



# Building agricultural resilience to climate change impacts: Describing two projects undertaken in Australia and in the Pacific

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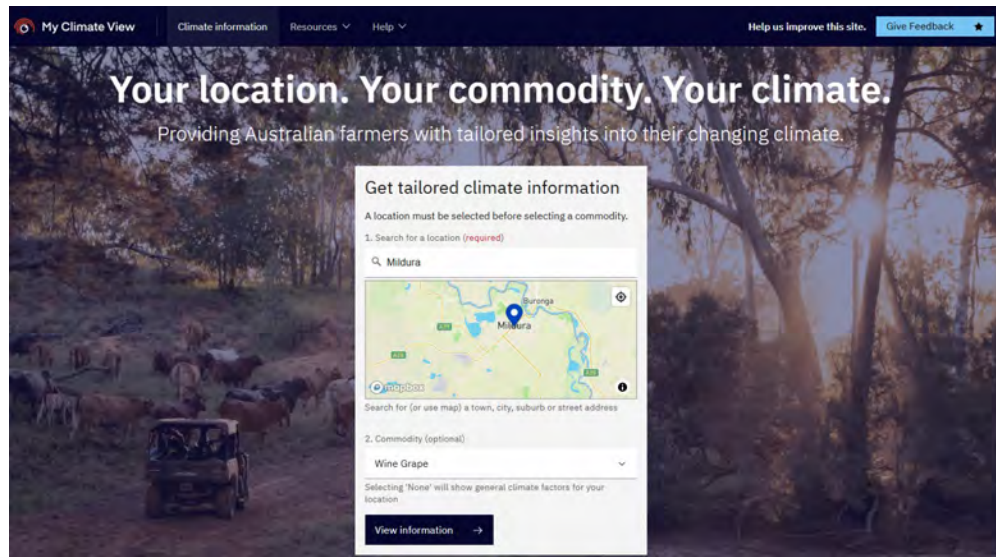
Session 2, 12<sup>th</sup> August 2025





# Comparison of projects undertaken in Australia and Vanuatu

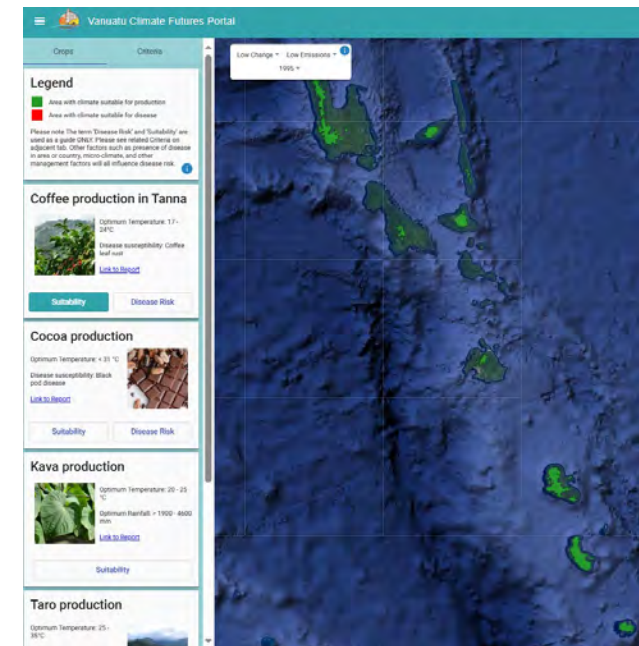
## Australia: My Climate View



Targets farm management planning through helping farmers understand the future climate in relation to their location and commodity.



## Vanuatu: Van-KIRAP



Aims to build technical capacity and deliver information and tools through application climate information into five targeted development sectors:

- **Agriculture**
- Tourism
- Infrastructure
- Water
- Fisheries



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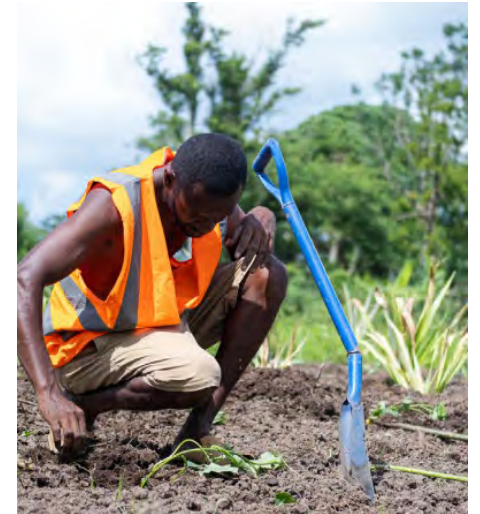
## Shared objectives in relation to Agriculture

Both projects shift the paradigm towards standardised use of science-based information to inform planning decisions under changing climate conditions.

Both have web-based portal delivery.

Application of climate science principles were broadly similar across both projects:

- Designed for multiple future timescales (e.g. 2030, 2050)
- Range of emissions scenarios: low, medium and high
- Range of climate model output explored



