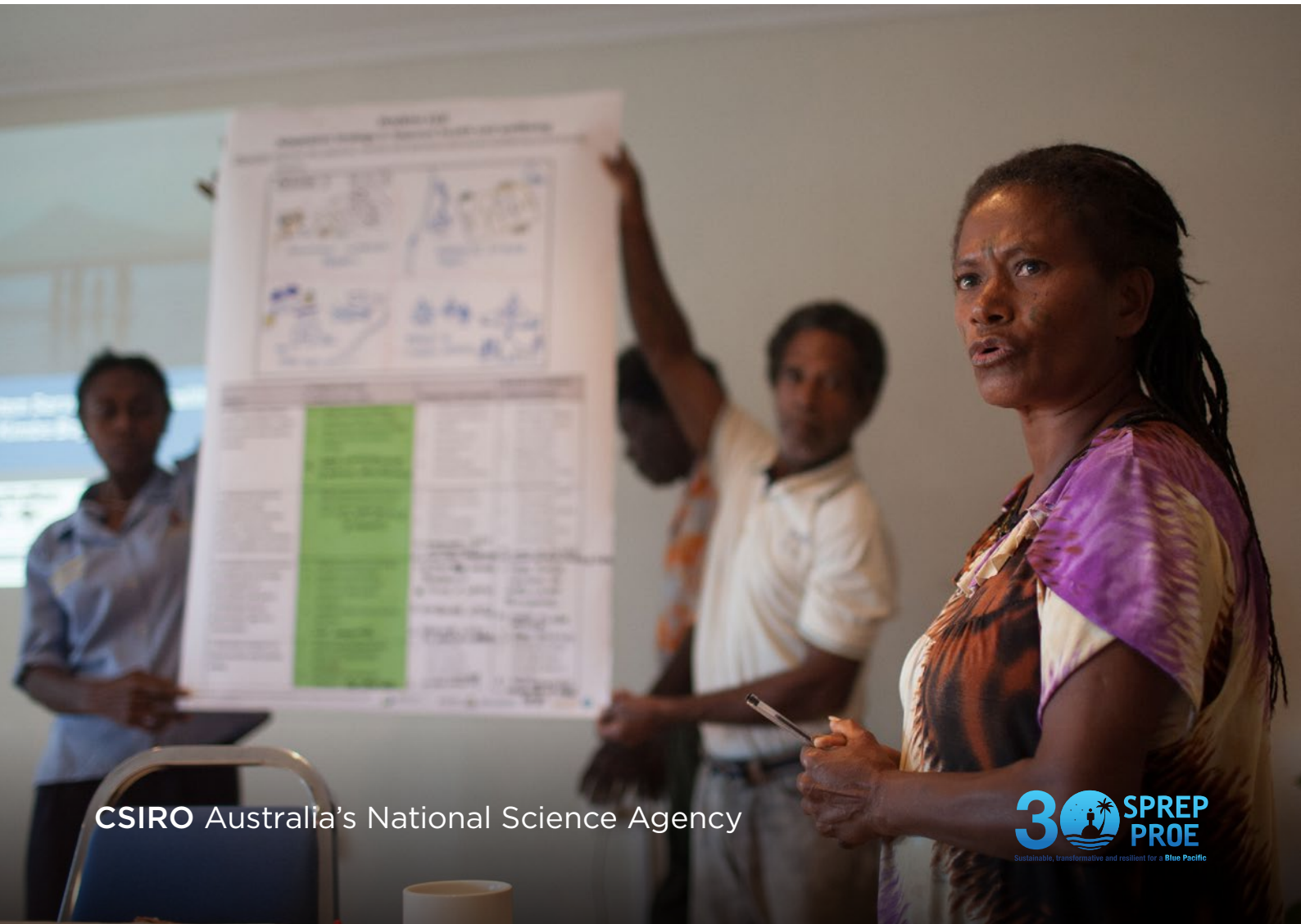
Knowledge Broker Support Program

Volume 1 – Foundation – Climate information module

The Knowledge Broker Support Program (KBSP) was funded by the Australian Department of Foreign Affairs and Trade, through the Australia Pacific Climate Partnership.



