

Vanuatu Climate Risk and Vulnerability Assessment

September 2026

Vanuatu Climate Risk and Vulnerability Assessment

Copyright © 2026

Global Green Growth Institute
Jeongdong Building 19F
21-15 Jeongdong-gil
Jung-gu, Seoul 04518
Republic of Korea

The Global Green Growth Institute does not: (i) make any warranty, either express or implied; or (ii) assumes any legal liability or responsibility for the accuracy, completeness, or any third party's use or the results of such use of any information, apparatus, product, or process disclosed of the information contained herein; or (iii) represents that its use by any third party would not infringe privately owned rights. The views and opinions of the authors expressed herein do not necessarily state or reflect those of the Global Green Growth Institute.

All Images © GGGI, unless otherwise stated.

Acknowledgement

The Government of Vanuatu, through the Department of Climate Change, would like to acknowledge the valuable support and contributions of the many institutions, organisations and individuals who contributed to the development of the Vanuatu Climate Risk and Vulnerability Assessment.

This assessment was undertaken as part of the readiness and preparatory support program; *Enhancing Adaptation Actions through the National Adaptation Plan of Vanuatu*, with the support of the Global Green Growth Institute (GGGI) and funding from the Green Climate Fund (GCF). The Government of Vanuatu acknowledges the continued partnership and technical support provided by GGGI in advancing Vanuatu's climate change adaptation and resilience efforts.

The Department of Climate Change extends its appreciation to the government ministries and departments, provincial and local stakeholders, development partners, civil society organisations, private sector representatives, research and technical institutions, and other stakeholders who contributed information, technical knowledge, data, and perspectives throughout the assessment process.

Particular appreciation is extended to those who participated in the sector workshops and consultations. Their contributions and knowledge helped strengthen the assessment by incorporating sector-specific expertise and local perspectives on climate risks, vulnerabilities, exposure and resilience across Vanuatu.

The Government of Vanuatu also wishes to acknowledge the technical expertise and commitment of GHD Pty Ltd (GHD), the lead consulting firm responsible for supporting the development of this assessment, and Urban Intelligence, whose specialist contributions to the Climate Risk and Vulnerability Assessment, including the development of the methodology, risk analysis and climate risk mapping, were instrumental to the completion of this report. The Government appreciates the professionalism, technical knowledge, and collaborative engagement demonstrated throughout the assessment process.

The Government of Vanuatu also acknowledges the technical experts, consultants and assessment team whose expertise and efforts supported the analysis, preparation and development of this report.

The Department of Climate Change recognises that the development of a comprehensive understanding of climate risk and vulnerability requires collaboration across sectors and institutions. The contributions made throughout this process provide an important foundation for strengthening climate change adaptation planning and supporting the development and implementation of the National Adaptation Plan and Provincial Adaptation Plans.

The Government of Vanuatu is grateful to all those who contributed to this assessment and whose collective efforts have supported the advancement of climate-resilient development in Vanuatu.

Disclaimer

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system or transmitted, in any form or by any means, electronic, photocopying, recording or otherwise, for commercial purposes without prior permission of the Government of Vanuatu.

The material in this publication may be used, shared, copied, reproduced, printed and/or stored for non-commercial purposes, provided that appropriate acknowledgment is given to the Department of Climate Change, Ministry of Climate Change Adaptation, Meteorology, Geohazards, Environment and Energy, Government of Vanuatu, and the Global Green Growth Institute (GGGI).

The views and information contained in this publication are intended to support climate change adaptation planning and decision-making in Vanuatu. The findings and recommendations presented in this assessment do not necessarily reflect the views of all contributing institutions, partners or stakeholders.

In all cases, the material may not be altered or otherwise modified without the express permission of the Department of Climate Change, Ministry of Climate Change Adaptation, Meteorology, Geohazards, Environment and Energy, Government of Vanuatu.

This publication has been prepared with the support of the Global Green Growth Institute (GGGI) under its partnership with the Government of Vanuatu. Responsibility for the content of this publication remains with the Government of Vanuatu.

Foreword



Climate change presents one of the most significant challenges to Vanuatu's sustainable development. As a Small Island Developing State, Vanuatu remains highly vulnerable to the increasing impacts of climate change, which pose risks to our communities, livelihoods, ecosystems, infrastructure and economic development.

Strengthening our understanding of climate risks and vulnerabilities is therefore fundamental to building a climate-resilient Vanuatu. The Vanuatu Climate Risk and Vulnerability Assessment provides an important foundation for this effort by bringing together available evidence on the climate risks and vulnerabilities affecting our country and providing a basis for strengthening adaptation planning and decision-making.

The Government of Vanuatu, through the Department of Climate Change, continues to work closely with development partners to strengthen national capacity to respond to climate change. This assessment has been developed with the support of the Global Green Growth Institute (GGGI) under the GCF funded 'Enhancing Adaptation Actions through the National Adaptation Plan' readiness and preparatory support project as part of our continued partnership to advance climate-resilient and sustainable development in Vanuatu.

The findings of this assessment will support the Government and its partners in identifying priority areas for climate change adaptation and in strengthening the integration of climate risk considerations into national, provincial, sectoral and local planning. It will also contribute to the development implementation of Vanuatu's National Adaptation Plan, Provincial Adaptation Plans, and sustainable development priorities.

As climate risks continue to evolve, access to sound evidence and strengthened collaboration will remain essential to ensuring that adaptation efforts are effective, inclusive and responsive to the needs of our people. This assessment is intended to support that continued effort and to strengthen the foundation for informed climate action across Vanuatu.

REPUBLIC OF VANUATU
Director General of Climate Changes Adaptation, Meteorology, Geohazards, Environment & Energy
Directeur Général de Climat Changé Adaptation, Météorologie, Géorisques, Environnement et Énergie
REPUBLIQUE DE VANUATU

David Gibson
Director General
Ministry of Climate Change Adaptation, Meteorology, Geohazards, Environment and Energy
Government of Vanuatu

Executive Summary

Introduction and Purpose

Understanding climate risk in Vanuatu requires examining how the country's human and physical geography shapes vulnerability, exposure, and resilience, and how climate hazards interact with these conditions.

To enhance national climate and disaster resilience, the Government of Vanuatu commissioned this Climate Risk and Vulnerability Assessment (CRVA) as part of the National Adaptation Plan (NAP) Readiness process, in partnership with the Global Green Growth Institute (GGGI) and other partners, with funding from the Green Climate Fund (GCF).

The CRVA provides a baseline understanding of climate risks and vulnerabilities in Vanuatu by identifying key hazards, assessing exposure of people, assets, and systems, and analysing sectoral and community vulnerability. It serves as the evidence base for the National Adaptation Plan (NAP) and Provincial Adaptation Plans (PAPs).

The assessment focuses on physical climate risks and does not assess transition risks. Subsequent phases of the NAP process will build on the CRVA to support the identification, prioritisation, and financing of adaptation options, including concept notes, pre-feasibility studies, and a financing strategy.

Key Messages

The CRVA highlights the following key messages:

- Climate risks in Vanuatu are systemic and interconnected, with cascading impacts across sectors.
- Key hazards include coastal flooding, tropical cyclones, drought, extreme rainfall, sea-level rise, marine heatwaves, and ocean acidification affecting multiple sectors.
- Natural ecosystems and productive sectors are highly vulnerable, with implications for food security, livelihoods, and economic stability.
- Infrastructure is highly exposed, particularly in coastal and flood-prone areas, threatening connectivity and essential services.
- Climate risks to human wellbeing are increasing, especially for vulnerable groups, due to compounded pressures across health, water, food, and livelihoods.

Role of the CRVA in the NAP Process

This CRVA provides the evidence base for adaptation planning under the NAP and PAPs. While it does not directly prioritise adaptation actions, it informs subsequent prioritisation, planning, and investment decisions. The assessment includes spatial analysis to identify geographic hotspots of climate risk across Vanuatu.

The findings can support NAP and PAP development by helping to:

- identify key risks and geographic hotspots;
- inform sectoral and cross-sectoral adaptation planning;
- support the development of climate finance proposals, including concept notes and pre-feasibility studies; and
- guide policy, planning, and budgeting decisions at national and provincial levels.

Key Observations from the Sector assessments

Climate change risks in Vanuatu can be broadly grouped into four interconnected categories across the nine sectors; risks to natural ecosystems, productive sectors, infrastructure, and human health and wellbeing.

Risks to Natural Ecosystems Natural ecosystems support biodiversity, cultural practices, livelihoods and daily life in Vanuatu. Climate change is likely to cause loss and degradation of ecosystems, including coral reefs, mangroves, seagrass, and forests, reducing habitat quality and threatening biodiversity. Coastal ecosystems face simultaneous pressures from sea-level rise, marine heatwaves, and ocean acidification, while terrestrial ecosystems are affected by changing rainfall patterns, prolonged drought, and rising temperatures. Climate change is also expected to exacerbate existing pressures from human activity and invasive species.

Ecosystem degradation has cascading impacts across sectors, including reduced food security, limited access to clean water, declining natural resources, and impacts on tourism and cultural practices.

Risks to the Productive Sectors

Productive sectors such as agriculture, forestry, and fisheries, are highly vulnerable to climate variability and extreme events. These sectors are essential for food security, livelihoods, and economic activity.

Agriculture and forestry are affected by drought, rising temperatures, and tropical cyclones, with crop-specific sensitivities. Fisheries are impacted by increasing sea surface temperatures, marine heatwaves, ocean acidification, and habitat loss, which may lead to declining fish stocks.

Declining productivity threatens food security, rural livelihoods, and cultural practices, and may increase pressure on natural resources, potentially accelerating ecosystem degradation.

Risks to Infrastructure

Infrastructure is highly exposed to climate hazards, particularly in coastal and flood-prone areas.

Damage and disruption to transport, utilities, and essential services can isolate communities, affect livelihoods, and limit access to healthcare, food, and water. These disruptions have cascading impacts across sectors, affecting livelihoods, service delivery, and economic activity.

Risks to Human Wellbeing

Climate risks to human wellbeing arise from both direct and indirect impacts, including health risks, reduced water and food security, and disruptions to essential services. Vulnerable groups, including women, children, older persons, people with disabilities, and rural communities, face heightened risks due to limited adaptive capacity and greater exposure. These impacts are compounded by disruptions across infrastructure, ecosystems, and livelihoods.

Cross-Sectoral Insights

The CRVA highlights that climate risks in Vanuatu are highly interconnected. Impacts in one sector often propagate across others, creating cascading effects on ecosystems, infrastructure, livelihoods, and wellbeing.

These interconnections mean that risks should not be addressed in isolation, but require integrated, cross-sectoral approaches to adaptation planning and investment that address shared vulnerabilities and system-wide risks.

Limitations and Data Gaps

This CRVA represents a first national baseline assessment and is subject to several data limitations. These include gaps in hazard modelling coverage, inconsistencies in spatial and sectoral data, and limited availability of locally calibrated damage and vulnerability functions.

In some sectors, qualitative information was used to supplement limited quantitative data. The spatial resolution of climate modelling data also constrains detailed analysis at provincial and local levels. The assessment is also based on current exposure and land-use patterns, which may change over time and influence future risk profiles.

Despite these limitations, the CRVA provides a strong baseline evidence base for understanding climate risks in Vanuatu and supports future improvements in data systems and risk assessment.

Summary Recommendations

The CRVA highlights priority areas for strengthening climate risk assessment and resilience planning:

- Improve national data systems, including hazard modelling, spatial datasets, and sector-specific information;
- Strengthen data sharing, coordination, and centralised data management across institutions;
- Address key data gaps through targeted data collection and improved modelling approaches;
- Promote consistent methodologies for future risk assessments;
- Strengthen integration of climate risk information into sector planning and decision-making; and
- Enhance engagement with local knowledge systems and communities to improve understanding of risk at sub-national levels.

A detailed list of recommendations can be found in the last chapter of this report.

Contents

Acknowledgement v
Disclaimer vi
Foreword vii
Content xi
List of Figures xv
List of Tables xvi

1 Introduction 19
1.1 Geography of Vanuatu 20
1.2 Population 22
1.3 Economy 22
1.4 Education 23
1.5 Employment 23
1.6 Gender and Inequality 23
1.7 Health, Nutrition and WASH 24
1.8 Kastom and Traditional Knowledge 24
1.9 Infrastructure 25
1.10 Ecosystems 25
1.11 Current Climate and Climate Influences 26
1.12 Significant Past Events and Experiences in Vanuatu 27
1.12.1 Tropical Cyclones 27
1.12.2 Drought 28
1.12.3 Extreme Rainfall, Flooding and Landslides 28
1.12.4 Earthquakes, Volcanic Eruptions and Tsunami 29
1.13 Vanuatu's Future Climate and Hazards 29
1.13.1 Tropical Cyclones 29
1.13.2 Coastal Change 29
1.13.3 Hydrological Change: Changes in Rainfall 30
1.13.4 Meteorological Change 33
1.13.5 Marine Temperature 34
1.13.6 Ocean Acidification 35
1.14 Climate Governance and Policy Context 36
1.14.1 International Context 36
1.14.2 Pacific Regional Context 37
1.14.3 National Context 37

2 Methodology 39
2.1 CRVA Method Overview 40
2.2 Limitations and Data Gaps 40
2.3 Climate Change Risk Assessment Framework 41
2.4 Climate Scenarios and Timeframes 42
2.5 Data and Analytical Approach 43
2.6 Element Identification and Data Sources 43
2.7 Exposure Analysis 44
2.8 Vulnerability Analysis 45
2.9 Qualitative and Quantitative Risk (Consequence) Assessment 46
2.10 Limitations of the Assessment 47
2.11 Sector CRVA Assessments 48

3 Agriculture Sector 49
3.1 Key Findings for Agriculture 50
3.2 Overview of the Agriculture sector 51
3.3 Climate Hazards and Exposure of the Sector 51
3.3.1 Hazard Data Availability and Limitations 51
3.4 Climate Risk Assessment for the Agriculture Sector 52
3.4.1 Cross-Cutting Risks and Implications for Agricultural Systems 53
3.5 Compounding, Cascading Risks and Interdependencies for the agriculture Sector 53
3.6 Summary and Considerations 56

4 Ecosystems Sector 57
4.1 Key Findings for Ecosystems 58
4.2 Overview of the Ecosystems Sector 58
4.2.1 Terrestrial Ecosystems 59
4.2.2 Terrestrial and Freshwater Animals 59
4.2.3 Freshwater Rivers, Lakes and Wetlands 60
4.2.4 Coastal and Marine Habitats 60
4.2.5 Mangroves 60
4.2.6 Seagrass 61
4.2.7 Coral Reef 62
4.2.8 Coastal and Marine Animal Species 63
4.3 Existing Ecosystem Stressors 64
4.4 Hazard Data Availability and Suitability 64
4.4.1 National Distribution of Key Elements 64
4.4.2 Climate Risk Assessment for Ecosystems 65
4.5 Cross-Cutting Risks and Implications for Ecosystem Systems 66
4.6 Compounding, Cascading Risk and Interdependencies 67
4.6.1 Overview of Compounding Risk 67
4.7 Summary and Considerations 70

5 Education Sector 71
5.1 Key Findings for Education 72
5.2 Sector Overview 72
5.2.1 Access, Participation and Equity 72
5.2.2 Education Infrastructure and Systems 73
5.2.3 Role of Education in Social Protection and Development 73
5.2.4 National Distribution of Education Assets 73
5.2.5 Hazard Data Availability and Suitability 74
5.3 Vulnerability of the Education Sector 74
5.3.1 Sensitivity of Education Systems 74
5.3.2 Social Vulnerability and Equity 74
5.3.3 Adaptive Capacity 74
5.4 Climate Risk Assessment 75
5.5 Cross-Cutting Risks and System Implications for Education 76
5.5.1 Risk Scores and Spatial Patterns of Exposure 76
5.6 Compounding, Cascading Risk and Interdependencies 78
5.7 Summary and Considerations 79

6 Fisheries Sector 81
6.1 Key Findings for Fisheries 82
6.2 Overview of the Fisheries Sector 82
6.3 Current Threats and Challenges for the Fisheries Sector 83
6.4 Hazard Data Availability and Suitability 83
6.5 Climate Risk Assessment for the Fisheries Sector 84
6.6 Cross-Cutting Risks and Implications for the Fisheries Sector 85
6.7 Compounding, Cascading Risks and Interdependencies 86
6.7.1 Interdependencies Across Sectors 86
6.8 Summary and Considerations 88

7 Forestry Sector 89
7.1 Key Findings for Forestry 90
7.2 Overview of the Forestry Sector 90
7.3 Hazard Data Availability and Suitability 91
7.3.1 National Distribution of Forestry Assets and Infrastructure 91
7.4 Climate Risk Assessment for the Forestry Sector 92
7.4.1 Supporting Data and Spatial Risk Patterns 92
7.5 Cross-Cutting Risks and Implications for the Forestry Sector 96
7.6 Compounding, Cascading Risks and Interdependencies 96
7.6.1 Compounding Climate Pressures on Forest Systems 96
7.6.2 Cross-Sector Environmental Linkages 98
7.7 Summary and Considerations 98

8 Health and Nutrition Sector 99
8.1 Key Findings for Health and Nutrition 100
8.2 Overview of the Health and Nutrition Sector 100
8.2.1 National Distribution of Health Infrastructure and Access Networks 101
8.3 Exposure to Climate Hazards 102
8.3.1 Air Temperature 103
8.3.2 Drought and Precipitation 103
8.3.3 Coastal Flooding and Sea-Level Rise 103
8.4 Consequences – Risk Scores 104
8.4.1 Fluvial and Pluvial Flooding 105
8.4.2 Consequences – Risk Scores 107
8.5 Vulnerabilities for All Hazards 108
8.6 Consequences for All Hazards 109
8.7 Compounding, Cascading Risk and Interdependencies 114
8.8 Summary and Considerations 116

9 Infrastructure Sector 117
9.1 Key Findings Infrastructure 118
9.2 Overview of the Infrastructure Sector 118
9.3 Hazard Data Availability and Exposure 120
9.4 Transport Infrastructure (Roads, Bridges and Airports) 124
9.5 Communications and Energy Infrastructure (Towers and Electricity Utilities) 125
9.6 Exposed Buildings 126
9.7 Tropical Cyclones 133
9.8 Compounding, Cascading Impacts and Interdependencies 134
9.9 Summary and Considerations 137

10 Tourism 139
10.1 Key Findings for Tourism 140
10.2 Overview of the Tourism Sector 140
10.3 Compounding, Cascading Risks and Interdependencies 144
10.4 Summary and Considerations 146

11 Water, Sanitation and Hygiene (WASH) 147
11.1 Key Findings for WASH 148
11.2 Overview of the WASH Sector 148
11.3 Compounding, Cascading Risk and Interdependencies 154
11.4 Summary and Considerations 156

12 Conclusions and Recommendations 157
12.1 Risks to Natural Ecosystems 158
12.2 Risks to the Productive Sectors 158
12.3 Risks to infrastructure 158
12.4 Risks to Human Health and Wellbeing 159
12.5 Concluding Statement 159
12.6 Recommendations 159

Glossary 161
References 164
Appendices 177

List of Figures

Figure 1 Administrative Boundaries of Vanuatu Showing Provinces and Area Councils 21
Figure 2 Historically recorded cyclone tracks for North, Central and South Vanuatu 27
Figure 3 Projected percentage change in precipitation in Vanuatu for RCPs 4.5 and 8.5 and at four timesteps, for months of May – October (top) and November – April (bottom) as 20-year averages 31
Figure 4 Projected drought model variation for Vanuatu, for duration of drought, frequency of drought, and intensity of drought events at four timesteps 33
Figure 5 Projected surface air temperature change over time in Vanuatu for RCPs 4.5 and 8.5 at four timesteps 34
Figure 6 Projection of the number of days of severe and extreme marine heatwaves per year in Vanuatu at two timesteps under SSP5-8.5 35
Figure 7 Projected change in pH in Vanuatu under RCPs 4.5 and 8.5 at two timestep for North, Central and South Vanuatu 36
Figure 8 Process for conducting a quantitative exposure and consequence assessment as part of a wider semi-qualitative climate risk assessment 41
Figure 9 North, Central, and South regions of Vanuatu used in CRVA. 45
Figure 10 Illustrative multi-hazard pathways showing cascading impacts across sectors. 55
Figure 11 The extent of seagrass meadows across North, Central, and South Vanuatu 62
Figure 12 The extent of coral reef systems across North, Central, and South Vanuatu. 63
Figure 13 The distribution of mangrove, seagrass, coral reef systems, and terrestrial forest ecosystems across the North, Central, and South regions both as a percentage and an area 65
Figure 14 Illustration of the interdependencies between ecosystems and other sectors that create cascading and compounding risks. 69
Figure 15 Distribution of education elements considered in quantitative analysis across the North, Central and South regions of Vanuatu. 73
Figure 16 Illustration of the interdependencies between Education and other sectors that create cascading and compounding risks 78
Figure 17 Distribution of fisheries elements considered in quantitative analysis across the North, Central, and South regions of Vanuatu. 84
Figure 18 Illustration of the interdependencies between ecosystems and other sectors that create cascading and compounding risks 87
Figure 19 Distribution of forestry elements considered in quantitative analysis across the North, Central and South regions of Vanuatu. 92
Figure 20 Illustration of the interdependencies between ecosystems and other sectors that create cascading and compounding risks. 97
Figure 21 Distribution of health-related elements considered in quantitative analysis across the North, Central and South regions of Vanuatu. 102
Figure 22 Illustration of the interdependencies between Health and Nutrition and other sectors 115
Figure 23 Vanuatu's road network distribution 119
Figure 24 Distribution of Infrastructure Assets 121
Figure 25 Illustration of the interdependencies between the infrastructure sector and other sectors that create cascading and compounding risks 136
Figure 26 Distribution of tourism-related elements across Vanuatu 141
Figure 27 Interconnections between sectors and climate hazards 145
Figure 28 Distribution of WASH infrastructure and associated road networks considered in the quantitative analysis across the North, Central and South regions of Vanuatu. 150
Figure 29 Illustration of the interdependencies between WASH and other sectors that create cascading and compounding risks 155
Figure A-01 Comparison of old and new filterable regions in Vanuatu Resilienced 178

List of Tables

Table 1 Key Vanuatu Population Statistics 22
Table 2 Summary of Observed Climate Characteristics in Vanuatu 26
Table 3 Median sea-level rise projections (in metres) showing uncertainty bands of 5-95%. Values represent absolute change from the baseline of 1995 30
Table 4 The multi-model mean for extreme daily rainfall with return periods of 10–100 years for Port Vila and Luganville as a percentage increase in baseline (1970-2000) 31
Table 5 Climate scenarios with estimated global warming ranges. 42
Table 6 Element/asset datasets used in this assessment 43
Table 7 Climate Hazard Assessment for the Agriculture Sector 52
Table 8 Key interdependencies between agriculture and other sectors and associated cascading impacts 54
Table 9 Climate Hazard Assessment for the Ecosystems Sector 65
Table 10 Summary of Climate Hazard Assessment for the Education Sector 75
Table 11 The Normalised Risk Scores for the Education sector associated with coastal flooding and sea-level rise at 0.0m, 0.5m, 1.0m and 1.5m. 77
Table 12 Risk Scores for the Education sector and fluvial and pluvial flooding 77
Table 13 Climate Hazard Assessment for the Fisheries Sector 85
Table 14 Forestry Sector Climate Risk Summary by Hazard 93
Table 15 Forestry Sector Species Vulnerability to Air Temperature Changes 94
Table 16 Forestry Sector Species Vulnerability to Drought and Precipitation Changes. 94
Table 17 Forestry Sector Risk Scores for coastal flooding and sea-level rise 94
Table 18 Risk Scores for the Forestry Sector and Fluvial and Pluvial Flooding 95
Table 19 Forestry Sector Species Vulnerability to Tropical Cyclones 95
Table 20 Summary of Climate Hazard Exposure Characteristics for the Health and Nutrition Sector 102
Table 21 Median sea-level rise projections (in metres) showing uncertainty bands of 5–95%. Values represent absolute change from the baseline of 1995 104
Table 22 Normalised Risk Scores for Coastal Flooding and Sea-Level Rise (0.0 m, 0.5 m, 1.0 m, 1.5 m) 105
Table 23 Health Facilities Exposed to Fluvial and Pluvial Flooding by AEP Scenario 106
Table 24 Normalised Risk Scores for Fluvial and Pluvial Flooding (1%, 2% and 10% AEP). 107
Table 25 Climate hazards, vulnerabilities and potential consequences for infrastructure systems in Vanuatu 122
Table 26 Median sea-level rise projections for Vanuatu under RCP2.6, RCP4.5 and RCP8.5 scenarios 124
Table 27 Number of bridge assets exposed to a 1% AEP coastal flooding event under present-day conditions and 0.5 m, 1.0 m and 1.5 m sea-level rise increments. 125
Table 28 Normalised risk scores for infrastructure assets exposed to a 1% AEP coastal flood event 127
Table 29 Number of elements within the areas where 1% AEP, 2% AEP and 10% AEP fluvial/pluvial flood models are available across Santo, Efate, Malekula and Tanna. 128
Table 30 The number of buildings on Malekula exposed to a 1% AEP, 2% AEP, and 10% AEP fluvial/pluvial flood events by the Area Council 129
Table 31 The number of buildings on Tanna exposed to a 1% AEP, 2% AEP, and 10% AEP fluvial/pluvial flood event by the Area Council. 130
Table 32 Number of exposed buildings within the modelled areas of Santo under 10%, 2%, and 1% AEP fluvial/pluvial flood events 131
Table 33 Number of exposed buildings within the modelled area of Efate under 10%, 2%, and 1% AEP fluvial/pluvial flood events. 132
Table 34 Risk Scores for fluvial/pluvial flooding for present day 1%, 2% and 10% AEP. 133
Table 35 Key Interconnections and Cascading Risks 135
Table 36 Climate hazards, vulnerabilities and potential consequences for the Tourism sector 142

Table 37 Normalised Risk Scores for the Tourism sector associated with coastal flooding and sea-level rise at 0.0m, 0.5m, 1.0m and 1.5m sea-level rise increments. 142
Table 38 Normalised risk scores for the Tourism sector associated with fluvial and pluvial flooding under 1%, 2%, and 10% AEP flood events 143
Table 39 Hazards Vulnerabilities and Potential Consequences 151
Table 40 Normalised risk scores for the WASH sector associated with coastal flooding and sea-level rise at 0.0 m, 0.5 m, 1.0 m, and 1.5 m. 153
Table 41 Normalised risk scores for the WASH sector associated with fluvial and pluvial flooding under 1%, 2%, and 10% AEP flood events. 154
Table 42 Invited workshop representatives 177
Table 43 Hazard availability and data gaps for Vanuatu, based on data provided for this assessment. 179
Table A-01 Summary of key quantitative hazard sources for the Agriculture sector 180
Table A-02 Summary of key qualitative sources for the Agriculture sector 181
Table A-03 Summary and suitability of hazard information available for the Ecosystems sector 182
Table A-04 Summary of key qualitative sources for the Ecosystems sector 183
Table A-05 Summary and suitability of hazard information available for the Education sector 184
Table A-06 Summary of key qualitative sources for the Education sector 185
Table A-07 Summary and suitability of hazard information available for the Fisheries sector 185
Table A-08 Summary of key qualitative sources for the Fisheries Sector 186
Table A-09 Summary and Suitability of Hazard Data for the Forestry Sector 187
Table A-10 Summary of key qualitative sources for the Forestry sectors 187
Table A-11 Summary and suitability of quantitative hazard information available for the Health and Nutrition sector 188
Table A-12 Summary of key qualitative sources for the Health and Nutrition sector 188
Table A-13 Summary and suitability of hazard information available for the infrastructure sector 189
Table A-14 Summary of key qualitative sources for the infrastructure sector 190
Table A-15 Length of road (km) exposed to a 1% AEP coastal flooding event at present-day sea level and
Table A-16 0.5 m, 1.0 m and 1.5 m sea-level rise increments for Efate, Malekula and Santo (annex) 190
The number of buildings on Efate exposed to a 1% AEP coastal flooding event at present sea
Table A-17 level, 0.5m 1.0m and 1.5m increments of sea-level rise for the most affected area councils. 191
The number of buildings on Malekula exposed to a 1% AEP coastal flooding event at present
Table A-18 sea level, 0.5m 1.0m and 1.5m increments of sea-level rise for all area councils 191
The number of buildings on Santo exposed to a 1% AEP coastal flooding event at present
Table A-19 sea level, 0.5m 1.0m and 1.5m increments of sea-level rise for all area councils 192
Summary and suitability of hazard information available for the Tourism sector 192
Table A-20 Summary of key qualitative sources for the Tourism sector 193
Table A-21 Summary and suitability of hazard information available for the WASH sector 193
Table A-22 Summary of key qualitative sources for the WASH sector 195





CHAPTER

01

Introduction

The Republic of Vanuatu (Vanuatu) faces a combination of environmental and socio-economic challenges, creating a complex landscape for understanding climate change impacts and related adaptation measures within the country. Vanuatu comprises 83 islands in the Melanesian Southwest Pacific. The archipelago stretches over 1,300 km (Latitude 13°S to 21°S and Longitude 166°E to 171°E) and is characterised by significant cultural diversity, with over 100 indigenous languages and rich historical beliefs and traditions.

Vanuatu achieved political independence from periods of French and British colonisation on July 30, 1980, and graduated from the UN's list of Least Developed Countries in 2020. The formal government system operates alongside traditional governance structures, often referred to as 'kastom'. These governance systems influence decision-making, resource management, and community responses to climate risks.

Social organisation in Vanuatu traditionally centres on kinship systems, chiefly hierarchies, and reciprocal exchange networks that regulate access to land and marine resources. Traditional governance systems continue to operate alongside modern state institutions through mechanisms such as island councils and traditional courts that apply kastom law to resolve disputes and manage community affairs. Customary law and practices are recognised and supported under the Protection of Traditional Knowledge and Expressions of Culture Act 2019 [33]. These systems play an important role in climate risk management and adaptation, particularly in relation to land and marine resource governance and community-level decision-making.

Vanuatu's geographic range contributes to diverse landscapes, including steep volcanic terrain, high plateaus, rolling hills, forests, lagoons, rocky shorelines, and offshore coral reefs. This geographic diversity contributes to varying exposure and vulnerability to climate hazards across the islands.

1.1 Geography of Vanuatu

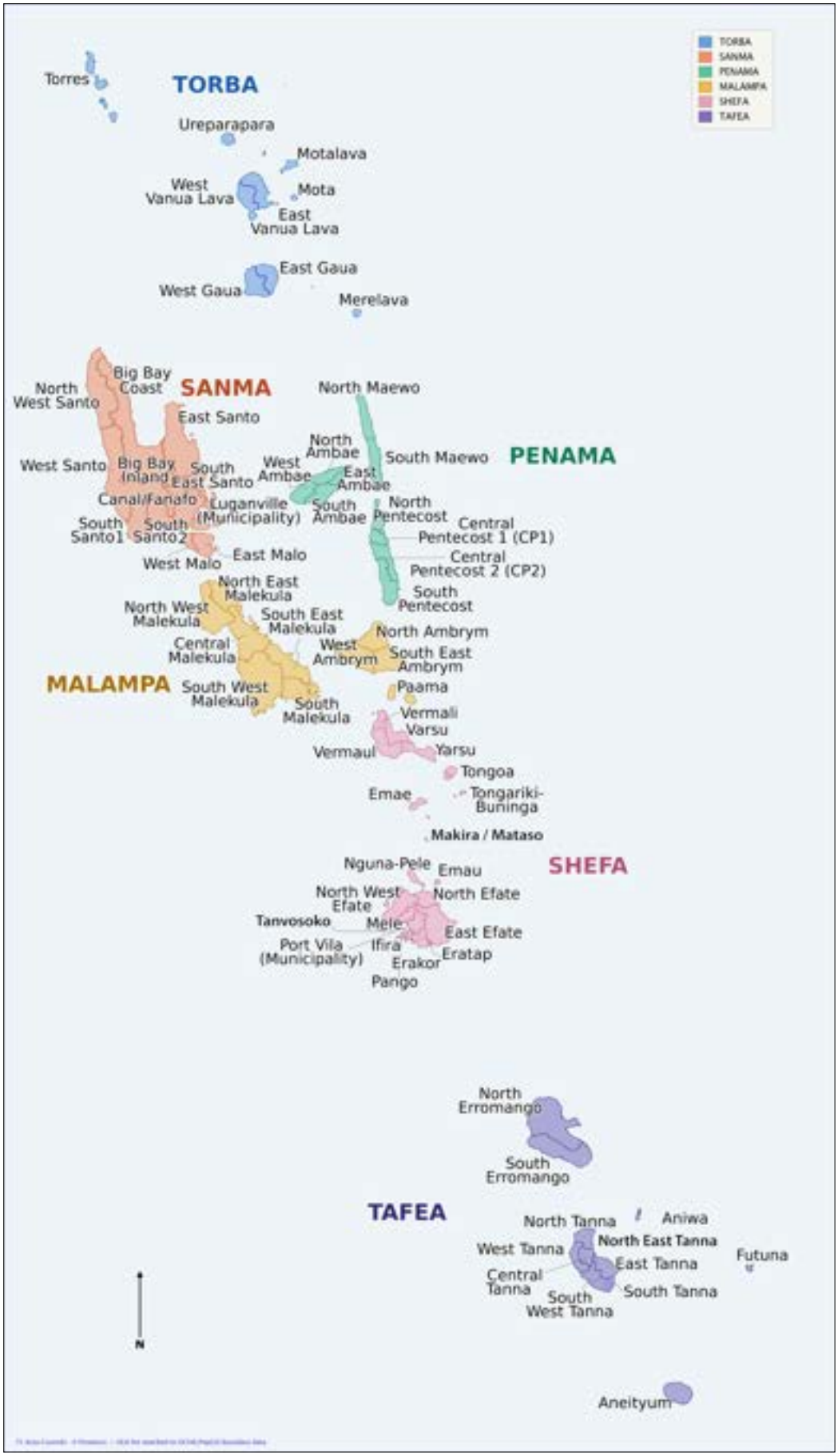
Vanuatu comprises 83 islands and has a history dating back approximately 4,000 years (~1,300 BC). The archipelago includes around 65 permanently inhabited islands, with others remaining uninhabited. The physical geography of Vanuatu is one of the most diverse in the Pacific region, characterised by a relief that ranges from rugged mountains and high plateaus to rolling hills and low plateaus, with coastal terraces and offshore coral reefs. Located along the Pacific 'Ring of Fire', Vanuatu has several active volcanoes across different islands. This geophysical setting contributes to Vanuatu's multi-hazard risk profile, including exposure to volcanic activity, earthquakes, and tsunamis [1] with recent events outlined in Section 1.12.

Vanuatu's climate is shaped by its position in the tropical Southwest Pacific, where warm ocean waters, seasonal wind patterns, and complex island topography create a diverse range of climatic conditions across the archipelago. The islands experience a tropical climate characterised by distinct wet and dry seasons, with temperatures moderated by oceanic influences and rainfall patterns that vary significantly between the windward (east) and leeward (west) sides of the islands. These climatic variations influence the distribution and intensity of climate hazards and associated risks across the islands.

The total land area is approximately 12,300 square kilometres, with around 2,550 kilometres of coastline, and an Exclusive Economic Zone of approximately 680,000 square kilometres (extending up to 200 nautical miles from land). The largest island is Espiritu Santo (Santo). The capital, Port Vila, is located on Efate Island and is the largest urban centre, with a population of over 49,000 people [2].

The country maintains a decentralised governance structure with six provinces (Malampa, Penama, Sanma, Shefa, Tafea, and Torba [17]) (see Figure 1). Under the provincial governments are 71 Area Councils, which form the primary administrative units used for spatial analysis in this assessment.

Figure 1. Administrative Boundaries of Vanuatu Showing Provinces and Area Councils



1.2 Population

The population, based on the 2020 national census (Table 1), was approximately 300,000 people [2]. The majority of the population, 233,266, lives rurally [2], placing Vanuatu as having one of the highest percentages of rural populations in Oceania. There are an estimated 138 distinct indigenous languages, giving it one of the world's highest linguistic densities per capita. The common language is Bislama, with French and English also spoken. In terms of ethnicity, the population of Vanuatu primarily identifies as Ni-Vanuatu (99%) [2]. Traditional knowledge and customary beliefs are followed by the majority of the population. There is a diverse religious landscape across Vanuatu and within provinces, as 86% of the population identify as following a religion [4].

Port Vila and Luganville serve as the main urban areas, with populations of 49,528 and 18,062, respectively, in 2020 [5]. In 2020, there were 62,876 private households in Vanuatu, with the average household size comprising 4.8 people [6]. Vanuatu has one of the highest growth rates in the world, with an estimated average annual rate of population growth of 2.3% (this rate has stayed consistent from the 2009 to 2020 census due to persistent high rates of fertility).

The average population density for Vanuatu was 24.4 people per km² in 2020, an increase from 19.1 people per km² in 2009 [4]. This makes Vanuatu one of the 50 least densely populated countries globally. The urban population has grown two to three times faster than the rural population; estimates suggest Port Vila has grown by an additional 20,000 people since the 2020 census. Additionally, the urban growth rate between genders shows a higher growth rate of women in urban areas than men, largely due to employment opportunities.

Vanuatu's population is relatively young, with 39% of its 2020 population aged under 15 years old and a median age of 20 years old [4]. The gender ratio between men and women for rural and urban areas is fairly even (~104,000 males and ~101,000 females in rural areas [4]), however, actual figures for rural areas may differ slightly and seasonally due to male migration associated with recognised seasonal employer (RSE) work schemes in Australia and New Zealand [7].

Table 1. Key Vanuatu Population Statistics

Indicator	Vanuatu	Urban	Rural	Torba	Sanma	Penama	Malampa	Shefa	Tafea
Total population	300,019	66,753	233,266	11,330	60,884	35,607	42,499	103,987	45,714
Females	148,422	33,147	115,275	5,619	29,602	17,574	21,004	51,772	22,851
Males	151,597	33,606	117,991	5,711	29,602	18,003	21,495	52,215	22,862

Source: Vanuatu 2020 Household Census [8].

1.3 Economy

Vanuatu has a diverse economy that reflects both traditional economic practices such as barter and exchange and conventional economic practices that are based on payment, including cash. The traditional economy remains the primary form of economic activity in rural areas, while urban areas are predominantly cash based. However, there is a noted resurgence of traditional practices in urban areas [9].

There is an ongoing transition from trade and exchange, particularly in rural areas where cash was not historically part of daily life, towards conventional cash-based livelihoods. With the shift to more westernised lifestyles, demand for consumer goods has increased. As a result, there is growing rural to urban migration to centres such as Santo and Efate, as well as seasonal labour migration to Australia and New Zealand [7], to generate income. In addition, there has been a shift from growing traditional subsistence crops to cash crops such as kava, copra and cocoa. This shift may reduce the availability of food for local consumption and increase dependence on imported food.

The formal economy is dominated by the service sector, contributing 64% of GDP, followed by agriculture at 19% and industry at 10% [10]. Tourism is an important sub-sector within services and contributes over 40% of GDP, but is highly sensitive to external shocks, including natural disasters [11]. About 85% of exports are food products, while reliance on imported food is increasing, heightening exposure to price volatility and supply disruptions [11] [12].

GDP per capita is low at approximately USD 3,023 [13], and does not fully reflect the contribution of subsistence and customary economic systems to livelihoods. The Human Development Index was 0.621 in 2023, ranking 146 out of 193 countries and UN recognised territories [14].

In recent years, Vanuatu is highly exposed to climate variability and extreme events. Tropical cyclones and associated hazards such as flooding, extreme winds and storm surge disrupt economic activity and affect key sectors including agriculture, fisheries and tourism [3] [15] [16].

1.4 Education

Vanuatu mandates access to education for all children; however, primary and secondary education are neither compulsory nor free. There are significant disparities in access between rural and urban areas. While there is an increasing social shift towards education [17], many households must generate cash to support schooling, often reducing available family labour, particularly in agriculture and home gardens.

When family labour decreases, especially with many men engaged in Recognised Seasonal Employer (RSE) work [7], children are frequently withdrawn from school after disasters, during droughts, or at peak gardening periods such as planting, irrigating, and harvesting. This disrupts learning outcomes [17]. Men typically control household and community decision-making, including choices about school attendance [13], and boys are often prioritised for education over girls [17] [18].

In many rural areas, schools also serve as emergency shelters and recovery centres during and after tropical cyclones, resulting in periods when education is unavailable.

1.5 Employment

Vanuatu's employment context reflects both traditional and conventional economic systems, recognising subsistence farming and customary livelihoods as central sources of resource generation across many islands. The labour force, defined as people aged 15 years and above, comprises approximately 134,000 individuals, of which 43% are women [4] [20].

National statistics show unemployment to be relatively low, with almost all people aged 15 years and above engaged in some form of traditional (subsistence production) or formal (paid) employment. However, despite low unemployment, there are significant issues related to job quality, gender disparity, and exposure to disaster-related disruption [20]. Given agriculture's position as the largest source of employment, the sector (traditional and conventional) is particularly vulnerable to climate change, natural disasters, and associated disruptions [3] [15] [21]. Most recently, the country ranks 93rd out of 180 countries in terms of the vulnerability of its employment sector to climate change and natural disasters [22].

The majority of employed people work in the agriculture, forestry, and fishing sector (42%), followed by wholesale and retail trade (6%) and household activities (6%) [4].

1.6 Gender and Inequality

Vanuatu is a largely patriarchal society, with gender inequality evident across multiple dimensions. The Gender Inequality Index score of 0.556 ranks the country 146th globally, reflecting disparities in health, education, economic participation, and decision-making [23]. While overall human development outcomes between men and women are relatively close, women continue to face structural disadvantages [14].

Women have limited access to resources, minimal participation in decision-making, and no control over customary land. They also carry a disproportionate workload, combining agricultural, domestic, and income-generating activities, which affects their wellbeing and opportunities [24]. Migration patterns, such as RSE work, further increase this burden [7].

Although attitudes towards girls' education are improving and women are increasingly involved in agricultural production and markets, gender roles remain entrenched, particularly in agriculture and fisheries [17] [19] [25].

The Government has committed to addressing these inequalities through national frameworks, including the National Gender Equality Policy 2020–2030 [26].

Gender inequality is a key vulnerability factor in disaster and climate contexts. Women are disproportionately affected by climate-related events due to restricted access to land, increased caregiving responsibilities, and limited inclusion in decision-making. Disasters disrupt access to shelter, food, healthcare, and protection services, and can increase gender-based violence, further weakening resilience and adaptive capacity.

1.7 Health, Nutrition and WASH

Vanuatu's food security and nutrition are largely supported by domestic agriculture and coastal fisheries, although reliance on imported food is increasing, particularly in urban areas. Rural households remain predominantly subsistence-based, while urban households depend more on cash-based food purchases due to limited access to land. This shift towards cash-based livelihoods and urban migration has increased the consumption of imported food, which is often less nutritious, contributing to declining food security and a transition from subsistence crops to cash crops [12]

Water security remains a persistent challenge for households [25]. Water is sourced from rainfall, groundwater, and surface water, with availability varying across islands. Larger islands generally have access to both groundwater and surface water, while some smaller islands lack one or both sources (e.g. Mataso, Buninga, the Torres Islands group, and small islands off Malekula and Santo) [27]. In addition, small islands with groundwater, as well as low-lying coastal areas, are at high risk of saltwater intrusion into groundwater resources [25].

Approximately 56% of the urban population has regular access to water through public or private utilities, including individual or shared household piped systems [13] [25]. In Port Vila, water supply is primarily provided by a private company serving urban households and the tourism sector. Many households also collect rainwater and draw on groundwater; however, groundwater supplies are diminishing and increasingly polluted [27]. The expansion of private water providers and the growing availability of imported bottled water reflect increasing pressure on existing systems [27].

In Luganville, water is supplied by the Department of Public Works. However, the rapid growth of informal settlements in urban areas, including Port Vila and Luganville, has led many households to depend on streams and rivers, which are often contaminated. Outside the capital, water quality testing and groundwater assessment remain limited or sporadic.

Rural communities rely on rainwater collection during the wet season and groundwater from boreholes and wells, with systems managed at the community level. Water stress is significant during dry periods due to competition between household and agricultural use. Recent initiatives, including improved storage and desalination systems (e.g. Ambae and Aniwa), aim to strengthen water security in drought-prone and saline-affected areas [13] [25].

While data and monitoring are not comprehensive across urban and rural areas, key sources of water pollution include landfills, hotel discharges, pit latrines and septic tanks, animal grazing, poor sanitation and waste facilities, industrial discharge, timber processing, and oil from power generation and abandoned equipment [27].

Access to sanitation and hygiene also remains a major issue, with approximately 22% of the population having access to limited hygiene services in 2022, and 27% having access to limited sanitation services [28]

1.8 Kastom and Traditional Knowledge

Vanuatu's concept of kastom refers to traditional practices, beliefs, and knowledge systems that guide daily life, resource management, and social organisation, while continuing to evolve over time [29]. The country's cultural diversity, with over 100 indigenous languages and distinct kastom systems across its islands, reflects long-standing environmental adaptation and the development of knowledge systems linked to ecosystems, agriculture, governance, and spiritual beliefs.

Traditional knowledge systems are grounded in a detailed understanding of environmental cycles, biodiversity,

and sustainable resource management. These include agroforestry practices, seasonal knowledge, and marine and forest management, which contribute to resilience to environmental hazards [32] [30]. For example, traditional agricultural systems adapted to climate variability support resilience in rural and isolated areas [13] [31] [32], while practices such as tabu areas regulate the use and protection of terrestrial and marine resources [26

Despite their importance, traditional knowledge systems face increasing pressure from urbanisation, social change, climate impacts, and interactions with formal governance and religious systems. At the same time, there is growing recognition of their value for climate adaptation, biodiversity conservation, and sustainable development, with efforts to document, revitalise, and integrate these systems into planning processes, including disaster risk reduction and climate adaptation strategies [34].