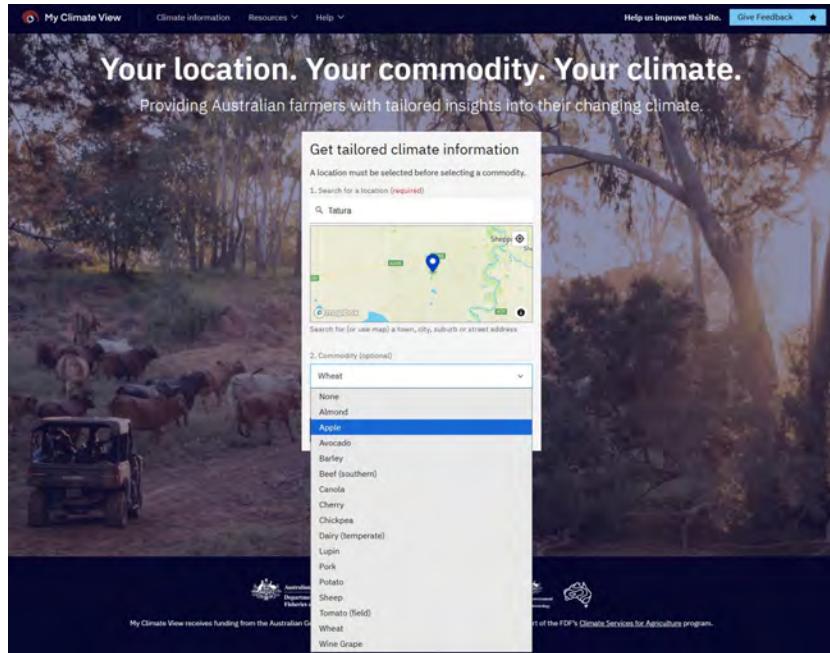
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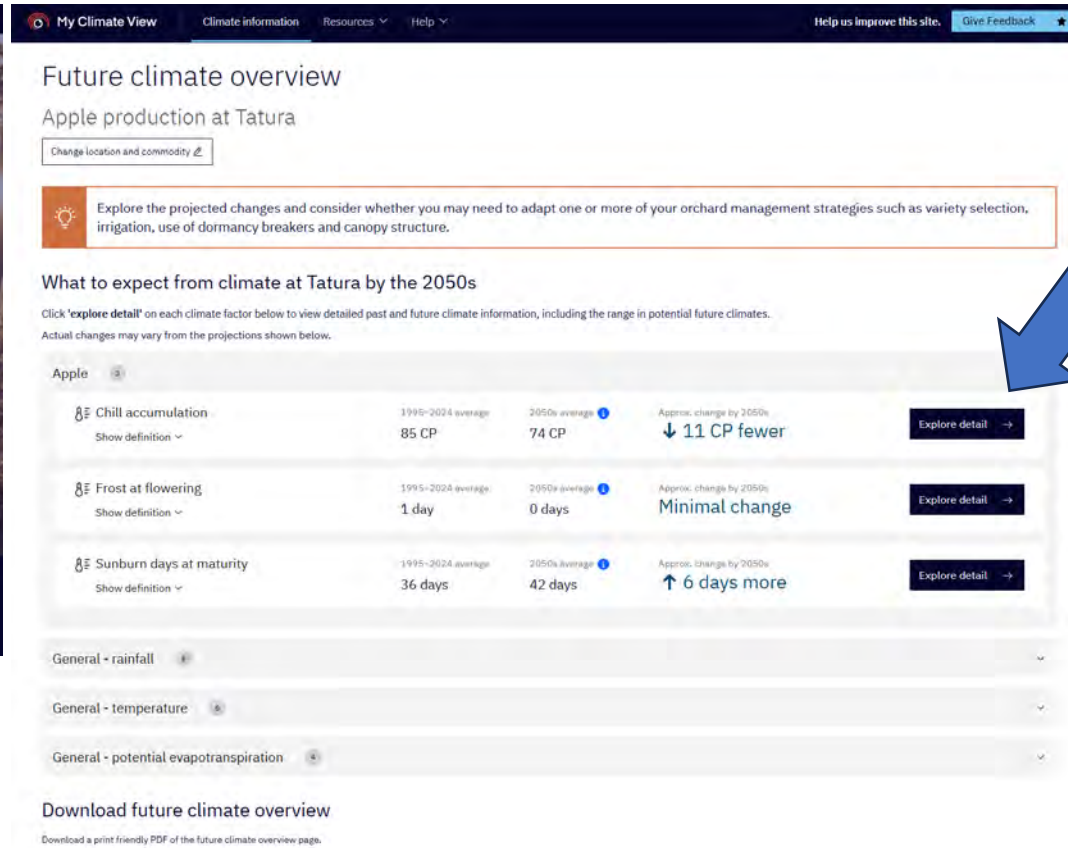


# My climate view example output

## Apples in Tatura (central Victoria)



1. Choose your location
2. Choose commodity from curated list
  - no apple option for tropical regions
  - no banana option for cooler areas



### 3. 'Snapshot'

Data shown for 2050s

- Median results
- Medium emissions

Tailored climate risks for apple include:

- Chill accumulation
- Frost at flowering
- Sunburn days at maturity

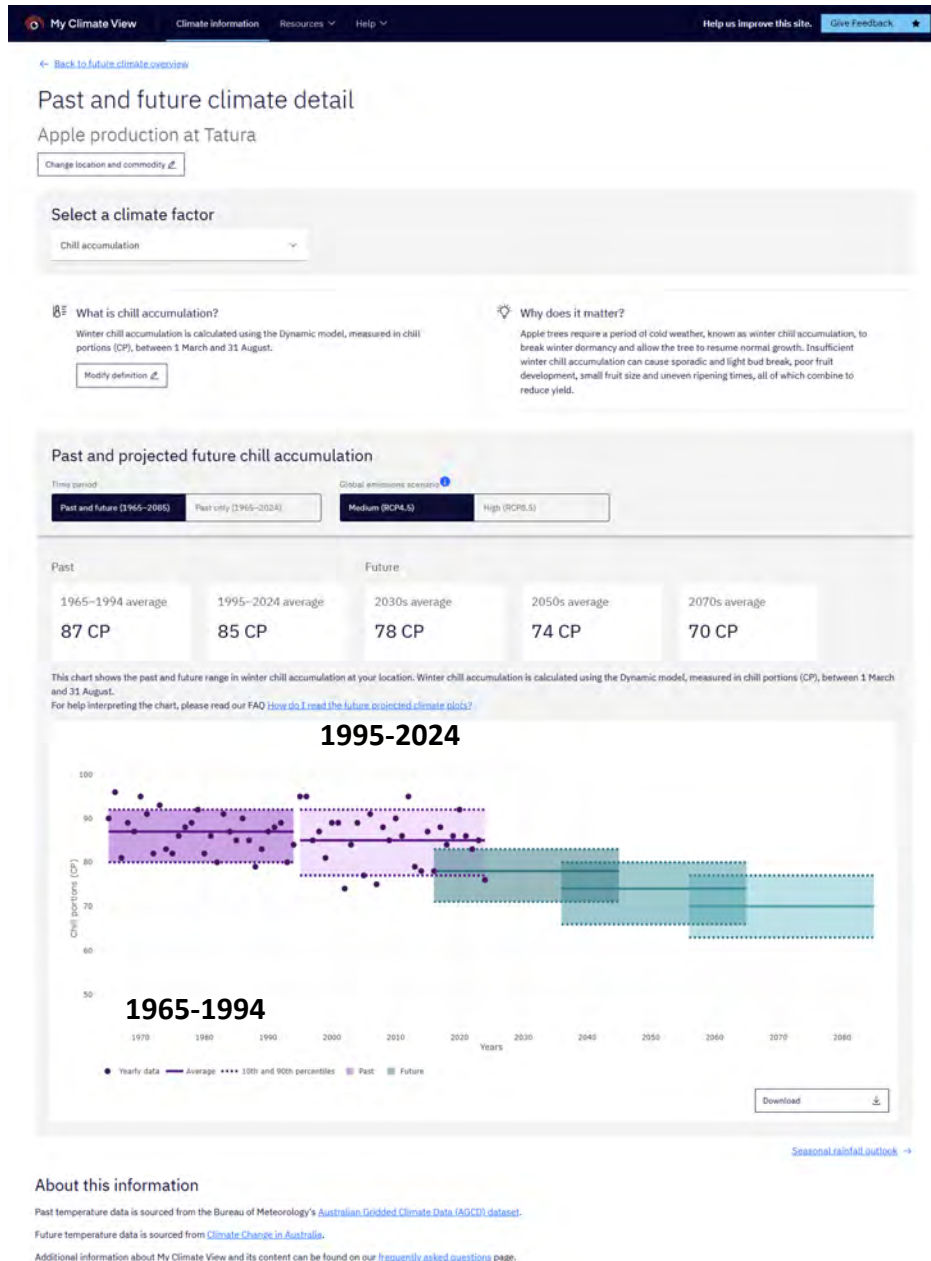


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# My climate view example output