Citation

Cosijn, M., Meharg, S. Grigg, N., Busilacchi, S., Barbour, E., Nadelko, A., Skewes, T., Taboada, M.B., Hayes, D. and Butler, J.R.A., 2023, Knowledge Broker Support Program Volume 1 – Foundation Modules, CSIRO, Canberra, 72 pp.

Copyright

Important disclaimer

Cover photo: Knowledge broker in action. Photo by Tom Greenwood, 2017. Photo below by Tom Greenwood.

Climate information

This module introduces some climate data sources and information available for the Pacific region.

After completing this module, you will better understand:

1. **Where and how to access various climate information;**
2. **When to get specialist assistance to support you;**
3. **Challenges of using climate data.**

Introduction

In this module, we assume that you have listened to stakeholders and identified a clear problem that requires climate information.

It is likely you will need to work with climate specialists to identify appropriate climate information and how to use it. Before doing so, it is useful to have an overview of the kinds of information that are available.

It is easy to be overwhelmed by the many kinds of climate information found in different places, so in this module, the focus is on easily accessible, general climate information for both historical and future periods.

This module introduces some climate information, along with associated guidance that is readily available.

Where possible, we focus on sources that are tailored specifically to the Pacific region.

Some definitions

- **CLIMATE DATA** – Historical climate observations along with direct model outputs covering historical and future periods.
- **CLIMATE PRODUCT** – A derived synthesis of climate data
- **CLIMATE INFORMATION** – Climate data, climate product and / or climate knowledge
- **CLIMATE SERVICE** – Climate information provided in a way that assists decision-making by individuals and organisations.
- **CLIMATE PROJECTIONS** – Changes to climate are simulated on the basis of a given set of input conditions—a given representative concentration pathway (RCP) scenario and the climate model in which it is used.
- **CLIMATE SCENARIOS** – These can be based on projections but will often require specific formulation so the impact model can use the climate change information.

Getting started on climate information

RCCAP – Regional Climate Consortium for Asia and the Pacific

www.rccap.org

The Regional Climate Consortium for Asia and the Pacific (RCCAP) website is a helpful place to start.

It provides links to recent updated climate change information for the Pacific, observed and modelled climate data, guidance on how to use climate information, and a set of case studies from the Pacific showing how this kind of climate information is used in vulnerability and impact assessments. It is also a good place to learn some of the basics, including definitions of common terms.

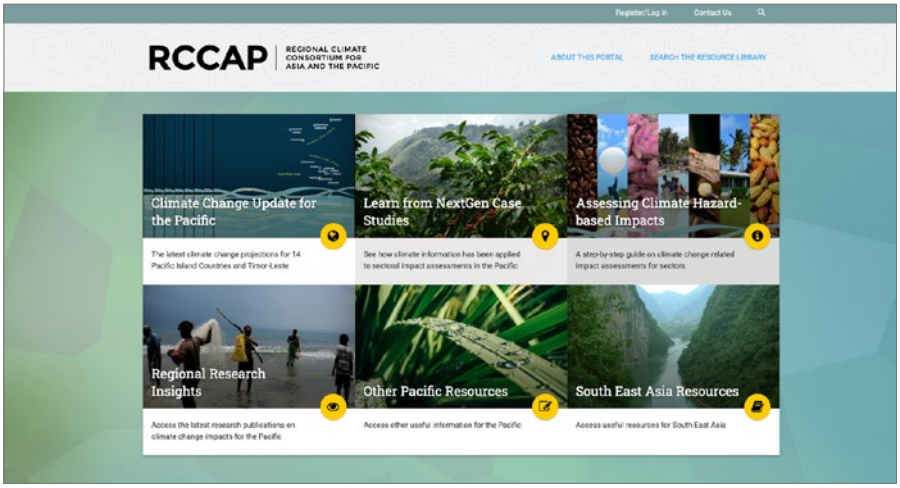


Figure 29 The Regional Climate Consortium for Asia and the Pacific (RCCAP) website