Kastom remains a living knowledge system, maintained and transmitted across generations through daily practice and community life. Its preservation is essential for sustaining cultural identity and strengthening community resilience, particularly in supporting early warning systems and locally grounded climate adaptation strategies [34].

1.9 Infrastructure

Vanuatu's infrastructure reflects the challenges of a dispersed archipelago, with systems that are limited in coverage and highly vulnerable to natural hazards. Transport relies on a small network of airports (28), ports, and sea routes, though inter-island shipping infrastructure is underdeveloped and costly. Road networks are concentrated on Efate and Santo, while outer islands depend on basic tracks. Telecommunications have expanded, but internet access remains variable and expensive, and essential services such as electricity, water, and sanitation are largely concentrated in urban centres.

Infrastructure is highly exposed to climate and geological hazards, including cyclones, earthquakes, and volcanic activity, which frequently damage critical systems such as roads, power lines, and communications. Geographic dispersion, with around 80% of the population in rural areas and many living on remote islands, makes infrastructure development and service delivery costly and inefficient. Port Vila and Luganville are the main centres of formal infrastructure, while smaller and dispersed populations limit investment feasibility and increase construction costs due to logistical challenges and limited contractor capacity. In addition, maintenance constraints contribute to infrastructure deterioration over time [35]

Key infrastructure areas include transportation (aviation, land, shipping), energy, ICT, tourism, agriculture, climate and disaster management, water supply, health and education, and solid waste management.

1.10 Ecosystems

Vanuatu's ecosystems span terrestrial, coastal, and marine environments and, while less diverse than neighbouring countries such as Solomon Islands and Fiji, exhibit notable endemism. The country lies within the East Melanesian Biodiversity Hotspot, comprising approximately 1,600 islands and recognised for its high biodiversity value. These ecosystems provide essential services, including food, water, materials, medicines, fuel, and coastal protection, while supporting livelihoods, cultural practices, and intergenerational knowledge transfer.

Terrestrial ecosystems include montane forests, lowland rainforests, seasonal forests, and coastal vegetation, with natural forest cover estimated at 4,440 km^2 [36]. Vegetation patterns are shaped by altitude, rainfall, and disturbance factors such as cyclones and volcanic activity, with trade winds creating wetter eastern zones and drier leeward areas. Biodiversity includes 12 native bat species and over 100 bird species, of which around 30 are endemic or near-endemic.

Freshwater ecosystems are widespread, with numerous rivers and streams often characterised by steep headwaters and reduced or ephemeral flow during dry periods. The longest river is the Jordan River on Santo, and there are approximately 25–30 natural freshwater lakes across multiple islands, with Lake Letas on Gaua being the largest. These systems support diverse aquatic species, including native fish such as flagtails and grunters, the endemic marbled eel, as well as gobies, sleepers, freshwater prawns, and snails

Coastal and marine ecosystems include mangroves, seagrass beds, and coral reefs. Mangroves cover approximately 2,500–3,000 hectares (around 2,000 hectares on Malekula) with 24 species recorded. Seagrass beds support high biodiversity and provide key habitat for species such as

dugongs and green turtles, while coral reefs extend over 1,200 km² and host 450–500 fish species and approximately 295 hard coral species. These ecosystems provide essential services, including coastal protection, carbon storage, and nursery habitats, and support local livelihoods through fisheries and tourism, as well as five threatened or vulnerable turtle species.

1.11 Current Climate and Climate Influences

Vanuatu's climate is strongly influenced by the South Pacific Convergence Zone (SPCZ), where trade winds and westerly winds converge, generating high rainfall [37]. The position of the SPCZ is shaped by major climate drivers, including the Madden–Julian Oscillation (MJO), El Niño–Southern Oscillation (ENSO), and the Interdecadal Pacific Oscillation (IPO), which operate across different timescales and affect rainfall, sea surface temperatures, and tropical cyclone occurrence [37].

ENSO is a key driver of climate variability. El Niño conditions are generally associated with reduced rainfall, increased drought risk, fewer cyclones, and cooler sea surface temperatures, while La Niña brings higher rainfall, warmer conditions, and potentially more cyclones.

Overall, there are two main seasons: November to April (wet season), which is warmer and wetter, and May to October (dry season). However, the climate remains generally warm, with relatively little seasonal variation in average temperature (around 4–5 °C). The northern islands are warmer than the southern islands, and local air temperatures are closely correlated with ocean temperatures [38].

Average annual hottest day temperatures between 1985 and 2005 show little variation across the country, as summarised in Table 2.

Rainfall patterns are influenced by the movement of the SPCZ and ENSO, with higher rainfall generally occurring year-round in the north compared to the south [39]. Average annual and seasonal rainfall have not shown significant long-term variation since 1951, with totals ranging from 1,000 to 3,800 mm at Aneityum and 900 to 3,500 mm at Port Vila [38].

Local rainfall variability is driven by the interaction of the dominant south-easterly trade winds with island topography, resulting in higher rainfall on northeastern and eastern sides and lower rainfall on northwestern and western sides of the islands. The average annual maximum daily rainfall between 1985 and 2005 shows considerable year-to-year variation, indicating significant interannual variability in rainfall [38] [39].

Average sea surface temperatures recorded by the Port Vila tide gauge between 1993 and 2021 varied seasonally, ranging from just over 25°C in August to 29°C in February and March [38].

Table 2. Summary of Observed Climate Characteristics in Vanuatu

Weather station	Average Monthly Temperature Range (°C)	Annual Hottest Day (°C)	Annual Maximum daily rainfall (mm)
Vanuatu South White Grass Airport	21-26	32.6 (31.4-34.0)	122 (60-447)
Vanuatu Central Bauerfield Airport (Port Vila)	23-27	33.0 (32.1-34.0) 34.7 (34-35.4)	201 (71-539) 167 (77-377)
Vanuatu North Sola-Pekoa Airport (Santo)	24-26.5	32.7 (31.5-33.2) 32.7 (32.0-34.0)	240 (106-301) 162 (79-267)

1.12 Significant Past Events and Experiences in Vanuatu

Vanuatu's experience with natural hazards provides important context for assessing and communicating climate change risks. Risk perception is shaped by cultural and personal experience, influencing the acceptance of risk-reduction measures and behavioural change [43]. The following sections document major hazard events and their impacts, drawing on available written records to outline the country's disaster risk profile [44]. These records reflect only the recent past and do not capture significant events preserved through oral traditions and traditional knowledge.

Historical experience, together with traditional knowledge, has long informed community resilience and cultural identity. As climate change alters the frequency, intensity, and nature of hazards, building on this foundation while adapting to evolving risk profiles will be critical for resilience and sustainable development.

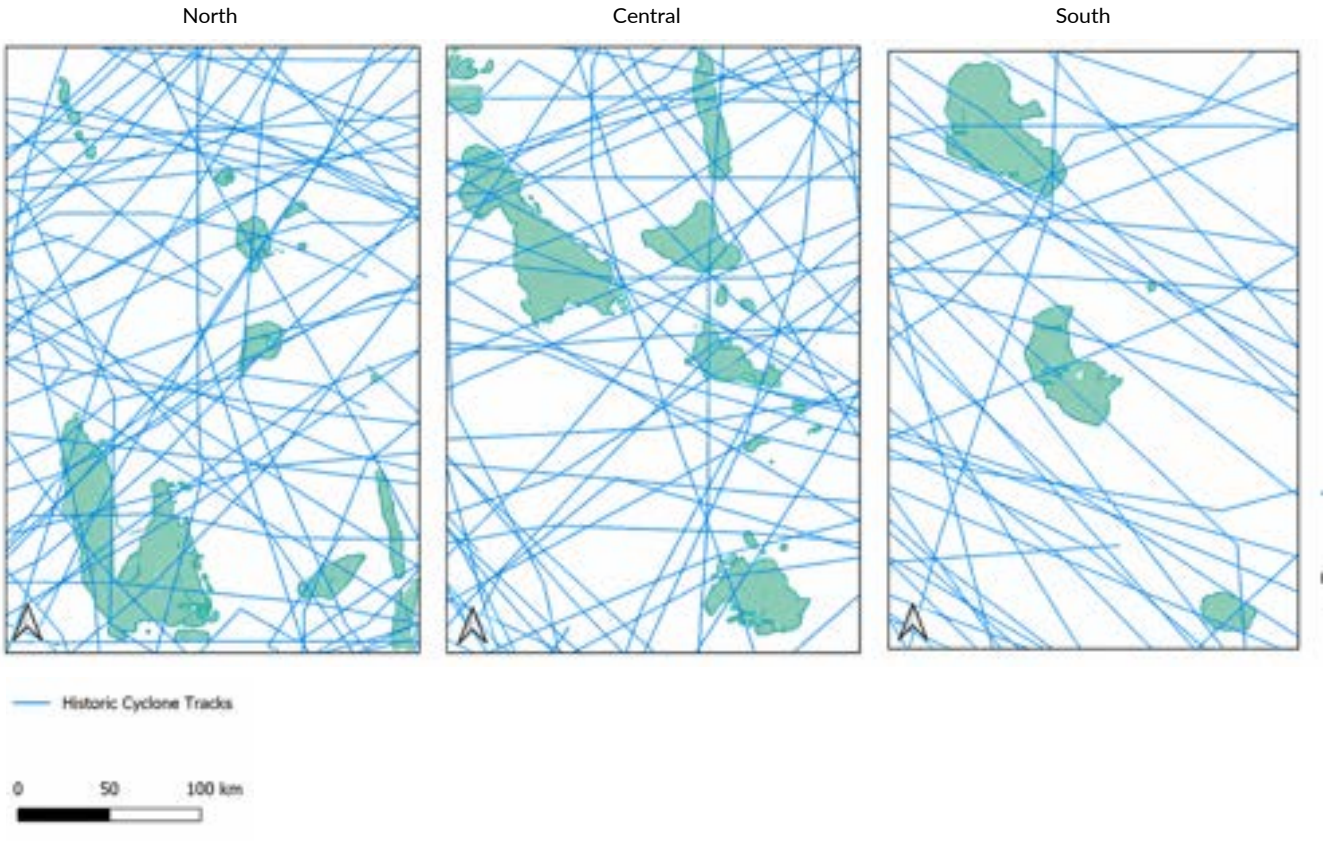
1.12.1 Tropical Cyclones

Vanuatu is highly exposed and vulnerable to tropical cyclones, which often bring multiple hazards including flooding, storm surge, and landslides. The country's experience over recent decades highlights the severe and recurring nature of these events.

Between 1971–1995 and 1996–2021, the average number of tropical cyclones passing within 500 km declined from approximately 36 to 26 per decade. However, cyclone intensity (mean wind speed) increased by approximately 15%, and the proportion of Category 3–5 cyclones rose from 45% to 57% [62]

Cyclone occurrence is also influenced by ENSO, with higher frequency during La Niña events (~13 per decade) compared to El Niño and neutral conditions (~9 per decade).

Figure 2. Historically recorded cyclone tracks for North, Central and South Vanuatu



Tropical Cyclone Pam (2015) was a Category 5 event that struck between 12–14 March 2015, with wind speeds of around 250 km/h and gusts up to 320 km/h. Eleven people were killed, approximately 65,000 displaced, and about 17,000 buildings damaged or destroyed, with crop losses affecting at least 80% of the rural population. The islands of Tanna, Erromango, and Efate were most affected, and damage extended to health infrastructure across 22 islands [44]

Tropical Cyclone Harold (2020) also Category 5, struck during the COVID-19 pandemic, compounding impacts. It affected approximately 188,000 people, with the greatest damage in Sanma, Penama, and Malampa provinces [46] [47] [48]. Physical damage was estimated at VT 7.7 billion, while combined impacts with COVID-19 reached VT 68 billion (around 61% of GDP), highlighting the scale of cascading risks [47].

Tropical Cyclones Judy and Kevin (2023) both Category 4, made landfall within 48 hours, bringing severe winds, rainfall, flooding, and storm surges [3]. The events coincided with earthquakes, demonstrating the potential for multiple hazards to occur simultaneously. Although no fatalities were reported, 6,384 homes were destroyed and 12,768 damaged, with housing losses estimated at VT 19 billion and total recovery needs at VT 91.6 billion. A national State of Emergency was declared, and GDP growth projections were reduced from 3.6% to 3.0% [3]

Tropical Cyclone Lola (2023) reached Category 5 intensity before weakening and making landfall in Vanuatu as a Category 4 cyclone. Initial estimates indicated that approximately 150,000 people may have been affected; subsequent reporting revised the directly impacted population to approximately 91,000. The cyclone brought destructive winds, heavy rainfall, flooding and coastal inundation across several islands. A six-month State of Emergency was declared for affected provinces [52]. Earlier events, including Tropical Cyclone Lusi (2014) and Tropical Cyclone Hola (2018), also caused fatalities, displacement and widespread damage to housing, water systems, schools and crops [49] [50] [55].

Earlier cyclones include Tropical Cyclone Lusi (2014), which resulted in ten deaths and displaced over 100 people [49], and Tropical Cyclone Hola (2018), which caused widespread damage to homes, water supply, schools, and crops, with at least two fatalities reported [50] [55].

1.12.2 Drought

Drought is a slower-onset hazard in Vanuatu, affecting agriculture, food security, water availability, and public health. It is typically associated with El Niño conditions and can last from several months to over two years [52]. Drought may result not only from reduced rainfall but also from limited access to surface and groundwater, with small low-lying islands, volcanic islands, and leeward (western) areas most exposed based on local knowledge.

Consultations identified areas particularly vulnerable to water shortages, including small island groups (e.g. Torres and Banks Islands, Nguna), volcanic islands (e.g. Tanna, Ambae, Ambrym), and leeward sides of larger islands such as north-western Santo, Malekula, and Pentecost.

The 2015 El Niño event led to severe drought lasting between two and seven months, compounding impacts from Tropical Cyclone Pam earlier that year. Crop losses, inability to replant, and drying water sources intensified food insecurity and water shortages. Communities relied on limited and often contaminated water, leading to deteriorating WASH conditions and increased health risks [53] [54].

Health impacts included dehydration, malnutrition, and increased cases of diarrhoea and water-borne diseases, with young children particularly vulnerable. At least one infant death was attributed to drought-related illness [53] [54]. Earlier droughts in 1997–1998 and 1982–1983, lasting up to 13 months, demonstrate the recurring nature of drought risk despite limited historical records.

1.12.3 Extreme Rainfall, Flooding and Landslides

While floods are often associated with tropical cyclones, extreme rainfall events independent of cyclone activity have also caused flooding hazards and triggered landslides. The combination of steep terrain, high rainfall intensity and, in some cases, human-induced landscape changes can create conditions for slope failures.

Heavy rainfall from Tropical Cyclone Lusi in 2014 triggered a landslide in Santo that destroyed a small village, with six people reported missing [55]. In October 2013, a landslide struck Paama Island in Malampa Province, with an estimated 400 households affected. While authorities reported no casualties, food gardens and water supplies were destroyed, and animals were killed [56].

1.12.4 Earthquakes, Volcanic Eruptions and Tsunami

Vanuatu lies within the Vanuatu Subduction Zone (VSZ) along the Pacific Ring of Fire, making it highly exposed to earthquakes, volcanic eruptions, and tsunami hazards [1] [57]. While earthquakes generate significant risks through ground shaking and secondary impacts such as landslides, infrastructure damage, and tsunamis, they are not explicitly modelled in this CRVA due to data and complexity constraints.

The December 2024 Port Vila earthquake (Mw 7.3) illustrates the scale of potential impacts, resulting in fatalities, widespread infrastructure damage, displacement, and pressure on health and WASH systems [58] [59] [60].

Historical records confirm that earthquakes, volcanic activity, and associated tsunamis are recurrent hazards in Vanuatu, reinforcing the country's multi-hazard risk profile [1] [61].

1.13 Vanuatu's Future Climate and Hazards

Vanuatu's climate system is increasingly influenced by global climate change, with projected changes in temperature, precipitation, sea level, and extreme weather events (e.g. tropical cyclones) expected to affect the environment, communities, and economy. Understanding current climate patterns alongside future projections is essential for effective adaptation planning.

This section provides an overview of climate-related changes relevant to the subsequent sectoral assessments, drawing on Van-KIRAP data sourced from CSIRO. It is intended to provide context for the qualitative and quantitative assessments presented in the sector analysis later in this document.

More detailed climate projections are based on CSIRO data available through the Van-KIRAP platform at https://vanclimatefutures.gov.vu/

1.13.1 Tropical Cyclones

Future projections indicate that tropical cyclones passing near Vanuatu may become less frequent but more intense. However, projections remain uncertain due to natural variability, limited long-term observations, and constraints in global climate models, resulting in generally low to medium confidence. Despite this, some consistent trends can be identified.

Under a high emissions scenario (Representative Concentration Pathways (RCP) 8.5), the average number of cyclones passing within 500 km of Vanuatu is projected to decrease by approximately 12% by the end of the century, while wind speed intensity and rainfall rates are projected to slightly increase. The frequency of tropical cyclones is projected to decrease in the future during La Niña conditions but increase during El Niño conditions [62].

1.13.2 Coastal Change

Sea-level rise is the primary driver of coastal change, increasing coastal erosion and periodic flooding associated with storm events and extreme high tides, and potentially leading to permanent inundation of low-lying areas.

Coastal flooding occurs when sea levels exceed normal high tides and extend onto low-lying land, while coastal erosion results from wave action on sediments and can be intensified by human activities or changes in sediment supply.

Median sea-level rise has been modelled by CSIRO under the Van-KIRAP project [63] (Table 3), excluding tides, storm surges, large wave events, and ENSO-related variability. Projections indicate accelerated sea-level rise beyond mid-century, with higher increases under RCP8.5 and more gradual increases under RCP4.5.

Table 3. Median sea-level rise projections (in metres) showing uncertainty bands of 5-95%. Values represent absolute change from the baseline of 1995 [63]

	RCP2.6		RCP4.5		RCP8.5	
2030	0.13	[0.10-0.17]	0.13	[0.09-0.17]	0.14	[0.10-0.17]
2050	0.23	[0.17-0.30]	0.24	[0.18-0.31]	0.28	[0.22-0.37]
2070	0.32	[0.24-0.43]	0.37	[0.28-0.48]	0.48	[0.37-0.64]
2090	0.42	[0.30-0.56]	0.5	[0.38-0.68]	0.73	[0.56-0.99]

To assess impacts on ecosystems and infrastructure, a DoCC hydrodynamic model is applied using coastal flooding from a 1% AEP (1-in-100-year) event at four sea-level increments (present day, 0.5 m, 1.0 m, and 1.5 m). The model incorporates storm surge components into baseline sea levels and is integrated into Resilience Explorer® to overlay flood extents with key elements of value.

Rather than relying on future scenarios, this approach shows how exposure increases as sea levels rise. Using extreme events provides a clearer understanding of risk, as they extend further inland and affect more assets and ecosystems than average conditions.

Overall, sea-level rise is expected to increase the frequency and extent of coastal flooding and erosion, with impacts ranging from more frequent high-water events to permanent land loss. While storm surges from tropical cyclones may further exacerbate these risks, they are not included in this assessment.

1.13.3 Hydrological Change: Changes in Rainfall

Future seasonal rainfall patterns in Vanuatu remain highly uncertain, largely due to potential shifts in the South Pacific Convergence Zone (SPCZ). A northward shift would result in drier conditions, a southward shift in wetter conditions, while no shift would maintain current patterns [64]. Climate models do not agree on the direction of change, meaning all outcomes remain plausible.

As a result, no clear long-term trends emerge in seasonal rainfall projections (Figure 3). Multi-model median rainfall for both wet and dry seasons remains close to present-day levels across scenarios and time periods.

Under RCP4.5, wet season rainfall remains stable throughout the century, with modest variability (±10–15%). Under RCP8.5, similar stability persists until mid-century, but uncertainty increases significantly by 2071–2090, with projections ranging from decreases of around 20% to increases exceeding 15%, and some outliers reaching up to 60%

Dry season rainfall shows consistently stable medians across both scenarios and all time periods, with relatively narrow variability (±10%), suggesting limited change in seasonal averages.

Across all regions, rainfall projections show similar distribution patterns, indicating that uncertainty is consistent across the archipelago rather than region-specific.

In contrast to relatively stable seasonal rainfall averages, extreme daily rainfall is projected to increase across all regions of Vanuatu, for all time periods and emissions scenarios. Projections indicate increases of up to approximately 30% under RCP4.5 and up to 70% under RCP8.5 by the end of the century for locations such as Port Vila, with similar trends observed across provinces and regions [64].

Figure 3. Projected percentage change in precipitation in Vanuatu for RCPs 4.5 and 8.5 and at four timesteps, for months of May – October (top) and November – April (bottom) as 20-year averages

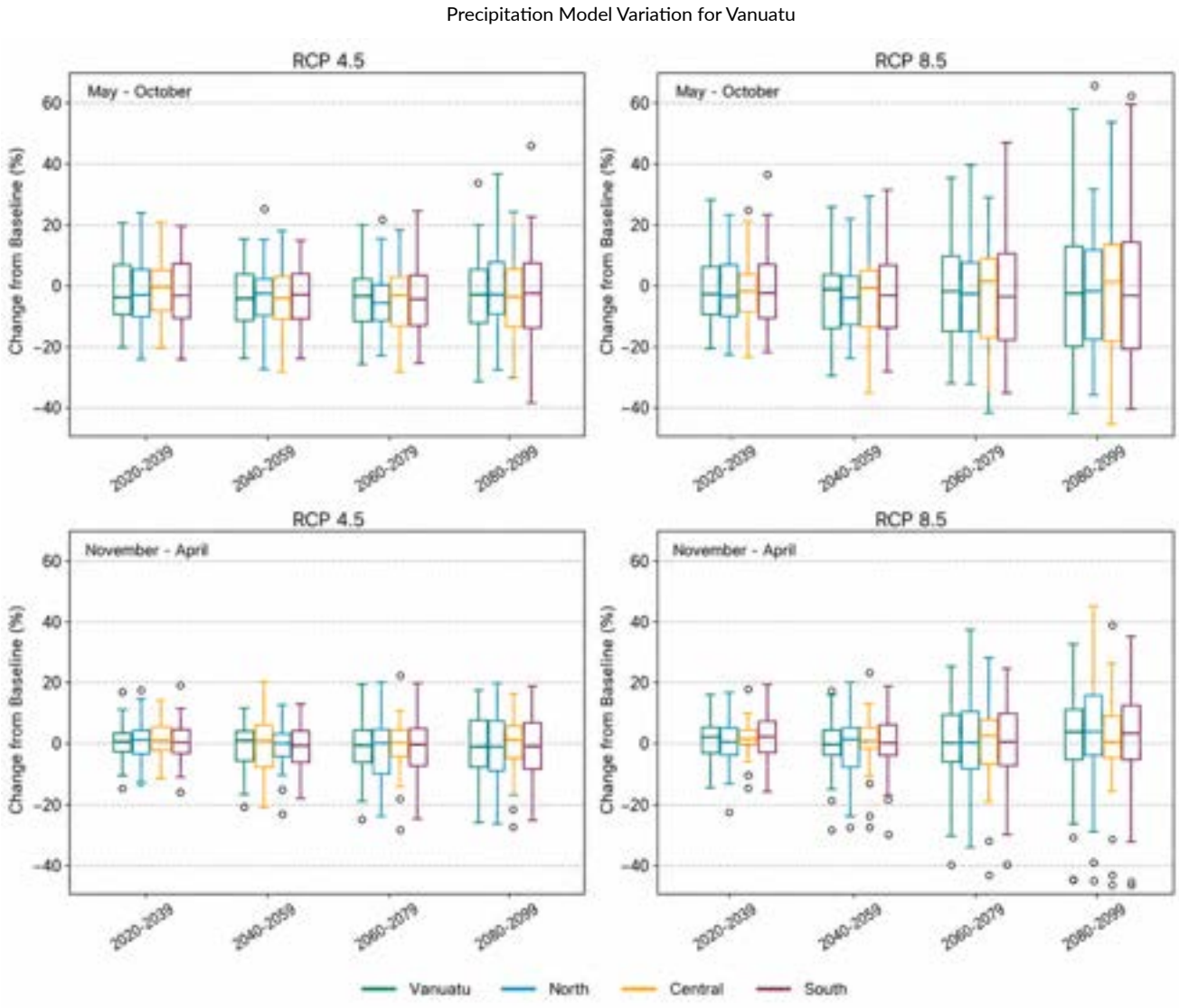


Table 4. The multi-model mean for extreme daily rainfall with return periods of 10–100 years for Port Vila and Luganville as a percentage increase in baseline (1970-2000)

Location	RCP	2040 - 2070	2070 - 2100
Port Vila	4.5 8.5	+ 21% + 40%	+ 30% + 70%
Luganville	4.5 8.5	+18% +27%	+ 26% + 57%

Fluvial and Pluvial Flooding

Fluvial and pluvial flooding in Vanuatu are closely linked to extreme rainfall events, which are projected to intensify under climate change [40] [41] [42]. Fluvial flooding occurs when rivers overflow during heavy or prolonged rainfall, while pluvial flooding occurs when intense rainfall exceeds drainage capacity, particularly in low-lying and urban areas. As a result, flood frequency is expected to increase.

The DoCC has developed present-day fluvial and pluvial flood models for Malekula, Tanna, selected catchments near Port Vila (including most of Mele and parts of Erakor Area Council), and Luganville (including all of Luganville and parts of Canal-Fanafo and South Santo Area Councils). The models simulate 10%, 2%, and 1% Annual Exceedance Probability (AEP) events and provide flood extent and depth information. Although they do not incorporate climate change, they remain valuable for assessing current flood risks to assets and infrastructure. A bathtub modelling approach is used, whereby areas below flood height and connected to waterways are considered inundated.

These flood layers are integrated into Resilience Explorer® and overlaid with key elements of value to assess exposure, consistent with the approach used for sea-level rise (see Chapter 2).

Drought

Drought is a period of prolonged drier-than-normal conditions that restrict activities and water availability. It can arise from reduced rainfall (meteorological drought), low soil moisture (agricultural drought), or reduced freshwater availability (hydrological drought) [65] [66].

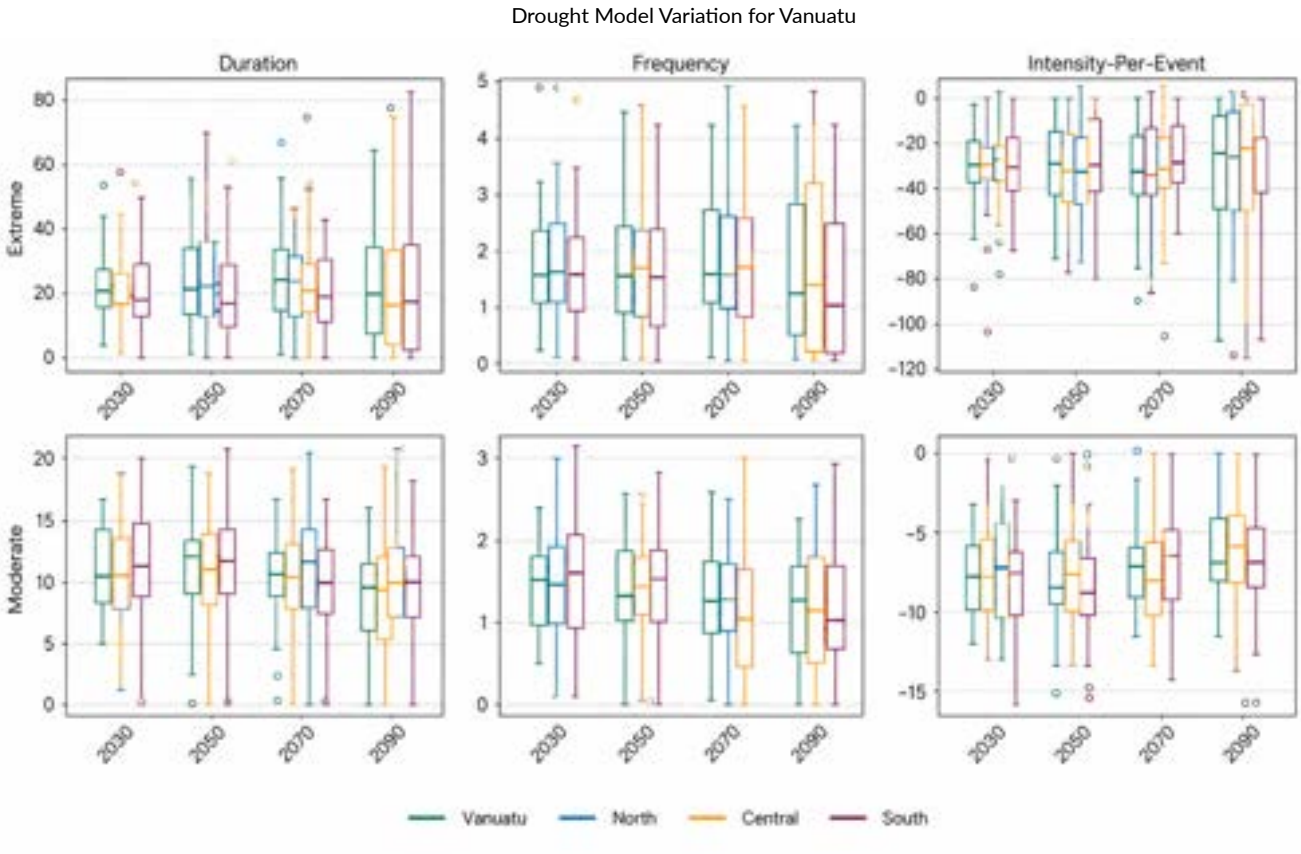
As part of the VAN-KIRAP, CSIRO applies the Standardized Precipitation Index (SPI) to characterise meteorological drought based on the precipitation anomalies relative to long-term local averages. SPI values of zero indicate normal conditions, while negative values indicate below-average rainfall, with increasingly negative values reflecting greater drought intensity. In this context, drought is defined when SPI remains at or below −1 (SPI ≤ −1) for a sustained period of at least three consecutive months. Drought categories include moderate drought (SPI −1.0 to −1.5), severe drought (SPI −1.5 to −2.0), and extreme drought (SPI ≤ −2.0) [66]. While SPI captures rainfall deficits, it does not account for evapotranspiration or alternative water sources.

Due to high uncertainty in future rainfall patterns, linked to potential shifts in the SPCZ, projected changes in drought frequency, duration, and intensity across Vanuatu remain uncertain. Under RCP8.5, projections show wide variability across models, regions, and time periods (Figure 4), particularly toward the end of the century.

Despite this uncertainty, several tentative conclusions emerge:

- Drought Duration: Projected to remain broadly consistent across regions and time periods. Extreme droughts show median durations of ~20–25 months per 20-year period through 2070, decreasing slightly by 2090. By 2090, interquartile ranges span ~10–35 months, with some models indicating low-probability, high-impact durations of 60–90 months. Moderate droughts remain ~10–15 months per 20-year period through 2070, with slight decreases by 2090.
- Drought Frequency: Remains relatively stable at ~1–2 events per 20-year period (about once every 10–15 years) through 2070, with a possible decline to ~1 event per 20 years by 2090; however, uncertainty remains high.
- Drought Intensity: Measured as cumulative negative SPI over the duration. Extreme droughts maintain median intensities of ~−20 to −30, with a slight decrease by 2090, although some projections reach −100 to −120. Moderate droughts remain relatively stable at ~−6 to −8.

Figure 4. Projected drought model variation for Vanuatu, for duration of drought, frequency of drought, and intensity of drought events at four timesteps



1.13.4 Meteorological Change

Climate change is expected to significantly increase air temperatures across Vanuatu.

Median Air Temperature and Hot Days

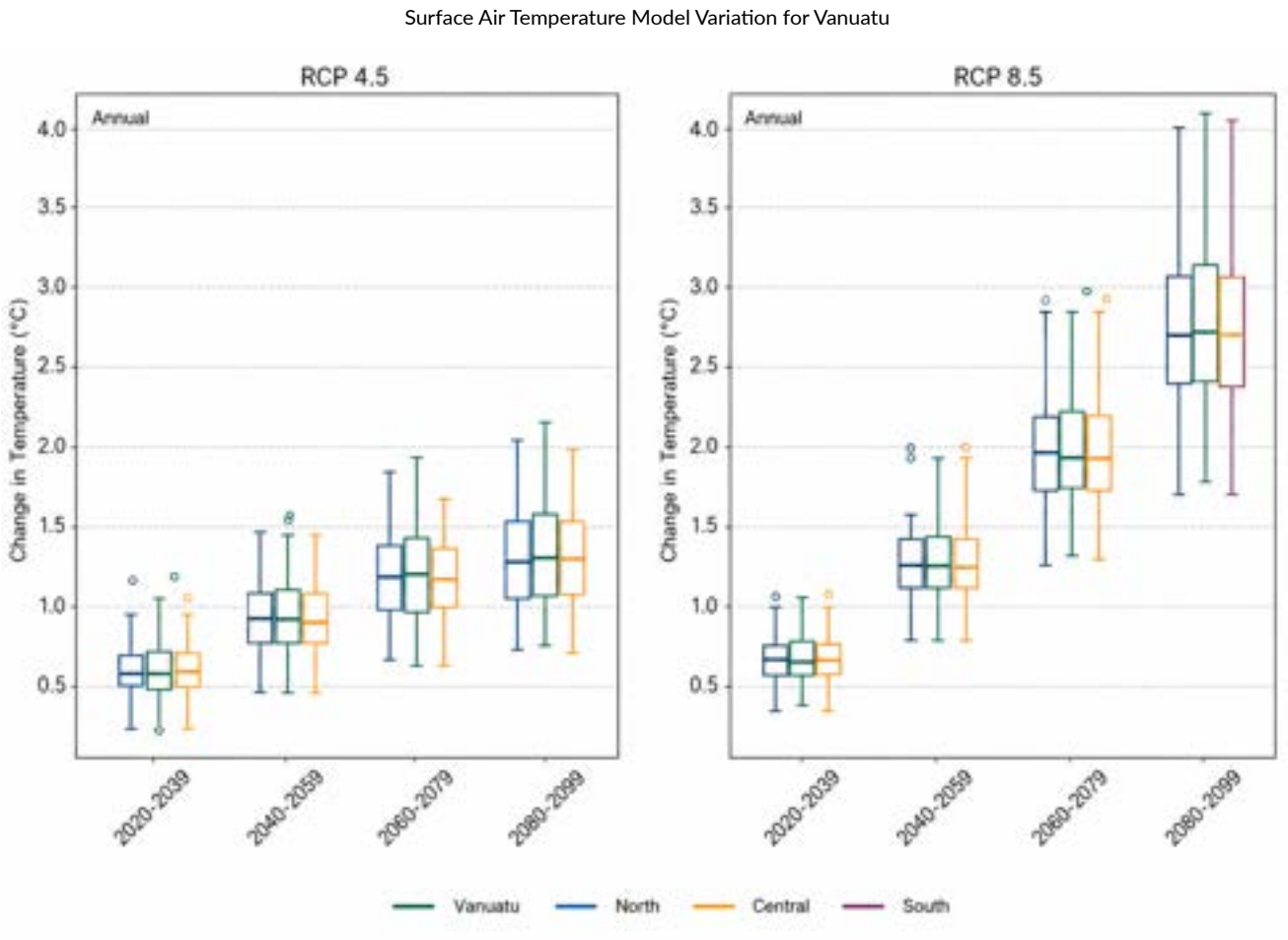
Projected air temperature changes are shown for RCP4.5 and RCP8.5 across the North, Central, and South regions (Figure 5).

Under RCP4.5, median annual temperatures increase steadily from approximately 0.6°C in 2030–2050 to around 1.2–1.5°C by 2071–2090. Under RCP8.5, early-period warming is similar, but temperatures rise more rapidly, reaching approximately 2.5–2.7°C by 2071–2090, nearly double the increase under RCP4.5.

Model agreement remains strong under RCP4.5, with interquartile ranges of approximately 0.3–0.5°C throughout the century. In contrast, RCP8.5 shows increasing variability toward the end of the century, with interquartile ranges widening to approximately 2.3°C–3.1°C and outliers approaching 4.0°C.

Across all regions, temperature projections show nearly identical patterns, with median differences typically below 0.1°C. This indicates that warming is spatially uniform across the archipelago.

Figure 5. Projected surface air temperature change over time in Vanuatu for RCPs 4.5 and 8.5 at four timesteps



1.13.5 Marine Temperature

Ocean temperatures in Vanuatu are increasing and are expected to continue rising, with implications for marine ecosystems. Sea surface temperatures have increased by approximately 0.23°C per decade between 1981 and 2021 [68].

A marine heatwave (MHW) occurs when sea surface temperatures remain unusually warm for at least five consecutive days and may persist for months. MHWs are classified into four intensity levels: moderate, strong, severe, and extreme. They are influenced by large-scale climate variability, including the El Niño–Southern Oscillation (ENSO), Interdecadal Pacific Oscillation (IPO), North Pacific Gyre Oscillation (NPGO), and Pacific Decadal Oscillation (PDO) [67]. ENSO has the strongest influence in Vanuatu, with El Niño associated with stronger MHWs in the central and eastern Pacific, and La Niña with stronger events in the western Pacific. Local conditions, such as reduced wind and clear skies, can further intensify sea surface warming by limiting ocean mixing [67 68].

Projections of future MHWs, based on Van-KIRAP and CSIRO data, are presented for three regions (North, Central, and South) (Figure 6).

Severe Marine Heatwaves:

By 2040–2059, severe MHW days are projected to increase substantially from near-zero to median values of approximately 30 days/year in the North, 25 days/year in the Central region, and 22 days/year in the South (Figure 6). However, variability is high, with some models projecting up to 80–120 days per year.

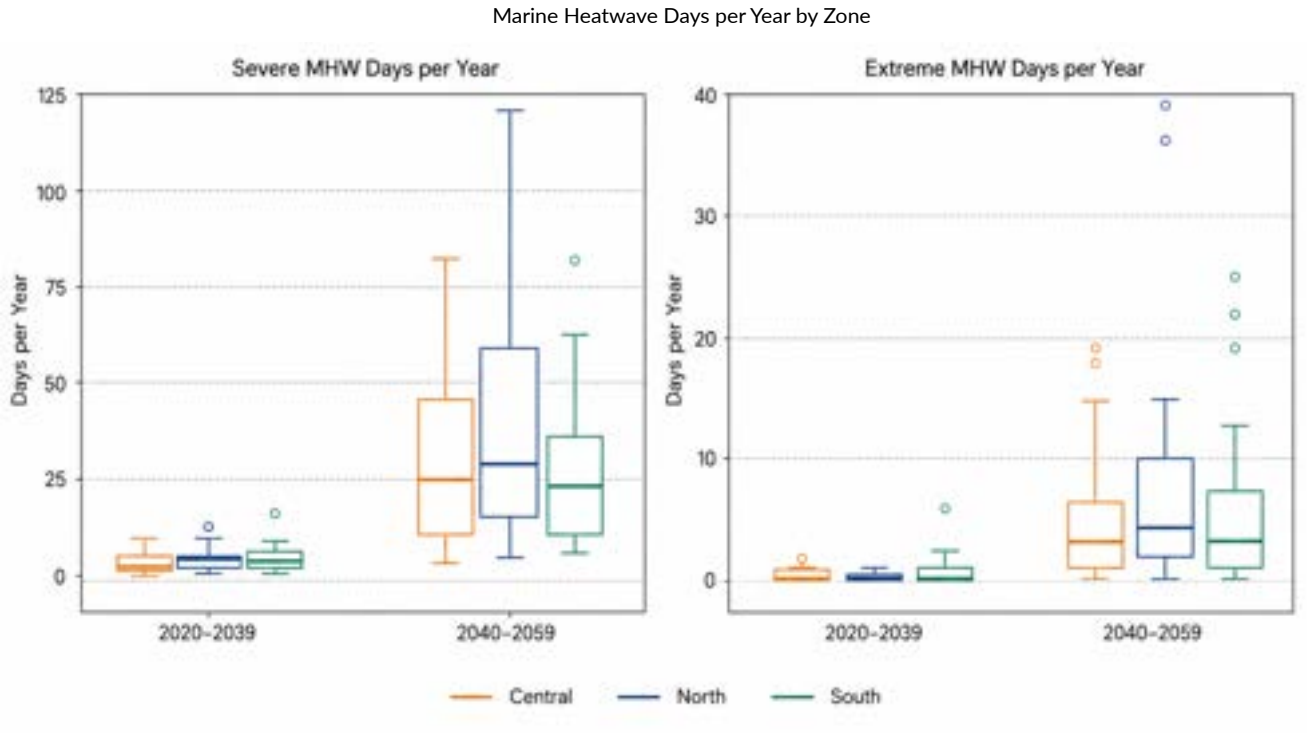
Extreme Marine Heatwaves:

Extreme MHWs, largely absent in 2020–2039, are projected to emerge by 2040–2059, with median values of approximately 3–5 days/year across regions (Figure 6). Maximum projections reach 35–40 days/year in the North and 15–25 days/year in the Central and South regions.

Regional differences in median values are modest, with the South generally lower, but uncertainty ranges are wider in the North, indicating greater variability in potential outcomes.

Marine heatwaves are a major driver of coral bleaching and reef degradation. Prolonged severe events (e.g. ~30+ days) can result in widespread coral mortality.

Figure 6. Projection of the number of days of severe and extreme marine heatwaves per year in Vanuatu at two timesteps under SSP5-8.5.



1.13.6 Ocean Acidification

As atmospheric CO_2 concentrations increase, greater amounts of CO_2 are absorbed by the ocean, altering seawater chemistry and lowering pH (ocean acidification). This shifts the balance of the carbonate system, reducing the availability of carbonate ions required by marine organisms to build and maintain calcium carbonate structures (including aragonite, a mineral form of calcium carbonate) at various life stages. Under increasingly acidic conditions, this process can also increase the vulnerability of existing calcium carbonate structures to dissolution [73] [69].

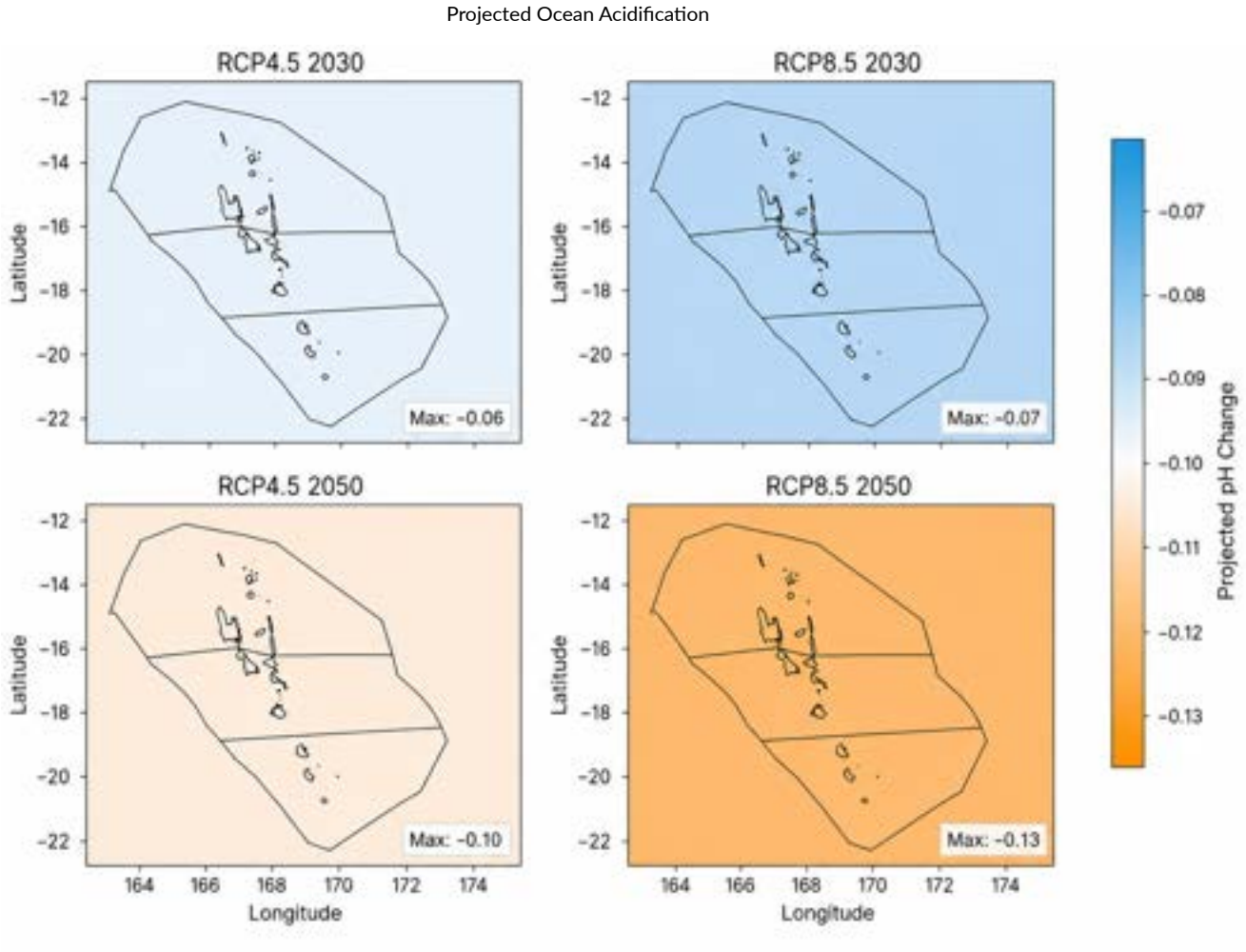
These chemical changes can have severe impacts on marine ecosystems, particularly organisms that rely on calcium carbonate shells or skeletons.