## 4. Explore detail

- Chill accumulation

Limited text information to describe the climate risk and why it is included

Data presentation settings (bold is depicted):

- historical only or **historical & future**
- emission scenarios (**medium** and high)

Data median through time

- consistent with summary page

- Past (2 periods; purple) Future (3 periods; green)
- Purple dots = observations
- Model range = width of bands



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# Vanuatu:





## Banana, Kava, Coconut

# Tropical Cyclones



# Vanuatu agriculture sector: Case studies and mapping tool

## Case studies: Cocoa



### CLIMATE CHANGE IMPACTS ON COCOA PRODUCTION IN VANUATU

This case study examines climate change impacts on cocoa production in Vanuatu using a step-by-step approach. Guidance around conducting this type of assessment is provided in more detail on the [Vanuatu Climate Futures Portal](#), along with other case studies (coffee, yams), fact sheets, visualisation tools and technical resources. This case study can be used as an example for undertaking similar climate hazard-based impact assessments.

#### STEP 1 Understand the context and scope

The climate is changing due to global warming. Vanuatu has warmed by 0.7 °C since the pre-industrial period (1850–1900) [1], however there has been little change in annual average rainfall, cyclones [2], or dry spells [3]. In the coming decades, annual average temperature is projected to increase, with more heatwaves, little change in annual average rainfall, more extreme daily rainfall, fewer cyclones but a greater proportion of severe cyclones [1, 2].

Cocoa (*Theobroma cacao* L.; Malvaceae) is one of the major cash crops of Vanuatu [4], along with others such as kava, coconut and coffee [5]. Aligning agricultural crop production to the climate is an important factor for producers to consider. **Here we explore the temperature and rainfall suitability for cocoa production in Vanuatu under current and future climate conditions.** For information on how this climate related impact assessment fits into a broader risk framework, see the [Climate risk factsheet](#).



Figure 1 Cocoa pods growing at Lambu plantation (top left), conversation with Alen Tavahat at the processing facility and bean sorting shed (top right and bottom left) and the finished product, chocolate (bottom right). (Photos: CSIRO)

#### STEP 2 Engage and meet with stakeholders

In July 2023, Vanuatu Meteorology and Geo-hazards Department (VMGD) staff and Van-KIRAP sector leads along with CSIRO scientists visited farm manager Alen Tavahat at the Lambubu cocoa plantation in Malekula and were given a tour of the facility. Aspects of cocoa production were discussed, including variety selection, plant propagation, and climate requirements for the crop and cocoa bean processing stages: fermentation, drying, storing and export. For this case study key literature was also drawn upon [6], as well as Vanuatu cocoa industry planning reports [7].

#### STEP 3 Explore background information and historic climate data

Current demand for Pacific fine flavour cocoa and its unique qualities means it is an important cash crop for Vanuatu. While not a major cocoa producer by global standards, cocoa is one of Vanuatu's main exports, with more than 1,500 tonnes exported annually. More than 30 % of Vanuatu's population rely on cocoa for their source of income, and in some communities, it is a significant source of livelihood and the only provider of employment [4].

In Vanuatu, most cocoa is produced by smallholder farmers (around 9000 reported in 2014 [8,9]). Cocoa is then exported by a smaller number of licensed exporters. A major advantage that cocoa offers these smallholder farmers is that it can be integrated into a food garden or grown under mature coconut trees [9]. While cocoa is a crop that can be widely grown in Vanuatu, it is currently concentrated in the more northern provinces, such as Sanma, Penama and Malampa [1] (Figure 2). The 'Handbook for Cocoa in Vanuatu', written by Sewell and Lau (1993) and quoted in [9], describes optimum climatic conditions as:

- Growing temperature of between 22 °C and 31 °C. This temperature range broadly aligns with other studies not specific to Vanuatu, where a mean maximum temperature range of 30–32 °C, a mean minimum temperature range of 18–21 °C, and an absolute minimum of 10 °C are advised [10].
- Rainfall of 1500 to 4000 mm per annum.
- Rainfall in each month above 100 mm [9]. If there are more than 3 consecutive months with rainfall less than 100 mm, the area is not suitable for cocoa [9].



These climatic conditions are met in parts of the main cocoa growing islands of Malekula, Espiritu Santo and Malo, as well as in most other central and northern islands [9]. Cooler and more southern areas with drier July–September periods (less than 100 mm monthly rainfall) have reduced suitability for cocoa production [11]. For the period centred on 1995 (1970–2000), the suitable area for cocoa production is indicated with the lighter green shading in Figure 2.

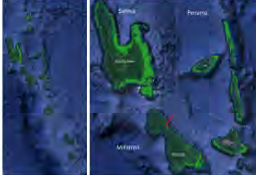


Figure 2 Climate suitability\* (1970–2000) for cocoa production (lighter green shading) for Vanuatu (left) and focus on production areas with provinces named, with some individual islands named (highlighted) approximate location of the visit in July 2023 indicated by red arrow (right).

\*Suitable is defined as average annual minimum temperature greater than 22 °C, average annual maximum temperature less than 31 °C, total annual rainfall 1500–4000 mm, average monthly rainfall for each month is greater than 100 mm [9]. Climate data source: WorldClim.

#### STEP 4 Collect information about future climate scenarios

Climate models indicate annual average temperatures will increase in Vanuatu by 0.7–1.3 °C by 2050, relative to 1986–2005 (Table 1). This warming will be associated with more heatwaves. It is unclear whether rainfall will increase or decrease by 2050 [1, 2] and while projected median changes in average rainfall by 2050 are small, the annual rainfall in the wettest days is expected to increase [2]. The projected ranges presented in Table 1 take account of uncertainty in greenhouse gas emissions scenarios [8], regional climate responses simulated by climate models for each emissions scenario, and natural climate variability (see also Step 5).

Table 1 Projected changes in Vanuatu average annual temperature and rainfall for 20-year periods centred on 2030 and 2050 relative to 1986–2005. Model median changes are given, with the 10th–90th percentile uncertainty range in brackets. For 2050, changes are shown for low emissions (RCP2.6; green) and high emissions (RCP8.5; red). In 2030, changes are similar for low and high emissions [1].