Other climate data sources

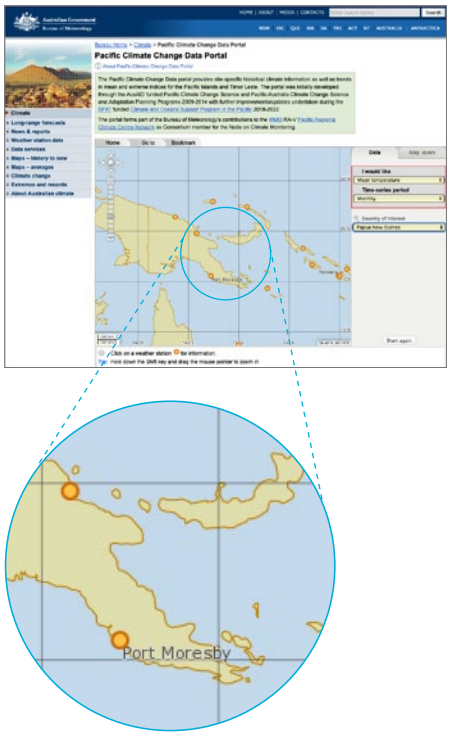


Figure 30 The orange circles indicate where temperature data is available in Papua New Guinea. Source: *http://www.bom.gov.au/climate/pccsp/*

There is a whole world of climate science out there. Many groups around the world are working on many different aspects of climate science, and there is also a lot of replication of modelling experiments so that we can understand how reliable and robust the science is.

Observed climate data in the Pacific

Climate observations recorded at official meteorological stations from across the Pacific region are a valuable resource for understanding past and current local climate.

The Australian Bureau of Meteorology hosts a **Pacific Climate Change Data Portal** (http://www.bom.gov.au/climate/pccsp/) where you can access readily available historical climate information.

Figure 30 shows you the locations where temperature data is available in Papua New Guinea.

There may be additional weather station and climate data available through local government and research agencies.

If weather station data is not available at a location of interest, there may be other valuable local knowledge of climate conditions, and there are global gridded climate products that attempt to fill in the gaps. Observed climate data is also vital for checking that these gridded data sets represent local climate well.

Gridded climate data

WorldClim (www.worldclim.org) provides high-resolution estimates of climate in places where we don't have measurements. It is open-source gridded climate data:

- WorldClim v1.4 (1960-1990 means); and
- WorldClim v2.1 (1970-2000 means).

Via WorldClim, there are monthly climate data for temperature, rainfall, solar radiation, wind speed and more.

A set of 19 bioclimatic variables are provided that are biologically relevant. They are commonly used by ecologists and agricultural researchers to relate ecological and agricultural responses to different aspects of climate change.

For example, extreme temperatures are important for some species, and so the maximum temperature of the warmest month (BIO5) could be a useful variable.

WorldClim can be useful in areas where you may not have an available record of past and current climate.

Projecting future climates is a core part of the science, this is conducted by many research groups around the world, each developing and running different global climate models.

The Intergovernmental Panel on Climate Change (IPCC)

The Intergovernmental Panel on Climate Change (IPCC) has been collating, synthesising, and communicating the findings of the global climate research community since its formation in 1988. It follows a rigorous, multi-year process involving hundreds of scientists to review published research and prepare assessment reports that are released every few years.

The IPCC is currently in its Sixth Assessment cycle, which produces four assessment reports. The reports are the result of a rigorous, peer-reviewed process involving the research of thousands of scientists. The reports are very detailed and complex, and not intended for general audiences, but it is helpful to know of their existence because the authoritative messages of the IPCC are founded on these assessment reports:

1. **AR6 Climate Change 2021: The Physical Science Basis.**
   https://www.ipcc.ch/report/sixth-assessment-report-working-group-i/
   Publication date: August 2021
2. **AR6 Climate Change 2022: Impacts, Adaptation and Vulnerability.**
   https://www.ipcc.ch/report/sixth-assessment-report-working-group-ii/
   Publication date: February 2022
3. **AR6 Climate Change 2022: Mitigation of Climate Change.**
   https://www.ipcc.ch/report/sixth-assessment-report-working-group-3/
   Publication date: March 2022
4. **AR6 Synthesis Report: Climate Change 2022.**
   https://www.ipcc.ch/report/sixth-assessment-report-cycle/
   Publication date: September 2022