Ocean pH is projected to decline by approximately 0.06–0.07 units by 2030, and by 0.10 units under RCP4.5 and 0.13 units under RCP8.5 by 2050 (Figure 7). Because the pH scale is logarithmic, these changes represent a substantial alteration of ocean chemistry.

Projections indicate relatively uniform acidification across Vanuatu's waters.

A decline of 0.10–0.13 pH units is expected to significantly affect coral reef systems by reducing calcification rates and increasing dissolution, weakening reef structures and reducing resilience to other stressors such as marine heatwaves and tropical cyclones.

Figure 7. Projected change in pH in Vanuatu under RCPs 4.5 and 8.5 at two timestep for North, Central and South Vanuatu



1.14 Climate Governance and Policy Context

1.14.1 International Context

Vanuatu is highly vulnerable to climate change and actively engages in international efforts to address greenhouse gas emissions and climate impacts. These efforts provide the broader global context for assessing and managing national climate risks.

International frameworks such as the United Nations Framework Convention on Climate Change (UNFCCC) and the Paris Agreement guide global climate action, including commitments on mitigation, adaptation, and loss and damage. As a Small Island Developing State (SIDS), Vanuatu contributes to and benefits from these processes, particularly through mechanisms that support adaptation planning, climate finance, and technical assistance.

Vanuatu has also played a prominent role in global climate advocacy, including efforts to strengthen accountability for climate action. These international processes shape expectations for national planning and reporting and influence the availability of financial and technical resources for climate resilience.

1.14.2 Pacific Regional Context

Pacific Island countries share common vulnerabilities, including exposure to tropical cyclones, storm surge, drought, and saltwater intrusion. These shared risks have fostered strong regional cooperation and collective advocacy on climate change.

Regional organisations and partnerships support coordinated responses to climate change, including the development of climate information services, disaster risk management systems, and adaptation planning frameworks. These efforts strengthen regional capacity and promote consistency in approaches to climate risk assessment and resilience-building.

Regional initiatives also facilitate knowledge sharing and the integration of traditional knowledge with scientific data, supporting locally appropriate adaptation strategies. This regional collaboration provides an important platform for aligning national efforts with broader Pacific priorities and strengthening collective resilience.

1.14.3 National Context

Climate governance in Vanuatu is led by the DoCC, which coordinates national climate policy and supports the integration of climate risk considerations across sectors. Climate information, monitoring, and early warning services are supported by the Vanuatu Meteorology and Geohazards Department (VMGD) and the Vanuatu Bureau of Statistics (VBoS).

Effective climate risk management requires coordination across sectors and levels of governance. This CRVA aligns with key national policies, strategies, and programmes that underpin climate resilience and adaptation planning.

Key policy and programme frameworks include:

- Climate Change and Disaster Risk Reduction Policy (2022–2030) [72]
- Revised and Enhanced Nationally Determined Contribution (2021–2030) [71]
- Vanuatu Loss and Damage Policy (2025) [75]
- Vanuatu 2030: The People's Plan [73]
- Statistical Development Plan for Disaster Related Statistics (2024–2028) [70]
- Van KIRAP (Climate Information Services for Resilient Development)
- Vanuatu Community based Climate Resilience Project (VCCRP)





CHAPTER

02

Methodology

2.1 CRVA Method Overview

Climate Risk and Vulnerability Assessments (CRVAs) provide a structured approach to understanding how climate change affects people, ecosystems, infrastructure, and economic sectors. They identify climate hazards, assess exposure and vulnerability, and evaluate the likelihood and severity of impacts under different future scenarios.

By combining climate projections with information on assets, infrastructure, environmental conditions, and social context, CRVAs support evidence-based decision-making. They help identify priority risks, compare vulnerabilities across sectors and regions, and inform the design of targeted and effective adaptation measures, enabling resources to be directed toward actions that deliver the greatest reduction in climate risk.

Beyond technical analysis, CRVAs play an important role in governance and communication. They provide a common framework and shared language that enables government agencies, communities, development partners, and the private sector to engage consistently on climate risks. By translating complex climate science into practical information, CRVAs support land-use planning, infrastructure design, emergency preparedness, and investment decisions.

In contexts such as Vanuatu, where climate risks are high and adaptation resources are limited, robust risk assessments are particularly valuable. They support transparency and accountability by establishing clear baselines, identifying knowledge gaps, and providing a defensible evidence base for prioritising adaptation investments.

Understanding of climate risk evolves as new data become available and as climate conditions change. The Vanuatu Resilience Explorer®, licensed to the DoCC, provides a dynamic platform for updating and visualising risk information over time and complements other national tools, including the Vanuatu Climate Futures Portal. Through systematic evaluation of hazards, exposure, and impacts, this CRVA addresses key questions: what is at risk, where vulnerabilities are concentrated, and where further information is required.

Structure of this report

The structure of this report is as follows:

Chapter 2 describes the methods used to undertake the CRVA, including the climate change risk assessment framework, its core components, and key limitations.

Chapters 4 to 12 present nine sectoral assessments, each of which can be read as part of the overall CRVA or as a standalone sectoral analysis.

- Agriculture (Chapter 3)
- Ecosystems (Chapter 4)
- Education (Chapter 5)
- Fisheries (Chapter 6)
- Forestry (Chapter 7)
- Health and Nutrition (Chapter 8)
- Infrastructure (Chapter 9)
- Tourism (Chapter 10)
- Water, Sanitation and Hygiene (WASH) (Chapter 11)

Chapter 12 presents the conclusions of the CRVA, including sector-specific findings and overarching conclusions across all sectors. It also identifies data gaps and provides recommendations for future work based on issues identified during the assessment and those that may emerge over time.

2.2 Limitations and Data Gaps

Data quality, availability, accessibility, and usability have constrained the scope and precision of this first national CRVA. Addressing these limitations will be important for strengthening future assessments and supporting more targeted climate resilience and adaptation planning.

Uncertainty and spatial resolution in climate model outputs (supplied by CSIRO) for hazards such as marine heatwaves, drought, precipitation, and ocean acidification limit the ability to prioritise risk at provincial or administrative levels. Climate projections are available only at a coarse scale, effectively dividing the country into three regions (North, Central, and South), with substantial inter-model variability for key climate variables.

Hazard data coverage is uneven across the country. In some cases, data required for quantitative risk assessment are unavailable or inaccessible, requiring the use of qualitative information to inform sectoral assessments (notably for ecosystems, forestry, and fisheries). Existing hazard datasets largely reflect project-based initiatives, with varying geographic and hazard focus depending on scope, resources, and donor priorities.

Key hazard-related data gaps include:

- Lack of national-scale pluvial and fluvial flooding models, with current assessments limited to Malekula, Tanna, and selected catchments near Port Vila and Luganville.
- Limited flooding scenarios, with coastal flooding modelled for only a single return period (1% Annual Exceedance Probability) and fluvial/pluvial flooding assessed under present-day conditions only.
- Insufficient consideration of groundwater emergence and salinisation, particularly in low-lying and coastal areas.

Data gaps also affect exposure and vulnerability analysis. Spatial asset, land-use, and land-cover datasets are inconsistent, with some information available only for selected islands or provinces.

Key exposure and vulnerability data gaps include:

- Absence or inaccessibility of Pacific-specific damage and vulnerability functions, limiting analysis largely to exposure rather than impact estimation.
- Variable quality, reliability, and spatial resolution of sector-specific datasets, indicating a need for data validation and ground-truthing.

Despite these limitations, the CRVA provides a useful baseline assessment to support the National Adaptation Plan (NAP), Provincial Adaptation Plans (PAPs), and sector-level consideration of climate risks and adaptation priorities.

2.3 Climate Change Risk Assessment Framework

Climate risk arises when valued elements are exposed to climate hazards and may experience adverse consequences. In climate terms, risk reflects the interaction between hazards, exposure, vulnerability, and consequences under uncertainty [76]. Risk is greatest where communities, infrastructure, ecosystems, or culturally important places cannot easily withstand or recover from impacts.

This CRVA applies a structured risk assessment framework that links climate hazards to consequences. As shown in Figure 8, the framework involves collating climate scenarios, identifying valued elements, assessing vulnerability and exposure, and translating exposure into consequences using qualitative and quantitative methods. It supports a semi-quantitative assessment of exposure and consequences within a broader risk context and is designed to inform decision-making.

Figure 8. Process for conducting a quantitative exposure and consequence assessment as part of a wider semi-qualitative climate risk assessment



2.4 Climate Scenarios and Timeframes

To understand potential future risks, this assessment uses internationally recognised climate scenarios to explore how our climate might change in the future.

In current practice, these frameworks are often combined (e.g. SSP2-4.5), where the SSP describes the socio-economic pathway and the number reflects the level of greenhouse gas forcing. Some hazard data in this assessment uses the older RCP framework, while newer data applies the combined SSP framework.

The scenarios used most consistently across the assessment are summarised in Table 5.

Sea-level rise and coastal flooding are increasingly assessed using specific increments of sea-level rise (e.g. 0.5 m), rather than scenario-based projections.

Managing uncertainty through scenarios: Climate scenarios are used to manage uncertainty by exploring a range of plausible futures, rather than predicting a single outcome. This supports the development of flexible adaptation strategies.

Data sourced from the CSIRO-led Van-KIRAP program predominantly uses RCP4.5 and RCP8.5. Marine heatwave modelling (CSIRO) uses SSP5-8.5, while sea-level rise and coastal flooding assessments apply incremental approaches.

The use of different scenarios and timeframes reflects the available hazard data. Climate projections from different sources (e.g. CSIRO and other commissioned modelling) are not fully aligned, which limits direct comparison across hazards. As a result, this assessment prioritises internal consistency within each sectoral analysis, rather than across the report as a whole.

The available data did not support the development of a small set of consistent national future scenarios (as used in some national risk assessments, such as Australia's 2025 National Climate Risk Assessment [77]). Instead, this assessment draws on the best available data for each hazard and sector.

Recent expert assessments suggest that future warming is likely to align with moderate to high emissions pathways [54] [55]. While uncertainty remains, the key implication for adaptation planning is the need to prepare for a range of possible futures [56].

> *Climate scientists use two main frameworks to describe possible futures:*
>
> ***RCPs** (Representative Concentration Pathways) focus on greenhouse gas concentrations in the atmosphere. They're named by numbers (e.g. RCP4.5, RCP8.5) that represent the amount of extra warming energy trapped in the Earth's system by 2100.*
>
> ***SSPs** (Shared Socioeconomic Pathways) describe different ways our society, economy, and population might develop. Each SSP tells a different.*

Table 5. Climate scenarios with estimated global warming ranges.

Scenario	Description	Estimated warming by 2100 (°C)*
SSP2 – 4.5*	**Middle of the Road:** A future where social, economic, and technological trends do not shift markedly from historical patterns.	2.1 – 3.5
SSP5 – 8.5*	**Fossil-fuelled Development:** A world relying heavily on fossil fuels with rapid technological progress and high energy intensity.	3.3 – 5.7

*Scenarios marked with an asterisk were the primary focus of this assessment.
* Temperature ranges are relative to pre-industrial levels.

2.5 Data and Analytical Approach

The data analysis and risk modelling presented in this assessment draw on multiple datasets and analytical approaches, including the Resilience Explorer® platform. This platform integrates diverse data sources to support the assessment of climate risks across Vanuatu. Infrastructure data, historical hazard information, and available climate projections were analysed to develop a comprehensive understanding of current and future climate risks. These analyses support the identification of areas, sectors, and assets most exposed to climate-related hazards.

This approach demonstrates how integrated data and analytical tools can support evidence-based decision-making for climate adaptation and resilience planning in Vanuatu.

2.6 Element Identification and Data Sources

Understanding what is valued by communities is fundamental to climate risk assessment. Element identification maps the assets, infrastructure, communities, and natural systems that matter in Vanuatu. This step connects climate projections to tangible elements people value, including homes, livelihoods, cultural sites, infrastructure, and ecosystems.

Data on these elements were compiled from publicly available and partner-provided sources, including datasets assembled by GGGI in collaboration with the Department of Climate Change (Table 6). These datasets provide broad national coverage across key sectors; however, data availability is uneven for certain sectors and sub-national assets. These datasets form the basis for assessing exposure and potential impacts across sectors in subsequent sections.

The process of identifying and compiling element datasets also highlights knowledge gaps, particularly where assets or values important to local communities are underrepresented in formal datasets. These gaps are acknowledged as a limitation of the assessment and are considered in the interpretation of results.

The process of identifying and compiling data on these elements also highlights potential knowledge gaps, areas or assets that may be underrepresented in formal datasets but are important to local communities.

Table 6. Element/asset datasets used in this assessment

Source	Element/Asset	Coverage	Description
GGGI	Airports	National	Attributes: Name
GGGI	Beach landings	National	Attributes: Island, Province
GGGI	Bridges	National	PCRAFI II bridges. Attributes: Name, material, condition, height
GGGI	Buildings	National	PCRAFI II buildings. Attributes: Floor height, construction type, age, condition
UNEP/WCMC	Coral reefs	National	Distribution of coral reefs
GGGI	Crops	National	Distribution of key crops throughout Vanuatu
GHD	Electricity utilities	National	PCRAFI II electricity utilities. Attributes: Description, ownership, condition, asset type, source type, date
SIDS	Fisheries	National	Area fished, derived from a one-week sample of industrial fishing vessel locations. Attributes: Type, hours fished
SPC	Forests	National	Distribution of forests, derived from the 2011 land use survey
GGGI	Health facilities	National	Includes pharmacies, dispensaries, and health centres

Table 6. Element/asset datasets used in this assessment (continued)

Source	Element/Asset	Coverage	Description
GGGI	Logging concessions	National	Areas with logging concessions. Attributes: Company name
GMW	Mangroves	National	Distribution of mangroves
GGGI	Network towers	National	PCRAFI II network towers. Attributes: Type, material, use, height, condition, description
GGGI	Provincial headquarters	National	Locations of provincial headquarters
GGGI	Roads	National	PCRAFI II roads layer. Attributes: ID, name, classification, surface type
GGGI	Schools	National	Distribution of learning facilities. Attributes: ID, population, name
UNEP/WCMC	Seagrass	National	Distribution of seagrass
OSM	Tourist accommodation	National	Attributes: Name, type
GGGI	Waste management centres	Regional	Distribution of landfills and recycling centres in main population centres
GGGI	Water infrastructure	Regional	PCRAFI II water infrastructure (e.g. wells, bores, pumps). Attributes: Type, water source, condition, treated, ownership

2.7 Exposure Analysis

Exposure analysis identifies where climate hazards may directly affect assets, systems, and communities, and which elements may require adaptation. Assets are considered exposed where they are located within the spatial extent of a hazard. Exposure information is presented in detail in Chapter 1. In the sector chapters, exposure is highlighted only where it is directly relevant.

Exposure does not automatically result in damage or loss. Some assets may be exposed to a hazard but remain unaffected due to their design, location, condition, or adaptive capacity. For example, a building constructed on raised foundations may be exposed to shallow flooding without experiencing significant damage. Whether exposure results in harm depends on vulnerability, including an asset's sensitivity to hazards and its capacity to cope and adapt.

Hazard datasets used to assess exposure were compiled and analysed in collaboration with the Department of Climate Change, drawing on available Vanuatu Government, partner, and climate information sources. Data availability varies across hazards, with some datasets available nationally and others limited to specific regions, catchments, scenarios, or time periods. A summary of hazard data availability and key gaps is provided in Appendix C.

Spatial Framework

This assessment divides Vanuatu into three geographic regions—North, Central, and South (Figure 9). This regional grouping aligns with the available climate data, particularly datasets from the Van-KIRAP program, and is consistent with previous analyses.

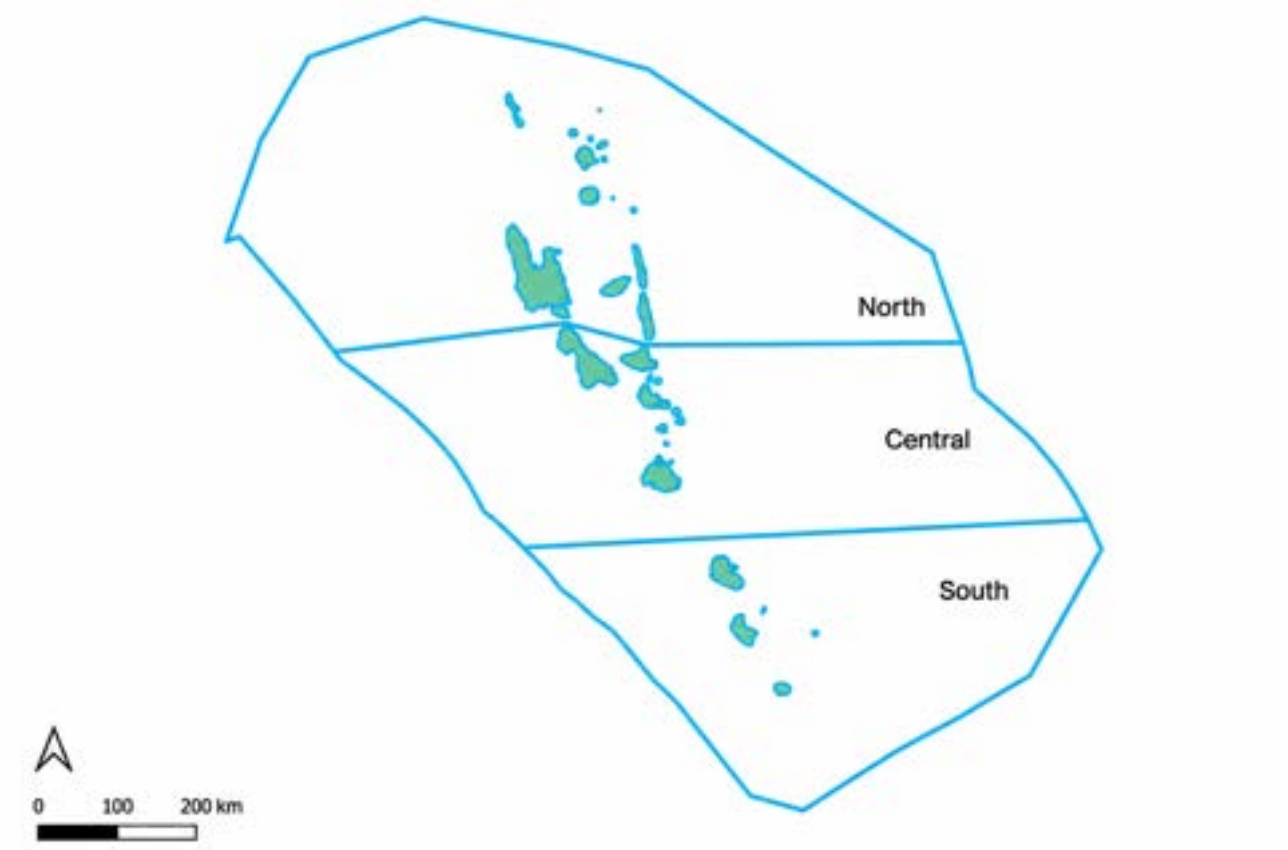
The North region includes Maewo and Pentecost, and all islands to the north. The South region includes Erromango and all islands to the south. The Central region includes the remaining islands, from Efate in the south to Malekula and Ambrym in the north.

Higher-resolution climate data was not consistently available across all hazards. As a result, most analyses are undertaken at this regional scale. Finer spatial resolution data (typically less than 10 m) was only available for specific hazards,

including sea-level rise, coastal flooding, and selected flood models for Malekula, Tanna, and the Luganville and Port Vila catchments.

Qualitative data were drawn from a range of sources, including inputs from the Department of Climate Change and GGGI, as well as a literature review covering local, national, regional, and global sources. These data are referenced throughout the report. Sector chapters include summary tables outlining key qualitative data sources, their relevance, and the insights they provide.

Figure 9. North, Central, and South regions of Vanuatu used in CRVA.



2.8 Vulnerability Analysis

Vulnerability is determined by the sensitivity of an element to damage or harm resulting from exposure to a hazard or climate-related change, and its capacity to adapt. Vulnerability can be assessed using both quantitative and qualitative approaches.

Quantitative approaches typically apply vulnerability, damage, or fragility functions, which describe how an element, most commonly an infrastructure or asset type, responds to increasing levels of hazard exposure. For example, these functions may estimate the extent of damage to a building under different flood depths (e.g. 20 cm versus 50 cm of inundation).

At present, asset-specific vulnerability or fragility functions are not available for Vanuatu infrastructure. As a screening-level assumption, the assessment therefore applies a uniform damage factor, whereby exposed assets are assumed to experience a moderate level of damage. This assumption is highly uncertain and does not reflect asset-specific design, condition, or resilience; however, it provides a consistent basis for comparative risk assessment. This approach can be refined through future studies or more detailed data collection across government departments and projects.

For some biological systems, including plants and animals, information on temperature tolerances and preferred ranges is available and can be used to indicate potential vulnerability to climate change. Where quantitative vulnerability information is not available, vulnerability is assessed qualitatively based on expert judgement and targeted literature review.

2.9 Qualitative and Quantitative Risk (Consequence) Assessment

This assessment applies both quantitative and qualitative approaches to understand climate risk and its potential consequences. While exposure analysis identifies what may be affected by climate hazards, consequence (or risk) assessment considers the severity of those impacts and supports prioritisation of adaptation actions.

Where sufficient data were available, a quantitative risk assessment was undertaken. Sector specific spatial analysis was used to assess relative risk within modelled hazard extents. Where spatial resolution allowed, analysis was conducted at the Area Council administrative boundary level to support locally relevant planning and decision making.

Risk Scores

Risk to sector specific assets is expressed as the proportion of assets potentially damaged within each sector under each hazard scenario. This is calculated as:

Percentage of asset type damaged = (damage adjusted count or length of affected assets ÷ total assets within the study area) × 100

Risk scores are normalised to a 0–1 scale across Area Councils to allow comparison of relative risk. These scores are indicative and do not represent absolute values of loss or damage. Rather, they are designed to highlight areas of comparatively higher risk to support adaptation planning and prioritisation.

A decrease in an Area Council's relative risk score over time does not necessarily indicate reduced absolute exposure or risk. It may instead reflect proportionally greater increases in risk in other Area Councils under the same climate scenario. As a result, the Area Council with the highest relative risk in each scenario is assigned a score of 1, with all other scores scaled accordingly.

Due to limited availability of asset specific vulnerability or damage functions, a simplified assumption has been applied whereby exposed assets are considered to experience a moderate level of damage. This approach enables consistent comparative analysis across sectors and locations but remains highly uncertain and should be refined as more detailed vulnerability information becomes available.

Qualitative Risk Assessment

Where quantitative data were limited or unavailable, a qualitative risk assessment approach was applied to ensure that important risks were not excluded from consideration. This approach draws on literature review, expert input, and stakeholder engagement to capture risks that cannot be robustly quantified but may nevertheless have significant consequences.

Literature Review

The literature review was conducted iteratively throughout the assessment process, drawing on local, national, regional, and global sources. It provided critical context on hazards, exposure, vulnerability, and potential impacts, particularly where quantitative datasets were incomplete or unavailable. This ensured that the absence of numerical data did not prevent relevant climate risks from being identified and considered.

Workshops and Stakeholder Engagement

Workshops were held for each of the nine priority sectors in May and October 2025, involving government representatives, technical experts, and non government organisations. These workshops supported the identification of key hazards and climate change impacts, validation of quantitative findings, and incorporation of local and sector specific knowledge.

The workshops also helped to identify interconnections and cascading impacts between sectors, clarify locally significant elements that may not be evident in regional scale datasets, and address key information gaps. Insights from these workshops, together with findings from the literature review and sector consultations, have been integrated into the qualitative component of the assessment, ensuring that both technical evidence and local knowledge inform the overall risk analysis.

2.10 Limitations of the Assessment

This CRVA focuses on the physical risks associated with climate change. It does not assess transition risks associated with the shift to a low emissions, climate resilient society, nor does it explicitly account for broader external factors. Transition risks may include changes in migration patterns, supply chains, international travel, or consumer preferences. External factors refer to influences beyond the borders of the Republic of Vanuatu, such as geopolitical tensions, migration or climate displacement, and global supply chain disruptions.

Several limitations related to data availability and methodological constraints should be noted.

Across Vanuatu, climate hazard and climate related datasets vary considerably in spatial coverage, resolution, timeframes, and intended application. Although multiple hazard assessments have been undertaken ([78] [94]), a common limitation across these studies is the lack of comprehensive, high resolution data at the national scale. This constrained the CRVA project team across multiple aspects of quantitative analysis, including data access, availability, usability, and interpretation.

Examples of these limitations include:

- Modelling data for marine heatwaves, drought, precipitation, and ocean acidification are available only at broad regional scales (North, Central, and South), limiting the ability to identify and prioritise risk at finer spatial scales.
- In some cases, required datasets do not exist, such as fluvial and pluvial flood models for islands other than Malekula and Tanna, and for catchments outside selected areas around Port Vila and Luganville.

More broadly, hazard data in Vanuatu reflects an accumulation of separate projects undertaken for specific purposes. Each project has prioritised different hazards, locations, and modelling approaches based on available resources and scope, particularly where new hazard data generation was required. This has resulted in a fragmented national scale hazard dataset and highlights the need for improved multi agency coordination to systematically address data gaps for future CRVAs and national and provincial adaptation planning processes.

Similar limitations apply to element datasets, including spatial information on assets, infrastructure, land use, and land cover. In some cases, quantitative element data do not exist; in others, coverage is limited to specific islands or provinces. One example is water infrastructure, where spatial data availability and consistency vary significantly across the country.

Data availability is further complicated by fragmented data ownership across government departments. While cross departmental memoranda to support data sharing are emerging, the process of identifying and obtaining relevant datasets has been time consuming. As a result, some datasets that are believed to exist were not available for inclusion in this CRVA, contributing to residual data gaps.

In several thematic areas, multiple—sometimes conflicting—data sources were identified across agency reports and academic publications. In some cases, this made it difficult to determine the most accurate or current values. For example, the reported number of bird species in Vanuatu varies across reputable sources, complicating biodiversity related risk analysis and future monitoring efforts. Addressing such inconsistencies is a key focus of the project's Monitoring, Evaluation, Research and Learning (MERL) report.

In addition, it has not always been possible to determine the original collection date of datasets, particularly where figures have been repeatedly cited without clear attribution. Gillet and Fong (2023) [79] illustrate this issue through the example of subsistence fisheries production estimates in Vanuatu, where figures derived from surveys conducted in the mid 1980s have continued to be cited for decades, creating a misleading impression of data currency.

A further limitation is the absence of asset specific vulnerability or damage functions for Vanuatu, which has required the use of simplified assumptions regarding post event damage levels. These assumptions support comparative risk analysis but introduce uncertainty at the individual asset level.

The assessment also assumes current land use and population distributions over long future time horizons (up to 100 years). While this is a common methodological challenge in climate risk assessments, it is particularly significant in Vanuatu given ongoing population growth and settlement change.

Overall, this CRVA provides a baseline assessment derived from the best available information at the time of analysis. Despite the limitations outlined above, the findings, particularly when used in combination with the Vanuatu Resilience Explorer® platform, offer valuable insights to support national and provincial adaptation planning and decision making.

The quantitative CRVA was undertaken using administrative boundary datasets available in 2024 (Area Council and municipal boundaries). Updated administrative boundary data have since been incorporated into the Resilience Explorer® platform to support ongoing spatial analysis. This results in some differences between CRVA reporting units and the current Resilience Explorer® filters. However, comparative analysis indicates a high level of consistency between the two boundary datasets. As the assessment results are driven primarily by hazard–element interactions rather than administrative delineations, findings are not expected to be materially affected at national or sectoral scales.

Users are advised to interpret location specific results with awareness of this update when comparing CRVA outputs with Resilience Explorer® analyses generated after April 2026. Additional technical detail on the boundary updates and comparative analysis is provided in the memorandum included as Appendix B.

2.11 Sector CRVA Assessments

In the next chapters the CRVA results for each of the priority sectors: Agriculture, Ecosystems, Education, Fisheries, Forestry, Health and Nutrition, Infrastructure, Tourism, and Water, Sanitation and Hygiene (WASH) are presented. The priority sectors are presented as individual sections; however, there is significant inter-relation between the sectors with cross-dependencies.

The sector assessments and findings in this report provide a baseline risk assessment that can:

- Increase understanding of sector vulnerabilities and risk.
- Understand what information is missing and underpin the process of prioritising investment in new knowledge.
- Enable some degree of risk prioritisation.
- Support the development of NAP and PAPs tailored to the unique. characteristics and challenges of each sector while recognising interconnections with other sectors (i.e. key relational dependencies and adaptation collaboration).

Each assessment includes:

- Area overview and key findings: A brief introduction to the area, followed by a summary of the most critical climate risks identified.
- Hazard Data Availability and Exposure: An assessment of available hazard information and spatial distribution of exposure across the area.
- Vulnerability assessments for elements in each sector, where appropriate, and data is available.
- Discussion of direct and indirect risks and consequences relevant to the sector and identification of interconnections with other sectors and cascading impacts across systems.

Each sectoral report has a slightly different structure, contingent on the types of quantitative data available for analysis, the relevant hazard, and the depth and breadth of qualitative sources. Risks in each sector were assessed using the CRVA methodology that has been outlined, combining quantitative spatial analysis with qualitative insights from stakeholder workshops and literature review.

Importantly, a brief summary of the climate change projections is provided in each sector chapter for reference; readers are referred to chapter 1 for clarification.



CHAPTER

03

Agriculture Sector

3.1 Key Findings for Agriculture

Multiple climate pressures on crops, livestock, and productivity: Vanuatu's agricultural sector faces multiple climate vulnerabilities that threaten staple crops, livestock, and farmer productivity. Temperature increases create heat stress for cattle and reduce viable working hours for agricultural workers, while sweet potato faces tuber impairment above 34°C. Staple crops show varying tolerances to extremes, with kava vulnerable to both drought and waterlogging, taro intolerant of drought, and cassava susceptible to waterlogging.

Increasing pest and disease pressures under warmer conditions: Rising temperatures create favourable conditions for pests including the coconut rhinoceros beetle and tuber-eating beetles, while warmer night-time temperatures increase the prevalence of Taro Leaf Blight.

Severe impacts from cyclones, flooding, and salinisation: Tropical cyclones cause severe damage through high winds affecting coconuts, kava, and bananas, while flooding and salinisation impact sweet potato and taro production. Cyclones also destroy crops and livestock, damage infrastructure, and disrupt access to gardens through fallen timber, while tools, seeds, and storage facilities are often lost.

Disruption to markets, infrastructure, and economic productivity: Climate hazards reduce agricultural productivity and GDP, with transport route failures preventing market access for extended periods as roads become impassable and wharves require costly repairs.

Geographic concentration of risk in key areas: Spatial analysis indicates that Central Malekula's agriculture sector is most at risk from fluvial and pluvial flooding, followed by North-West Malekula and South-East Malekula across all AEP scenarios (1%, 2%, and 10%). Central, South, and South-East Malekula are also among the most at risk from coastal flooding and sea-level rise.

Disproportionate impacts on women and gender inequalities: Climate impacts on agriculture disproportionately affect women and exacerbate existing gender inequalities. Women face heavy workloads managing agricultural work alongside marketing, handicraft production, caregiving, and household responsibilities, while having limited access to resources and decision-making. As primary traders of agricultural produce, their main income source is particularly vulnerable to crop losses and disruptions to market access, increasing economic strain and care burdens during recovery periods.

Food insecurity and increasing reliance on imported foods: Agricultural losses drive households toward imported foods, which are often more expensive and less nutritious. As subsistence production declines, this shift contributes to negative health outcomes and reduced household income.

Cascading impacts on health, education, and traditional systems: Reduced agricultural production intensifies vulnerability across the health and education sectors. Educational outcomes are affected when children are withdrawn from school to support household labour during droughts or post-cyclone recovery. At the same time, traditional agricultural knowledge is challenged as climate conditions disrupt established practices.

Increasing vulnerability of food systems and supply chains: Food supply chain disruptions increase dependency on imported food, exposing Vanuatu to external price shocks and supply risks, and further undermining national food security.

3.2 Overview of the Agriculture sector

Agriculture underpins livelihoods, food and nutritional security, and the broader economy in Vanuatu, supporting subsistence production, local exchange, and export earnings, while encompassing horticulture and livestock production (with fisheries and forestry addressed separately in this assessment). This central role is reflected in the high level of engagement across the population, with over 87% involved in agricultural activities [80], alongside widespread access to customary land, where approximately 85% of the population has access and 94% report it as sufficient for their needs [90].

At the same time, agricultural production is highly fragmented, being distributed across more than 147,000 small land parcels, which characterises the sector as predominantly smallholder based. Even though around 40% of the total land area is suitable for agriculture, only a portion is actively cultivated, indicating both constraints and untapped potential within the system [24]. In practice, the sector remains largely rain-fed and is therefore inherently sensitive to climate variability. Staple crops such as taro, yam, cassava, and sweet potato continue to underpin subsistence livelihoods, whereas income generation is driven by crops such as copra, kava, cocoa, and beef. Despite agriculture being the primary livelihood activity for most households, its contribution to GDP remains relatively modest, given that only a share of production is commercialised; nevertheless, the primary sector contributes approximately 20% of national GDP, with agriculture accounting for 83% of this share [74].

Geographically, production is concentrated in rural and low-lying coastal areas, where reliance on locally grown food is high. Consequently, households produce an estimated 40–60% of their food on average, with some remote communities depending almost entirely on subsistence production. In contrast, food insecurity affects approximately 21% of the population, particularly in urban areas where access to land is more limited [82].The sector is also evolving, with a gradual shift underway from traditional subsistence systems toward cash crop production and alternative income sources, including seasonal labour schemes [24 83 84]. However, this transition is occurring alongside increasing urbanisation, which is reducing access to land and reinforcing dependence on purchased food.

Importantly, agriculture remains closely tied to cultural practices and traditional knowledge systems, where planting decisions are guided by seasonal calendars and local ecological understanding [82]. Yet, these systems are becoming less reliable as climate variability intensifies, disrupting established patterns and affecting productivity. Collectively, these dynamics highlight a sector that is both central and vulnerable. Structural constraints, including limited land availability, declining soil productivity, restricted water access, and high transport costs, continue to limit resilience, while the concentration of agriculture in coastal zones further amplifies exposure to cyclones, flooding, and sea-level rise.

3.3 Climate Hazards and Exposure of the Sector

The agriculture sector is exposed to multiple climate hazards, including tropical cyclones, coastal flooding and sea-level rise, fluvial and pluvial flooding, drought, extreme rainfall, and increasing air temperatures. These hazards affect agricultural productivity through direct damage, as well as through changes in water availability, soil conditions, and pest and disease dynamics.

Agricultural production is widespread across Vanuatu but is predominantly concentrated in coastal and low-lying areas. Crop distribution is dominated by coconuts, followed by perennial and seasonal crops and kava. While this reflects the availability of suitable land, it also increases exposure to key hazards, particularly coastal flooding, salinisation, and cyclone impacts.

3.3.1 Hazard Data Availability and Limitations

The assessment of climate-related risks for the agriculture sector draws on both quantitative and qualitative data; however, the availability, resolution, and reliability of this information vary across hazard types. Climate projections for temperature, rainfall, and drought are available at aggregated regional scales, limiting the ability to capture local variability. Flood modelling is available only for selected locations and does not always incorporate future climate scenarios. Tropical cyclone assessments rely largely on historical data, with limited projections of future risk.

Qualitative inputs, including sector consultations, national reports, and expert knowledge, provide important insights into crop sensitivities and localised impacts. However, significant gaps remain, particularly for crop-specific vulnerability data and spatially detailed agricultural datasets.

These limitations introduce uncertainty into the assessment and should be considered when interpreting results. The

reliance on aggregated data and partial spatial coverage may underestimate localised risks or fail to capture site-specific vulnerabilities. Strengthening national data systems, hazard modelling, and agricultural datasets will be critical for improving future risk assessments. Datails of the available resources are presented in the Appendix C-Tables A-02 and A-03

3.4 Climate Risk Assessment for the Agriculture Sector

Climate hazards affect agriculture through distinct but overlapping pathways, influencing crop productivity, livestock systems, and agricultural infrastructure. The table below summarises the key vulnerabilities and consequences associated with each hazard.

Table 7. Climate Hazard Assessment for the Agriculture Sector

Climate Hazard	Vulnerability (Crops, Livestock, Locations)	Key Consequences (Production, Systems, Economy)
Air Temperature Increase	Staple crops show clear thresholds: sweet potato tuber formation impaired above ~34°C; bananas affected above ~35°C (flowering and bunching); taro and cassava have optimal ranges but are sensitive to extremes. Livestock (cattle, pigs, poultry) experience heat stress affecting fertility, feed intake, and health. Warmer night temperatures increase Taro Leaf Blight, while pest pressures increase (e.g. coconut rhinoceros beetle, tuber-eating beetles).	Reduced crop yields and storage quality across staple crops. Decline in livestock productivity and health. Increased pest and disease outbreaks, including new and expanding invasive species. Reduced labour productivity due to heat stress and shorter working hours.
Drought and Rainfall Variability	Rain-fed systems (≈98% of agriculture) are highly sensitive to rainfall variability. Taro is highly drought-sensitive; kava is vulnerable to both drought and waterlogging; cassava is drought-tolerant but highly susceptible to waterlogging; bananas are sensitive to moisture variability. Long droughts (20–25 months) severely affect staple crops. High uncertainty in rainfall projections affects planning.	Crop failure and reduced yields during drought periods. Flooding and waterlogging damage crops during extreme rainfall. Increased uncertainty in planting and crop establishment. Increased labour burden for water access and soil management. Declines in crop quality and price instability.
Coastal Flooding and Sea-Level Rise	Agriculture concentrated in low-lying coastal areas is highly exposed to inundation and salinisation. Crops such as taro, bananas, and sweet potato are highly sensitive to saltwater intrusion. Coastal groundwater salinisation affects irrigation and livestock water sources. High exposure in areas such as Central, South, and South-East Malekula.	Loss of productive agricultural land and declining yields due to salinisation. Need to shift agriculture inland or adopt salt-tolerant crops. Increased travel distance and labour to access viable land. Pressure on inland ecosystems due to land expansion.
Fluvial and Pluvial Flooding	Crops such as kava, cassava, and sweet potato are highly vulnerable to waterlogging; taro shows some tolerance depending on species. Flood-prone areas include Central, North-West, and South-East Malekula, as well as parts of Santo and Efate.	Crop destruction, soil erosion, and loss of agricultural inputs. Damage to infrastructure and delayed recovery. Increased exposure of key production areas (especially Malekula). Disruption to planting cycles and productivity.
Tropical Cyclones	Crops including coconuts, kava, bananas, and cassava are highly vulnerable to strong winds and heavy rainfall. Bananas are often destroyed early; coconuts experience premature nut fall; kava plants are uprooted. Livestock and rural infrastructure are also highly exposed.	Widespread destruction of crops, livestock, and infrastructure. Loss of seeds, tools, and storage facilities. Severe disruption to transport networks (roads, wharves, airstrips), limiting market access. Prolonged recovery periods and reduced agricultural output. Increased dependence on imported food.

3.4.1 Cross-Cutting Risks and Implications for Agricultural Systems

Beyond individual hazards, a range of cross-cutting risks influences the resilience of agricultural systems. Climate change is expected to intensify pest and disease pressures, including the expansion of invasive species, while rising temperatures reduce labour productivity due to heat stress.

Uncertainty in rainfall patterns complicates agricultural planning, as both prolonged droughts and extreme rainfall disrupt planting cycles, crop establishment, and yields. This reduces farmer confidence and increases the likelihood of production losses across seasons.

These impacts extend beyond agricultural production to broader economic and food systems. Reduced output can affect household income, market stability, and food security, while increasing exposure to external supply and price shocks.

Structural constraints further amplify these risks. Limited access to land and water, combined with high transport costs and infrastructure challenges, restrict the ability of farmers to adapt effectively. In some areas, climate pressures may also intensify land-use conflicts and increase pressure on already constrained productive land.

These interconnected risks highlight the need for integrated adaptation approaches that address both climate hazards and underlying system constraints.

3.5 Compounding, Cascading Risks and Interdependencies for the agriculture Sector

Climate impacts on agriculture can compound existing social, economic, and institutional vulnerabilities, creating consequences that extend well beyond crop and livestock production. Reduced agricultural productivity influences household income, food security, education, health, gender equity, ecosystems, tourism, and overall community resilience, illustrating the strong interdependencies between sectors.

Gender and social vulnerability. These impacts are not experienced evenly across the population. Women, in particular, are likely to be disproportionately affected, given their already significant workloads across agriculture, small-scale marketing, handicraft production, caregiving, household responsibilities, and voluntary community work. Women also often face limited access to resources, land, and decision-making. As primary traders of agricultural produce in marketplaces, climate-related crop losses and disruptions to market access can directly affect their livelihoods and economic independence. These pressures may heighten household and community tensions, especially where income opportunities decline while care and recovery responsibilities increase.

Impacts on children and education. Children are affected through indirect pathways. Reduced agricultural income and increasing food insecurity can place additional strain on households, particularly during droughts or following tropical cyclones, when children may be withdrawn from school to support labour needs or income generation. Education systems may face further disruption where schools are used as emergency or recovery shelters, resulting in temporary closures.

Household food security and health outcomes. At the household level, declining agricultural production often leads to increased expenditure on food. When subsistence crops are damaged or yields decline, households may rely more heavily on purchased food, including imported foods. These foods are often more expensive and may offer lower nutritional value, thereby increasing risks of poor health outcomes such as obesity, diabetes, and heart disease. Disruptions to ports, wharves, airports, storage facilities, and transport routes can further constrain food supply chains, particularly in the aftermath of tropical cyclones.

Traditional knowledge and adaptive capacity. Climate change may weaken the effectiveness of traditional agricultural knowledge. Shifts in rainfall patterns, temperature regimes, and hazard conditions can reduce the reliability of customary planting practices, crop varieties, and preservation methods. Without deliberate efforts to support and adapt these systems, there is a risk of increasing dependence on imported foods. However, integrating traditional knowledge with improved climate information presents a viable pathway to strengthen resilience.

Institutional and implementation constraints. Consultation participants emphasised the importance of strengthening traditional practices, local food production, and economic resilience within the agriculture sector. They also identified opportunities for more integrated approaches, including sustainable agriculture mapping and master planning, to

support improved land use, food systems, and community-level behaviour change. However, progress has been constrained by logistical and funding limitations, with delays frequently linked to government processes, limited staffing, transport challenges, and the need for stronger accountability mechanisms.

Land and resource pressures. Agricultural land itself is under increasing pressure. Productive soils are affected by sedimentation, waterlogging, erosion, and cyclone damage, while access to suitable land is further constrained by damaged or limited infrastructure. These pressures reinforce existing vulnerabilities and highlight the need for coordinated responses across sectors.

Climate hazards affect multiple sectors simultaneously, with impacts propagating across systems and creating cascading effects. Key interdependencies between agriculture and other sectors are summarised in Table 8, while these multi-hazard pathways are illustrated in Figure 10.

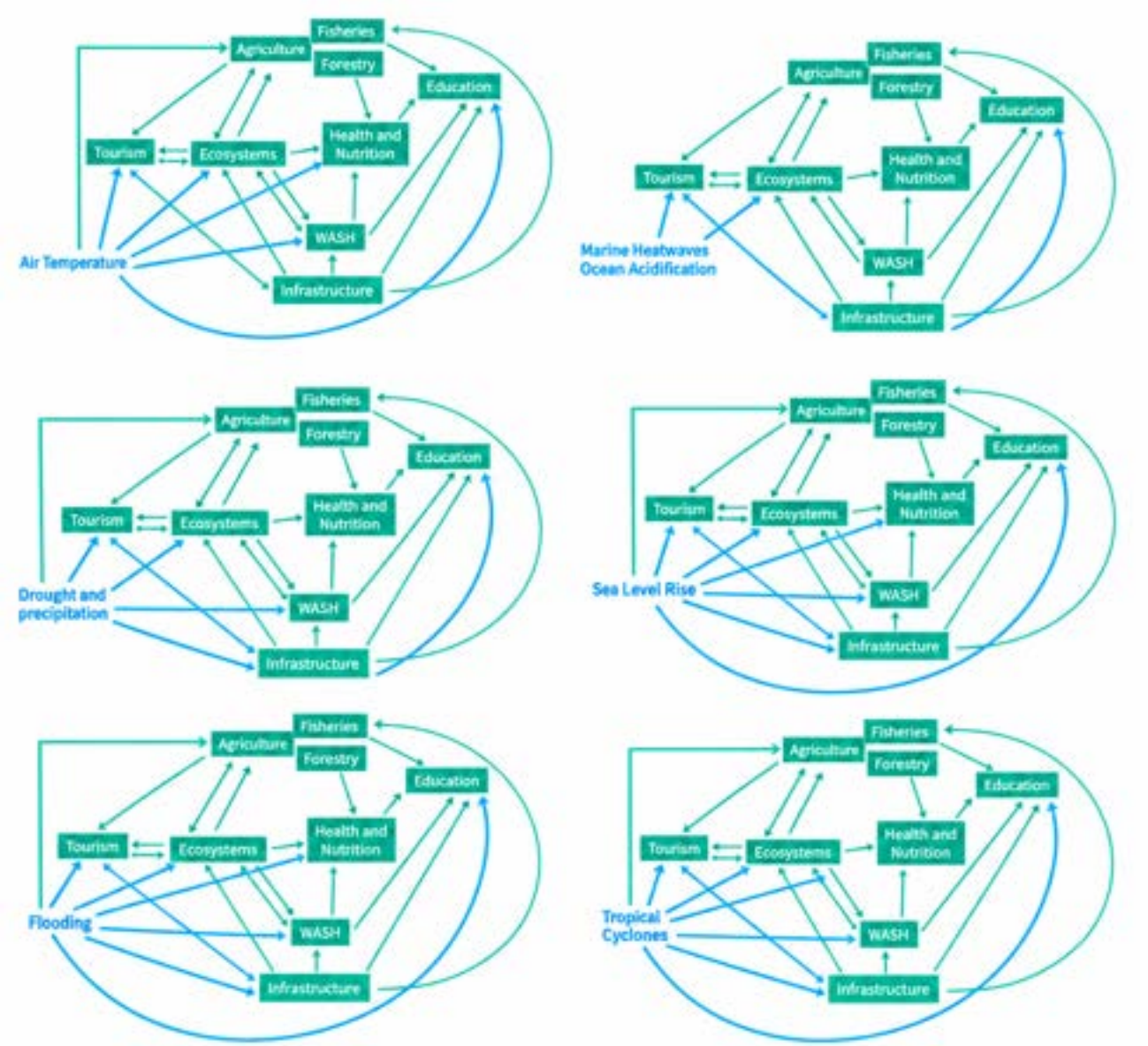
While Table 8 summarises key interdependencies between agriculture and other sectors, Figure 10 presents a system-wide view of how different climate hazards can trigger cascading impacts across sectors.