	2030	2050
2050 least warming model (RCP2.6)		
2050 most warming model (RCP8.5)		

#### STEP 5 Analyse climate-related impacts

To assist with this, it is useful to frame the analysis around relevant climate variables. We do under a 'least change' or 'most plausible' scenario, as the 'storyline approach' [11]. The scenario is based on future greenhouse gas emissions, the regional climate response to those emissions, and the natural climate variability. For an explanation of methods and data limitations associated with climate projections, see [Climate scenarios for use in impact assessments](#).


Cocoa plants can produce fruit for 30–50 years so this impact assessment considers climate conditions for a 20-year period centred on 2050 (2040–2059). Future climate suitability for cocoa production at this time, under a plausible 'least change scenario' (low emissions, lower warming, with decreased rainfall) and plausible 'most change scenario' (high emissions, higher warming, with increased rainfall) indicates that sites with optimum climate conditions for cocoa production may change (Figure 3). In the northern regions the maximum temperature is being exceeded at some sites, reducing suitability. In many areas, as minimum temperatures increase, suitability increases particularly in the south, and some more elevated areas in the north. This assessment also assumes no adaptation practices are implemented to reduce impacts throughout this period (see Step 7). By 2050, the area with a suitable climate for cocoa is estimated to increase 22 % for a 'least warming and low emissions' scenario and 103 % for a 'most warming and high emissions' scenario.

The [Vanuatu Climate Futures Portal](#) provides options to explore different future scenarios for cocoa production (and other crops), and the ability to interact with the climate variables separately to better understand the drivers of some of the production suitability shifts seen in Figure 3. Furthermore, future climate suitability for coffee and root crops has also been undertaken and reported in separate infobyes. Collectively there appears to be a potential for a change in the climate suitability of some crops in some locations in Vanuatu. For example, while suitability for coffee production may decline in Tanna under some future scenarios, opportunities for cocoa and taro production may improve.

#### STEP 6 Other climate and non-climate factors


It is important to note that only temperature and rainfall conditions are assessed in Step 5. Other climate and non-climate factors are listed below that may also influence suitability for cocoa production. Further analysis around any or all of these may be prudent.

Climate factors affecting cocoa production	
High temperature	Constant temperatures above 31 °C have been associated with more bushy plants. With much cooler night-time temperatures, this loss of apical dominance does not occur [9].
Tropical cyclones and wind	Cocoa cannot withstand strong steady winds or cyclones, but can recover quickly after being damaged by a cyclone [9]. High wind speed is detrimental to flowering/seed germination in nurseries [10]. It is best to plant cocoa in areas where there are lighter winds and in areas that are relatively protected from cyclones [9] (see <a href="#">Tropical cyclone factsheet</a> for more information).
Drought	Cocoa production is adversely affected by drought. Long periods of drought will cause cocoa buds to wither, resulting in reduced yields [13]. Sensitivity to prolonged high temperatures is exacerbated if coinciding with limited water availability [13] (see <a href="#">Drought factsheet</a> for more information).
Sunshine	Cocoa requires 4.5 to 6.5 hours of sunshine per day for full production [9].
El Niño Southern Oscillation (ENSO)	ENSO is a large-scale driver of climate variability in the Pacific, affecting rainfall and drought [14]. In El Niño years, the South Pacific Convergence Zone (SPCZ) moves north-east, leading to drier conditions. In La Niña years, the SPCZ moves south-west, leading to wetter conditions. ENSO also affects tropical cyclone frequency [15]. La Niña and El Niño extremes are projected to increase in future [16, 17] (see <a href="#">Climate variability explainer</a> ).
Non-climate factors affecting cocoa production	
Cocoa Black Pod Disease (CBPD) ( <i>Phytophthora palmivora</i> ) has been a serious issue for cocoa growers in Vanuatu [9], with increased pressure occurring under higher rainfall conditions [13] (above 2500 mm per year). Control of the fungus can be achieved through use of chemicals [9], or 'sanitary' pruning management to remove diseased branches on a periodic basis [18].	
Cocoa Pod Borer (CPB) ( <i>Conopomorpha cramerella</i> ) is found in Vanuatu, however links to climate or climate variability are not known.	
Worker productivity, soil properties and a range of other relevant socio-economic factors affect the practices, livelihoods, and wellbeing of smallholder cocoa production.	




#### STEP 7 Plan future adaptation


There are several ways in which cocoa growers can become more resilient to these climate challenges. Issues identified in Steps 1 to 6 provide valuable input to stakeholder discussions about actions that can build resilience. This is a complex participatory process. Adaptation can be incremental or transformative, with enablers and barriers, synergies and trade-offs, pathways and limits, costs, and benefits. The process usually starts with consideration of adaptation options. Adaptation options that could be considered, tested, and verified in the community to improve resilience includes:




New farm management practices




Farming in new areas




Change crops to more heat/disease tolerant varieties




Diversify the farming system to include other crops



Less west facing slopes to avoid afternoon sun exposure



Maintain 75% shading




Selective breeding of climate tolerant cocoa varieties

#### STEP 8 Communicate findings

Communicating the assessment findings to key sector stakeholders is the final step of the climate hazard-based impact assessment. Multiple communication formats, co-designed and co-produced with target users in mind are more likely to support action and decision-making. The contents of this infobye, together with other related resources shown below, can be disseminated and shared with key stakeholders to help them plan for and adapt to the changing climate.

[Vanuatu Climate Futures Portal](#)  
[Case Studies](#)  
[Fact Sheets](#)  
[Guidance Material](#)  
[Videos](#)







# CLIMATE CHANGE IMPACTS ON COCOA PRODUCTION IN VANUATU

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## AGRICULTURE

### STEP 1 Understand the context and scope

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Figure 4 Cocoa pods growing at Lambuho plantation (top left), conversation with Kusan Ragooni (top right) at the processing facility (bottom left) and top right and bottom left) and the finished product, chocolate (bottom right) (Photos CC-BY)

### STEP 2 Engage and meet with stakeholders

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### STEP 3 Explore background information and historic climate data

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In Vanuatu, most cocoa is produced by smallholder farmers (around 800 reported in 2014 [8,9]). Cocoa is then exported by a smaller number of licensed exporters. A major advantage that cocoa offers these smallholder farmers is that it can be integrated into a food garden or grown under mature coconut trees [7]. While cocoa is a crop that can be widely grown in Vanuatu, it is currently concentrated in the more northern provinces, such as Sanna, Penama and Malampa [10].