The full set of IPCC Assessment Reports, Special Reports and Methodology Reports can be found at: https://www.ipcc.ch/reports/

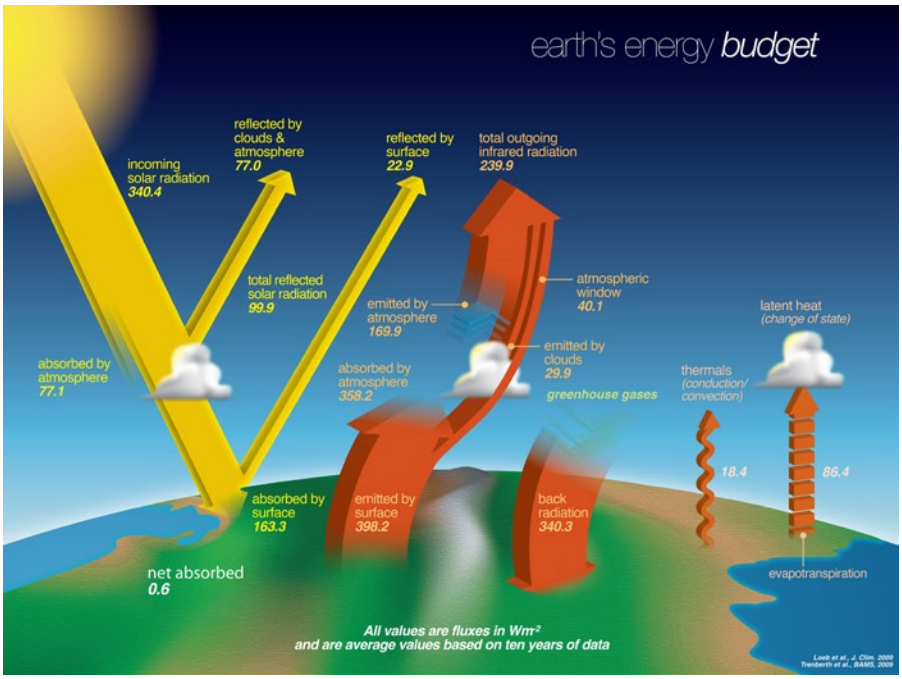


Figure 31 Earth's energy budget. Image credit: NASA

Climate scenarios

There are many uncertainties to navigate when exploring possible climate futures: we don't know what future greenhouse gas emissions will be, there are uncertainties in how the Earth's climate system will respond and how local climate will respond to global climate change, and there are many other sources of climate variability.

There are many different global climate models, and each model is the result of different choices in how to mathematically represent the climate system. The existence of so many models is useful for exploring uncertainties in the climate science. Climate scenarios define different emission pathways, and these are used in climate models to explore the consequences of different future greenhouse gas emissions.

Representative Concentration Pathways (RCP)

When you start looking for climate information, you will hear a lot about these things called RCPs. They have very strange names: RCP 2.6, 4.5, 6.9, and 8.5.

Representative Concentration Pathways (RCPs) are scenarios that describe assumptions about how greenhouse gas emissions, land use and land cover could change over time. The numbers 2.6, 4.5, 6.9 and 8.5 refer to the planet's radiative forcing. Radiative forcing is the difference between radiation incoming from the sun and outgoing radiation from the planet. Different greenhouse gas emissions and land use trajectories lead to different levels of radiative forcing, and the higher the radiative forcing, the more the planet warms. The RCPs refer to different levels of radiative forcing at the end of this century.

They are called "representative" concentration pathways because for any level of radiative forcing, there are many different possible pathways for reaching that point.

RCP 8.5 High Emissions

Under this scenario, global temperatures are very likely to increase by 3.3 to 5.7 degrees by the end of the century. Impacts on people and nature will result from changes in the climate. This scenario is often referred to as "business as usual" because emissions continue to rise at current rates, but this term adds confusion because it can mean different things to different people. Referring to it as a "high emissions" scenario is clearer.

