability in responding to hazards, and identifying and reducing exposures and vulnerabilities
- **Health and safety regulation:**
  - Water, sanitation, chemical safety and health care waste regulations are implemented taking into consideration climate variability and change, and environmental sustainabilityamong healthcare workers, patients, served communities

Assessment of vulnerability related to WASH and healthcare waste management are meant to facilitate effective monitoring and assessment of water, sanitation, chemical use and healthcare waste; improve risk management and enhance adherence to health safety and regulation to increase the resilience of healthcare facilities to climate-related risks.

524

Healthcare workforce _Assessment areas & objectives

- **Capacity to deal with climate-related health risks**
  - Having healthy working environment
  - Ensuring environmentally sustainable actions
- **Capacity development**
  - Training, information and knowledge management to minimize environmental risks resulting from operating the health care facility
- **Communication an awareness-raising**
  - Communicating, coordinating and increasing awareness related to climate resilience and environmental sustainability among healthcare workers, patients, served communities

In assessing vulnerability related to healthcare workforce, the main objective is to ascertain human resource capacity to deal with climate-related health risks, capacity building and information flow meant to raise awareness and preparedness to handle observed and future risks.

Infrastructure_Assessment areas and objectives

- **Adaptation of current systems and infrastructures**
  - Considering climate-resilience and environmental sustainability and implementing building regulations when building and retrofitting healthcare facilities
- **Promoting new systems and technologies**
  - New systems that promote resilience and sustainability and enhance service delivery
- **Sustainability of healthcare operations**
  - Procurement of low environmental impact technologies, products and processes

Assessment objectives related to infrastructure and technology include adapting current systems and infrastructures to climate change, promoting new systems and technologies and increasing sustainability of healthcare operations.

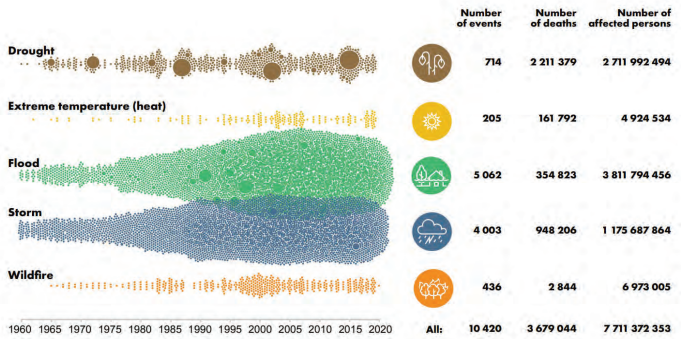
525

Energy services_Assessment areas and objectives

- **Monitoring and assessment**
  - Information regarding energy services to promote climate-resilient and environmentally sustainable actions
- **Risk management**
  - Strengthened capacity to manage energy-related risks to workers, patients and served communities
  - Assessment of climate-resilience and environmental sustainability in responding to hazards
- **Health safety and regulation**
  - Implementing energy use and access regulations for resilience and sustainability

With regards to energy services, the assessment objectives include generation of information to promote resilient energy services, strengthening capacity to manage energy-related risks to workers and patients, increase capacity to respond to hazards in environmentally sustainable ways and implement energy use and access regulations for resilience and sustainability of healthcare facility operations.

Step 3: Understanding potential impacts



Note: Each dot represents an event; circle size represents the number of affected persons.

Figure 3 of WHO 2021: Vulnerability and Adaptation Assessment Tool Kit

Understanding potential impacts entails estimating the number of people prone to each of the climate-related hazard. Globally, the number of people prone to most of the hazards is on the rise.

Checklist for assessing climate hazards and impacts on a health care facility (WHO, 2021, Annex A)

CLIMATE HAZARD TYPE	IS HAZARD OR EXPOSURE PRESENT? Yes/No	ARE THESE AREAS IMPACTED? X Current observed impacts O Possible impacts with changed conditions			
		Health workforce	WASH and health care waste	Energy services	Infrastructure, technologies, products, processes
Flood					
Storm					
Sea-level rise					
Drought					
Heatwave					
Wildfire					
Cold wave					

This is a sample checklist used in assessing vulnerability and adaptation in a healthcare facility. Vulnerability of each of the four components of the facility is assessed with regards to each hazard.

526

Climate-sensitive diseases and health outcomes

FLOOD 	Water- and food-borne diseases (diarrhoea from bacterial, viral and parasitic diseases, hepatitis A, typhoid fever, gastroenteritis, salmonellosis, *Escherichia coli* infection, cholera, cryptosporidium, campylobacteriosis, intestinal nematode infections); vectorborne diseases (dengue, Zika virus disease, malaria, chikungunya, West Nile virus fever); zoonotic diseases (rabies, rodentborne diseases, hantavirus diseases, leptospirosis); acute respiratory infections (influenza, pneumonia); eye and skin infections; tetanus; legionellosis	Deaths; drowning; physical traumas; hypothermia; animal bites; chemical poisoning and intoxication; electrical shock; mental health effects (acute traumatic stress, anxiety and depression, insomnia); cardiovascular diseases (stroke, diabetes, heart attack); chronic respiratory diseases (asthma, COPD, respiratory allergies); venomous animal bites (snakes, scorpions); eye, nose and skin irritation; protein-energy malnutrition; renal failure (due to lack of access to health care, dialysis)	Damaged or flooded health care facilities; building collapse; water and food contamination; changes in vector habitat (including that of mosquitos, ticks and rodents); mold in indoor environment; flooded sewage and waste systems; lack of power; overcrowding increasing infectious diseases; release of and exposure to hazardous chemicals; food insecurity

Figure 3 of WHO 2021: Vulnerability and Adaptation Assessment Tool Kit

Climate-sensitive diseases and health outcomes related to floods include water and food borne diseases (diarrhea, cholera, typhoid, gastroenteritis, etc.); vector-borne diseases (dengue, zika, malaria, etc.); respiratory infections, among others. Flood impact pathways include flooding of healthcare facilities, collapse of buildings, water and food contamination, etc.

Climate-sensitive diseases and health outcomes

CLIMATE HAZARD	CLIMATE-SENSITIVE DISEASES (INFECTIOUS DISEASES)	CLIMATE-SENSITIVE HEALTH OUTCOMES (NONCOMMUNICABLE DISEASES AND UNINTENTIONAL INJURIES)	POSSIBLE EXPOSURE PATHWAYS
INCREASED TEMPERATURE 	Waterborne diseases (diarrhoeal diseases, *Naegleria fowleri* infection, campylobacter infection, cholera, harmful algal bloom toxins); vectorborne diseases (dengue, malaria, Lyme disease, West Nile virus, Rift Valley fever, tickborne encephalitis); zoonotic diseases (rodentborne diseases, hantavirus diseases, leptospirosis); foodborne diseases (salmonellosis, mycotoxin effects); airborne diseases (influenza and other respiratory infections)	Cardiovascular diseases; chronic respiratory diseases (asthma, chronic obstructive pulmonary disease (COPD), respiratory allergies); protein-energy malnutrition (adverse nutritional effects causing childhood stunting)	Changed weather patterns; accelerated survival, growth, virulence and transmission of certain pathogens; heat exposure; increased biological hazards; pathogens in warmer fresh waters; surface toxic algal bloom; water and food contamination; changes in vector habitat (including that of mosquitoes, ticks, rodents); reduced soil moisture and nutrients; increased food insecurity

Figure 3 of WHO 2021: Vulnerability and Adaptation Assessment Tool Kit

Climate-sensitive diseases and health outcomes include; infectious diseases, non-communicable and unintentional injuries related to increased temperature.

Climate-sensitive diseases and health outcomes

CLIMATE HAZARD	CLIMATE-SENSITIVE DISEASES (INFECTIOUS DISEASES)	CLIMATE-SENSITIVE HEALTH OUTCOMES (NONCOMMUNICABLE DISEASES AND UNINTENTIONAL INJURIES)	POSSIBLE EXPOSURE PATHWAYS
SEA-LEVEL RISE 	Diarrhoeal diseases; cholera; hepatitis A; vectorborne diseases; zoonotic diseases; respiratory infections	Deaths; drowning, electrical shock; mental health (acute traumatic stress, anxiety and depression); cardiovascular diseases (hypertension); chronic respiratory diseases (asthma, COPD, respiratory allergies); protein-energy malnutrition; kidney disease	Increased saline water intrusion; freshwater contamination; flooded health care facilities; damaged health care facilities due to erosion; lack of power; food contamination; flooded sewage and waste systems; loss of crop productivity due to inundation or salinization; permanently displaced populations

Figure 3 of WHO 2021: Vulnerability and Adaptation Assessment Tool Kit

Sea level rise is mainly associated with increased risk of diarrhoeal, vector-borne and zoonotic diseases. Impact pathways include intrusion of saline water, contamination of fresh water, flooding of healthcare facilities, power loss, etc.

528

Climate-sensitive diseases and health outcomes

STORM 	Diarrhoeal diseases; cholera; hepatitis A; vectorborne diseases; zoonotic diseases; intestinal nematode infections; tetanus; respiratory infections; polymicrobial wound infections (by *Escherichia coli, Klebsiella, Serratia, Proteus and Pseudomonas*); mucormycosis	Deaths; drowning; physical traumas; wounds; hypothermia; animal bites; chemical poisoning and intoxication; electrical shock; mental health effects (acute traumatic stress, anxiety and depression, insomnia); cardiovascular diseases; chronic respiratory diseases (asthma, COPD, respiratory allergies); protein-energy malnutrition; renal failure (due to lack of access to health care, dialysis)	Lack of power; building collapse; damaged or flooded health care facilities; water and food contamination; food productivity disruption; flooded or damaged sewage and waste systems; mold in indoor environment; high levels of particulate matter from dust storms; changes in vector habitat (including that of mosquitos, ticks and rodents); release of and exposure to hazardous chemicals; food insecurity; displaced populations; prolonged disruption of public health services

Figure 3 of WHO 2021: Vulnerability and Adaptation Assessment Tool Kit

Storm-related diseases and health outcomes include diarrhoeal, vector-borne, zoonotic and intestinal diseases. Storm impact pathways include lack of power, damaged healthcare facilities, building collapses, flooded sewage systems, food and water contamination, etc.

Climate-sensitive diseases and health outcomes

HEATWAVE	Respiratory infections; water- and food-borne diseases (campylobacteriosis, salmonellosis, diarrhoeal diseases, cholera, cryptosporidiosis); harmful algal bloom toxins	Death; cardiovascular diseases (stroke, heart diseases, diabetes, thrombogenesis); heat stress; heat exhaustion; heat syncope; heat oedema; heat rash; dehydration-induced heat cramps; chronic respiratory diseases (asthma, COPD, respiratory allergies); protein-energy malnutrition; kidney disorder; aggravated chronic pulmonary conditions; eyes and skin irritation; mental illness; metal and chemical toxicity	Heat exposure; air pollution (particulate matter and ozone); surface water algal blooms due to increased level of nutrients; water and food contamination; food insecurity; power outages; increasing frequency of warm days and nights; increased concentration of metals, phosphorus and phytoplankton in water due to warmer waters and less oxygenation; threat due to individual level risk factors (age, sex, culture, body weight, drug treatment, body acclimatization)

Figure 3 of WHO 2021: Vulnerability and Adaptation Assessment Tool Kit

Heat waves affect health outcomes in form of increased risk of respiratory infections, water and food-borne diseases, diarrhoeal diseases and harmful alga bloom toxins. Heatwave impact pathways include heat exposure, air pollution, alga concentration on surface water, increased concentration of metals, power outages, food and water contamination.

529

Climate-sensitive diseases and health outcomes

DROUGHT	Diarrhoeal diseases; cholera; hepatitis A; vectorborne diseases (dengue, malaria, Zika virus disease, chikungunya, Lyme disease, West Nile virus fever, Valley fever); zoonotic diseases; intestinal nematode infections; respiratory infections; eye and skin infections (scabies, trachoma, conjunctivitis); meningococcal meningitis	Cardiovascular diseases; chronic respiratory diseases (asthma, COPD, respiratory allergies); kidney diseases; cancers (skin, bladder, lung); protein-energy malnutrition; mental health effects (stress, anxiety and depression); eyes, nose and skin irritation; musculoskeletal problems	Reduction in or lack of access to water; hygiene services reduction; water and food contamination; food insecurity; changes in vector habitat (including that of mosquitos, ticks and rodents); air pollution; increased dust; hot temperature; dry air; lack of power; water pollutants (iron, manganese, fluoride, arsenic) and salinity concentrations; cyanobacterial blooms; reduced soil moisture; increasing frequency of warm days and nights; displaced populations

Figure 3 of WHO 2021: Vulnerability and Adaptation Assessment Tool Kit

Drought impacts on health outcomes are in form of increased risk of diarrhoeal, vector-bone, zoonotic, intestinal, respiratory and meningococcal diseases. Impact pathways for drought include lack of water, deterioration of hygiene services, food and water contamination, food insecurity, salinity concentration, reduced soil moisture, air pollution, etc.

Climate-sensitive diseases and health outcomes

COLD WAVE 	Respiratory infections (such as influenza)	Deaths; cardiac workload leading to cardiovascular stress (heart diseases); exposure to extreme cold which causes veins and arteries to narrow and blood to become more viscous increasing cardiac workload; hypothermia leading to cardiac workload; aggravation of pre-existing chronic diseases such as diabetes, respiratory diseases (asthma, chronic bronchitis and emphysema) and cardiovascular conditions (heart diseases, stroke); frostbite (freezing of skin exposed to the cold)	Extreme cold exposure; power outages; water access reduction; hygiene reduction; agricultural disruption; food insecurity; broken water pipes and internal flooding of health care facility; disruption of health services; threat due to individual level risk factors (age, body weight, drug treatment, behaviour, clothing, smoking, drinking alcohol); reduced mobility; excess of outdoor physical activity; chronic diseases; malnutrition; certain neurological disorders; alteration of the body's core temperature (impairing body acclimatization)

Figure 3 of WHO 2021: Vulnerability and Adaptation Assessment Tool Kit

For cold waves, the main risk is respiratory infections which happen due to extreme cold exposure. Other impact pathways include power outages, reduction in water access, food insecurity, internal bleeding, etc.

Climate-sensitive diseases and health outcomes

CLIMATE HAZARD	CLIMATE-SENSITIVE DISEASES (INFECTIOUS DISEASES)	CLIMATE-SENSITIVE HEALTH OUTCOMES (NONCOMMUNICABLE DISEASES AND UNINTENTIONAL INJURIES)	POSSIBLE EXPOSURE PATHWAYS
WILDFIRE 	Increased susceptibility to respiratory infections	Death; burns; injuries; mental health effects (acute traumatic stress, anxiety and depression, insomnia); chronic respiratory diseases (asthma, COPD, respiratory allergies); cardiovascular diseases (heat stroke, diabetes); dehydration-induced heat cramps; smoke intoxication (from particulate matter and other air pollutants); wheezing and shortness of breath; adverse pregnancy outcomes (e.g. low birth weight and preterm birth); carbon monoxide poisoning; eyes, nose and skin irritation (corneal abrasion)	Exposure to flames; radiant heat and smoke increasing mortality rate; ambient air pollution amplifying high temperatures; exposure to carbon monoxide, ozone and particulate matter (smoke- and heat-related diseases); toxic effects from oxidative and proinflammatory components of particulate matter; water contamination by ash (with polycyclic aromatic hydrocarbons and heavy metals); power outages

Figure 3 of WHO 2021: Vulnerability and Adaptation Assessment Tool Kit

Wild fires often increase susceptibility to respiratory infections through exposure to flames, radiant heat and smoke, ambient air pollution, increased mortality, water contamination by hydrocarbons, among others.

Checklist for assessing vulnerability to Flood

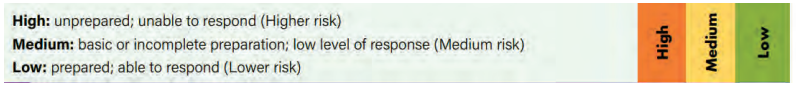
1.1 Health workforce

1.1.1 Healthcare workforce _Human resources

From this slide onwards, we are going to go through the detailed guidelines to conduct vulnerability and adaptation assessment related to flood risk, covering the four healthcare facility components. The first component is healthcare workforce and three sub-components are assessed. Sub-component 1 focuses of human resources. Note that the presentation will cover vulnerability to floods only for illustration purposes; for vulnerability to other climate-related risks, please refer to the WHO (2021) checklist for assessing healthcare facility vulnerability and assessment. The link to the document is provided here;
https://www.who.int/publications/i/item/9789240036383

Assessment scales and criteria

- **High vulnerability (high risk)**
  - Unprepared; unable to respond to climate-related risks
- **Medium vulnerability (medium risk)**
  - Basic or incomplete preparation; low level of response
- **Low vulnerability (low risk)**
  - Prepared; able to respond to climate-related risks
- **Grading risk level**



The vulnerability of healthcare facilities is assessed within three scales. High vulnerability indicates unpreparedness of the healthcare facility to respond to climate-related risks; medium vulnerability indicates availability of basic or incomplete preparedness mechanisms; while low vulnerability indicates the healthcare facility is prepared and able to respond to risks.

1.1.2 Healthcare workforce_Capacity building

trained on public health and climate change hazards including health impacts related to floods?	Risk level
equipped with knowledge, experience, training and resources to manage flood risk reduction at the facility and in the local communities?*	☐ ☐ ☐
engaged in the development of plans and responses to flood risk?	☐ ☐ ☐
prepared and able to implement risk reduction actions for protecting themselves?	☐ ☐ ☐
prepared with a contingency plan for additional health workforce to strengthen performance capacity?	☐ ☐ ☐
prepared with a contingency plan for continuing to provide services at other facilities or in the local communities (health primary care), if necessary?*	☐ ☐ ☐
trained to detect posttraumatic stress disorder among staff to take prompt action?*	☐ ☐ ☐
trained to manage hazardous chemicals in emergency situations?	☐ ☐ ☐
trained to an appropriate standard to maintain the correct level of safety of electrical power supply, in both routine and emergency/disaster situations?*	☐ ☐ ☐

The second sub-component of healthcare workforce is capacity building. Assessment in this regard attempts to ascertain the extent to which workforce is trained and engaged in the detection of floods and development of flood management contingency plans

1.1.1 Healthcare workforce _Human resources

Is the healthcare facility:	Risk level
provided with programmes for supporting staff with regards to mental health, injuries, medical treatment and related support measures?*	☐ ☐ ☐
equipped with an emergency plan for shift relay or replacement of health professionals to ensure that staff get adequate rest?*	☐ ☐ ☐
prepared with a contingency plan for accessing additional health workforce to strengthen performance capacity?*	☐ ☐ ☐
provided with an information system to manage occupational safety and health in the facility during a flood?	☐ ☐ ☐
equipped with an emergency plan to protect health workers from multiple biological and chemical hazards?	☐ ☐ ☐
provided with a postflood employee recovery assistance programme according to staff needs?	☐ ☐ ☐
equipped with a coordinated plan, including volunteers on standby, to assist during an emergency or to support health professionals?*	☐ ☐ ☐
provided with full personal protective equipment, especially for clean-up crews (including waterproof safety boots, goggles, work gloves and masks)?*	☐ ☐ ☐
provided with safe water and food during an event?*	☐ ☐ ☐

The underlying question while assessing flood vulnerability related to the human resources subcomponent of healthcare workforce is whether or not workers are equipped with skills, protective equipment, tools and supplies and information to handle risks posed by floods.

Checklist for assessing vulnerability to Flood

1.2 WASH & healthcare waste management

We now turn our attention to assessing flood-related vulnerability of WASH and healthcare waste management systems of healthcare facilities.

1.1.3 Healthcare workforce_communication & awareness-raising

Is the healthcare facility:	Risk level
provided with a safe internal communication system, specially in emergency situations?*	☐ ☐ ☐
informed on how to use and follow a surveillance system to track health outcomes?	☐ ☐ ☐
aware of contingency plans for accessing and leaving the facility during flood emergencies, and health workforce transportation?	☐ ☐ ☐
regularly participating in community disaster planning committees to: improve knowledge on how to reduce risks, be prepared and respond to floods, and recover better than before through adaptation measures?*	☐ ☐ ☐
prepared with clear messaging about water and food safety during and after a flood?	☐ ☐ ☐
prepared with clear messaging, and staff trained on exit and evacuation routes that are clearly marked and free of obstacles to enable emergency evacuation)?*	☐ ☐ ☐
equipped with a flood plan or programme with clear instructions on how to proceed during flood emergency situations?	☐ ☐ ☐
equipped with a community health educational programme to assist the community to reduce vulnerabilities to flood impacts?	☐ ☐ ☐
equipped with a community health educational programme to improve community health in the face of flood risks?	☐ ☐ ☐

Awareness-raising is the third sub-component of healthcare workforce. Assessment questions here elicit information on internal communication systems during emergencies, availability of surveillance systems to track health outcomes, participation in community disaster risk management planning, information sharing about water and food safety after floods, and community health education programmes.

1.2.1 WASH & healthcare waste management– monitoring & assessment

Does this healthcare facility:	Risk level
have an updated assessment plan to map risks to the sanitation infrastructure in place, and to identify where services could be disrupted from floods?	☐ ☐ ☐
verify water safety conditions, including updated risk assessments to map water resources and water supplies for the facility?*	☐ ☐ ☐
have a quality monitoring plan for drinking water during and after the event?	
regularly assess its sanitation system for any possible damage in the event of flooding?	☐ ☐ ☐
monitor sewer overflows in order to fix pumps in advance of the flood season?	☐ ☐ ☐
regularly verify safety conditions and proper functioning of all elements of the water distribution system, including storage tanks, cisterns, valves, pipes and connections, and water disinfection?	☐ ☐ ☐
have information on water system installation that ensures lower risk of contamination?	☐ ☐ ☐
conduct a waste audit to reduce waste as much as possible?	☐ ☐ ☐

While assessing flood risk vulnerability related to WASH and healthcare waste management, three sub-components are considered. The first sub-component is monitoring and assessment which is meant to ascertain whether or not a healthcare facility has an updated mapping of health risks, monitoring plan for drinking water during flood, verified water safety conditions and distribution systems. The lack of such systems indicates severe vulnerability of the healthcare facility.

1.2.2 WASH & healthcare waste management_risk management

Does this health facility:	Risk level
have a natural floodwater infiltration system to reduce risk of facility flooding?	☐ ☐ ☐
have anti-mosquito breeding measures?	☐ ☐ ☐
have a schedule for emptying latrines in advance of the flood season to avoid overflows?	☐ ☐ ☐
have a safe health care waste storage place?	☐ ☐ ☐
have a safe waste disposal system before, during and after floods?	☐ ☐ ☐
have an established safe management approach to health care waste transport (including hazardous waste) in case of floods?*	☐ ☐ ☐
have chemical, radioactive and biological hazardous waste stored in a safe place and on a level above the ground floor?*	☐ ☐ ☐
have water storage tanks appropriately covered to prevent access or contamination, and safety located for flooding events?*	☐ ☐ ☐
have onsite water purification equipment to provide safe drinking water?	☐ ☐ ☐
have nonreturn valves installed on water supply pipes to prevent backflows?*	☐ ☐ ☐
have waste pits able to withstand flood events?	☐ ☐ ☐
have a surveillance system for diseases related to water quality and sanitation?*	☐ ☐ ☐
keep waste sealed in rubbish bins to avoid rodents?	☐ ☐ ☐

The second sub-component of WASH is risk management. Assessment here focuses on understanding whether the healthcare facility has a natural flood infiltration system, mechanisms to combat mosquito breeding, safe waste water and chemical storage systems, sufficient water storage tanks and purification facilities and water surveillance mechanisms.

Checklist for assessing vulnerability to Flood

1.3 Energy Services

We now go through the guidelines for assessing vulnerability related to energy services, which is the third component of healthcare facilities

1.2.3. WASH & healthcare waste management– health & safety regulation

Does this healthcare facility:	Risk level
have an emergency water supply plan?*	☐ ☐ ☐
staff who are trained to an appropriate standard to maintain the correct level of safety of water quality controls, use of supplies and alternative sources?	☐ ☐ ☐
have a water safety plan in place, in case of water contamination?*	☐ ☐ ☐
have a mechanism or regulation to carry out sanitary inspections of water supply, and when necessary, establish a temporary ban on use, until improvements are made?	☐ ☐ ☐
have a contingency plan to ensure effective and timely delivery of safe water during floods and emergencies over the short- and long-term?*	☐ ☐ ☐
have a plan to provide and maintain adequate cleaning and disinfection supplies (such as chlorine, filters or other water treatment technology, rapid water testing kit) for water safety?	☐ ☐ ☐
have an emergency plan for maintenance and restoration of waste management systems?*	☐ ☐ ☐

The third sub-component of WASH is health safety and regulation where the assessment focuses on ascertaining availability of emergence water supply plans and adherence to water safety regulations and sanitary inspections

1.3.1 Vulnerability in energy – monitoring & assessment

Does this healthcare facility heave:	Risk level
regularly assess its energy system to ensure that it can cope with flood events?	☐ ☐ ☐
have an emergency backup generator (including fuel, where relevant) that is able to cover at least all critical service areas and equipment during and after a flood event?	☐ ☐ ☐
periodically check emergency backup generators (including fuel, where relevant)?	☐ ☐ ☐
assess whether renewable energy (if available, such as solar) is sufficient to power critical equipment?	☐ ☐ ☐
identify priority areas within the facility which would require emergency power during and after a flood event?	☐ ☐ ☐

Like we have seen for the previous component, the energy component also has three main sub-components to be focused on during the assessment. The first sub-component is monitoring and assessment that focuses on regular energy systems assessment to ascertain ability to cope with flood events, back-up generators and renewable energy options for emergency and sustainable energy supply.

1.3.2 Vulnerability in energy – risk management

Does this health care facility:	**Risk level**
have a secure place to protect the backup generator (e.g. an elevated place; including fuel or battery storage, where relevant) from flood waters?*	☐ ☐ ☐
have adequate daylight to ensure proper visibility during a power outage?	☐ ☐ ☐
have power-operated doors that can easily be opened manually to permit exit in case of power failure?	☐ ☐ ☐
have appliance thermometers in the refrigerator and freezer to determine if food, vaccines and other essential refrigeration-dependent medical supplies are safe?	☐ ☐ ☐
have a clear guidance to alert staff on safety measures (e.g. never restore power when the power is off, until a professional inspects and ensures the integrity of the electrical system; do not use electrical equipment that has been exposed to flood waters until checked by an electrician; unless power is off, never enter flooded areas or touch electrical equipment if the ground is wet)?	☐ ☐ ☐

The second sub-component of energy services is risk management. Assessment here emphasizes existence of back-up generators to handle power outages, adequate daylight to ensure visibility, power-operated doors that can be manually opened during power failure, refrigerators with thermometers to monitor temperatures under which vaccines and essential supplies are stored and clear guidance to alert staff on safety measures related to floods.

Checklist for assessing vulnerability to Flood

1.4 Infrastructure, technologies, products and processes

Vulnerability to floods related to healthcare related infrastructure and technologies is assessed in subsequent slides.

1.3.3 Vulnerability in energy_health safety & regulation

Does this healthcare facility:	Risk level
have an emergency plan for power outages in the short- and long-term (before, during and after a flood)?	☐ ☐ ☐
work with energy utility agencies to prevent suspension of electricity services?	☐ ☐ ☐
have a management plan for intermittent energy supplies or system failure?	☐ ☐ ☐
have a plan or regulation to determine ways to reduce overall energy use?	☐ ☐ ☐
have an emergency plan to ensure availability of adequate lighting, communication and information systems, and refrigeration and sterilization equipment during a flood?*	☐ ☐ ☐

The health safety and regulation sub-component of energy services concerns contingency plans to deal with power outages, working with energy agencies to prevent suspension of electricity services, management of intermittent power supply and failure, regulations to reduce energy use.

1.4.1. Vulnerability in infrastructure_adaptation of current systems

Does the health facility,	Risk level
have knowledge, experience (considering previous damages) and resources (including human, material, financial, supplies chain and logistics) to manage flood risk reduction?*	☐ ☐ ☐
provide greater advocacy on health workforce education to cover climate change risks and responses?	☐ ☐ ☐
work with the local government to support vulnerable local populations to actively participate in risk reduction management, policy making, planning and implementation?	☐ ☐ ☐
conduct climate risk and vulnerability assessments for all facility sectors to identify risk scenarios, vulnerabilities and the facility's response capacity?	☐ ☐ ☐
utilize the assessed information as a basis to plan and prioritize measures to reduce risk impact?	☐ ☐ ☐
in their annual planning consider how climate risks may change in the future?	☐ ☐ ☐
have resources available to adopt risk reduction measures on the building and its infrastructure, technologies, products and processes?	☐ ☐ ☐
regularly update these assessments, considering emerging scientific information?	☐ ☐ ☐
have a schedule to inspect the facility regularly, both internally and externally, for signs of deterioration (e.g. cracks or sinking structural elements) to avoid or reduce flood impacts?	☐ ☐ ☐

Adaptation of current systems involves existence of knowledge, experience and resources to manage flood risk, advocacy and local governance systems to manage risks and protect vulnerable communities, safeguarding against risk to buildings and infrastructures and regular inspection of facilities

1.4.1. Vulnerability in infrastructure_adaptation of current systems 2

Does this health care facility:	Risk level
evaluate the condition and safety of structural and nonstructural elements impacted by previous exposure to flood?*	☐ ☐ ☐
have a safe location for critical services and equipment in a flood emergency situation?*	☐ ☐ ☐
have a safety plan to prevent medical and laboratorial equipment and supplies, and food packages to be exposed to flood waters?	☐ ☐ ☐
have procedures to store food and bottled water on shelves that will be safely out of the way of contaminated water in case of flooding?	☐ ☐ ☐
have an effective emergency risk communication plan to reduce risks and impacts for health workers and patients?*	☐ ☐ ☐
have a contingency plan in place for safe and efficient personnel evacuation (including health staff and patients) before, during and following a flood?*	☐ ☐ ☐
have a clear and consistent mechanism for secure evacuation of health workers and patients?	☐ ☐ ☐
have a plan to transfer critical equipment and medical supplies to another health care facility or to a secure storage?	☐ ☐ ☐
explore the relationship between social learning and adaptation measures in the face of flood threats to identify and implement the best behavioural responses from successful health facilities?	☐ ☐ ☐

Continuous evaluation of the safety of structural and nonstructural systems impacted by floods coupled with contingency measures to deal with flood emergencies is crucial for reducing vulnerability of healthcare facilities, staff, patients and served communities.

1.4.1. Vulnerability in infrastructure_adaptation of current systems 4

Does this health care facility	Risk level
have machine rooms that are resistant to flooding or rooftop damage?	☐ ☐ ☐
ensure removal of equipment and power supplies from basements and ground floor level to avoid damage from flooding?	☐ ☐ ☐
have a coordinated mechanism across the health sector in different levels of government, to manage the response and risks resulting from public health emergencies and disasters (including sharing of resources and supplies, transferring of patients, and health workforce support)?*	☐ ☐ ☐
have established procedures for procuring, and safely transporting and storing medical devices, pharmaceuticals, vaccines, laboratorial supplies, parenteral nutrition and blood supplies, and other essential medical supplies?	☐ ☐ ☐
have established procedures or plans for procuring, transporting and storing bottled water and food supplies during an emergency?*	☐ ☐ ☐
have a space within or external to the facility for the storage and stockpiling of additional supplies, considering ease of access, security, temperature, ventilation, light exposure and humidity?	☐ ☐ ☐
have a plan to house staff at the health care facility if shelter is required (sleeping areas, food, water)?	☐ ☐ ☐
have an established post-flood recovery plan of all infrastructure facilities (structural and nonstructural elements)?*	☐ ☐ ☐

The assessment should further ascertain adaptive capacity of existing systems in terms of availability of flood-proof machine and server rooms, comprehensive and multi-stakeholder flood response mechanisms, external storage spaces for essential or emergency supplies, emergency shelter for staff and post-flood recovery plan.

1.4.1. Vulnerability in infrastructure_adaptation of current systems 3

Does this health care facility	Risk level
have evaluation tools (e.g. forms) to identify damages and minimum needs in terms of health workers and medical supplies to ensure continuous functioning of services?*	☐ ☐ ☐
have a mechanism for providing prompt maintenance and repair of equipment required for essential services?	☐ ☐ ☐
have a plan for relocating medical devices, medicines, mobile equipment and other supplies and services in case of operational disruption or outbreaks and epidemics that overwhelm the facility?	☐ ☐ ☐
have walls protected and insulated against moisture and mold?	☐ ☐ ☐
assess the performance and vulnerabilities of each critical part of the facility (structural and nonstructural elements) that can be affected by floods?	☐ ☐ ☐
have measures to remove mosquito breeding sites?	☐ ☐ ☐
have roof drainage systems for rainfall?*	☐ ☐ ☐
have rooftop structures and equipment revised for anticipated increased rainfall?*	☐ ☐ ☐
have roofs that are leak-proof and insulated?*	☐ ☐ ☐

Assessment of infrastructures and technologies further focuses on availability of tools to identify flood-induced damages and maintain essential services, leak-proof roofs and drainage systems and augmented rooftops to handle heavy rainfall.

1.4.3. Sustainability of healthcare facility operations

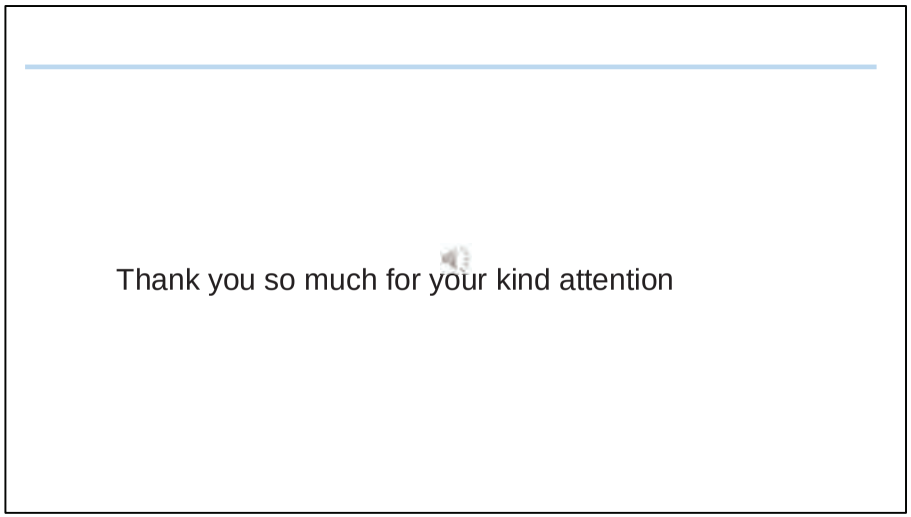
Does this health care facility:	Risk level
have adaptive governance capacity regarding evaluation and measures for risk identification, risk reduction and response?	☐ ☐ ☐
have partnerships established between the facility, community and local authorities to reduce vulnerabilities in the surrounding areas?	☐ ☐ ☐
have a secure storage for hazardous chemicals to avoid their damage or release during a flood event?*	☐ ☐ ☐
have a defined and sustained budget as part of core budgeting for emergency preparedness and response to flood events?*	☐ ☐ ☐
have an access route for public transportation which is likely to remain operational during or immediately following a flood event?	☐ ☐ ☐
review building code design baselines against rainfall volumes, and map each risk?*	☐ ☐ ☐

The final sub-component of infrastructure and technologies concerns the sustainability of healthcare facility operations, including measures for risk identification, reduction and response, community-based measures to reduce vulnerability, secure storage of hazardous chemicals, budgeting for flood emergencies, access routes for public transport during floods and reviewing building codes to increase resilience of infrastructure.