The Handbook for Cocoa in Vanuatu<sup>1</sup>, written by Sewell and Lau [11] and quoted in [9], describes optimum climatic conditions as:

- Growing temperature of between 21 °C and 31 °C; this temperature range broadly applies with other studies not specific to Vanuatu, where a mean maximum temperature range of 30–32 °C, a mean minimum temperature range of 18–21 °C, and an absolute minimum of 10 °C were advised [10].
- Rainfall of 1500 to 4000 mm per annum;
- Rainfall in each month above 100 mm; if there are more than 3 consecutive months with rainfall less than 100 mm, the area is not suitable for cocoa [9].







**STEP 4** Collect information about future climate scenarios

Climate models indicate annual average temperatures will increase in Vanuatu by 0.7–1.3 °C by 2050, relative to 1986–2005 (Table 1). This warming will be associated with more heatwaves. It is unclear whether rainfall will increase or decrease by 2050 [1, 2] and while projected median changes in average rainfall by 2050 are small, the amount of rainfall on the wettest day is projected to increase [2]. The projected ranges presented in Table 1 take account of uncertainty in greenhouse gas emissions scenarios [3], regional climate responses simulated by climate models for each emissions scenario and natural climate variability (see also Table S1).

Table 3. Projected changes in Vientiane average annual temperature and rainfall for 20-year periods centred on 2030 and 2050 relative to 1986–2005. Model median changes are given, with the 10th–90th percentile uncertainty range in brackets. For 2050, changes are shown for low emissions (RCP2.6; green) and high emissions (RCP8.5; red). In 2030, changes are similar for low and high emissions (1.1).






	2030	2050
21. The projected		

To assist with this, it is useful to frame the analysis around relevant questions, ensuring the full range of projected climate outcomes is considered. We would use a 'least change' or 'most change' approach as the 'storyline approach' (12). The scenarios are based on future greenhouse gas emissions, the regional responses to those emissions, and the natural climate system (see [Climate projections for use in impact assessments](#) [explainer](#) for explanation of methods and data limitations associated with climate projections).

cocoa plants can produce fruit for 30–50 years so this impact assessment considers climate conditions for a 20-year period centred on 2050 (2040–2060). Future climate suitability for cocoa production at this time, under a plausible 'least change scenario' (low emissions, lower warming, with decreased rainfall) and plausible 'most change scenario' (high emissions, higher warming, with increased rainfall) indicates that areas with optimum climate conditions for cocoa production are at risk of being lost. The warm temperate zone at the maximum temperature is being exceeded at some sites, reducing suitability. In many areas, as minimum temperatures increase, suitability increases particularly in the south, and some more elevated areas in the north. This assessment also assumes no adaptation practices are implemented to reduce impacts throughout this period (see Table 7). By 2050, the area of suitable climate for cocoa is estimated to decrease 22.9% for a 'least warming and low emissions' scenario and 103% for a 'most warming and high emissions' scenario.

The **Vanuatu Climate Futures Portal** provides options to explore different future scenarios for cocoa production (and other crops), and the ability to interact with the climate variables separately to better understand the drivers of some of the production suitability shifts seen in Figure 3. Furthermore, future climate suitability for **coffee** and **root crops** has also been undertaken and reported in separate infographics. Collectively there appears to be a potential for a change in the climate suitability of some crops in some locations in Vanuatu. For example, while suitability for coffee production may decline in Tanna under some future scenarios, opportunities for cocoa and taro production may improve.

It is important to note that only temperature and rainfall conditions are assessed in Step 1. Other factors listed below that may also influence suitability for cocoa production. Further analysis is a

Climate factors affecting cocoa production	
High temperature	 <p>Constant temperature above 31 °C will have much cooler night-time temperature, this is</p>
Tropical cyclones and wind	 <p>Cocoa cannot withstand strong steady winds or cyclones by a cyclone [9]. High wind speed is detrimental [10]. It is best to plant cocoa in areas where there is relatively protected from cyclones [9]. [See <a href="#">Tropical</a></p>
Drought	 <p>Cocoa production is adversely affected by drought. It withers, resulting in reduced yields [13]. Sensitivity if coinciding with limited water availability [13] [See <a href="#">Drought</a></p>
Sunshine	 <p>Cocoa requires 4 to 6.5 hours of sunshine per day</p>
El Niño Southern Oscillation (ENSO)	 <p>ENSO is a large-scale driver of climate variability in El Niño years, the South Pacific convergence zone leading to drier conditions. In La Niña years, the SP conditions. ENSO also affects tropical trade winds are projected to increase in future [16, 17]. [See <a href="#">El Niño</a></p>

Non-climate factors affecting cocoa production	
Pests and other species	Cocoa Black Pod Disease (CBPD) ( <i>Phytophthora palmivora</i> ) is a major constraint to cocoa production in growers in Vanuatu [9], with increased pressure occurring in the highlands (above 2500 mm per year). Control of the fungus can be achieved by 'sanitary' pruning management to remove diseased pods [10].

affecting production	
	Cocoa Pod Borer (CPB) ( <i>Conopomorpha cramerella</i> ) however links to climate or climate variability are not clear

Worker productivity, soil properties and a range of other relevant socio-economic factors are also important for cocoa production.



is projected

table 1 take

scenarios [8],

See also Step 5)

Signature

relative to

---

<b>STEP 1</b>	<b>Understand the context and scope</b>
<b>STEP 2</b>	<b>Organise meeting of potential stakeholders to discuss project</b>
<b>STEP 3</b>	<b>Explore relevant background information and historic climate data</b>
<b>STEP 4</b>	<b>Collect information about future climate scenarios</b>
<b>STEP 5</b>	<b>Analyse climate-related impacts under 'best-case' and 'worst-case' scenarios</b>
<b>STEP 6</b>	<b>Evaluate all other climate and relevant non-climate factors</b>
<b>STEP 7</b>	<b>Plan future adaptation measures and treatments</b>
<b>STEP 8</b>	<b>Communicate findings</b>