RCP 2.6 Low Emissions

Under this scenario, global temperature increase is very likely to stay below 2.4 degrees by the end of the century. This scenario will only come about if there are significant changes in policies, decisions, and actions all around the world. Under this scenario impacts on people will include impacts of societal transitions to new ways of operating that limit emissions.

Shared Socio-economic Pathways (SSPs)

There are new ways to present emissions pathways that also consider socio-economic trends. These are known as Shared Socio-economic Pathways (SSPs). Future work around climate projections will use these SSP descriptions instead of, or along with, the RCP descriptions.

In the IPCC 6th assessment, scenario names are in the format SSPx-y, where SSPx refers to the SSP, and y refers to the relevant RCP.
The table below summarises the estimated changes in global surface temperature for each scenario for different 20-year time periods.

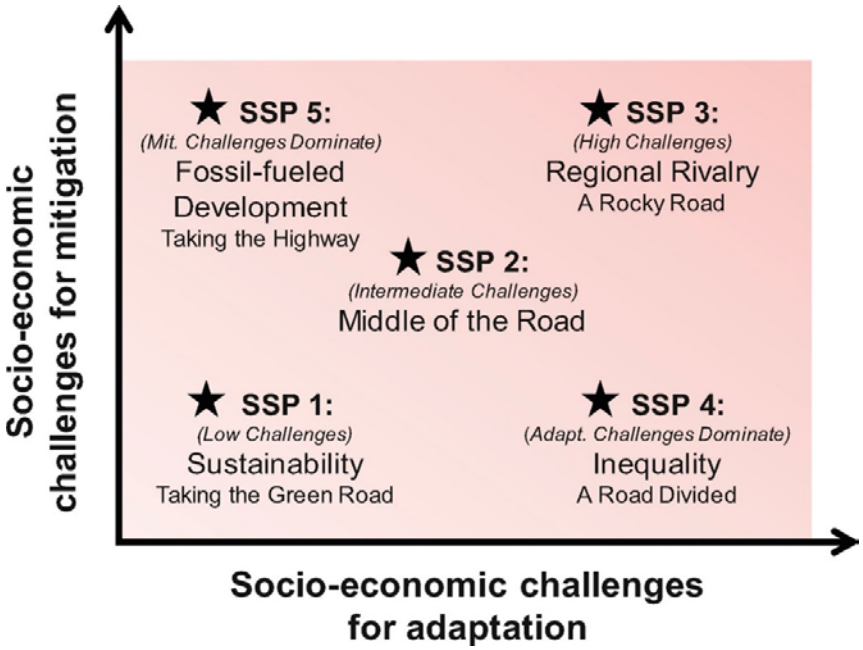


Figure 32 Shared Socio-economic Pathways (SSPs) Source: O'Neill, B.C et al 2017. The roads ahead: Narratives for shared socioeconomic pathways describing world futures in the 21st century. Global Environmental Change 42, 169–180. *https://doi.org/10.1016/j.gloenvcha.2015.01.004*

If the world does succeed in limiting climate change, it will be a very different world operating in very different ways, and so everyone will be adapting to those societal changes in addition to the direct impacts of climate change that have already been locked in. **Adaptation is needed in any future!**

Accessing climate projections

There is a wealth of modelled climate change projections available in large, online databases. In particular, the global intercomparison project, CMIP (Coupled Model Intercomparison Project), makes available model configurations and output results for all the scenarios and model experiments used in the IPCC assessments.

If you are not a climate scientist, these model datasets are difficult to understand and use, and so the IPCC has also created an interactive atlas for people to explore the latest findings. Learn more via https://interactive-atlas.ipcc.ch/

Many groups around the world have also undertaken further analysis and interpretation to create more accessible climate information products. It is too early for these products to be available using the most recent (CMIP6) results, however products developed using CMIP5 model runs are readily available, and they will be updated to CMIP6 over time.

When is specialist guidance needed?