1.4.2. Promotion of new systems and technologies

Does this health care facility:	**Risk level**
have an information system between the health sector and meteorological services to communicate about climate hazards?	☐ ☐ ☐
have an established plan to review, evaluate and catalogue climate risks related to floods for the health care facility's location?*	☐ ☐ ☐
have an established plan to review, evaluate and catalogue risks related to floods for the health care facility's supply chain?*	☐ ☐ ☐
have electronic patient health records to make available to other receiving health care facilities, in case of evacuation?	☐ ☐ ☐
have information and communication systems safely secured with backup arrangements (via cloud, satellite) to satisfy the facility's demand?*	☐ ☐ ☐
ensure information and communication flow between the health workforce and policy makers, particularly during high-stress situations and demands created by emergencies?	☐ ☐ ☐
have an established, clear and consistent knowledge transfer procedure for a public health emergency?*	☐ ☐ ☐
have identified capacities, resources and needs to better cope and manage floods?	☐ ☐ ☐
perform site and building maintenance procedures that include specifications on how the weather may affect the safety and continued functioning of the facility?	☐ ☐ ☐
have an information system for tracking and monitoring diseases following flood events?	☐ ☐ ☐

In assessing the promotion of new systems and technologies, consideration is given to information flow between health and meteorological services, periodic review of flood risks and their implications for the location and supply chains of the healthcare facility as well as site and building maintenance procedures



Please attempt these quizzes below to ascertain your level of understanding of the content that we have studied so far. All questions are mandatory and multi-choice in nature, so kindly circle the option you perceive to be correct or most appropriate to the question. Thank you so much for your kind attention and participation in this training session. I wish you the best in applying the acquired knowledge to build resilience of health systems and facilities in your respective countries.

541

1.4.3. Sustainability of healthcare facility operations 2

Does this health care facility	Risk level
have trees planted in a secure place that will not block access to the facility or fall on the building during an event?	☐ ☐ ☐
have estimates of the consumption (such as amount used per week) of essential medical, pharmaceutical, nutritional and laboratorial supplies, personal protective equipment, food, etc., using the most likely flood scenario?	☐ ☐ ☐
undertake risk assessments of the supply chain for essential medical and nonmedical products?	☐ ☐ ☐
have a secure plan to ensure continuity of the facility's supply and delivery chain?	☐ ☐ ☐
have secure access to essential backup services, such as sterilization, laundry and cleaning services, via multiple agreements with different facilities to maintain functioning of critical services?	☐ ☐ ☐
have secure access to essential backup food sources via multiple agreements with different vendors, and through cooperative agreements with other facilities to maintain functioning of critical services?*	☐ ☐ ☐

Sustainability is further enhanced by tree planting in safe places within healthcare facilities, accurate estimates of consumption needs of essential supplies, assessment of risks in supply chains, storage of back-up supply of essential supplies like food stuffs, medicines, etc.

Reference materials

- Jankowska, M. M., Lopez-Carr, D., Funk, C., Husak, G. J., & Chafe, Z. A. (2012). Climate change and human health: Spatial modeling of water availability, malnutrition, and livelihoods in Mali, Africa. *Applied Geography*, *33*, 4-15.
- Ringler, C., Zhu, T., Cai, X., Koo, J., & Wang, D. (2010). Climate change impacts on food security in sub-Saharan Africa. *Insights from Comprehensive Climate Change Scenarios*, *2*.
- Colón-González, F. J., Sewe, M. O., Tompkins, A. M., Sjödin, H., Casallas, A., Rocklöv, J., ... & Lowe, R. (2021). Projecting the risk of mosquito-borne diseases in a warmer and more populated world: a multi-model, multi-scenario intercomparison modelling study. *The Lancet Planetary Health*, *5*(7), e404-e414.
- Bandyopadhyay, S., Kanji, S., & Wang, L. (2012). The impact of rainfall and temperature variation on diarrheal prevalence in Sub-Saharan Africa. *Applied Geography*, *33*, 63-72.
- Watts, N., Amann, M., Arnell, N., Ayeb-Karlsson, S., Belesova, K., Boykoff, M., ... & Montgomery, H. (2019). The 2019 report of The Lancet Countdown on health and climate change: ensuring that the health of a child born today is not defined by a changing climate. *The Lancet*, *394*(10211), 1836-1878.

542

Reference materials

- World Health Organization. (2021). Climate change and health: vulnerability and adaptation assessment
- World Health Organization. (2013). Protecting Health from Climate Change: Vulnerability and Adaptation Assessment
- World Health Organization. (2015). Human health and climate change in Pacific Island countries
- World Health Organization. (2015). Checklists to Assess vulnerabilities in Health Care Facilities in the Context of Climate Change
- Pan American Health Organization and World Health Organization. (2008). Protecting Health from Climate Change
- World Health Organization. (2003). Methods of assessing human health vulnerability and public health adaptation to climate change
- General multiple source (WHO). Health and climate change toolkit

Reference materials

- Theron, E., Bills, C. B., Hynes, E. J. C., Stassen, W., & Rublee, C. (2022). Climate change and emergency care in Africa: A scoping review. *African Journal of Emergency Medicine*, *12*(2), 121-128.
- Mphekgwana, P. M. (2022). Influence of environmental factors on injury severity using ordered logit regression model in Limpopo Province, South Africa. *Journal of environmental and public health*, *2022*.
- Joshi, M., Goraya, H., Joshi, A., & Bartter, T. (2020). Climate change and respiratory diseases: a 2020 perspective. *Current Opinion in Pulmonary Medicine*, *26*(2), 119-127.
- Moner-Girona, M., Kakoulaki, G., Falchetta, G., Weiss, D. J., & Taylor, N. (2021). Achieving universal electrification of rural healthcare facilities in sub-Saharan Africa with decentralized renewable energy technologies. *Joule*, *5*(10), 2687-2714.
- IPCC (2022). Sixth Assessment Report, Chapter 7: Health, wellbeing and the changing structure of communities

Reference materials

- Trærup, S. L., Ortiz, R. A., & Markandya, A. (2011). The costs of climate change: a study of cholera in Tanzania. *International journal of environmental research and public health*, *8*(12), 4386-4405.
- Amegah, A. K., Rezza, G., & Jaakkola, J. J. (2016). Temperature-related morbidity and mortality in Sub-Saharan Africa: A systematic review of the empirical evidence. *Environment international*, *91*, 133-149.
- Chersich, M. F., Swift, C. P., Edelstein, I., Breetzke, G., Scorgie, F., Schutte, F., & Wright, C. Y. (2019). Violence in hot weather: Will climate change exacerbate rates of violence in South Africa?. *South African Medical Journal*, *109*(7), 447-449.
- Cooper, S., Hutchings, P., Butterworth, J., Joseph, S., Kebede, A., Parker, A., ... & Van Koppen, B. (2019). Environmental associated emotional distress and the dangers of climate change for pastoralist mental health. *Global Environmental Change*, *59*, 101994.
- Rother, H. A., Etzel, R. A., Shelton, M., Paulson, J. A., Hayward, R. A., & Theron, L. C. (2020). Impact of extreme weather events on Sub-Saharan African child and adolescent mental health: a protocol for a systematic review. *Atmosphere*, *11*(5), 493.

Steps involved in the vulnerability assessment and adaptation planning process in Pacific island countries

WHO framework for vulnerability assessment and adaptation planning	Vulnerability assessment and adaptation planning process implemented in PICs
Determine scope of assessment	• Project designed and resourced • Eleven PICs divided into three regions along roughly geographic and cultural lines • Expert technical guidance provided to each group • Inception meetings held and work plans made for each country
Describe current distribution and burden of climate-sensitive diseases	• Available information and data on climate and climate-sensitive diseases reviewed and described in each country • Environmental epidemiological analysis undertaken where possible
Identify and describe current strategies, policies and measures that reduce the burden of climate-sensitive diseases	• Health sector and other relevant policies (e.g., climate change policies, strategic development plans) reviewed and linked with health adaptation planning
Review the health implications of the potential impact of climate variability and change on other sectors	• Wide stakeholder, cross-sectoral engagement ensured in health adaptation planning
Estimate the future potential health impact using scenarios of future climate change, population growth and other factors and describe the uncertainty	• Some modeling of future climate change-attributable burden of disease attempted; limited by lack of downscaled climate projections and sufficient quantity and quality of data on climate-sensitive diseases
Synthesize the results and draft a scientific assessment report	• National Climate Change and Health Action Plans (NCCHAPs)—or equivalent—prepared for each of the 11 PICs
Identify additional adaptation policies and measures to reduce potential negative health effects, including procedures for evaluation after implementation	• Adaptation strategies prioritized • Highest priority adaptations commenced in some PICs (Table 3) • Guidance provided to countries on methods for iterative information management, monitoring, and evaluation

Source: McIver et al. Health impacts of climate change in Pacific island countries: a regional assessment of vulnerabilities and adaptation priorities. Environmental Health Perspectives 2016;124:1707-17014

3

Highest priority climate-sensitive health risks, with highest priorities indicated by X

	Country												
Climate-sensitive health risk	Cook Islands	FSM	Fiji	Kiribati	Marshall Islands	Nauru	Niue	Palau	Samoa	Solomon Islands	Tonga	Tuvalu	Vanuatu
Direct effects													
Health impacts of extreme weather events[a]	x	x			x	x	x	x	x	x	x	x	x
Heat-related illness[b]	x					x	x			x			x
Indirect effects													
Water security & safety (including water-borne diseases)[c]	x	x	x	x	x	x	x	x	x	x	x	x	x
Food security & safety (including malnutrition & food-borne diseases)[d]	x	x	x	x	x	x	x		x	x	x	x	x
Vector-borne diseases[e]	x	x	x	x	x	x	x	x	x	x	x	x	x
Zoonoses[f]		x	x					x					
Respiratory illness[g]	x	x			x	x	x	x		x		x	x
Disorders of the eyes, ears, skin, and other body systems[h]			x		x		x			x		x	x
Diffuse effects													
Disorders of mental/psycho-social health[i]		x	x		x	x		x		x		x	x
Non-communicable diseases (NCDs)[j]		x	x		x		x	x	x	x	x	x	x
Health system deficiencies[k]			x	x									
Population pressures[l]				x									

Source: McIver et al. Health impacts of climate change in Pacific island countries: a regional assessment of vulnerabilities and adaptation priorities. Environmental Health Perspectives 2016;124:1707-17014

4

CBCRP-PCCC Virtual Training Course

Health Systems and Climate Change
Enhancing Resilient and Low-carbon Development in the Pacific

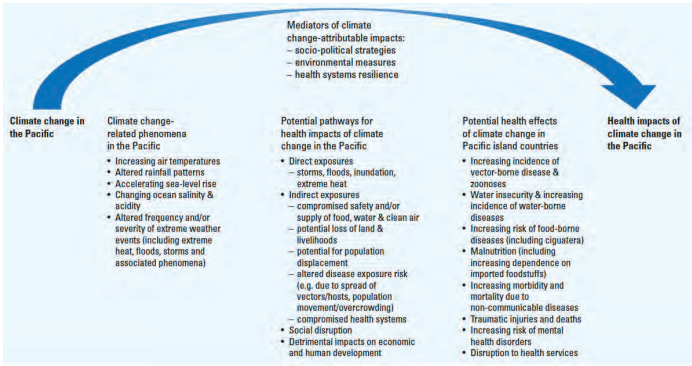
Government of Samoa, SPREP, and JICA

Module 1. Understanding of risks of climate change impacts on human health and health services, and GHG emission from health services
1.2 Vulnerability and adaptation assessment
Cases of vulnerability and adaptation assessment in the Pacific

Dr. Kristie Ebi,
Professor, Department of Global Health, University of Washington

1

Pacific vulnerability and adaptation assessments, 2010-2012



Source: McIver et al. Health impacts of climate change in Pacific island countries: a regional assessment of vulnerabilities and adaptation priorities. Environmental Health Perspectives 2016;124:1707-17014

2

WHO Country Profile: Kiribati Infectious Diseases

Fig. 2.2. Mean relative vectorial capacity for dengue fever transmission in Kiribati

The mean relative vectorial capacity for dengue fever transmission is projected to increase towards mid-century under both a high and low emissions scenario.

- Adaptation
  - Develop integrated disease surveillance and early warning and response systems for climate-sensitive health risk that include climate information
  - Continue to implement activities that increase the climate resilience of health infrastructure

Source: WHO Health and Climate change Country Profile 2017: Kiribati, Fig 2.2.

7

Projects are beginning to conduct or update vulnerability and adaptation assessments, including:

- Global Environment Facility (GEF) Least Development Country Fund (LCDF), starting 2022
  - Kiribati
  - Solomon Islands
  - Tuvalu
  - Vanuatu
- Green Climate Fund (GCF), Concept Note submitted
  - Republic of the Marshal Islands
- Korea International Cooperation Agency (KOICA), started 2022
  - Fiji

5

Fiji: highest priority climate-sensitive health risks

Direct effects	
Health impacts of extreme weather events	✓
Heat-related illness	
Indirect effects	
Water security and safety (including waterborne diseases)	✓
Food security and safety (including malnutrition and foodborne diseases)	✓
Vector-borne diseases	✓
Zoonoses	✓
Respiratory illness	
Disorders of the eyes, ears, skin and other body systems	✓
Diffuse effects	
Disorders of mental/psychosocial health	✓
Noncommunicable diseases	✓
Health systems problems	✓
Population pressures	

Source: WHO Health and Climate change Country Profile 2021: Fiji

8

Republic of the Marshall Islands GCF Concept Note Theory of Change

Source: Readiness Proposal, with WHO for the Republic of the Marshall Islands, 30 December 2021

6

Reference

- McIver L, Kim R, Woodward A, Hales S, Spickett J, Katscherian D, Hashizume M, Honda Y, Kim H, Iddings S, Naicker J, Bambrick H, McMichael AJ, Ebi KL. Health Impacts of Climate Change in Pacific Island Countries: A Regional Assessment of Vulnerabilities and Adaptation Priorities. Environ Health Perspect. 2016 Nov;124(11):1707-1714. doi: 10.1289/ehp.1509756. Epub 2015 Dec 8. PMID: 26645102; PMCID: PMC5089897. https://pubmed.ncbi.nlm.nih.gov/26645102/
- Readiness Proposal, with WHO for the Republic of the Marshall Islands, 30 December 2021, https://www.greenclimate.fund/sites/default/files/document/marshall-islands-who-mhl-rs-002.pdf
- WHO Health and Climate change Country Profile 2017: Kiribati, https://www.who.int/publications/i/item/health-and-climate-change-country-profile-2017-Kiribati
- WHO Health and Climate change Country Profile 2021: Fiji, https://www.who.int/publications/i/item/WHO-HEP-ECH-CCH-21.01.01

11

Fiji: national planning for health and climate change

Has a national health and climate change strategy or plan been developed?[a]	✓
Title: Climate Change Health Strategic Action Plan (CCHSAP) Year: 2016–2020	
Content and implementation	
Are health adaptation priorities identified in the strategy/plan?	✓
Are the health co-benefits of mitigation action considered in the strategy/plan?	✓
Performance indicators are specified	✓
Level of implementation of the strategy/plan	Medium
Current health budget covers the cost of implementing the strategy/plan	✗

✓=yes, ✗=no, O=unknown, N/A=not applicable, TBA=to be advised

[a] In this context, a national strategy or plan is a broad term that includes national health and climate strategies as well as the health component of national adaptation plans (H-NAPs).

Source: WHO Health and Climate change Country Profile 2021: Fiji

9

WHO Country Profile Fiji: Recommendations

- Strengthen the implementation of the Climate Change and Health Strategic Action Plan for Fiji
- Assess health vulnerability, impacts and adaptive capacity to climate change
- Strengthen integrated risk surveillance and early warning systems
- Address barriers to accessing international climate change finance to support health adaptation

Source: WHO Health and Climate change Country Profile 2021: Fiji

10

Contents

1. Objectives
2. National Climate Resilience framework for Samoa
3. Assessing the Vulnerabilities and the Implementation of the Intervention Process
4. The Main Components and Methods used for climate risk assessment of health facilities in Samoa
5. Summary
6. Quiz

The content of the presentation includes number one (1)objectives of which there are three, number two (2) how the national climate resilience framework for Samoa was developed based on guidance recommended by international climate resilient frameworks. Number three (3) assessing and understanding the risks, vulnerabilities and impacts of health facilities in Samoa, followed by the implementation of the intervention process. Please note that when we assess the vulnerabilities and implement the intervention process, this will be tailored to suit Samoa's local context.
Number four (4) the main components and methods used to conduct climate risk assessment of health facilities in Samoa will be outlined. The presentation will then be summarized followed by a Quiz.

CBCRP-PCCC Virtual Training Course

Health Systems and Climate Change
Enhancing Resilient and Low-carbon Development in the Pacific

Government of Samoa, SPREP, and JICA

Module 1.2 Vulnerability and Adaptation

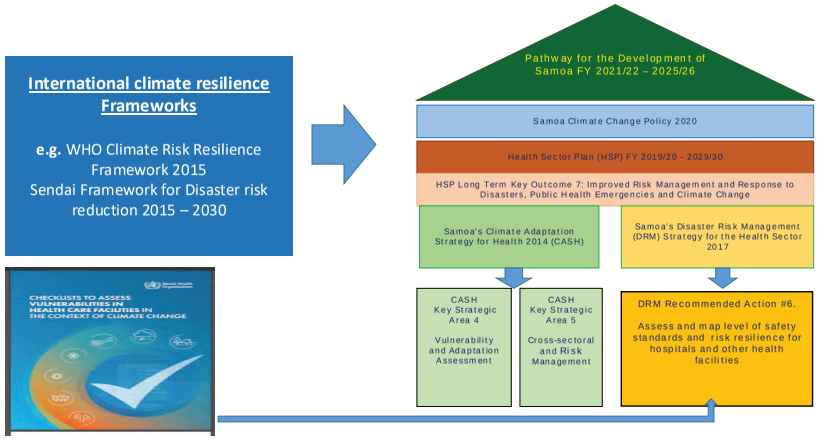
- Climate risk assessment of health facilities in Samoa

Victoria Ieremia-Faasili (Principal Climate Change and Health)
Climate Change and Health Unit
National Health Surveillance & International Health Division
Ministry of Health, Samoa
Email: victoriaf@health.gov.ws

Talofa everyone!

I am Victoria Ieremia-Faasili, the Principal Climate Change and Health Officer from the Ministry of Health in Samoa.
I will be presenting on our Climate Change and Health Unit's effort towards conducting climate risk assessment of health facilities in Samoa as part of Module 1.2 :Vulnerability and Adaptation

National Climate Resilience Framework



As stated on the previous slide, the first objective is to understand how the national climate resilience framework in Samoa was developed.

The International frameworks such as the WHO Climate Risk Resilience Framework 2015 and the Sendai Framework for Disaster Risk Reduction 2015 – 2030 were used to guide the national climate resilience framework of Samoa.

The Government of Samoa identifies climate change as a key priority in its Pathway for the development of Samoa FY -2021/22 – 2025/26. This is in line with Samoa's Climate Change Policy 2020 and the Health Sector Plan FY 2019/20 – 2029/30. In this Health Sector Plan, The Long Term Key Outcome 7 : 'Improved risk management and response to disasters, public health emergencies and climate change was identified as a priority.

In line with the Health Sector Plan, Samoa's Climate Adaptation Strategy for Health 2014 known as CASH include two Key Strategic Areas. Area 4: Vulnerability and adaptation assessment and Area 5: Cross sectoral and risk management. Still in line with the Health Sector Plan, is Samoa's Disaster Risk Management or DRM Strategy for the Health Sector 2017. Within this DRM Strategy, is recommended action 6, this is to assess and map level of safety standards and risk resilience for hospitals and other health facilities.

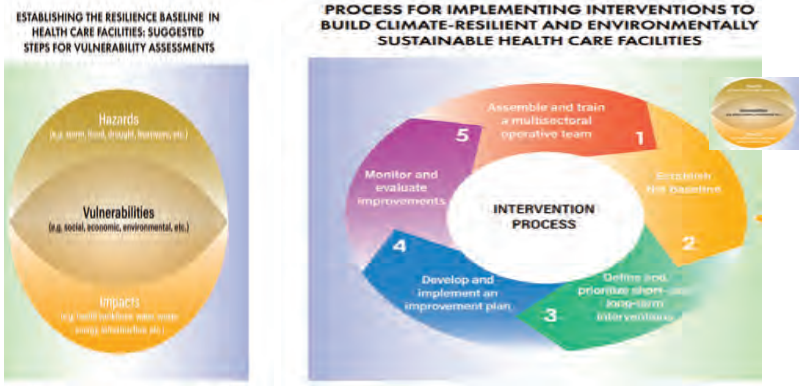
With so many competing priorities for disaster risk management and climate

Objectives

- To understand the **National Climate Resilience Framework**
- To understand the **risks, vulnerabilities** and **impacts** of climate change on health facilities
- To understand the **components** and **methods** used to assess the **climate risk assessment** of health facilities

Here are the three objectives, first objective is (1) to understand how the national climate resilience framework for Samoa was developed with guidance recommended by international climate resilient frameworks. The second (2) objective is to understand the risks, vulnerabilities and impacts of climate change on health facilities in the context of Samoa. And then the third (3) objective is to understand the main components and methods used to assess the climate risk assessment of health facilities in Samoa.

Assessing vulnerabilities and intervention process



Source: Checklists to Assess Vulnerabilities in Healthcare Facilities in the Context of Climate Change. Geneva: World Health Organisation; 2021

In view of the Disaster Risk Management Recommended Action number 6 “to assess and map level of safety standards and risk resilience for hospitals and other health facilities ” I will now discuss how we assessed the climate risk resilience of health facilities in Samoa. This is done by conducting a vulnerability assessment followed by an intervention process.

Firstly, there needs to be an assessment on the vulnerabilities, hazards and impacts of climate change on health facilities. This is then followed by the intervention process.

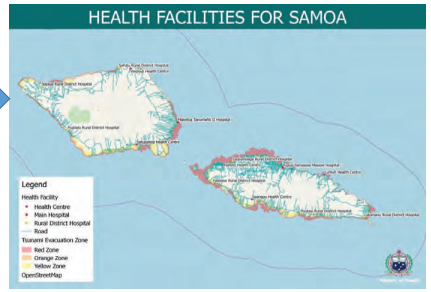
Step 1: For Samoa, the Climate Change and Health Unit coordinates a **multi-sectoral operative team** (this is referred to as the assessment team).

Step 2: When **establishing the baseline**, it is important that we assess potential hazards, vulnerabilities and impacts specific to your local context. Hazards include climatic, geological and environmental elements such as storm, flood, drought, heat wave, earthquake and volcanic eruption. In addition, we need to assess the vulnerabilities of health facilities keeping in mind the local social, economic and environmental conditions. Furthermore, this step includes assessing the potential impacts of climate change on health facilities in terms of health workforce capacity, water, sanitation and hygiene or WASH, waste, energy, building infrastructure and transportation. Again, this depends on the local context of your country.

change activities, this Recommended Action No. 6 is identified as one of the key performance indicators for the climate change and health unit under Ministry of Health’s National Health Surveillance and International Health Regulations Division. This activity specifically relates to the climate risk assessment of health facilities in Samoa which is guided by the WHO Checklist.

Components used to conduct climate risk assessment of health facilities

- Building Infrastructure
- Proximity to Hazard Zones
- Hospital Accessibility
- WASH
- Power & Communication
- Fire Safety
- General Site Tidiness
- Safety Procedures in place for Disasters



These are some of the examples of the main components used by the assessment team to conduct climate risk assessment of health facilities in Samoa.

For e.g building infrastructure, Proximity to Hazard Zones (e.g tsunami), Hospital Accessibility in terms of road infrastructure as shown in the health facilities map for Samoa.

Other examples include Water Sanitation and Hygiene (WASH), Power & Communication, Fire Safety, General Site Tidiness and Safety Procedures in place for disasters. Again I emphasize that these components are specific to the context of Samoa and depending on the review of the checklist by the assessment team.

Step 3: Once the baseline has been established, a list of **short and long term interventions** are recommended by the assessment team. These interventions are prioritized in terms of urgency to address the risk resilience of health facilities.

Step 4. These interventions identified in Step 3 are then devised into developing an **implementation and improvement plan**

Step 5 completes the process by the implementation of **monitoring and evaluation procedures** to track progress of the implementation plan.

Methods to conduct climate risk assessment of health facilities Cont'

- Interpretation of Results using the Risk Ranking Tool

Table 1. Example of a Risk Ranking Tool

Hospital Name	Structure Proximity to hazard Zones	Hospital Accessibility	Backup Power	Communication	WASH	Fire Safety	Building Infrastructure	Safety procedures in place
Hospital A	Good	Very Poor	Poor	Good	Poor	Poor	Good	Satisfactory
Hospital B	Poor	Satisfactory	Very Poor	Poor	Good	Satisfactory	Satisfactory	Poor

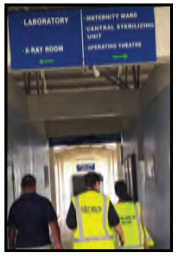
- Final Report

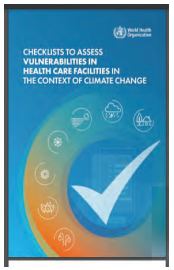
Continuing on from the methods used to conduct climate risk assessment of health facilities. The interpretation of results using the risk ranking tool is conducted by specialists in their respective areas. For example building infrastructure is assessed by the Assets and Maintenance team. As shown in this example, table 1 the ranking can range from Very Poor to Good and reflected by color codes.

All information is collated and presented in a final report highlighting short and long term interventions, with an implementation and improvement plan overseen by monitoring and evaluation procedures.

Methods to conduct climate risk assessment of health facilities

- Site visit and assessment using Health Facilities Checklist





The methods utilized by the assessment team to conduct climate risk assessment of health facilities in Samoa are as follows.

Firstly a Site visit and assessment using the health facilities checklist is carried out, here is an example of a checklist used by our assessment team. This checklist is based on WHO Checklists to Assess Vulnerabilities in Healthcare Facilities in the Context of Climate Change 2021. This assessment needs to be tailored to suit the local context. For example, Samoa experiences tsunamis and cyclones therefore there is a strong focus on building structure and proximity to hazard zones, access to transportation, power, water and communication, fire safety and existing evacuation procedures and their resilience to extreme weather events.

Objectives

- To understand the **National Climate Resilience Framework**
- To understand the **risks, vulnerabilities** and **impacts** of climate change on health facilities
- To understand the **components** and **methods** used to assess the **climate risk assessment** of health facilities

552

Now we refer back to the Objectives of the presentation whether you have understood the following three main objectives.

Good luck with the Quiz.

Summary

- The National Climate Resilience framework is in line with International climate resilience guidelines
- Important to assess the relevant vulnerabilities such as social, economic and environmental impacts specific to the local context
- Completion of 5 Steps of the Intervention Process
- Utilize the Risk Ranking Tool to assess the climate resilience of health facilities for the final report

In summary, this presentation has given you an overview of how the national climate resilience framework for Samoa was developed with guidance recommended by international climate resilience guidelines.

In addition, the presentation demonstrates the importance of assessing specific relevant local vulnerabilities such as social, economic and environmental impacts specific to the local context. This is followed by completing all the 5 steps of the intervention process.

Lastly, the overall assessment can be conducted by utilizing the Risk Ranking Tool to assess the climate resilience of health facilities prior to the compilation of the final report.

FAAFETAI

Reference materials

- Operational Framework for Building Climate Resilient Health Systems. Geneva: World Health Organisation; 2015
- Paris Agreement Under the United Nations Framework Convention on Climate Change; 2015
- Sendai Framework for Disaster Risk Reduction. United Nations Office for Disaster Risk Reduction; 2015-2030
- WHO Guidance for Climate-Resilient and Environmentally Sustainable Health Care Facilities. Geneva: World Health Organisation; 2020
- Checklists to Assess Vulnerabilities in Healthcare Facilities in the Context of Climate Change. Geneva: World Health Organisation; 2021
- Pathway for the Development of Samoa FY 2021/22 – 2025/26. Ministry of Finance, Economic Policy and Planning Division, Samoa; 2022
- Samoa Climate Change Policy. Ministry of Natural Resources and Environment, Climate Change and Global Environment Facility Division; 2020
- Health Sector Plan FY 2019/20 – 2029/30 Implementation Plan. Ministry of Health, Samoa; 2018
- Climate Adaptation Strategy for Health (CASH). Ministry of Health, Samoa; 2014
- Disaster Risk Management: A Strategy for the Health Sector. Ministry of Health, Samoa; 2017

CBCRP-PCCC Virtual Training Course

Health Systems and Climate Change
Enhancing Resilient and Low-carbon Development in the Pacific

Government of Samoa, SPREP, and JICA

Module 1. Understanding of risks of climate change impacts on human health and health services, and GHG emission from health services

1.3 GHG emissions from health services

Dr Aditya (Adi) Vyas | Public health physician
University of Notre Dame, Sydney, Australia
adi@curion.com.au

CONTENTS

1. Health service activities
2. Scope of greenhouse gas emissions
3. Carbon footprint of health
4. Opportunities to reduce healthcare carbon emissions

Overview of the presentation

Two topics covered in this sub-module:

- Potential greenhouse gas (GHG) emissions from health services
- Carbon footprint

In order to address these two topics, we need to understand:

- What activities do health services undertake?
- What environmental resources do health activities require?
- What do we mean by the scope of carbon emissions (scope 1, 2 and 3)?
- What sectors of the economy contribute to health carbon emissions?
- How is the carbon footprint calculated?
- What can we do to reduce carbon emissions from health services?

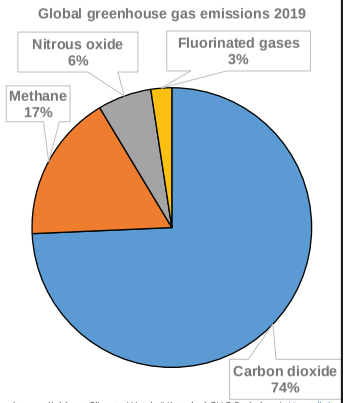
What activities do health services undertake?

Health services undertake a range of different activities, which can be categorised as:

- Treatment
- Prevention
- Improvement
- Promotion
- Protection

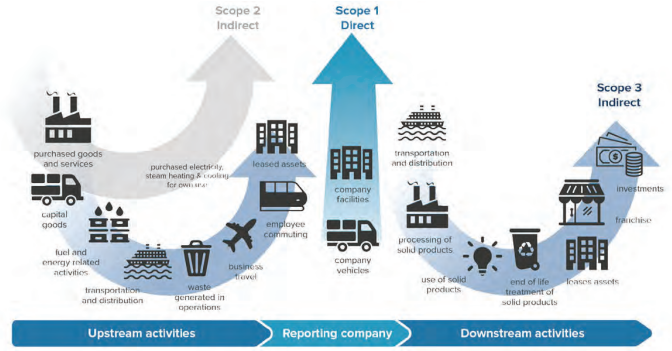
Each of these activities contribute to greenhouse gas emissions from health services.

- Greenhouse gases contribute to global warming and climate change
- Carbon dioxide (CO_2) is the major greenhouse gas, and so we often refer to "carbon emissions" interchangeably with "greenhouse gas emissions"
- Other important greenhouse gases are: methane (CH_4), nitrous oxide (N_2O) and fluorinated gases (such as hydrofluorocarbons HFCs)



Pie chart generated from data available at Climate Watch (Historical GHG Emissions). Hyperlink.

What activities do health services undertake?



Source: Health Care Without Harm 2019. Healthcare's carbon footprint. Hyperlink.

7

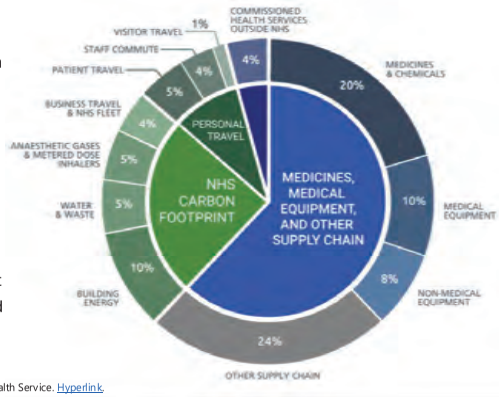
What activities do health services undertake?

This diagram from the National Health Service (NHS) in England shows the different activities undertaken by health services across the country, and their relative contribution to the overall carbon footprint of the organisation.

The term "carbon footprint" refers to the total greenhouse gas emissions by an organisation.

Financial expenditure and carbon emissions are linked:

- Each type of health service activity is associated with a certain financial cost
- This financial expenditure can be used to estimate the amount of carbon emissions from health services



Source: National Health Service 2020. Delivering a 'Net Zero' National Health Service. Hyperlink.

5

555

What do we mean by the scope of carbon emissions?

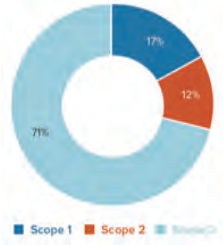
In addition to categorising upstream and downstream activities, the previous slide also categorised carbon emissions as 'scope 1', 'scope 2' and 'scope 3'.

The Greenhouse Gas Protocol defines these as:

- Scope 1: Direct emissions from sources owned or directly controlled by health facilities, generated on site
- Scope 2: Indirect emissions from the generation of purchased energy, mostly electricity
- Scope 3: All other indirect emissions that occur in producing and transporting goods and services, including the full supply chain

Globally, scope 3 emissions are the largest proportion of the health sector's carbon emissions. Therefore, health services must:

- Address and reduce the direct emissions (scope 1) and energy sources (scope 2), which are easier to measure
- Change the way we purchase and procure goods, deliver models of care, and how we transport people and goods to and from health services (scope 3)



Source: Health Care Without Harm 2019. Healthcare's carbon footprint. Hyperlink.

8

What environmental resources do health activities require?

Looking 'upstream' and 'downstream' from the point where health services are delivered helps us to identify the environmental impact that health services make.

Upstream activities include:

- Purchasing energy (fossil fuel extraction)
- Procuring medical equipment and pharmaceuticals (manufacturing)
- Using water (land use changes, environmental modification)
- Building hospitals (built environment and amenity)
- Sourcing and manufacturing food (agriculture)

Downstream activities include:

- Generating waste (landfill, incineration)
- Disposing water, chemical, radiological waste (groundwater and soil contamination)
- Transporting goods and people (air pollution)

The next slide describes these upstream and downstream activities in relation to scope of emissions.

6

Calculating the env. footprint of a regional health sector

The state of New South Wales (NSW) is the largest in Australia by economic output and has a population of ~8 million, mostly concentrated in Sydney (population of ~5 million). There are ~200 public healthcare facilities and many private facilities in the state.

What did we analyse? We investigated the "environmental footprint" of the entire health sector in NSW (both public and private facilities) by considering three environmental indicators:

- Carbon emissions
- Waste generated
- Water used

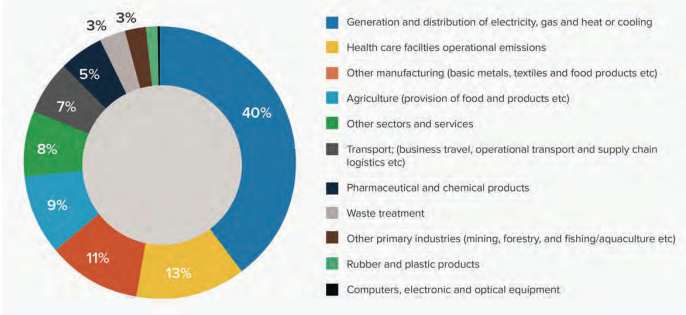
How did we calculate the footprint?

- Identified the coding of different economic sectors (Australian and New Zealand Standard Industrial Classification from Australian Bureau of Statistics)
- Obtained health expenditure data for NSW (Australian Institute of Health and Welfare)
- Integrated this with data on carbon intensity of different economic sectors (Australian Industrial Ecology Virtual Laboratory at University of Sydney)

11

What are the sources of emissions from health services?

This slide shows the other sectors of the economy that contribute to the carbon emissions generated by health services. Energy usage is the major contributor, particularly through the use of fossil fuel (non-renewable) sources of energy.



Source: Health Care Without Harm 2019. Healthcare's carbon footprint. Hyperlink.

9

556

Calculating the env. footprint of a regional health sector

What method did we use?

- Environmentally extended input-output analysis

What were our findings? The health sector in NSW is responsible for, per annum:

- 7908 kgtonnes of greenhouse gas emissions
- 246 gigalitres of water use
- 1624 kgtonnes of waste generation

What were the broader impacts of this paper?

- First comprehensive regional assessment of environmental impacts of a health system in Australia
- Informed the NSW Ministry of Health on carbon hotspots in the regional health sector
- Encouraged the development of a policy position statement on how the NSW Ministry of Health could respond to climate change
- Led to inclusion of environmental sustainability as a strategic outcome within the Future Health Strategy (the 10 year plan for NSW Ministry of Health) and inclusion of key objectives on climate risk and net zero emissions

12

How is the carbon footprint calculated?