# Vanuatu agriculture sector: Case studies and mapping tool

## Mapping tools: Cocoa



'Suitable' for Cocoa is defined

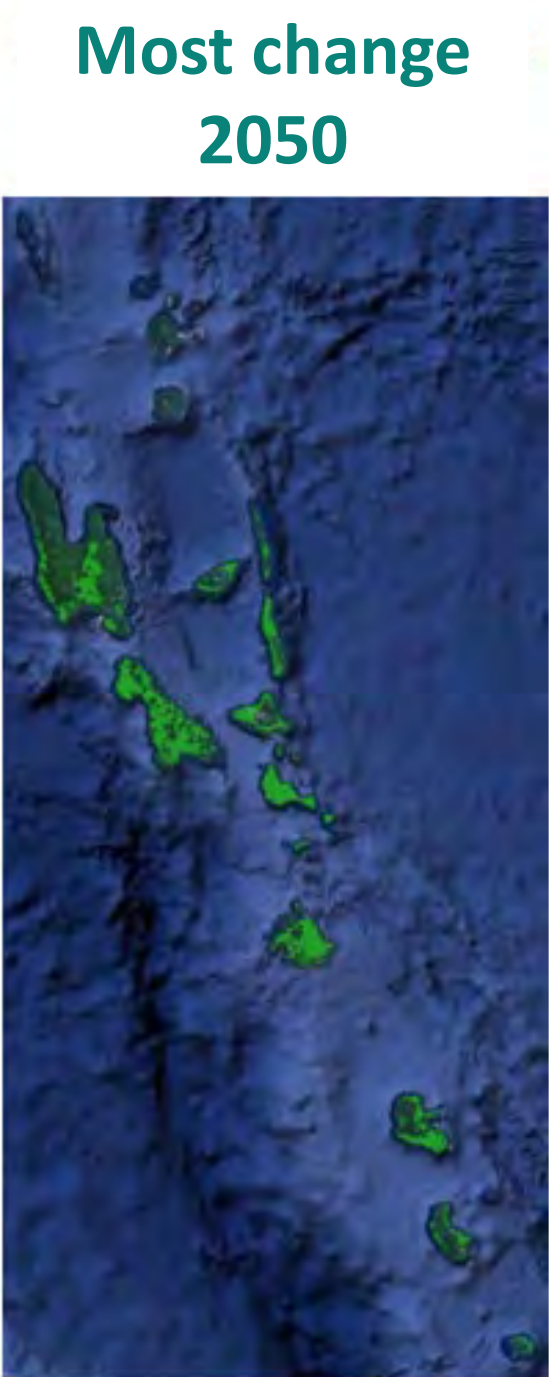
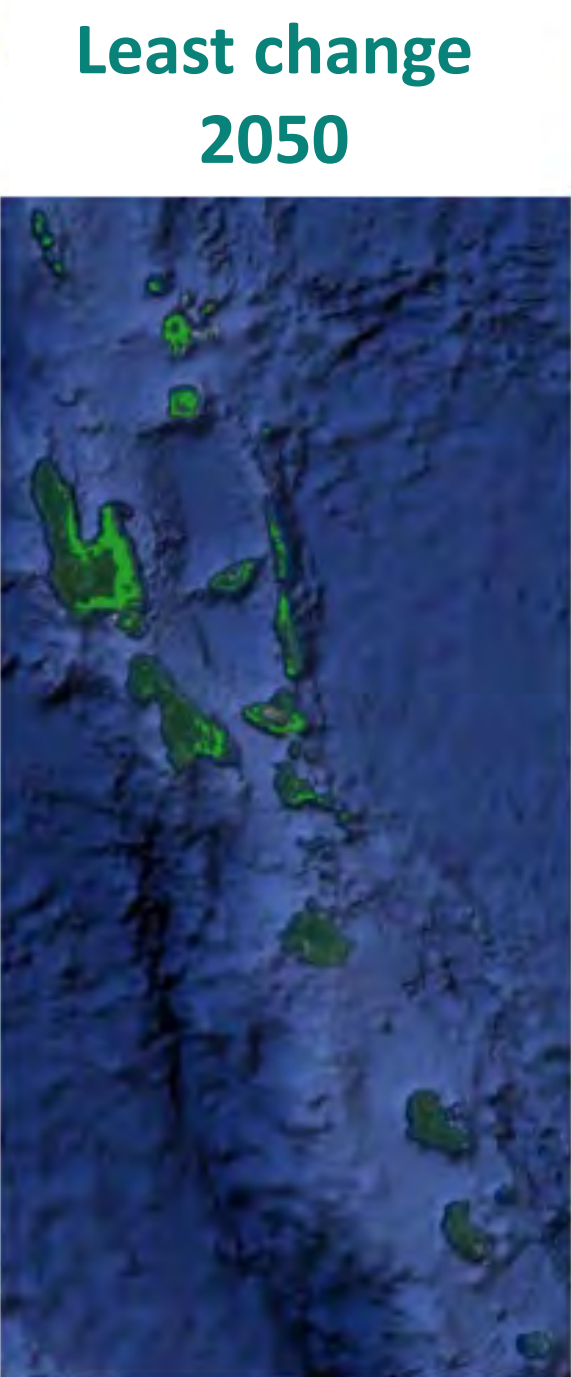
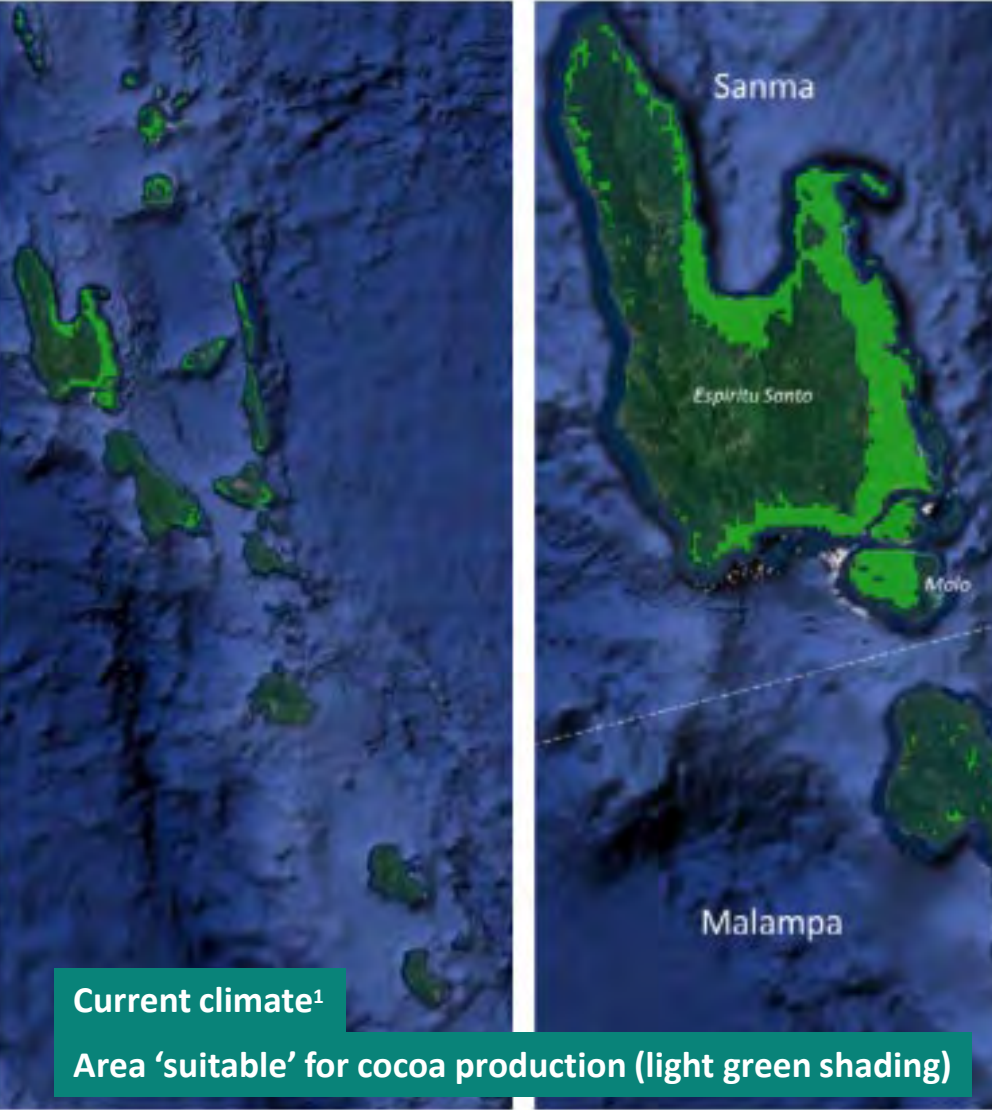
- Not too hot:
  - average annual maximum temperature less than 31 °C
- Not too cold:
  - average annual minimum temperature greater than 22 °C
- total annual rainfall 1500–4000 mm
- average monthly rainfall for each month is greater than 100 mm