Figure 10 illustrates how climate hazards initiate impacts that propagate across sectors, reinforcing feedback loops and amplifying overall system vulnerability. These dynamics highlight the importance of integrated, cross-sectoral adaptation planning.

Table 8. Key interdependencies between agriculture and other sectors and associated cascading impacts

Sector	Link with Agriculture	Potential Cascading Impacts
Education	Subsistence agriculture supports children's nutrition and ability to participate effectively in school.	Droughts and cyclones may increase household labour demands, leading to reduced school attendance or withdrawal. Schools used as evacuation centres may also close temporarily.
Health and Nutrition	Agriculture provides food and income, supporting dietary diversity and household wellbeing.	Reduced production may increase malnutrition risks or reliance on less nutritious imported foods, contributing to non-communicable diseases.
Ecosystems	Agriculture interacts with land, forests, and water systems for food production.	Declining production may increase pressure on marine, freshwater, and forest resources through fishing, foraging, or harvesting.
Tourism	Tourism relies on locally produced food for supply chains and visitor experiences.	Reduced agricultural output may increase food costs and reduce availability of local produce for tourism operators.
Infrastructure	Roads, ports, markets, and storage facilities support agricultural production and trade.	Damage to infrastructure disrupts access to farms, markets, and supply chains, reducing income and food availability.
Fisheries	Fisheries may serve as an alternative food source when crops fail.	Increased reliance on fisheries may place additional pressure on coastal and freshwater resources.
WASH	Agriculture depends on water availability and quality.	Droughts and water contamination may reduce production and increase competition for water resources.
Forestry	Forest systems support livelihoods, food, and ecosystem services.	Increased reliance on forest resources during agricultural decline may contribute to degradation if not managed sustainably.

Figure 10. Illustrative multi-hazard pathways showing cascading impacts across sectors.



3.6 Summary and Considerations

Agriculture plays a central role in supporting household income, food security, and nutrition in Vanuatu. However, the sector is highly exposed to climate hazards, including drought, flooding, and tropical cyclones.

In the short term, climate impacts are likely to reduce production, income, and food availability. Over the longer term, repeated and compounding impacts may affect community resilience and influence the ability of some communities to remain in their current locations.

Declines in production may increase reliance on alternative food sources, including imported food and natural resource harvesting, placing additional pressure on ecosystems if not managed sustainably.

Strengthening resilience in the agriculture sector will require improving the reliability of food production systems, supporting sustainable land and resource management, and strengthening linkages with other sectors such as health, education, infrastructure, and ecosystems.

Given existing data limitations, continued investment in sector-specific data, improved modelling, and integration of local and traditional knowledge will be essential to support more targeted and effective risk assessments.



CHAPTER

04

Ecosystems Sector

4.1 Key Findings for Ecosystems

Marine heatwaves, increased sea surface temperature, sea level rise, intensity of rainfall events and drought will increasingly impact Vanuatu's ecosystems and potentially result in degraded terrestrial, freshwater, coral reef, mangrove and seagrass ecosystems. Tropical cyclones already cause damage, and are not projected to increase in frequency, but may be more intense.

Marine heatwaves, sea level rise, and ocean acidification will collectively affect the extent and species diversity of coral reef systems, mangroves, and seagrass meadows, as well as the fish and invertebrate populations that depend on them. In combination, marine heatwaves and ocean acidification will likely cause increased incidence of coral bleaching and affect coral growth. Sea level rise may cause loss of mangrove and seagrass habitat through coastal squeeze at a rate that may accelerate towards the end of the century.

Ocean acidification and marine heatwaves are projected to occur across Vanuatu's exclusive economic zone, leaving few if any coral reef systems unaffected and few if any refuges for sensitive marine species.

Changes and degradation in terrestrial and freshwater ecosystems will occur due to increased air temperatures and ongoing drought, which may lead to the loss of threatened species and create space for the expansion of invasive species.

Climate-related pressure on ecosystems may be compounded by human activities, creating a potential downward spiral. Human activities from tourism, forestry, fisheries, agriculture, and infrastructure already affect the structure and function of natural ecosystems due to disturbances and disruptions (e.g. logging, land clearance and management practices, harvesting certain animal species, increased sedimentation, and discharge of pollutants). Human activities may worsen the impacts of climate change.

The health of ecosystems and the services they provide impacts many other sectors because of the reliance on, and deep connection with, the natural environment. For example, ecosystem degradation could lead to reduced food security, impacting health and nutrition, coastal squeeze could result in a loss of the protection afforded to villages and infrastructure by mangrove and fringing reef systems, reduced ability to gather food, material for buildings, medicine, and fuel, and practice kastom. Impacts on health and well-being as the connection between humans and the natural environment breaks down. Access to clean water and natural resources to support local livelihoods.

4.2 Overview of the Ecosystems Sector

In Vanuatu, many people rely on natural ecosystems and the resources (e.g. food, fibre, and fuel) and services (e.g. clean water and shade) they provide for nutrition, health, and livelihoods in their everyday lives [92]. Access to natural resources and land is a critical underpinning of wellbeing, supporting kastom and the intergenerational transfer of knowledge and practices [93]. In addition, ecosystems provide recreational opportunities, (eco)tourism, aesthetic value, and an ongoing connection to nature.

Vanuatu's ecosystems range from relatively intact systems that remain largely subject to natural processes, to those that are heavily used and modified by human activity [88]. The relative geological age and isolation of the Vanuatu Islands result in fewer endemic (found only in Vanuatu) species than in neighbouring countries such as the Solomon Islands or Fiji. However, this is a broad comparison, as some plant and animal species do exhibit significant endemism. Importantly, local plant biodiversity is considered poorly understood and under-described [89], suggesting that additional, currently undocumented species may exist.

Many known plant and animal species are considered at risk, with 378 species identified as critically endangered, endangered, vulnerable, or near threatened. Seven species are listed as Critically Endangered on the IUCN Red List (as of 2022), including Beck's Petrel (Pseudobulweria becki), Hawksbill Turtle (Eretmochelys imbricata), Oceanic Whitetip Shark (Carcharhinus longimanus), and several endemic plant species [25].

Despite these knowledge gaps, the value of Vanuatu's ecosystems is internationally recognised. Vanuatu lies within

the East Melanesian Biodiversity Hotspot identified by the Critical Ecosystem Partnership Fund (CEPF) [90], one of the most biologically important regions globally due to species richness and endemism. Six priority areas for investment have been identified: Gaua, Santo Mountain Chain, Tongoa-Lalka, Tanna-Green Hill, Fortuna, and Aneityum.

Vanuatu is a signatory to the United Nations Convention on Biological Diversity (UNCBD) and has an active National Biodiversity Strategy and Action Plan (NBSAP) for 2018–2030 [91]. Conservation efforts are ongoing, with 161 conservation areas registered with the Department of Environmental Protection and Conservation (DEPC), the majority of which are marine. Of these, 40 are terrestrial and five include terrestrial and inland water systems, covering a total area of approximately 807.72 km^2 [25]. These areas are largely community-established and legally supported under the Environmental Protection and Conservation Act [CAP 283]. In addition, many locally managed areas exist as tabu areas, marine sanctuaries, and community conservation zones under customary and fisheries management systems.

There is also strong community interest in restoring degraded ecosystems. Evidence from UNDP [86] and recent consultations indicates widespread support for conservation and restoration initiatives, including the establishment of conservation areas to protect biodiversity for future generations. As reflected in community perspectives, there is growing concern that species once commonly observed are declining, and that younger generations may lose the opportunity to experience and learn from them: "I believe we should have conservation areas so that our children can observe different species… I no longer observe different species of birds that I remember seeing here as a child. Now, my children have no knowledge of these species" [86]. Community-led actions, including mangrove restoration, coral reef rehabilitation, and agroforestry, have shown positive outcomes, particularly where traditional knowledge is integrated into management approaches.

4.2.1 Terrestrial Ecosystems

Vanuatu's terrestrial ecosystems are characterised by tropical moist broadleaf forests within the Australasia realm, forming part of the Vanuatu Rainforest Bioregion [94]. These systems are influenced by relatively stable temperatures and high rainfall, although spatial variation exists due to topography and prevailing wind patterns.

There are an estimated 1,000 vascular plant species in Vanuatu, of which approximately 150 are endemic. Diversity is particularly high among orchids and palms [91]. However, vegetation classification and ecological understanding remain incomplete, and overall ecosystem condition is not well documented.

Vegetation patterns are strongly influenced by altitude, rainfall, soil type, disturbance regimes (including cyclones and volcanic activity), and human land use. The South-easterly Trade Winds create distinct windward and leeward conditions, with higher rainfall typically occurring on the eastern sides of islands and drier conditions on the western sides, where a seasonal dry period may occur between April and October [9436].

Several broad vegetation types are recognised:

- Montane forest and rainforest (typically above 500–600 m elevation)
- Lowland rainforest (below 600 m elevation, often exceeding 30 m in height)
- Seasonal forest, scrub, and grasslands in drier or disturbed areas
- Vegetation on volcanic surfaces dominated by early colonising species
- Coastal and littoral vegetation, including salt-tolerant species such as mangroves and Pandanus

Estimates suggest that around 74% of land remains under natural vegetation [91], although this includes modified systems. Montane and lowland forests account for approximately 36% of land area, while scrub, grasslands, and thickets account for around 43%, and bare ground approximately 21% [25]. Wetlands and mangroves together represent less than 1%.

Despite this apparent coverage, evidence suggests that many forest ecosystems have been modified and may be in decline, with limited data available to accurately assess condition [3695].

4.2.2 Terrestrial and Freshwater Animals

A number of terrestrial animal species are either endemic to Vanuatu or nearly endemic, meaning that although they are not restricted to Vanuatu, they have a narrow geographic range that may include some neighbouring island nations. However, for some animals, there is no consistent agreement on the number of species, their endemism and conservation status, and these figures are regularly revisited, with numbers differing across reports.

In terms of mammals, bats and Flying Foxes (Chiroptera) are the only mammals native to Vanuatu (12 species) [91]. They are thought to be important pollinators and seed dispersers for native tree species [25]. Notably, both the Fijian Blossom-bat and Banks Flying Fox are considered vulnerable [25].

With respect to avifauna, according to the National Biodiversity Strategy and Action Plan, there are 121 species of birds in Vanuatu; however, the World Bank Database lists 187 bird species, with 56 of those as usually resident species [25], reflecting differences in classification and data sources. Of these species, ten are on the IUCN Red List: Santa Cruz Ground-Dove (Endangered), Vanuatu Megapode (found on Ambae), Baker's Imperial Pigeon (Vanuatu Mountain Pigeon), Green Palm Lorikeet, Vanuatu Chestnut-bellied Kingfisher, Royal Parrot Finch and Santos Mountain Starling (Vulnerable); as well as Thicket Warbler, Rusty-winged Starling and Tanna Fruit-Dove (Near Threatened) [25].

Similarly, nine endemic reptiles are on the IUCN Red List, of which the Anaytom Emo Skink (Emoia aneityumensis), found only on Aneityum, is endangered, and the Common Emo Skink (E. erronan), found only on Futuna and Aniwa, is endangered. In addition, one endemic land snail (Partula milleri) is critically endangered, and P. eurania is endangered [91].

4.2.3 Freshwater Rivers, Lakes and Wetlands

Freshwater ecosystems occur across Vanuatu and are described in Kalfatak et al. (2014) [95] [96]. Rivers and streams are numerous and are generally characterised by steep gradients in the upper inland reaches, before transitioning to lower-gradient, slower-moving waters as they approach the coast [91] [97]. Many stream beds are steep and can carry large volumes of water during heavy rainfall. However, some streams are ephemeral and dry out during seasonal dry periods or droughts [96] [11].

Vanuatu has around 25–30 natural freshwater lakes, found on Ambae, Ambrym, Efate, Epi, Espiritu Santo, Gaua, Maewo, Malekula, Tanna and Thion. Lake Letas, on Gaua, is the largest [96]. Wetlands are relatively few and tend to be small, occurring around lake fringes, lakeshores, or in depressions on inland plateaus [96].

Freshwater ecosystems support approximately 38 recorded endemic freshwater species. Freshwater fish are closely linked to the marine environment, with many species having marine larval stages, known as amphidromy [97]. Small gobies, particularly those in the subfamily Sicydiinae, are common and are thought to have high species diversity. Larger species, including eels (Anguilla spp.), spot-tail bass (Lutjanus fuscescens), mullets (Mugilidae), and grunters (Terapontidae), are important food sources for local communities. Neritid snails and prawns are also harvested and consumed.

According to the National Biodiversity Strategy and Action Plan (2022), Vanuatu has 96 known crustacean and fish species associated with freshwater systems, comprising 29 decapod crustaceans and 67 fish species. Of these, five are endemic to Vanuatu and seven are endemic to both Vanuatu and New Caledonia [91].

4.2.4 Coastal and Marine Habitats

Marine and coastal ecosystems in Vanuatu are extensive and of critical importance to the wellbeing of Ni-Vanuatu people socially, culturally, and economically. Key coastal and marine ecosystems include mangroves, seagrasses, and coral reefs, which provide essential services such as food provision, shoreline protection, and habitat for biodiversity.

4.2.5 Mangroves

Mangroves are intertidal tree species that grow between mean sea level and the highest spring tide [98]. Their distribution is largely determined by local topography and tidal range, with flat coastal areas and large tidal ranges supporting more extensive mangrove coverage.

In Vanuatu, mangrove forests are estimated to cover approximately 2,500–3,000 hectares, of which around 2,000 hectares are located on Malekula, primarily along the east coast. Elsewhere, mangroves are more fragmented and typically occur as narrow strips within intertidal zones of estuaries, lagoons, and sheltered shorelines. Approximately 24 mangrove species have been identified across the country [96].

For the purposes of this assessment, Vanuatu is grouped into three regions—North, Central, and South (Figure 9). This regional framing supports comparison of ecosystem distribution and climate risks across the country. As shown in Figure 11, mangrove distribution within the Central region is highly localised and discontinuous, occurring in small coastal pockets rather than forming extensive, contiguous systems.

This spatial pattern reflects the limited availability of suitable low-lying coastal environments in the Central islands and highlights the uneven distribution of mangrove-related ecosystem services. Areas where mangroves are present are likely to benefit from natural coastal protection, nursery habitats for fish, and carbon storage, while areas without mangroves may be more exposed to coastal erosion and storm impacts.

Mangroves are also important for local livelihoods, providing firewood and supporting food sources such as mangrove crabs and fish [99]. Their ecological and socio-economic importance makes them a critical component of coastal resilience, particularly in the context of increasing climate pressures such as sea-level rise and coastal flooding.

Figure 11. The extent of mangroves across Central Vanuatu



Source: Vanuatu Resilience Explorer®

4.2.6 Seagrass

Seagrass beds occur in inshore and intertidal zones of many subtropical and tropical countries and typically form low-growing meadows of grass-like flowering plants [100]. In Vanuatu, seagrass is generally found in shallow, sheltered, soft-sediment environments such as estuaries and embayments. Its distribution is influenced by environmental conditions including temperature, salinity, wave exposure, currents, light availability, nutrient levels, and water clarity [101].

Seagrass plays an important ecological and socio-economic role. It stabilises marine sediments, improves water quality through nutrient uptake, and contributes to carbon sequestration. Seagrass meadows also provide critical nursery habitat for marine species and support biodiversity, including sea cucumbers and urchins. In Vanuatu, seagrass diversity is relatively high, with approximately 13 species recorded, and these habitats are an important food source for dugongs and green turtles [25].

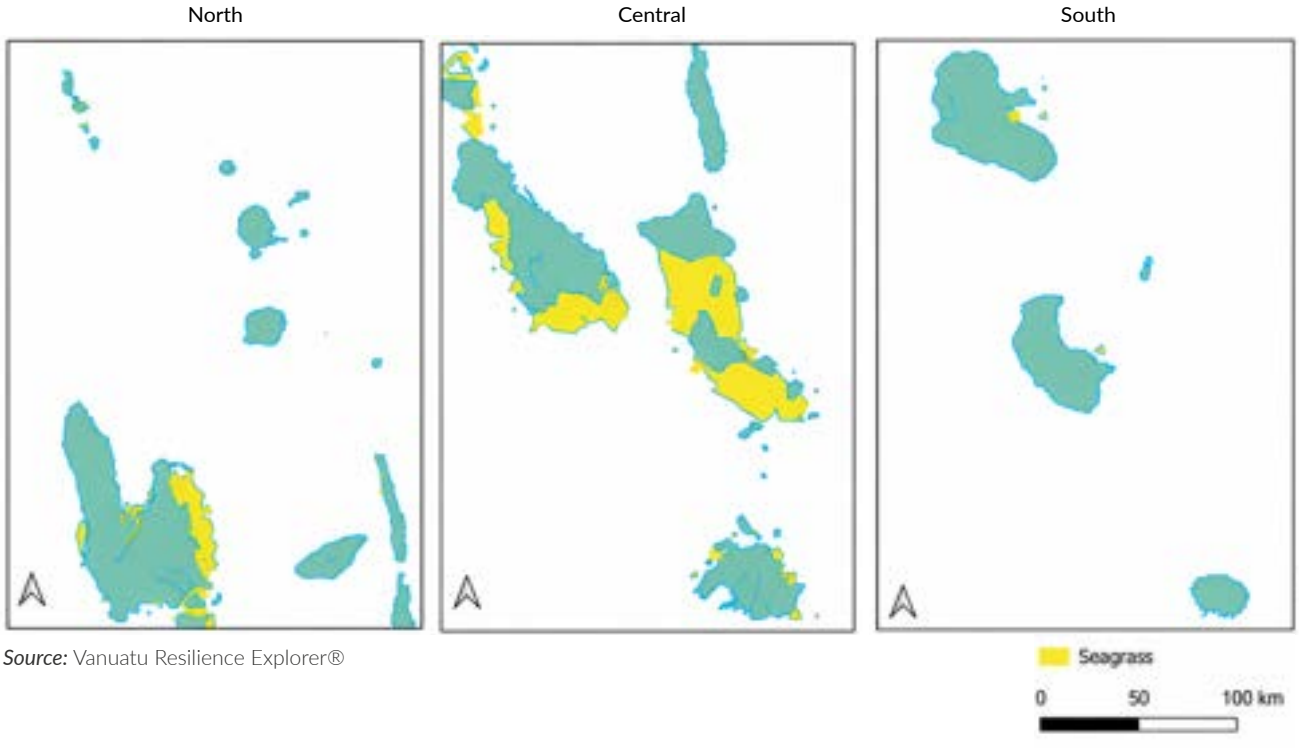
Most seagrass meadows in Vanuatu are relatively small and patchy in extent. However, more extensive seagrass beds have been identified in areas with wider intertidal zones, particularly around the Maskelyne Islands and along the south-east coast of Malekula [96]. As shown in Figure 12, seagrass distribution varies across the three regions of Vanuatu (North, Central, and South; see Figure 9), with the Central region supporting the most extensive and continuous seagrass coverage, while the North and South regions exhibit more limited and fragmented patches.

This spatial pattern reflects differences in coastal geomorphology and the availability of sheltered, shallow-water environments suitable for seagrass growth. Areas with more extensive seagrass coverage are likely to provide greater ecosystem services, including coastal stabilisation and support for fisheries, whereas areas with limited seagrass presence may have reduced ecological buffering capacity and habitat availability.

Although there is limited location-specific information on temperature tolerance ranges for seagrass in Vanuatu, optimal growth conditions for tropical species are generally between 23°C and 32°C, with stress likely occurring at temperatures between 35°C and 40°C [102].

Overall, seagrass ecosystems are in decline across the western Pacific [103], indicating increasing pressure on these habitats and the ecosystem services they provide.

Figure 12. The extent of seagrass meadows across North, Central, and South Vanuatu



Source: Vanuatu Resilience Explorer®

4.2.7 Coral Reef

Vanuatu has more than 1,200 km² of coral reef, supporting diverse and productive marine ecosystems. Most islands are surrounded by discontinuous fringing reefs, with some atolls, barrier reefs, and patch reef systems also present [25] (Figure 13).

Coral reefs are formed by colonies of coral polyps living in symbiosis with photosynthetic algae (zooxanthellae), which provide much of the energy required for reef growth and contribute to coral colouration. Reef distribution is influenced by environmental factors including light availability, sea surface temperature, salinity, water clarity, and suitable substrate.

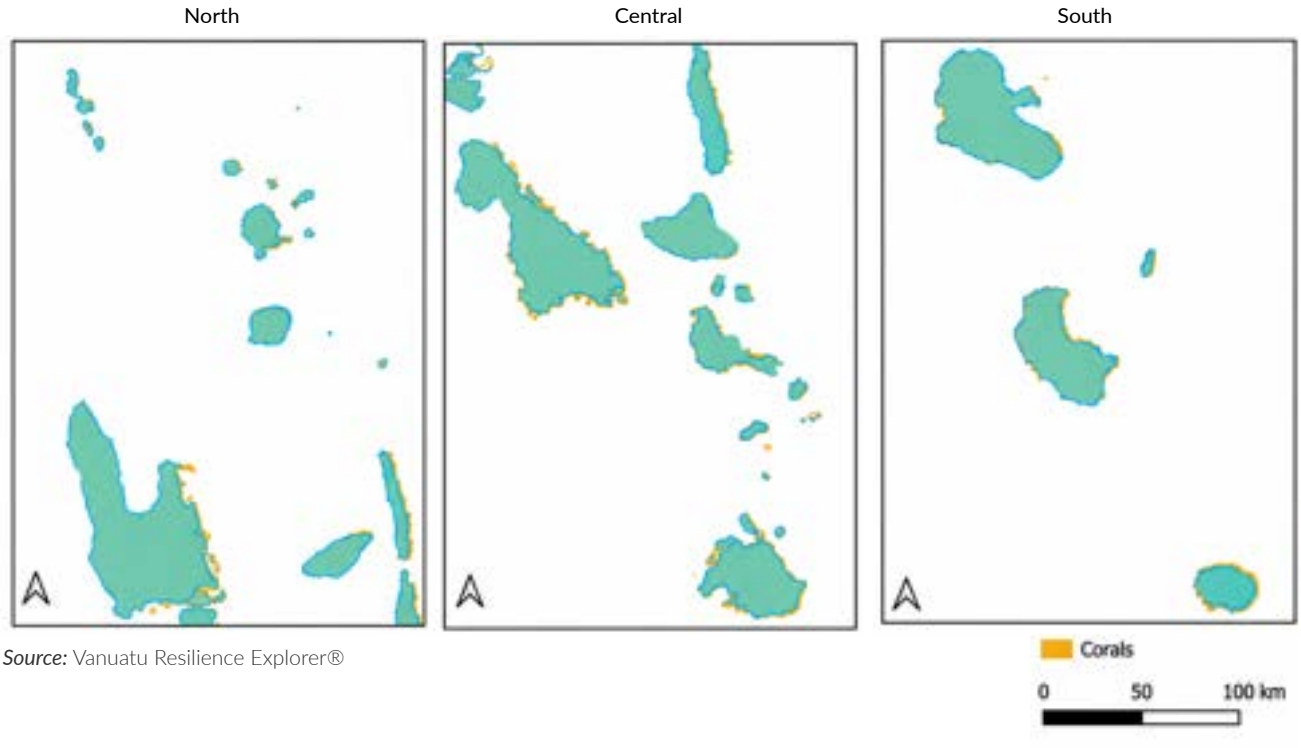
As shown in Figure 13, coral reefs are widely distributed across all three regions of Vanuatu (North, Central, and South; see Figure 9), generally forming near-continuous fringes along coastlines. Compared to mangroves and seagrass, coral reefs are more spatially extensive and consistently present across the archipelago, reflecting the widespread availability of suitable marine conditions.

This broad distribution indicates that coral reefs provide ecosystem services at a national scale, including coastal protection, fisheries support, and biodiversity habitat. However, it also means that climate-related pressures—such as increasing sea surface temperatures, ocean acidification, and cyclone impacts—have the potential to affect reef systems across all regions simultaneously.

Coral reefs in Vanuatu exhibit a range of structural forms, with shallow reefs often characterised by coralline algae, plate corals, and branching structures, while branching corals tend to dominate at greater depths. Reefs with higher structural complexity generally support greater biodiversity by providing habitat and refuge for marine species [104]. However, such complexity may also increase susceptibility to physical damage during extreme events such as tropical cyclones, due to greater surface area exposed to wave energy [104].

A recent nationwide assessment identified high coral diversity (51 genera recorded), a strong presence of juvenile corals, and generally high structural complexity, indicating relatively healthy reef systems. Fish diversity was also high, although dominated by smaller species. Economically important species such as sea cucumbers, trochus, and green snails were present but rare, while sea urchins were

Figure 13. The extent of coral reef systems across North, Central, and South Vanuatu (Source Vanuatu Resilience Explorer®).



Source: Vanuatu Resilience Explorer®

abundant and Crown-of-Thorns starfish were rare at the national scale [105].

Coral reef systems also provide critical ecosystem services for local communities, including food supply, income generation, and tourism, making them a cornerstone of coastal livelihoods and national economic activity.

4.2.8 Coastal and Marine Animal Species

Coastal and marine ecosystems in Vanuatu support a diverse range of animal species, including those often described as "charismatic megafauna," such as turtles and dugongs, which hold significant social, cultural, and economic value.

The dugong (Dugong dugon) is listed as Vulnerable on the IUCN Red List, and Vanuatu is considered to represent the eastern limit of its distribution [101]. Dugongs are highly dependent on seagrass meadows for feeding, linking their presence closely to the health and extent of these habitats. In addition to their ecological role, dugongs contribute to local tourism, with opportunities for viewing and interaction reported in areas such as Efate and Malekula, including Pango Village (Port Vila) and Gaspard Bay (Lamap) [101].

Five species of marine turtles recorded in Vanuatu are listed as threatened or vulnerable: the Green turtle (Chelonia mydas), Hawksbill turtle (Eretmochelys imbricata), Leatherback turtle (Dermochelys coriacea), Olive Ridley turtle (Lepidochelys olivacea), and Loggerhead turtle (Caretta caretta). Of these, the Hawksbill turtle is classified as Critically Endangered and is found across multiple islands, with documented nesting sites including west Malekula (Wiawi Village and Bamboo Bay) and Moso Island off Efate [106].

Reef-associated biodiversity is also high. Vanuatu's coral reef systems support approximately 450–500 fish species and an estimated 295 species of hard corals [25]. Invertebrate diversity is similarly high, although less comprehensively documented.

Overall, these species are closely linked to the condition of key ecosystems such as seagrass meadows and coral reefs, and their presence reflects the relatively high ecological value of coastal and marine environments in Vanuatu. At the same time, their dependence on specific habitats highlights their sensitivity to environmental change and habitat degradation.

4.3 Existing Ecosystem Stressors

Vanuatu's terrestrial, coastal, and marine ecosystems are already under pressure from multiple non-climatic stressors, which interact with and amplify climate risks. These stressors are already contributing to ecosystem degradation, biodiversity loss, and reduced resilience.

Key stressors include:

- Natural disturbances: Cyclones, flooding, volcanic activity, and landslides, which damage forests, reefs, and coastal systems.
- Invasive species: Plants and animals that outcompete or prey on native species, altering habitats and ecosystem balance.
- Land clearance and logging: Expansion of agriculture, settlements, and resource extraction leading to habitat loss, forest degradation, and increased sediment runoff.
- Overharvesting: Unsustainable extraction of species (e.g. fish, crabs, bats, timber), reducing population stocks and ecosystem function.
- Pollution and sedimentation: Waste, nutrient runoff, plastics, and sediment degrading water quality and smothering coral reefs and seagrass.
- Coral bleaching: Increasing thermal stress leading to loss of coral cover and reduced reef growth and recovery capacity.

Overall implication:

These stressors reduce ecosystem health and adaptive capacity, increasing vulnerability to climate hazards such as sea-level rise, temperature increase, and extreme events.

4.4 Hazard Data Availability and Suitability

The assessment of climate risks to the ecosystems sector draws on multiple hazard datasets and qualitative sources with varying levels of resolution and coverage. A summary of the key hazard datasets and their suitability for adaptation planning is provided in Appendix C Tables A-04 and A-05.

Overall, most hazard datasets are assessed as having medium suitability, primarily due to aggregation at the regional scale (North, Central, South) and the use of long-term averages, which limit the granularity of the assessment. Additional limitations include the absence of climate change projections for some hazards and reliance on qualitative or historical data in certain cases.

To address these constraints, the assessment integrates high-quality qualitative evidence, including sector consultations, national reports, and recent scientific studies.

4.4.1 National Distribution of Key Elements

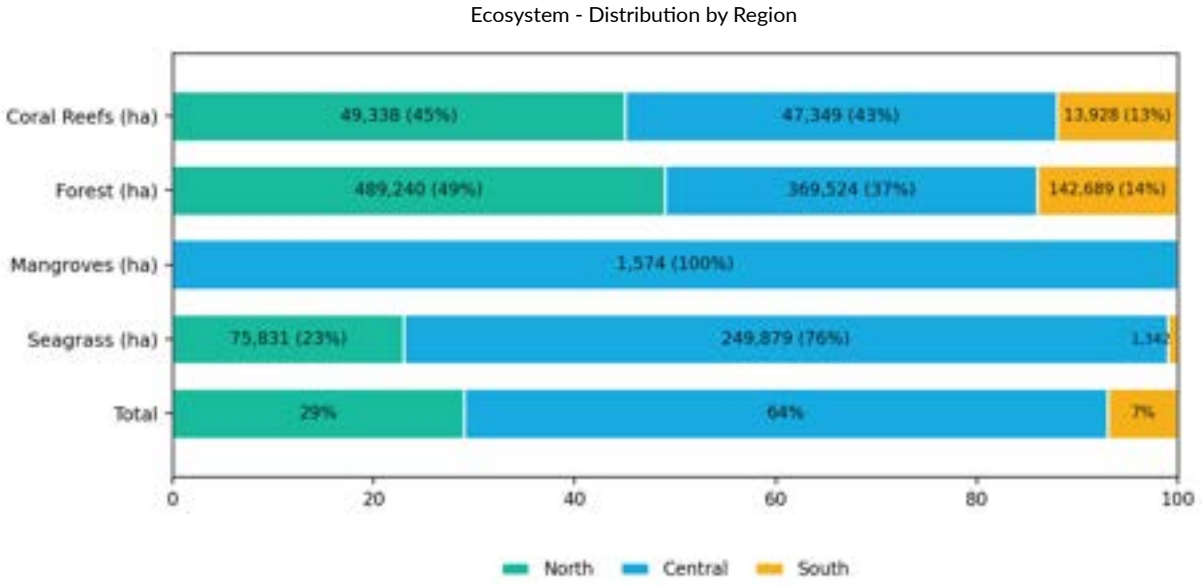
The distribution of mangrove, seagrass, coral reef systems, and terrestrial forest ecosystems across Vanuatu's North, Central, and South regions is presented in Figure 14, which shows both the relative percentage and total area of each ecosystem type by region. For the purposes of this assessment, natural systems have been grouped into these regions to align with the resolution of the climate models (air and sea temperature, ocean acidification, drought, and precipitation), enabling comparison of impacts across the country.

As illustrated in Figure 14, the Central region contains the largest share of natural ecosystems (64%), compared to the North (29%) and South (7%). This dominance is driven primarily by the concentration of coastal and marine ecosystems, with the vast majority of mangrove (1,574 ha) and seagrass (249,879 ha) ecosystems located in the Central region.

In contrast, the North region supports the largest extent of terrestrial forests (489,240 ha) and a substantial share of coral reefs (49,388 ha), indicating its importance for land-based ecosystem services and biodiversity. The South region contributes only a small proportion across all ecosystem types, reflecting a comparatively limited ecological resource base.

Overall, Figure 14 highlights clear regional differences in both the type and extent of ecosystems, with the Central region characterised by coastal and marine dominance, and the North by terrestrial forest systems. These spatial patterns have important implications for climate risk, as exposure and vulnerability will vary by region depending on the ecosystems present. For example, regions with extensive seagrass and mangrove systems may be more exposed to coastal and marine hazards, while forest-dominated regions may be more sensitive to drought, temperature increases, and extreme rainfall events.

Figure 14. The distribution of mangrove, seagrass, coral reef systems, and terrestrial forest ecosystems across the North, Central, and South regions both as a percentage and an area



4.4.2 Climate Risk Assessment for Ecosystems

Climate hazards affect ecosystems through distinct but overlapping pathways, influencing ecosystem structure and function, species distribution, and the provision of ecosystem services. Table 9: Climate Hazard Assessment for the Ecosystems Sector summarises the key vulnerabilities and consequences associated with each hazard.

Table 9. Climate Hazard Assessment for the Ecosystems Sector

Climate Hazard	Vulnerability (Ecosystems, Species, Locations)	Key Consequences (Ecosystem Function, Biodiversity, Livelihoods)
Air Temperature Increase	Terrestrial and freshwater species have optimal temperature ranges; exceedance leads to physiological stress (e.g. increased metabolism, evapotranspiration), reduced reproduction, and mortality. Temperature tolerances and adaptive capacity are poorly documented. Freshwater systems (rivers, streams, lakes) are sensitive to warming, particularly in exposed systems. Limited dispersal capacity due to steep terrain, isolated islands, and fragmented habitats.	Shifts in species distribution (altitudinal and latitudinal), with movement to higher elevations or cooler southern areas. Localised extinctions where dispersal is constrained. Changes in seasonality (flowering, nesting, migration), creating ecological mismatches. Temperature-driven feminisation of turtle populations threatens long-term viability of already vulnerable species.
Marine Heatwaves	Coral reefs highly sensitive to prolonged elevated sea surface temperatures (bleaching risk). Seagrass systems in shallow estuaries and embayments approach upper thermal limits (>~26°C depending on species). Fish and marine species experience stress when temperature thresholds are exceeded. Adaptive capacity of marine ecosystems remains poorly understood but likely low.	Coral bleaching reduces reef structure and habitat availability. Decline in reef-dependent biodiversity and fish populations. Fish kills and shifts in fish distribution to cooler waters. Loss of ecosystem services supporting fisheries, food security, and livelihoods. Temporary refuge areas may persist but are expected to decline over time.

Table 9. Climate Hazard Assessment for the Ecosystems Sector (continued)

Climate Hazard	Vulnerability (Ecosystems, Species, Locations)	Key Consequences (Ecosystem Function, Biodiversity, Livelihoods)
Ocean Acidification	Reduced carbonate ion availability limits coral calcification and shell formation for marine organisms. Coral reefs (~1,200 km^2) highly sensitive, particularly branching corals below 5 m depth. Species dependent on calcium carbonate structures (corals, shellfish) have low adaptive capacity and limited ability to relocate.	Degradation of coral reef structure and loss of habitat complexity. By ~2050, ~85% of reefs may struggle to grow under low pH conditions. Impacts cascade to 450–500 fish species and higher trophic levels. Declining fish stocks affect food security and livelihoods. Loss of reef integrity reduces resilience of coastal ecosystems.
Drought and Rainfall Variability	Tropical forests highly sensitive to drought, with lower adaptive capacity than scrub/grass systems. Freshwater systems vulnerable to both prolonged drought (drying of streams) and intense rainfall (high flow velocity, erosion, sediment transport). Sedimentation affects aquatic habitats and light penetration.	Changes in vegetation composition and distribution across islands. Increased water stress reduces forest health and resilience. Decline in freshwater biodiversity due to prolonged dry periods and disturbance from extreme rainfall. Sediment deposition smothers aquatic species and degrades habitats.
Coastal Flooding and Sea-Level Rise	Coastal ecosystems (mangroves, seagrass, beaches, coastal forests) sensitive to inundation, salinity, and light changes. High exposure to "coastal squeeze" where inland migration is blocked by steep terrain or infrastructure. Mangroves and seagrass can migrate if sedimentation and space allow; adaptive capacity is low where barriers exist. Coastal forests vulnerable to groundwater salinisation.	Loss and fragmentation of mangrove and seagrass habitats, reducing nursery areas for fish and impacting species such as dugongs. Decline in coastal biodiversity and ecosystem services. Loss of sandy beaches reduces nesting habitat for turtles and seabirds. Increased uncertainty in extent of impacts due to limited elevation data.
Tropical Cyclones	Terrestrial forests, coral reefs, and seagrass systems exposed to wind damage, wave action, and sedimentation. Repeated high-intensity cyclones reduce recovery time (e.g. Cyclones Pam and Harold impacts). Nesting sites for turtles and seabirds highly exposed. Seagrass and coral systems vulnerable to debris and sediment loading. Adaptive capacity reduced where recovery intervals shorten.	Widespread damage to forests, coral reefs, and seagrass ecosystems. Loss of habitat and biodiversity, particularly for already threatened species. Damage to nesting sites reduces recruitment of species such as turtles. Disruption to ecosystem services supporting food systems and livelihoods. Increased pressure on natural resources during recovery periods.

4.5 Cross-Cutting Risks and Implications for Ecosystem Systems

Beyond individual hazards, ecosystems in Vanuatu are exposed to compounding and interacting climate pressures that affect their overall resilience. Many ecosystems are already subject to multiple stressors simultaneously, for example, coral reefs are affected by marine heatwaves, ocean acidification, and cyclone damage, reducing their capacity to recover between events and increasing the likelihood of long-term degradation.

A key cross-cutting risk is the limited adaptive capacity of species and ecosystems under changing conditions. Many species have poorly understood tolerance thresholds, and geographic constraints—including steep terrain, incised valleys, and the isolation of islands—limit the ability of species to migrate in response to climate shifts. This increases the risk of localised extinctions, particularly for species that are not mobile or depend on specific habitats.

Ecosystem changes are also occurring unevenly across the country. For example, reef systems around Tanna, Epi, and West Maewo may act as temporary refuges under

current marine heatwave conditions but are expected to face increasing exposure over time. In coastal areas such as Malekula and Efate, ecosystems are already experiencing pressures from sea-level rise, coastal erosion, and habitat loss, including documented declines in mangrove ecosystems around Emten Lagoon near Erakor Bridge. These location-specific dynamics highlight that ecosystem resilience varies significantly across islands and regions.

Climate change is altering ecological relationships and system dynamics, including the timing of species interactions such as breeding, migration, and food availability. These shifts can create mismatches between interdependent species, affecting recruitment and long-term population stability. In marine systems, changes in temperature and reef condition are influencing fish distribution and abundance, with direct implications for coastal food systems.

The impacts of climate hazards are strongly interconnected across ecosystem types. For example, increased rainfall intensity and erosion in upland areas can lead to higher sediment loads in rivers, which are then transported to coastal zones, degrading coral reefs and seagrass habitats. Similarly, damage to forests from cyclones can increase sediment runoff, compounding pressures on downstream marine ecosystems. These land–sea linkages amplify the overall impact of climate change beyond individual hazard events.

Ecosystem degradation has direct implications for livelihoods, food security, and cultural values. Many communities depend on fisheries, forests, and coastal ecosystems for subsistence and income. Observations from communities, such as concerns in Efate about declining fish availability during warmer periods, and reports of food shortages following Cyclone Harold in northern islands such as Linduri Village, illustrate how ecosystem impacts translate into human vulnerability.

Structural constraints further limit ecosystem resilience. Coastal systems face barriers to inland migration, resulting in coastal squeeze where natural habitats cannot shift landward due to steep topography or infrastructure. In addition, limited availability of high-resolution elevation data (e.g. LIDAR) constrains the ability to assess and plan for future habitat loss. Increasing competition for land and coastal space may further restrict ecosystem adaptation pathways.

These interconnected risks highlight the need for integrated, ridge-to-reef approaches to adaptation that consider linkages between terrestrial, freshwater, and marine systems. Strengthening ecosystem resilience will require not only addressing climate hazards but also reducing existing pressures, protecting critical habitats, and enabling natural processes such as migration and recovery to occur where possible.

4.6 Compounding, Cascading Risk and Interdependencies

4.6.1 Overview of Compounding Risk

Ecosystems in Vanuatu are exposed to compounding and cascading climate risks that may occur simultaneously or in close succession. Climate related stressors interact across terrestrial, freshwater, and marine systems, affecting habitats such as sandy beaches, mangroves, seagrass meadows, coral reefs, and indigenous forests. As these habitats change or degrade, their capacity to support biodiversity is reduced, with vulnerable and threatened species facing a heightened risk of decline or local extinction.

Compounding Marine Stressors: Marine ecosystems are subject to multiple, interacting pressures. Marine heatwaves, ocean acidification, and tropical cyclones act together to stress coral reefs and associated ecosystems. Coral bleaching driven by heat stress coincides with declining ocean pH (approximately −0.10 under RCP4.5 and −0.13 under RCP8.5 by 2050), reducing calcification and weakening reef structure. These combined pressures diminish reef extent and health, with cascading impacts on biodiversity, fisheries productivity, and long term ecosystem viability.

Terrestrial and Freshwater Ecosystem Changes: Changes in temperature, rainfall patterns, and drought frequency are likely to degrade terrestrial and freshwater ecosystems. Increased drought persistence may reduce forest resilience and alter vegetation composition. Streams and waterways may become more seasonal or ephemeral, reducing habitat availability and affecting freshwater biodiversity. At the same time, more intense rainfall events increase erosion, landslides, and sediment transport across catchments.

Species Shifts and Invasive Pressures: Rising air and sea surface temperatures, along with increased disturbance from cyclones and other extreme events, may favour existing and new pest or invasive species. These species may establish and spread more rapidly than native species, outcompeting them for resources. Concurrently, climate driven changes may force species range shifts, with some species unable to adapt or relocate, leading to population declines or loss.

Ridge to Reef Interdependencies: Ecosystem impacts are strongly interconnected across landscapes. Upland erosion, cyclone damage, and land disturbance increase sediment loads, which are transported through rivers to estuaries and coastal waters. This sedimentation can smother seagrass beds and coral reefs, compounding stress on marine ecosystems already affected by warming seas and ocean acidification. These ridge to reef linkages amplify climate impacts beyond individual hazards, demonstrating the cascading nature of ecosystem risk.

Cross Sector Pressures on Ecosystems: Ecosystems are further influenced by pressures from agriculture, forestry, fisheries, tourism, and infrastructure development. Land clearing, overharvesting, pollution, and coastal development contribute to ongoing degradation and may intensify as population growth and climate pressures increase. These non climate stressors interact with climatic changes, compounding ecosystem vulnerability.

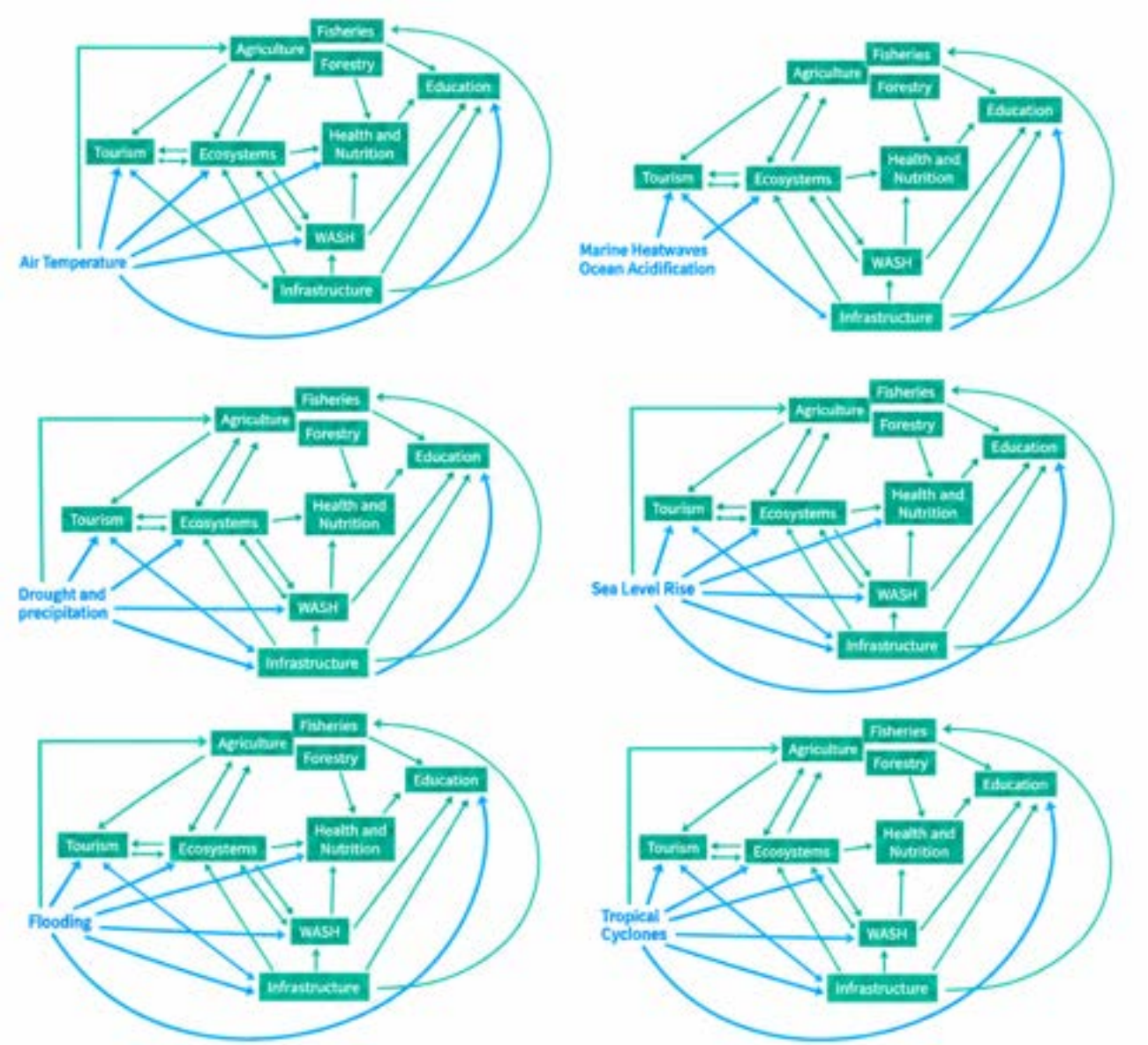
Implications for Livelihoods and Wellbeing: Ecosystem degradation has direct implications for communities and livelihoods. Declining ecosystem services affect food security, coastal protection, water quality, and access to natural resources. Reduced availability of key species undermines kastom practices and traditional knowledge systems, with broader impacts on cultural identity, health, wellbeing, and income generation, particularly in fisheries and tourism dependent communities.