There are two main methods for calculating the carbon footprint of an organisation: **input-output analysis** ("top down") and **lifecycle assessment** ("bottom up").

	Method 1: Environmentally extended input-output analysis	Method 2: Process-based lifecycle assessment
Simple description	Top down	Bottom up
This method applies emissions factors (carbon intensity of different activities) to…	Financial expenditure in different economic sectors	Components used in the manufacture of a specific product
Benefits	Easier and less expensive to carry out	Results in more specific findings
Limitations	Based on modelling, makes assumptions about supply chain, data sets may have gaps	Less easy and more expensive to carry out, requires extensive data gathering
Example	Malik 2018. The carbon footprint of Australian health care. https://doi.org/10.1016/S2542-5196(17)30180-8	Jeswani 2019. Life cycle environmental impacts of inhalers. https://doi.org/10.1016/j.jclepro.2019.117733

10

What can we do to reduce healthcare carbon emissions?

2. Opportunities to reduce emissions from Rasheed 2021. Decarbonising healthcare in low and middle income countries: potential pathways to net zero emissions. https://doi.org/10.1136/bmj.n1284

These two papers provide guidance which can be tailored to the local context, together with regional and national plans for climate response in the health sector.

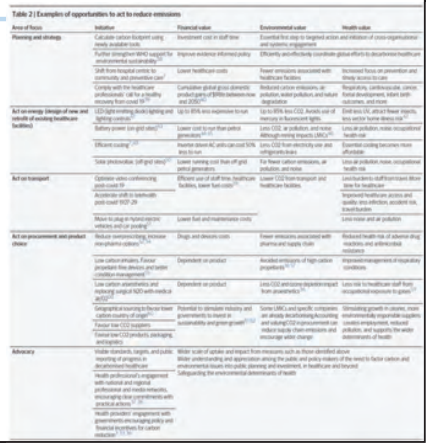
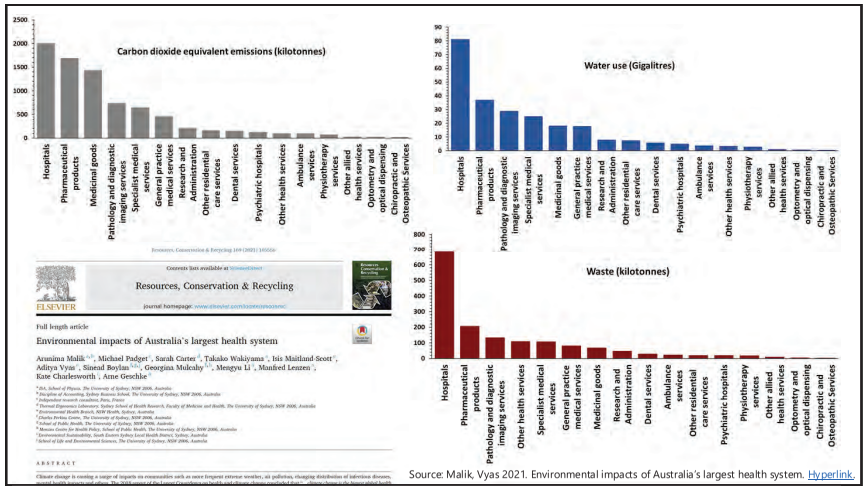


Table 2 | Examples of opportunities to act to reduce emissions

Area of focus	Initiative	Financial value	Environmental value	Health value
Planning and strategy	Calculate carbon footprint using newly available tools	Investment cost in staff time	Essential first step to targeted action and initiation of cross-organisational and systems engagement	
	Further strengthen WHO support for environmental sustainability[10]	Improve evidence informed policy	Efficiently and effectively coordinate global efforts to decarbonise healthcare	
	Shift from hospital centric to community and preventive care[11]	Lower healthcare costs	Fewer emissions associated with healthcare facilities	Increased focus on prevention and timely access to care
	Comply with the healthcare professionals' call for a healthy recovery from covid-19[12 13]	Cumulative global gross domestic product gains of $98tn between now and 2050[14]	Reduced carbon emissions, air pollution, water pollution, and natural degradation	Respiratory, cardiovascular, cancer, foetal development, infant birth outcomes, and more
Act on energy (design of new and retrofit of existing healthcare facilities)	LED light emitting diode lighting and lighting controls[15]	Up to 85% less expensive to run	Up to 85% less CO_2, Avoids use of mercury in fluorescent lights.	Emit less UV, attract fewer insects, less vector borne illness risk[16]
	Battery power (on-grid sites)[17 18]	Lower cost to run than petrol generators[19 20]	Less CO_2, air pollution, and noise. Although mining impacts LIBs[21 22]	Less air pollution, noise, occupational health risk
	Efficient cooling[23 24]	Inverter driven AC units can cost 50% less to run	Less CO_2 from electricity use and refrigerants leaks	Essential cooling becomes more affordable
	Solar photovoltaic (off-grid sites)[17 18]	Lower running cost than off-grid petrol generators	Far fewer carbon emissions, air pollution, and noise	Less air pollution, noise, occupational health risk
Act on transport	Optimise video conferencing post-covid-19	Efficient use of staff time, healthcare facilities, lower fuel costs[25 26]	Lower CO_2 from transport and healthcare facilities	Less burden to staff from travel. More time for healthcare
	Accelerate shift to telehealth post-covid-19[27-29]			Improved healthcare access and quality since infection, accident risk linked burden
	Move to plug-in hybrid electric vehicles and car pooling[30]	Lower fuel and maintenance costs		Less noise and air pollution
Act on procurement and product choice	Reduce overprescribing, increase non-pharma options[31-33]	Drugs and devices costs	Fewer emissions associated with pharma and supply chain	Reduced health risk of adverse drug reactions and antimicrobial resistance
	Low carbon emulers, Favour proximate-free devices and carbon creditor management[34]	Dependent on product	Avoided emissions of high carbon propellants[35 36]	Improved management of respiratory conditions
	Low carbon anaesthetics and replacing surgical N2O with medical air[37]	Dependent on product	Less CO_2 and ozone depletion impact from anaesthetics[38]	Less risk to healthcare staff from occupational exposure to gases[39]
	Geographical sourcing to favour lower carbon country of origin[40]	Potential to stimulate industry and governments to invest in sustainability and green growth[41 42]	Some LMICs and specific companies are already decarbonising. Accounting and valuing CO_2 improvement can reduce supply chain emissions and encourage wider change	Stimulating growth in cleaner, more environmentally responsible suppliers creates employment, reduced pollution, and supports the wider determinants of health
	Favour low CO_2 suppliers			
	Favour low CO_2 products, packaging, and logistics			
Advocacy	Visible standards, targets, and public reporting of progress in decarbonised healthcare	Wider scale of uptake and impact from measures such as those identified above. Wider understanding and appreciation among the public and policy-makers of the need to factor carbon and environmental issues into public planning and investment, in healthcare and beyond. Safeguarding the environmental determinants of health		
	Health professional's engagement with national and regional professional and media networks, encouraging clear commitments with practical actions[43 44]			
	Health providers' engagement with governments encouraging policy and finance incentives for carbon reduction[45 46]			



Source: Malik, Vyas 2021. Environmental impacts of Australia's largest health system. Hyperlink.

Summary of the presentation

This sub-module 1.3 has covered the following key points.

The activities undertaken by healthcare facilities while delivering healthcare have an environmental footprint: we produce significant amounts of carbon emissions, consume water, and generate waste.

Health systems have a major role to play in climate change mitigation by reducing their directly controlled (scope 1) carbon emissions, purchasing renewable energy (scope 2), and ensuring a low carbon supply chain (scope 3).

The environmental footprint of the health system can be assessed in two ways: "top down" using input-output economic modelling, and "bottom up" using product-specific lifecycle assessment. Both have a role to play.

What can we do to reduce healthcare carbon emissions?

We will cover this topic further in Module 2 Climate adaptation and mitigation options of health systems.

For the current sub-module, we can consider two papers which provide recommendations.

1. Six actions for climate-smart health care from Health Care Without Harm 2019. Healthcare's carbon footprint. https://noharm-global.org/documents/health-care-climate-footprint-report

SIX ACTIONS FOR CLIMATE-SMART HEALTH CARE

Action 1 **Reduce health care's climate footprint now.** Actors at all levels in the health sector can build on the ongoing work of thousands of hospitals and health systems already addressing their climate footprint to forge parallel and related paths toward net zero emissions. Key steps can be based on the Greenhouse Gas Protocol and should include:

Scope 1: Take immediate action to reduce health care facility emissions.

Scope 2: Invest in and advocate for the decarbonization of local and national energy systems and the implementation of clean, renewable energy.

Scope 3: Set and implement criteria for low-carbon or zero-emissions procurement so as to begin to decarbonize the supply chain.

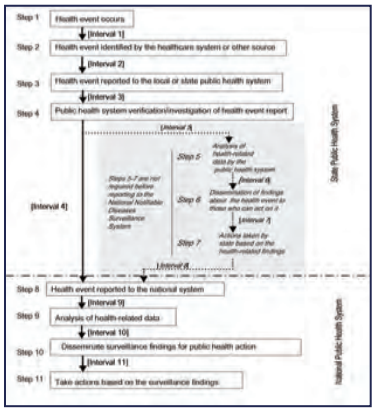
Action 2 **Support a societal transition to clean, renewable energy.** The health sector in every country should advocate for a rapid phase-out of fossil fuels and a transition to clean, renewable energy so as to help move health care energy consumption to net zero emissions while also protecting public health from both local pollution and global climate impacts.

Action 3 **Chart the course for zero emissions health care by 2050.** A coherent global road map is necessary to identify key pathways forward, while establishing timelines and frameworks for action. The road map should be based on principles of global equity for climate and health, a unified, climate-smart approach to mitigation and resilience, and an approach that fosters action at all levels.

Action 4 **Make development assistance for health climate-smart.** Bilateral aid agencies, multilateral development banks, other health funding agencies, and philanthropies should integrate climate-smart principles and strategies into their health aid, lending, and policy guidance for developing countries. These funding climate mitigation and adaptation should integrate health into their programs. This should be undertaken in alignment with the outcomes of the UN Secretary General's 2019 Climate Action Summit.

Action 5 **Establish and implement government action plans for climate-smart health care.** National and sub-national governments should build on existing initiatives to establish action plans to decarbonize their health systems, foster resilience, and improve health outcomes. Implementation should contribute to government climate policy and nationally determined contributions to the Paris Agreement. The countries most responsible for the problem should lead the way.

Action 6 **Deepen research on health care and climate change.** Further research is necessary to better understand trends in the interplay of health care and climate change, including an analysis of the future trajectory of health care emissions, in-depth analysis of the supply chain and its climate impact, national and sub-national level health care climate footprinting, economic and health analysis of the costs and benefits of transitioning to climate-smart healthcare, and more.



SURVEILLANCE FOR OUTBREAK PREDICTION

Prof. Dr. Axel Kroeger
Albert-Ludwigs-Universität Freiburg - Centre for Medicine and Society, Germany

Ass. Prof. Dr. Laith Hussain
University of Gothenburg, Sweden

Supported by TDR and ECH WHO, Geneva

Supported by TDR and ECH WHO, Geneva; Freiburg University, Germany; Gothenburg University, Sweden

1

Reference materials

- Health Care Without Harm 2019. Healthcare's carbon footprint. https://noharm-global.org/documents/health-care-climate-footprint-report
- Rasheed 2021. Decarbonising healthcare in low and middle income countries: potential pathways to net zero emissions. https://doi.org/10.1136/bmj.n1284
- World Health Organization 2021. Expert meeting on measuring greenhouse gas emissions and other environmental sustainability concerns in health care facilities. https://cdn.who.int/media/docs/default-source/climate-change/ghg-meeting-report-01.04.21.pdf?sfvrsn=e0c03c41_7&download=true
- Climate Watch (Historical GHG Emissions). https://www.climatewatchdata.org/
- National Health Service 2020. Delivering a 'Net Zero' National Health Service. https://www.england.nhs.uk/greenernhs/wp-content/uploads/sites/51/2022/07/B1728-delivering-a-net-zero-nhs-july-2022.pdf
- Malik 2018. The carbon footprint of Australian health care. https://doi.org/10.1016/S2542-5196(17)30180-8
- Jeswani 2019. Life cycle environmental impacts of inhalers. https://doi.org/10.1016/j.jclepro.2019.117733
- Malik, Vyas 2021. Environmental impacts of Australia's largest health system. https://doi.org/10.1016/j.resconrec.2021.105556

17

CONTENT

TO UNDERSTAND :

1 Characteristics and components of a surveillance system

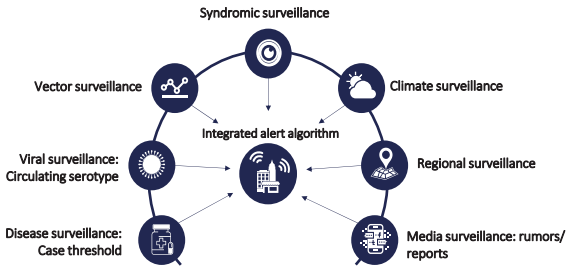
2 Missed cases & expansion factor

3 How to improve the surveillance system

4 Summary

2

MAIN COMPONENTS OF A SURVEILLANCE SYSTEM



Outbreak prediction leading to staged response

5

Characteristics and components of a surveillance system

3

DEFINITIONS

Passive surveillance relies on standardized reporting forms provided by the state or local health departments. These completed forms are returned to the health department when cases of disease are detected. Passive reporting systems are generally less costly than other reporting systems and data collection is not burdensome to health officials, but the challenge is how to increase the reporting mentality of health providers and ensure a standardized case classification (Thacker et al. 1986).

Active / enhanced surveillance involves outreach by the public authority, such as regular telephone calls or visits to laboratories, hospitals and providers, to stimulate reporting of specific diseases. It places intensive demands on resources and should be limited to specific purposes (Thacker et al. 1986).

Sentinel surveillance is a special form of active surveillance. It involves collecting case data from a sample of providers and then extrapolating them to a larger population. The advantage is that it is less expensive (being restricted to small areas) and produces data of higher quality; the disadvantage is the inability to ensure that the sample population is representative (Thacker et al. 1986).

6

PURPOSE OF A SURVEILLANCE SYSTEM

1. Document **«burden of disease»**
2. Describe temporal and spatial **trends**
3. Predict or detect **outbreaks** at an early stage
4. Show the **effects of an intervention**

4

Missed cases and Expansion factor

9

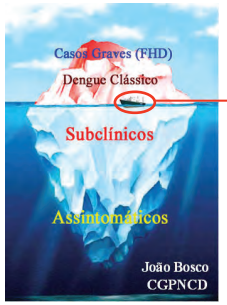
ATTRIBUTES OF A "GOOD" SURVEILLANCE SYSTEM

ATTRIBUTES	BRIEF DEFINITION
Sensitivity	Proportion of cases/outbreaks detected out of all cases/outbreaks
Timeliness	Speed between detection, reporting and response
Simplicity	Ease of operation of the surveillance system
Data quality	Completeness and validity of the data recorded
Positive Predictive Value	Proportion of reported cases, actually having Dengue
Representativeness	Ability to describe spatial and temporal Dengue distribution in the whole population
Acceptability	Willingness of people and organisations to participate
Accuracy/Specificity	Ability to distinguish between a Dengue outbreak and another outbreak, between a case and another illness, and between mild and severe disease

7

560

- WHAT ARE MISSED CASES?
- WHAT IS THE «EXPANSION FACTOR»?

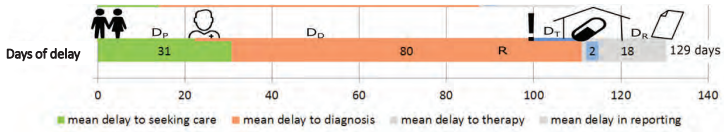


Surveillance

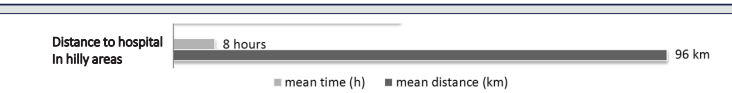
Cortesy of João Bosco, Brazil

10

TIMELINESS: DIAGNOSTIC DELAY (VL IN NEPAL) LEADS TO : DELAYED TREATMENT + PROLONGED TRANSMISSION



LONGEST DELAY - DIAGNOSTIC DELAY AFTER SEEKING CARE TO DIAGNOSIS OF VL (~2 ½ MONTHS)



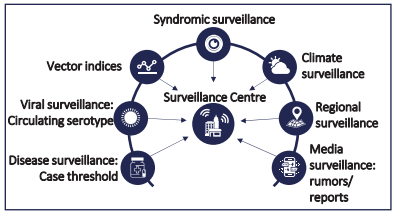
8

SURVEILLANCE LINKED TO STAGED RESPONSE

INITIAL RESPONSE
Outbreak Investigation
Assure contingency plan is available
Update background information
Enhance surveillance
Enhance routine activities
Complete preparatory activities including training
Prioritize risk areas

EARLY RESPONSE
Activate communication channels
Risk communication and outbreak declaration
Consider M&E activities
Implement community based risk reduction activities
Inform clinicians and prepare dengue treatment areas
Ensure guidelines for case detection, treatment and triage
Intensify vector control activities

LATE RESPONSE
Full implementation of contingency plan including M&E activities and stopping rules



13

How to improve the surveillance system

11

IMPROVEMENT OF THE REPORTING SYSTEM

- Ensure **weekly reporting**
- Increase **understanding & acceptability** of surveillance
- Add **laboratory** support to the clinical diagnosis (RDTs if available)
- Include the **private sector**
- Avoid **double reporting**
- Analyse **data at all levels (**including the lowest possible)
- Improve **feedback** of reported data and reporting lines
- Use **simple forms and electronic reporting**
- Use simple and standardized **case definition/classification**
- Add **additional** active/sentinel/syndromic **components**

12

OUTBREAK RESPONSE: TAKING DENGUE AS AN EXAMPLE

Prof. Dr. Axel Kroeger
Albert-Ludwigs-Universität Freiburg - Centre for Medicine and Society, Germany

Ass. Prof. Dr. Laith Hussain
University of Gothenburg, Sweden

Supported by TDR and ECH WHO, Geneva

Supported by TDR and ECH WHO, Geneva; Freiburg University, Germany; Gothenburg University, Sweden[1]

1

CONTENT

TO UNDERSTAND :

1 Resource requirements and main activities

2 Activities for outbreak prevention or mitigation

3 Staged response

4 Effectiveness of outbreak response

5 Conclusions

2

FACTS ON MITIGATING OUTBREAKS OF DENGUE, CHIKUNGUNYA AND ZIKA

- No vaccine available to stop the spread
- The only prevention is to reduce vector densities and/or reduce person-vector contact
- General rules of integrated vector management (IVM) have to be applied (countries have usually guidelines)
- Additionally to special measures (e.g. space spraying) the routine vector control measures will be intensified

4

RESOURCE REQUIREMENTS AND MAIN ACTIVITIES

- **Rapid response team (RRT)** to coordinate multisectoral, multidisciplinary, multilevel, environmental, political, social and medical inputs
- Outbreak **investigation** (confirm the outbreak, the pathogen, source, transmission dynamics, spatial extension, hot-spots, patients' age/sex etc.)
- **Risk communication** (to authorities and the population)
- **Outbreak declaration**
- **Additional human resources** for *clinical management* and *vector control*
- Monitoring and evaluation of all elements
- Include "**stopping rules"** into your contingency plan
- Staff **training** for outbreaks in the inter-epidemic period
- Separate *outbreak preparedness* activities from *routine measures*

3

IMPACT MITIGATION OF AN OUTBREAK

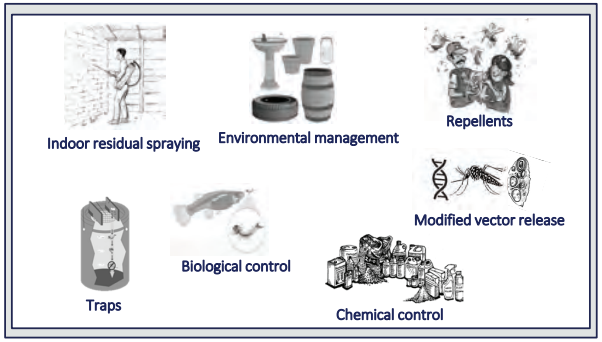
In your hospital/health centre you receive 200 dengue patients per day (instead of 1 or 2 patients in «normal» times).

What can you do regarding:

- Curative services? (triage)
- Families (social/economic)?
- Financing?

7

DENGUE VECTOR CONTROL OPTIONS



5

OUTBREAK MANAGEMENT AT CLINICAL SERVICES

- Consider surge capacity of hospitals (which varies widely)
- Focus on training for diagnosis und clinical management to decrease mortality rates
- Hands-on training during ward rounds and case conferences
- Emergency resources and planning must include clinical aspects and supplies

Example: Hospital outbreak management plans were present in 9/22 participating hospitals in Latin-America and 8/20 participating hospitals in Asia

8

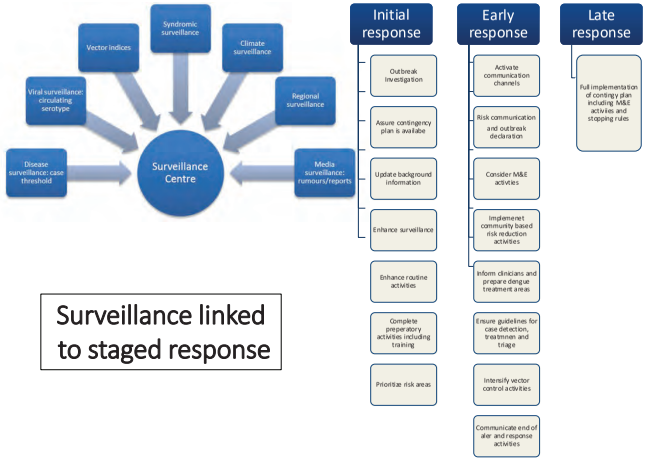
EXAMPLES OF DENGUE VECTOR CONTROL: EFFICACY/ COSTS/ ACCEPTANCE/ SUSTAINABILITY / OPERATIONAL ISSUES

6

CONCLUSIONS

- «Prevention is better than cure»
- Outbreak preparedness is useful
- Outbreak warning provides opportunities for:
  - Enhancing intra- and inter-institutional cooperation
  - Mitigating or even preventing outbreaks by early response
  - Planning ressource allocation in advance
  - Keeping control services alert

11



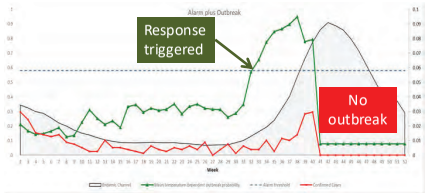
Surveillance linked to staged response

9

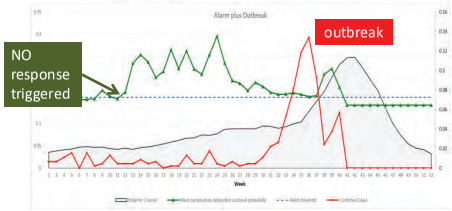
12

EFFECTIVENESS OF OUTBREAK RESPONSE: EWARS PROSPECTIVE STUDY IN MEXICO

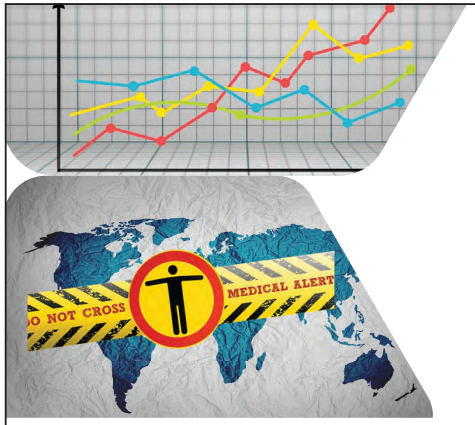
Culiacan



San Nicolas de los Garza



10



Forecasting Outbreaks

Prof. Dr. Axel Kroeger
Albert-Ludwigs-Universität Freiburg - Centre for Medicine and Society, Germany

Ass. Prof. Dr. Laith Hussain
University of Gothenburg, Sweden

Supported by TDR and ECH WHO, Geneva

Supported by TDR and ECH WHO, Geneva; Freiburg University, Germany; Gothenburg University, Sweden

1

OBJECTIVES of the SESSION

To understand:

- What is an outbreak
- What is an outbreak alarm
- How does outbreak warning (prediction) work
- The Early Warning and Response Systems (EWARS plus) – TDR/WHO

2

WHAT IS AN OUTBREAK?

"CASE NUMBERS ABOVE NORMAL"

Outbreak Situation A

NO cases and suddenly one case appears (EBOLA, POLIO, COVID-19, SARS) If another case appears: local transmission = OUTBREAK

Outbreak Situation B

Continuously sporadic cases. "Sudden unexpected increase of cases" = OUTBREAK

WHAT IS AN UNEXPECTED INCREASE?

"Unexpected" compared to the average of previous years. This historical pattern is visualised in the ENDEMIC CHANNEL

3

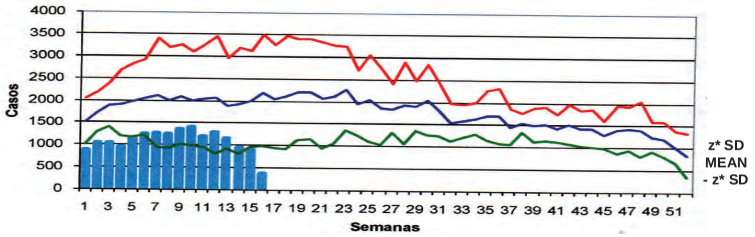
3

Outbreak definition using the ENDEMIC CHANNEL

- Current case numbers exceed the upper limit of the endemic channel

«upper limit» = outbreak threshold: z * SD of the moving average

Z-factor (Z*SD) = The multiplying factor of the Standard Deviation which can increase/ decrease the threshold i.e. define fewer/ more outbreaks, respectively



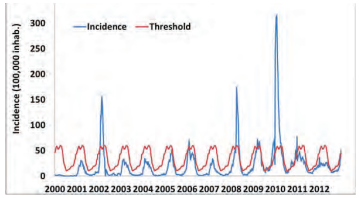
The endemic channel visualizes the **historical pattern** (=«expected cases») with upper and lower thresholds and the **seasonal peak(s)** of case numbers

4

4

MAGNITUDE OF OUTBREAKS

- Large outbreaks
- Small outbreaks



Brazilian classification

- "High risk" > 300 dengue cases per 100.000 inhabitants or > 0.06 dengue deaths per 100.000 inhabitants

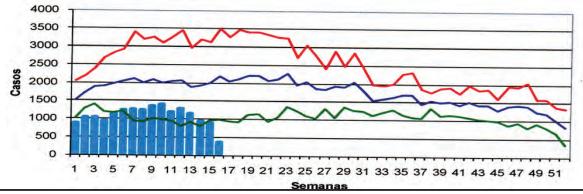
(Boletin dengue Brazil 2014; Plano de Contingencia Nacional de Epidemias Dengue 2015)

7

7

CALIBRATING THE ENDEMIC CHANNEL

- Each time point on the middle line is the average of cases of the last 5 to 10 years of that week +/- 3 weeks (in total 3+1+3 = 7 weeks, called "moving average")
- The upper line is the "alarm threshold", calculated as z*SD above the mean.
- Z may vary from district to district. The optimal value of z contributes to the highest sensitivities and PPV of outbreak prediction.



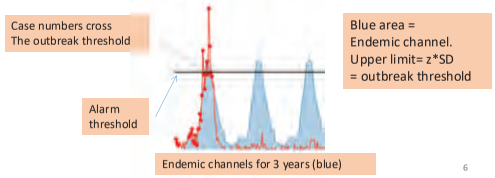
5

5

Definitions (1): OUTBREAK

- **Outbreak indicator** = *probable cases* or *confirmed cases* or *hospitalised cases* or deaths
- **Outbreak threshold (a)** = upper line of the endemic channel (depending on z)
- **Outbreak threshold (b)** = a pre-defined incidence level of expected cases
- **Outbreak window** = The time (no. of weeks) we wait after case numbers have crossed the threshold to declare an outbreak (or the end of an outbreak)
- **Outbreak period** = Duration of an outbreak

NB "Outbreak" depends on the *z value* (defining the upper line of the endemic channel), the minimum accepted *disease incidence* and the *"outbreak window"*



6

6

Potential Alarm indicators: Pros and Cons

Alarm indicators	Weekly availability	Issues
Meteorological (**temperature, rainfall, humidity**)	+++	• Irregular meteorological stations • MoU with met. services required • Less precision with satellite images
Entomological - larval indices - **ovitrap indices**	++? +++	• Inconsistent collection • Difficult to standardise • Routinely collected; easy to standardise
Epidemiological - **Patients` age** - % seropositivity of samples - predominant serotype	+++ (+) (+)	• Indicates probably change of serotype • Often not weekly reported • No weekly reports
Event based - Social media reports - Large gatherings - Others	(+) -	• Usefulness to be tested • occasionally

3

3

Forecasting Outbreaks (Part 2)

Prof. Dr. Axel Kroeger
Albert-Ludwigs-Universität Freiburg - Centre for Medicine and Society, Germany

Ass. Prof. Dr. Laith Hussain
University of Gothenburg, Sweden

Supported by TDR and ECH WHO, Geneva

Supported by TDR and ECH WHO, Geneva; Freiburg University, Germany; Gothenburg University, Sweden

1

Definitions (2b): OUTBREAK ALARM

- **Alarm threshold** = Line above which an alarm indicator turns into an alarm signal
- **Alarm signal** (outbreak alarm) = Values of the alarm indicator (e.g. mean weekly temperature) above the alarm threshold
- **Alarm window** = The time (number of weeks) we wait after the alarm indicator has crossed the alarm threshold (to avoid singular alarm spikes triggering an outbreak alarm)

4

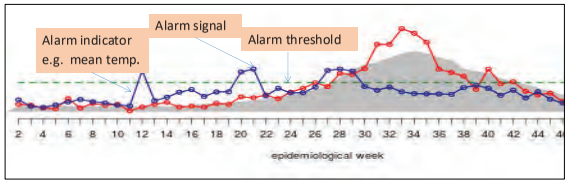
4

Definitions (2a): OUTBREAK ALARM

- **Alarm indicator** = A variable which might show that an outbreak is coming.

(Metereological, entomological, epidemiological, social alarm indicators)

Suitable alarm indicators are weekly available throughout the year and of suitable quality (see following table)



2

2

Forecasting Outbreaks (Part 3)

Prof. Dr. Axel Kroeger

Albert-Ludwigs-Universität Freiburg - Centre for Medicine and Society, Germany

Ass. Prof. Dr. Laith Hussain

University of Gothenburg, Sweden

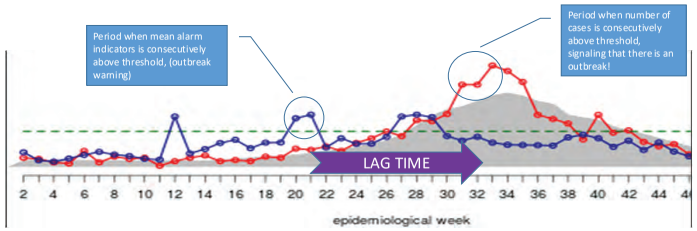
Supported by TDR and ECH WHO, Geneva

Supported by TDR and ECH WHO, Geneva; Freiburg University, Germany; Gothenburg University, Sweden

1

Definitions (3): Lag time

- The *Lag time* or *prediction period* is the number of weeks from alarm signal to start of the outbreak



The lag time depends particularly on climate variables:

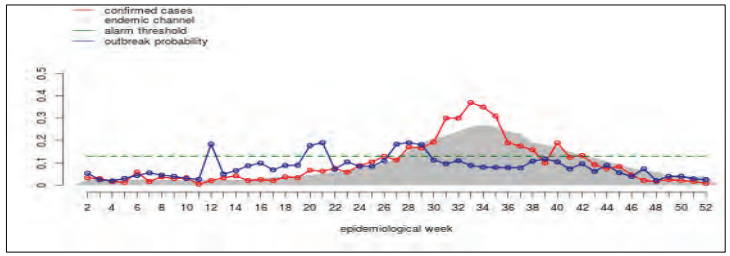
- **Short lag time** = favourable meteorological conditions for vectors (higher temperature and humidity, rainfall)
- **Long lag time** = Unfavourable conditions for the vector e.g. too hot, too cold, too much rain, too dry

2

2

Synoptic view: alarm and outbreak

The **alarm indicator** (blue line) turns into an **alarm signal** (above the dotted green line) and is followed by an outbreak (case numbers, red line, cross the upper level of the endemic channel, grey area)



5

5

Definitions (2c): STAGED ALARM

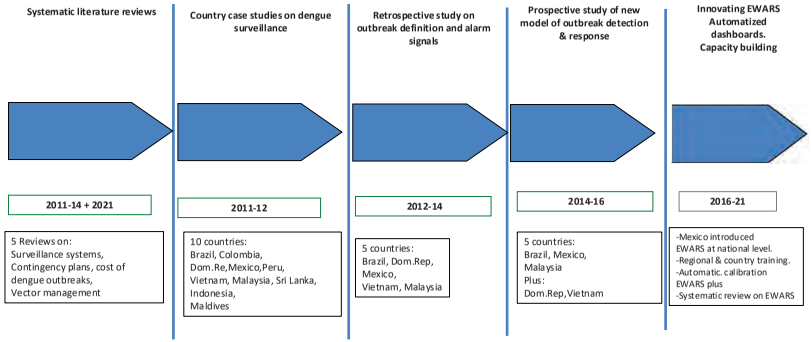
- **Initial alarm (weeks before start of outbreak, lower level of probability) =** single alarm signal (after completing the alarm window) is present for one or two weeks
- **Early alarm (weeks before start of outbreak but higher probability) =** Multiple alarm signals in the 1st week OR one alarm signal for more than 2 weeks
- **Late alarm** = When the outbreak has already started (i.e. case numbers have crossed the alarm threshold for more than 2 weeks

NB. The level of the outbreak response depends on the type of alarm (staged response)

6

6

Brief history of EWARS development



5

5

The EARLY WARNING AND RESPONSE SYSTEM (EWARS plus, TDR/WHO)

- The development and validation
- Literature reviews
- How is EWARS used by countries?
- How has it been tested so far

3

3

CHARACTERISTICS OF EWARS TDR/WHO (1)

ONE HUB: https://alramadona.shinyapps.io/Ewars_dashboard/

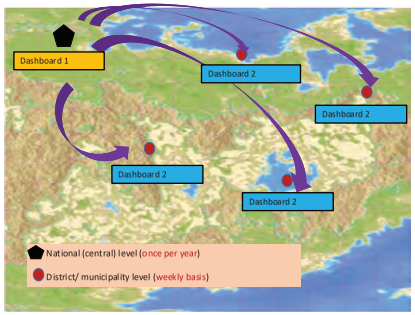
- **Officers at national level (Dashboard I)**

❖ *1st dashboard*: validate model ++ oversee the outbreak prediction at district level ++ train sub-national level

- *Parameters are automatically and instantly linked to sub-national level via web*

❑ **Officers at district/ municipality level**
❖ *2nd dashboard*: weekly prospective data input, interpretation & action

❑ *This platform facilitates a free sustainable DATABASE for the surveillance data*



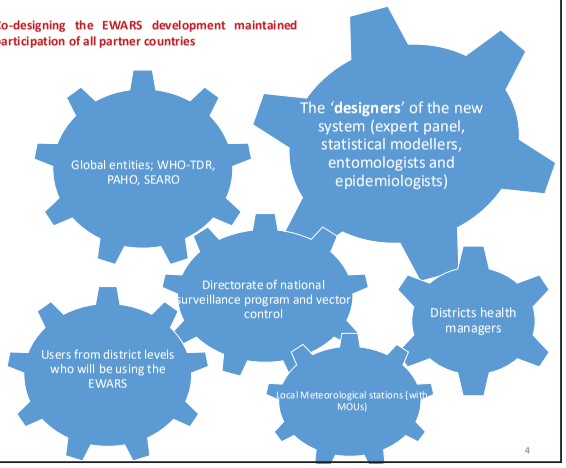
6

6

Co-design approach

"Co-design involves and maintains working together to design a new product, making full use of each other's knowledge, resources and contributions, to achieve better outcomes or improved efficiency"

Co-designing the EWARS development maintained participation of all partner countries



4

4

EXAMPLE for validity testing of outbreak alarms: PPV and Sensitivity (Mexico)

Alarm Indicator	Outbreak indicator	Positive Predictive Value (%)	Sensitivity (%)
mean temp	hospitalized cases	72	81
rainfall	hospitalized cases	65	87
mean age	hospitalized cases	74	89
probable cases	hospitalized cases	83	100
Ovitrap (%positive traps)	hospitalized cases	60	79
humidity	hospitalized cases	50	94
Serotype	hospitalized cases	75	100
multiple indicators*	hospitalized cases	77	84

* temperature, rainfall, mean age, probable cases, positive ovitrap & humidity

9

9

CHARACTERISTICS(2): Calibrating the model using first half of data

RETROSPECTIVE STUDY
Run-in phase (Dashboard I)

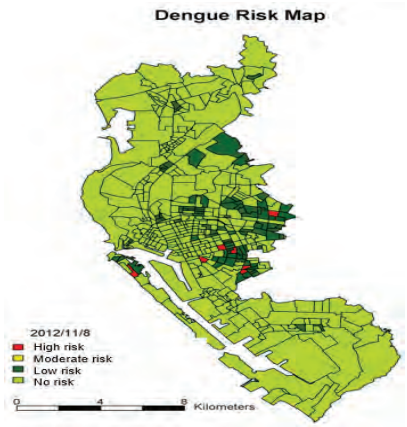
- Define «outbreak threshold» and find best district outbreak indicator
- Identify «alarm indicators» and thresholds for alarm signals
- Defining prediction distance (time lag) that best suits the disease and alarm indicators profile
- Generate graphical assessment for defining adequate endemic channel level, adjusting for endemic severity and adjusting for seasonality

7

7

CHARACTERISTICS(4): **Spatial analysis**

- Provides a rapid visual summary of spatial information
- Crucial for describing the spatial and temporal variation of the disease
- Identifies areas of unusually high risk areas (hot spots)



Source: Ciaran Nugent, Forest Service, Department of Agriculture, Food and the Marine (DAFM).