<sup>1</sup>WorldClim climatology



# Vanuatu agriculture sector: Mapping tools: Cocoa

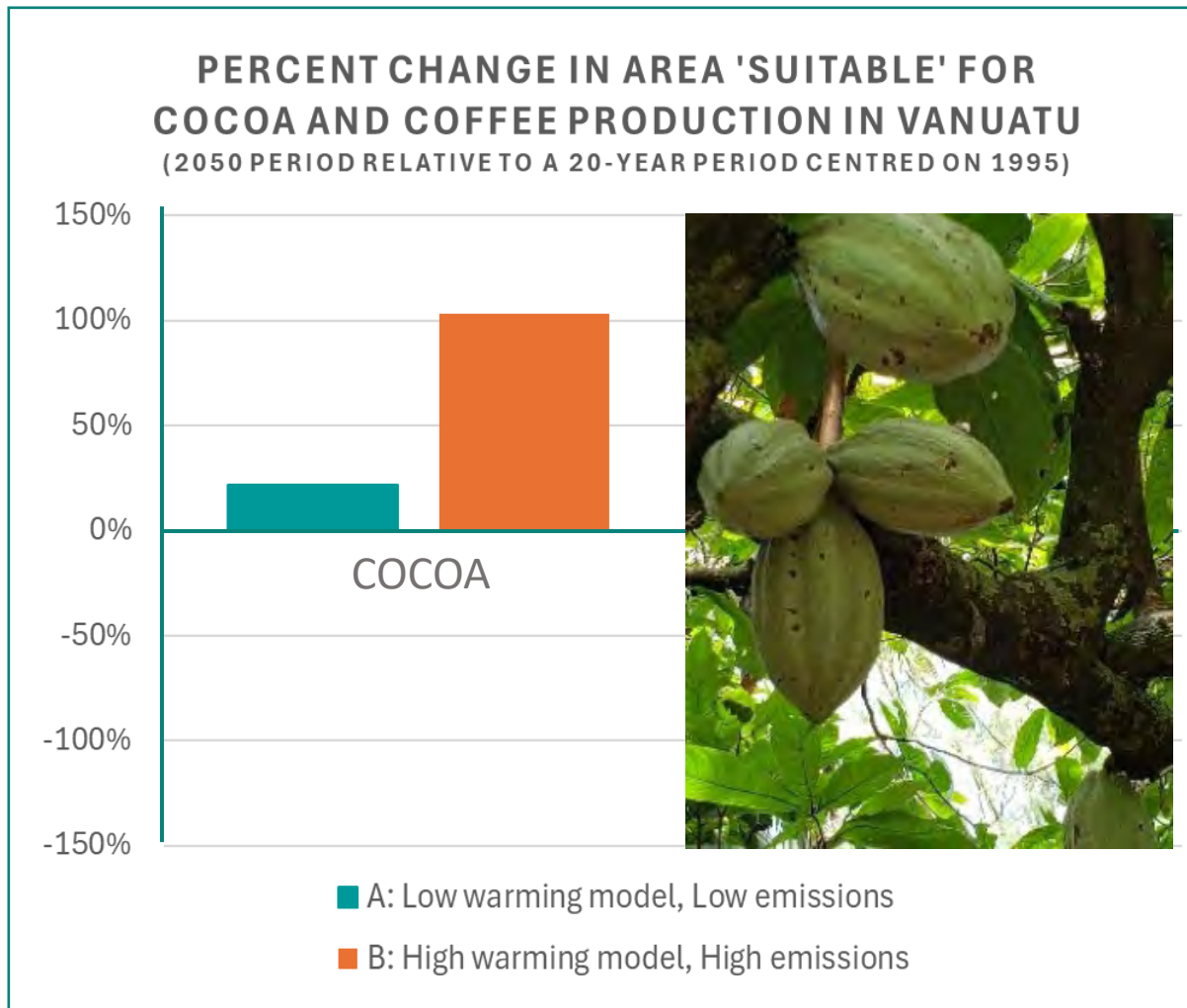


¹WorldClim climatology



# Vanuatu agriculture sector:

## Mapping tools: Cocoa and coffee



'Suitable' for Cocoa is defined

- Not too hot:
  - average annual maximum temperature less than 31 °C
- Not too cold:
  - average annual minimum temperature greater than 22 °C
- total annual rainfall 1500–4000 mm
- average monthly rainfall for each month is greater than 100 mm