Limits to Ecosystem Adaptation: There are clear limits to ecosystem adaptation under increasing climate pressure. Coastal ecosystems face barriers to inland migration due to development and land tenure constraints, resulting in coastal squeeze and habitat loss. Data limitations, such as the lack of high resolution elevation or ecosystem mapping, constrain detailed planning and risk assessment. Competing land uses further restrict available adaptation pathways, increasing the likelihood of irreversible ecosystem change.

Interdependencies and Cascading Risk Pathways

Figure 15 illustrates the interdependencies between ecosystems and other key sectors, highlighting how climate hazards interact with ecosystems to create cascading and compounding risks across social, economic, and environmental systems. Changes affecting ecosystems—such as degradation of coral reefs, forests, wetlands, and freshwater systems—do not occur in isolation. Instead, impacts propagate across sectors including agriculture, fisheries, health and nutrition, WASH, infrastructure, tourism, and education. Climate stressors such as rising air and sea temperatures, drought, flooding, sea level rise, and tropical cyclones can directly affect ecosystems, while ecosystem degradation in turn amplifies risks to livelihoods, service delivery, and wellbeing. These interconnected pathways demonstrate how initial climate impacts can trigger secondary and tertiary effects across multiple sectors, increasing overall vulnerability and limiting response and adaptation options.

Figure 15. Illustration of the interdependencies between ecosystems and other sectors that create cascading and compounding risks.



4.7 Summary and Considerations

Although Vanuatu's ecosystems have evolved under dynamic conditions influenced by natural hazards and human activity, the climate has remained relatively stable to date. Climate change introduces new and interacting pressures that may:

- Act at both the species level (e.g. turtles) and ecosystem level (e.g. mangroves, forests, coral reefs)
- Occur alongside and amplify existing pressures on natural systems
- Create compounding impacts, where multiple hazards affect ecosystems simultaneously
- Introduce new stressors to systems that may already be under strain

Climate change is projected to affect and potentially degrade terrestrial, freshwater, coral reef, mangrove, and seagrass ecosystems, leading to the loss or damage of habitats and species. Coastal ecosystems are particularly exposed to overlapping pressures from sea-level rise, increasing sea surface temperatures, and ocean acidification, while terrestrial and freshwater systems face changing rainfall patterns, prolonged droughts, and rising air temperatures.

As a result, habitat quality and extent are likely to decline across ecosystems over time, with implications for biodiversity. These changes are expected to amplify the impacts of human activities, increasing ecosystem degradation. Given the strong dependence of communities and sectors on natural systems, ecosystem change will have widespread implications for livelihoods, wellbeing, and economic resilience in Vanuatu.



CHAPTER

05

Education Sector

5.1 Key Findings for Education

Vanuatu's Education sector will face further pressures as climate hazards increasingly affect education-related infrastructure and negatively impact student attendance. Key hazards include coastal inundation associated with sea-level rise, temperature increases, changes in water and food availability due to drought, and damage resulting from tropical cyclones and flooding.

Rising temperatures and undernutrition from drought-related food insecurity can lower students' ability to concentrate. Schools without cooling systems will be particularly at risk from heat-related disruptions.

An increase in flooding (coastal, fluvial, pluvial) and tropical cyclone intensity can damage and contaminate school buildings and WASH facilities, leaving them unsafe or unsuitable for use. Schools may be forced to close or operate on reduced hours until repairs can be made. Permanent inundation due to sea-level rise may mean some coastal schools will have to relocate buildings or close altogether.

Children's learning and sense of routine are negatively impacted when schools close due to flood-related damage, school routes become inaccessible, or when schools are used as temporary shelters or evacuation centres. Disrupted education can increase the risk of anti-social behaviour and that children will drop out of school before completing their studies.

Under present day conditions, South Malekula, Erakor, North-East Malekula and North Tanna have the highest proportion of school-related elements (schools, roading) at risk from coastal flooding and sea-level rise, compared to other areas. From 1.0m SLR, South-East Malekula becomes the area with the highest proportion of elements potentially exposed.

Of those areas with available flood data, West Tanna, Port Vila, Whitesands and Central Malekula have the highest proportion of school-related elements at risk from fluvial and pluvial flooding. Under a 1% AEP flood event, West Tanna has the highest proportion of school-related elements at risk compared to other areas. In the event of 2% and 10% AEP flooding, Port Vila becomes the area with the highest proportion of elements at risk relative to others.

Girls, students living with a disability, and rural students are likely to disproportionally experience negative impacts on their education for numerous reasons, including disrupted school attendance due to being kept at home, issues with safely accessing school, and inadequate school WASH facilities.

5.2 Sector Overview

Overview of the Education Sector

Vanuatu's Education sector spans Early Childhood Care and Education (ECCE) through to post-secondary education and training, and plays a central role in human development, livelihoods, and long-term national prosperity. It is also a major employer, representing the largest government service sector in the country [107].

Educational attendance is not compulsory, reflecting the geographic dispersion and remoteness of many communities. This contributes to uneven access, with children in rural and isolated areas disproportionately affected. However, recent initiatives, including the School Grant Scheme, have supported increased participation, particularly for students attending schools outside their immediate communities [107].

Vanuatu's population is young and growing, placing increasing pressure on education infrastructure, teaching capacity, and learning resources. While significant reconstruction efforts followed Tropical Cyclone Pam, when more than half of schools were damaged or destroyed affecting over 34,500 children, continued investment is required to meet demand and improve resilience [21] [107].

5.2.1 Access, Participation and Equity

Enrolment levels vary across the education system. As of 2023, 83.8% of primary school-aged children were enrolled in primary education, compared to 53.4% in ECCE and 50.7% in secondary education [108]. Dropout rates increase during the junior secondary years (ages 12–15).

Barriers to access include:

- School fees, particularly for low-income households
- Distance and transport costs, especially in remote areas
- Household labour demands (domestic and agricultural)
- Limited parental support for education
- Inclusion challenges for children with disabilities

Gender disparities are evident, particularly at lower levels of education, where boys may be prioritised when household resources are constrained. However, girls tend to have higher retention rates in secondary education.

School exclusion also has important child protection implications. Children who are out of school for extended periods are more exposed to risks such as family violence, harmful labour, and early or forced marriage. These risks are often heightened in post-disaster contexts and in remote communities where access to services is limited.

5.2.2 Education Infrastructure and Systems

The education system relies on a network of school facilities, transport infrastructure, teaching staff, and learning materials. Infrastructure includes classrooms, WASH facilities, dormitories, administrative buildings, and teacher accommodation.

Many schools are located in coastal or low-lying areas or in remote inland locations, increasing exposure to climate hazards and limiting access during extreme events. Schools often depend on shared water systems with surrounding communities, and supply chains for learning materials can be disrupted following disasters.

Schools also serve as evacuation centres during hazard events. While this supports community response, it can delay the resumption of education services and place additional strain on infrastructure.

5.2.3 Role of Education in Social Protection and Development

Education provides a structured and protective environment for children and contributes to long-term economic and social resilience. It supports improved health outcomes, livelihood opportunities, and adaptive capacity.

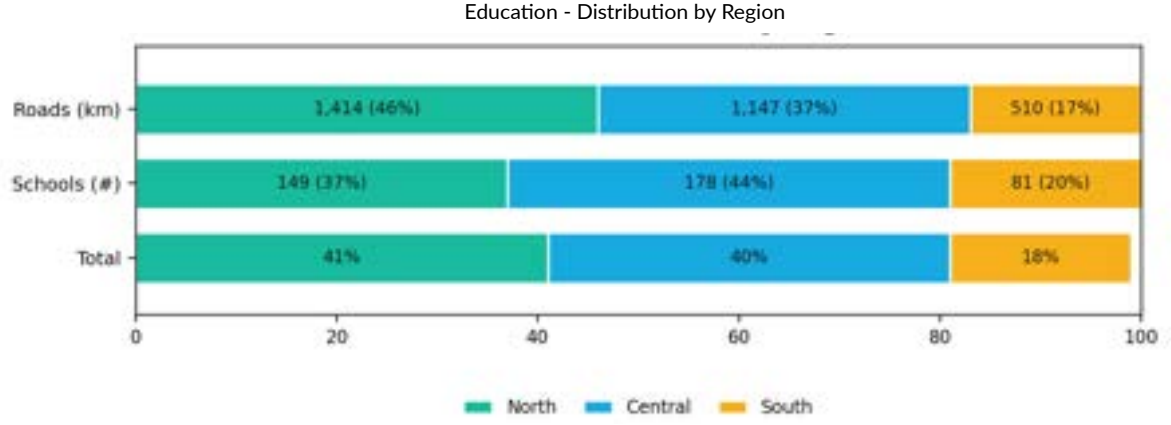
Disruptions to education can have cascading impacts. Reduced access to schooling can affect learning outcomes, increase dropout rates, and limit future employment opportunities. Over time, this can reduce household and national capacity to respond to climate risks, reinforcing cycles of vulnerability.

5.2.4 National Distribution of Education Assets

Education facilities and associated road networks are distributed across Vanuatu's North, Central, and South regions (Figure 16). The Central region contains the largest proportion of schools (44%), followed by the North (37%) and South (20%). Road infrastructure is most concentrated in the North (46%), followed by the Central (37%) and South (17%) regions.

This distribution influences exposure to climate hazards, particularly where infrastructure is concentrated in coastal or hazard-prone areas.

Figure 16. Distribution of education elements considered in quantitative analysis across the North, Central and South regions of Vanuatu.



5.2.5 Hazard Data Availability and Suitability

The assessment of climate risks to the Education sector draws on multiple hazard datasets and qualitative sources with varying levels of detail and coverage. A summary of the key hazard datasets and their suitability for adaptation planning is provided in Appendix C (Tables A-06 and A-07).

Overall, most hazard datasets are assessed as having medium suitability. This is primarily due to aggregation at the regional scale (North, Central, South) and the use of long-term averages, which limit the spatial granularity of the assessment. In particular, projections for drought, precipitation, and air temperature are averaged over 20-year periods, reducing their ability to capture local variability and short-term extremes.

Additional limitations include the absence of climate change projections for fluvial and pluvial flooding, and the reliance on historical cyclone track data for tropical cyclone analysis, with limited quantitative modelling of future risk.

To address these constraints, the assessment integrates high-quality qualitative evidence from sector consultations, national policies, post-disaster needs assessments, and recent studies. These sources provide critical insights into infrastructure damage, access constraints, recovery challenges, and the role of schools as community shelters during hazard events.

5.3 Vulnerability of the Education Sector

5.3.1 Sensitivity of Education Systems

Education systems are highly sensitive to climate hazards due to their dependence on physical infrastructure, access routes, and supporting services.

Many school buildings are not designed to withstand extreme weather conditions. For example, temporary learning facilities used after disasters are often vulnerable to rainfall, overheating, and overcrowding. A teacher in Port Vila described how, during rain events, tents used for schooling become “cold and muddy,” requiring classes to be suspended and materials to be relocated, sometimes disrupting education for extended periods.

Schools in coastal and low-lying areas are particularly exposed to flooding and sea-level rise. Access routes, including roads and footpaths, are also vulnerable, and schools with limited or single access routes are especially at risk of becoming isolated during hazard events.

Dependence on shared water resources further increases sensitivity, particularly during drought conditions, when water availability may be prioritised for household use over school operations.

5.3.2 Social Vulnerability and Equity

Climate-related disruptions to education disproportionately affect vulnerable groups, including girls, children with disabilities, and students in rural and remote communities.

During periods of disruption, children may be required to contribute more to domestic or agricultural work. Girls are more likely to bear increased domestic responsibilities, which can reduce attendance and increase dropout rates. Inadequate WASH facilities can further discourage attendance, particularly for adolescent girls.

Children with disabilities face additional barriers related to accessibility, appropriate learning environments, and inclusion in teaching methods. These challenges are often exacerbated during and after climate-related events.

Food insecurity associated with climate hazards can also affect learning outcomes, as children experiencing hunger or undernutrition may struggle to concentrate and engage in school.

5.3.3 Adaptive Capacity

Adaptive capacity within the education sector is constrained by infrastructure limitations, resource availability, and institutional capacity.

Many schools lack adequate ventilation or cooling systems, making them vulnerable to rising temperatures. Access to reliable water supply remains a challenge, particularly during droughts, and schools often depend on shared or limited resources.

Recovery following disasters can be slow due to logistical challenges, including reliance on ferries to transport materials and limited availability of skilled labour. For example, following Tropical Cyclone Lola in 2023, delays in safety assessments prevented some schools from reopening.

The sector is also dependent on external funding for reconstruction and recovery, which can delay the restoration of services.

5.4 Climate Risk Assessment

Climate hazards affect the Education sector through both direct impacts on infrastructure and indirect impacts on access, learning conditions, and wellbeing. The table below summarises the key vulnerabilities, consequences, and geographic patterns associated with each hazard.

Table 10. Summary of Climate Hazard Assessment for the Education Sector

Climate Hazard	Key Vulnerabilities	Key Consequences	Key Locations / Evidence
Air Temperature Increase	Poorly ventilated classrooms; lack of cooling systems; sensitivity of children to heat stress	Reduced concentration and learning outcomes; schedule disruption; increased absenteeism; potential school closures; reduced cognitive performance	Widespread across Vanuatu; impacts particularly pronounced in afternoon periods
Drought	Dependence on shared or limited water supply; inadequate school WASH facilities; competition with community water use	Reduced school hours or closures; increased time spent collecting water; reduced attendance; increased exposure to labour and protection risks; impacts on nutrition and learning	Community evidence highlights water access challenges (e.g. Mataloi: students walking long distances for water)
Extreme Rainfall	Temporary or poorly constructed facilities; inadequate drainage and shelter	Disruption to classes; unsafe and uncomfortable learning environments; repeated school closures during heavy rain events	Workshop evidence (Port Vila): schooling in tents disrupted for up to a week during storms
Coastal Flooding & Sea-Level Rise	Coastal location of schools; exposure of access routes; reliance on single access points; vulnerability of WASH and infrastructure	Damage to school infrastructure; permanent inundation and relocation; reduced access; overcrowding and sub-standard facilities; increased travel distance for students	High exposure in South Malekula, South-East Malekula, Erakor, North Efate, North-East Malekula; additional exposure under 0.5m–1.5m SLR scenarios
Fluvial & Pluvial Flooding	Schools located in flood-prone areas; limited drainage; reliance on transport and supply chains; use of schools as shelters	Damage and contamination of buildings; delayed reopening; overcrowding; disruption to learning; increased health and protection risks	Approx. 62 of 408 schools (15%) exposed under 1% AEP; highest exposure in Tanna (up to 46%), Port Vila (~30%), Malekula (~26%), South Santo (~33%)
Tropical Cyclones	Weak or non-resilient infrastructure; remote access; reliance on external support for recovery; competing recovery priorities	Widespread infrastructure damage; prolonged closures; loss of materials; reduced teacher availability; increased costs; delayed recovery	TC Pam: >50% of schools damaged, ~34,500 children affected; TC Lola (Ambrym): delays in school reopening due to lack of assessments

5.5 Cross-Cutting Risks and System Implications for Education

The hazard-specific impacts outlined above interact across systems, creating cascading and compounding risks that are not fully captured within individual hazard assessments.

Education disruption in Vanuatu is driven not only by direct damage to school infrastructure, but by failures in interconnected systems. Disruptions to transport infrastructure can prevent students, teachers, and materials from reaching schools, while impacts on WASH systems can force schools to reduce operating hours or close entirely. In many cases, schools are also used as evacuation centres, delaying the resumption of education even where infrastructure remains intact.

Climate hazards also contribute to repeated and prolonged interruptions to learning. When schools close or operate under reduced capacity, students fall behind academically and are at increased risk of dropping out. These disruptions affect not only immediate learning outcomes but also long-term human capital development and future adaptive capacity.

Social impacts are significant and often disproportionately affect vulnerable groups. During disruptions, children may be required to undertake domestic or agricultural labour, with girls more likely to experience increased household responsibilities. Reduced school attendance increases exposure to child protection risks, including violence, exploitation, and early marriage, particularly in post-disaster contexts.

Health and wellbeing impact further compound these risks. Flooding, poor WASH conditions, and overcrowded temporary learning environments increase the risk of disease transmission. At the same time, mental and emotional stress associated with repeated hazard events and displacement can impair cognitive development, behaviour, and learning outcomes. Teachers are also affected, with impacts on their ability to attend and deliver education effectively.

Climate impacts on livelihoods, particularly in agriculture and fisheries, can reduce household income and food security. This can lead to reduced ability to pay school fees, increased reliance on child labour, and declining school attendance.

Overall, these dynamics highlight that risks to the Education sector are systemic and interdependent, requiring integrated responses that go beyond infrastructure to address access, social protection, and service continuity.

5.5.1 Risk Scores and Spatial Patterns of Exposure

Risk scores were developed to identify areas with the highest relative proportion of education assets (schools and associated road infrastructure) exposed to flooding hazards. Scores are normalised, where a value of 100 represents the highest relative exposure across Area Councils, and all other values are scaled accordingly.

For coastal flooding and sea-level rise, results indicate that exposure is concentrated in a number of coastal areas, particularly:

- South Malekula and South-East Malekula, which consistently rank highest across scenarios
- Erakor and North Efate, which show increasing exposure under higher sea-level rise scenarios
- North-East Malekula and North Tanna, which remain among the most exposed under current conditions

Exposure patterns shift with increasing sea-level rise. From 1.0m SLR onwards, South-East Malekula becomes the highest-ranked area, while North Efate rises in relative importance. Some areas, such as North-East Malekula, show variation in ranking across scenarios, reflecting differences in the relative distribution of exposed assets.

For fluvial and pluvial flooding, exposure is concentrated in:

- West Tanna, which has the highest exposure under a 1% AEP event
- Port Vila, which becomes the highest-ranked location under 2% and 10% AEP scenarios
- Whitesands and Central Malekula, which consistently rank among the highest exposed areas

Flood exposure analysis indicates that:

- Approximately 15% of schools (62 of 408) are exposed under a 1% AEP event
- Exposure remains significant across 2% and 10% AEP scenarios

- Tanna shows the highest concentration of exposed schools, with up to 46% of schools affected under extreme events

Detailed rankings of the top ten Area Councils for each hazard scenario are provided in Tables 11 and 12 respectively.

Table 11. The Normalised Risk Scores for the Education sector associated with coastal flooding and sea-level rise at 0.0m, 0.5m, 1.0m and 1.5m. The scores were calculated using the schools layer and roading layer to determine which administrative boundary areas have the most elements at risk from coastal flooding. The scores were then normalised and ranked. The ten highest-ranked locations are presented here. Red arrows indicate a new entry or increased ranking position. Yellow arrows indicate a decreased ranking position.

0.0 m SLR	0.5 m SLR	1.0 m SLR	1.5 m SLR
South Malekula (100)	South Malekula (100)	South-East Malekula (100)	South-East Malekula (100)
Erakor (96.7)	Erakor (87.7)	South Malekula (64.7)	South Malekula (87.2)
North-East Malekula (90.5)	Nguna (81)	North Efate (60.2)	North Efate (68.2)
North Tanna (89.8)	North-East Malekula (79.4)	Erakor (51.8)	North-East Malekula (66.2)
South-East Malekula (71.5)	South-East Malekula (79.4)	Mele (51.3)	Central Malekula (57.4)
North Efate (56.3)	North Tanna (77.7)	Nguna (48.3)	Mele (50.1)
Malorua (53.4)	North Efate (56.5)	North-East Malekula (47)	Erakor (48.4)
Mele (50.4)	Malorua (53.2)	Central Malekula (46.1)	Nguna (46.1)
Nguna (46.6)	Mele (47.7)	North Tanna (45)	North Tanna (42)
East Santo (44.7)	East Santo (38.8)	Malorua (35)	Malorua (36.8)

Table 12. Risk Scores for the Education sector and fluvial and pluvial flooding. The scores were calculated using the school and roads layers to determine which administrative boundary areas had the highest proportion of elements at risk from fluvial and pluvial flooding, relative to others. The scores were then normalised and ranked. The ten highest ranked locations are presented here. Red arrows indicate a new entry or increased ranking position. Yellow arrows indicate a decreased ranking position.

1% AEP	2% AEP	10% AEP
West Tanna (100)	Port Vila (100)	Port Vila (100)
Whitesands (78.1)	Central Malekula (82.3)	Whitesands (95.9)
Port Vila (76.6)	West Tanna (80.9)	West Tanna (95.1)
Luganville (66.4)	Whitesands (79.9)	Central Malekula (81)
Central Malekula (63)	South-East Malekula (66.8)	South-East Malekula (77.9)
South-East Malekula (50.5)	Luganville (66.7)	North-West Malekula (64.4)
Middle Bush Tanna (48.2)	North-West Malekula (56.7)	Middle Bush Tanna (57.3)
North-West Malekula (43.4)	Middle Bush Tanna (47.9)	Luganville (53.7)
South-West Tanna (36.7)	North-East Malekula (45.8)	Mele (35.7)
North-East Malekula (34.7)	South-West Tanna (39.1)	South-West Tanna (35.5)

5.6 Compounding, Cascading Risk and Interdependencies

Physical damage to education infrastructure is likely to compound across multiple climate hazards, including tropical cyclones, coastal flooding, and fluvial and pluvial flooding, leaving reduced time for communities and schools to recover between events (see Figure 18). This can increase the likelihood that schools remain closed or are only partially repaired, particularly where limited resources are prioritised for other critical infrastructure such as WASH, health facilities, and transport networks.

Compounding climate hazards may also increase the likelihood that children are kept home to assist with household recovery efforts or domestic labour, reducing school attendance. In the event of a disaster, consultation participants noted that schools are often used as emergency shelters, which can further delay the resumption of normal learning activities. These challenges highlight the need for improved coordination within and across sectors, including stronger leadership from the Ministry of Education.

Figure 17. Illustration of the interdependencies between Education and other sectors that create cascading and compounding risks

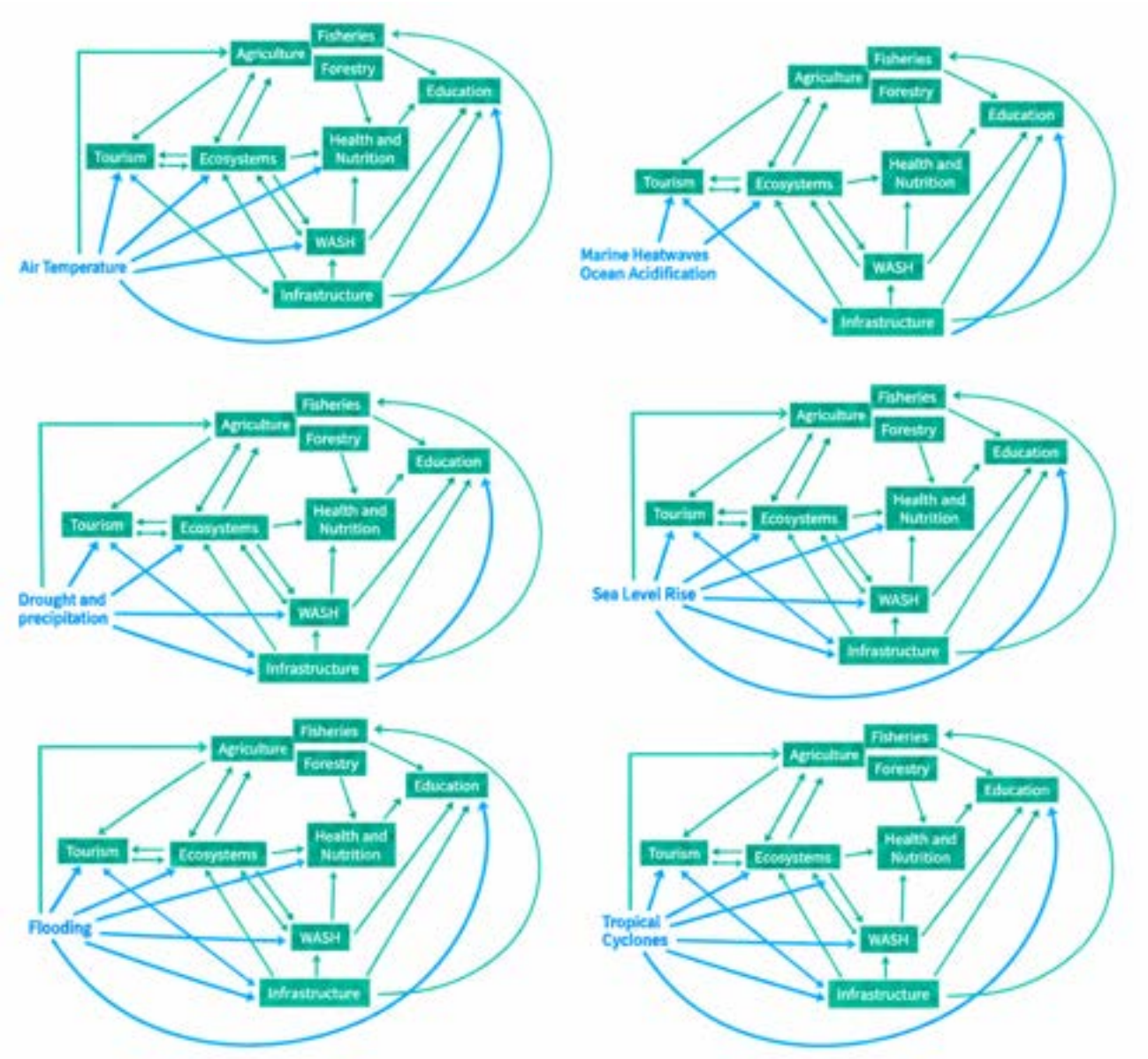


Figure 17 illustrates how climate hazards create cascading impacts across interconnected sectors, amplifying risks to education beyond direct physical damage. While hazards directly affect school infrastructure, their impacts are transmitted through critical supporting systems. Damage to transport infrastructure can limit access for students and teachers, as well as delay the delivery of materials needed for repairs and the replacement of learning resources. At the same time, disruptions to WASH infrastructure can significantly affect student attendance, health, and wellbeing. In some cases, children may be required to collect water, further reducing time available for education. Poor sanitation, limited access to clean water, and inadequate hygiene facilities can also contribute to the spread of disease, dehydration, and reduced safety and privacy within school environments.

Impacts on health and nutrition further compound these challenges, undermining the ability of students and teachers to attend school and participate effectively in learning. More broadly, climate-related shocks to livelihoods in the agriculture, forestry, fisheries, and tourism sectors can reduce household income and food security. As a result, families may prioritise immediate survival needs, leading to reduced school attendance or complete withdrawal from education. As described by one adolescent:

"As a family we ran short of food within a month of the cyclone. When we ate, we ate sparingly… Sometimes I'd go to bed hungry. My parents could not afford my school fees" [112].

Climate-related disruptions to education systems also interact with child protection, social welfare, and justice systems. When school-based safeguards are interrupted, gaps in social protection and case management services can leave vulnerable children without adequate support. Strengthened coordination between education, health, child protection, and gender-based violence services are therefore essential to ensure an integrated, child- and youth-sensitive response to climate risks.

Overall, these interdependencies demonstrate that risks to education are systemic rather than isolated. Climate hazards do not only damage school infrastructure but also disrupt the broader systems that enable education to function. Effective adaptation planning must therefore take a cross-sectoral approach, addressing both direct and indirect drivers of disruption to ensure continuity of learning and safeguard long-term educational outcomes.

5.7 Summary and Considerations

Reliable and safe access to high-quality education is essential for the wellbeing and long-term prosperity of Vanuatu's population. Climate-related hazards—including tropical cyclones, flooding, sea-level rise, drought, and increasing temperatures—can significantly disrupt access to schooling and compromise learning environments. These disruptions extend beyond immediate impacts, affecting student health, attendance, and educational attainment, with the potential to translate into long-term socioeconomic consequences, including reduced employment opportunities and increased vulnerability.

As highlighted in Figure 18, risks to education are not isolated but arise through cascading impacts across interconnected systems. Damage to school infrastructure, disruptions to transport networks, and failures in WASH services can collectively limit access to safe and functional learning environments. At the same time, climate impacts on health, nutrition, and household livelihoods further constrain students' ability to attend and participate in education. These dynamics underscore the systemic nature of education risk in Vanuatu.

Several key considerations emerge from this assessment:

Critical infrastructure resilience. Continuity of education depends not only on the condition of school facilities but also on supporting infrastructure, particularly transport and WASH systems. Damage to roads, footpaths, and boats can restrict access to schools and delay recovery, while compromised WASH services can render schools unsafe or unusable. Strengthening the resilience of these interconnected systems is essential to maintaining access to education during and after climate events.

Vulnerable populations and equity. Climate impacts on education are not evenly distributed. Girls, adolescents, children with disabilities, and students in rural and remote areas are more likely to experience disruptions to attendance, reduced safety in accessing schools, and inadequate learning conditions. Adaptation responses must be explicitly equity-focused, integrating child protection, safeguarding, and inclusive design into school infrastructure, emergency preparedness, and recovery planning.

Interconnected and cross-sectoral risks. Education outcomes are closely linked to other sectors, including Health and Nutrition, WASH, and Transport, as well as livelihood sectors such as Agriculture, Fisheries, Forestry, and Tourism. Climate shocks affecting these sectors can reduce household income and food security, increasing the likelihood that children are withdrawn from school. Education may also be deprioritised during response and recovery phases, as attention shifts to immediate survival needs. Adaptation planning must therefore adopt a coordinated, cross-sectoral approach that recognises and addresses these interdependencies.

Overall, strengthening the resilience of the education sector requires moving beyond a focus on school infrastructure alone, towards integrated approaches that ensure continuity of learning, protect vulnerable groups, and address the broader systems that enable education to function effectively in a changing climate.



CHAPTER

06

Fisheries Sector

6.1 Key Findings for Fisheries

Climate hazards are driving ecosystem degradation and fisheries decline. Ocean acidification, marine heatwaves, and sea level rise are expected to degrade fisheries through the loss of critical habitats, including mangroves, seagrass, and coral reefs. These changes affect species survival, reproduction, and growth, including impacts on shell and coral formation due to reduced carbonate availability, as well as broader ecosystem structure and function.

Changes in access and species distribution will affect fisheries availability. Rising sea levels and coastal flooding may reduce access to nearshore fishing areas, while increasing water temperatures, changes in food availability, and sedimentation from extreme rainfall events are likely to alter fish migration patterns. These combined pressures may reduce the availability of key fisheries resources.

Livelihoods, food security, and fishing practices will be directly affected. Reduced access to nearshore fisheries and reef species will affect a vital source of protein and income for fishing dependent communities. Fishers may need to increase fishing effort, travel further, identify new fishing grounds, or shift to alternative food sources. Competition for declining resources is likely to increase, with a risk of overfishing and further depletion of nearshore fisheries.

A compounding cycle of ecosystem and economic decline is likely. As fishing practices intensify in response to declining stocks, additional pressure is placed on already degraded ecosystems. This creates a reinforcing cycle in which reduced productivity leads to increased effort, further ecosystem degradation, and continued declines in fisheries. These impacts are expected to cascade through coastal food security, household economies, and cultural practices.

Fisheries are strongly interconnected with other sectors. Impacts on fisheries extend to tourism, agriculture, health and nutrition, and education, and are influenced by infrastructure such as wharves and roads that enable access to fishing areas. Degradation of coral reefs can affect tourism, while reduced access to marine protein may increase reliance on agriculture. Increased effort required for fishing may also affect household dynamics, including reduced time available for education.

Adaptive capacity exists but is under pressure. Communities are already adapting through livelihood diversification and changes in fishing practices. However, these responses may increase pressure on less exploited areas and are constrained by limited resources, capacity, and governance challenges.

Emerging pressures may further increase uncertainty. Potential deep-sea mining and labour migration may affect ecosystem health, fishing capacity, and the long-term resilience of the sector, adding to existing climate and environmental pressures.

6.2 Overview of the Fisheries Sector

As a small island developing state, Vanuatu's fisheries are critical for food security, nutrition, livelihoods, export revenue, and cultural practices. Fish account for approximately 16% of total protein intake, with average consumption of 38.8 g per person per day [79] [113]. More than 70% of Ni-Vanuatu adults have direct access to marine resources, primarily through coastal and inshore fisheries [79].

The sector contributes an estimated 1.5% of GDP, although this varies due to data limitations [79] [114]. Fisheries participation is widespread, with approximately 72% of rural households engaged in subsistence or commercial fishing, compared to 11% of urban households [79] [25] [115]. Coastal subsistence fisheries provide the highest value of fish harvest nationally, supporting both food security and local economies.

The Vanuatu Fisheries Department leads governance, policy, and management, while customary systems (kastom) play a central role in regulating access, seasonal use, and conservation at the community level. Management measures include tabu areas, seasonal restrictions, and species-specific regulations for key resources such as sea cucumbers, turtles, and tuna [105].

Fisheries are diverse and can be grouped into eight categories: coastal commercial, coastal subsistence, offshore foreign based, offshore domestic, freshwater and estuarine, aquaculture, recreational, and export aquarium fisheries [115].

- Coastal fisheries (commercial and subsistence) dominate livelihoods, supplying domestic markets, tourism, and exports. Key species include reef fish, pelagic species (tuna, mahi mahi), and invertebrates (sea cucumbers, trochus).
- Subsistence fisheries remain central to food systems and are strongly governed by kastom, supporting approximately 15,500 households with an estimated value of VT520–635 million annually [115].
- Offshore fisheries are dominated by foreign fleets targeting tuna, with 18,000 tonnes allowable catch but ~9,000 tonnes harvested annually. Economic linkages to the domestic economy remain limited despite licence revenues (~USD 1.38 million/year) [116] [117].
- Freshwater fisheries provide localised subsistence value, particularly in rural areas.
- Aquaculture is emerging as a strategic area for food security and reef restoration, though still small-scale.
- Recreational fishing contributes to tourism (e.g. ~13,000 charter tourists in 2012), while aquarium fisheries remain under-documented.

6.3 Current Threats and Challenges for the Fisheries Sector

The fisheries sector depends on healthy and productive marine and freshwater ecosystems; however, several existing pressures are already affecting these systems, as outlined below.

Overfishing: Overfishing is increasing, particularly in urban areas, with fishing pressure on key reef species rising by about 480% since 1950 [105]. More efficient fishing methods are increasing catch rates, contributing to stock depletion, with some species already requiring management interventions.

Ecosystem Change and Degradation: Declining ecosystem health, driven by sedimentation, pollution and disturbance events, is affecting fisheries productivity, especially in nearshore areas. Limited monitoring constrains understanding, but continued degradation could reduce ecosystem productivity and threaten food security.

Increasing Abundance of Pest Species: Outbreaks of crown of thorns starfish (Acanthaster planci) are damaging coral reefs and reducing habitat quality in areas such as Efate and Santo. These events also affect fishing practices and can compound impacts following disturbances such as Cyclone Pam.

6.4 Hazard Data Availability and Suitability

The fisheries CRVA integrates multiple hazard datasets of varying resolution and reliability. Overall, most hazards, including marine heatwaves, ocean acidification and sea level rise, are assessed as having medium suitability due to coarse spatial resolution and the need for aggregation. Tropical cyclone data is comparatively less robust for quantitative analysis, as it relies primarily on historical track data rather than forward projections.

Given these limitations, qualitative inputs play an important role in strengthening the assessment. Workshop discussions and sector specific studies provide critical insights into water quality and sedimentation impacts, ciguatera poisoning risks, socio economic and cultural impacts, and observed ecosystem changes that are not well captured in available datasets.

A summary of hazard data availability and suitability, along with key qualitative sources for the fisheries sector, is provided in Appendix C, Tables A-08 and A-09.

Fisheries Elements and Spatial Distribution

Fisheries elements include environments that sustain fish populations, such as seagrass, mangroves and coral reef systems, as well as beach landing sites and tracked fishing activity areas. These elements have been analysed across the North, Central and South regions to align with the resolution of climate models and enable comparison of impacts across the country.

As shown in Figure 18, approximately half of the weeklong tracked commercial fishing activity occurs in the South region of the exclusive economic zone, accounting for about 47 percent of total activity. While based on a short sampling period, this indicates the relative importance of offshore fishing grounds in the South for commercial operations.

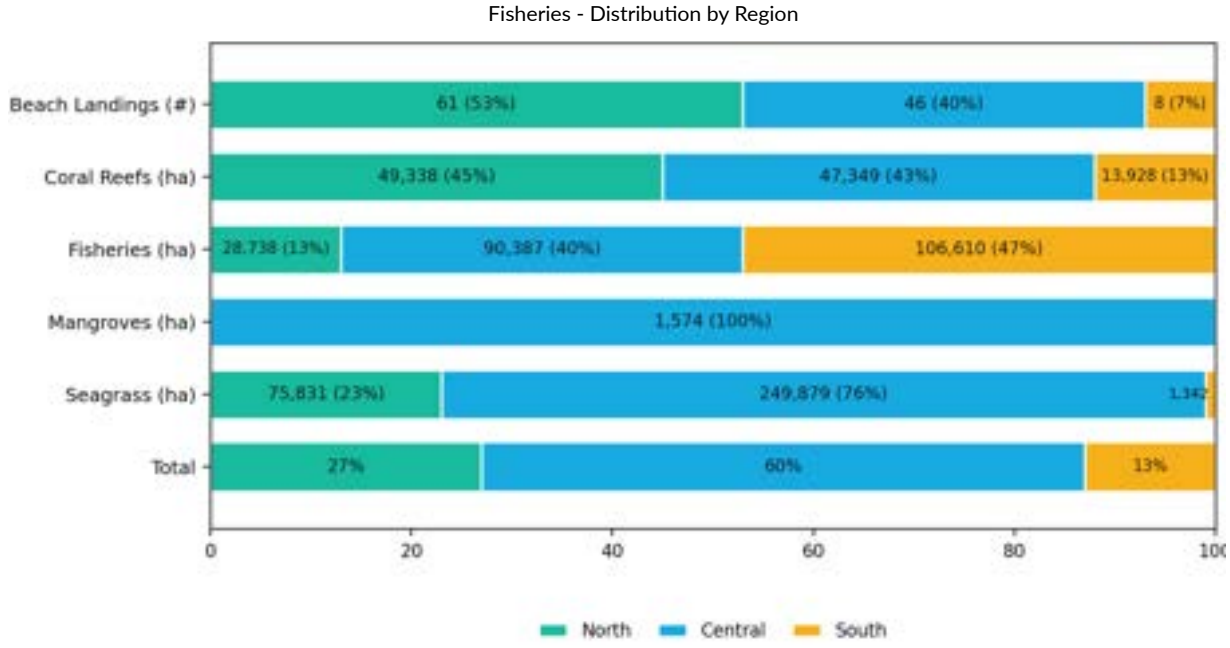
In contrast, beach landing sites and coral reef systems are more concentrated in the North and Central regions. The North records the highest number of landing sites, with 61 locations, followed by 46 in the Central region. Coral reef

coverage is similarly distributed, with approximately 49,000 ha in the North and 47,000 ha in the Central region.

Seagrass ecosystems are predominantly located in the Central region, covering approximately 249,000 ha, compared to about 75,000 ha in the North and a much smaller extent in the South, at around 1,300 ha. Mangroves are only identified in the Central region, with an estimated extent of approximately 1,500 ha.

Overall, the distribution highlights a spatial distinction between nearshore ecosystem assets and landing infrastructure, which are concentrated in the North and Central regions, and commercial fishing activity, which is more prominent in the South (Figure 19).

Figure 18. Distribution of fisheries elements considered in quantitative analysis across the North, Central, and South regions of Vanuatu.



6.5 Climate Risk Assessment for the Fisheries Sector

The fisheries sector is exposed to multiple climate hazards that interact with ecological and socio-economic systems to influence fisheries productivity and access to resources. These hazards affect species composition, habitat integrity, and fishing practices, with implications for livelihoods and food security. A summary of key hazards, associated vulnerabilities, consequences, and supporting evidence is provided in Table 13.

Table 13. Climate Hazard Assessment for the Fisheries Sector

Climate Hazard	Exposure / Location	Key Vulnerabilities	Key Consequences	Evidence / Statistics
Marine Heatwaves	Coastal and offshore waters within the EEZ; reef, lagoon and pelagic systems	Thermal stress on reef, estuarine and shallow water species. Limited knowledge of temperature tolerance of key inshore species. Tuna such as skipjack (Katsuwonus pelamis), yellowfin (Thunnus albacares), and bigeye (Thunnus obesus) are vulnerable to overheating, particularly at larval and juvenile stages. Degradation of coral reefs and seagrass habitats that support breeding and shelter.	Shifts in species composition and migration of fish stocks. Reduced access to coastal fisheries or need to travel further offshore. Eastward and higher latitude shifts in tuna distribution. Increased incidence of ciguatera poisoning affecting food safety and fisheries livelihoods.	Sustained commercial tuna catches occur below approximately 30°C SSTs (skipjack 20–29°C; yellowfin 20–30°C). Tuna migration outside the EEZ likely as temperature ranges shift. Warmer waters linked to increased ciguatera risk from Gambierdiscus species.
Ocean Acidification	Reef and nearshore ecosystems; coral reef dependent fishing grounds	Reduced calcium carbonate availability affecting coral reefs and shelled organisms. Loss of reef structural complexity reduces fish diversity and abundance. Decline in shellfish survival and juvenile recruitment.	Declining fisheries productivity and lower catch rates. Increased competition among fishers and greater effort required. Shift to alternative fishing grounds or target species.	Strong linkage between reef condition, habitat complexity and fish diversity. Declines in shellfish survival and recruitment expected under lower pH conditions.
Coastal Flooding and Sea-Level Rise	Low lying coastal areas, lagoons, beaches, wharves, mangrove and seagrass systems	Damage to beach landing sites and wharf infrastructure. Coastal squeeze leading to loss of mangroves (Rhizophora spp.) and seagrass habitats. Reduced nursery habitat for juvenile fish.	Restricted access to fishing areas. Declining fish stocks due to habitat loss. Increased fishing effort and intensified competition among fishers.	Mangroves and seagrass act as both fishing grounds and critical nursery habitats for juvenile fish.
Tropical Cyclones	Nationwide, with strongest impacts in exposed coastal and island communities	Damage to fisheries infrastructure, including wharves and landing sites. Physical damage to coral reefs, seagrass and mangroves.	Temporary or prolonged loss of access to fishing areas. Reduced fisheries productivity and livelihood disruption.	Cyclones consistently identified as causing damage to both infrastructure and critical fish habitats.

6.6 Cross-Cutting Risks and Implications for the Fisheries Sector

The impacts of climate change on fisheries extend beyond individual hazards and interact with existing environmental and human pressures. Fisheries in Vanuatu are highly dependent on the health of coral reefs, seagrass, and mangroves, which are increasingly affected by marine heatwaves, ocean acidification, cyclones, and sea-level rise. These pressures are compounded by non-climatic stressors such as sedimentation, pollution, and overfishing, particularly in coastal and urban areas. As ecosystem condition declines, fish stocks, habitat quality, and species diversity are reduced, creating a reinforcing cycle where increased fishing pressure further accelerates resource depletion.

Food security and nutrition are especially sensitive to these changes. Fish remains a primary source of protein for many Ni-Vanuatu households, particularly in rural and coastal communities. Declining fish availability, combined with population growth, is likely to reduce access to affordable

and nutritious food, increasing reliance on imported or less healthy alternatives. At the same time, climate-related risks such as ciguatera poisoning are expected to increase with warming waters and reef degradation, affecting both food safety and public health outcomes.

Livelihoods and local economies are also exposed. A significant proportion of households rely on fisheries for income and subsistence, and reductions in catch are likely to intensify competition for marine resources and reduce household earnings. Community consultations indicate that fishers are already adapting through livelihood diversification and by travelling further or identifying new fishing areas. While this demonstrates adaptive capacity, it may shift pressure to previously less-exploited areas and create longer-term sustainability challenges, particularly where governance and monitoring are limited.

Cultural practices and broader development pressures further shape sector vulnerability. Fisheries are closely linked to kastom-based management systems and traditional knowledge, which may be disrupted as species availability and fishing practices change, leading to potential loss of knowledge over time. At the same time, poor waste management, sanitation issues, and land-based runoff continue to degrade coastal water quality and fish habitats. Emerging risks, including potential deep-sea mining and labour migration through seasonal employment schemes, may further influence ecosystem health, fishing capacity, and long-term resilience of the sector.