10

10

CHARACTERISTICS(3): Evaluating the model using second half of data

Determining validity of prediction (Dashboard I, evaluation phase)

Sensitivity (of the alarm)
The proportion of alarms that successfully predict defined outbreaks

i.e. no. of correct outbreak alarms/ total outbreaks

PPV
(Positive Predictive Value)
The proportion of true alarms out of all alarms
i.e. no. of correct alarm periods/ total no. of alarm periods

Examples:

Sensitivity = 90%
9 out of 10 outbreaks have been correctly detected

PPV= 70%
7 out of ten alarm singals were correct

8

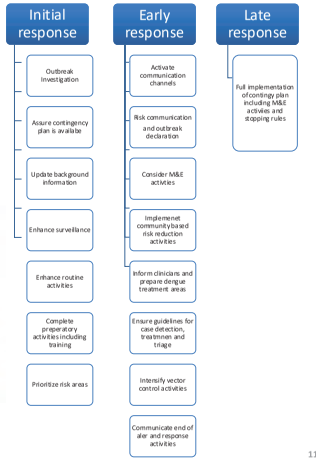
8

BACKGROUND READING

13

13

CHARACTERISTICS(5): Level of alarm leading to staged response



11

11

Evidence-based tool

PLOS ONE

Early warning and response system (EWARS) for dengue outbreaks: Recent advancements towards widespread applications in critical settings

Laith Hussain-Alkhateeb, Axel Kroeger, Piero Olliaro, Joacim Rocklöv, Maquins Odhiambo Sewe, Gustavo Tejeda, David Benitez, Balvinder Gill, S. Lokman Hakim, Roberta Gomes Carvalho, Leigh Bowman, Max Petzold

https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0196811

Supported by the Federal Ministry of Health, TDR, Global Health Hub Germany

Policy Brief

Innovation and Collaboration: the EWARS Framework for infectious diseases

PLOS NEGLECTED TROPICAL DISEASES

REVIEW

Early warning systems (EWSs) for chikungunya, dengue, malaria, yellow fever, and Zika outbreaks: What is the evidence? A scoping review

Laith Hussain-Alkhateeb[1]*, Tatiana Rivera Ramírez[2], Axel Kroeger[2], Ernesto Gozzer[3], Silvia Runge-Ranzinger[4,4]

https://journals.plos.org/plosntds/article?id=10.1371/journal.pntd.0009686

PLOS ONE

RESEARCH ARTICLE

Alarm Variables for Dengue Outbreaks: A Multi-Centre Study in Asia and Latin America

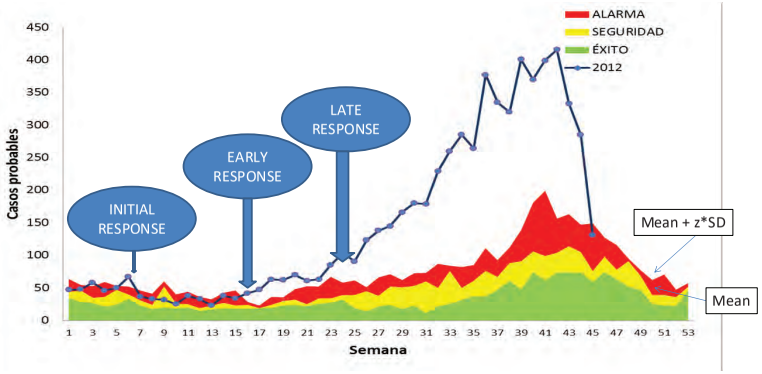
Leigh R. Bowman[1,5]*, Gustavo S. Tejeda[2], Giovanini E. Coelho[3], Lokman H. Sulaiman[4], Balvinder S. Gill[4], Philip J. McCall[1], Piero L. Olliaro[5], Silvia R. Ranzinger[6,6], Luong C. Quang[7], Ronald S. Ramm[8], Axel Kroeger[1,5], Max G. Petzold[5,9]

https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0157971

14

14

Staged response to an outbreak



12

12

CBCRP-PCCC Virtual Training Course

Health Systems and Climate Change
Enhancing Resilient and Low-carbon Development in the Pacific

Government of Samoa, SPREP, and JICA

Module 2. Climate adaptation and mitigation options of health systems

2.1 Health workforce: surveillance, assessment, risk communication and planning

Session 3: The WHO-Spatio-temporal EWARS Framework (Part1)

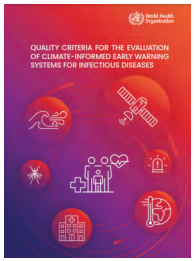
Ass. Prof. Dr. Laith Hussain-Alkhateeb
School of Public Health and Community Medicine, University of Gothenburg, Sweden
Prof. Dr. Axel Kroeger
Albert-Ludwigs-Universität Freiburg - Centre for Medicine and Society

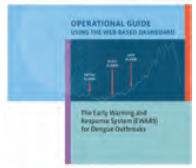
1

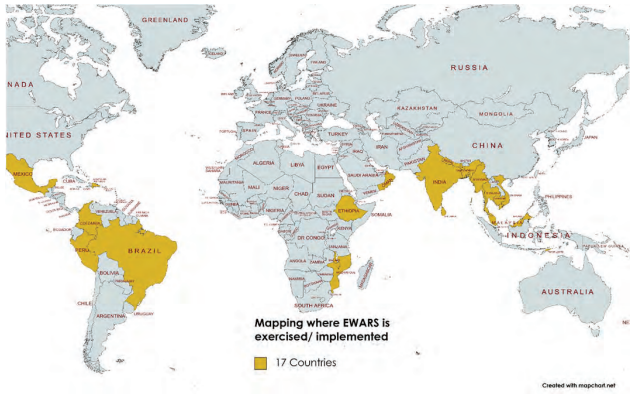
The WHO-Spatio-temporal EWARS Framework (Part1)

No.1

2







https://www.who.int/publications/i/item/10665345530

https://apps.who.int/iris/handle/10665/332323

15

15

MANY THANKS FOR YOUR INTEREST

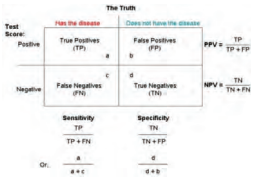
16

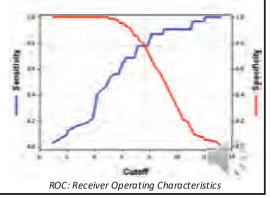
16

Evaluating the statistical performance of EWARS

How EWS discriminates between periods of outbreak and no-outbreak?

- *Two types of error are common in the context of outbreak predictions:*
  - *Issuing false alarms (false positive (FP))*
  - *Missing true outbreak (false negative (FN))*
- *FP and FN can be minimized by determining the optimal cut-off*
- *The optimal cut-off (threshold) is the minimum difference between the weighted sensitivity and the weighted specificity (figures in the next slide)*
- *SE, SP, PPV, NPV, ROC statistics are used to determine the **optimal cut-off***
  - *SEnsitivity: the % of true positive (e.g., 80% sensitive=80% of people who have the disease will test positive)*
  - *SPecificity: the % of true negative (e.g., 80% specificity=80% of people who do not have the disease will test negative)*
  - *Positive predictive value (PPV): the probability that following a positive test result, that individual will truly have the disease*
  - *Negative predictive value (NPV): the probability that following a negative test result, that individual will truly not have the disease*
  - *Receiver operating characteristic (ROC): plotting the Sensitivity against the 1-Specificity at various threshold settings*





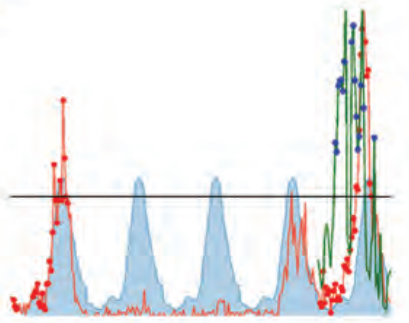
ROC: Receiver Operating Characteristics

5

The WHO-Spatio-temporal EWARS Framework

Ass. Prof. Dr. Laith Hussain-Alkhateeb
School of Public Health and Community Medicine, University of Gothenburg, Sweden

Prof. Dr. Axel Kroeger
Albert-Ludwigs-Universität Freiburg - Centre for Medicine and Society



Supported by TDR and ECH WHO, Geneva; Freiburg University, Germany; Gothenburg University, Sweden

3

Criteria for the operational features of the EWARS

- *The implementation mode of the EWARS*
- *The integration, flexibility and adaptability of the EWARS*
- *The warning delivery and dissemination*
- *The resources and coordination of EWARS*
- *The EWARS' overall feasibility of the process*

EXAMPLE FROM THE IMPLEMENTATION ASPECTS OF THE EWARS:

1. Is there a concrete plan in place with adequate resources and a timeline for the implementation of the EWARS?
2. Does the EWARS demonstrate evidence of prospective predictive ability?
3. Does the EWARS apply an open-source software application?
4. Does the EWARS allow technical and practical adaptations of local public health response and action plans? (i.e. the possibility of harmonizing/ integrating the local response guidelines into the tool)
5. Is the EWARS able to access, share and effectively use available data for generating risk management messages?

6

The learning objectives of this session

- Brief summary of gaps and opportunities of EWARS
- Introducing the core criteria of EWARS

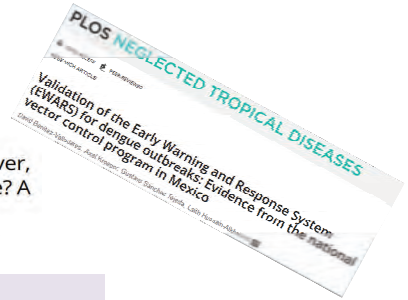
4

PLOS NEGLECTED TROPICAL DISEASES

REVIEW

Early warning systems (EWSs) for chikungunya, dengue, malaria, yellow fever, and Zika outbreaks: What is the evidence? A scoping review

Laith Hussain-Alkhateeb[1]*, Tatiana Rivera Ramírez[2], Axel Kroeger[2], Ernesto Gozzer[3], Silvia Runge-Ranzinger[2,4]



- ❑ Only few studies presented statistical **prediction validity** of EWS
- ❑ Almost all EWS tools require **highly skilled users** (advanced statistics)
- ❑ No assessment of the **integration of the EWS into a routine surveillance** system
- ❑ Only few studies addressed the **users' perspective** of the tool
- ❑ **Spatial prediction** (map high transmission areas) rarely done

*Find suggested studies for further readings under "recommended studies" slide

9

The WHO-Spatio-temporal EWARS Framework (Part1)

No.2

7

Unfinished agenda of EWARS

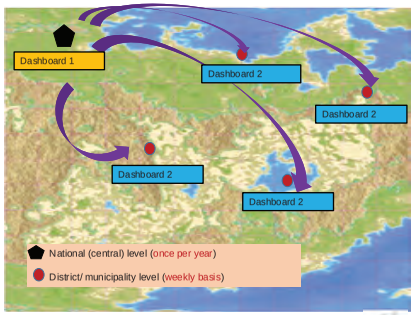
- The majority of the (unnecessary) technical challenges are due to incomplete or inconsistent data!
- The calibration process in view of the inconsistent disease trends tends to be challenging for users
- The need for quantifying the size/ magnitude of the outbreak predicted for more adequate intervention
- Uncertainty of the probability provided (credible confidence)

10

Recap: Introduction to EWARS

ONE HUB: https://github.com/maquins/ewars_Plus

- **Officers at national level (Dashboard I)**
  - ❖ *1st dashboard*: validate model ++ oversee the outbreak prediction at district level ++ train sub-national level
  - *Parameters are automatically and instantly linked to sub-national level via web*
- ❑ **Officers at district/ municipality level**
  - ❖ *2nd dashboard*: weekly prospective data input, interpretation & action
- ❑ *This platform facilitates a free sustainable DATABASE for the surveillance data*

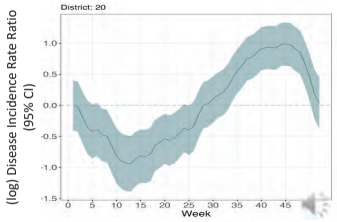


8

8

Introduction to the tool design

- The EWARS model is developed taking advantage of the hierarchical nature of the countries surveillance data:
  - Space : e.g. villages, districts, provinces
  - Time : weekly reporting of disease and alarm indicators
- Disease incidence rate is modelled including the delayed effect of weather variables on disease risk
- Spatial-temporal covariance are included to provide robust estimates using distributed lag non linear Bayesian framework (Bayesian inference with +INLA)
- A baseline (random effect) model and non-linear function of incidence-week included to capture seasonality or the unmeasured/ unknown annual variability (this allows for changes in population immunity between outbreak years or particular interventions…etc.)
- Figure: shows the epidemiological week average of the disease seasonality, which is assumed to be stationary each year



13

The WHO-Spatio-temporal EWARS Framework (Part1)

No.3

11

The concept of Time-lag

- Biologically its takes sometime after experiencing some weather conditions (e.g. increased temperature of rainfall…etc.) to observe for example increase in vector population.
- This period is called the lag time and can be in *day*, *weeks*, *months* etc.
- The various components of the time lag include:
  - the period for mosquito larval production to increase
  - The development of the mosquito and the virus within the mosquito (extrinsic incubation period)
  - the time before the first blood meal in which the mosquito transmits the virus to a human host
  - the time before the appearance of clinical manifestations of dengue
- The lag specifies the temporal dependency between exposure and outcome
- The climate-disease risk relationship including the lag period is then modelled
- We model the delayed effect of weather variables on disease risk.

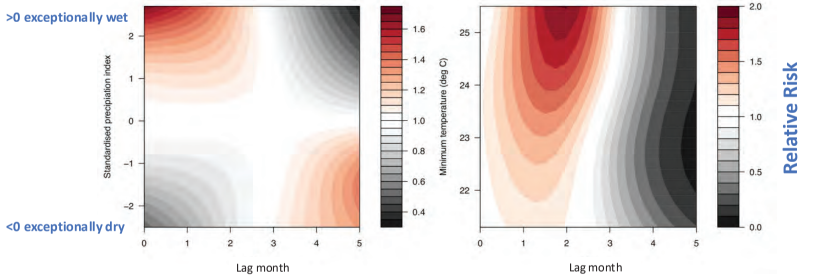
14

The EWARS+ Model

12

The exposure-lag-response association

Exposure (eg. weather); lag (Prediction period); response (disease incidence); relative risk (reference is the average value for temperature and the 'zero' value for precipitation)



- The relative risk of dengue is greatest at short lag times (between 1 and 2 months) for exceptionally wet conditions
- Exceptionally dry conditions are associated with increased dengue relative risk 5 months later
- Dengue relative risk is greatest 1 to 2 months after higher Tmin values (i.e., 25.5˚C)
- Overall, moderately wet and warmer conditions contribute more to the relative risk

17

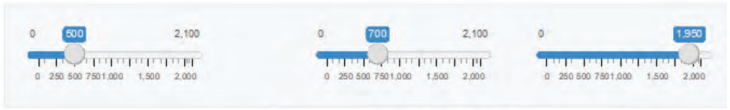
The concept of Time-lag

- Disease cases follow a seasonal pattern, depending primarily on the variability of the climate indicators
- Temperature, humidity and rainfall are positively associated with the number of cases.
- Generally, the time-lag tends to decrease with increasing temperature, humidity of rainfall – there are usually optimal measurements for each weather condition and a corresponding disease.
- Beyond this optimal measurement – e.g. >30 °C for Dengue – the time lag starts to increase, delaying the disease onset
- The time-lag can on the other hand increase with effective vector-control and response

15

576

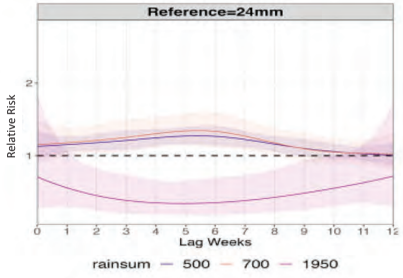
Varying lag periods in relation to precipitation



The relative risk of dengue in wetter circumstances compared to the annual average precipitation value is greatest at lag times between 5 and 7 weeks), and the risk decreases in longer lag times ((between 8-12 months).

Extreme wet-periods (flooding), tend to reduce the risk of outbreak (flushing effect)

RR= comparing the tested measure against the reference (24mm)

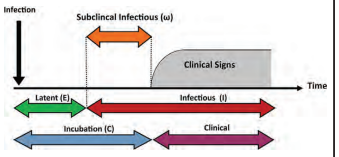


18

Criteria for the temporal prediction of EWARS

What, when and for how long an action must take in outbreak risk areas (lag time)?

- *While research has shown diverse effects of a range of lag times from exposure to disease outbreak (prediction window), no systematic review confirms a definitive range of an appropriate lag time for each exposure (climate indicator)*
- *The main objective of temporal prediction is to identify the onset time of the disease outbreak and its duration (lag time or incubation period)*



Arzt, J., Branan, M.A., Delgado, A.H. *et al.* Quantitative impacts of incubation phase transmission of foot-and-mouth disease virus. *Sci Rep* **9**, 2707 (2019).

16

CBCRP-PCCC Virtual Training Course

Health Systems and Climate Change
Enhancing Resilient and Low-carbon Development in the Pacific

Government of Samoa, SPREP, and JICA

Module 2. Climate adaptation and mitigation options of health systems

2.1 Health workforce: surveillance, assessment, risk communication and planning

Session 3: The WHO-Spatio-temporal EWARS Framework (Part2)

Ass. Prof. Dr. Laith Hussain-Alkhateeb
School of Public Health and Community Medicine, University of Gothenburg, Sweden
Prof. Dr. Axel Kroeger
Albert-Ludwigs-Universität Freiburg - Centre for Medicine and Society

1

Thank you!

19

The WHO-Spatio-temporal EWARS Framework (Part2)

No.1

2

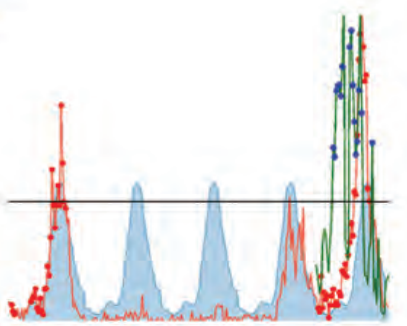
Featuring the calibration process in Dashboard I
(retrospective phase)

5

The WHO-Spatio-temporal EWARS Framework

Ass. Prof. Dr. Laith Hussain-Alkhateeb
School of Public Health and Community Medicine, University of Gothenburg, Sweden

Prof. Dr. Axel Kroeger
Albert-Ludwigs-Universität Freiburg - Centre for Medicine and Society

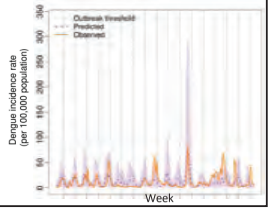


Supported by TDR and ECH WHO, Geneva; Freiburg University, Germany; Gothenburg University, Sweden

3

Modelling concept (for the experts!)

1. The model prediction are based on exposure–lag–response functions of key climate variables and the seasonality term.
2. Negative binomial regression is used to generate the incidence rate per population
3. The DLNM is used to understand and describe the relationship between exposure-lag-disease, which can further define an adequate lag-time (here we set 12 weeks)
4. The Bayesian hierarchal model will be used to conduct leave-one-out cross-validation process to generate the model parameters that can be tested (which parameters better predict the outbreak)
   - To test the predictive ability of the model, we refitted the model 52-weeks per data-year, removing one week at the time to produce out-of-sample prediction
5. The annual random effect term (seasonal) was included in the model fitting to quantify the association between climate factors and variation in dengue.
6. The probability for the predicted incidence rate to exceed the endemic channel will be assessed using the ROC



*Out-of-sample=forecasting for weeks that was not part of the data sample

**ROC: Receiver Operating Characteristics

6

The learning objectives of this session

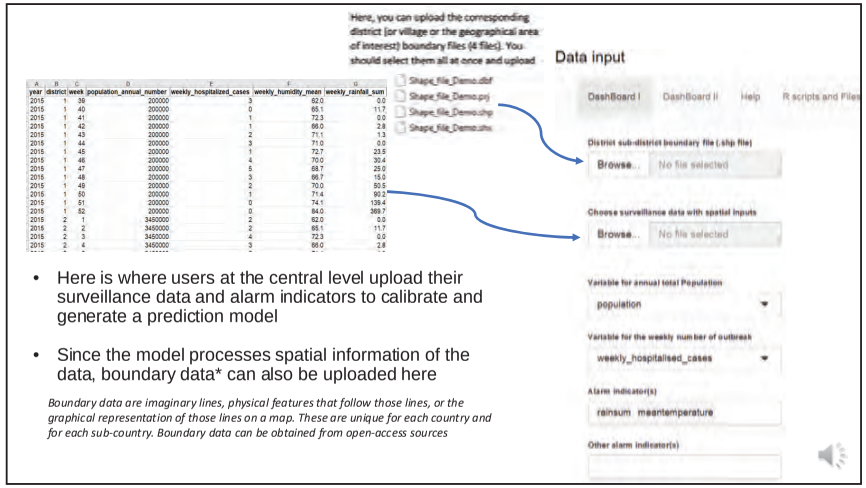
- Introducing the technical and mathematical concept of EWARS
- Overview of the Early Warning And Response System features and applications
- Understanding the concept of 'Lag-Time' in the disease outbreak prediction and prevention process

4

The WHO-Spatio-temporal EWARS Framework (Part2)

No.2

9



- Here is where users at the central level upload their surveillance data and alarm indicators to calibrate and generate a prediction model
- Since the model processes spatial information of the data, boundary data* can also be uploaded here

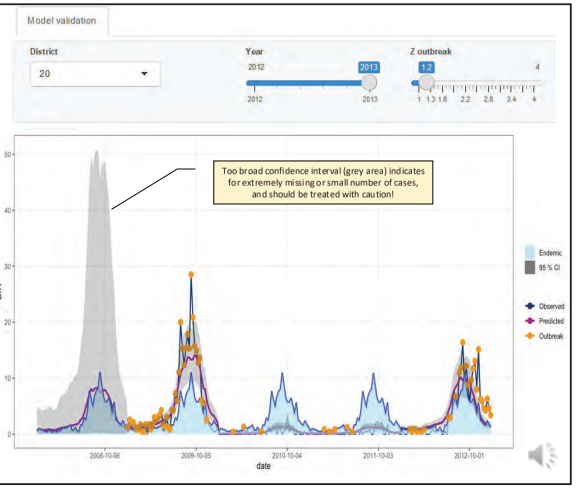
Boundary data are imaginary lines, physical features that follow those lines, or the graphical representation of those lines on a map. These are unique for each country and for each sub-country. Boundary data can be obtained from open-access sources

7

Model Calibration
(run-in phase)

❑ The model produces out-of-sample predicted probabilities of exceeding the outbreak threshold:

1. Weekly predictive probabilities of cases for each district (incidence rate) is first computed from alarm indicators parameters
2. This predicted disease probability is compared against thresholds (i.e. case number based on endemic channel)
3. The probability of exceeding the endemic channel (threshold) is calculated (alarm signal)
4. Each week in the validation period was predicted



10

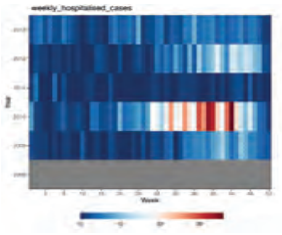
Exploratory analysis

weekly annual summary:

- minimum ,maximum ,mean and median
- 25th and 75th percentiles
- % of missing data by year
- It indicates and helps user to spot missing or inconsistencies records

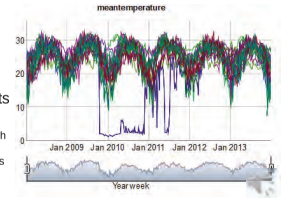
Time series plots

This provides trend of data for one district (geo-location) which informs users of missing information, the profile of the data summarized ie. the magnitude of measures being summarized and its distribution



Interactive Time series plots

This provides comparison of data (of each variable) across all districts which can indicate for strange records also how different disease trends compares in difference areas within one country



8

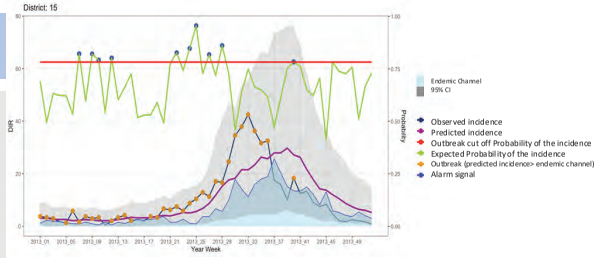
Elements of Dashboard II
(prospective phase)

13

Model Validation
(evaluation phase)

- The evaluation of the model performance is based on how the predicted incidence rate exceeds the threshold (endemic channel) compared with the observed number of cases
- ROC** is calculated to determine optimal thresholds to issue alarm signals for the binary events of exceeding the moving outbreak threshold (exceeds/ not exceeds).
- The model is then said to be able to (or not) correctly distinguish between outbreak and non-outbreak weeks

**ROC: Receiver Operating Characteristics*



Metric	Value	Lower	Upper
Cutoff probability	0.132	NA	NA
Area under the Curve (AUC)	0.849	0.722	0.976
Accuracy	0.788	0.782	0.795
Sensitivity	0.818	0.590	1.046
Specificity	0.780	0.654	0.907
Positive Predictive Value (PPV)	0.500	0.269	0.731
Negative Predictive Value (NPV)	0.941	0.862	1.020

Sensitivity: the proportion of events that occurred (i.e., outbreaks) that were correctly predicted

Specificity: the proportion of events that were predicted not to occur and did not occur

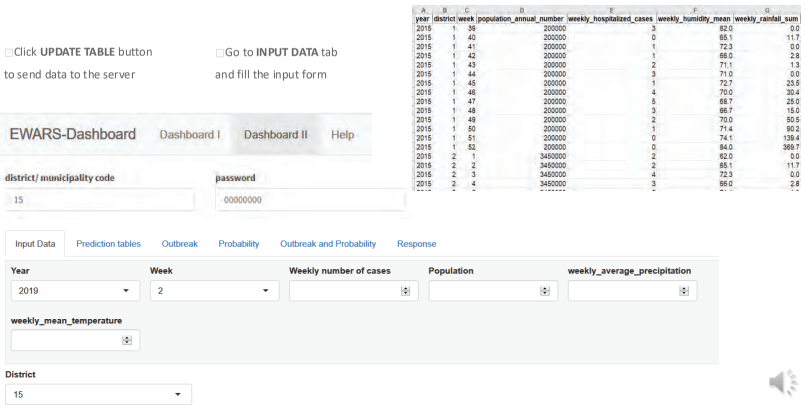
PPV: proportion of correct positive predictions

NPV: proportion of correct false predictions

11

580

Prospective part (Dashboard II): entering weekly alarm information for prediction



year	district	week	population_annual_number	weekly_hospitalized_cases	weekly_humidity_mean	weekly_rainfall_sum
2015	1	39	200000	3	82.0	0.0
2015	1	40	200000	0	85.1	11.7
2015	1	41	200000	1	72.3	0.0
2015	1	42	200000	1	68.0	2.8
2015	1	43	200000	2	71.1	1.3
2015	1	44	200000	3	71.0	0.0
2015	1	45	200000	1	72.7	23.5
2015	1	46	200000	4	70.0	30.4
2015	1	47	200000	5	68.7	25.0
2015	1	48	200000	3	86.7	15.0
2015	1	49	200000	2	70.0	50.5
2015	1	50	200000	1	71.4	90.2
2015	1	51	200000	0	74.1	139.4
2015	1	52	200000	0	84.0	369.7
2015	2	1	3450000	2	82.0	0.0
2015	2	2	3450000	2	85.1	11.7
2015	2	3	3450000	4	72.3	0.0
2015	2	4	3450000	3	68.0	2.8

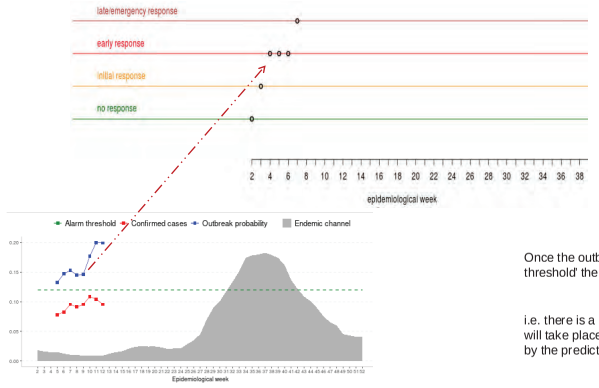
14

The WHO-Spatio-temporal EWARS Framework (Part2)

No.3

12

Prospective part (Dashboard II): Instant and staged-response of alarm signals



Staged-response:

Initial alarm (weeks before start of outbreak, lower level of probability) = single alarm signal (after completing the alarm window) is present for one or two weeks

Early alarm (weeks before start of outbreak but higher probability) = Multiple alarm signals in the 1st week OR one alarm signal for more than 2 weeks

Late alarm = When the outbreak has already started (i.e. case numbers have crossed the alarm threshold for more than 2 weeks

Once the outbreak probability exceeds the 'Alarm threshold' the 'alarm signal' is generated!

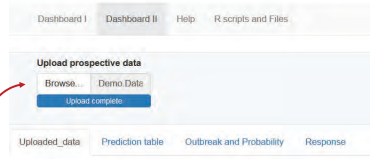
i.e. there is a significant probability that outbreak will take place in the weeks ahead, as indicated by the prediction distance

17

Prospective part (Dashboard II): entering weekly alarm information for prediction

Seasonal climate forecasts offer the possibility of forecasting disease epidemics many months in advance (a clear advantage for disease control planners) – despite issues related to accuracy and accessibility of forecast data.

year	district	population	week	weekly_hospitalised_cases	mean_humidity	rainsum	meantemperature
2022	3	1138000	1	NA	50.21	8.12	18.52
2022	3	1138000	2	NA	53.92	84.70	14.35
2022	3	1138000	3	NA	55.50	0.00	19.81
2022	3	1138000	4	NA	49.71	35.30	16.99
2022	3	1138000	5	NA	63.00	6.30	17.93
2022	3	1138000	6	NA	52.00	47.25	21.60
2022	3	1138000	7	NA	47.00	0.50	19.21
2022	4	124000	1	NA	50.21	0.75	18.52
2022	4	124000	2	NA	53.92	7.84	14.35
2022	4	124000	3	NA	55.50	8.12	19.81
2022	4	124000	4	NA	49.71	84.70	16.99
2022	4	124000	5	NA	63.00	0.00	17.93
2022	4	124000	6	NA	52.00	35.30	21.60
2022	4	124000	7	NA	47.00	6.30	19.21
2022	5	449000	1	NA	50.21	47.25	18.52
2022	5	449000	2	NA	53.92	0.50	14.35
2022	5	449000	3	NA	55.50	0.75	19.81



EWARS + can process prospective climate information (on weekly basis) as well as climate forecast data (uploading forecast data of weeks or months ahead).

EWARS keeps a fixed 12 weeks time-lag (prediction distance)

15

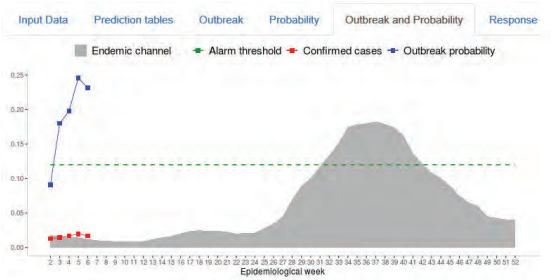
Elements of Dashboard II
(risk mapping)

18

Prospective part (Dashboard II): data interpretation

Once the outbreak probability exceeds the 'Alarm threshold' we generate 'alarm signal'

i.e. there is a significant probability that outbreak will take place in the weeks ahead, as indicated by the prediction distance



16

CBCRP-PCCC Virtual Training Course

Health Systems and Climate Change
Enhancing Resilient and Low-carbon Development in the Pacific

Government of Samoa, SPREP, and JICA

Module 2. Climate adaptation and mitigation options of health systems

2.1 Health workforce: surveillance, assessment, risk communication and planning

Session 4: The WHO-Spatio-temporal EWARS Framework Risk mapping (Part1)

Ass. Prof. Dr. Laith Hussain-Alkhateeb
School of Public Health and Community Medicine, University of Gothenburg, Sweden
Prof. Dr. Axel Kroeger
Albert-Ludwigs-Universität Freiburg - Centre for Medicine and Society

1

The WHO-Spatio-temporal EWARS Framework Risk mapping (Part1)

No.1

2

Recommended readings!

- Early Warning and Response System (EWARS) for dengue outbreaks: operational guide using the web-based dashboard. . Licence: CC BY-NC-SA 3.0 IGO
- Hussain-Alkhateeb, L., Kroeger, A., Olliaro, P., Rocklöv, J., Sewe, M.O., Tejeda, G., Benitez, D., Gill, B., Hakim, S.L., Gomes Carvalho, R. and Bowman, L., 2018. Early warning and response system (EWARS) for dengue outbreaks: Recent advancements towards widespread applications in critical settings. PloS one, 13(5), p.e0196811.
- Hussain-Alkhateeb, L., Rivera Ramírez, T., Kroeger, A., Gozzer, E. and Runge-Ranzinger, S., 2021. Early warning systems (EWSs) for chikungunya, dengue, malaria, yellow fever, and Zika outbreaks: What is the evidence? A scoping review. PLoS neglected tropical diseases, 15(9), p.e0009686.
- Benitez-Valladares, D., Kroeger, A., Tejeda, G.S. and Hussain-Alkhateeb, L., 2021. Validation of the Early Warning and Response System (EWARS) for dengue outbreaks: Evidence from the national vector control program in Mexico. PLOS Neglected Tropical Diseases, 15(12), p.e0009261.
- Cardenas, R., Hussain-Alkhateeb, L., Benitez-Valladares, D., Sánchez-Tejeda, G. and Kroeger, A., 2022. The Early Warning and Response System (EWARS-TDR) for dengue outbreaks: can it also be applied to chikungunya and Zika outbreak warning?. BMC Infectious Diseases, 22(1), pp.1-13.