When it comes to considering the specific implications of climate change in your project or system, you are likely to need more specialist guidance. Specialists can point you to the appropriate data for your needs and ensure you are aware of limitations and assumptions. This could include:

1. **Identifying appropriate climate-related questions that will help address your needs** e.g. how might a specific crop be impacted by future changes in temperature and rainfall?
2. **Choosing an appropriate future time frame.**
3. **Identifying what spatial resolution is relevant for analysis** e.g. will country-level averages be appropriate or is more location-specific analysis required?
4. **Identifying relevant climate scenarios** e.g. is it important to plan for extreme scenarios?
5. **Accessing guidance on conducting a climate hazard-based impact assessment, and tools for supporting this** e.g. the Pacific climate futures tool
6. **Interpreting uncertainty** e.g. should we be working with ranges of upper and lower estimates to ensure our decisions are robust to uncertainty?
7. **Assessing the confidence in and limitations of the findings, and judging whether available information is suitable for the intended purpose.**

REMEMBER: You are not alone!

It is not up to you to have all the answers, but it is helpful to be able to reach out to others and find the people who have the skills and knowledge specific to your system.

This could be within your own organisation, or more broadly in your knowledge brokering network, and wider networks of academics, local government agencies, and NGOs.

Don't forget that as a knowledge broker sometimes you will be helping people engage with highly uncertain or complex knowledge.

Next Generation Climate Projections for the Western Tropical Pacific

The Australia-Pacific Climate Partnership (APCP) has conducted a project entitled "Next Generation Climate Projections for the Western Tropical Pacific".

The project has generated reports for 15 Pacific Island countries, making the global climate science more relevant and accessible to a wider range of users in the Pacific.

These reports provide country-level summaries of historical and projected temperature, rainfall, cyclones, extreme rainfall, and sea level.

The reports also provide standardised future scenarios and climate change storylines useful for future planning, and there is guidance for assessing local impacts.

Figure 33 Current and Future Climate Reports for Papua New Guinea and the Solomon Islands. ***https://www.rccap.org/climate-change-update-for-the-pacific/***

"The climate crisis is both the easiest and the hardest issue we have ever faced. The easiest because we know what we must do. (...) The hardest because our current economics are still (...) destroying ecosystems in order to create everlasting economic growth." — Greta Thunberg

Climate stripes

The stripe pattern developed by Hawkins (2018) gives an indication of the variability, or ups and downs, in the temperature record. For Solomon Islands, we see a clear change from more blue (cooler than average) to more red (warmer than average) years since 1850, with more red bars, especially since 1995.

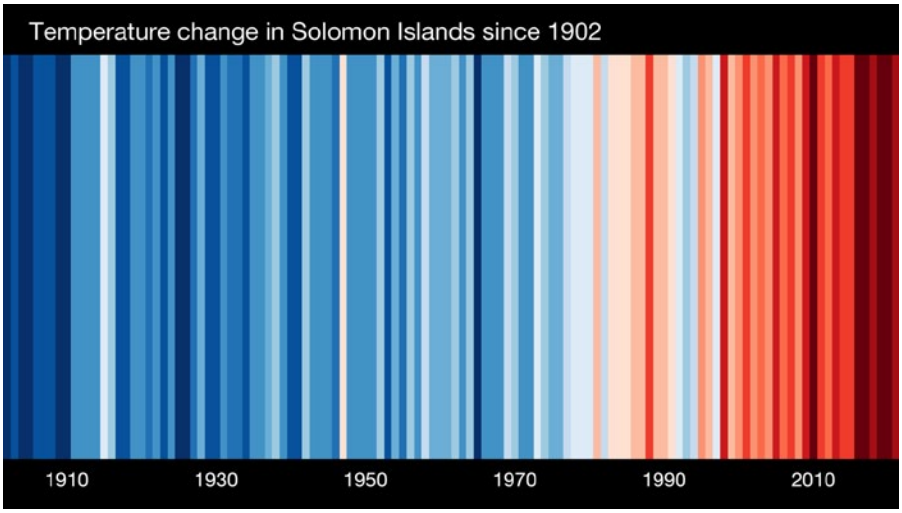


Figure 34 Climate Stripes for The Solomon Islands. Source: https://showyourstripes.info/

Projected change — near, medium and long term

This graphic shows change under a very high emissions pathway (RCP8.5) in the pink shaded band, and a very low emissions pathway (RCP2.6) in green, with the model averages shown as thick lines.