6.7 Compounding, Cascading Risks and Interdependencies

Climate change impacts on fisheries are not experienced in isolation but occur through a series of cascading effects that begin with environmental change and extend through ecological, social, and economic systems. Marine heatwaves, ocean acidification, sea level rise, and tropical cyclones are expected to alter marine ecosystems by degrading coral reefs, seagrass beds, and mangroves, which are critical habitats for many fish species. As these ecosystems decline, fish stocks are reduced and species composition changes, leading to lower catch rates and increasing pressure on remaining resources. Fishers are already responding by travelling further or shifting fishing practices, which can increase costs, reduce efficiency, and place additional pressure on previously less exploited areas.

These ecological changes have direct consequences for food security, livelihoods, and community wellbeing. Coastal populations, including approximately 270,000 people living near the shoreline and around 15,500 households engaged in subsistence fishing, depend heavily on fisheries for protein and income [79]. Projected declines in fish catch of between 11 and 73 percent by 2050 are likely to intensify competition for marine resources and contribute to reduced dietary quality, lower household incomes, and increased vulnerability among rural communities [79]. As fish availability declines, there is also a risk of increased reliance on less nutritious food sources and unsustainable harvesting practices, including pressure on vulnerable or protected species.

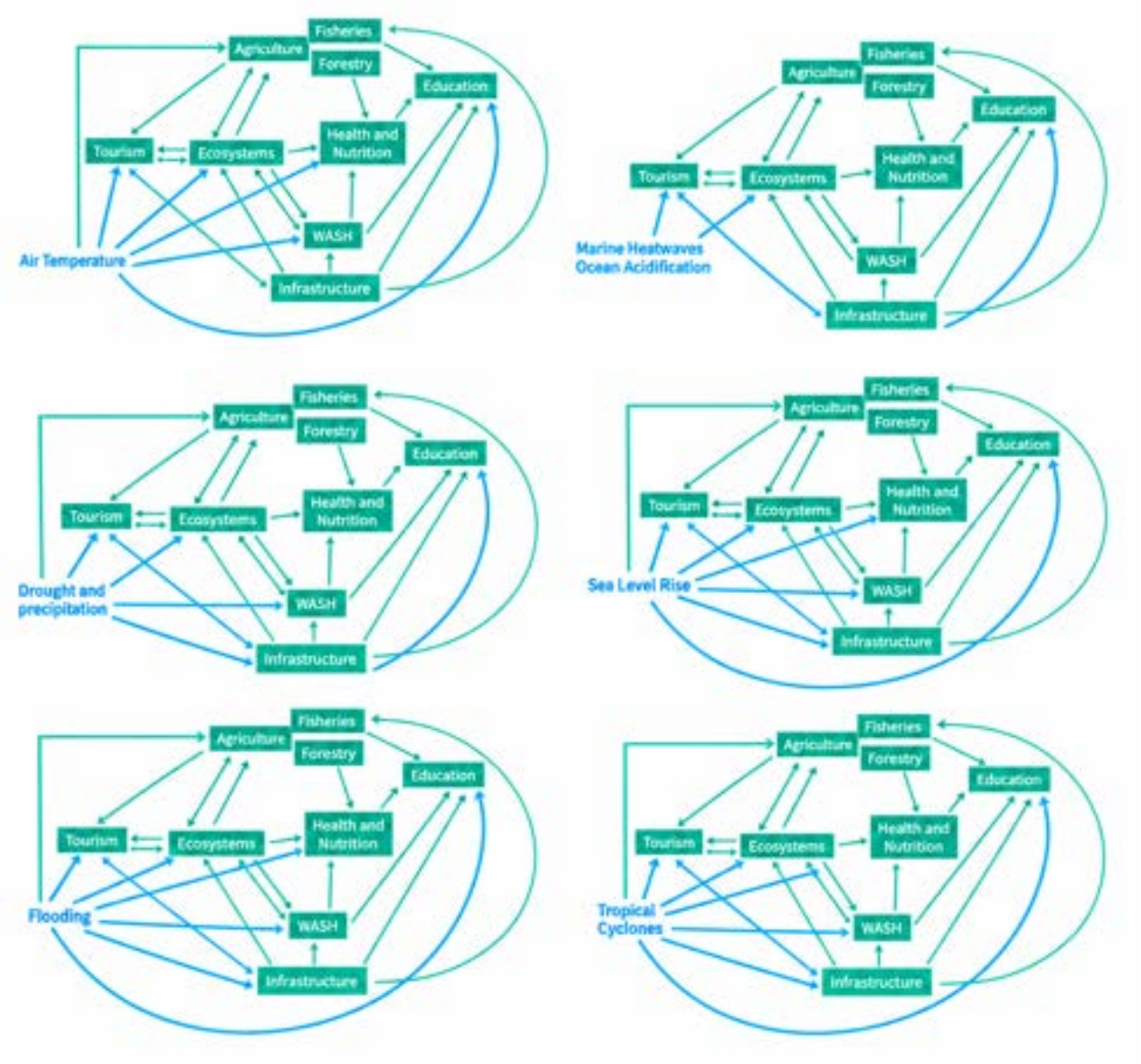
Over time, these responses can reinforce a cycle of increasing vulnerability. Reduced fish stocks lead to intensified fishing effort, which further degrades already stressed ecosystems and accelerates declines in productivity. At the same time, broader pressures such as population growth, land-based pollution, and limited management capacity contribute to declining ecosystem health. Environmental factors such as sediment runoff, poor sanitation, and waste accumulation continue to affect coastal water quality, further undermining fisheries and increasing risks to human health. These interacting pressures create a compounding cycle in which ecological decline, economic stress, and social impacts reinforce one another.

6.7.1 Interdependencies Across Sectors

The cascading risks described above are closely linked to interdependencies between fisheries and other sectors. Changes in ecosystems directly affect fisheries productivity, which in turn influences food security, nutrition, and household income. Increased fishing pressure can further degrade ecosystems, creating feedback loops that extend beyond the fisheries sector. At the same time, land based activities in agriculture and forestry contribute to sedimentation and water quality decline, which affect coastal habitats that support fisheries. Damage to infrastructure from cyclones and sea level rise can limit access to fishing areas, particularly for commercial operators, while impacts on fisheries can reduce income from tourism and related services.

Figure 19 illustrates these interconnections, showing how climate hazards interact with ecosystems and multiple sectors to create cascading and compounding risks across the system.

Figure 19. Illustration of the interdependencies between ecosystems and other sectors that create cascading and compounding risks



6.8 Summary and Considerations

Vanuatu's fisheries play a critical role in national food security and coastal livelihoods, with 61 percent of households regularly engaging in fishing activities [118]. Marine resources provide a significantly higher share of animal protein for people in Vanuatu compared to the global average, making subsistence fisheries essential for nutrition security, particularly among coastal communities [118]. The sector includes both reef fisheries, which are often over exploited near urban areas but under utilised in outer islands, and offshore fisheries supported by a fleet of several hundred vessels. The main threats to the sector arise from ocean warming, ocean acidification, and extreme weather events, which directly affect marine ecosystems and fish populations.

The fisheries sector is highly dependent on the condition of natural marine systems. Sustaining fisheries productivity will require managing both climate related impacts and human pressures on key ecosystems, including coral reefs, seagrass beds, and mangroves. Impacts on fisheries will directly affect the food security and livelihoods of the 72 percent of rural households engaged in subsistence or commercial fishing.

As marine productivity declines, pressure on existing fish stocks is likely to increase, leading to greater competition for resources, shifts toward harvesting different species, and expansion into previously less exploited areas. These responses may provide short term coping strategies but are likely to increase pressure on already stressed ecosystems. Over time, this can contribute to a cycle of declining ecosystem health, reduced fish availability, and increasing vulnerability for communities that depend on fisheries for food, income, and cultural practices.



CHAPTER

07

Forestry Sector

7.1 Key Findings for Forestry

Climate hazards are driving forest degradation. Tropical cyclones, rising temperatures, and changing rainfall patterns are expected to degrade forest ecosystems through wind damage, storm surge, and drought stress, increasing vulnerability of key species and reducing forest productivity.

Flooding and sea level rise create concentrated spatial risks. Central Malekula ranks highest for fluvial and pluvial flooding, followed by South-East Malekula and Port Vila. South and South-East Malekula are most at risk from coastal flooding and sea level rise across all scenarios.

Forest loss reduces ecosystem services and increases erosion. Loss of forest cover, particularly coastal trees, contributes to soil erosion, landslides, and reduced regeneration capacity, while degrading water regulation and increasing downstream vulnerability.

Cascading impacts affect land, water, and coastal systems. Forest degradation increases sediment transport into waterways and coastal areas, affecting water quality and marine ecosystems and reducing overall system resilience.

Livelihoods and cultural practices are at risk. Declines in timber and non-timber forest products affect income, food security, and access to materials, while loss of key species impacts cultural practices such as traditional canoe construction.

Disturbance increases long-term degradation risks. Disturbed forests are more vulnerable to invasive species, limiting regeneration and reducing natural protection against future climate hazards.

7.2 Overview of the Forestry Sector

Vanuatu's forestry sector is characterised by significant data gaps despite strong dependence on forest resources for daily life, with up to 90% of Ni-Vanuatu relying on wood and wood products [24] [120]. Forests occupy an estimated 36% of total land area, with plantation forests covering approximately 2,900 ha or 0.24% of land area [180]. Key tree species include Sandalwood (Santalum austrocaledonicum), Whitewood (Endospermum medullosum), Elm or Laurel (Cordia alliodora), and Beach almond or natapoa (Terminalia catappa), with only Cordia alliodora classified as exotic [87].

The sector includes both commercial timber operations and extensive use of non-timber forest products. Wood remains the main source of fuel, while nuts, seeds, construction materials, and medicinal products contribute to local economies [120]. Approximately 25% of agricultural households are involved in forestry. Firewood collection is the primary use for 88% of natural forest households, while timber production dominates planted forest use for 58% of households [85]. Forest resources also support cultural practices such as traditional canoe building, which remains important for transport and inshore fisheries.

Commercial logging peaked in the 1960s, with largely uncontrolled harvesting leading to resource depletion [120]. Current sustainable yields are estimated at 52,000 m^3 per year, although harvesting has declined due to limited supply [120]. The sector now operates under constraints related to resource availability, infrastructure, and access to markets, particularly in remote areas.

A major limitation for the sector is the absence of up-to-date data, with the national forestry inventory last completed in 1991 to 1992. Although workshop participants indicated that a more recent inventory exists, it was not available for this assessment. This lack of current baseline data constrains understanding of forest condition, species distribution, and ecosystem health, limiting the ability to assess vulnerability and plan effective adaptation measures.

Findings for the forestry sector are therefore indicative and based on available data, literature, and expert inputs. Significant uncertainty remains due to the absence of a recent national forest inventory and limited spatial and species-level data.

7.3 Hazard Data Availability and Suitability

The assessment of climate risks to the forestry sector integrates multiple hazard datasets with varying levels of spatial resolution, temporal coverage, and reliability. Overall, most hazards, including drought, precipitation, air temperature, and sea level rise, are assessed as having medium suitability for adaptation planning.

Drought projections are based on the Standardised Precipitation Index and consider frequency, duration, and intensity across different severity levels. Precipitation and air temperature projections are derived relative to historical baseline periods and analysed under multiple climate scenarios, while sea level rise and coastal flooding are assessed using scenario-based modelling at defined increments.

However, these datasets are aggregated across North, Central, and South regions and averaged over long time periods, which limits the ability to capture local variability and site-specific conditions. This constrains detailed interpretation at finer spatial scales and reduces confidence in hazard-specific assessments, particularly where interactions between hazards and forest systems are complex.

Fluvial and pluvial flooding datasets are available only for present-day conditions in selected locations and do not incorporate future climate change projections. Tropical cyclone data is largely qualitative, based on projected changes in intensity and frequency, with limited quantitative modelling beyond historical track analysis.

Given these constraints, qualitative sources play a critical role in strengthening the assessment. Available literature and expert inputs provide insight into species vulnerability, ecosystem responses, and socio-economic impacts that are not fully captured in quantitative datasets. However, it should be noted that workshop-based inputs for the forestry sector were limited due to the cancellation of the first sector workshop, further contributing to gaps in locally validated information.

In addition to hazard data limitations, forestry exposure and vulnerability assessments rely on proxy indicators, including logging concessions and road networks, to represent the spatial distribution of forestry assets. These proxies provide an indication of exposure but do not fully capture the extent of forest resources, non-timber forest products, or community dependence on forest ecosystems.

A summary of the key hazard datasets and their suitability for adaptation planning is provided in Appendix C (Tables A-10 and A-11).

7.3.1 National Distribution of Forestry Assets and Infrastructure

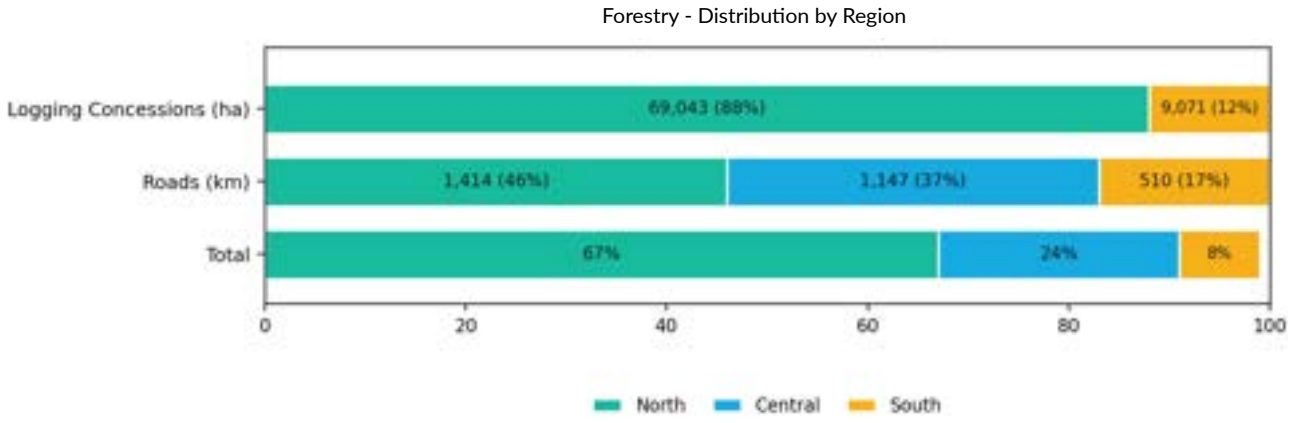
Forestry assets and infrastructure have been spatially divided into the North, Central, and South regions to align with the aggregated format of the climate data used in the analysis. The two key components considered are logging concessions and road networks, which are used as indicators of forestry activity and access across the country.

As shown in Figure 20, the distribution of forestry assets and infrastructure is uneven across regions. The North region holds approximately 88% of national logging concessions, covering about 69,000 ha, while no logging concessions are identified in the South. This indicates a strong concentration of commercial forestry activity in the North.

Road infrastructure is more broadly distributed, with the North accounting for 46%, the Central region 37%, and the South 17% of total road length. Overall, the combined distribution of forestry assets and infrastructure shows that 67% are located in the North, 24% in the Central region, and 8% in the South.

This spatial pattern highlights that forestry exposure to climate hazards is concentrated in the North, while access and connectivity vary across regions. It also suggests that risks to forestry operations, ecosystem services, and livelihoods may differ significantly depending on location.

Figure 20. Distribution of forestry elements considered in quantitative analysis across the North, Central and South regions of Vanuatu.



7.4 Climate Risk Assessment for the Forestry Sector

7.4.1 Supporting Data and Spatial Risk Patterns

The patterns summarised in Table 14 Forestry Sector Climate Risk Summary by Hazard are supported by detailed species-level thresholds and spatial risk analysis presented in the tables below. These supporting data provide additional context on how different hazards affect forest systems and where impacts are likely to be most pronounced.

Detailed species-level thresholds and hazard-specific vulnerability characteristics are presented in Table 15 (temperature thresholds), Table 16 (drought and precipitation thresholds), and Table 19 (cyclone vulnerability). These tables highlight that key forestry species have relatively narrow tolerance ranges, indicating that even moderate changes in temperature and rainfall may significantly affect forest composition and productivity.

Spatial risk patterns for flooding-related hazards are presented in Table 17 and Table 18, which provide relative risk scores across administrative areas based on the distribution of forestry assets and infrastructure. These patterns show that risk is not evenly distributed and is concentrated in specific locations where exposure and access infrastructure overlap.

Table 17 presents the relative risk scores for coastal flooding and sea level rise across four sea level rise scenarios. Results indicate that South-East Malekula consistently ranks as the highest-risk area, followed by South Malekula, with increasing risk observed in Central Malekula, Port Vila, and North Efate under higher sea level rise conditions. This suggests that coastal forestry systems in these areas may face increasing pressure from saltwater intrusion and loss of productive land.

Table 18 presents the relative risk scores for fluvial and pluvial flooding under 1%, 2%, and 10% AEP scenarios. Central Malekula consistently ranks as the highest-risk area across all scenarios, followed by South-East Malekula and Port Vila, with additional areas such as Luganville and North-West Malekula showing notable levels of risk. This indicates that flood-related impacts on forestry are closely linked to the distribution of infrastructure and low-lying areas, with implications for access and operational continuity.

These risk scores are normalised and represent relative exposure rather than absolute risk, reflecting the distribution of logging concessions and road infrastructure used as proxy indicators for forestry sector exposure. As such, they should be interpreted as indicators of priority areas for further investigation and planning rather than precise measures of impact.

Table 14. Forestry Sector Climate Risk Summary by Hazard

Climate Hazard	Vulnerability	Consequences
Air Temperature	Tree species have optimal temperature ranges beyond which heat stress occurs. Sandalwood, Whitewood, and Beach Almond show varying thresholds, with tropical species generally having low adaptive capacity. Prolonged temperature increases increase susceptibility to pests and disease and reduce growth rates.	Slower growth rates and changes in forest composition are expected. More sensitive species may be outcompeted, leading to reduced distribution of valuable species. In some areas, transitions from tropical forest to scrub or grassland may occur, reducing ecosystem productivity and resource availability.
Drought and Precipitation	Drought tolerance varies across species. Whitewood and Beach Almond have low tolerance to prolonged dry periods, while Sandalwood has limited tolerance. Scrub and grassland species on the leeward side are more drought-adapted (Table 16). Tropical forest species are particularly vulnerable to prolonged water stress.	Increased drought frequency and variability in rainfall may reduce forest productivity and alter species composition. Prolonged drought may result in transitions from forest to scrub or grassland. Loss of forest cover reduces ecosystem services such as shade and water regulation, which are highly valued by communities.
Coastal Flooding and Sea Level Rise	Forestry species vary in tolerance to salinisation and coastal inundation. Coastal species such as Beach Almond are vulnerable to saltwater intrusion and storm surge. Vulnerability assessment is constrained by limited species-level data and relies on proxy indicators such as logging concessions and roads.	Coastal flooding and sea level rise may reduce the area available for forestry and affect productivity through saltwater intrusion. Risk scores indicate that South-East Malekula ranks highest across all scenarios (100), followed by South Malekula (60.1 to 78.5). Central Malekula, Port Vila, and North Efate show increasing risk under higher sea level rise scenarios (Table 17). Loss of forestry resources affects community livelihoods, including small-scale production such as honey, coconut oil, and crafts.
Fluvial and Pluvial Flooding	Vulnerability is uncertain due to lack of baseline data on species and flood tolerance. Exposure is inferred from the presence of logging concessions and road networks, many of which are located in low-lying areas.	Flooding may disrupt forestry operations, damage infrastructure, and limit access to forest areas. Risk scores indicate that Central Malekula consistently ranks highest (100) across 1%, 2%, and 10% AEP scenarios, followed by South-East Malekula and Port Vila. Other areas, including Luganville and North-West Malekula, also show notable risk (Table 18).
Tropical Cyclones	Cyclones affect forests through wind damage, flooding, and storm surge. Sandalwood shows tolerance to wind but vulnerability to storm surge. Beach Almond is vulnerable to both storm surge and higher wind categories. Whitewood is more resilient, although younger trees are vulnerable to wind damage (Table 19).	Cyclones can lead to loss of forest cover, reducing habitat availability and carbon storage. Soil becomes exposed to erosion, reducing regeneration capacity and long-term productivity. Loss of coastal forests reduces natural protection, increasing vulnerability of communities and infrastructure. Forests are also valued as windbreaks during cyclones, highlighting their protective function.

Table 15. Forestry Sector Species Vulnerability to Air Temperature Changes

Species	Temperature Thresholds (°C)			Primary Uses
	Optimal	Maximum	Minimum	
Sandalwood	23-27	29-33	16-22	Valued for the export market, overharvested.
Whitewood	22-28	29-32	15-24	Valued for the export market in Japan.
Beach Almond	23-28	25-32	17-24	Vital for coastal protection as roots stabilise soils, Timber, edible nuts and medicinal purposes.

Table 16. Forestry Sector Species Vulnerability to Drought and Precipitation Changes [87].

Species	Precipitation Thresholds (mm)	Drought Thresholds (months)	Primary Uses
Sandalwood	800-2500	2-5	Valued for the export market, overharvested.
Whitewood	1500-5600	0	Valued for the export market in Japan.
Beach Almond	1000-4500	0-6	Vital for coastal protection as roots stabilise soils, Timber, edible nuts and medicinal purposes.

Table 17. Forestry Sector Risk Scores for coastal flooding and sea-level rise

0.0 m SLR	0.5 m SLR	1.0 m SLR	1.5 m SLR
South-East Malekula (100)	South-East Malekula (100)	South-East Malekula (100)	South-East Malekula (100)
South Malekula (60.1)	South Malekula (78.5)	South Malekula (72.0)	South Malekula (70.5)
Port Vila (24.0)	Port Vila (34.3)	Central Malekula (49.6)	Central Malekula (65.7)
South-East Santo (21.2)	South-East Santo (30.7)	Port Vila (39.3)	North Efate (41.5)
North Efate (19.4)	Central Malekula (29.6)	South-East Santo (30.1)	Port Vila (40.1)
Central Malekula (17.0)	North Efate (23.1)	North Efate (27.1)	South-East Santo (34.0)
Aniwa (15.5)	Malorua (19.0)	Malorua (21.9)	Luganville (27.8)
Malorua (14.7)	Eratap (16.4)	Canal – Fanafo (21.0)	Malorua (24.8)
Eratap (13.7)	Canal – Fanafo (15.7)	Luganville (19.3)	Eton (24.2)
Erakor (12.8)	Luganville (14.1)	Eton (18.3)	Canal – Fanafo (23.5)

Table 18. Risk Scores for the Forestry Sector and Fluvial and Pluvial Flooding. The scores were calculated using a spatial layer of logging concessions and roads to determine which administrative boundary areas had the most elements at risk from fluvial and pluvial flooding at 1% AEP, 2% AEP and 10%AEP. The scores were then normalised and ranked. The top ten locations are presented here.

Normalised Risk Score		
1% AEP	2% AEP	10% AEP
Central Malekula (100)	Central Malekula (100)	Central Malekula (100)
South-East Malekula (54.7)	South-East Malekula (54.8)	South-East Malekula (53.8)
Port Vila (50.1)	Port Vila (49.2)	Port Vila (46.6)
West Tanna (38.6)	Luganville (35.6)	North-West Malekula (27.2)
Luganville (38.3)	North-West Malekula (27.7)	Luganville (26.4)
North-West Malekula (28.3)	West Tanna (23.9)	West Tanna (23.7)
South-East Santo (23.5)	South-East Santo (23.0)	South-East Santo (21.6)
Whitesands (20.9)	North-East Malekula (18.0)	North-East Malekula (17.4)
South-West Tanna (19.3)	Canal – Fanafo (17.3)	Whitesands (14.9)
North-East Malekula (18.3)	Whitesands (14.9)	Canal – Fanafo (14.8)

Table 19. Forestry Sector Species Vulnerability to Tropical Cyclones [87].

Species	Primary Uses	Cyclones
Sandalwood	Valued for the export market, overharvested	It can survive defoliation and salt burn from cyclonic winds but can be damaged and destroyed with related storm surges.
Whitewood	Valued for the export market in Japan,	Less susceptible to damage than introduced species, although young trees are vulnerable to high wind speeds, larger trees lose branches.
Beach Almond	Vital for coastal protection as roots stabilise soils, Timber, edible nuts and medicinal purposes	Vulnerable to storm surges and rising sea levels. Category 2 and above winds can cause breakage and uprooting.

7.5 Cross-Cutting Risks and Implications for the Forestry Sector

The impacts of climate change on forestry extend beyond individual hazards and interact with existing environmental, social, and economic pressures. Forest ecosystems in Vanuatu are already influenced by land use change, logging, and limited governance capacity, and climate hazards are expected to amplify these pressures.

Forest degradation reduces critical ecosystem services, including soil stability, water regulation, and carbon storage. Loss of forest cover increases soil erosion, which contributes to sediment transport into rivers and coastal systems. This creates direct linkages with other sectors, particularly agriculture and fisheries, where sedimentation can reduce soil productivity and degrade coral reef and estuarine habitats that support fisheries.

Livelihoods are highly dependent on forest resources, with up to 90% of the population relying on wood and non-timber forest products. Declines in forest productivity and access to resources may reduce household income and limit availability of materials for construction, fuel, and traditional practices. Cultural uses of forests, including canoe building and medicinal plant use, may also be affected by changes in species distribution and availability.

Climate impacts may also reinforce a cycle of increasing vulnerability. Reduced forest cover leads to soil degradation and lower productivity, which can drive further land use change, including expansion of agriculture into forest areas. This, in turn, increases pressure on remaining forest ecosystems and reduces their ability to recover from climate shocks.

Institutional and operational challenges further constrain adaptation. Limited infrastructure, difficult terrain, land tenure issues, and capacity constraints affect the implementation of forestry initiatives. While policies and community-based approaches exist, scaling up these efforts remains a challenge.

Overall, forestry risks are shaped by the interaction of climate hazards, environmental degradation, and socio-economic pressures. Addressing these risks will require integrated approaches that consider forest ecosystems as part of a broader system linking land, water, coastal environments, and livelihoods.

7.6 Compounding, Cascading Risks and Interdependencies

7.6.1 Compounding Climate Pressures on Forest Systems

The increased frequency and duration of drought, rising temperatures, and tropical cyclones are likely to interact and compound, degrading forest ecosystems and disrupting forest-dependent livelihoods. Drought-weakened forests become more vulnerable to cyclone damage, particularly in the North where logging activity is concentrated, accounting for approximately 69,000 ha or 88% of national concessions.

Soil Degradation and Water System Impacts

Drought and cyclone impacts can lead to canopy loss, exposing soils to erosion and reducing nutrient availability required for regeneration. As forest condition declines, water regulation services are also affected, with impacts extending to downstream catchments. These pressures intensify where catchments are directly exposed to climate hazards, creating cumulative stress on watershed systems. Degraded watersheds lose their ability to regulate water flow, increasing agricultural water stress and driving expansion into forest areas, further accelerating land conversion.

Coastal Forest Loss and Erosion Feedback

The loss of coastal trees contributes to increased coastal erosion under subsequent cyclone events and sea level rise. This creates a reinforcing cycle in which initial forest degradation increases exposure to future hazards. These impacts extend beyond forest areas, affecting adjacent agricultural land and coastal communities.

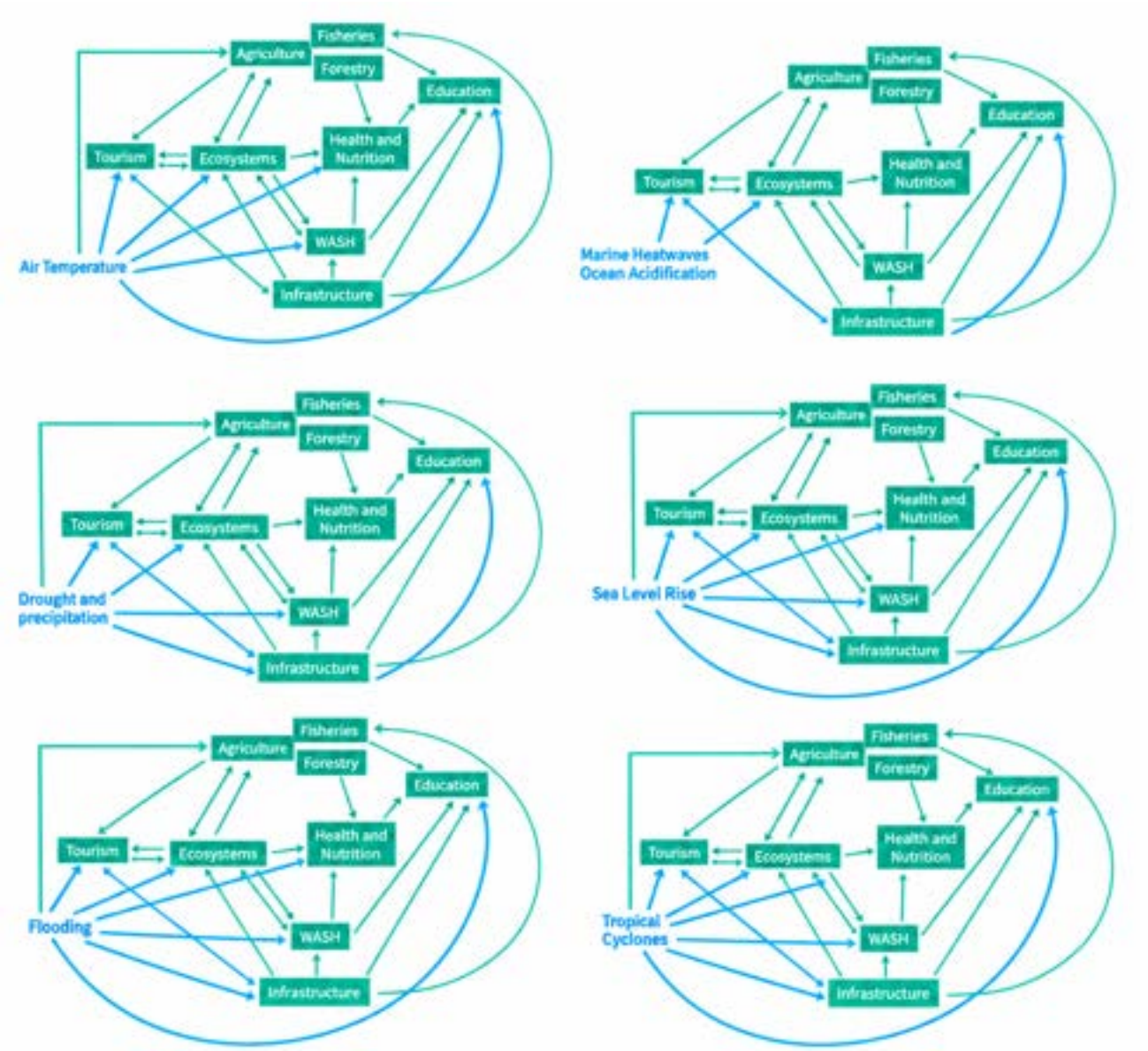
Invasive Species and Reduced Regeneration

Disturbed forests are also more susceptible to invasive species such as Merremia peltata, a fast-growing climber that can smother native vegetation following disturbance [120]. The spread of invasive species limits natural regeneration and alters forest composition, reducing long-term ecosystem resilience.

Cascading Degradation and Feedback Loops

These interacting processes create a cascading cycle in which climate stress weakens forest resilience, increasing vulnerability to extreme events, while post-disturbance

Figure 21. Illustration of the interdependencies between ecosystems and other sectors that create cascading and compounding risks.



conditions limit recovery. At the same time, declining forest condition contributes to water stress and land degradation, which in turn drive further pressure on remaining forest areas. This cycle reinforces both ecological degradation and livelihood vulnerability.

Livelihoods, Culture, and Food Security Implications

Impacts on the forestry sector extend directly to social and economic systems. With up to 90% of Ni-Vanuatu relying on forests for fuel, construction materials, food, and income, forest degradation has immediate implications for household wellbeing and food security. The decline of suitable coastal tree species also affects cultural practices, including traditional canoe building, which is linked to transport and inshore fisheries.

Infrastructure and Supply Chain Disruptions

Existing structural constraints further amplify these risks. The forestry sector already operates under challenging logistical conditions due to limited infrastructure and the remote location of forest resources [120]. Climate-related extreme events increase these challenges by damaging roads

and bridges, disrupting access to forest areas, processing facilities, and markets [121]. These disruptions affect both commercial timber supply chains and access to non-timber forest products that support rural livelihoods.

Institutional and Implementation Constraints

Institutional and operational constraints also influence the sector's ability to respond. Consultations highlighted that many forestry-related projects face delays due to land tenure disputes, staffing shortages, and difficult site access. While policies and technical solutions exist, capacity limitations and challenges in sustaining community engagement constrain implementation. However, where community-based approaches are effectively applied, positive outcomes have been observed.

7.6.2 Cross-Sector Environmental Linkages

Degradation of forest systems, driven by both climate hazards and human pressures such as agricultural expansion and harvesting, can lead to a loss of species diversity and changes in ecosystem structure and function. These changes increase susceptibility to erosion and landslides, allowing sediment to enter waterways and be transported to coastal and marine systems, where it may degrade habitats that support fisheries. A decline in forest diversity may also have flow-on implications for kastom, as well as human health and nutrition, as access to forest-based resources becomes more limited.

Interdependencies Across Sectors

The interconnected nature of these risks across sectors is illustrated in Figure 21, which shows how climate hazards interact with ecosystems and socio-economic systems to create cascading and compounding impacts across Vanuatu. Forestry both influences and is influenced by other sectors, particularly through its role in maintaining ecosystem services such as soil stability, water regulation, and coastal protection. Understanding these interdependencies is essential for designing integrated adaptation responses that strengthen resilience across the system.

7.7 Summary and Considerations

Vanuatu's forestry sector, covering approximately 36% of total land area and supporting up to 90% of the population through forest resources, faces increasing climate risks that directly affect ecosystem health and livelihoods. Climate hazards, including drought, rising temperatures, and tropical cyclones, are expected to reduce forest productivity, alter species composition, and increase vulnerability to degradation.

These impacts are compounded by significant data limitations, with no updated national forest inventory available since 1991 to 1992. This constrains the ability to assess current forest conditions, identify priority areas, and develop targeted and evidence-based adaptation strategies.

Climate risks interact with existing pressures, including land use change, agricultural expansion, and resource extraction, creating reinforcing cycles of forest degradation. As forest condition declines, critical ecosystem services such as soil stability, water regulation, and coastal protection are reduced, increasing vulnerability to erosion, water stress, and extreme weather events.

The impacts of forestry degradation extend beyond the sector itself. Reduced forest cover contributes to sedimentation in waterways and coastal systems, affecting agriculture and fisheries, while declining access to forest resources has direct implications for household livelihoods, food security, and cultural practices. Infrastructure damage and access constraints further limit the ability of communities and the private sector to utilise forest resources effectively.

Addressing these risks will require integrated approaches that consider the interconnections between forestry and other sectors, strengthen governance and institutional capacity, and improve data availability. Enhancing community-based management, supporting sustainable land use practices, and improving access to information will be critical for building resilience in the forestry sector and across the wider system.



CHAPTER

08

Health and Nutrition Sector

8.1 Key Findings for Health and Nutrition

Extended drought periods, increasing air temperatures, increased flood risk, sea-level rise, and potentially more intense tropical cyclones are expected to negatively affect health and nutrition through a range of direct and indirect pathways. Key impacts include increases in injuries, dehydration, heat-related illness, malnutrition, respiratory illness, mental health stress, violence, cultural wellbeing stress including potential loss of kastom, and the spread of water-borne, food-borne, and vector-borne diseases.

Extended drought periods of approximately 20–25 months may compromise water supplies, undermining WASH conditions that are essential for preventing diarrhoeal illnesses, typhoid, leptospirosis, respiratory infections, and skin infections. Drought conditions may also reduce agricultural productivity and crop yields, negatively affecting food security and nutrition, particularly in rural areas.

Temperature increases will result in heat-related illnesses, cardiovascular disease exacerbation and asthma, as well as degrade temperature-sensitive medicines and supplies, particularly in rural health centres with limited refrigeration.

Flooding, sea-level rise and tropical cyclones will damage health and WASH infrastructure, contaminate water supplies and crops, disrupt access to healthcare, lead to physical harm and increase stress levels.

The areas with the highest proportion of health-related assets (health facilities and roading) at risk from coastal flooding and sea-level rise are South Malekula, South-East Malekula, Central Malekula and Luganville. Notably, Norsup Hospital in Malampa Province, which services over 46,000 people, becomes potentially exposed under 1.5m of sea-level rise.

Of those areas with available location data, Central Malekula, North-West Malekula, Luganville and South-East Malekula have the highest proportion of health-related assets at risk from fluvial and pluvial flooding. Under a 1% AEP flood event, 10 of 129 health facilities are potentially exposed to fluvial and pluvial flooding (8% of all health facilities), which also includes Norsup Hospital in Malampa Province.

Children, adolescents, older people, women, people living with a disability, and those on low-incomes face compounded vulnerabilities through various means, including physiological factors, greater reliance on subsistence farming, experiences of stigma or discrimination, and increased gender-based violence risks when displaced or traveling further to access WASH facilities. Rural and remote communities also face additional challenges due difficulties accessing essential goods and services including healthcare and food markets.

8.2 Overview of the Health and Nutrition Sector

Health services in Vanuatu are delivered through a decentralised network of public, private, and NGO facilities distributed across the six provinces [122]. The health system includes five public hospitals, along with a range of health centres, dispensaries, and aid posts, supported by public health programmes focused on health promotion, disease control, and surveillance. While healthcare is not free for residents, subsidies are in place to improve affordability. The Vanuatu Health Sector Strategy outlines the country's ongoing efforts to achieve Universal Health Coverage [123].

Despite these efforts, funding constraints continue to limit the capacity of the health system to meet population needs, particularly in rural and remote areas [123]. Vanuatu has one of the lowest ratios of health workers to population in the Pacific [78 123 124]. Access to healthcare remains a significant challenge, with many people required to travel long distances, sometimes across islands, to access specialised services. In some areas, fewer than one in five people live within one hour's travel of a dispensary or health centre [123]. These access challenges are further compounded by natural hazards, which frequently disrupt transport networks and service delivery. Climate change is expected to exacerbate these existing inequities.

Malnutrition continues to be a major concern. Dietary patterns have shifted away from traditional foods due to a combination of socio-economic and climatic pressures, affecting both food availability and consumption [83 84]. In urban areas, increased reliance on imported and processed

foods has contributed to rising levels of overweight and obesity. As of 2016, 62% of women and 52.2% of men aged 18 and over were overweight, with obesity affecting 30% of women and 20% of men [126]. In contrast, rural populations often maintain more diverse diets but face higher levels of food insecurity due to their exposure to disruptions [84].

Undernutrition remains prevalent, particularly among children. As of 2022, 31.4% of children under five were affected by stunting [128]. Micronutrient deficiencies, especially iron and iodine deficiencies, are also widespread among women of reproductive age and young children [83]. These overlapping nutrition challenges reflect a dual burden of malnutrition across the population.

The Vanuatu Food Safety and Nutrition Policy (2022–2030), led by the Ministry of Health, recognises the influence of disasters and climate change on access to safe and nutritious food [83]. Climate-sensitive health risks, including diarrhoeal and vector-borne diseases, are expected to increase, with cascading effects on nutritional outcomes. Strengthening food security and building resilient food systems will therefore be critical to improving health and nutrition outcomes in the context of a changing climate.

Hazard Data Availability and Suitability

The assessment of climate risks to the Health and Nutrition sector draws on a combination of quantitative hazard datasets and qualitative evidence, each with varying levels of detail and suitability for adaptation planning.

A summary of the quantitative datasets is provided in Annex C Table A-10. Overall, most hazard datasets are assessed as having medium suitability, primarily due to limitations in spatial resolution, temporal averaging, and representation of future climate conditions. In particular, many datasets are aggregated across broad regional groupings (North, Central, and South) and averaged over 20-year periods, which constrains the ability to assess localised risks and variability.

Additional limitations include the absence of climate change projections in some datasets (e.g. fluvial and pluvial flooding), and the reliance on historical data for hazards such as tropical cyclones, where future risk is primarily described qualitatively.

A summary of the key hazard datasets and their suitability for adaptation planning is provided in Appendix C (Tables A-12 and A-13). These sources provide critical insights into observed impacts and system vulnerabilities that are not fully captured in quantitative models.

Evidence from stakeholder consultations and post-disaster assessments highlights recurring impacts on health service delivery, particularly in rural and remote areas where outreach systems are easily disrupted by extreme events. Reported impacts include increased incidence of climate-sensitive diseases, mental health challenges, and disruptions to food security.

Across sources, there is also consistent concern regarding nutrition outcomes, including persistent undernutrition and increasing reliance on imported, nutrient-poor foods. These challenges are further compounded by workforce constraints and coordination challenges within the health system.

Overall, while quantitative datasets provide a useful baseline for understanding hazard exposure, their limitations necessitate strong reliance on qualitative evidence to capture the full extent of risks to the Health and Nutrition sector.

8.2.1 National Distribution of Health Infrastructure and Access Networks

Figure 22. illustrates the spatial distribution of health related assets included in the quantitative analysis across the North, Central, and South regions of Vanuatu. Owing to the scale of the climate hazard modelling and the need to aggregate multiple datasets, assets are analysed at the regional level to ensure a consistent basis for comparison.

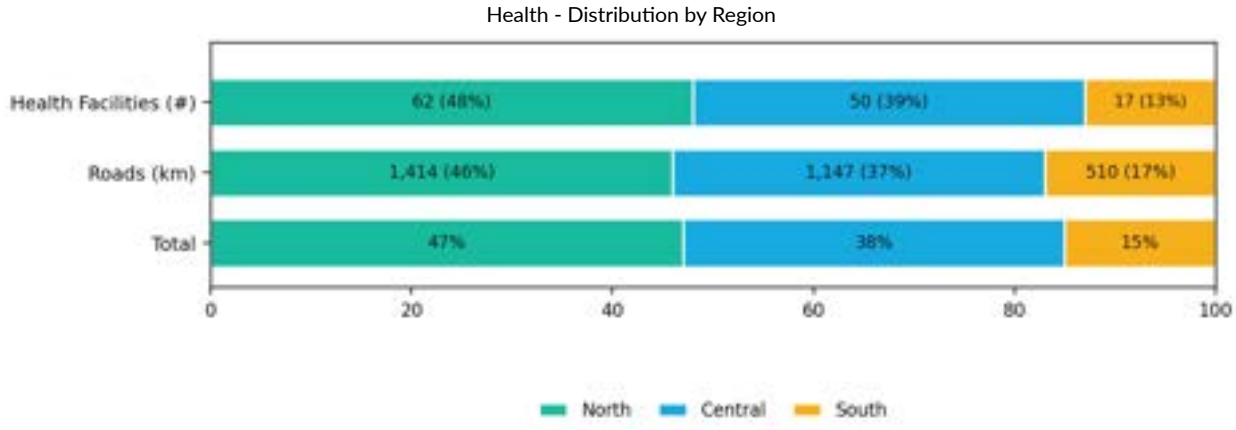
For the Health and Nutrition sector, the analysis covers key assets that underpin service delivery and access, namely health facilities, such as hospitals, health centres, dispensaries, and provincial offices, as well as the road network, which plays a critical role in enabling connectivity to these services.

Across both asset types, a broadly consistent spatial pattern is evident. The North region accounts for the largest proportion of health facilities (48%), followed by the Central region (39%), with the South region containing a comparatively smaller share (13%). A similar distribution is observed for the road network, with 46% located in the North, 37% in the Central region, and 17% in the South.

This concentration of health infrastructure and access networks in the North and Central regions, relative to the South, has important implications for understanding uneven exposure to climate hazards and potential access constraints during climate related disruptions.

Climate change poses a range of direct and indirect risks to the Health and Nutrition sector, often arising from the interaction of multiple hazards. Given this complexity, vulnerabilities and consequences associated with heat, drought, precipitation, flooding, tropical cyclones, and sea level rise are assessed in an integrated manner under the 'Vulnerabilities for All Hazards' and 'Consequences for All Hazards' sections of this chapter.

Figure 22. Distribution of health-related elements considered in quantitative analysis across the North, Central and South regions of Vanuatu.



8.3 Exposure to Climate Hazards

Climate hazards affecting the Health and Nutrition sector in Vanuatu vary in their spatial distribution, intensity, and level of certainty. While some hazards, such as air temperature, affect the country relatively uniformly, others, such as flooding and sea-level rise, present more localised risks, particularly for health infrastructure and access networks.

To provide a consolidated overview, Table 20 summarises the exposure characteristics of key climate hazards considered in this assessment.

Table 20. Summary of Climate Hazard Exposure Characteristics for the Health and Nutrition Sector

Hazard	Exposure Pattern	Key Characteristics	Confidence
Air Temperature	National (uniform)	Gradual warming across all regions; stronger under RCP8.5	High
Drought	National (variable)	Duration and frequency relatively stable; high uncertainty in projections	Low–Medium
Precipitation	National (uncertain)	Seasonal rainfall uncertain; extreme rainfall increasing	Medium
Coastal Flooding & SLR	Localised (coastal)	Increasing inundation, erosion, salinisation	High
Fluvial & Pluvial Flooding	Localised (catchments)	Linked to extreme rainfall; limited future projections	Medium
Tropical Cyclones	National (episodic)	Fewer but more intense events; high uncertainty	Low–Medium

The following sections provide further detail on hazard-specific exposure, with emphasis on implications for health infrastructure, access, and service delivery.

8.3.1 Air Temperature

Exposure

Projected changes in air temperature are available for two scenarios – RCP4.5 and RCP8.5 – and are aggregated for the North, Central and South regions. It is likely that all spatial regions will be affected relatively equally, with the main differences occurring between emissions scenarios rather than geographic variation.

Annual air temperature increases under RCP4.5 show steady progression from approximately 0.6°C above baseline in 2030–2050, rising to 0.9°C in 2051–2070, and reaching 1.2–1.5°C by 2071–2090.