19

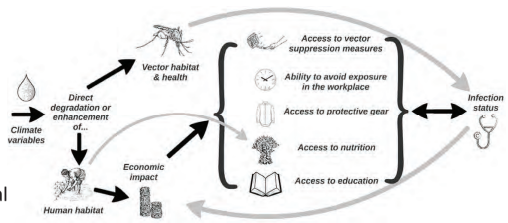
Thank you!

20

Where the intervention should be directed?

- The location of Vector Borne Disease (VBD) transmission is complicated by day-biting vectors (when people move around) and disease latency periods
- This may be important for the investigation of possible climatic, epidemiological and entomological risk factors.

Pathways between climate and disease, highlighting how both social and vector elements interact



Muurlink, O.T., Taylor-Robinson, A.W. The 'lifecycle' of human beings: a call to explore vector-borne d… from an ecosystem perspective. Infect Dis Poverty 9, 37 (2020). https://doi.org/10.1186/s40249-020-…

5

The WHO-Spatio-temporal EWARS Framework

Risk mapping

Ass. Prof. Dr. Laith Hussain-Alkhateeb

School of Public Health and Community Medicine, University of Gothenburg, Sweden

Prof. Dr. Axel Kroeger

Albert-Ludwigs-Universität Freiburg - Centre for Medicine and Society

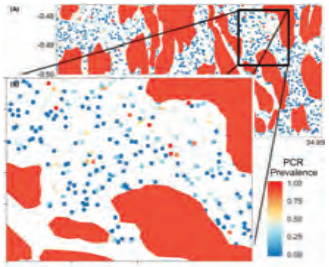
Supported by TDR and ECH WHO, Geneva; Freiburg University, Germany; Gothenburg University, Sweden

3

Where the intervention should be directed? (2)

- Usually control programs stratify localities with a high risk of transmission by their history (e.g. DENV), the persistence of cases or vector abundance, and the population (i.e. areas) at risk (distribution of vulnerable groups).
- In cities where the disease is endemic, it is usually the case that certain areas always have the highest incidence of transmission over time – For instance, most of the cases reported in district **x** for several years were concentrated in e.g. 40% of the urban areas!

High-Burden Households Consistently Located Outside of 'Hotspots

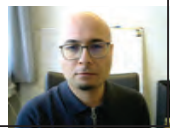


Stresman, G., Bousema, T. and Cook, J., 2019. Malaria hotspots: is there epidemiological … for fine-scale spatial targeting of interventions?. *Trends in parasitology*, *35*(10), pp.822-834.

6

The learning objectives of this session

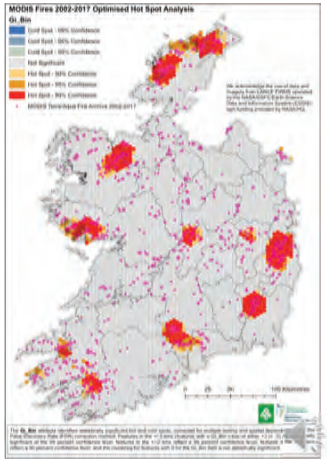
- Why localised intervention is needed?
- Brief introduction to the concept, data and methods of spatial analysis



4

Spatial analysis!

The main objective of spatial epidemiology is to identify the spatial pattern of diseases – that is, to determine whether disease events are distributed evenly, randomly, or aggregated in time and space.



Source: Ciaran Nugent, Forest Service, Department of Agriculture, Food and the Marine (DAFM).

9

Where the intervention should be directed? (3)

- Effective control of *A. aegypti* and arbovirus transmission in hotspots reduces the dissemination of mosquitoes and viruses to other areas of the city, leading to lower levels of the disease in untreated areas (Less infected people bringing the virus home from work or school)
- Recognition of hotspots based on the history of infections is important for establishing programs to prevent epidemics and develop more efficient and cost effective strategies.

7

584

Spatial analysis (2)

- Before any analysis, it is important to identify the type of surveillance data that is available to perform the spatial stratification:

1. Area data: number of cases per well-defined spatial sub-unit within a larger unit: for example, cases of DENV or malaria may cluster in small units such as neighborhoods which are located within a larger unit that would be the city or district
2. Geo-referenced data points . The data consist of cases whose geographical coordinates have been recorded (usually the patient's home or hospitals/ labs where cases are reported from).

10

The WHO-Spatio-temporal EWARS Framework Risk mapping (Part1)

No.2

8

The WHO-Spatio-temporal EWARS Framework Risk mapping (Part1)

No.3

13

Spatial analysis (3)

- Surveillance systems may record cases with a physical address (house number, street, intersection, postal code, district, municipality, province or state, etc.)
- Spatial data are generated by converting epidemiological/ demographic data (e.g. home address of the incident cases) to spatial data.
- Physical location is converted to geographic information in the form of latitude and longitude in a process called “geocoding.”

11

Surveillance data

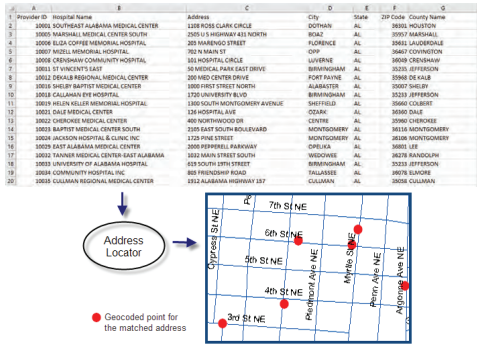
- Outbreak detection is one of the functions of the surveillance system
- Surveillance systems differ with respect to a number of qualities (*contextual factors*)
- Selection of appropriate methods for space–time disease predication should consider data quality, acceptability, representativeness, timeliness, and stability

Scale	The spatial and temporal extent of the system (e.g., local/regional/national/international)
Scope	The intended target of the system (e.g., single disease/multiple disease, single host/multiple host, known pathogens/unknown pathogens)

14

Spatial analysis (4)

- This converting process is possible with open access geographic information tools, which gives GIS points.
- Using geocoded information can integrate data from different sources, making it possible to correlate entomological data with epidemiological and demographic information.



12

Data Needs: Risk mapping (Suveillance)

- Disease cases and covariates data, aggregated spatially (and temporally) at the chosen administrative unit level
  - Weekly resolution still encouraged but model can work with monthly data as well
- Note: the administrative ID in shapefile should match ID in surveillance data for linkage

Shapefile with district boundaries

17

Why Bayesian Hierarchical model?

- IN EWARS we use the computationally efficient INLA methodology in R to run the Bayesian models
- Bayesian hierarchical models are robust and flexible:
  - They allows us to capture influence of explanatory variables while controlling for spatial and spatio-temporal correlation in data
  - These models are able to describe the variability in the response variable as a function of covariates and random effects that account for unexplained variation.
  - The model will be able to provide uncertainty around the risk estimates

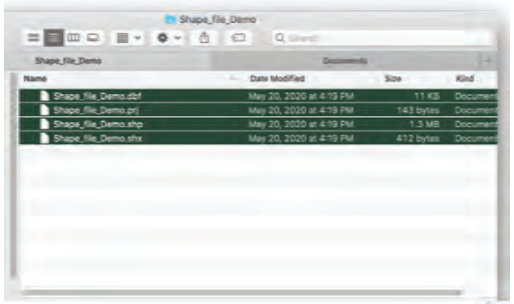
15

Thank you!

18

Data Needs: Risk mapping (Shapefiles)

- Country areal administrative boundaries(district/county). The smaller the better.
  - this usually comes as shapefiles
- Different format for shapefiles exits, in EWARS we currently use geographic boundary files with *.shp* extention
  - if point data(latitude, longitude) is available, we could use this as well



16

The WHO-Spatio-temporal EWARS Framework

Risk mapping

Ass. Prof. Dr. Laith Hussain-Alkhateeb

School of Public Health and Community Medicine, University of Gothenburg, Sweden

Prof. Dr. Axel Kroeger

Albert-Ludwigs-Universität Freiburg - Centre for Medicine and Society

Supported by TDR and ECH WHO, Geneva; Freiburg University, Germany; Gothenburg University, Sweden

1

The learning objectives of this session

- Understading the shape (boundary) files and their process for the spatial analysis
- Introducing the Risk Mapping application of EWARS

2

Surveillance Data: Formats for spatial analysis

Data format 1 – using data aggregated at district level. (NB. 'District' here represents the ID of the smallest geographical unit; this will be useful for comparing spatial units(districts) with each other by the central level).

year	district	population	week	weekly_hospitalised_cases	rhdailymean	rainsum	meantemperature
2008	1	1141000	44	0	67.065714	0	18.681428571428608
2008	1	1141000	45	0	31.841429	0	20.573571428571401
2008	1	1141000	46	0	30.802857	0	22.399999999999986
2008	1	1141000	47	0	25.982857	0	15.828571428571408
2008	1	1141000	48	0	42.721429	0	20.814285714285699
2008	1	1141000	49	0	39.172857	0	16.040714285714301
2008	1	1141000	50	0	34.857143	0	17.092857142857099
2008	1	1141000	51	0	44.661429	0	18.671428571428592
2008	1	1141000	52	0	47.072857	0	16.257142857142898
2009	1	1138000	1	0	50.206667	0	18.521428571428607
2009	1	1138000	2	0	53.922857	0	14.349999999999996
2009	1	1138000	3	0	55.5	0	19.807142857142899
2009	1	1138000	4	0	49.714286	0	16.992857142857101
2009	1	1138000	5	2	63	0	17.928571428571398
2009	1	1138000	6	1	52	0	21.600000000000014
2009	1	1138000	7	0	47	0	19.207142857142917
2009	1	1138000	8	0	75.637143	0	21.578571428571408
2009	1	1138000	9	0	42.612857	0	19.792857142857093
2009	1	1138000	10	2	56.751667	0	18.199999999999993

3

Surveillance Data: Formats for spatial analysis

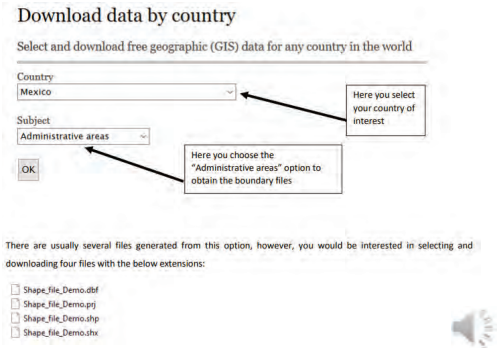
Data format 2 – using point data. The 'X' and 'Y' columns represents the longitude and latitude coordinates of data source points. In this figure, we present example of geo-tagged data from household level within a defined geographical area (e.g. district or region).

	district	year	x	y	week	rainsum	mintemperature	meantemperature	maxtemperature
49	15	2020	-104.5209	24.08692	1	34.4	13.399999618530273	22	30.600000381469727
50	15	2020	-104.5182	23.29564	1	39.6	15.199999809265137	22.700000762939453	30.200000762939453
51	15	2020	-104.3942	25.24401	1	14.7	18.399999618530273	27.899999618530273	37.400001525878906
52	15	2020	-104.3885	23.12993	1	41.2	15.199999809265137	23.200000762939453	31.200000762939453
53	15	2020	-104.2981	24.94559	1	20.9	15.899999618530273	25.299999237060547	34.700000762939453
54	15	2020	-104.203	22.83854	1	47.3	16.700000762939453	24.299999237060547	32
55	15	2020	-104.1694	25.21993	1	14.7	18.399999618530273	27.899999618530273	37.400001525878906
56	15	2020	-104.0696	24.44785	1	27.3	14.800000190734863	21.5	32.200000762939453
57	15	2020	-104.0424	25.14582	1	14.7	18.399999618530273	27.899999618530273	37.400001525878906
58	15	2020	-104.0026	26.7514	1	11.9	19.700000762939453	29	38.400001525878906
59	15	2020	-103.9881	24.35829	1	25.3	13.800000190734863	23	32.200000762939453
60	15	2020	-103.8797	26.1749	1	8.1	19.700000762939453	29	38.299999237060547
61	15	2020	-103.4844	25.34185	1	9.4	18.899999618530273	27.700000762939453	36.599998474121094
62	15	2020	-103.3445	26.28322	1	7.9	19.5	28.600000381469727	37.799999237060547
63	15	2020	-103.0263	24.50444	1	14.4	17.799999237060547	26.799999237060547	35.900001525878906
64	15	2020	-102.9134	24.56134	1	12.4	17.700000762939453	26.600000381469727	35.599998474121094
65	15	2020	-102.5786	24.62329	1	12.4	17.700000762939453	26.600000381469727	35.599998474121094
66	15	2020	-102.4931	24.47041	1	15.9	15	24.799999237060547	34.599998474121094
67	15	2020	-107.131	25.49996	2	115	22.700000762939453	28.299999237060547	34
68	15	2020	-106.9731	25.07157	2	129.8	17.5	22.899999618530273	28.399999618530273
69	15	2020	-106.9435	25.42512	2	129.8	17.5	22.899999618530273	28.399999618530273
70	15	2020	-106.7223	25.18269	2	129.8	17.5	22.899999618530273	28.399999618530273
71	15	2020	-106.6578	25.49998	2	129.8	17.5	22.899999618530273	28.399999618530273
72	15	2020	-106.5509	24.60299	2	99.3	22.5	27.600000381469727	32.799999237060547

4

Examples of free sources of country shapefiles

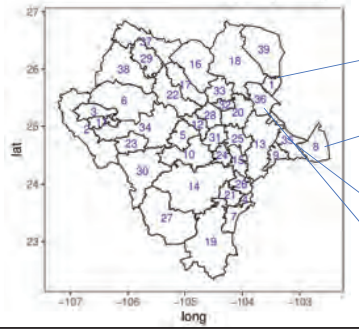
1. https://spatialdata.dhsprogram.com/boundaries/#view=table&countryId=AF
2. https://www.diva-gis.org/gdata
3. https://ec.europa.eu/eurostat/web/gisco/geodata/reference-data/administrative-units-statistical-units/countries



7

Shapefile and surveillance data linkage

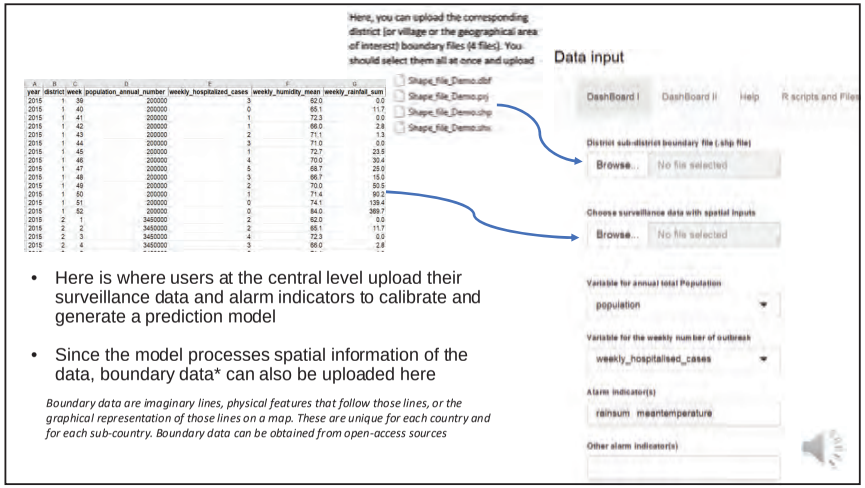
District boundaries (shapefile)



Surveillance data

district	year	pop	cases	temp
1	2009	1138000	3	31.6
7	2009	137000	2	28.8
8	2009	124000	1	29
19	2009	679000	15	
35	2009	700000	0	42.2
36	2009	424000	0	19.4
39	2009	218000	0	28.4

5



- Here is where users at the central level upload their surveillance data and alarm indicators to calibrate and generate a prediction model
- Since the model processes spatial information of the data, boundary data* can also be uploaded here

Boundary data are imaginary lines, physical features that follow those lines, or the graphical representation of those lines on a map. These are unique for each country and for each sub-country. Boundary data can be obtained from open-access sources

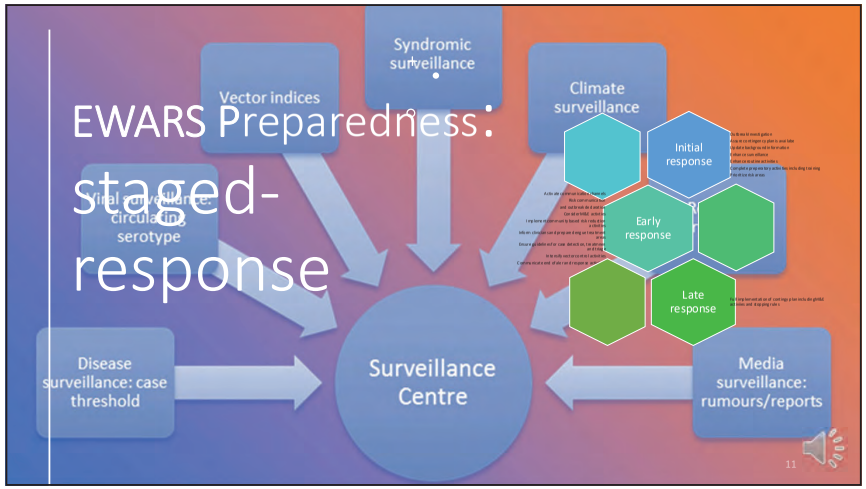
8

Linking boundary (shape) files to Surveillance Data

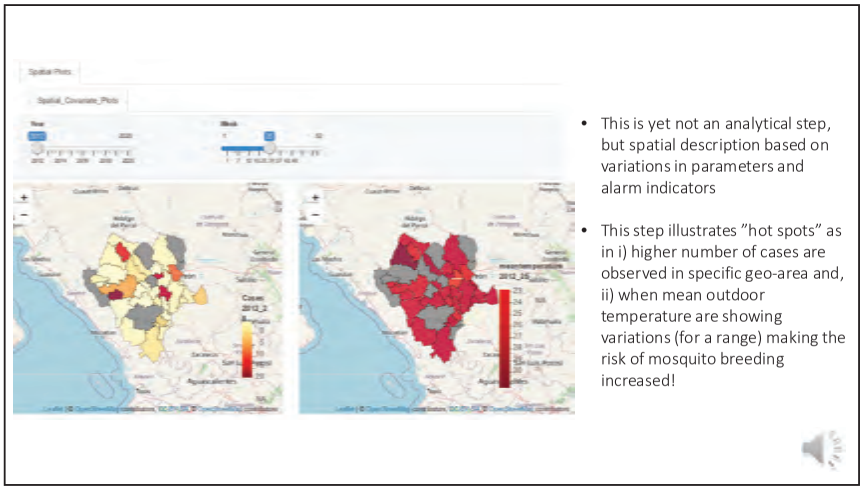
- Boundary files and surveillance data needs to be linked before it can be processed for risk mapping
- The geographical unit "district" (or village, province…etc.) can be used as a primary key linking both data sets.
- Users can align the corresponding variable from the boundary files to that of the surveillance by renaming the corresponding variable under the boundary files to "district"
- Several software can be used to do this simple process e.g. QGIS or R softwares can be sought here!

	CVE_ENT	CVE_MUN	NOM_MUN	OID_1	cov_	cov_id	district
0	10	007	G\xf3mez Palacio	343	343	344	1
1	10	034	Tamazula	344	344	345	2
2	10	037	Topia	345	345	346	3
3	10	038	Vicente Guerrero	346	346	347	4
4	10	039	Nuevo Ideal	347	347	348	5
5	10	035	Tepehuanes	348	348	349	6
6	10	033	S\xfachil	349	349	350	7
7	10	027	San Juan de Guadalupe	350	350	351	8
8	10	031	Santa Clara	351	351	352	9
9	10	001	Canatl\xeln	352	352	353	10
10	10	002	Canelas	353	353	354	11
11	10	003	Coneto de Comonfort	354	354	355	12
12	10	004	Cuencam\xe9	355	355	356	13
13	10	005	Durango	356	356	357	14
14	10	008	Guadalupe Victoria	357	357	358	15

6



11



9

589

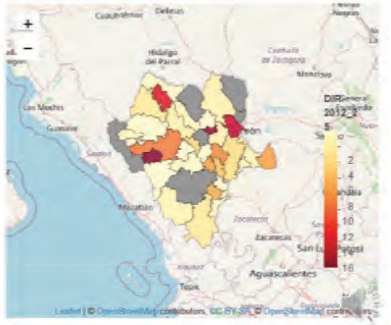
Recommended readings!

- Pan American Health Organization. Technical document for the implementation of interventions based on generic operational scenarios for Aedes aegypti control. Washington, D.C.: PAHO; 2019.
- Blangiardo, M. and Cameletti, M., 2015. Spatial and spatio-temporal Bayesian models with R-INLA. John Wiley & Sons.
- T. Subba Rao, 2017. "Spatial and Spatio-Temporal Bayesian Models with R-INLA , by Marta Blangiardo and Michela Cameletti . Published by John Wiley and Sons , Chichester, UK , 2015 . Total number of pages: 308. ISBN 978-1-," Journal of Time Series Analysis, Wiley Blackwell, vol. 38(1), pages 145-146, January.
- Hussain-Alkhateeb, L., Rivera Ramírez, T., Kroeger, A., Gozzer, E. and Runge-Ranzinger, S., 2021. Early warning systems (EWSs) for chikungunya, dengue, malaria, yellow fever, and Zika outbreaks: What is the evidence? A scoping review. PLoS neglected tropical diseases, 15(9), p.e0009686.

12

Risk Mapping

- Here comes the analytical spatial statistics
- The model processes all covariates input in the model e.g. alarm indicators, population size of each district, number of cases, the magnitude of cases in neighbouring districts..etc.)
- The generated "risk map" indicates for 'hot spots' based on the model analysis
- DIR=dengue incidence rate/ 10000
- Darker color refers to higher incidence rate of dengue



10

Overview of the presentation

Module 2 covers the four fundamental requirements for proper functioning of health systems in response to climate change.

Module 2.1 covers the climate adaptation and mitigation options of health systems related to the health workforce.

Module 2.2 covers the remaining three fundamental requirements:

1. Energy use
2. Infrastructure, technology and products (and buildings)
3. Water and waste

This sub-module is structured as follows:

- Understanding the **building blocks of health systems**, which guide climate adaptation and mitigation options, and show us where interventions can be made
- Identifying interventions for the **three fundamental requirements** (energy, buildings, water and waste) according to the **two goals** of achieving climate resilience and environmental sustainability

CBCRP-PCCC Virtual Training Course

Health Systems and Climate Change
Enhancing Resilient and Low-carbon Development in the Pacific

Government of Samoa, SPREP, and JICA

Module 2. Climate adaptation and mitigation options of health systems

2.2 Facilities and infrastructure

Dr Aditya (Adi) Vyas | Public health physician
University of Notre Dame, Sydney, Australia
adi@curion.com.au

Climate adaptation and mitigation options

Module 2 focuses on climate adaptation and mitigation options of health systems.

- There are many options, pathways, approaches and interventions available to achieve climate adaptation and mitigation in the health system
- This field of research and practice is rapidly developing, and potential options for health systems are still being tested and experimented
- There is no single correct approach due to different local contexts, changing climatic factors, disparities in the health status of populations, and existing efforts on health system strengthening

There are two important definitions for this sub-module.

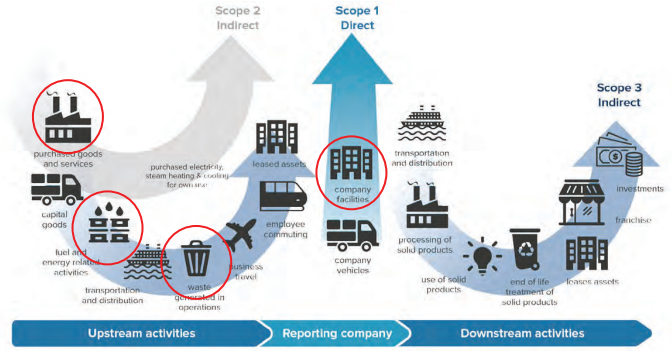
- **Climate resilience**: climate-resilient health systems have the ability to anticipate, respond to, cope with, recover from and adapt to climate-related shocks and stresses, so as to bring sustained improvements in population health, despite an unstable climate
- **Environmental sustainability**: environmentally sustainable health care facilities are those that improve, maintain or restore health, while minimizing negative impacts on the environment and leveraging opportunities to restore and improve it

These definitions can be found in the World Health Organization 2020 Guidance for Climate Resilient and Environmentally Sustainable Health Care Facilities.

CONTENTS

1. Health system building blocks
2. Health service activities
3. Fundamental requirements for health system functioning
   - Energy use
   - Infrastructure, technology and products (and buildings)
   - Water and waste
4. Goals of climate resilience and environmental sustainability

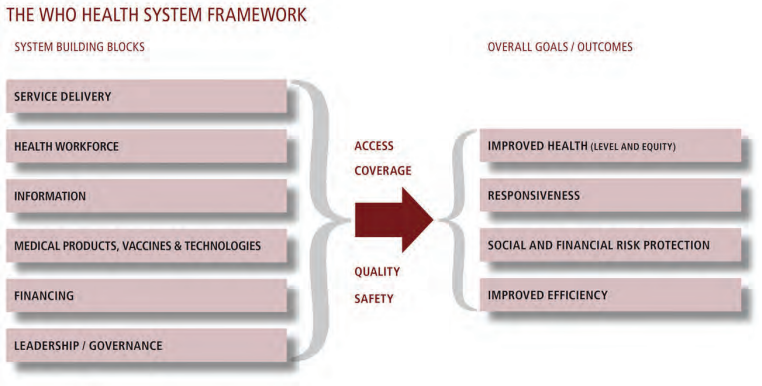
What activities do health services undertake?



Source: HCWH 2019. Healthcare's carbon footprint. Hyperlink.

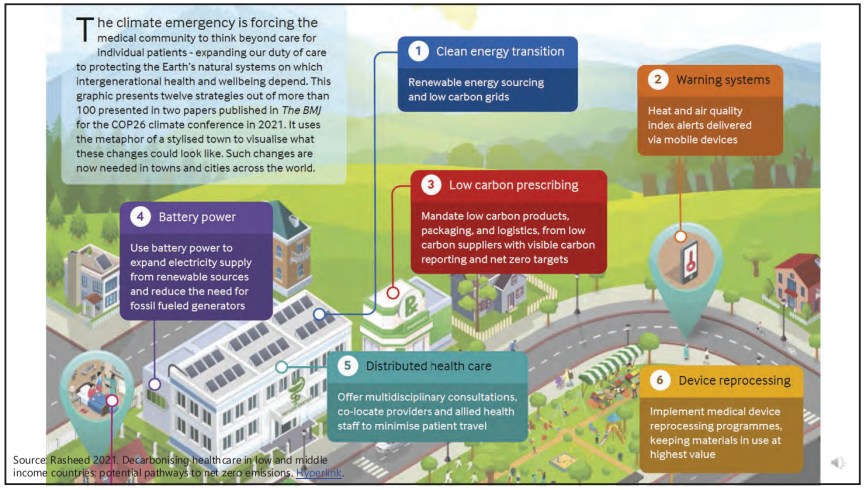
7

THE WHO HEALTH SYSTEM FRAMEWORK



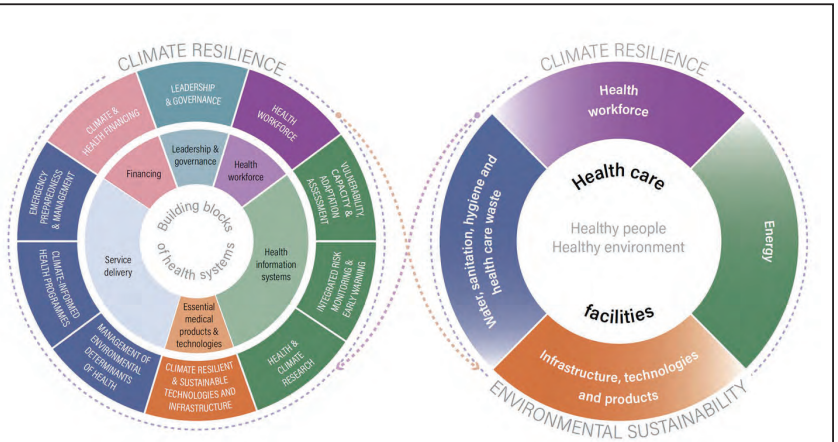
Source: WHO 2007. Everybody's business - strengthening health systems to improve health outcomes. Hyperlink.

5



Source: Rasheed 2021. Decarbonising health care in low and middle income countries: potential pathways to net zero emissions. Hyperlink.

8

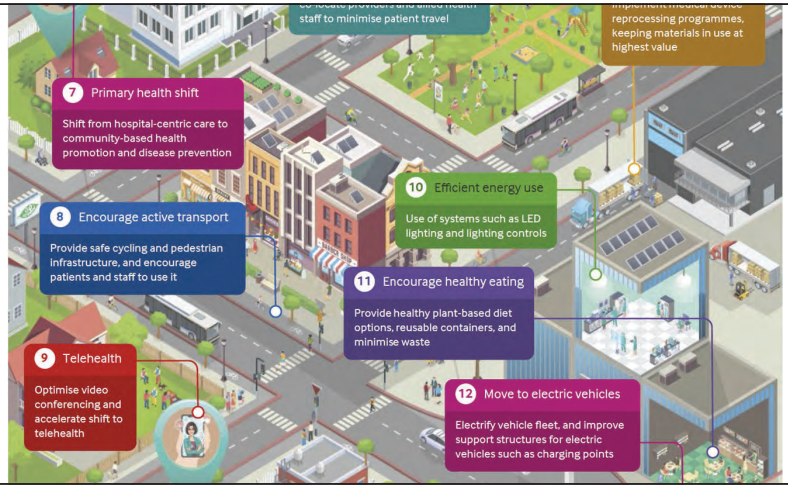


Source: WHO 2020. WHO guidance for climate resilient and environmentally sustainable health care facilities. Hyperlink.

6

1. Energy use

11



9

Energy use: climate resilience

Do you remember the definition of climate resilience?

What are the issues?

- **Access to energy** which is reliable and affordable to power basic services such as lighting, communications, refrigeration, diagnostics and the medical devices required for health services
- **Disruption to energy supply** due to climate events; storms can destroy power lines, floods can affect power generators, heatwaves can increase energy demand

What are the solutions?

- Using **renewable energy sources** has multiple benefits: **off-grid systems** (such as solar energy) are resilient to national electricity grid disruptions; decentralised and **local generation** of energy avoids disruption to the fossil fuel supply chain (for example due to international events such as war or pandemics)
- **Emergency response planning** for climate-related disruptions to energy supply at the healthcare facility, regional and national health sector levels can reduce the impacts of climate events: some interventions include measuring the energy demand of healthcare facilities, periodically checking emergency back up generators, and established maintenance plans for local systems

12

10

Energy use: environmental sustainability

Interventions (level of achievement) **Low, unavailable, unable** **Medium, in progress, incomplete** **High, completed, achieved**	**Action level**			**Observations**
Prioritized energy sources and saving measures which are least costly to introduce and/or those which would bring the biggest saving	☐	☐	☐	
Installed energy-efficient lighting (such as light emitting diode (LED))	☐	☐	☐	
Natural light used wherever possible	☐	☐	☐	
Opening windows (with installed mosquito nets where required) and making use of natural air flow and light	☐	☐	☐	
Added occupancy sensor switches for lighting in frequently unoccupied spaces	☐	☐	☐	
Replaced older air conditioners, refrigerators and other appliances and medical equipment with energy efficient models	☐	☐	☐	
Improved energy efficiency of the health care facility vehicles fleet, and encouraging staff, patients and visitors to walk or use car pools, public transport, or bicycles whenever possible*	☐	☐	☐	

Source: WHO 2020. WHO guidance for climate resilient and environmentally sustainable health care facilities. Hyperlink.

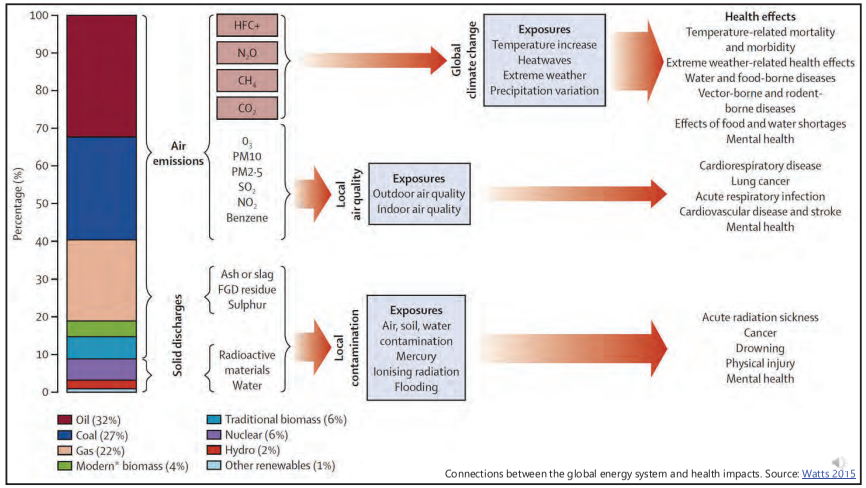
15

Energy use: climate resilience

Interventions (level of achievement) **Low, unavailable, unable** **Medium, in progress, incomplete** **High, completed, achieved**	**Action level**			**Observations**
Assessed energy needs, availability and alternative sources of renewable energy	☐	☐	☐	
Assessed points of greatest heat loss in buildings (such as roofs, especially flat ones) and added or upgraded insulation, and draught proofing*	☐	☐	☐	
Periodically checked emergency backup generators, even if rarely used	☐	☐	☐	
Renewable energy (such as solar) is sufficient to power equipment like refrigerators	☐	☐	☐	
Assessed all heating, ventilation and air conditioning ductwork pipes, ensuring they are in good condition and supported adequately by the facility building structure	☐	☐	☐	
Assessed that location of energy backup or renewable energy infrastructure can withstand extreme weather events (such as strong winds, hail, floods)	☐	☐	☐	

Source: WHO 2020. WHO guidance for climate resilient and environmentally sustainable health care facilities. Hyperlink.

13



Connections between the global energy system and health impacts. Source: Watts 2015

16

Energy use: environmental sustainability

Do you remember the definition of environmental sustainability?

What are the issues?

- **Combustion of fossil fuels** results in global climate change (due to greenhouse gas and carbon emissions) and local health impacts (due to air pollution generated at the site of energy generation and resource extraction)
- **Inefficient use of energy** technologies such as inefficient devices and appliances, contributing to fuel waste, costs, and air pollution

What are the solutions?

- **Transitioning to renewable energy** has several co-benefits: reducing hospital admissions and chronic disease, reducing the financial cost of generating energy, and reducing the overall financial cost to society of having to treat illness
- **Increasing energy efficiency** such as upgrading electric lighting fixtures, improving the quality of insulation (passive cooling and shading options, avoiding heat loss from buildings)
- Considering the **carbon intensity of the supply chain**: the 'upstream' activities of the health system such as purchasing pharmaceuticals, sourcing patient food, and transporting goods between facilities require large amounts of energy which leads to greenhouse gas emissions; solutions include purchasing low-carbon medications and devices, sourcing food from local producers using regional agricultural supply chains, and shifting to electric vehicles where possible

14

Infrastructure: climate resilience

Interventions (level of achievement) **Low, unavailable, unable** **Medium, in progress, incomplete** **High, completed, achieved**	**Action level**			**Observations**
Mapped exposure of health care facility to all types of hazards and risk of the events (such as biological, chemical, geological, hydrometeorological, technological, societal)*	☐	☐	☐	
Mapped the catchment area of the health care facility in terms of the geographical area and population for whom the health care facility would be expected to provide health care for extreme climate event emergencies and disasters*	☐	☐	☐	
Building is regularly inspected, both internally and externally, for signs of deterioration such as broken plaster, cracks or sinking structural elements, and the causes determined	☐	☐	☐	
Health care facility has sufficient natural ventilation with protection against disease vectors	☐	☐	☐	

Source: WHO 2020. WHO guidance for climate resilient and environmentally sustainable health care facilities. Hyperlink

19

2. Infrastructure, technology and products (and buildings)

Health system infrastructure refers to a range of elements which can be grouped into three categories:

- Structural elements: physical buildings and places where healthcare is delivered
- Non-structural elements: critical systems (electricity, water supply, waste management, fire protection), laboratory services, office and administrative equipment, supporting technologies (such as disease surveillance systems and digital health or virtual care)
- Non-structural elements related to the health workforce: awareness raising, training and education

17

Infrastructure: environmental sustainability

Do you remember the definition of environmental sustainability?