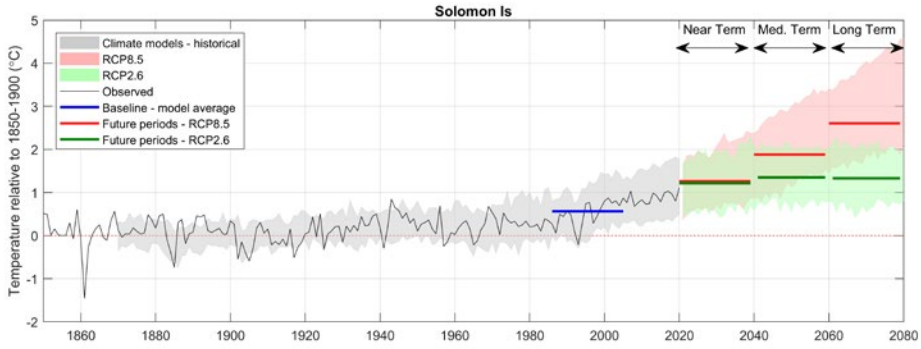


Figure 35 Emission pathways

Rainfall projection

This graphic shows change in the average rainfall and 6-month seasonal rainfall in the Solomon Islands region at different global warming levels relative to the 1986–2005 baseline.

The bars represent multi-model median and the 10th–90th percentile range.

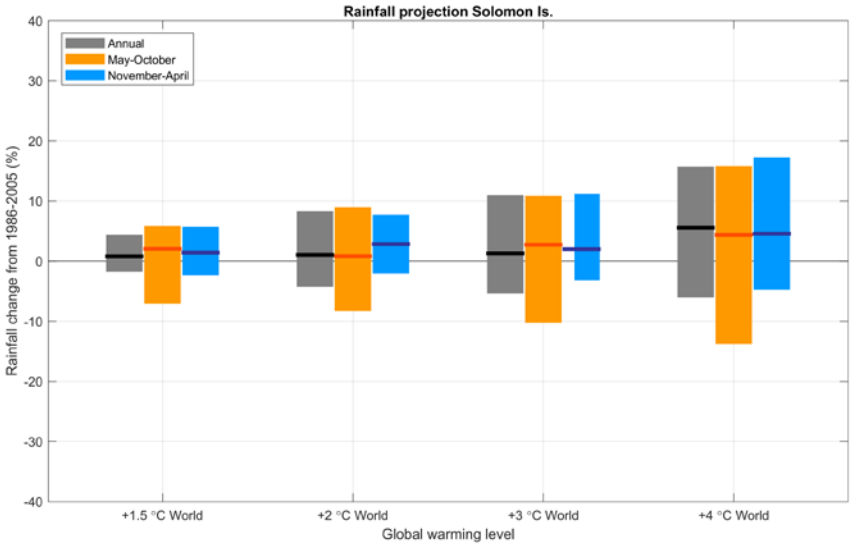


Figure 36 Rainfall projection. Images sourced from: CSIRO and SPREP (2021). 'NextGen' Projections for the Western Tropical Pacific: Current and Future Climate for Solomon Islands. Final report to the Australia-Pacific Climate Partnership for the Next Generation Climate Projections for the Western Tropical Pacific project. Commonwealth Scientific and Industrial Research Organisation (CSIRO) and Secretariat of the Pacific Regional Environment Programme (SPREP), CSIRO Technical Report, Melbourne, Australia. *https://doi.org/10.25919/nge2-sr30 | https://www.rccap.org/climate-change-update-for-the-pacific/*