RCP8.5 tracks similarly to RCP4.5 through mid-century, with increases of around 0.6°C in 2030–2050 and approximately 1.0°C in 2051–2070. After 2070, warming accelerates sharply, reaching median increases of 2.5–2.7°C by 2071–2090. Model uncertainty is higher under this scenario.

Overall, the whole country is likely to experience relatively uniform exposure to changes in median temperature. Projections for air temperature are explained in further detail in Chapter 1.

8.3.2 Drought and Precipitation

Exposure

Drought and average seasonal rainfall projections show high variability, largely because the position and behaviour of the South Pacific Convergence Zone (SPZ) an important driver of rainfall remains uncertain across climate models. Despite this uncertainty, several general trends can be identified.

The duration of drought events is projected to remain relatively consistent across all regions. Extreme droughts are expected to maintain median durations of approximately 20–25 months through to 2070, with a slight decrease below 20 months by 2090. However, some models project much longer durations (60–90 months) by 2090, representing low-probability but high-impact scenarios that could severely disrupt systems and operations.

Moderate drought conditions are also projected to remain relatively stable, with median durations of approximately 10–15 months through to 2070, followed by a slight decrease by 2090.

The frequency of both extreme and moderate drought events is expected to remain relatively constant at around 1.5 events per 20-year period until 2070. By 2090, a slight decrease in frequency (to approximately one event per 20 years) may occur; however, the variation across model outputs remains high, indicating significant uncertainty.

In terms of intensity, extreme droughts are projected to remain broadly comparable to present-day conditions, with a slight decrease in median intensity by 2090. Nonetheless, some models indicate the potential for considerably more intense drought events. Moderate droughts are expected to remain similar in intensity to current conditions.

Due to this uncertainty, there are no clear trends in average wet and dry seasonal rainfall across scenarios or timeframes. Median rainfall values for both seasons remain broadly consistent with present-day conditions across all regions. However, model uncertainty increases toward the end of the century, particularly for the wet season.

In contrast, extreme daily rainfall is projected to increase across all regions, scenarios, and timeframes relative to the 1970–2000 baseline (2040–2070 and 2070–2100). These increases are expected across North, Central, and South Vanuatu and all six provinces, with implications for flood risk and associated impacts.

Projections for drought and precipitation are explained in further detail in Chapter 1.

8.3.3 Coastal Flooding and Sea-Level Rise

Exposure

As sea-level rises, the frequency and extent of coastal flooding, tidal inundation, and coastal erosion are expected to increase. Impacts are likely to range from higher water levels during spring tides and storm surges reaching further inland, to permanent land loss. Changes in sea level may also lead to salinisation of groundwater systems, particularly in shallow and unconfined coastal aquifers, and increase the tidal influence in river systems.

Median sea-level rise projections for Vanuatu, modelled by CSIRO as part of the Van-KIRAP project, are presented in Table 21.

Table 21. Median sea-level rise projections (in metres) showing uncertainty bands of 5–95%. Values represent absolute change from the baseline of 1995

Year	RCP2.6	RCP4.5	RCP8.5
2030	0.13 [0.10–0.17]	0.13 [0.09–0.17]	0.14 [0.10–0.17]
2050	0.23 [0.17–0.30]	0.24 [0.18–0.31]	0.28 [0.22–0.37]
2070	0.32 [0.24–0.43]	0.37 [0.28–0.48]	0.48 [0.37–0.64]
2090	0.42 [0.30–0.56]	0.50 [0.38–0.68]	0.73 [0.56–0.99]

Table 21 shows that median sea-level rise increases progressively over time, with more rapid acceleration beyond mid-century. Sea-level rise is higher under RCP8.5 compared to lower emissions scenarios, while RCP4.5 demonstrates a steady and continuous increase throughout the century.

To better understand the implications of sea-level rise for health-related assets, a model provided by the DoCC was applied. This model assesses the extent and depth of coastal flooding associated with a 1% Annual Exceedance Probability (AEP) event (i.e. a 1-in-100-year event) across four sea-level rise increments: present day (0.0 m), 0.5 m, 1.0 m, and 1.5 m.

Under current-day conditions (0.0 m SLR), two out of Vanuatu's 129 health facilities are exposed to a 1% AEP coastal flood event (2% of all health facilities). This remains consistent under 0.5 m SLR, before increasing to four facilities (3%) under 1.0 m SLR and seven facilities (5%) under 1.5 m SLR.

The exposed facilities are:

- Current day (0.0 m SLR): A dispensary on Akhamb Island and a provincial office in Luganville
- 0.5 m SLR: As under 0.0 m SLR
- 1.0 m SLR: As under 0.0 m SLR, with the addition of a dispensary in Aulua (near Fartafu) and one on Uripiv Island
- 1.5 m SLR: As under 1.0 m SLR, with the addition of a dispensary in Vinmavis, Norsup Hospital in Malampa Province on Malekula (servicing over 46,000 people), and a health centre in Port Olry on Espiritu Santo

Overall, while the proportion of exposed facilities remains relatively low, exposure increases progressively with sea-level rise and begins to affect larger and more critical facilities, including those that serve significant populations.

8.4 Consequences – Risk Scores

Risk scores are used to identify areas with the highest relative concentration of health-related assets (including health facilities and road networks) exposed to coastal flooding and sea-level rise. These scores are indicative and comparative rather than absolute. The Area Council with the highest level of exposure is assigned a score of 100, and all other scores are expressed relative to that value.

It is important to note that a decrease in relative risk score does not necessarily indicate a reduction in absolute risk. Instead, it may reflect a greater increase in exposure in other areas under the same climate scenario. Changes in ranking positions, as indicated by arrows in Table 22, therefore represent relative shifts in risk between areas rather than absolute increases or decreases.

Results indicate that South Malekula, South-East Malekula and Central Malekula consistently have the highest proportion of health-related assets at risk from coastal flooding and sea-level rise. These areas dominate across scenarios, reflecting both the concentration of assets and their exposure to coastal processes.

Luganville also ranks consistently among the higher-risk areas across scenarios, although its relative ranking declines at higher sea-level rise increments as other areas, particularly Central Malekula, experience more rapid increases in exposure.

Under present-day conditions and at 1.0 m sea-level rise, South Malekula has the highest proportion of health-related elements at risk compared to other areas. At 1.5 m SLR, it becomes the area with the second-highest proportion of elements at risk, following Central Malekula, which shows a notable increase in exposure at each sea-level rise increment.

East Santo also experiences a marked increase in the proportion of health-related assets at risk under 1.5 m sea-level rise. In contrast, Port Vila and South-East Santo show a decline in relative ranking from 1.0 m SLR and above, reflecting comparatively smaller increases in exposure relative to other areas.

Detailed rankings and changes in relative position are presented in Table 22.

Table 22. Normalised Risk Scores for Coastal Flooding and Sea-Level Rise (0.0 m, 0.5 m, 1.0 m, 1.5 m)

0.0 m SLR	0.5 m SLR	1.0 m SLR	1.5 m SLR
South Malekula (100)	South Malekula (100)	South Malekula (100)	Central Malekula (100)
Luganville (75.2)	Luganville (72.3)	South-East Malekula (92.1)	South Malekula (48)
South-East Malekula (13.8)	South-East Malekula (22.5)	Central Malekula (83.4)	South-East Malekula (44.7)
Port Vila (7.4)	Port Vila (14.8)	Luganville (72.3)	Luganville (35.9)
South-East Santo (6.6)	South-East Santo (13.3)	Port Vila (20.7)	East Santo (28.6)
North Efate (6)	North Efate (10)	South-East Santo (16.3)	North Efate (11.8)
Aniwa (4.8)	Central Malekula (9)	North Efate (14.3)	Port Vila (11.4)
Malorua (4.6)	Malorua (8.2)	Malorua (11.5)	South-East Santo (9.6)
Eratap (4.3)	Eratap (7.1)	Canal – Fanafo (10)	Malorua (7.1)
Erakor (4)	Canal – Fanafo (6.5)	Eton (9.6)	Eton (6.9)

Note: Scores are relative and normalised, with the highest-risk Area Council assigned a value of 100. Red arrows indicate a new entry or increased ranking position, while yellow arrows indicate a decreased ranking position.

8.4.1 Fluvial and Pluvial Flooding

Exposure

Flood events are closely linked to extreme daily rainfall, which is projected to increase in intensity across Vanuatu, indicating that flood events are likely to become more severe.

Extreme daily rainfall is expected to increase relative to the 1970–2000 baseline for all time periods (2040–2070 and 2070–2100) and emissions scenarios (RCP4.5 and RCP8.5) across North, Central and South Vanuatu, as well as all six provinces (Table 23). These projected increases in extreme rainfall intensity are a key driver of fluvial and pluvial flooding risk, as more intense rainfall events increase the likelihood and severity of flood events.

Table 23. The multi-model mean for extreme daily rainfall with return periods of 10–100 years for Port Vila and Luganville as a percentage increase in baseline (1970–2000)

Location	RCP	2040–2070	2070–2100
Port Vila	4.5	+21%	+30%
	8.5	+40%	+70%
Luganville	4.5	+18%	+26%
	8.5	+27%	+57%

The Department of Climate Change (DoCC) has developed fluvial and pluvial flooding models for present-day conditions for Malekula, Tanna, and two catchments near Port Vila and Luganville for 10%, 2% and 1% Annual Exceedance Probability (AEP) events. Although these models do not include a climate change component, they provide useful insight into current flood exposure risks for health-related assets and infrastructure.

Further details regarding country-level projections for fluvial and pluvial flooding are outlined in Chapter 1.

Under a 1% AEP flood event, 10 of the 129 health facilities for which location data is available are exposed (8% of all health facilities). Exposure is highly concentrated on Malekula, where 7 out of 20 facilities (35%) are affected. On Tanna, 2 out of 11 facilities (18%) are exposed, while on Espiritu Santo, 1 out of 4 facilities (25%) is exposed. No facilities are exposed in the Port Vila area.

Under a 2% AEP event, 7 of the 129 health facilities are exposed (5%). Six of these are located on Malekula (30% of facilities on the island), with one exposed facility on Espiritu Santo (25%). No facilities are exposed in Port Vila or on Tanna under this scenario.

Under a 10% AEP event, 5 of the 129 health facilities are exposed (4%). Exposure remains concentrated on Malekula, with 4 facilities affected (approximately 20% of facilities on the island), and one exposed facility on Espiritu Santo (25%). No facilities are exposed in Port Vila or on Tanna.

The specific health facilities exposed under each scenario are summarised in Table 24.

Table 24. Health Facilities Exposed to Fluvial and Pluvial Flooding by AEP Scenario

Facility / Location	1% AEP	2% AEP	10% AEP
Norsup Hospital (Malampa, Malekula)	✓	–	–
Atchin Health Centre (Malekula)	✓	✓	–
Leviamp Dispensary (Malekula)	✓	✓	✓
Horrok Dispensary (Malekula)	✓	✓	✓
Vinmavis Dispensary (Malekula)	✓	✓	✓
Tisman Dispensary (Malekula)	✓	✓	–
Akhamb Dispensary	✓	✓	✓
Greenhill Health Centre (Tanna)	✓	–	–
Lamnatu Dispensary (Tanna)	✓	–	–
Luganville Office (Espiritu Santo)	✓	✓	✓

Overall, exposure to fluvial and pluvial flooding is highly localised, with a strong concentration on Malekula and limited exposure in urban centres such as Port Vila.

8.4.2 Consequences – Risk Scores

Results indicate that Central Malekula and North-West Malekula consistently have the highest proportion of health-related assets at risk from fluvial and pluvial flooding.

Risk scores are used to identify the relative concentration of health-related assets (including health facilities and road networks) exposed to flooding across administrative areas. These scores are comparative rather than absolute, with the highest-risk Area Council assigned a value of 100 and all other areas expressed relative to this.

As shown in Table 25, under a 1% AEP event, Central Malekula has the highest proportion of health-related elements at risk, followed by North-West Malekula. Under 2% and 10% AEP events, these areas switch ranking, with North-West Malekula becoming the highest-risk area.

Luganville consistently ranks third across all scenarios, indicating a sustained level of exposure relative to other areas.

South-East Malekula ranks among the higher-risk areas under 1% and 2% AEP events, but its relative ranking declines under the 10% AEP scenario as other areas, such as South Malekula and Port Vila experience greater relative increases in exposure.

Table 25. Normalised Risk Scores for Fluvial and Pluvial Flooding (1%, 2% and 10% AEP).

1% AEP	2% AEP	10% AEP
Central Malekula (100)	North-West Malekula (100)	North-West Malekula (100)
North-West Malekula (81.7)	Central Malekula (84.9)	Central Malekula (81.5)
Luganville (60.9)	Luganville (71.4)	Luganville (61.6)
South-East Malekula (52.2)	South-East Malekula (63.7)	South Malekula (49.1)
Middle Bush Tanna (43.8)	North-East Malekula (53.4)	Port Vila (40.3)
North-East Malekula (43.6)	South Malekula (50.3)	South-East Malekula (24.2)
South Malekula (41.3)	Port Vila (47.3)	West Tanna (20.5)
Port Vila (40.6)	West Tanna (23)	South-East Santo (18.6)
North Tanna (37.1)	South-East Santo (22.1)	North-East Malekula (14)
West Tanna (31.3)	Canal – Fanafo (16.6)	Whitesands (12.9)

Note: Scores are relative and normalised, with the highest-risk Area Council assigned a value of 100. Red arrows indicate a new entry or increased ranking position, while yellow arrows indicate a decreased ranking position.

Exposure

Tropical cyclones passing near Vanuatu are projected to be less frequent but more intense over time.

However, projections for cyclones are challenging due to natural variability, a lack of long-term observational data, and the limitations of some models in simulating cyclones. As a result, many future tropical cyclone projections are associated with low to medium confidence.

Tropical cyclones are more common during La Niña events (~13 per decade) compared with El Niño and neutral conditions (~9 per decade). Under a high emissions scenario (RCP8.5), the average number of cyclones passing

within 500 km of Vanuatu is projected to decrease by approximately 12% by the end of the century, while wind speed intensity and associated rainfall rates are projected to increase slightly.

The frequency of tropical cyclones is projected to decrease under La Niña conditions but increase during El Niño conditions [62].

Projections for tropical cyclones are explained in further detail in Chapter 1.

8.5 Vulnerabilities for All Hazards

Climate change poses a significant risk to Vanuatu's Health and Nutrition sector, with direct and indirect implications for physical and mental health, safe WASH, food security, healthcare service functioning, social cohesion, and cultural wellbeing. The risks are wide-ranging and complex, reflecting the interaction of multiple climate hazards and existing system vulnerabilities.

Exposure to climate change and climate-related hazards can directly affect physical, mental, social and cultural wellbeing, and indirectly affect the infrastructure, ecosystems and landscapes that support wellbeing and the continuation of kastom.

Vulnerabilities Relating to Health Infrastructure

Healthcare infrastructure in Vanuatu is highly vulnerable to damage and disruption from extreme events such as tropical cyclones, flooding, and sea-level rise, which can compromise service delivery. For example, during Cyclone Pam, 39 health facilities were damaged, including two hospitals, 15 health centres, and 22 dispensaries [21]. In addition, the 2024 Port Vila earthquake demonstrated how infrastructure failure can rapidly overwhelm the health system, with significant structural damage to Vila Central Hospital occurring alongside a surge in demand for emergency care.

Several health facilities are also exposed to flooding hazards. For example, Norsup Hospital in Malampa Province on Malekula, which serves over 46,000 people, is exposed to both coastal flooding under 1.5 m sea-level rise and fluvial and pluvial flooding under a 1% AEP event.

Climate hazards can compromise healthcare infrastructure and systems through:

- Physical damage to facilities, equipment, supplies, and waste management systems
- Damage to administrative buildings responsible for planning and coordination
- Loss of power, affecting service delivery, cold-chain storage, and sanitation
- Reduced water availability or contamination, affecting hygiene and service provision
- Reduced workforce capacity due to access constraints, illness, or increased demand

These vulnerabilities are compounded by existing workforce shortages, particularly in rural areas, and limited surge capacity within emergency response systems.

Vulnerabilities Relating to Accessing Healthcare Services

Access to healthcare services is highly dependent on functioning transport systems, which are vulnerable to disruption from climate hazards. Damage to roads, ports, and air transport infrastructure, or temporary inaccessibility due to flooding or extreme weather, can prevent or delay access to both emergency and routine healthcare services.

For example, approximately 185,000 people experienced disrupted access to essential healthcare services following Tropical Cyclones Judy and Kevin. Disruptions also affect the ability of healthcare providers to reach communities, particularly in rural and remote areas.

Transport disruptions can further compromise supply chains for essential medical goods, including medications, vaccines, and equipment. These vulnerabilities disproportionately affect rural populations, who already face structural barriers to accessing healthcare services.

Vulnerabilities Relating to Safe WASH

Safe water, sanitation, and hygiene (WASH) systems are highly vulnerable to climate variability and extreme events, which can affect water availability, quality, and infrastructure.

Key vulnerabilities include:

- Contamination of water sources during extreme weather events such as cyclones and floods
- Reduced water availability and higher pollutant concentrations during drought conditions
- Damage to WASH infrastructure, including water supply, sanitation, and hygiene facilities
- Saltwater intrusion into groundwater supplies in coastal areas due to sea-level rise
- Increased competition for limited water resources during droughts or contamination events

Vulnerabilities Relating to Food Security

Food security in Vanuatu is highly vulnerable to climate change due to strong reliance on subsistence agriculture and fisheries, both of which are climate sensitive.

Key vulnerabilities include:

- Impacts of changing temperature and rainfall patterns on agricultural production
- Disruption of traditional planting calendars and reduced crop reliability
- Loss of coastal ecosystems affecting fisheries and marine food sources
- Changes in ocean temperature and acidification affecting fish distribution and breeding
- Increased prevalence of invasive species under changing climate conditions
- Rising food prices due to reduced supply and disrupted production systems
- Increased reliance on imported foods and loss of traditional food systems

Extreme events further compound these vulnerabilities through:

- Damage to crops, livestock, and fisheries
- Disruption of food supply chains and processing systems
- Water scarcity affecting agricultural productivity
- Power outages affecting food storage and preservation

These pressures increase the risk of food insecurity and reduce dietary diversity, particularly for vulnerable populations.

Vulnerabilities Relating to Cultural Practices and Sites

Climate change poses risks to kastom knowledge, cultural practices, and sites of significance, which are central to wellbeing and identity in Vanuatu.

Key vulnerabilities include:

- Damage to cultural sites, heritage buildings, and sacred places from extreme events
- Changes in seasonal patterns affecting traditional practices
- Loss of traditional food sources and associated knowledge
- Loss of land and changing landscapes affecting connection to place
- Displacement from communities and ancestral lands
- Potential erosion of social cohesion due to environmental and socio-economic stress

These impacts occur within a broader context of ongoing socio-cultural change, where climate change may accelerate the loss of traditional knowledge and practices.

8.6 Consequences for All Hazards

Climate change and climate-related hazards have significant consequences for the Health and Nutrition sector, affecting physical health, mental wellbeing, healthcare systems, and broader social and environmental determinants of health. These consequences arise both directly during hazard events and indirectly through disruptions to infrastructure, services, and essential systems.

Physical Health Consequences

Physical health impacts from extreme weather events and climate hazards are of high concern. These can include both direct and indirect impacts arising during or following a climate hazard.

Key physical health risks for Vanuatu include [130]:

- Fatalities or injuries incurred during extreme weather events and the clean-up phase that follows.
- Dehydration, exhaustion, heat-related illnesses and exacerbation of existing health conditions can occur due to an increase in both average air temperature and the number of hot days (e.g. heatstroke, cardiovascular disease, diabetes, asthma), particularly affecting younger and older populations, and those undertaking outdoor labour [132].
- Water-borne illnesses due to contact with, or consumption of, contaminated water following an extreme weather event [129].
- Food-borne illnesses due to consumption of contaminated food (e.g. food sources exposed to contaminants during a flood event) [129].
- Ciguatera fish poisoning resulting from changes in the growth and distribution of algal blooms, including outbreaks where surveillance gaps exist and community-level understanding of the risks is low [119].
- Malnutrition due to food insecurity as a result of climate hazards (e.g. crop failure due to drought, saltwater intrusion, or damage from destructive winds or flooding) [129]. This is of high concern, as the project stakeholder consultation identified that malnutrition had almost doubled in the past 10 years based on 2023 MICS results and 2013 DHS results. However, in the absence of a nutrition surveillance system, there is difficulty to quantitatively measure specific climate-induced malnutrition. Infants and children are particularly vulnerable.
- Spread of infectious diseases due to overcrowding (including in evacuation centres) due to buildings or housing being damaged [133] [134].
- Increases in the prevalence of vector-borne diseases (e.g., malaria, dengue) due to warming temperatures and post-flood pooling of water, creating breeding grounds for disease-carrying insects [129] [135]. Increases in vector-borne diseases was highlighted in the project consultation as a major concern.
- Increases in respiratory illnesses due to reduced air quality, for example as a result of tropical cyclones disturbing silt or dispersing pollutants, or due to heatwaves exacerbating existing air pollution [136].
- Increased instances of violence and abuse due to heightened stress and tension from experiencing natural disasters or their flow-on effects, or due to heat stress during high temperatures [137] [138]. Women and girls living with a disability are particularly vulnerable to such violence (including sexual abuse) due to discrimination, exclusion, physical isolation and reliance on perpetrators of violence and abuse for care or mobility [3]. Reflecting this risk, the Ministry of Health has responsibilities under the Gender and Protection Cluster to contribute to emergency response and humanitarian operations in a way that addresses gender-based discrimination and violence [139].
- First responders and those involved in restoring essential services (including clearing of debris following an extreme weather event) are particularly at risk of injury, death, or exposure to harmful contaminants.

Community consultation as part of this project highlighted a need for strengthening health system foundations to make them more resilient, with key challenges including limited human resources, weak cross-sector coordination, and logistical barriers during disasters. Consultation participants stressed the importance of inclusive health services, scale up of nutrition-specific interventions, nutrition-sensitive policies, and support for vulnerable populations.

Mental and Emotional Wellbeing Consequences

Climate change poses a significant threat to mental and emotional wellbeing. While the people of Vanuatu may have higher levels of resilience due to previous exposure to natural disasters, the increasing frequency and severity of climate-related natural hazards is likely to challenge this resilience over time. Further, previous experiences might also mean people do not seek mental health services due to perceived stigma that seeking help may be seen as having a lack of resilience [44] [140]. Another challenge is Vanuatu's current shortage of mental health specialists (e.g. psychiatrists), which can undermine people's ability to access mental health support [125]. Limitations and under-resourcing in mental health services were highlighted in the project consultation as major concerns.

Climate change and climate-related hazards can lead to a range of poor mental health outcomes, including mental distress, anxiety, stress, depression and trauma [130]. These can, in turn, result in increases in substance abuse, poor sleep, suicide, and interpersonal violence.

Risks to mental health for Vanuatu from climate-related hazards can arise from:

- Direct exposure to natural hazards. Children, adolescents and those with existing mental health conditions are particularly vulnerable to mental health trauma following extreme weather events, as are those most directly impacted and first responders [130] [141].
- Increased stress and exhaustion amongst the health workforce, many of whom already experience pressure associated with high workloads due to understaffing [123].
- Dislocation from place, communities, and other social support systems.
- Compromised access to mental health services.
- Stress associated with the indirect impacts of climate change, such as water or food insecurity.
- Fear, trauma and other emotional harm from experiences of event-related violence, harassment and abuse.
- Financial stress linked to costs associated with:
    - Damage to homes.
    - Damage to, or loss of, property.
    - Increased costs of goods, services, and transportation post-event.
    - Reduced income due to loss of cash crops, disruption to employment, and compromised access to employment.
- Worry or distress about changes in the climate and its effects on the environment and society in general, including the loss of traditional knowledge and practices.

More specifically, climate change is a significant source of climate-related anxiety, grief and a sense of lost future opportunities for children and young people as they witness damage to their homes, schools, ecosystems and cultural sites. Pacific youth face the reality that the world has changed through little impact by their country, yet the impacts of that change are most felt in their home. Awareness of this injustice and confronting the global stage to share their stories also present a persistent long-term mental health stressor:

"Through no fault of our own, we are living with devastating tropical cyclones, flooding, biodiversity loss and sea-level rise. We have contributed the least to the global emissions that are drowning our land. As young people, the world's failure to stop planet-killing emissions is not a theoretical problem. It is our present and it is our future that is being sold out" [142].

Being able to maintain access to community and family networks is essential for supporting mental health following a disaster, as is the availability of mental health services and education about the importance of mental health amongst the public and healthcare professionals [44] [143]. For many, faith and spiritual wellbeing can also be an important source of resilience and mental wellbeing following a natural disaster [44].

Consequences Relating to Impacts on Healthcare Infrastructure

The flow-on effects of compromised healthcare infrastructure include:

- Increased risk of death and long-term disability from injuries and illnesses associated with an extreme event, where timely care is not available.
- Increased risk of death and long-term disability if access to routine care is compromised during or following an event (e.g., non-event related emergency care, treatment for chronic health conditions, vaccinations, sexual and reproductive healthcare, maternal and neonatal care).
- Reduced access to safe and effective medication or vaccines due to spoilage, where power infrastructure is compromised or high temperatures exacerbate existing cold-chain challenges (e.g. in areas already experiencing persistent fuel shortages and weak electricity access such as Torba, Tafea and remote islands).
- Heightened risk of heat stress-related illness for patients and staff where health facilities are unable to use cooling systems during periods of high temperatures.
- Greater likelihood of the spread of diseases if safe WASH conditions are not able to be maintained within the healthcare system during or following an event.

Consequences Relating to Impacts on Healthcare Service Access

When physical access to healthcare and emergency services becomes compromised, this increases the risk of death, long-term disability, and infectious disease outbreaks. It can also lead to worse health outcomes by reducing access to routine healthcare services such as vaccinations, health screenings, maternal and reproductive healthcare, and treatment for chronic health conditions [47]. Disrupted access can also prevent health surveillance activities from being undertaken.

Some population groups are more vulnerable to disrupted access to healthcare and emergency services:

- Young, older and disabled populations are particularly vulnerable as they have limited mobility and may be more reliant on others to access healthcare services. Along with pregnant women, they are also generally more vulnerable to the effects of being unable to receive timely medical care due to physiological factors or having higher existing health needs.
- More generally, those with existing chronic diseases (e.g. diabetes, renal disease) are at heightened risk of negative health outcomes, including exacerbation of their conditions when their continuity of care is disrupted due to compromised access.
- For children, disruptions can mean missed immunisations, growth monitoring and management of acute malnutrition. For adolescents, climate-related access barriers can reduce uptake of sexual and reproductive health, mental health and other age-appropriate services, with long-term consequences for their wellbeing and rights.
- Those living in low-income households already experience greater difficulty accessing services due to associated travel costs (petrol, payment for boat trips etc.), and this is likely to be worsened if they need to travel further due to damaged or disrupted infrastructure.
- Access to healthcare services also remains limited in rural communities in particular [144], increasing their vulnerability to climate-related hazards. This includes those living on remote islands, which are dependent on boat travel that is sensitive to fuel price increases and storm-related oceanic conditions.

Even when people are still physically able to access to healthcare services, their access to timely care can still be compromised when healthcare system capacity becomes strained due to heightened demand and reduced staffing capacity. This can occur particularly when there are disease outbreaks that occur in the aftermath of a natural hazard, such as dengue, malaria, diarrhoeal diseases, and leptospirosis outbreaks.

Consequences Relating to Impacts on Safe WASH

Without adaptation, the impacts of climate change on WASH are likely to increase stress on Vanuatu's health system, in turn increasing the health burden of a range of diseases, dehydration, and exposure to harmful pollutants in Vanuatu. There is also likely to be an increase in the number of deaths attributable to unsafe WASH services. As of 2019, the mortality rate attributable to unsafe WASH services in Vanuatu was 25 deaths per 100,000 [145].

Health impacts from unsafe WASH include:

- Diarrhoeal illnesses, including acute gastroenteritis, with risk of death particularly high amongst young children [146] [147] [148].
- Other WASH-related illnesses, including typhoid, Leptospirosis, respiratory infections and skin infections such as scabies and rashes [146] [149] [150] [151]. This includes a potential increase in the prevalence of yaws (also known as 'the 50 vatu sore'), which spreads amongst poor hygiene conditions, undermining eradication efforts [152].
- Dehydration, with implications for health including negatively affecting the cognitive functioning and development of children [153].
- Malnutrition when scarce clean water leads to reduced food production [154].
- Increased risk of skin and eye irritation, organ damage, neurological disorders and cancer due to contact or ingestion of harmful pollutants, toxins and chemicals in contaminated water [155].
- Risk of gender-based violence where women and girls need to travel further to access communal WASH facilities, or when WASH facilities are damaged, reducing safety and security (e.g. exposed walls, no lighting, no locks) [21] [78] [111].

In addition to younger, older and disabled populations, Vanuatu's rural populations are likely to be at increased risk as they are particularly reliant on basic water services, which are often intermittent and subject to contamination [156] [157] [158].

Consequences Relating to Impacts on Food Security

The health impacts of food insecurity are wide-ranging and are both direct and indirect. They include:

- Malnutrition (including undernutrition and micronutrient deficiencies) due to a reduction in the amount or variety of foods available to eat. This can lead to an increased risk of infectious diseases, poor system functioning, and poor physical development particularly amongst children, with long-term consequences for health and cognitive and motor function [151]. People with a disability are also particularly vulnerable when they are unable to access foods that are appropriate for their physical needs (e.g. soft foods) [111].
- Further reliance on imported high-calorie food (e.g. rice) or processed food that is high in sugars and fats, leading to an increase in the burden of obesity and non-communicable diseases (e.g. cardiovascular disease, diabetes, certain cancers) that are the leading cause of death in Vanuatu [127] [159]. Vanuatu is already experiencing a shift away from traditional foods towards imported foods, particularly in urban areas [34] [113].
- Stress and competition for scarce food resources, potentially leading to domestic violence [111] and conflict.
- Disproportionate impact on younger and older populations who are particularly vulnerable to the health impacts of food insecurity due to physiological factors.
- Disproportionate impact on low-income households (of which women, female-headed households, and people living with disability are more likely to comprise), due to greater risk of food insecurity [21] [113].
- Disproportionate impact on women, who are more reliant on subsistence farming and therefore more vulnerable to food insecurity [21]. Further, where local custom is that women eat last, this may increase their risk of receiving insufficient nutrition during food shortages [21]. Pregnant or lactating women are particularly vulnerable.
- Rural populations are also vulnerable, with limited access to markets and transportation and a heavy reliance on subsistence farming and fishing. Rural populations in Vanuatu already consume, on average, 350 kcal per capita per day less than people living in urban areas [113]. For example, the more densely populated provinces of Shefa and Sanma have the highest levels of average dietary energy consumption, while the more rural provinces of Tafea and Torba have the lowest levels [113].

Social Cohesion and Community Wellbeing Consequences

Climate hazard impacts can strain or disrupt community relationships and support systems, potentially undermining social cohesion and community wellbeing more generally.

As exposure to climate change-related hazards increases, the cumulative stress on affected households and communities could erode community wellbeing and resilience via a number of means:

- Repeated experiences of natural hazards and recovery creating 'disaster fatigue' that undermines resilience.
- Compounded mental stress, concern for safety, trauma, and uncertainty about the future.
- Increasing inequities, including for those living in rural areas and those on low incomes.
- Physical and emotional violence, including increased risk of gender-based violence and violence towards children and people living with a disability [3] [111]. More specifically, climate-related shocks can increase the risk of neglect, exploitation and abuse of children, including sexual violence, child labour and early and forced marriage – particularly when families are displaced, livelihoods are disrupted or caregivers migrate for work.
- Health and safety risk for women, girls and marginalised groups in evacuation centres due to the close proximity of shelters, lack of privacy, poor lighting conditions, and the need to access communal water supplies and latrines [133] [134].

- Increased stress and potential heightened vulnerability for communities and households pre- and post-disaster when male family members are not present due to undertaking overseas seasonal work [111].
- Potential conflicts over resources, including water, food and materials needed for rebuilding.
- Potential disruption to democratic processes, breakdowns in law enforcement or loss of trust in government systems.

Cultural Wellbeing Consequences

Climate change and related hazards may negatively affect cultural wellbeing in Vanuatu by undermining people's ability to undertake cultural practices and disrupting their connections to place.

Climate change is occurring within the context of ongoing socio-cultural changes to society across Vanuatu, including a shift away from traditional cultural practices that can be described as "loss of kastom" [34]. By disrupting usual social and natural resource systems, climate change can exacerbate or accelerate some of those changes. For example, accelerating the loss of traditional knowledge and the ability to undertake traditional food security and housing practices that reduce vulnerability during extreme weather events. Wellbeing can also be negatively affected when people's ability to engage in the cultural practices that inform their sense of identity, social connection, and connection to ancestry is undermined. When cultural wellbeing is diminished, this can in turn undermine social cohesion.

8.7 Compounding, Cascading Risk and Interdependencies

Vanuatu's Health and Nutrition sector faces compounding climate risks, where multiple hazards interact to increase the overall level of stress on systems and populations.

Across the country, rising air temperatures are likely to place additional strain on the health system, particularly when they occur simultaneously with prolonged drought and reduced availability of safe drinking water. Older adults and young children are especially vulnerable to these combined pressures, particularly where heat exposure, water scarcity, and consumption of contaminated water occur together.

Physical damage to health-related infrastructure may also compound across hazards. For example, tropical cyclones, coastal flooding, and fluvial and pluvial flooding can collectively damage health facilities, transport networks, and supporting infrastructure, reducing the capacity of the health system to respond effectively and recover between events.

Other compounding impacts from multiple hazards include:

- Combined effects of drought, high temperatures, saltwater intrusion, and floodwater contamination increasing the risk of crop failure, food contamination, and malnutrition
- Increased mental stress, trauma, and social tension resulting from repeated or concurrent hazard events
- Warmer temperatures and post-flood water pooling increasing the risk of vector-borne disease transmission

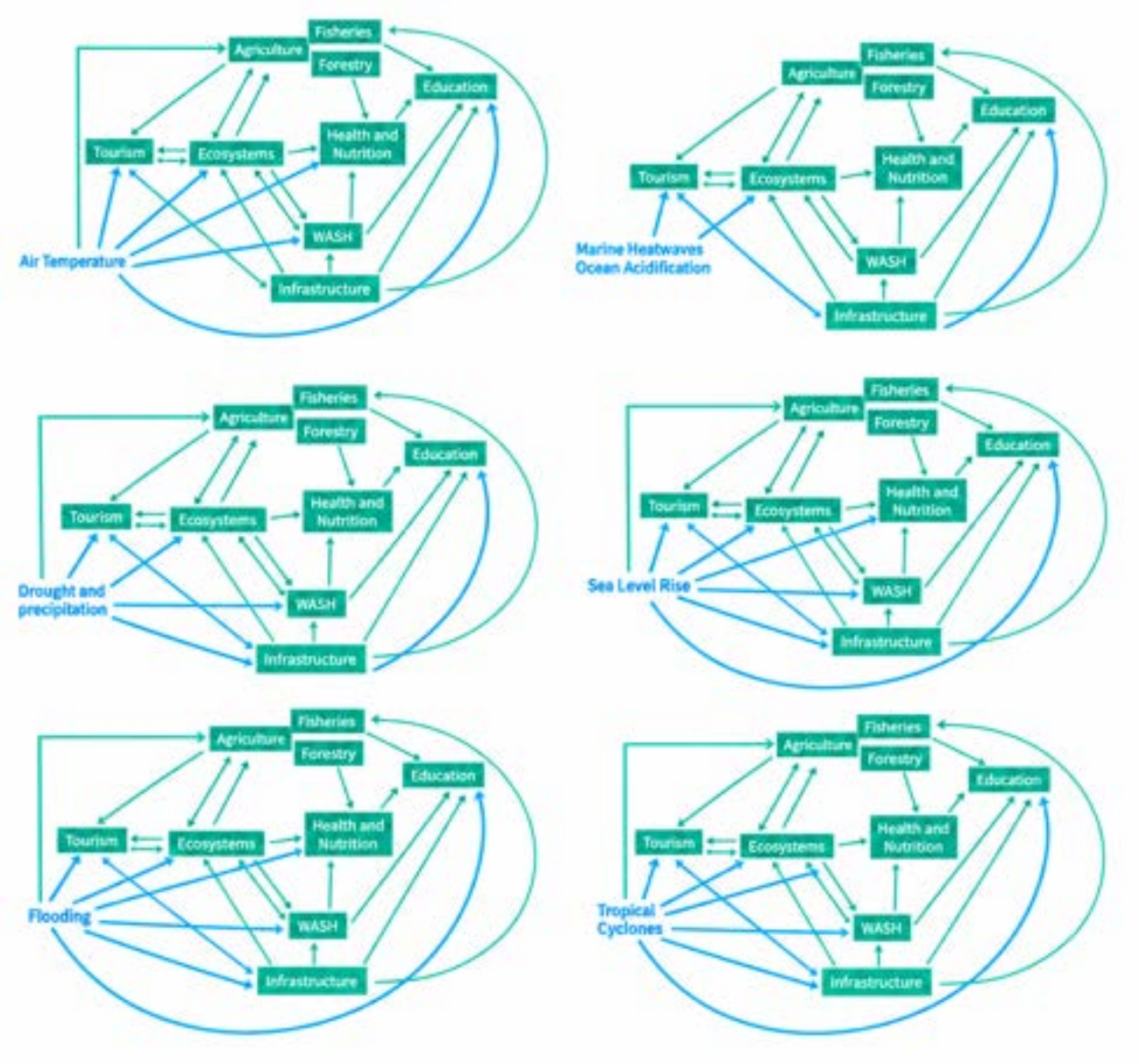
Climate risks to the Health and Nutrition sector also occur through cascading impacts and interdependencies with other sectors, as illustrated in Figure 23.

Access to safe WASH services is essential for maintaining public health. Disruptions to water supply, sanitation infrastructure, or hygiene conditions can increase the risk of disease transmission and reduce the safety and dignity of vulnerable groups, including women, children, and people living with disabilities.

Transport infrastructure plays a critical role in enabling access to healthcare services and essential goods. When roads, ports, or airports are damaged or inaccessible due to climate hazards, communities may become isolated, limiting access to medical care, clean water, and food. These disruptions can also affect supply chains for medications, medical equipment, and emergency response.

Climate impacts on agriculture, fisheries, forestry, and ecosystems can cascade into the Health and Nutrition sector by reducing food availability, increasing the risk of contamination, and limiting income-generating opportunities. Similarly, disruptions to the tourism sector can reduce household income, affecting the ability of individuals and

Figure 23. Illustration of the interdependencies between Health and Nutrition and other sectors



communities to access essential goods and services required for health and wellbeing.

There are also feedback effects within the system. Poor health can reduce individuals' ability to work, engage in subsistence activities, or generate income, which in turn can worsen food insecurity and limit access to healthcare and other essential services.

At the population level, poor health outcomes can affect school attendance and learning outcomes. Over time, reduced educational attainment can negatively impact productivity, social wellbeing, and long-term development outcomes for communities across Vanuatu.

8.8 Summary and Considerations

Vanuatu's Health and Nutrition sector faces significant climate risks across multiple domains, with particularly high concerns around safe WASH, food security, healthcare service functioning and access, social cohesion, cultural wellbeing and the direct impacts on physical and mental health. The combined risks from tropical cyclones, sea-level rise, coastal erosion, flooding, drought, and landslides create complex challenges for adaptation planning.

Several key considerations emerge from this assessment:

Critical infrastructure resilience: The exposure of healthcare facilities, WASH systems, and transportation infrastructure highlights the need for targeted adaptation strategies to strengthen essential services. Coastal and flood-prone clinics, dispensaries, aid posts, roads, ports, and other supporting infrastructure are particularly vulnerable to disruption. The cascading impacts of infrastructure failure on health outcomes, emergency response, safety, and social wellbeing make resilience-building a priority for early action.

Vulnerable populations and equity: Children, older people, people living with disabilities, women, low-income households, and rural and remote communities are disproportionately vulnerable to climate-related health impacts. Adaptation planning should therefore adopt an equity-focused approach that addresses the specific needs, capacities, and barriers faced by these groups, including limited access to healthcare and essential services.

Traditional knowledge: It is Traditional knowledge systems remain essential for strengthening climate resilience and supporting locally appropriate adaptation responses. For example, traditional knowledge regarding the signs of approaching cyclones contributed to preparedness efforts during Cyclone Pam and was credited with helping reduce loss of life. Traditional building practices, including cyclone-resistant housing designs, also supported community resilience and recovery. Similarly, traditional ecological knowledge continues to play an important role in identifying and responding to risks such as ciguatera fish poisoning outbreaks as ocean temperatures and acidification increase.

Interconnected and cascading risks: The Climate risks to Health and Nutrition are closely interconnected with risks affecting the WASH, Agriculture, Ecosystems, Forestry, Fisheries, Tourism, Infrastructure, and Education sectors. Impacts on agriculture and fisheries, for example, can reduce food availability, undermine nutrition, and weaken household incomes, with flow-on effects for health and wellbeing. Effective adaptation planning will therefore require coordinated cross-sector approaches that recognise these interdependencies rather than addressing risks in isolation.



CHAPTER

09

Infrastructure Sector

9.1 Key Findings Infrastructure

Infrastructure systems in Vanuatu are highly exposed to multiple climate hazards, particularly coastal flooding, sea-level rise, fluvial/pluvial flooding, and tropical cyclones. Central and South Malekula, Luganville, and West Tanna consistently record some of the highest infrastructure risk scores, with exposure concentrated around low-lying coastal areas, transport corridors, and urban centres.

Transport, electricity, communications, and water systems are highly interconnected, meaning infrastructure failures can create widespread cascading impacts across multiple sectors. Disruptions to electricity, transport, and communications can affect health services, WASH systems, supply chains, livelihoods, tourism, and emergency response capacity.

Critical transport infrastructure is increasingly vulnerable to climate impacts, particularly coastal inundation and flooding. Several airports, including Anaytom, Aromai, and Lamen Bay, are located within approximately 2 m of mean sea level, while maritime infrastructure and inter-island transport systems face increasing risks from sea-level rise, storm surge, and tropical cyclones.

Infrastructure failures may generate economic disruptions that exceed direct physical damage costs. Damage to transport, electricity, and communications infrastructure can disrupt supply chains, reduce tourism activity, limit market access, interrupt essential services, and increase recovery costs for households, businesses, and government.

Climate-resilient and inclusive infrastructure planning, early warning systems, and strengthened local preparedness mechanisms will be critical for reducing future infrastructure risks. Improved infrastructure design, proactive maintenance, resilient transport and utility systems, and community-based disaster risk reduction measures will be increasingly important under changing climate conditions.

9.2 Overview of the Infrastructure Sector

Infrastructure provides the essential services that enable daily life, including electricity, water supply, wastewater services, communications and transport. It also underpins economic activity, public service delivery, and social and cultural wellbeing.

For this assessment, the infrastructure sector includes electricity utilities, network towers, wastewater assets, communications infrastructure and transport networks. Buildings are also considered within this sector because they form part of Vanuatu's built environment, although they are not strictly classified as infrastructure. The scope of the assessment is partly shaped by data availability, as comprehensive infrastructure asset data was difficult to locate.

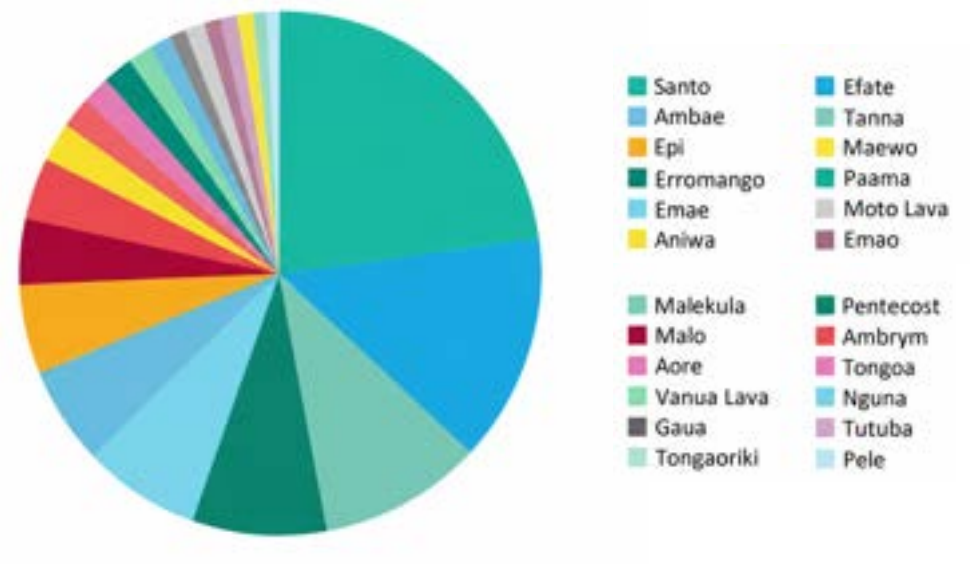
Vanuatu's transport networks include roads, airports, boats and ferries. The road network is estimated at approximately 2,241 km and varies considerably in standard and condition. According to the 2014 national road inventory, around 50% of roads are located on the three main islands of Efate, Santo and Malekula (Figure 25) [160]. Unpaved gravel and earth roads make up the majority of the network, while sealed roads account for only around 10% and are concentrated on Efate and Santo [160]. Roads provide access for both vehicles and pedestrians, while beaches, walking tracks and small boats remain important transport routes in areas where roads are absent. There are also approximately 116 recorded bridges across the country, in addition to numerous unmarked fords in rural areas.

Figure 24 illustrates the distribution of Vanuatu's road network by island, highlighting the concentration of transport infrastructure on the country's larger and more populated islands.