What are the issues?

- **Physical facilities** that have a net zero carbon footprint
- **Construction materials** that are from lower emission or renewable sources
- **Essential environmental services** (energy, waste, water and sanitation services) that themselves have a net zero carbon footprint

(Notice that this list of issues is the same for climate resilience and environmental sustainability – this demonstrates that there are co-benefits of action to mitigate climate change which, in turn, reduces the pressure for adapting to climate events and improves the climate resilience of health systems.)

What are the solutions?

- **Decarbonise the health sector**, also known as achieving net zero carbon emissions, by purchasing electricity from renewable energy sources
- Initiating a health sector-wide **sustainable procurement program**, which means purchasing goods and services that are produced using low carbon or net zero carbon emission techniques
- **Conserving water**, for example by treating (disinfecting) and reusing water used in medical procedures to supply the sanitation system and irrigate the grounds of the healthcare facility
- **Managing waste** without generating air pollution emissions, for example by reducing the amount of waste burned or incinerated, and developing safe waste landfill sites which do not result in chemical leakage to nearby communities and populations

20

Infrastructure: climate resilience

Do you remember the definition of climate resilience?

What are the issues?

- **Physical facilities** that remain operational during and after climate events
- **Construction materials** that do not result in occupational or environmental hazards
- **Essential environmental services** (energy, waste, water and sanitation services) that are not compromised by climate variability and change

What are the solutions?

- **Retrofitting** existing healthcare facilities to ensure they are climate resilient
- **Constructing** new healthcare facilities after thorough climate vulnerability and adaptation assessment, considering a smaller physical footprint of the facility, and delivering healthcare in different ways (e.g. virtual care through digital technology)
- **Emergency response planning** for climate-related disruptions to health facility buildings and supporting infrastructure, for example: assessing the climate hazards that can put the health care facility's structural and non-structural elements in danger, and mapping the exposure of health care facilities to hazards and risks from climate events

18

Water and waste: climate resilience

What are the issues?

- **Access to good water quality** which is safe to drink and available when needed remains an issue in many parts of the world
- **Disruption to water supply** due to climate change and climate events; floods can impact sanitation systems and lead to wastewater overflow, sea level rise can increase salinity in coastal aquifers and flood sewage systems

What are the solutions?

- **Upgrading and building** drinking water and wastewater systems that avoid cross-contamination during normal operation and during climate events
- **Emergency response planning** for climate-related disruptions to water supply at the healthcare facility, regional and national health sector levels can reduce the impacts of climate events: some interventions include long-term drought management plans, and healthcare facility water conservation and reuse systems

23

Infrastructure: environmental sustainability

Interventions (level of achievement) **Low, unavailable, unable** **Medium, in progress, incomplete** **High, completed, achieved**	**Action level**			**Observations**
Implemented a clear environmentally sustainable procurement policy statement or protocol for all types of products, equipment and medical devices used in the health care facility*	☐	☐	☐	
Health care facility staff trained on effective and efficient procurement practices	☐	☐	☐	
Health care facility staff encouraged to use bicycles, public transportation and carpools to minimize transportation emission	☐	☐	☐	
Equipment and supplies purchased from local sources as much as possible, when available*	☐	☐	☐	
Equipment and supplies purchased giving priority to environmentally friendly products (such as minimal packaging, reusable and recyclable products, avoiding hazardous chemicals and non-degradable plastics)*	☐	☐	☐	
Health care facility purchases energy-efficient products (medical devices, vehicles, computers)*	☐	☐	☐	

Source: WHO 2020. WHO guidance for climate resilient and environmentally sustainable health care facilities. Hyperlink.

21

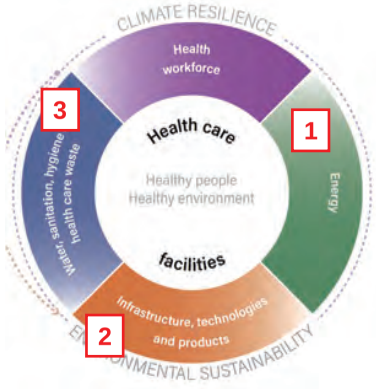
Water and waste: climate resilience

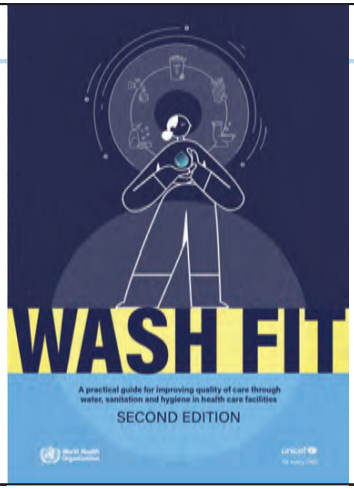
Interventions (level of achievement) **Low, unavailable, unable** **Medium, in progress, incomplete** **High, completed, achieved**	**Action level**			**Observations**
Health care facility able to provide clean water for patients and the health workforce during climate related disasters:*	☐	☐	☐	
Readily available disaster response and recovery plan for the water system with adequate supplies (such as chlorine, filters or other water treatment technology, rapid water testing kit)	☐	☐	☐	
Long term water collection system in place to ensure water access during extreme climate events (such as capturing rain during the monsoon season and storing water in tanks for use during the dry season)	☐	☐	☐	
Ensured effective and timely delivery of safe water during emergencies over the short- and long-term*	☐	☐	☐	
Improved storage areas for storing extra waste generated through higher demands on health care facilities (such as in outbreaks or impacts from climate related events)*	☐	☐	☐	
Waste pits are built to withstand climate events and emergencies*	☐	☐	☐	

Source: WHO 2020. WHO guidance for climate resilient and environmentally sustainable health care facilities. Hyperlink.

24

3. Water and waste

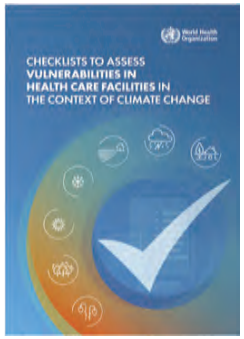




22

Integrating the four fundamental requirements

CLIMATE HAZARD TYPE	IS HAZARD OR EXPOSURE PRESENT? Yes/No	ARE THESE AREAS IMPACTED? X Current observed impacts O Possible impacts with changed conditions: Health workforce	WASH and health care waste	Energy services	Infrastructure, technologies, products, processes
Flood					
Storm					
Sea-level rise					
Drought					
Heatwave					
Wildfire					
Cold wave					



Source: WHO 2021. Checklists to Assess vulnerabilities in Health Care Facilities in the Context of Climate Change. Hyperlink.

27

Water and waste: environmental sustainability

What are the issues?

- Disposal of **hazardous waste** (infectious, toxic or radioactive substances) generated during the delivery of healthcare, which results in air pollution and carbon emissions due to open burning and incineration
- Using **disposable and single-use plastics** in the delivery of healthcare, which increases the amount of waste generated and increases the overall carbon footprint of the health sector
- **Infection prevention and control** protocols which do not adequately prevent the inappropriate use of and excessive wastage of pharmaceuticals, resulting in antimicrobial resistance, itself a threat to the ability to treat infectious diseases in the future

What are the solutions?

- Implementing and ensuring effective **waste management legislation and regulations**, to ensure patients, healthcare workers and members of the community are not exposed to hazardous waste generated by the health sector
- Developing **recycling and circular economy programs**, which consider the lifecycle of products used in healthcare delivery, and follow the hierarchy of reduce, reuse, recycle, recover

25

Summary of the presentation

This Module 2.2 has covered the following key points.

Health systems and healthcare facilities need to address **three fundamental requirements** for proper functioning:

1. Energy use
2. Infrastructure, technology and products (and buildings)
3. Water and waste

Interventions to support these three fundamental requirements need to achieve **two goals**:

- Climate resilience
- Environmental sustainability

Understanding the **building blocks of health systems** guides the climate adaptation and mitigation options, and shows us where effective interventions can be made.

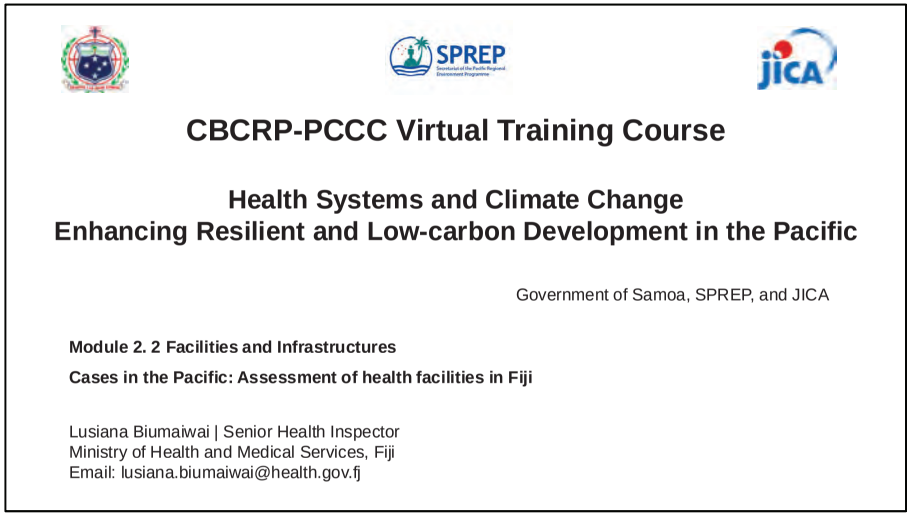
28

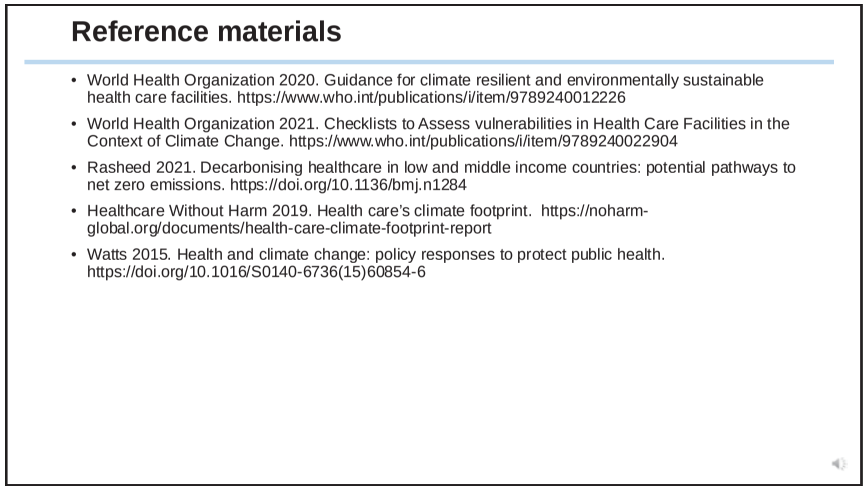
Water and waste: environmental sustainability

Interventions (level of achievement) **Low, unavailable, unable** **Medium, in progress, incomplete** **High, completed, achieved**	**Action level**			**Observations**
Wastewater is safely managed through use of on-site treatment (such as septic tank followed by drainage pit) or sent to a functioning sewer system*	☐	☐	☐	
Established recycling programme for all types of non-hazardous waste*	☐	☐	☐	
Established segregation collection of different types of waste according to hazards*	☐	☐	☐	
Phased out of incineration of medical waste: a variety of non-burn technologies are available to safely disinfect, neutralize or contain waste (such as autoclaving)	☐	☐	☐	
Waste disposal system includes separate bins for potentially infectious waste, sharps, chemicals, pharmaceuticals, non-hazardous wastes	☐	☐	☐	
Cleaning products that contain hazardous chemicals such as those found in some soaps, disinfectants and pesticides are clearly labeled following the Globally Harmonized Classification System	☐	☐	☐	

Source: WHO 2020. WHO guidance for climate resilient and environmentally sustainable health care facilities. Hyperlink.

26





597

Bula vinaka respective participants and facilitators. My name is Lusiana Biumaiwai, I am a Environmental Health Officer by profession. I currently manage the Pollution Control, Waste Management and Climate Change aspects of Health with the Environmental Health Unit under the umbrella of the Ministry of Health and Medical Services, Fiji. I am honored and privileged to deliver this presentation and I hope that it will bring some enlightenment and wayfoward in solving impacts of climate change

CONTENTS

1. Introduction
2. Purpose and Aim
3. Assessment Outcome (Domain 1 to Domain 7)
4. Summary of the presentation
5. References

I would like to acknowledge my appreciation to our Climate Change SSA, Ms Kelera Oli and the assessment consultant, Ms Railala Nakabea for their assistance in the compilation of this presentation. The content compromises of the elements of discussion in this presentation. This presentation is a summary of works carried out in the assessment of health care facilities in Fiji and focuses on two divisions only.

1.0 Introduction

- The Ministry of Health delivers its services to 214 Health Care Facilities nationally
- Climate Hazard Vulnerability Assessment (CHVA) was conducted to ascertain the vulnerability and hazard exposures of the healthcare facilities to the impacts climate change.
- The *'Guidelines for Climate Resilient and Environmentally Sustainable Health Care Facilities in Fiji' (CRESHCF)* was the tool used for this assessment.
- CHVA – for 114/214 HCFs in FIJI
- The Health Care Facility vulnerability assessment program was a collaboration with the Fiji Ministry of Health & Medical Services (MOHMS), Pacific Climate Change and Environment (PCE) & WHO Division of Pacific Technical Support (DPS) office.

HCFs includes health centers, nursing stations, sub divisional hospitals, divisional hospitals and specialized hospital

With the aim of meeting the MoHMS Annual Corporate Plan – 20% vulnerability assessment of all Health Care Facilities

The assessment begun on the 2nd qtr of 2021/2022 fiscal year and is currently ongoing. This has been prolonged due to the COVID movement restrictions and therefore it should be completing by end of the calendar year

The assessment was done using a tool (CRESHCF). The 7 domain of climate hazards (Derived from WHO publications and existing tools)
Risks and Vulnerabilities
Climate Hazards and vulnerabilities of the HCFs
Environmental issues
Social issues in the communities
Health issues
Infrastructural safety of the HCF
Non-infrastructural safety of the HCF

4.0 Assessment Outcome

Divisions	Type of Health Care Facilities				
	Nursing Station	Health Center	Sub-divisional Hospital	Divisional Hospital	Specialist Hospital
Central	21	23	5	1	2
Western	27	29	5	1	
Total	**48**	**52**	**10**	**2**	**2**

A total of 114 HCF was assessed and the breakdown are as per table on the slide
This presentation summarizes/ give brief on the assessment conducted for two divisions.

2.0 Purpose

- Assist MoHMS Fiji in developing outcomes to build a resilient health systems through climate resilience and environmental sustainable HCF strategies

3.0 Aim

To assess vulnerabilities of Health Care Facilities to the impacts of climate change and conditions

This will also help the communities have a better understanding of the climate hazards, exposures and vulnerabilities that will possibly affect HCFs and also their own environment/surrounding.

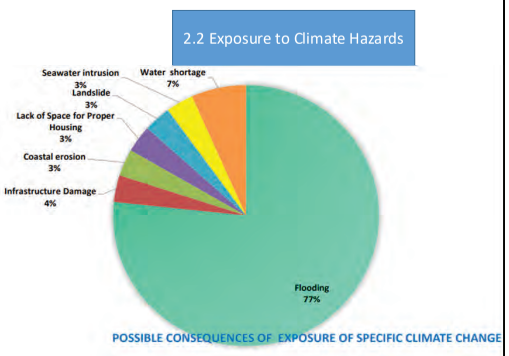
1.To assess the vulnerabilities and exposures of Climate change on HCFs using the 7 domains of Climate hazards by:

>Interviewing Key Informants, Officer In Charge and Management in regards to Health issues, Environmental and Social risks in the communities as precursors to climate vulnerabilities.

>Conduct site audit for Infrastructural safety of the HCF and Non-infrastructural safety

2. To prioritize and rank the likelihood of exposure and vulnerability of potential impacts onto HCFs

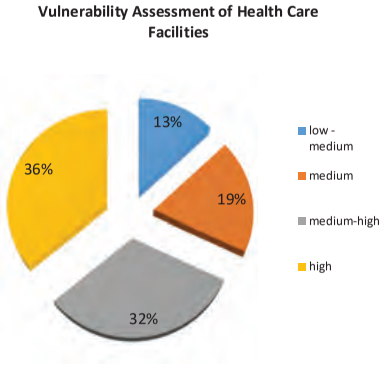
Domain 2
: Climate Hazards and Vulnerability of Health Care Facilities



2.1 Based on the CHVA, more than 90% of the HCFs in both Medical Divisions are exposed to extreme weathering & ageing and had not been renovated in the past 2 years. More than 70% experience flooding of access roads & bridges leading to the HCF. More than 80% raised the issue of distance and lack of appropriate roads to their HCF. 12% of HCFs are vulnerable to sea-level rise, hence a significant percentage for these 2 Divisions.

2.2 In terms of climate hazards,a total high of 77% have responded that flooding is a possible consequence of climate change. Water shortage, infrastructure damage and seawater intrusion, lack of space for proper housing, landslide and coastal erosion were also highlighted as possible consequences of climate change exposures to these HCFs.

4.1Results



Domain 1: Risks and Vulnerabilities

Picture credit: *Nakabea R, 2020*

13% of HCFs indicates low-medium vulnerability for exposure of climate change; 19% indicates medium vulnerability, 32% medium - high vulnerability and 36% High vulnerability

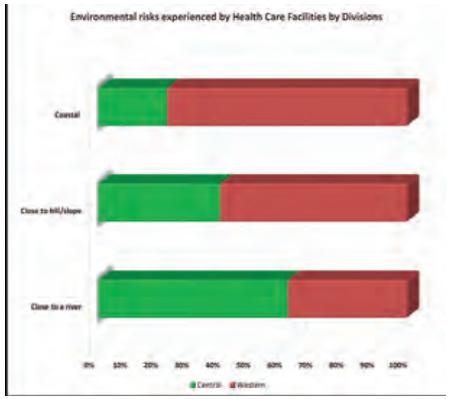
Clearly capture in the photos: Salt deposit from water supply and borehole status – vulnerable to hazards as it is covered with Corrugated Iron only

Domain 4: Social issues in the communities

Age range (yrs.)	Common social risks reported
0-5years	• Vaccination defaulters – (as parents & guardians face financial challenges to afford transportation costs to HCFs) • Child abuse reported in some HCFs • Children negligence • Children's welfare not looked after • Skin infection due to overcrowding • Detected Mild malnutrition
6-14	• Parents unable to send children to school Lack of adult and parental supervision during the Covid-19 lockdown period for homeschool worksheets & online (zoom) classes • Reports of children smoking • Child abuse/Sex assault reported
15-19	• Teenage pregnancy • School dropouts • Peer pressure • Drug & smoking abuse • Alcohol abuse
20-59	• High Unemployment • Drug-use and kava abuse • Physical abuse • DV – due to financial constraints, extramarital affairs, alcohol abuse • Attempted suicide
60-69	• Elderly negligence from own children • NCDs • Lack of access to nutritious food • Default SOPD clinic - due to lack of financial support
70+	• Lack of family and social support • Default SOPD clinic - due to lack of financial/family support

These issues are not directly influenced by climate change but indirectly impacts social issues within the communities that are looked after by these health care facilities

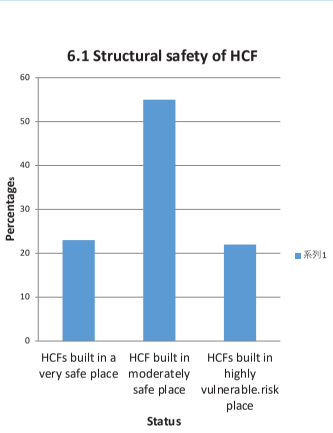
Domain 3: Environmental Issues

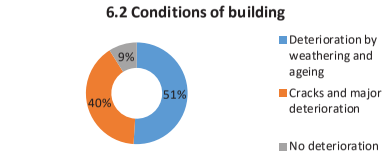


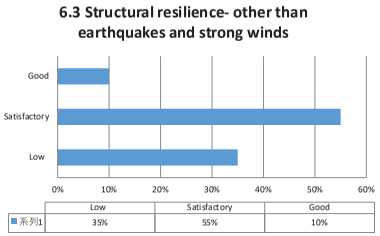
Picture Credit: *Nakabea R, 2020*

The graph shows the exposures of environmental risks challenged by healthcare facilities at various settings in the two divisions. It is observed that most healthcare facilities are located closer to a river or through a river access in the Central division whilst most HCFS in the Western division are located in a coastal region or closer. The graph also depicts that 35% of HCFs in the Central division & 65% in the Western Division are located closer to a hill or on a slope, which indicates susceptibility to landslides and erosion.

Domain 6: Infrastructural Safety of Health Care Facility







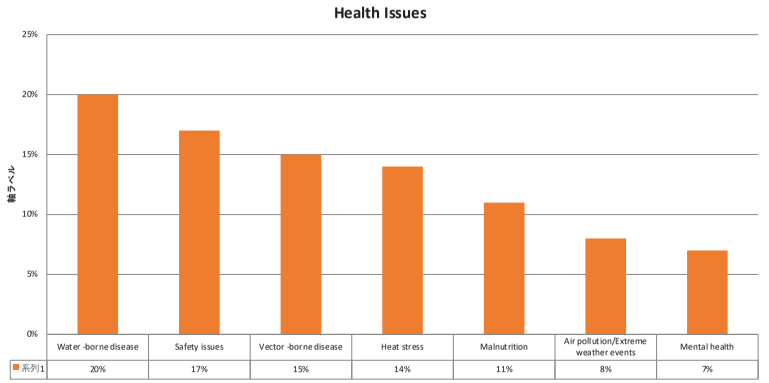
6.1 23% of HCFs that were surveyed are built in a very safe place, 56% of HCFs that were surveyed are built in moderately safe place, 22% of HCFs are built in highly vulnerable and risk place (such as vulnerable to rising sea level or flooding or landslide)

6.2 51% showed deteriorations caused only by weathering and normal ageing. 40% have cracks on the ground and first floors; major deterioration caused by weathering or normal ageing. 9% have no deteriorations or cracks observed.

6.3 35% of HCFs are observed to have low structural resilience to hazards present at the site of the building. 56% have satisfactory structural resilience (taking account of structural risk reduction measures in place whilst 10% have good structural resilience.

602

Domain 5: Health Issues



This graph illustrates the different health outcomes of interest presented from all the Health Care Facilities that were audited. 20% indicates water-borne diseases cases that were commonly presented at the HCFs in both divisions. 17 % indicates safety issues of the Health Care Facility, 15% illustrates vector borne diseases, 14% represents Heat stress, 11% malnutrition, whilst 8% indicates both Air Pollution and Extreme weather events - that causes injuries or deaths in these facilities. 7% represents mental health in all the audited health care facilities

Summary of the presentation

- It can be determined that more than 60% of Health Care Facilities are within the medium to high range of vulnerability from the 2 divisions
- Based on the outcomes of these assesments,31 HCF identified and prioritized to be most vulnerable to climate change and requires immediate infrastructural improvements to protect the facilities from exposure to further impacts
- Recommendations on improvement
- Way forward

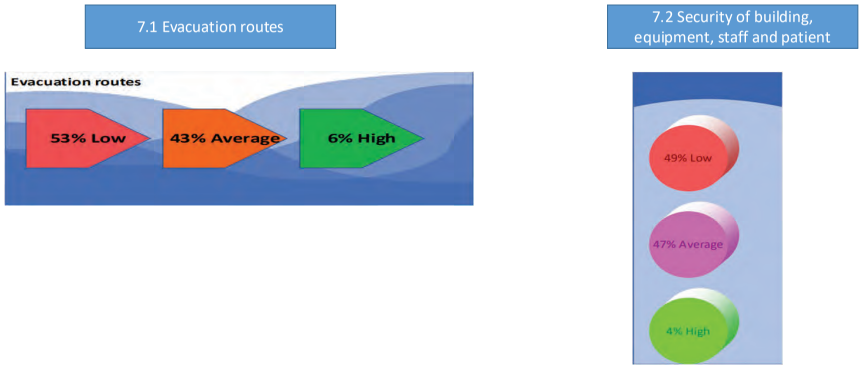
603

Recommendation -The assessment also allowed areas of improvement:

1. Our HCFs requires regular surveillance of infrastructural weather-related problems to protect the facilities from exposures to further impacts of climate change & extreme weathering
2. Improvements to water supply infrastructures and installation of desalination plants to provide wholesome and continuous watersupply to the HCFs.
3. Provisions of well - ventilated facilities with cooling mechanisms to bolster the heat in all HCFs.
4. Protect the living environment and surrounding of the HCFs by proper fencing
5. Relocation of Health care facility to higher grounds considering the rise in sea level and flooding occurrences
6. Adoption of renewable or hybrid energy source to power refrigerators & lights.
7. Communication and raising awareness to the health workforce on the climate resilience adaptation strategies to enable them to assess potential health impacts of Climate Change

8. Way forward – Adaptation activities to be implemented based on the Assessment outcome (align to the the Fiji National Adaptation 5 year plan and the SDG's)

Domain 7: Non-infrastructural Safety of Health Care Facilities



7.1 Evac routes - 53% of HCFs are without marked evacuation routes and many of these routes are blocked. 43% are marked and clear of obstacles whereas 6% of the HCFs have clearly marked evacuation routes and free of obstacles.

7.2 49% of the Healthcare facilities were observed with Low and no security measures protection in place. 47% have some form of physical security protection – with fencing and locked cupboards and storage for supplies and equipment, asset tracking and inventory. Only 4% of HCFs that were assessed have a wide range of security measures in place and keeping the facility secured and assets, equipment,

CBCRP-PCCC Virtual Training Course

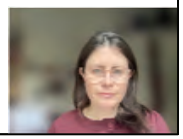
Health Systems and Climate Change: Enhancing Resilient and Low-carbon Development in the Pacific

Government of Samoa, SPREP, and JICA

Module 2

2.3 Quality criteria for Health National Adaptation Plans

Kathryn Bowen| Professor –Environment, climate and global health
University of Melbourne
kathryn.bowen@unimelb.edu.au



604

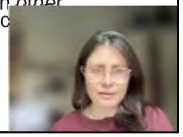
Reference

- *Nakabea. R, 2022:* Climate Hazard Vulnerable Assessment (CHVA) Baseline report for Central & Western Health Care Facilities – Ministry of Health and Medical Services, Fiji (Unpublished)
- Health.gov.fj. 2022. [online] Available at: <https://www.health.gov.fj/wp-content/uploads/2021/03/Guide-for-CRESHCF.pdf> [Accessed 1st September 2022].

Ladies and Gentlement, Participants and Facilitators, before you is a brief presentation on the Vulnerability Assessment of Health Care Facilities in Fiji. Vinaka vakalevu

Introduction to the Guidelines:
Purpose, criteria overview and audience

- WHO Guidelines
  - Complement HNAP guidelines, Operational Framework for Building Climate Resilient Health Systems
  - Raise the standards and ambition of health adaptation planning
- Six criteria
  1. Leadership and enabling environment
  2. Cross-sectoral coordination and policy coherence
  3. Comprehensive coverage of climate-sensitive health risks
  4. Comprehensive coverage of adaptation options and actions
  5. Resourcing
  6. Monitoring, evaluation and reporting
- Target audience
  - Primary – MoH staff, or staff responsible for developing HNAP
  - Secondary – agencies supporting the HNAP and NAP processes in other sectors, NGOs, bilateral donors, WHO and other UN orgs + technic agencies



605

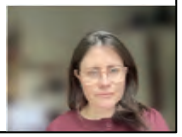
The WHO has published a guidance for developing the HNAP describing the principles and fundamental concepts of the national health adaptation planning process, critical elements of health adaptation to climate change, and steps in developing the plan. The WHO HNAP guidance aligns with the technical guidelines to formulate and implement NAPs developed by the LDC expert group (LEG). Additionally, the WHO developed the *Operational framework for building climate resilient health systems,* which guides countries in developing a systematic and comprehensive approach to addressing the health impacts of climate change. A flexible and context-specific approach that is country-driven and -owned is encouraged.

Countries often face challenges in the design, development and implementation of HNAPs. The WHO document should be used alongside the HNAP guidance as additional support in designing and developing a quality HNAP adaptable to specific country contexts.

The proposed criteria are not prescriptive and should be adapted to dynamic country contexts, uncertain and changing climatic conditions, and new knowledge and technologies. Country case studies are incorporated throughout the document to demonstrate practical applications of these criteria in specific settings.

CONTENTS

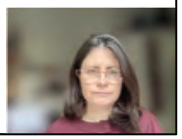
1. Introduction to the Guidelines
2. Six Criteria
   i. Leadership and enabling environment
   ii. Cross-sectoral coordination and policy coherence
   iii. Comprehensive coverage of climate-sensitive health risks
   iv. Comprehensive coverage of adaptation options and actions
   v. Resourcing
   vi. Monitoring, evaluation and reporting
3. Case study - Fiji



ensures that the health adaption plan feeds into and coordinates with the overall NAP.
An **iterative learning** approach promotes an iterative process for health adaptation to climate change, with time-bound plans which are periodically reviewed and updated.
Knowledge sharing and capacity building promotes inter-country collaboration and harmonizing of adaptation approaches at sub-regional levels and strengthens national capacity on climate change and health which is central to HNAP development and implementation.
Maximizing **cross-agenda synergies** with other multilateral such as The Sendai Framework and the SDGs.

Introduction to the Guidelines:
Guiding Principles

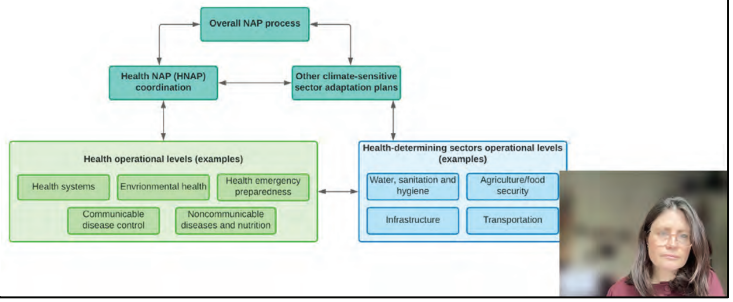
- Country-driven process
- Evidence-based planning
- Strengthening existing efforts
- Climate-informed health programming
- Non-prescriptive approach
- Cross-sectoral cooperation and coordination
- Integration with the process to formulate and implement the NAP
- Iterative learning
- Knowledge sharing and capacity building
- Cross-agenda synergies



A **country-driven** process ensures ownership by the countries.
Evidence-based planning ensures that health adaptation planning is based on the best available evidence. Any adaptation plan should aim at strengthening the development and availability of evidence, building the data and reducing knowledge gaps, and inform relevant policies.
Strengthening existing efforts towards health adaptation to climate change, including assessments, development and implementation of policies and programmes at local to national levels.
Climate-informed health programming integrates health adaptation to climate change into national health planning strategies, processes and monitoring systems.
Non-prescriptive approach provides a flexible and context-specific approach to health adaptation to climate change, and avoids duplication of efforts. National circumstances as well as available information and experience on health and climate change will determine the scope, institutional arrangements and resources required to implement the HNAP.
Cross-sectoral cooperation and coordination maximizes synergies across sectors, mainly across those that determine health, such as the food, water, energy and housing sectors. This calls for developing relevant health indicators within the adaptation monitoring systems in these sectors, ensuring that health considerations are integrated into their adaptation planning to avoid maladaptation.
Integration with the process to formulate and implement the NAP

HNAP Quality Criteria: #1
Leadership and Enabling Environment

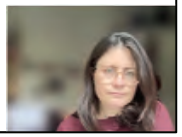
- Active engagement of the health sector in the process to formulate and implement the NAP
  - Critical to prioritise health and climate change at the national level, promote cross-sectoral synergies, and increase opportunities to access financing for health



Mandate for HNAP development, coordination, implementation, and monitoring and evaluation, which includes assigned roles and responsibilities and allocation of adequate human and financial resources, provides a strong foundation for effective health adaptation planning.

HNAP Quality Criteria: #1
Leadership and Enabling Environment

- MoH leads HNAP development
  - Crucial to the HNAP – process, development and implementation
  - Ministerial mandate
  - Health sector 'owns' health responses
  - Coordination with national climate change team
  - HNAP can be catalyst for further climate-resilience building processes
- Government endorsement/approval
  - Formalised endorsement is important at the ministerial level – signify commitment

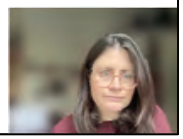


Mandate for HNAP development, coordination, implementation, and monitoring and evaluation, which includes assigned roles and responsibilities and allocation of adequate human and financial resources, provides a strong foundation for effective health adaptation planning.

HNAP Quality Criteria: #2

Cross-sectoral coordination and policy coherence

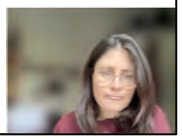
- Coordination and synergy with health-determining sectors
  - E.g. food and agriculture, energy, urban planning, water, sanitation and hygiene, disaster management
  - Participatory approach – promotes inputs from wide range of stakeholders; also strengthen leadership on health from other sectors
  - Stakeholder mapping – useful tool
  - HNAP could describe the cross-sectoral institutional arrangements in place



HNAP Quality Criteria: #1

Leadership and Enabling Environment

- Climate-informed health planning and programming
  - HNAP – useful tool for mainstreaming climate change into health until all health programming is climate informed
  - Health programs and development plans
  - Operationalisation will depend on country context and institutional arrangements



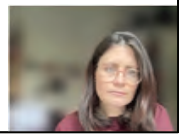
Mandate for HNAP development, coordination, implementation, and monitoring and evaluation, which includes assigned roles and responsibilities and allocation of adequate human and financial resources, provides a strong foundation for effective health adaptation planning.