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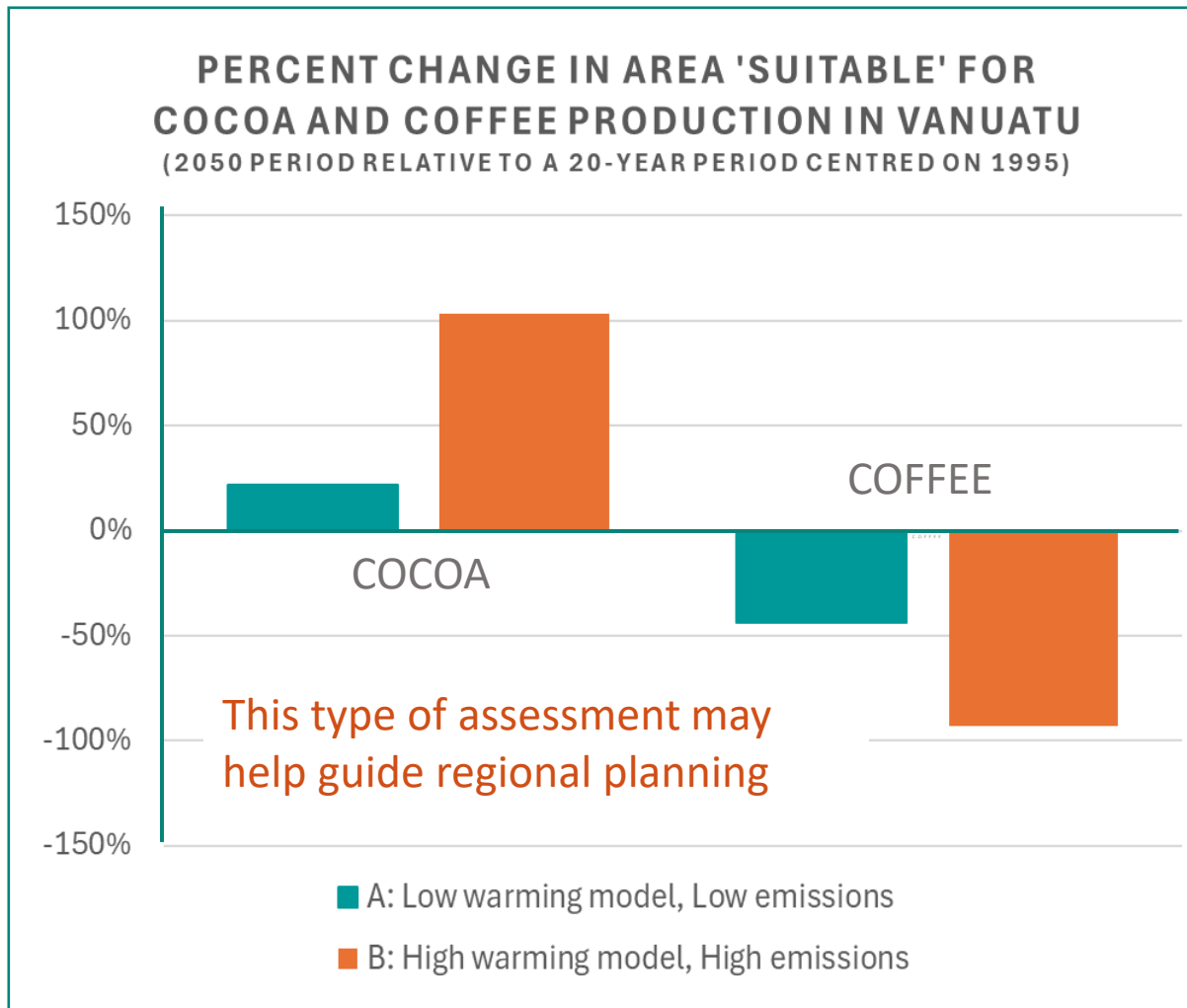
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# Vanuatu agriculture sector:

## Mapping tools: Cocoa and coffee



‘Suitable’ for Cocoa is defined

- Not too hot:
  - average annual maximum temperature less than 31 °C
- Not too cold:
  - average annual minimum temperature greater than 22 °C
- total annual rainfall 1500–4000 mm
- average monthly rainfall for each month is greater than 100 mm

‘Suitable’ for Coffee is defined

- mean annual temperature (17–24 °C)

- The term ‘suitable’ is used as a guide ONLY.
- Other climate variables, micro-climate, soil, and other management factors will all influence productivity as well as temperature.
- This assessment also assumes no adaptation practices are implemented throughout this period.



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# Some differences between projects

	My Climate View
Country	Australia
Target audience	Farmer and farm advisors
Location specific	Choose a location
Multiple commodities	22 (crops and livestock)
Target	Mainly about <b>how</b> it grows
‘User’ dial-up input	Limited
Timeframes	Observed past changes, future
Adaptation advice	No
Output (as shown)	Data and graphs of production metrics
Support etc.	Train the trainer, field days, industry events





# Some differences between projects

	My Climate View	Van-KIRAP
Country	Australia	Vanuatu
Target audience	Farmer and farm advisors	Sector decision makers
Location specific	Choose a location	Regional
Multiple commodities	22 (crops and livestock)	5 (crops, not livestock)
Target	Mainly about <b>how</b> it grows	Mainly about <b>where</b> it grows
‘User’ dial-up input	Limited	Yes, explore another crops’ suitability
Timeframes	Observed past changes, future	Past, future
Adaptation advice	No	Yes, limited / with caveats
Output (as shown)	Data and graphs of production metrics	Case studies, mapping tool
Support etc.	Train the trainer, field days, industry events	Workshops, fact sheets, video (in Bislama)





# Regional decision making and planning can be based on the latest science

We recommend:

- Co-development: The best ‘buy-in’ strategy when designing a project is to work with users from the beginning.
  - Build it together, go there, welcome iterations and updates.
- While progressing the project, recognize the option for capacity exchange.
  - We learn about their skills, they learn about ours
  - Better informed metrics translates to higher relevance, better take-up
- No ‘one size fits all’: “What is going to happen in future?”
  - “For where , for what, for whom, why are you asking?”



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For more information:

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[www.myclimateview.com.au](http://www.myclimateview.com.au)

My Climate View has been developed by CSIRO and the Bureau of Meteorology as part of the Australian Government's Future Drought Fund (FDF) Climate Services for Agriculture program, which receives funding from the FDF.



Future  
Drought  
Fund





## *Van-KIRAP – Vanuatu Klaemet Infomesen blong Redy, Adapt mo Protekt*

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***Tankiu Tumas***

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[www.pacificclimatechange.net](http://www.pacificclimatechange.net) | [www.pacificclimatechangescience.org](http://www.pacificclimatechangescience.org)

[www.rccap.org](http://www.rccap.org) | [www.org](http://www.org)







## Next steps

### My climate view:

- Revision and update of ag-climate science
- Technical publications of supporting ag-climate science
- Upgrade to CMIP6 data
- Other user enhancing features (e.g. 'build your own commodity' – TBC)



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### Vanuatu:

- IPCC Pacific 'write-shop' journal publication. A capacity exchange initiative
- Research Partnership for Resilient Disaster Response and Recovery Food Systems in Vanuatu (2025-2026)
  - Advance a shared, evidence-based understanding of how Vanuatu can create a more resilient food system in the face of an increasing number and severity of disruptive events, whilst enhancing the role of local nutritious food within the system.



The Crawford Fund Annual Conference  
**Progress and Prospects for  
Climate-Resilient Agrifood Systems:  
Actionable Recommendations for  
Policymakers and Practitioners**  
11-12 August 2025  
Parliament House, Canberra, Australia, and online