	Scenario 1* SPCZ moves north	Scenario 2* SPCZ moves south
Low emissions (RCP2.6)	***Warmer & drier*** • Annual temperature: +0.8°C • Annual rainfall: -5% • More heatwaves • Less humidity • More solar radiation • Heavier rainfall events • Greater tropical cyclone impacts • Sea level rise: 17-30 cm	***Much warmer & wetter*** • Annual temperature: +1.2°C • Annual rainfall: +10% • More heatwaves • More humidity • Less solar radiation • Much heavier rainfall events • Greater tropical cyclone impacts • Sea level rise: 17-30 cm
High emissions (RCP8.5)	***Much warmer & drier*** • Annual temperature: +1.2°C • Annual rainfall: -5% • More heatwaves • Less humidity • More solar radiation • Heavier rainfall events • Greater tropical cyclone impacts • Sea level rise: 21-37 cm	***Hotter & wetter*** • Annual temperature: +2.1°C • Annual rainfall: +10% • Many more heatwaves • More humidity • Less solar radiation • Much heavier rainfall events • Greater tropical cyclone impacts • Sea level rise: 21-37 cm

* These are indicative scenarios for an initial scan of impacts, but detailed impact/risk assessments may need to consider a more comprehensive range of scenarios tailored for specific regions, sectors or systems.

Figure 37 Standard scenarios for the Solomon Islands for the period 2040–2059 relative to 1986–2005 for low and high emission pathways and two climate change scenarios defined by the physical change 'storyline'. Source: CSIRO and SPREP (2021). 'NextGen' Projections for the Western Tropical Pacific: Current and Future Climate for Solomon Islands. Final report to the Australia-Pacific Climate Partnership for the Next Generation Climate Projections for the Western Tropical Pacific project. Commonwealth Scientific and Industrial Research Organisation (CSIRO) and Secretariat of the Pacific Regional Environment Programme (SPREP), CSIRO Technical Report, Melbourne, Australia. *https://doi.org/10.25919/nge2-sr30*

References and additional resources

If you would like to watch a YouTube video on this module, please see https://www.youtube.com/watch?v=PpJwjJ_sOl8

Case studies

The following case studies offer a chance to understand how climate data has been used in different projects:

NEXTGEN CLIMATE HAZARD-BASED IMPACT ASSESSMENTS

https://www.rccap.org/pacific-guidance-and-case-studies/ case-studies/

- **Black pearl production vulnerability in the Cook Islands**
  https://www.rccap.org/library/item/61fc956b7402a
- **Cocoa production in Papua New Guinea**
  https://www.rccap.org/library/item/61fb1c5a1b2bf
- **Cocoa production in Samoa**
  https://www.rccap.org/library/item/61fc98e622dd9
- **Coffee production in Papua New Guinea**
  https://www.rccap.org/library/item/61fc8ff78e221
- **Root crop production in Fiji**
  https://www.rccap.org/library/item/61fc966e7e618

CLIMATE RISK ASSESSMENTS

- **Analysing the impact of climate change on sweet potato crops in Papua New Guinea**
  https://www.rccap.org/pacific-guidance-and-case-studies/ case-studies/papua-new-guinea/
- **Climate Change and Cocoa on the Guadalcanal Plain, Solomon Islands**
  https://www.rccap.org/pacific-guidance-and-case-studies/ case-studies/solomon-islands/

Acknowledgements

Nicky Grigg (CSIRO): a research scientist who works in interdisciplinary teams on a diverse range of projects concerned with global change and social-ecological systems.

Anthony Nadelko (CSIRO): a research technician who investigates the environmental interactions, resource use efficiency and sustainability of natural and human-made ecosystems.

Leanne Webb (CSIRO): Climate Change Knowledge Broker at CSIRO offering tailored climate projection data and services to climate change impact researchers and industry stakeholders in Australia and the Pacific.

Your notes

As Australia's national science agency, CSIRO is solving the greatest challenges through innovative science and technology.

CSIRO. Unlocking a better future for everyone.

Contact us
1300 363 400
+61 3 9545 2176
csiro.au/contact
csiro.au

For further information
Environment
Michaela Cosijn
Michaela.Cosijn@csiro.au

Environment
Seona Meharg
Seona.Meharg@csiro.au

B&M | 23-00164