HNAP Quality Criteria: #3

Comprehensive coverage of climate-sensitive health risks

- Ambitious in coverage of of risks and identify medium- and long-term priorities and adaptation actions

Health impacts	Examples
Health impacts of extreme weather events	Injury or death
Heat-related illnesses	Heat stroke, heat rash, heat cramps, heat exhaustion
Respiratory illnesses	Infections, obstructive airways disease (such as asthma) and the pulmonary effects of heat and air pollution
Water-borne diseases and other water-related health impacts	Cholera, schistosomiasis, diarrhoeal illnesses, harmful algal blooms, leptospirosis
Zoonoses	Rabies
Vector-borne diseases	Malaria, dengue fever, zika virus, chikungunya, lyme disease
Malnutrition and food-borne diseases	Underweight, wasting, stunting micronutrient deficiencies, food-borne diseases causing diarrhoeal illness, ciguatera
Noncommunicable diseases	Circulatory diseases (such as cardiovascular disease, cerebrovascular disease, hypertension), endocrine disorders (such as diabetes), cancers
Mental and psychosocial health	Depression, anxiety, post-traumatic stress disorder
Impacts on health care facilities	Destruction of infrastructure, disruption of supply chains, impaired water access and availability, disruption or discontinuation of health services
Effects on health systems	Compromised access to health services, additional strains on scarce resources

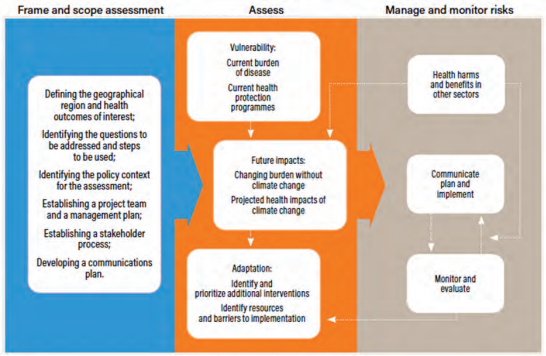


609

HNAP Quality Criteria: #3

Comprehensive coverage of climate-sensitive health risks

- Evidence-based HNAP
  - A comprehensive Vulnerability and Adaptation Assessment (V&A)



HNAP Quality Criteria: #3

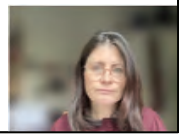
Comprehensive coverage of climate-sensitive health risks

- Prioritisation of climate-sensitive health risks
  - Criteria depends on context and could include:
    - Magnitude of risk
    - Size of affected population
    - Level of vulnerability
    - Available resources
    - Funding
  - Continue to review these in periodic V&As

HNAP Quality Criteria: #4

Comprehensive coverage of adaptation options and actions

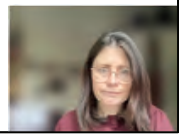
- Comprehensive adaptation options to address climate-sensitive health risks
  - WHO Operational Framework can help with developing comprehensive plans



HNAP Quality Criteria: #4

Comprehensive coverage of adaptation options and actions

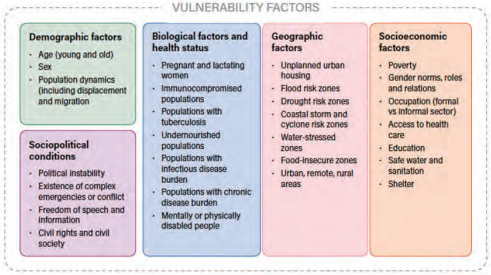
- Prioritisation of health adaptation actions
  - Magnitude of risk
  - Size of affected population
  - Level of vulnerability
  - Available resources
  - Funding
- Prioritisation promotes a HNAP that is realistic and feasible
- Final selected range of priority adaptation actions seeks to be comprehensive, target vulnerable populations, and address priority climate sensitive health risks

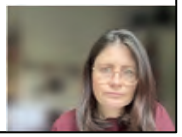


HNAP Quality Criteria: #4

Comprehensive coverage of adaptation options and actions

- Consideration of vulnerability factors to design and target adaptation actions
  - Most vulnerable populations are faced with the greatest impacts
  - WHO guide on mainstreaming gender in health adaptation to climate change programmes may be useful in this stage





HNAP Quality Criteria: #6

Monitoring, evaluation and reporting

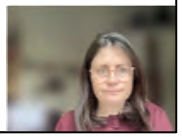
- The HNAP includes a monitoring, evaluation and reporting plan (M,E&R) plan to oversee implementation and impact
- V&As establish the baseline that can be used to monitor HNAP impact
- M,E&R plan specifies indicators at all levels (outputs/process, outcomes and impact) at short-, medium- and long-term timeframes, with designated roles and responsibilities (across sectors) and reporting requirements
- Ensure that information relevant to HNAP implementation is also integrated into NDCs, National Communications and other climate change and health processes

612

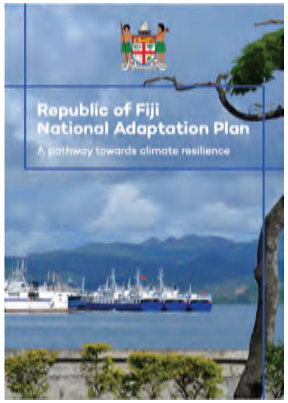
HNAP Quality Criteria: #5

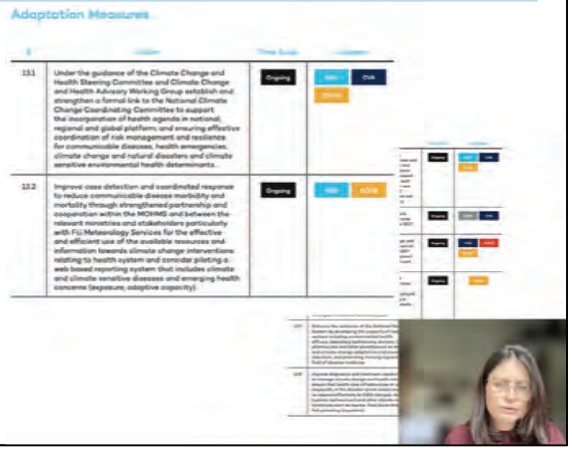
Resourcing

- Estimation of the required resources for HNAP implementation
  - Implementation requires financial and other resources
  - Essential to consider national capacity, and capacity building opportunities nationally, regionally and internationally
- Resource mobilization strategy
  - The HNAP outlines existing funding sources and gaps and presents a plan for addressing gaps and scaling up
  - E.g. streamline adaptation for health into national budget allocation processes, and planning for access to external funding funding sources including the GCF, GEF or Adaptation Fund (WHO is approved GCF readiness partner)
  - Cost-benefit analyses of action and inaction and ROI useful



CASE STUDY - Fiji

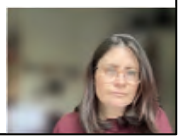




613

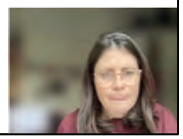
HNAP Quality Criteria: #6
Monitoring, evaluation and reporting

- Mechanism for periodic HNAP iterations
  - Specified implementation period for each iteration of the HNAP is recommended
    - allows for measurable goals to be set
    - regular assessment of country conditions
    - HNAP implementation
    - relevance and effectiveness of adaptation actions
    - new knowledge and technologies
  - Five-year period is recommended for each iteration of the HNAP

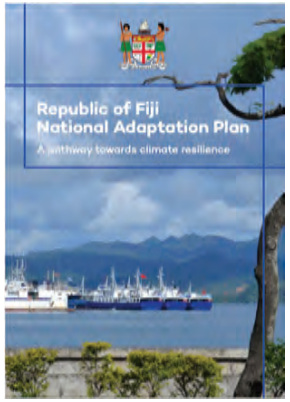


Summary of the presentation

- WHO Guidelines complement the HNAP guidelines, and raise the standards and ambition of health adaptation planning
- Principles – country-driven, evidence-based, strengthen existing efforts, integration with NAP
- Six Criteria
  i. Leadership and enabling environment
  ii. Cross-sectoral coordination and policy coherence
  iii. Comprehensive coverage of climate-sensitive health risks
  iv. Comprehensive coverage of adaptation options and actions
  v. Resourcing
  vi. Monitoring, evaluation and reporting



CASE STUDY - Fiji



CBCRP-PCCC Virtual Training Course

Health Systems and Climate Change
Enhancing Resilient and Low-carbon Development in the Pacific

Government of Samoa, SPREP- PCCC and JICA

Module 2.3 Polices and Regulations

Overview of the United Nations Framework Convention on Climate Change, Paris Agreement, Nationally Determined Contribution and National Adaptation Plan

Yvette Kerslake | Technical Adviser – Sciences to Services
Pacific Climate Change Centre - SPREP
yvettek@sprep.org

1

Reference materials

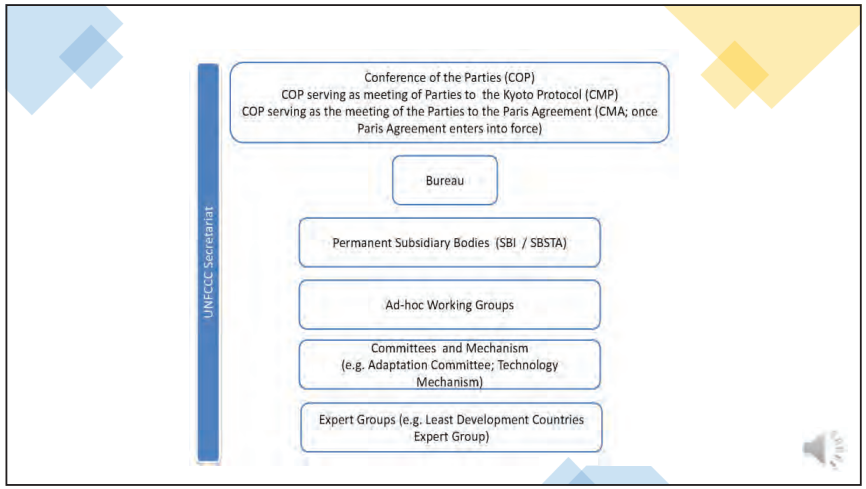
- Quality criteria for health national adaptation plans. Geneva: World Health Organization; 2021, Licence: CC BY-NC-SA 3.0 IGO
- WHO guidance to protect health from climate change through health adaptation planning. Geneva: World Health Organization; 2014
- Operational framework for building climate resilient health systems. Geneva: World Health Organization; 2015
- Republic of Fiji National Adaptation Plan: https://www4.unfccc.int/sites/NAPC/Documents/Parties/National%20Adaptation%20Plan_Fiji.pdf

615

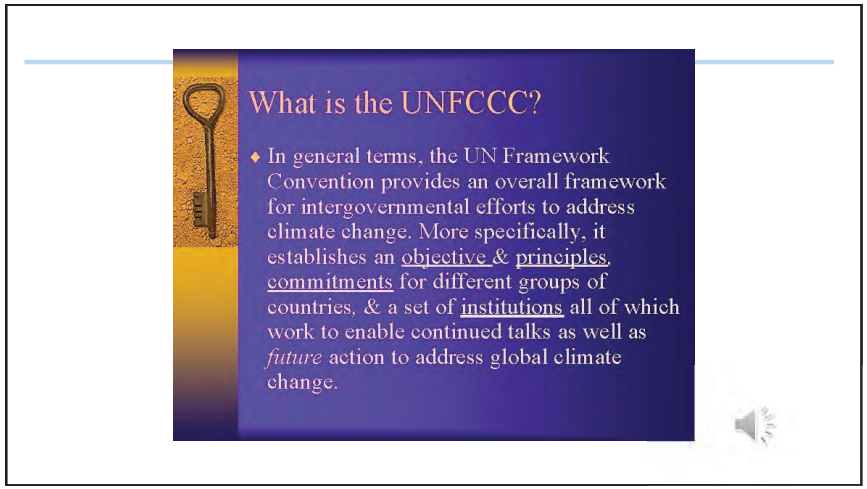
CONTENTS

1. Background on UNFCCC
2. Kyoto Protocol
3. Paris Agreement
4. National Determined Contribution
5. National Adaptation Plans / Joint National Adaptation Plans
6. Summary
7. References

2



5



3

Kyoto Protocol

- The 1st Conference of the Parties (COP1) in Germany in 1995 agreed to negotiate strengthened commitments for developed countries, and laid ground work for the Kyoto Protocol
- It was adopted in December 1997 at the COP3 in Japan, and entered into force in February 2005.
- It consists of Preamble, 27 Articles and 2 Annexes.

IMPORTANT text (excerpts from the Kyoto Protocol) A:\cpl07a01.wpd (unfccc.int)

Article 2
1. Each Party included in Annex I in achieving its quantified emission limitation and reduction commitments under Article 3, in order to promote sustainable development, shall:
   (a) Implement and/or further elaborate policies and measures in accordance with its national circumstances, such as: [i)-viii)]

Article 3
1. The Parties included in Annex I shall, individually or jointly, ensure that their aggregate anthropogenic carbon dioxide equivalent emissions of the greenhouse gases listed in Annex A do not exceed their assigned amounts, calculated pursuant to their quantified emission limitation and reduction commitments inscribed in Annex B and in accordance with the provisions of this Article, with a view to reducing their overall emissions of such gases by at least 5 per cent below 1990 levels in the commitment period 2008 to 2012.

6

United Nations Convention on Climate Change

- The UNFCCC was adopted in May 1992. It opened for signatory at Rio Earth Summit, and entered into force in March 1994.
- It consist of Preamble, 26 Articles and 2 Annexes.

IMPORTANT text (excerpts from the UNFCCC) Convention text with Annexes - English (unfccc.int)

Preamble
Acknowledging that the global nature of climate change calls for the widest possible cooperation by all countries and their participation in an effective and appropriate international response, in accordance with their common but differentiated responsibilities and respective capabilities and their social and economic conditions,
Determined to protect the climate system for present and future generations,

Article 2 Objective
The ultimate objective of this Convention and any related legal instruments that the Conference of the Parties may adopt is to achieve, in accordance with the relevant provisions of the Convention, stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. Such a level should be achieved within a time frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner.

4

9

Paris Agreement

- The COP17 in South Africa in 2011 committed to a new universal climate change agreement by 2015 for the period beyond 2020.
- It was adopted in December 2015 at the COP21 in France, and entered into force in November 2016.
- It consists of Preamble and 29 Articles

IMPORTANT text (excerpts from the Paris Agreement) Paris Agreement text English (unfccc.int)

Article 2

1. This Agreement, in enhancing the implementation of the Convention, including its objective, aims to strengthen the global response to the threat of climate change, in the context of sustainable development and efforts to eradicate poverty, including by:
   (a) Holding the increase in the global average temperature to well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels, recognizing that this would significantly reduce the risks and impacts of climate change;
   (b) Increasing the ability to adapt to the adverse impacts of climate change and foster climate resilience and low greenhouse gas emissions development, in a manner that does not threaten food production; and
   (c) Making finance flows consistent with a pathway towards low greenhouse gas emissions and climate-resilient development. .

7

Updated NDCs of the Pacific Countries

country	NDC	Date of submission	Health/risks/adaptation (excerpts)
Fiji	Updated NDC	31 December 2020	Target 9: Build strong healthcare system by implementing the 'Guidelines for climate-resilient and environmentally sustainable health care facilities in Fiji'.
Nauru	Updated NDC	14 October 2021	Conduct assessment of national public health implications of climate change, including resilience of public health infrastructure Adaptation • Increased preparedness for tropical diseases, heat stress, dehydration, and other climate change-driven public health impacts • Increased resilience of public health care infrastructure
PNG	Second NDC	16 December 2020	Adaptation i) 100 percent of PNG's population to benefit from introduced health measures to respond to malaria and other climate-sensitive diseases; iii) 10 percent of the total population (0.8 million beneficiaries (25 percent are women) have increased resilience of food and water security, health, and well-being in PNG;
RMI	NDC update	31 December 2020	Include health considerations as part of RMI's forthcoming National Adaptation Plan.

Cook Islands, FMS, Niue, Palau and Tuvalu submitted their 1st NDC in 2016.
All NDCs are available here: Nationally Determined Contributions Registry | UNFCCC

10

Nationally Determined Contribution under the Paris Agreement

Article 3: ALL PARTIES are to undertake and communicate ambitious efforts with the views to achieving the purpose of this Agreement.

Article 4: Each Party is required to prepare, communicate and maintain successive nationally determined contributions (NDCs) that it intents to achieve..

Countries communicate new or updated NDCs every five years starting in 2020.
• Nationally Determined Contributions (NDCs) | UNFCCC

Contents of the NDCs:

Excerpt from "Revised synthesis report by the secretariat"(FCCC/A/CMA/2021/8/Rev.1) Microsoft Word - 2115347E.docx (unfccc.int)

All Parties provided information on mitigation targets or mitigation co-benefits resulting from adaptation actions and/or economic diversification plans.

Most Parties provided quantified mitigation targets, expressed as clear numerical targets, while some included strategies, plans and actions as components of their NDCs for which there is no quantifiable information;

In terms of GHGs, almost all NDCs cover CO2 emissions, most cover CH4 and N2O emissions, many cover HFC emissions and some cover PFC, SF6 and/or NF3 emissions;

Most of the Parties that submitted new or updated NDCs have strengthened their commitment to reducing or limiting GHG emissions by 2025 and/or 2030, demonstrating increased ambition in addressing climate change.

8

Health related strategies and actions in the submitted NAPs

Fiji National Adaptation Plan (NAP) – A pathway towards climate resilience (2018)

Section 13: **Health**

13.1 Under the guidance of the Climate Change and Health Steering Committee and Climate Change and Health Advisory Working Group establish and strengthen a formal link to the National Climate Change Coordinating Committee to support the incorporation of health agenda in national, regional and global platform; and ensuring effective coordination of risk management and resilience for communicable diseases, health emergencies, climate change and natural disasters and climate sensitive environmental health determinants.

13.2 Retrofit the existing and installing innovative structures, energy and water supplies; medicines and equipment efficiency that guarantees safety and enable lifesaving support through the application of relevant legislations, policies and other reviewed standard health building designs and ensure such legislations, policies and designs are used for new health facilities to prevent vulnerability to CC impacts (apply in phases for existing that were not affected by TC Winston – Phase 1 & Phase 11).

13.6 Identify and prioritise adaptation needs and associated health risk exposures of communities and populations most vulnerable to climate variability and change, including workers employed in the informal sectors, through the profiling or use of existing data; and by developing proposals, recommendations and plans for adaptation strategies to address identified gaps.

13.8 Improve diagnostic and treatment capacities to manage climate change and health risks, to ensure that health care infrastructure at all levels (especially in the disaster-prone areas) are capable to respond effectively to CSDs (dengue, diarrhea, typhoid, leptospirosis) and other climate related conditions such as injuries, food borne illness and fish poisoning (ciguatera).

https://www4.unfccc.int/sites/NAPC/Documents/Parties/National Adaptation Plan_Fiji.pdf

13

Updated NDCs of the Pacific Countries

country	NDC	Date of submission	Health/risks/adaptation (excerpts)
Samoa	Second NDC	30 July 2021	Samoa recognizes that climate change will have significant impacts on the country, particularly in sectors including agriculture, health, tourism, forestry, and water as well as coastal infrastructure and marine ecosystems. These sectors and priority areas are highlighted within the Community Integrated Management (CIM) Plans and National Climate Change Policy 2020-2030.
Solomon Islands	Updated NDC	19 July 2021	a) Review and revise the NAPA and Ministry of Environment, Climate Change, Disaster Management and Meteorology (MECDM) Strategic Plan and develop a National Adaptation Plan (NAP) to address climate change over the short, medium and long term. The NAP shall address long term adaptation to climate change and short-term disaster risk reduction in relation to climate variability and contain an implementation plan.
Tonga	Second NDC	9 December 2020	(If climate change was to lead to an increase in the intensity of cyclones, it can be expected that the already existing negative impacts on agriculture, coral reefs and fisheries, and public health would be exacerbated.)
Vanuatu	Updated NDC	22 March 2021	(Vanuatu is very prone to natural disasters (Typhoon, tsunami, cyclones, earthquake, volcano eruption etc.), in the case of any major natural disaster or pandemic situation similar to COVID-19, Vanuatu may update/change the reference point.)

11

618

Health related strategies and actions in the submitted NAPs

Kiribati Joint Implementation Plan for Climate Change and Disaster Risk Management （KJIP） 2019-2028

STRATEGY 5: **STRENGTHENING HEALTH-SERVICE DELIVERY TO ADDRESS CLIMATE CHANGE IMPACTS**

Result 5.1: The public is aware of water safety and proactively reduces the spread of vector-, water- and food-borne diseases.

Result 5.2: KEY NATIONAL ADAPTATION PRIORITY – HEALTH SECURITY #4: Routine systems for surveillance of environmental health hazards and climate-sensitive diseases are strengthened, and the capacity of national and local health systems, institutions and personnel to manage climate change and disaster-related health risks are enhanced (KNAP #4). (Action 5.1.1 also contributes to this KNAP).

Result 5.3: Capacities are enhanced, and equipment provided to the MHMS Central Laboratory and Environmental Health Laboratory to test water and food, conduct vector control activities and analyse results.

Result 5.4: I-Kiribati population's general health status is enhanced to be more resilient to climate-related diseases and health impacts.

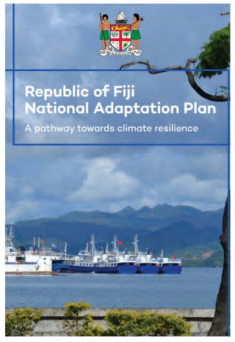
Result 5.5: A national climate change, disaster risk, outbreak preparedness governance framework, response plan and a sectoral environmental health plan, which incorporate surveillance and response to climate-sensitive diseases and disaster risks, are in place.

Result 5.6: KEY NATIONAL ADAPTATION PRIORITY - HEALTH SECURITY #5. Strengthened support for retrofitting medical facilities and health infrastructure adversely affected by, or susceptible to, the impacts of climate change.

Result 5.7: KEY NATIONAL ADAPTATION PRIORITY - HEALTH SECURITY #6. Enhanced Chemical waste management and alternatives to reduce contamination and pollution.

Kiribati-Joint-Implementation-Plan-for-Climate-Change-and-Disaster-Risk-Management-2019-2028.pdf (unfccc.int)

14



National Adaptation Plan

- Article 7: Each party is requested, as appropriate, to engage in adaptation planning processes and the implementation of actions.
- **Objectives of the NAP process:**
  - (a) To reduce vulnerability to the impacts of climate change, by building adaptive capacity and resilience;
  - (b) To facilitate the integration of climate change adaptation, in a coherent manner, into relevant new and existing policies, programmes and activities, in particular development planning processes and strategies, within all relevant sectors and at different levels, as appropriate (decision 5/CP.17, paragraph 1).
- **4 elements of the process to formulate & implement NAPs**
  - (a) Laying the groundwork and addressing gaps: e.g. submitting proposals to the GCF Readiness and Preparatory Support Programs, Developing a road map for the process;
  - (b) Preparatory elements: e.g. analyzing past climate data and scenarios of climate change, comprehensively assessing climate vulnerability;
  - (c) Implementation strategies: e.g. prioritizing climate change adaptation in national planning;
  - (d) Reporting, monitoring and review: e.g. designing and applying a monitoring and evaluation framework or system for NAPs.
  - excerpt from "Progress in the process to formulate and implement national adaptation plans"
  - FCCC/SBI/2021/INF.7 (unfccc.int)

12

Joint National Adaptation Plan

Since 2010, Pacific Island Countries (PICs) have taken steps to develop and implement an integrated action plan, or Joint National Action Plan (JNAP), for climate change (CC) and disaster risk management (DRM). Tonga was the first country to develop its JNAP and to get government approval in July 2010, with several other PICs following suit.

Through the NAP process some pacific island countries have opted to review their existing JNAPs for prioritized action including activities for Health e.g., Cook Islands 2nd Joint National Action Plan – A sectoral approach to climate change and Disaster Risk management

17

Health related strategies and actions in the submitted NAPs

Tonga Joint National Action Plan 2 on Climate Change and Disaster Risk Management 2018-2028

Objective 1: Mainstream climate change and disaster risk management approaches into government legislation, policies and plans at all levels
Sub-objective 1.3: Develop and implement the prioritized sector resilient plans such as biodiversity, education, energy, fisheries, forestry, **health,** infrastructure, land, water, and youth, including supporting policies and legislation where necessary.

Objective 3: Develop the capacity for resilience building responses throughout government, the private sector and civil society.
Sub-objective 3.1: Establish necessary mechanisms to ensure that all government agencies, the private sector, and civil society organisations are working together in a fully coordinated manner on all resilience-building activities across all sectors

Objective 4: Design and implement on-the-ground actions that build a Resilient Tonga by 2035 at national, island and community levels.
Sub-objective 4.3: Begin the progressive implementation of national level actions from relevant sector plans aimed at achieving the identified targets for a Resilient Tonga by 2035

JNAP2_Final-2018-2028.pdf (unfccc.int)

15

Summary of the presentation

- Brief overview of the United Nations Framework Convention on Climate Change, Paris Agreement, Nationally Determined Contribution and National Adaptation Plan
- Health sector is exposed to a multitude of climate change risks such as sea level and temperature rise, increasing frequency and intensity of storm surges and cyclones etc.
- It is important to align national Health policies and plans with existing climate change frameworks, to be mainstreamed in NAPs, JNAPs & NDCs etc. in order to address the above risks and mobilize resources for a sustainable and resilient Health sector.

18

Health related strategies and actions in the submitted NAPs

Timor-Leste's National Adaptation Plan Addressing climate risks and building climate resilience

III Health Sector Adaptation Priorities
Program 1: Integrate Climate Change Considerations into Health Sector Planning and Regulatory Frameworks
- Reviewing all existing guidelines, standard operating procedures to consider climate change and its adverse effects
- Review all existing guidelines and Standard Operating Procedures (SOPs) considering climate change and its adverse effects.
- Support preparation of —Health Risk and Preparedness Map‖ in relation to different climate risks, magnitude of existing and potential health risks due to each type of climate risk and existing and planned public health service delivery capacity at the national, sub-national and local levels.
- In close collaboration with national and sub-national health service delivery units and Comprehensive Primary Health Care system which includes Family Health and SISCA, establish surveillance and response mechanisms to deal with climate related public health issues

Program 2: Improve Health Sector Capacities for Managing Climate Risks
- Integrated disease surveillance and early warning systems
- Mainstreaming and implementation of climate change into the Comprehensive Primary health Care System
- Prepare the health workers, institutions, and communities on the prevention and response mechanisms to be adopted related to different diseases and health challenges exacerbated by climate change.
- Support the development of health database and data management systems which includes climate sensitive health risk and vulnerability information to facilitate effective, targeted and efficient delivery of health services

Timor Leste NAP.pdf (unfccc.int)

16

THEORY OF CHANGE IN DEVELOPING BANKABLE PROJECT PROPOSALS

DR. PETER KING

SENIOR POLICY ADVISOR

INSTITUTE FOR GLOBAL ENVIRONMENTAL STRATEGIES

BANGKOK REGIONAL CENTRE

A Theory of Change in developing bankable project proposals.

620

Reference

- https://unfccc.int/about-us/about-the-secretariat
- https://www.mdpi.com/2071-1050/13/8/4223/pdf
- https://www.globalsupportprogramme.org/nap-gsp
- https://unfccc.int/process-and-meetings/the-paris-agreement/nationally-determined-contributions-ndcs/nationally-determined-contributions-ndcs
- https://www.sprep.org/publications/jnap-development-and-implementation-in-the-pacific-experiences-lessons-and-way-forward
- https://www.google.com/search?q=unfccc+general+presentation&sxsrf=ALiCzsbnKQ1nq7QvT9nAlgPx9pPrvxsbbA:1661220533373&source=lnms&tbm=isch&sa=X&ved=2ahUKEwiAzqPe8Nv5AhXFA7cAHey8ABkQ_AUoAXoECAEQAw&biw=1366&bih=625&dpr=1#imgrc=lm-LCrWGHu23DM

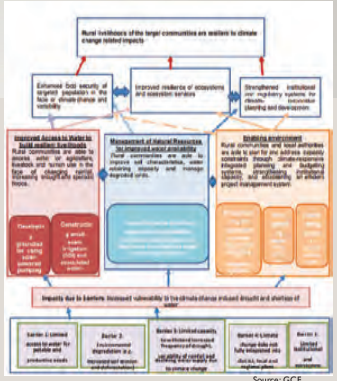
19

Thank you

20

THEORY OF CHANGE

- **SOME COMMON QUESTIONS**
- **What is the difference between a "theory of change" and the "logical framework"?**
- **What are the implementation implications of the theory of change?**
- **Why aren't the climate predictions a required element of the theory of change?**
- **Why is a theory of change best presented as a diagram instead of narrative text?**
- **Who should be involved in developing the theory of change?**



Source: GCF

Now some common questions that are often asked in relation to the theory of change.
Firstly, what is the difference between a theory of change and the logical framework? Often, they appear to be used interchangeably.

What are the implementation implications of a theory of change? Why are climate predictions a required element of the theory of change? And why is the theory of change often best presented as a diagram instead of a narrative text?
And who should be involved in developing the theory of change? Well, we'll try and answer some of those questions as we go through the presentation.

GCF GUIDANCE ON THEORY OF CHANGE

- The project scoping exercise should start with the identification of the climate change problem that the proposed project is aiming to address. This determination will form the starting point and basis for the theory of change diagram, which articulates how the project will address the identified problem.
- The theory of change, despite being called a "theory", is a methodological approach that allows AEs and project developers to design and plan a project by first setting up the long-term project goals and objectives then mapping backwards to identify the necessary preconditions to meeting those goals, the project outcomes and outputs, as well as the assumptions under which the theory of change is developed. In this way, the theory of change clearly articulates how the results chain will cascade from the theory of change statement to the project activities.
- The innovation of the theory of change lies in making the distinction between desired and actual outcomes, as well as in requiring stakeholders to model their desired outcomes before they decide on forms of intervention to achieve those outcomes.

GCF has provided guidance on a theory of change, and this presentation will help to understand exactly what GCF is looking for in relation to theory of change.
Firstly, the project scoping exercise should start with the identification of the climate change problem that the proposed project is aiming to address. Generally, that's done through a problem tree.
This determination will form the starting point and the basis for your theory of change diagram or narrative, which articulates how the project will address the identified problem.
The theory of change, despite being called a theory. is actually a methodological approach that allows accredited entities and project developers to design and plan a project by first setting up the long-term project goals and objectives and then mapping backwards to identify the necessary preconditions and inputs to meeting those goals.
The project outcomes and outputs as well as the assumptions under which the theory of change is developed.
In this way, a theory of change clearly articulates how the results chain will cascade from a theory of change statement to the project activities.
The innovation of the theory of change lies in making the distinction between what is a desired outcome and the actual outcomes, as well as in requiring stakeholders to model their desired outcomes before they decide on the forms of intervention to achieve those outcomes.

The **climate context** provides the scientific underpinning for evidence-based climate action decision-making and the theory of change for all activities funded by GCF. It ensures that the set of causal linkages between the climate and climate impacts/hazards and action and societal benefits is fully grounded in the best available climate data and science. It demonstrates that the proposed interventions advance a national priority related to climate change mitigation and/or adaptation in terms of reducing GHG emissions or improving the resilience of people and communities and should meet at least one of the eight GCF results areas.

The **theory of change** explains to the funder (GCF) why you think your project will work, and why the funder should expect the project to bring about the results you envision for the project. A good theory of change is like the backbone of a well-designed and fundable project proposal. Many proposals are rejected because they don't include a theory of change, or because the theory of change doesn't adequately show how the project moves from problem to solution.

The climate context provides the scientific underpinning for evidence-based climate action, decision making and the theory of change for all activities funded by the GCF. It ensures that the set of causal linkages between the climate and climate impacts or hazards, and action and societal benefits is fully grounded in the best available and most up to date climate data and science.
It demonstrates that the proposed interventions advance a national priority related to climate change mitigation and or adaptation in terms of reducing greenhouse gas emissions or improving the resilience of people and communities and should meet at least one of the eight GCF resolve areas.

The Theory of Change explains to the funder, that is the GCF, why you think your project will work and why the funder should expect the project to bring about the results you envision for the project.

A good theory of change, therefore, is like the backbone of a well designed and fundable project proposal. Many proposals, in fact, are rejected because they don't include a theory of change or because the theory of change doesn't adequately show how the project moves from problem to solution.

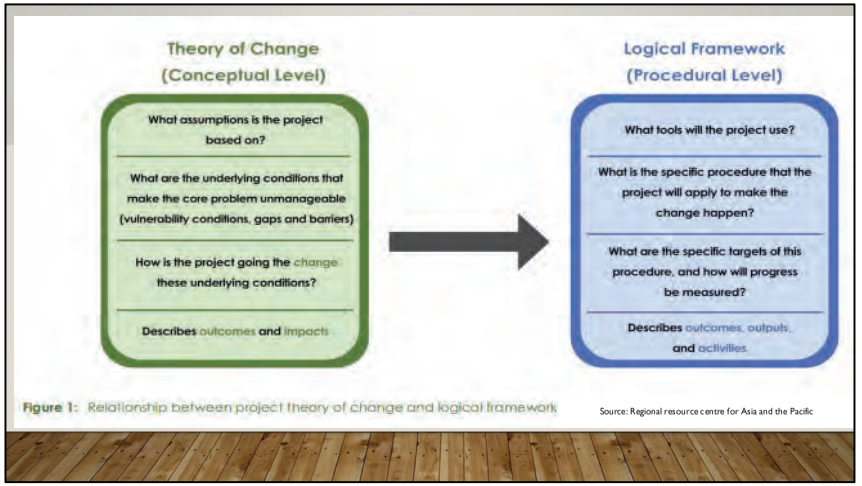


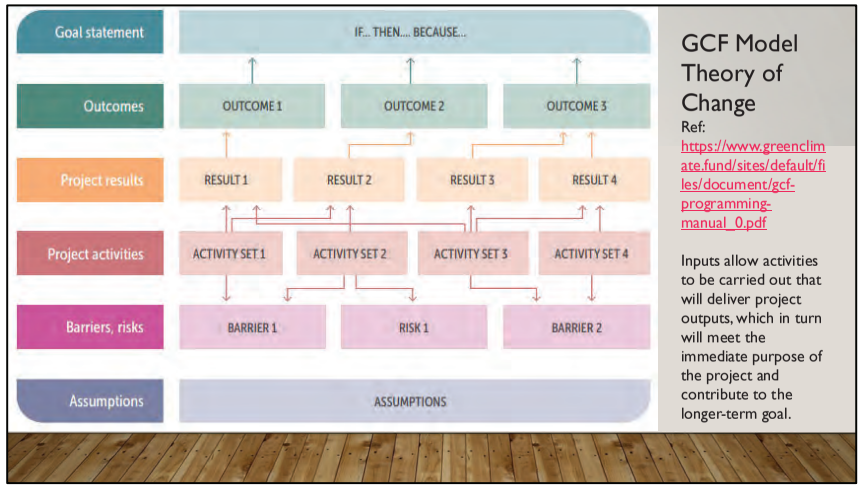
Figure 1: Relationship between project theory of change and logical framework

Source: Regional resource centre for Asia and the Pacific

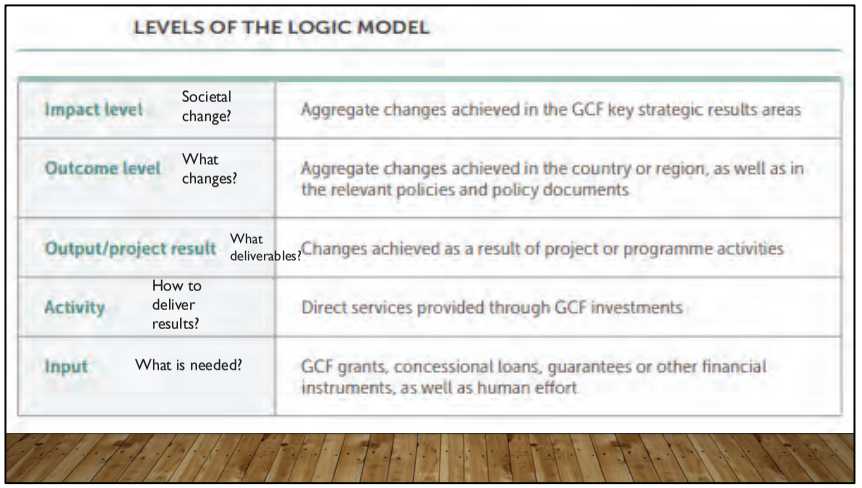
A good way to think about the difference between a theory of change and the logical framework is that the theory of change is essentially at a conceptual level.

So what assumptions is a project based on? What are the underlying conditions that make the core problem currently unmanageable, often through vulnerability assessments or identification of gaps and barriers?

And how is the project going to change these underlying conditions?
It will describe the outcomes and impacts at a high level of the logic chain.
The logical framework, however, is a more procedural arrangement where we look at what tools will a project use, what are the specific procedures that the project will apply to make the change that's desired actually happen?
And what are the specific targets of this procedure and how will progress be measured? And it describes the outcomes, the outputs and activities, as well as the input supports to achieve those activities.

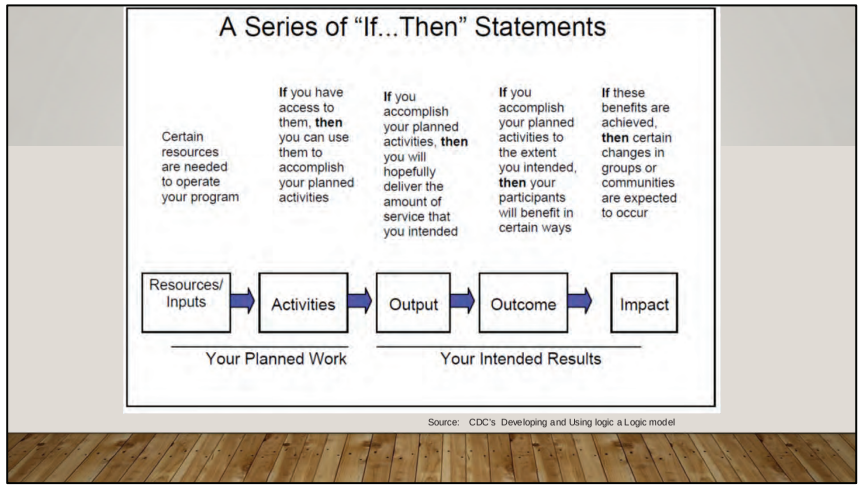


The GCF has provided a standard diagram that is relatively easy to fill in and it basically moves from the understanding of that inputs will allow activities to be carried out that will deliver project outputs which in turn will meet the immediate purpose of the project and contribute to the longer term goal that GCF is trying to achieve through its overarching paradigm shift.
Importantly, the goal statement also operates on a logical basis and says if we carry out activity X then we achieve output Y because we have undertaken a series of inputs.



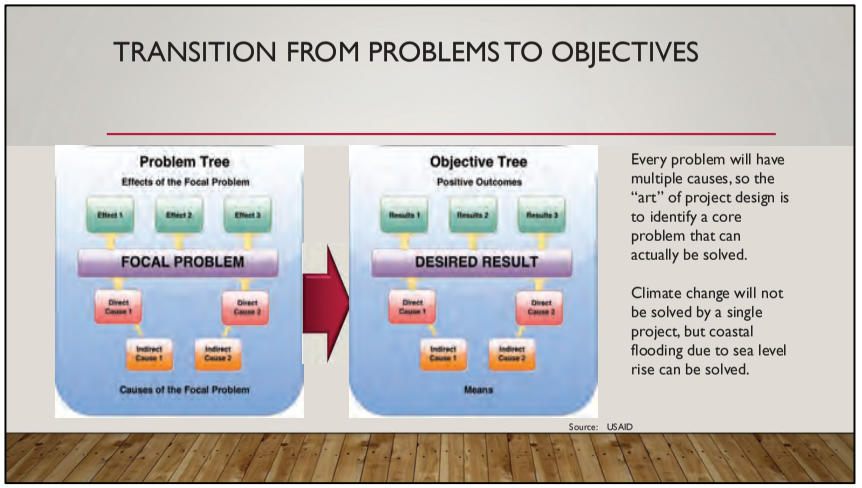
And there are different levels of the logic model that apply in the theory of change. At the impact level, which is the highest level, we're actually looking for societal change. What are the aggregate changes achieved in the GCF key strategic result areas?

At the outcome level, we're asking what changes? What changes are achieved in the country or region or project area, as well as in the relevant policies and policy documents at the national level? At the output or project result level we're really asking what are the tangible deliverables that the project will provide?
What are the changes achieved as a result of a project or programme activities?
At the activity level we're asking the question how do we deliver the results? And these are the direct services provided through GCF investments. And at the input level we ask what is needed to deliver the results?
These can be the GCF grants, concessional loans, guarantees or other financial instruments as well as the human effort that goes into project implementation.



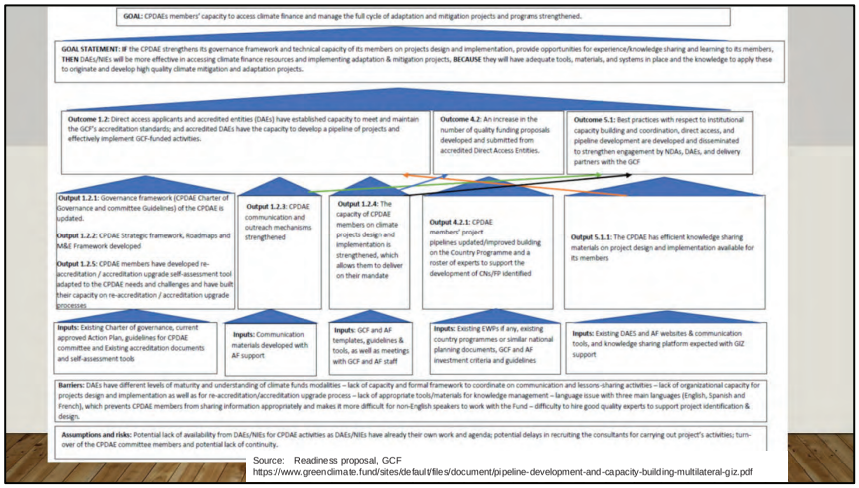
And the logic that underpins the theory of change is that you need certain resources to operate your programme or your project.
These are the inputs and if you have access to these inputs then you can use them to accomplish your planned activities. And if you accomplish your planned activities, then you will hopefully deliver the amount of products and or services that you intended as part of your project design.
And these are the outputs. And if you accomplish your outputs and planned activities to the extent you intended, then your participants or beneficiaries will benefit in certain ways. These are your outcomes.

And if these benefits to the participants and outcomes are achieved, then certain changes in organisations, communities or systems might be expected to occur and contribute to the impact that the GCF is looking for.



Now every problem will have multiple of course.

So the art of project design is to automatically identify a core problem that can actually be solved. Climate change is so enormous and so all encompassing it cannot be solved by a single project. But coastal flooding in a specific area due to sea level rise is something that can be solved through an adaptation project.
So it's really important then to identify a problem which is solvable and then the desired result is something which is actually achievable.



Source: Readiness proposal, GCF
https://www.greenclimate.fund/sites/default/files/document/pipeline-development-and-capacity-building-multilateral-giz.pdf

I won't go through the detail of this particular slide is simply to show the kind of diagrammatic format that the GCF is looking for.
In addition to the narrative type approach for the theory of change.

GOAL	Sustaining community resilience to climate change risks
GOAL STATEMENT	IF communities have access to safe shelter, water and food supplies all year-round and adopt climate resilient practices in their daily lives THEN community resilience can be sustained BECAUSE they are better prepared for climate change risks
RESULTS (Fund level) – defined by GCF	• A1.0 Increased resilience and enhanced livelihoods of the most vulnerable people, communities, and regions • A2.0 Increased resilience of health and well-being, and food and water security • A3.0 Increased resilience of infrastructure and the built environment to climate change
OUTCOMES (Fund level) – defined by GCF	• A5.0 Strengthened institutional and regulatory systems for climate-responsive planning and development • A6.0 Increased generation and use of climate information in decision-making • A7.0 Strengthened adaptive capacity and reduced exposure to climate risks • A8.0 Strengthened awareness of climate threats and risk-reduction processes
RESULTS (Project level) – defined by the project	• An effective island /district and community development and CCDRR plans • Community-driven climate resilient interventions are implemented and sustained • Strengthened capacity of the Local Government and NGOs /CSOs to support community-based adaptation measures • Strengthened leadership in climate change and disaster risk reduction within the Local Government, NGOs /CSOs and the Community • An operational and effective community-based small grants programme

Here is a fairly typical narrative type approach for a theory of change. It starts with an overarching goal which is sustaining community resilience to climate change risks. It has this if then because goal statement if communities have access to safe shelter, water and food supplies all year round and adopt climate resilient practices in their daily lives, then community resilience can be sustained because they're better prepared for any future climate change risks.

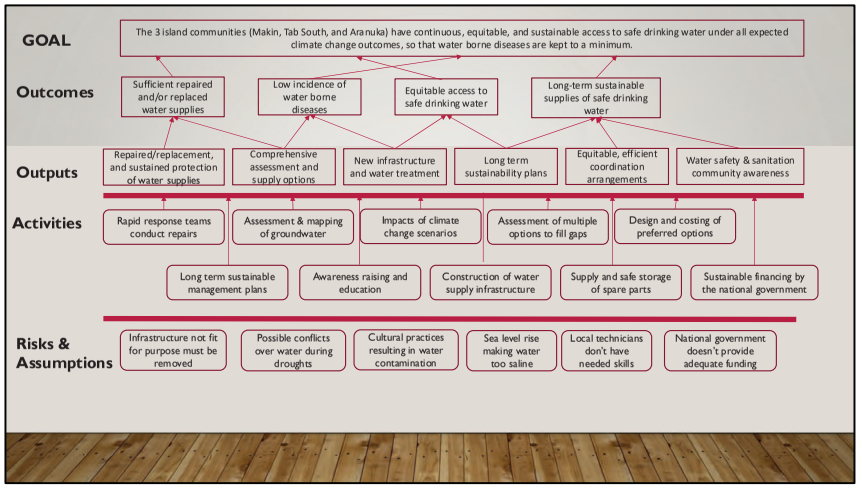
And the results which are at the fund level and defined by the GCF are increased resilience and enhanced livelihoods, increased resilience of health and wellbeing, food and water security, increased resilience of infrastructure and the built environment to climate change and these are defined by the GCF and must be reflected in the project design.

Similarly, at the outcome level these are also defined by the GCF and in this case would be a 5.0 through to a 8.0 relating to strengthened institutional and regulatory systems, increased generation and use of climate information, strengthen adaptive capacity and reduced exposure to climate risks and strengthen awareness of climate threats and risk reduction processes.

And the results are actually defined at the project level and are defined by the project proponent and these may be things like an effective island or district and community development with climate change and disaster risk reduction plans. Community driven climate impact interventions are implemented and sustained.
Strengthen capacity of local government and NGOs, strengthen leadership in climate change and DRR within the local government, and an operational and effective community based small grants programme to provide the funding to carry out these interventions.

So I'll leave it there and thank you for your attention. I hope this has given you some insight into what is a theory of change and how important it is in designing a bankable project, particularly for the GCF.

626



Here is another version, a simpler version of that rather complicated theory of change.
And here you can see that there is a logical connection between the various activities, the intended outputs, the outcomes and the ultimate goal of the project. And below the line there are the risks and assumptions that underpin the project design.

CONTENTS

1. Introduction
2. Problem tree
3. Objective tree
4. Logical framework
5. Summary

627

CBCRP-PCCC Training Course

“Enhancing Climate Resilience in Tourism in the Pacific”

Government of Samoa, SPREP and JICA

Module 3. Problem and Objective trees and logical framework

3.2 Project objectives

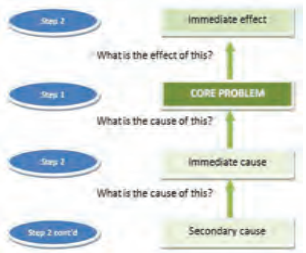
Peter King | Senior Policy Advisor
IGES

Tetsuya Yoshida
JICA Short-term Expert
Oriental Consultants Global, Co., Ltd.

Brainstorming a "Problem Tree"

Starting point: construct a **problem tree** that links causes and effects

1. Define "**core problem**"
   - Displacement due to flooding
   - Water/sanitation deficiencies
2. Identify **direct causes** and **direct effects**
   - Cause- Heavy rains
   - Cause- Overburdened infrastructure
   - Cause- Settlement in flood prone areas
   - Cause- Obstructed drains
   - Effect - Increased vulnerability
   - Effect - Damage to infrastructure
3. Identify **secondary (indirect) causes**
   - Rural-urban migration
   - Lack of planning
   - No responsible lead agency
   - Inadequate urban finance



Source: USAID

628

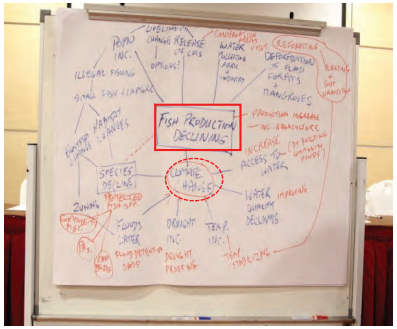
We start off with brainstorming a problem tree. A problem tree is something that links causes and effects. It basically has 3 steps. The first step is to define what is a core problem you're trying to solve. It could be something like displacement due to flooding or it could be water or sanitation deficiencies. Then, you identify the direct causes and the direct effects. The cause of flooding could be heavy rains or could be overburdened infrastructure or it could be settlements in flood-prone areas or obstructed drains. The effect could be an increase of vulnerability of communities or could be damage to roads and other infrastructure.
Then, the third step is to identify the secondary or underlying driving causes. These could be issues like so many people are moving from rural areas to urban areas, could be a lack of urban planning, could be that there is no responsible lead agency driving the process, or it could be that there is inadequate urban finance. The secondary cause leads to the immediate cause. The immediate cause leads to the core problem, and the core problem leads to the immediate effect. That's the logical chain of events that underpins a problem tree.

Introduction

- In formulating *a climate change adaptation/ mitigation project*, the theory of change and the **logical framework** are key elements.
- They are described as tools of logic that connect cause and effect.
- All projects are designed to overcome a problem, but problems may have multiple causes.
- How do we know if we have identified the **core problem** and the **main causes**?
- All projects are intended to achieve a purpose or a goal and if it fails to achieve that end point (or ultimate effect) then the project is regarded as a failure. In the case of climate change adaptation projects, failure may also result in maladaptation.
- This session is intended to help you come to the right decisions that will lead to a convincing logical framework that will guide successful implementation.

In formulating any climate change adaptation project, the theory of change in the logical framework are key elements but what do they really mean? They're described as tools of logic that connect cause and effect but how do we uncover those connections? Now all projects are designed to overcome a specific problem, but problems may have maltiple causes so how do we know if we have identified the core problem and the main causes? Again all projects are intended to achieve a purpose or a goal and if the project fails to achieve that in point or ultimate effect.
Then, the project is regarded as a failure. In the case of adaptation projects, failure may also result in what's called maladaptation or the opposite to what is expected. So, this session is intended to help you come to the right decisions that would lead to a convincing theory of change and a logical framework that will ultimately guide successful implementation.

The problem tree is the “engine” of the project design



Source: USAID

- Involve the project beneficiaries and ask them to brainstorm about what they think the problem is.
- Do not assume you know what the real problem is.
- Do not start from an assumption that climate change is the problem.

Useful tips:
- It is critical to identify the core problem right in formulating a project.
- Avoid including contributing causes in the core problem statement.
- Identify one most important issue as the core problem, and avoid including multiple elements in the core problem (e.g. property damage due to severe floods).

629

Now the problem tree is really the engine of the project design and it's always advisable to involve the project beneficiaries and ask them to brainstorm about what they think the problem is. As an expert don’t assume you know what the real problem is. You may not have sufficient local knowledge. And don't start from an assumption that climate change is a problem simply because you're preparing a concept note for the GCF. In this particular case that I've shown here where the brainstorming is very messy, the participant started with an assumption that
climate change was the core problem but as the brainstorming progressed it was realized that actually the core problem was a decline in fish productivity and climate change was really just one of multiple causes.

Brainstorming

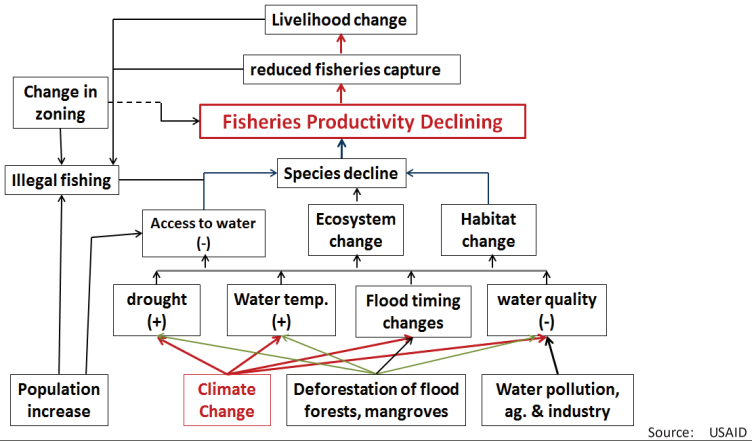
- Break participants into small groups.
- Prepare flipcharts, post-it notes, marker pens, and a table to spread out.

- Step 1. Consider what you think **the main problem** is.
- Step 2. Analyse what is **the main cause** of that main problem.
- Step 3. Check if there is **any other cause** of that direct cause.
- Step 4. Re-arrange all the answers in a tree.
- Step 5. Do the same for the effects, identify the **direct effects** and **indirect effects** of that main problem.

- You will be asked to do the same in an exercise in this training course.

Now to get to the problem tree. The best way of doing this is through brainstorming.
With breaking participants into relatively small groups so that every voice is heard making sure that they're all well equipped with flip charts, post-it notes, marker pens and a table to spread out on. And you start by asking each person what they think the main problem is and write down their answers on a post-it note. In a second-round ask each person what they think is the main cause of that core problem, and in the third round ask if there is any other cause of that direct cause. You rearrange all the answers in the form of a tree with roots and a trunk and some branches, starting off with a consensus on what you believe to be the main or the core problem. Step back from that and check if any key cause has been missed. Now do the same for the effects starting with the direct effects and then possibly secondary or indirect effects.
Now take note of these directions because later on in the course you'll actually be asked to do this in an exercise.

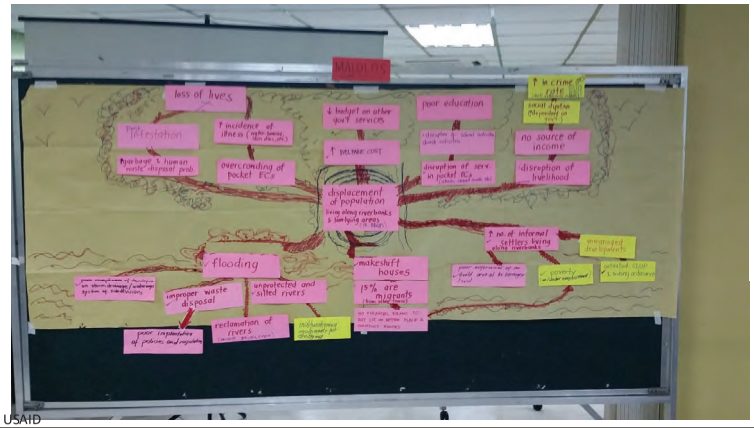
Reorganise the messy brainstorming



Source: USAID

Once you've done that then it's always good to try and reorganize the messy brainstorming approach into something which ultimately could go into a project document and demonstrate some clear thinking in terms of what are the causes, what is the core problem and what are the effects.

Use post-it notes to move things around

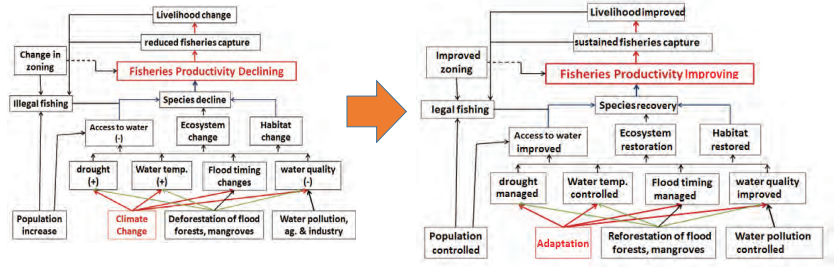


Source: USAID

Now the reason we suggest to use post-it notes is so that you can move things around on the roots and branches of the tree that enables you to organize your thoughts in a more logical fashion.

An Objectives Tree

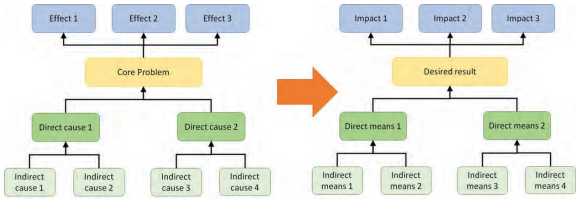
- Objectives trees transform all problems from your Problem Tree into an objective – Each negative problem will become a positive objective.
- Each cause can be transformed into a possible project activity or component. For example, water pollution control or reforestation could be key activities.



Source: USAID

We come up with an objectives tree by basically transforming all of your problems from your problem tree into an objective. So each negative problem is then turned around to become a positive objective. And note again that climate change might not be the core problem but it could be one of the contributing objectives. Below the core result or project output, each cause can be transformed into a possible project activity or component. For example, in this objectives tree, water pollution control, reforestation or ecosystem restoration could be key activities that ultimately contribute to species recovery and the improvement in fisheries productivity.

Transition from Problem tree to Objectives tree



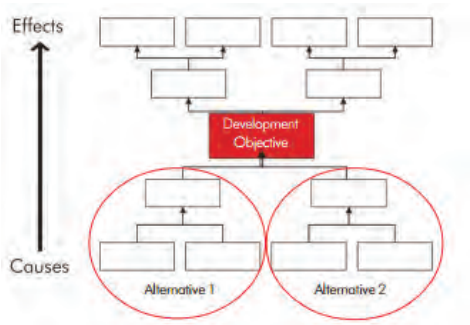
- Every problem will have multiple causes.
- The "art" of project design is to identify a Core Problem that can actually be solved.
- Climate change will not be solved by a single project, but an eroding coastline due to sea level rise can be solved.
- Solving the Core Problem will provide the desired result at the end of the project. This result will contribute to other positive outcomes and long-term impacts.

Tips:
- Problem tree and objectives tree are mirror images of each other – one negative, the other positive.
- The Means you identify in the Objectives Tree will be the basis of Project Activity in your Logical Framework.

Source: USAID

Once we have a problem tree worked out, it's relatively simple to transition from a problem tree to an objectives tree. Every problem will have multiple causes so the art of project design is to firstly identify your core or focal problem that can actually be solved. Climate change is a global problem, it is not going to be solved by a single project but an eroding coastline in a specific location due to the sea level rise can be solved. Now solving the core problem will provide the desired result at the end of the project, but that result in turn will contribute to other positive outcomes and long-term impact beyond the scope of the specific project.

Use the objectives tree to decide on project alternatives



- There may be several alternative ways that a project can contribute to the development objective.
- The objectives tree can help to illustrate these alternative pathways and lead to a consensus on which one shows the most promise for reaching the central development objective.
- In some cases, the objectives tree might highlight the possibility of complementary projects that will combine to reach the central development objective.

Useful tips:
- Direct Causes and Indirect Causes you identified in the Objectives Tree can be the basis of your Logical Framework (transformed as Project Activity and Inputs).
- You can put only the selected Causes in your Logical Framework which are relevant to your project objectives.

Source: ADB

632

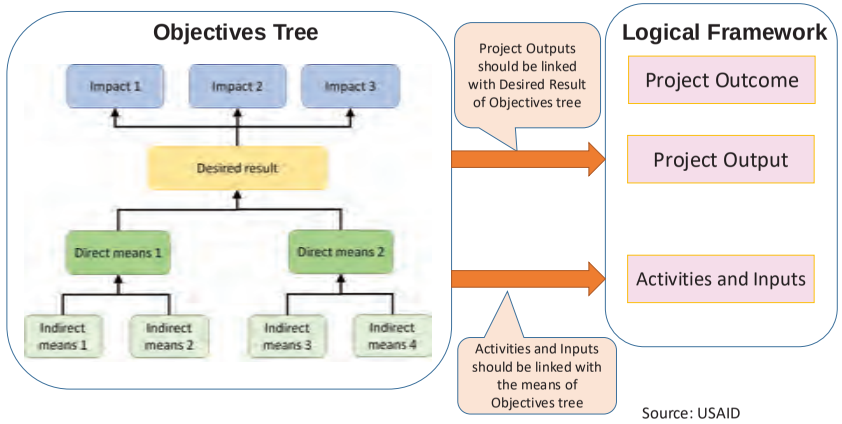
Now we can also use the objectives tree to decide on project alternatives. There are often several alternative ways that a project can contribute to the development objectives. The objectives tree can help you to illustrate these alternative pathways and lead to a consensus on which one shows the most promise for reaching the central development objective. In some cases, the objectives tree might also highlight the possibility of complementary projects that will each combine to reach the central development objective.

Check that no critical cause or effect has been missed

- Once your problem tree and objectives tree have been completed, stand back and discuss if anything has been missed or if a specific cause or effect is too minor to include.
- In the fisheries productivity example, one of the key elements that the brainstorming missed was the lack of capacity in the local compliance and enforcement agency, which was a contributing cause of the water pollution problem, the deforestation problem, and inadequate control of the illegal fishing. This omission could have been because the brainstorming group did not include people outside the government or potential beneficiaries.
- If this capacity issue was not addressed, then the whole project could fail. Later on we will see why the logical framework would have included this as a potential risk or assumption.

Once your problem tree and your objectives tree have been completed, stand back, have them side by side and discuss if anything is being missed or if a specific cause or effect is too minor to include. In the fisheries productivity example, one of the key elements with the brainstorming missed was the lack of capacity in the local compliance and enforcement agency, which was a contributing cause of the water pollution problem, the deforestation problem, and inadequate control of the illegal fishing. This omission could have been because the brainstorming group did not
include people outside the government or potential beneficiaries. Now if this capacity issue was not addressed, then the whole project could fail and later on we'll see why the logical framework would have included this as a potential risk or an assumption.

Develop the Logical Framework from the Objectives Tree



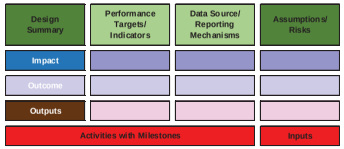
Source: USAID

633

Going from the objectives tree to the logical framework is a simple process where the means in the objectives tree are basically what becomes the inputs and activities that lead to the end of project outputs, which is the same as the desired result of the objectives tree. The purpose or outcome and the goals or impacts of the extension beyond the project boundary is equivalent to the results both direct and indirect that come from the objectives tree.

Logical Framework

- A logical Framework is also called:
  - Project Framework
  - Logframe
  - Project Decision Matrix
  - Results Framework
  - Design and Monitoring Framework
- Standard sections:
  - **Four Columns** – Design Summary (Description), Performance Targets, Monitoring Mechanisms, and Assumptions and Risks;
  - **Five Rows** – Goal, Purpose (Outcome), Outputs, Activities, Inputs.
- Note hierarchical "logical" relationships vertically and horizontally, link all 20 frames.
- **Inputs** allow **activities** to be carried out that will deliver project **outputs**, which in turn will meet the immediate purpose (**outcome**) of the project and contribute to the longer-term **goal**.



Source: ADB

Now turning to the logical framework, sometimes is also called the project framework or shortened to logframe. Sometimes it's called a project decision matrix, a results framework or a design and monitoring framework. These are essentially different terms for the same matrix. There are standard sections. There are four columns: a design summary or description, performance targets, monitoring mechanisms and assumptions and risks. And there are 5 rows: the goal, the purpose sometimes called an outcome, outputs, activities and inputs. So note that there is a hierarchical logical relationship both vertically and horizontally that links together all 20 frames of the logical framework. A way to understand this is that the inputs allow activities to be carried out that will deliver the project outputs, which in turn will meet the immediate purpose of the project and contribute to the longer-term goal.

Logical framework approach of Green Climate Fund (GCF)

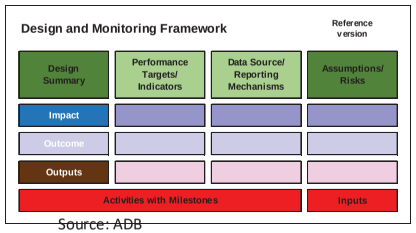
H.1.1. Paradigm Shift Objectives and Impacts at the Fund level[1]						
Paradigm shift objectives						
Increased climate resilient sustainable development	Please elaborate on the paradigm shift objectives to which the project/programme contributes.					
Expected Result	**Indicator**	**Means of Verification (MoV)**	**Baseline**	**Target**		**Assumptions**
				Mid-term (if applicable)	Final	
Fund-level impacts						
Choose appropriate expected results	*Please select relevant GCF indicators from the Fund's performance measurement framework. More than one indicator may be selected per expected impact result.*					

In this Logframe template (version 2.0), GCF specifies the ultimate goal (paradigm shift), fund-level impacts, and core indicators.
In addition to the core indicators, GCF also suggests additional indicators at:
https://www.greenclimate.fund/sites/default/files/document/mitigation-adaptation-performance-measurement.pdf
https://www.greenclimate.fund/document/integrated-results-management-framework

Paradigm shift objective: Increased climate resilient sustainable development
Fund-level impacts (adaptation):
- ✓ 1.0 Increased resilience and enhanced livelihoods of the most vulnerable people, communities, and regions
- ✓ 2.0 Increased resilience of health and wellbeing, and food and water security
- ✓ 3.0 Increased resilience of infrastructure and the built environment to climate change threats
- ✓ 4.0 Improved resilience of ecosystems and ecosystem services

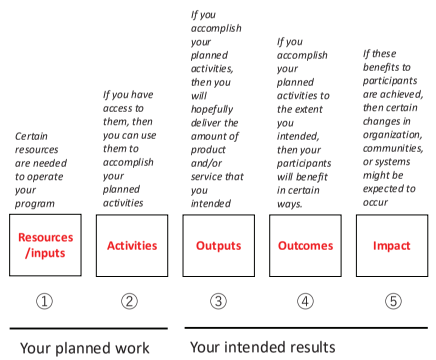
Core indicators (for adaptation): e.g. Total Number of direct and indirect beneficiaries; Number of beneficiaries relative to total population; Number and value of physical assets made more resilient to climate variability and change, considering human benefits (reported where applicable)

Performance targets



Source: ADB

- ➢ To ensure that each design "element" is implemented as planned, performance **targets** are specified, as are the mechanisms for **measuring** these targets – plus the **risks** that could upset achievement are explicitly recognized and assumed to be mitigated (by another project, by the government agency, or by other means).
- ➢ Unmitigated or unforeseen risks could torpedo an otherwise well-developed project.

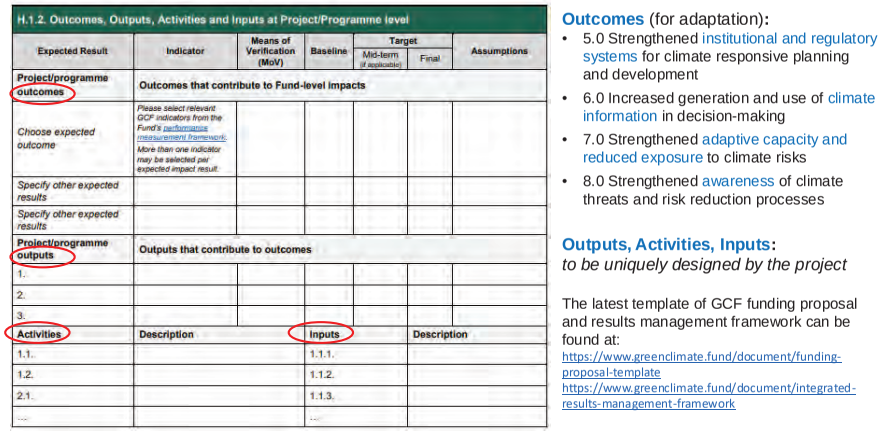


634

The way the Green Climate Fund approaches the logical framework is worthwhile getting a better understanding as you will often be involved in looking at this framework. The first thing to note is that the ultimate objective or the impact that is intended is specified as a paradigm shift objective of the GCF. Given that the overall mandate for the GCF is a paradigm shift. In the case of an adaptation project, this is increased climate-resilient sustainable development. The GCF also defines fund level impacts and in the case of an adaptation project, there are basically four of these:
increased resilience and enhanced livelihood with the most vulnerable people, communities and regions, increased resilience of health and well-being and food and water security, increased resilience of infrastructure and the built environment to climate change threats, or improved resilience of ecosystems and ecosystem services. Now for each of these impacts GCF has also indicated a number of core indicators. In the case of an adaptation project, it is the total number of direct and indirect beneficiaries plus the number of beneficiaries relative to the total population.
It could also be the number in value of physical assets made more resilient to climate variability and change considering human benefits where applicable.
Note that GCF specifies the ultimate goal, the fund level impacts and the core indicators. In addition to these core indicators, the GCF also suggests

In relation to performance targets, it's important to ensure that each design element is implemented as planned. So, performance targets are specified as well as the mechanisms for measuring those targets. Then in turn, the risks that could upset achievement are explicitly recognized and assumed to be mitigated either by another project, by the government agency or by other means. Unmitigated or unforeseen risks could actually torpedo an otherwise well-developed project. Another way to think about the logic of the logical framework is that your planned work will consist of the resources and inputs that you have available to operate your program. These contribute to a certain number of activities, so if you have those inputs, you can use them to accomplish your planned activities. These in turn lead to your intended results. Firstly, if you accomplish your planned activities, then you will hopefully deliver the amount of product or service that you intended at the end of the project. If you achieve those outputs, then you may benefit wider outcomes at your national level, at the regional level, or at the global level and if you achieve those outcomes
then you may be able to contribute in some way to much broader impact, such as the Paris agreement for example.

Logical framework approach of GCF (cont.)



H.1.2. Outcomes, Outputs, Activities and Inputs at Project/Programme level

Expected Result	Indicator	Means of Verification (MoV)	Baseline	Target		Assumptions
				Mid-term (if applicable)	Final	
Project/programme outcomes	**Outcomes that contribute to Fund-level impacts**					
Choose expected outcome	*Please select relevant GCF indicators from the Fund's performance measurement framework. More than one indicator may be selected per expected impact result.*					
Specify other expected results						
Specify other expected results						
Project/programme outputs	**Outputs that contribute to outcomes**					
1.						
2.						
3.						
Activities	**Description**		**Inputs**		**Description**	
1.1.			1.1.1.			
1.2.			1.1.2.			
2.1.			1.1.3.			
...			...			

Outcomes (for adaptation):

- 5.0 Strengthened institutional and regulatory systems for climate responsive planning and development
- 6.0 Increased generation and use of climate information in decision-making
- 7.0 Strengthened adaptive capacity and reduced exposure to climate risks
- 8.0 Strengthened awareness of climate threats and risk reduction processes

Outputs, Activities, Inputs:
to be uniquely designed by the project

The latest template of GCF funding proposal and results management framework can be found at:
https://www.greenclimate.fund/document/funding-proposal-template
https://www.greenclimate.fund/document/integrated-results-management-framework

635

Moving further down in the logical framework to the outcomes. The GCF also specifies the outcomes. In the case of adaptation projects, these are again four: strength and institutional and regulatory systems for climate responsive planning and development, increased generation and use of climate information in decision-making, strengthened adaptive capacity and reduced exposure to climate risks, and strengthened awareness of climate threats and risk reduction processes. Then to go one step further down to the project or program outputs. These are left up to the program designer or the project designer to specify. Then you come down to the activities and a description of those and the inputs required to achieve each of those activities and again a description of those and that information then goes into your budget proposal.

Note:
https://www.greenclimate.fund/sites/default/files/document/mitigation-adaptation-performance-measurement.pdf
Please refer to page 9 and 10 of the document “Mitigation and adaptation performance measurement frameworks” for outputs examples of GCF.

additional indicators and there is a website where you can see those additional indicators that you may use in your own project designs.

Note:
https://www.greenclimate.fund/sites/default/files/document/mitigation-adaptation-performance-measurement.pdf
Please refer to page 7 and 8 of the document “Mitigation and adaptation performance measurement frameworks” for details.

addition to the core indicators, GCF also suggests additional indicators for the outcome level while leaving the project output targets and indicators to the project designers.

Summary of this presentation

- All projects are designed to overcome a problem, but problems may have multiple causes, so a **"problem tree"** helps to sort out cause and effect.
- Similarly, all projects are intended to achieve a purpose or a goal and if we fail to achieve that end point (or ultimate effect) then the project is regarded as a failure. An **"objectives tree"** helps to identify the means of achieving a desired result or **output** at the end of a project, as well as indicating the longer-term **outcomes** and impacts that the project can contribute to.
- The **objectives tree** is simply the mirror image of the problem tree, where all negatives are turned into positives. The objectives tree may also highlight alternative pathways to achieve the desired result as well as indicating the possibility of multiple, complementary projects.
- The objectives tree contributes the "bones" of the **logical framework**, which consists of **Four Columns** – Design Summary, Performance Targets, Monitoring Mechanisms, and Assumptions and Risks; and **Five Rows** – Goal, Purpose (Outcome), Outputs, Activities, Inputs.
- Most funding sources require a logical framework (or equivalent) as a crucial part of any project proposal. The Green Climate Fund (GCF) specifies the ultimate goal (paradigm shift), fund-level **impacts**, and core **indicators**. In addition to the core indicators, GCF also suggests additional indicators for the **outcome** level, while leaving the project **output** targets and indicators to the project designers.

To summarize, all projects are designed to overcome a specific problem but problems may have multiple causes, so a problem tree helps to sort out cause and effect.
Similarly, all projects are intended to achieve a purpose or a goal and if we fail to achieve that endpoint or ultimate effect then the project is regarded as a failure. An objectives tree helps to identify the means of achieving a desired result or output at the end of a project as well as indicating the longer-term outcomes and impacts that the project can contribute to in some small way. The objectives tree is simply the mirror image of the problem tree where all of the negatives of the problem tree are turned into positives. The objectives tree also highlights alternative pathways to achieve the desired result of the project as well as indicating the possibility of multiple complementary projects to achieve the core objective. The objectives tree contributes
the bones of the logical framework which consists of 4 columns: a design summary, performance targets, monitoring mechanisms and assumptions and risks, and 5 rows: goal purpose, output activities and inputs giving a total of 20 elements that need to be filled in. Now most funding sources require a logical framework or its equivalent as a crucial part of any project proposal. The Green Climate Fund specifies the ultimate goal, that is a paradigm shift, the fund level impacts, which they have pre-defined and the core indicators. In