Boats and barges are the primary means of transport between islands and play a critical role in moving people, food supplies, fuel, construction materials and equipment. Inter-island ferries connect the main urban centres of Port Vila and Luganville to outer islands, although services to more remote islands may only occur infrequently. Maritime transport infrastructure is therefore essential for maintaining supply chains and supporting recovery and reconstruction following hazard events [161].

Figure 24. Vanuatu's road network distribution

Province	Island	Length (km)
Sanma	Santo	520
Shefa	Efate	337
Malampa	Malekula	267
Penama	Pentecost	199
Penama	Ambae	182
Tafea	Tanna	177
Sanma	Malo	94
Malampa	Ambrym	84
Shefa	Epi	71
Penama	Maewo	46
Sanma	Aore	43
Shefa	Tongoa	37
Tafea	Erromango	31
Malampa	Paama	23
Torba	Vanua Lava	23
Shefa	Nguna	22
Shefa	Emae	20
Torba	Moto Lava	14
Torba	Gaua	13
Sanma	Tutuba	12
Tafea	Aniwa	12
Shefa	Emao	9
Shefa	Tongoariki	5
Shefa	Pele	4
Total		**2245**



Source: Public Works Department [160]

Vanuatu does not have a centralised wastewater collection system. In urban areas, wastewater is primarily managed through individual septic tanks and soakage systems, while rural communities commonly rely on pit toilets or long-drop systems [161]. Limited wastewater treatment capacity and untreated discharges have contributed to ongoing water quality concerns in some coastal and lagoon environments [105] [162] [163] [164]. Notable improvements include the Port Vila Septage Treatment Plant and planned wastewater upgrades at Vila Central Hospital [162] [163].

Vanuatu has two major mobile telecommunications providers, Vodafone and Digicel, supported by approximately 230 network towers distributed primarily near population centres. Electricity services are provided by three main power suppliers, while emergency response infrastructure includes five fire stations, including one located at Bauerfield International Airport.

Housing and buildings in Vanuatu are constructed using a range of materials and building approaches [21] [165]. Traditional housing, commonly found in rural and outer island areas, is typically constructed from local materials such as grasses, bamboo, palm and timber. Semi-permanent housing combines traditional and modern materials, while permanent housing in urban areas is generally constructed from concrete, timber and corrugated iron [21] [165]. Industrial, commercial and government buildings are predominantly built using modern materials.

Infrastructure in tropical environments is exposed to ongoing deterioration from humidity, heavy rainfall, saltwater exposure and extreme events such as cyclones and flooding [166]. These conditions increase maintenance requirements and can shorten infrastructure lifespan, particularly where maintenance capacity, spare parts and technical expertise are limited.

The Vanuatu Infrastructure Strategic Investment Plan 2015–2024 (VISIP) [35] highlights the importance of climate-resilient transport and communications infrastructure and identifies the need for strengthened sector planning and investment coordination. VISIP estimates that substantial long-term investment is required to develop resilient infrastructure systems capable of supporting sustainable development, service delivery and climate resilience across Vanuatu [35].

9.3 Hazard Data Availability and Exposure

The assessment of climate risks to the infrastructure sector draws on multiple hazard datasets and qualitative information sources of varying suitability and spatial coverage. A summary of the key hazard datasets and their suitability for adaptation planning is provided in Appendix C (Tables A-14 and A-15).

Figure 25 illustrates the spatial distribution of infrastructure-related assets across Vanuatu for which data was available. The following sections combine quantitative analysis with insights from document reviews and sector-based workshops to assess infrastructure vulnerabilities and climate risks.

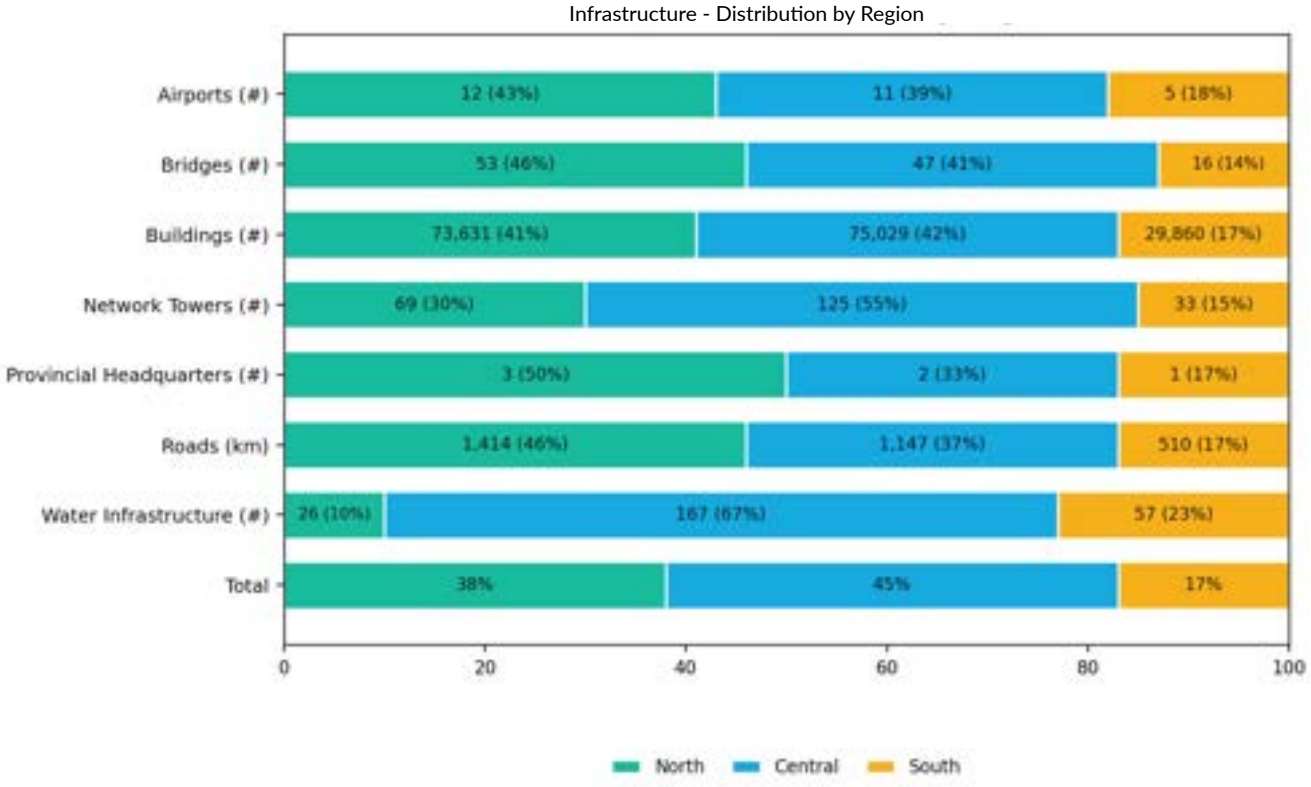
Climate change threatens infrastructure across Vanuatu through changing rainfall patterns, rising temperatures, sea-level rise and tropical cyclones. Increased flood intensity, coastal inundation and storm impacts are expected to place growing pressure on roads, airports, water and wastewater systems, telecommunications infrastructure and buildings. Existing infrastructure vulnerabilities, including reliance on unsealed roads, limited wastewater treatment systems and infrastructure exposure in low-lying coastal areas, are likely to increase disruption to essential services and connectivity across the archipelago.

National Distribution of infrastructure Assets

Figure 25 presents the spatial distribution of infrastructure-related assets across Vanuatu based on available data. To align with the resolution of the climate models used, assets were aggregated into the North, Central and South regions for hazards such as air temperature, drought and precipitation. More detailed, location-specific exposure analysis was undertaken for present-day fluvial and pluvial flooding, as well as coastal flooding and sea-level rise increments.

The analysis includes buildings, airports, water infrastructure, provincial headquarters, network towers, bridges and roads. Electricity utility data was excluded from the regional distribution and risk scoring due to apparent gaps in the dataset, particularly for the North region. Notably, no electricity utilities were recorded for Luganville or the wider North, which is highly unlikely given its status as Vanuatu's second-largest urban centre. Including this dataset could therefore have distorted regional exposure and risk results.

Figure 25. Distribution of Infrastructure Assets



The figure shows that infrastructure assets are concentrated in the North and Central regions, reflecting the distribution of population centres, transport corridors and service infrastructure. The South region contains comparatively fewer mapped assets across most categories.

Although the North and Central regions have broadly similar shares of total assets, some asset types are more regionally concentrated. The Central region contains approximately 67% of mapped water infrastructure and over half of network towers. Roads and buildings are relatively evenly distributed between the North and Central regions, while provincial headquarters and airports are present across all three regions.

This concentration in the North and Central regions indicates that climate hazards affecting these areas could disrupt a significant proportion of national connectivity and service delivery. In contrast, infrastructure in the South may face greater challenges related to remoteness, limited redundancy and reduced access to maintenance and recovery support.

Water infrastructure is discussed further in the WASH chapter.

Infrastructure Climate Risks

The following sections assess the exposure, vulnerabilities and potential consequences associated with key climate hazards affecting infrastructure systems across Vanuatu. The assessment considers both gradual climate changes, such as increasing temperatures and sea-level rise, and extreme events including flooding, drought and tropical cyclones.

Infrastructure systems in Vanuatu are highly interconnected, meaning that damage to roads, ports, airports, electricity networks, communications infrastructure or water systems can create cascading impacts across multiple sectors and communities. Many infrastructure assets are also located in coastal or low-lying areas and are exposed to compound risks associated with flooding, erosion, storm surge and saltwater intrusion.

The hazard-specific sections below combine quantitative exposure analysis with qualitative information from sector consultations, published literature and government planning documents to identify major infrastructure risks and their implications for connectivity, service delivery and long-term resilience. Table 26 summarises the major climate hazards affecting infrastructure systems in Vanuatu, together with the associated vulnerabilities and potential consequences.

Table 26. Climate hazards, vulnerabilities and potential consequences for infrastructure systems in Vanuatu

Climate Hazard	Vulnerabilities	Potential Consequences
Air temperatures	Accelerated deterioration of roads, bridges, buildings and power infrastructure due to heat, corrosion and weathering	Increased maintenance costs, reduced infrastructure lifespan, higher electricity demand and service disruptions
Drought and changing precipitation patterns	Water supply systems vulnerable to low flows and sedimentation; unsealed roads vulnerable to degradation; steep terrain susceptible to erosion and landslides	Damage to roads and water infrastructure, wastewater challenges, reduced mobility and disruption to essential services
Coastal flooding and sea-level rise	Coastal roads, bridges, ports, airports, buildings and utilities exposed to inundation, erosion and saltwater intrusion	Damage to infrastructure, loss of functionality, displacement of communities, reduced connectivity and potential relocation of assets
Fluvial and pluvial flooding	Roads, bridges, buildings, utilities and transport corridors exposed to riverine and surface flooding	Mobility disruption, property damage, service outages, isolation of communities and increased recovery costs
Tropical cyclones	Infrastructure exposed to destructive winds, flooding, storm surge and debris impacts	Widespread infrastructure damage, prolonged service disruption, economic losses and delayed recovery

Air Temperature

Exposure

Projected increases in air temperature are relatively consistent across the North, Central and South regions of Vanuatu, with the primary differences occurring between emissions scenarios rather than between geographic areas.

Under RCP4.5, annual air temperatures are projected to increase progressively from approximately 0.6°C above the 1986–2005 baseline during 2030–2050, to around 0.9°C by 2051–2070, reaching approximately 1.2–1.5°C by 2071–2090.

Under RCP8.5, projected warming follows a similar trajectory until mid-century before accelerating substantially after 2070. Median temperature increases reach approximately 2.5–2.7°C above baseline by 2071–2090, although uncertainty between models increases under this scenario.

Overall, all regions of Vanuatu are expected to experience relatively uniform exposure to increasing air temperatures.

Vulnerabilities and Consequences

Higher temperatures are expected to accelerate the deterioration of infrastructure materials, increasing maintenance requirements and repair costs. Roads, bridges, buildings, power infrastructure and telecommunications systems may all experience reduced lifespan and increased operational stress associated with heat, weathering and corrosion [167].

Infrastructure located in remote areas is likely to be particularly vulnerable due to limited maintenance capacity, higher transport costs and challenges associated with accessing replacement materials and technical expertise. Increasing temperatures may also increase electricity demand associated with cooling and refrigeration needs, placing additional pressure on electricity systems.

Over time, increasing temperatures may contribute to transport disruption, utility failures and increased infrastructure maintenance costs [77]. Heat-related impacts may also create cascading effects across other sectors by affecting human health, labour productivity, ecosystems, agriculture and water resources.

Drought and Precipitation

Exposure

Projected changes in drought and precipitation patterns across Vanuatu remain uncertain due to variability between climate models and the influence of the South Pacific Convergence Zone (SPCZ), which strongly affects regional rainfall patterns.

Overall, moderate and extreme drought durations are projected to remain broadly similar to present-day conditions through to around 2070, although some models indicate the potential for longer-duration extreme drought events by the end of the century. Drought frequency is also projected to remain relatively stable, with uncertainty increasing towards 2090.

Average seasonal rainfall projections do not show clear long-term increases or decreases across the North, Central and South regions. However, projections consistently indicate an increase in extreme daily rainfall events across all regions and emissions scenarios compared to the historical baseline period.

While long-term rainfall trends remain uncertain, increasing rainfall intensity is expected to increase flood risks, stormwater runoff and infrastructure damage across the country.

Vulnerabilities and Consequences

Reduced water availability and low river flows may affect water supply systems by increasing sediment concentrations and damaging mechanical components essential for system operation. Water supply vulnerabilities are discussed further in the WASH chapter.

Vanuatu's steep terrain increases vulnerability to erosion, landslides and flooding associated with vegetation loss and intense rainfall events. These hazards may damage roads, bridges and transport corridors, disrupting access to communities and essential services.

Much of Vanuatu's road network consists of unsealed or poorly surfaced roads [161], many of which already experience deterioration from potholes and erosion. Extended dry conditions combined with increasing temperatures are likely to further degrade these road surfaces and increase maintenance requirements.

Changing rainfall patterns may also affect wastewater systems and receiving environments. Overflowing septic systems and wastewater leachate may contaminate waterways, agricultural areas and coastal environments, creating environmental and public health risks [161] [168].

Increasing rainfall intensity and urbanisation are also expected to place growing pressure on stormwater systems, particularly in urban areas, increasing surface flooding and infrastructure disruption [163].

Coastal Flooding and Sea-level rise

Exposure

Sea-level rise is expected to increase the frequency and extent of coastal flooding, tidal inundation and coastal erosion nationwide. Potential impacts include more frequent high-water events, including storm surge and king tides reaching further inland, shoreline erosion, saltwater intrusion, groundwater salinisation in porous soils, and permanent land loss in low-lying coastal areas. These impacts are particularly important for infrastructure systems because many assets and population centres are concentrated along the coast.

Table 27. Median sea-level rise projections for Vanuatu under RCP2.6, RCP4.5 and RCP8.5 scenarios

Year	RCP2.6		RCP4.5		RCP8.5	
2030	0.13	0.10–0.17	0.13	0.09–0.17	0.14	0.10–0.17
2050	0.23	0.17–0.30	0.24	0.18–0.31	0.28	0.22–0.37
2070	0.32	0.24–0.43	0.37	0.28–0.48	0.48	0.37–0.64
2090	0.42	0.30–0.56	0.50	0.38–0.68	0.73	0.56–0.99

Median sea-level rise projections developed under the Van-KIRAP project indicate progressively increasing sea levels throughout the century, with greater acceleration beyond mid-century under higher emissions pathways.

Note: Values represent projected median sea-level rise relative to the 1995 baseline. Uncertainty bands indicate the 5th to 95th percentile projection range: Higher emissions scenarios result in substantially greater sea-level rise by the end of the century.

To assess infrastructure exposure under extreme coastal flood conditions, this assessment applies a model provided by DoCC. The model evaluates the extent and depth of flooding associated with a 1% AEP (1-in-100-year) coastal flood event at four sea-level increments: present day (0.0 m), 0.5 m, 1.0 m and 1.5 m.

Across all infrastructure types assessed, exposure increases consistently under higher sea-level rise increments. Exposure is concentrated around Efate, Malekula and Santo, reflecting the clustering of infrastructure within coastal population centres and transport corridors. Electricity utility exposure is likely underestimated due to incomplete datasets, particularly around Luganville.

9.4 Transport Infrastructure (Roads, Bridges and Airports)

Roads: Under present-day sea level conditions, approximately 38 km of road (around 1% of the national road network) is exposed to a 1% AEP coastal flood event. Exposure increases to approximately 66 km (2%) at 0.5 m sea-level rise, 98 km (3%) at 1.0 m, and 134 km (4%) at 1.5 m. The most exposed roads are concentrated on Efate, Malekula and Santo. Detailed road exposure by island is provided in Annex C Table A-16.

Airports: Lamap Airport (Malekula) and Lamen Bay Airport (Epi) are exposed under present-day conditions. No additional airports are identified as exposed in the model outputs; however, many airports are located within approximately 2 m of mean sea level, indicating sensitivity to higher sea-level rise increments. Bauerfield International Airport, located at approximately 6 m above mean sea level, is less directly exposed in the model outputs than lower-lying airports.

Bridges: Bridge assets were identified across multiple islands, including Tanna (16), Efate (29), Malekula (12), Santo (7), Pentecost (5), Aoba (4), Ambrym (1) and the Banks Islands around Sola (16). The dataset may include informal crossings or fords rather than engineered bridge structures and should be interpreted as indicative of crossing locations. Ground verification is recommended for planning and investment purposes.

Exposure to coastal flooding and sea-level rise remains relatively limited in some locations, particularly Tanna, where exposure levels remain largely unchanged across all sea-level rise increments. In contrast, exposure increases substantially on Efate, Malekula and Santo under higher sea-level rise scenarios, particularly in low-lying coastal areas and urban centres such as Port Vila, Lakatoro and Luganville.

The most notable increases occur on Malekula and Efate, where exposure expands substantially under higher sea-level rise increments, while Santo also shows a progressive increase, particularly around Luganville. No bridge assets in the Banks Islands (Sola) are exposed under the modelled coastal flood conditions, indicating minimal coastal flood exposure for these assets.

Table 28 summarises the number of bridge assets exposed under present-day conditions and future sea-level rise increments.

Table 28. Number of bridge assets exposed to a 1% AEP coastal flooding event under present-day conditions and 0.5 m, 1.0 m and 1.5 m sea-level rise increments.

Island / Area	Available Bridge Assets	Present Day (0.0 m)	0.5 m SLR	1.0 m SLR	1.5 m SLR
Tanna	16	1	1	1	1
Efate	29	11	13	13	16
Malekula	12	5	5	12	13
Santo	7	1	2	6	7
Banks Islands (Sola)	16	0	0	0	0

9.5 Communications and Energy Infrastructure (Towers and Electricity Utilities)

Network towers and electricity utilities are concentrated around coastal settlements and urban centres, reflecting the distribution of population, services and economic activity across the country. As a result, these assets are increasingly exposed to coastal flooding under higher sea-level rise increments.

Under the 1% AEP coastal flood event, seven network towers are exposed under present-day conditions, increasing to 13 towers at 0.5 m sea-level rise, 20 towers at 1.0 m and 27 towers at 1.5 m sea-level rise. Exposure is concentrated around Port Vila (Efate), Lakatoro (Malekula) and Luganville (Santo), where telecommunications infrastructure supports major population and service hubs. Disruption in these locations may have broader implications for connectivity and emergency communications.

Exposed Electricity Utilities: The available data show that electricity utilities are mainly located on Tanna, Efate, Malekula, and the Banks Islands (mainly around Sola). There do not appear to be any in Luganville, suggesting a lack of data rather than a lack of electricity utilities. Of the 194 (recorded) electricity utility nodes across Vanuatu, 3% (6 nodes), 6% (12 nodes), 9% (18 nodes), and 11% (21 nodes) are exposed to a 1% AEP coastal flood at present sea level, 0.5m, 1.0m, and 1.5m, respectively.

No electricity utilities are exposed to coastal flooding on Tanna or around Sola (Banks Islands) under the current set of AEPs. In Port Vila (Efate), under the current sea levels, three utilities out of 132 recorded locations are exposed, two at Government Wharf and one in the Central city. At 0.5m sea level, a further 3 utilities are exposed near Ring Road, close to Erakor Lagoon, and one on the coast in Nambatri. For 1.0m and 1.5m of sea-level rise, 10 (8%) are exposed, with 3 further utilities exposed close to the Ring road near Erakor Lagoon.

On Malekula, 27 electricity utilities are identified, around Lakatoro, Litzlitz/Litslits and Norsup Airport. Of these 27, 3 are exposed at a 1% AEP coastal flood under present-day sea levels (11% of the nodes), all in Litzlitz/Litslits. At 0.5m of sea-level rise, a further 2 electricity utilities are exposed (5 in total or 19% of the local utilities), an additional utility in Litzlitz/Litslits, and one in Tautu. Exposure increases at 1.0m of sea-level rise to 8 utilities (30%), with all three utilities at Tautu exposed, 1 near the Airport, and 4 at Litzlitz/Litslits. At 1.5m of sea-level rise 11 electricity utilities (41%) are potentially exposed in a 1% AEP coastal flood. Of these, 3 are at Tautu, 2 near Lakatoro, 5 at Litzlitz/Litslits, and 1 near the airport.

9.6 Exposed Buildings

Out of approximately 178,520 mapped buildings nationwide, an estimated 4,527 buildings (3%) are exposed under present-day conditions to a 1% AEP coastal flood event. Exposure increases progressively under higher sea-level rise increments, reaching approximately 6,953 buildings (4%) at 0.5 m sea-level rise, 9,860 buildings (6%) at 1.0 m and 12,549 buildings (7%) at 1.5 m sea-level rise. The dataset does not distinguish building use and is therefore likely to include residential, commercial, industrial and government buildings.

The highest absolute exposure occurs on Efate, Malekula and Santo across all sea-level rise increments. Efate records the highest overall exposure under present-day conditions and at 0.5 m sea-level rise, while Malekula becomes increasingly dominant under the 1.0 m and 1.5 m increments.

On Efate, the greatest concentration of exposed buildings occurs in and around Port Vila. Several area councils also show high proportional exposure by 1.5 m sea-level rise, including North Efate, where approximately 42% of mapped buildings are exposed. Ifira, Pango and Nguna also record exposure exceeding approximately 25% of mapped buildings under higher increments.

On Malekula, approximately 22% of mapped buildings are exposed at 1.5 m sea-level rise. Major concentrations occur within South Malekula, South-West Malekula and Central Malekula, each recording roughly one-third or more of mapped buildings exposed within those area councils under higher increments.

On Santo, building exposure is concentrated around Luganville and Canal–Fanafo, with East Santo showing increasing exposure under higher sea-level rise increments.

Detailed building exposure results for Efate, Malekula and Santo are provided in Annex C Tables A-17 and A-18

Santo has approximately 42,000 buildings, with buildings in Luganville and Canal-Fanto showing the greatest number of buildings exposed (Appendix C Table A-18) and the highest percentage of exposed buildings compared to the total number of buildings in the administrative area. East Santo experiences increased exposure at 1.5m of sea-level rise.

Vulnerabilities

The infrastructure sector is highly vulnerable to coastal flooding and sea-level rise because many assets, services and population centres are concentrated within coastal zones. Infrastructure exposed to coastal hazards may experience direct damage and loss of functionality from wave action, erosion, overtopping and inundation, as well as corrosion and degradation associated with saltwater exposure.

Structural Damage and Asset Degradation

Buildings may experience varying levels of damage depending on construction type and condition. Saltwater exposure can damage structural materials, finishes and internal contents, increasing repair and replacement requirements. Homes constructed using traditional materials or hybrid construction approaches may in some cases be repaired more rapidly using locally available materials and knowledge.

Roads, ports and airport infrastructure are also vulnerable to erosion, inundation and overtopping. Many airports nationwide are located in low-lying coastal areas, while port facilities may experience reduced structural integrity and operational functionality under rising sea levels and coastal flooding conditions. Damage to runways and transport infrastructure can be costly and time-consuming to repair, particularly in remote island settings.

Network towers and electricity utilities are vulnerable to both direct and indirect saltwater exposure. Saltwater intrusion and inundation can accelerate corrosion and damage electrical and communications infrastructure, reducing functionality and service reliability.

Service Disruption and Connectivity

Road infrastructure is particularly vulnerable because many islands rely on a single primary road that either circumnavigates or runs along the length of the island. In many locations, these roads closely follow the coastline and are therefore vulnerable to erosion, overtopping and inundation. Damage to or loss of these roads may fragment transport networks, isolate communities and disrupt the movement of people, goods and emergency services. Disruption to ports, airports, electricity systems and communications infrastructure may also affect supply

Table 29. Normalised risk scores for infrastructure assets exposed to a 1% AEP coastal flood event

Normalised Risk Score			
0.0 m SLR	0.5 m SLR	1.0 m SLR	1.5 m SLR
South Malekula (100)	Central Malekula (100)	Central Malekula (100)	Central Malekula (100)
Central Malekula (60.1)	South Malekula (36.6)	South Malekula (17.4)	South Malekula (13.3)
Vermali (59.1)	Eton (26.9)	Luganville (11.3)	Eton (12.3)
Port Vila (36.1)	Port Vila (26.0)	Eton (11.0)	Luganville (9.8)
Malorua (34.0)	Vermali (24.9)	Port Vila (10.8)	Port Vila (9.3)
Mele (32.7)	Malorua (15.0)	Vermali (9.8)	Vermali (7.4)
Eton (32.1)	Mele (14.2)	South-East Santo (6.3)	Mele (6.5)
South-East Malekula (19.0)	Luganville (11.2)	Malorua (6.3)	Malorua (4.9)
Eratap (17.3)	South-East Malekula (9.3)	Canal – Fanafo (5.8)	South-East Santo (4.9)
Canal – Fanafo (17.1)	South-East Santo (8.8)	Mele (5.8)	Canal – Fanafo (4.5)

chains, emergency response capacity and access to essential services, particularly in outer island and remote coastal communities.

Consequences

Increasing Pressure on Infrastructure Systems: Coastal flooding and sea-level rise are expected to place increasing pressure on national infrastructure systems over time. As exposure increases, infrastructure assets may face rising maintenance requirements, higher repair costs, and more frequent operational disruptions, highlighting the need for greater investment in resilience measures, coastal protection, and, in some locations, longer-term relocation planning. Transportation infrastructure, buildings, and port facilities are likely to experience some of the greatest pressures due to their concentration in low-lying coastal areas and their critical role in national connectivity and service delivery.

Economic and Strategic Implications: Strategic decisions may be required regarding the long-term viability, protection, or relocation of major infrastructure assets under higher sea-level rise scenarios. Airports and ports are particularly critical for tourism, trade, emergency response, and domestic connectivity, meaning disruptions to these systems could generate significant economic impacts across multiple sectors. As sea levels continue to rise, increasing pressure may also be placed on public investment and maintenance budgets, as infrastructure systems will require more frequent repair, upgrading, or relocation to maintain service continuity. Over the longer term, disruptions to transport systems may also contribute to displacement pressures in some locations where access becomes progressively more difficult or costly to sustain.

Relative Risk Concentration

The infrastructure sector assessment includes roads, provincial headquarters, network towers, buildings, bridges and airports. Electricity utility infrastructure was excluded from the relative risk scoring due to incomplete spatial datasets.

To support prioritisation, normalised risk scores were calculated using available spatial layers for infrastructure assets exposed to a 1% AEP coastal flood event under present-day conditions and sea-level rise increments of 0.5 m, 1.0 m and 1.5 m (Table 29). These scores are intended to identify areas where exposed infrastructure assets are most concentrated in relative terms and to support further analysis, planning and resilience-building initiatives.

Table 30. Number of elements within the areas where 1% AEP, 2% AEP and 10% AEP fluvial/pluvial flood models are available across Santo, Efate, Malekula and Tanna.

Element	Total Number	1% AEP	2% AEP	10% AEP
Airports	5	2	2	2
Bridges	59	49	46	43
Network Towers	162	34	25	17
Roads	1,379 km	343 km	286 km	233 km
Electricity Utilities	194	49	38	29
Buildings	96,909	29,038	24,756	20,940

Risk scores are relative and indicative rather than absolute values. The highest-ranked Area Council under each sea-level rise increment is assigned a score of 100, with all other scores normalised relative to that location. As a result, an Area Council's ranking or score may decrease between scenarios even where the absolute level of exposure increases, if exposure increases more rapidly elsewhere.

As shown in Table 29, South Malekula records the highest relative risk concentration under present-day conditions. Under the 0.5 m, 1.0 m and 1.5 m sea-level rise increments, Central Malekula becomes the highest-ranked Area Council. These findings indicate persistent concentrations of infrastructure exposure within Central and South Malekula under a 1% AEP coastal flood event as sea levels rise.

Table 29 also indicates that other areas consistently rank among the highest relative exposure concentrations, including Eton, Port Vila, Vermali, Luganville and South-East Santo. This suggests that several key urban, transport and service centres may experience increasing infrastructure exposure under higher sea-level rise increments.

Note: Scores are normalised and ranked to support comparison across locations and sea-level rise increments. Red arrows indicate an increase in relative ranking or the emergence of a location among the highest-ranked areas, while yellow arrows indicate a relative decrease in ranking. Scores represent relative exposure concentration rather than direct damage or economic loss.

Fluvial and Pluvial Flooding

Exposure

DoCC provided present-day fluvial and pluvial flood models for Malekula, Tanna, and catchments near Port Vila and Luganville, covering 10%, 2%, and 1% AEP flood events. The models include both flood extent and depth. Although they do not incorporate projected climate change impacts, they remain useful for understanding current flood exposure patterns for infrastructure and other valued assets.

The Luganville catchment model includes several Area Councils Including Luganville, and parts of Canal-Fanafo, South Santo, and South-East Santo. The Port Vila catchment model includes Port Vila, and parts of Mele and Erakor. Within the areas covered by the fluvial models, there are 5 Airports (28 across Vanuatu), 59 bridges (out of a total of 116 across the country), 1,379 km of roads (total around 3000 km), 162 network towers (out of 277 nationwide), and 96,909 buildings (out of a total of 178,520 in Vanuatu).

The available data show that electricity utilities are mainly located on Tanna, Efate, Malekula, and the Banks Islands (mainly around Sola). There do not appear to be any recorded in Luganville, which likely suggests a data gap rather than an absence of electricity utilities.

Of the 194 recorded electricity utilities across Vanuatu, 25% (49) are exposed to a 1% AEP fluvial/pluvial flood

Table 31. The number of buildings on Malekula exposed to a 1% AEP, 2% AEP, and 10% AEP fluvial/pluvial flood events by the Area Council. In brackets is the percentage of the exposed buildings compared to the total number of buildings in the area.

Area	Total Number of Buildings	1% AEP	2% AEP	10% AEP
Malekula Island	24,501	7,181	6,631	5,487
South Malekula	2,239	572 (26%)	521 (23%)	414 (18%)
South-West Malekula	2,471	754 (31%)	699 (28%)	592 (24%)
South-East Malekula	2,480	922 (37%)	843 (34%)	625 (25%)
Central Malekula	6,269	2,437 (39%)	2,270 (36%)	1,977 (32%)
North-West Malekula	4,266	1,024 (24%)	934 (22%)	767 (18%)
North-East Malekula	6,733	1,464 (22%)	1,357 (20%)	1,105 (16%)

event, 20% (38) are exposed to a 2% AEP and 15% (29) are exposed to a 10% AEP event. These electricity utilities are only located in Malekula, Tanna and Port Vila due to the limits of the flood models and the likely limits in the available electricity utility location data (i.e. no information for Luganville).

Exposed Infrastructure on Malekula

Malekula has two Airports, of these, Lamap Airport is exposed to all modelled flood return periods. A total of 3 of the 28 network towers are exposed, including 2 near Lakatoro and 1 near South-West Bay.

Of the 17 bridges on Malekula, 13 are exposed to a 10% AEP fluvial flood event, increasing to 14 for both the 2% and 1% AEP events. Nine of these bridges are located in Central Malekula, near Lakatoro and Norsup Airport, with the remainder in South-East and South Malekula.

There are approximately 392 km of roads on Malekula, of which 94 km, 111 km, and 118 km are exposed to 10%, 2%, and 1% AEP events, respectively. Exposure occurs across the island and is primarily associated with roads located near, or crossing, rivers and streams. Under a 1% AEP event, approximately 30% of the road network could be exposed, indicating that a substantial proportion of the transport network may be affected during less frequent but more severe flood events.

Twenty-seven electricity utilities are identified on Malekula, primarily around Lakatoro, Litzlitz/Litslits, and Norsup Airport within Central Malekula Area Council. Of these, 3 utilities (11%) are exposed to a 10% AEP fluvial flood event, including 1 in Litzlitz/Litslits and 2 in Norsup. Exposure increases to 7 utilities under a 2% AEP event, located in Norsup (3), Litzlitz/Litslits (3), and near Aop Beach (1). Under a 1% AEP event, one additional utility near Aop Beach becomes exposed, bringing the total to 8 utilities, or approximately 30% of Malekula's recorded electricity utilities.

Malekula has approximately 24,501 buildings, of which 22% (5,487), 27% (6,631), and 29% (7,181) are exposed to 10%, 2%, and 1% AEP fluvial/pluvial flood events, respectively (Table 31). Overall, building exposure remains high across all Area Councils, including during more frequent flood events such as the 10% AEP scenario. Central Malekula records both the largest number of exposed buildings and the highest proportion relative to the total building stock across all flood return periods.

Infrastructure Exposure on Tanna

Ten of the 14 bridges on Tanna are exposed to a 10% AEP fluvial flood event, increasing to 11 and 14 bridges under the 2% and 1% AEP events, respectively. Exposed bridges appear to be concentrated along the coast between Isangel and Lakhalo in West and North Tanna, with one bridge near Yanawan in South-West Tanna. Whitegrass Airport is not exposed to fluvial or pluvial flooding.

Table 32. The number of buildings on Tanna exposed to a 1% AEP, 2% AEP, and 10% AEP fluvial/pluvial flood event by the Area Council. In brackets is the percentage of the exposed buildings compared to the total number of buildings in the area.

Area	Total Number of Buildings	1% AEP	2% AEP	10% AEP
Tanna Island	25,805	7,875	5,081	4,488
Whitesands	4,476	1,198	751 (16%)	681 (15%)
West Tanna	10,398	4,165 (40%)	2,816 (27%)	2,504 (24%)
North Tanna	2,891	439 (14%)	282 (10%)	249 (9%)
South Tanna	364	101 (28%)	65 (18%)	57 (16%)
South-West Tanna	3,034	696 (23%)	479 (16%)	141 (5%)
Middle Bush Tanna	4,650	1,278 (27%)	689 (15%)	584 (13%)

Of the 31 network towers on Tanna, 3 are exposed under both the 10% and 2% AEP events, increasing to 8 under the 1% AEP event. All exposed towers are located between Bethal and Lenakel, including one at Whitegrass Airport.

There are approximately 374 km of roads on Tanna, of which 48 km, 56 km, and 94 km are exposed to 10%, 2%, and 1% AEP events, respectively. Exposure occurs across the island and is generally associated with roads located near rivers, streams, or river crossings. This includes roads around Lenakel, Isangel, Tanna Hospital, and Whitegrass Airport.

Tanna has 29 recorded electricity utilities located along the coast between Lenakel and Bethal in West Tanna. Of these, 1 utility is exposed to a 10% AEP fluvial flood event, increasing to 2 under the 2% AEP event and 7 utilities (24%) under the 1% AEP event. Under the 1% AEP scenario, exposed utilities are concentrated mainly around Lenakel (3) and Isangel (4)

There are approximately 26,000 buildings on Tanna, of which around 17% (4,488), 20% (5,081), and 35% (7,875) are exposed to 10%, 2%, and 1% AEP fluvial/pluvial flood events, respectively (Table 32). Most exposed buildings are located in West Tanna, which also records the highest proportion of exposed buildings relative to its total building stock. Overall, building exposure remains substantial even under more frequent (10% AEP) flood events.

Infrastructure Exposure Near Luganville

The modelled fluvial/pluvial flood catchment on Santo covers all of Luganville and parts of Canal-Fanafo, South Santo, and South-East Santo. These results should be interpreted with caution, as the modelled area represents only part of Santo and does not capture flood exposure across the entire island.

Santo-Pekoa International Airport is exposed under all modelled fluvial/pluvial flood return periods and is the only recorded airport on Santo. Of the 39 network towers within the modelled area, 7 are exposed to a 10% AEP flood event, increasing to 13 under the 2% AEP event and 15 under the 1% AEP event. Exposed network towers are concentrated mainly in Luganville and near the airport.

There are approximately 19 bridges within the modelled catchment, of which 15 are exposed to a 10% AEP event, increasing to 16 bridges (84%) under both the 2% and 1% AEP fluvial/pluvial flood events. Exposed bridges appear to be concentrated along the coast, including 1 in Saraoutou, 1 in Bombua, 5 in Luganville, 4 near Naoneban, and the remainder along the main road near Parisa.

Approximately 49 km, 68 km, and 76 km of roads are exposed to 10%, 2%, and 1% AEP flood events, respectively. Under the 1% AEP scenario, this represents approximately 18% of the total road network across Luganville, South Santo, Canal-Fanafo, and South-East Santo. Exposure is

Table 33. Number of exposed buildings within the modelled areas of Santo under 10%, 2%, and 1% AEP fluvial/pluvial flood events

Area	Total Number of Buildings (modelled region)	1% AEP	2% AEP	10% AEP
Total	17,188	5,914	5,337	4,121
South Santo	3,878	456 (12%)	415 (11%)	331 (9%)
Canal-Fanafo	886	229 (26%)	205 (23%)	177 (20%)
Luganville	9,142	4,067 (44%)	3,664 (40%)	2,756 (30%)
South-East Santo	3,267	1,152 (35%)	1,044 (32%)	848 (26%)

highest in Luganville, where approximately 33 km (31%) of roads are potentially exposed, compared to around 7.4 km (10%) in South Santo, 16 km (13%) in Canal-Fanafo, and 21 km (16%) in South-East Santo.

Across the modelled areas of South Santo, Canal-Fanafo, Luganville, and South-East Santo, approximately 23% (4,121), 31% (5,337), and 34% (5,914) of buildings are exposed to 10%, 2%, and 1% AEP fluvial/pluvial flood events, respectively (Table 33). Luganville records both the highest number and highest proportion of exposed buildings across all return periods. Importantly, building exposure remains substantial even under the more frequent 10% AEP flood event.

The results in Table 33 should be interpreted cautiously because, with the exception of Luganville, the other administrative areas are only partially covered by the fluvial model.

For reference, the total number of buildings across the full administrative areas is approximately 9,142 in Luganville, 6,697 in South Santo, 4,155 in Canal-Fanafo, and 5,526 in South-East Santo. Areas outside the model extent are also likely to experience flooding but are not represented in this analysis.

Infrastructure Exposure Near Port Vila

The modelled fluvial/pluvial flood catchment on Efate extends along the coast from Evergreen to near Au Bon Marché on Kumul Highway. It covers all of the Port Vila Area Council and parts of Mele and Erakor. These results should be interpreted with caution, as the modelled area represents only part of Efate and does not capture flood exposure across the entire island.

All 7 bridges within the modelled area are exposed under the 10%, 2%, and 1% AEP flood events. These bridges cross the main rivers and streams flowing through the capital and are located along the Ring Road, including near Mele (4), Tagabe (1), Blacksands (1), and Switi (1).

Of the 63 network towers within the modelled area, 5 are exposed to a 10% AEP fluvial/pluvial flood event, increasing to 6 under the 2% AEP event and 9 under the 1% AEP event. Exposed towers are located near Bauerfield International Airport, within central Port Vila, and around the edge of Erakor Lagoon.

Approximately 42 km (22%), 52 km (27%), and 55 km (29%) of the 193 km of roads within the modelled area are exposed to 10%, 2%, and 1% AEP fluvial/pluvial flood events, respectively. Most exposed roads are located within the Port Vila Area Council boundary. Under the 1% AEP scenario, approximately 43 km, or 34% of the Port Vila road network, is potentially exposed.

Within the modelled area, there are 92 recorded electricity utilities. Of these, 25 utilities (27%) are exposed to a 10% AEP fluvial/pluvial flood event, increasing to 29 (32%) under the 2% AEP event and 34 (37%) under the 1% AEP event. Exposed utilities are distributed across Port Vila and appear to be associated with waterways, overland flow paths, and low-lying areas. All exposed utilities are located within the Port Vila Area Council boundary.

Table 34. Number of exposed buildings within the modelled area of Efate under 10%, 2%, and 1% AEP fluvial/pluvial flood events.

Area	Total Number of Buildings (modelled region)	1% AEP	2% AEP	10% AEP
Modelled portion of Efate	14,830	8,073 (54%)	7,710 (52%)	6,846 (46%)
Port Vila	14,816	6,134 (41%)	5,863 (40%)	5,226 (35%)
Erakor	501	192 (38%)	183 (37%)	167 (33%)
Mele	2,440	1,749 (72%)	1,666 (68%)	1,455 (60%)

There are approximately 14,830 buildings within the modelled area, of which 46% (6,846), 52% (7,710), and 54% (8,073) are exposed to 10%, 2%, and 1% AEP fluvial/pluvial flood events, respectively (Table 34). Port Vila records the highest total number of exposed buildings, while Mele records the highest proportion of buildings exposed relative to its total building stock. Importantly, building exposure remains substantial even under the more frequent (10% AEP) flood event. For reference, the total number of buildings across the full administrative areas is approximately 14,816 in Port Vila, 2,457 in Mele, and 3,880 in Erakor. This indicates that almost all of Port Vila and Mele are covered by the model, while only a small portion of Erakor is represented.

Vulnerability

Low-lying buildings, airports, electricity utilities, roads, bridges, and related infrastructure are vulnerable to high-intensity rainfall, river flooding, surface flooding, and overland flows. While the exact magnitude of vulnerability cannot be quantified due to limited local fragility data, flooding is likely to result in a range of direct and indirect impacts on infrastructure and services.

Potential vulnerabilities include:

- Significant structural damage to roads, bridges (including fords), and airport runways due to washouts, erosion, or surface degradation.
- Surface ponding and sediment deposition in low-lying areas, affecting infrastructure functionality and access to services.
- Damage to buildings from inundation, erosion, siltation, and deterioration of interior and exterior building materials.
- Damage to network towers, electricity utilities, and water infrastructure, particularly to electrical and mechanical components, resulting in service disruptions.
- Flow-on impacts associated with electricity outages, including disruptions to communications, water supply systems, businesses, and essential services.
- Damage to homes and community infrastructure, with vulnerability influenced by construction materials and building condition. While homes constructed using traditional or hybrid materials may, in some cases, be more easily repaired, they may still be highly exposed to repeated flooding impacts.

Increasing urbanisation is expected to further increase flood-related impacts on infrastructure, property, and stormwater management systems, particularly in low-lying urban areas, as observed globally [163]. Specific vulnerability curves or fragility functions for Vanuatu were not identified during the assessment.

Consequences

Surface flooding, high river flows, and overland flow associated with heavy rainfall are likely to affect mobility (roads), communications (network towers), electricity distribution, property access, and public safety in both rural and urban areas. These impacts can disrupt daily activities and livelihoods, affecting people's ability to travel, work, and access essential services. Damage to homes may require significant time and financial resources for repairs, while severe damage may result in temporary or prolonged displacement of households.

To assess the relative consequences of fluvial/pluvial flooding, risk scores were calculated using spatial layers of available infrastructure elements. These scores were

Table 35. Risk Scores for fluvial/pluvial flooding for present day 1%, 2% and 10% AEP.

1% AEP	2% AEP	10% AEP
Luganville (100)	Luganville (100)	Central Malekula (100)
Central Malekula (98.4)	Central Malekula (99.9)	Luganville (96.5)
West Tanna (91.6)	West Tanna (67.0)	South Malekula (66.8)
Port Vila (57.2)	South Malekula (58.3)	West Tanna (63.7)
South Malekula (56.1)	Port Vila (53.1)	Port Vila (56.6)
Mele (25.4)	Mele (26.3)	Mele (26.9)
Canal – Fanafo (18.4)	Canal – Fanafo (18.9)	Canal – Fanafo (21.1)
South Santo (13.7)	South Santo (14.1)	South Santo (15.9)
South-East Santo (13.6)	South-East Santo (13.7)	South-East Santo (14.6)
North-West Malekula (10.0)	North-West Malekula (9.9)	North-West Malekula (10.4)

normalised to identify administrative areas with the highest concentration of exposed infrastructure under 10%, 2%, and 1% AEP flood events.

Luganville and Central Malekula emerge as the areas with the highest relative concentration of infrastructure exposed to fluvial and pluvial flooding, reflecting the concentration of infrastructure within the available modelled areas. South Malekula, West Tanna, and Port Vila also rank among the five highest-risk areas. West Tanna is particularly notable under the 1% AEP scenario, indicating elevated exposure during less frequent but more severe flood events.

9.7 Tropical Cyclones

Vulnerability

Infrastructure assets, including buildings, roads, network towers, electricity systems, ports, and airports, are highly vulnerable to high winds, coastal inundation, heavy rainfall, and flooding associated with tropical cyclones. Although infrastructure-specific fragility functions are not available for Vanuatu, several key vulnerabilities are evident.

Homes and buildings are particularly exposed to cyclone-related wind damage. The extent of damage depends on construction materials, structural design, maintenance, and the way building components are connected. Evidence on the relative resilience of traditional, hybrid, and modern housing types remains mixed and context specific. Some studies suggest that traditional homes may sustain greater structural damage but are easier to repair and may pose lower risks to life compared to hybrid or modern housing. However, other observations indicate that traditional houses in parts of Ambae, Maewo, and Pentecost survived Cyclone Harold with relatively limited damage [165]. Hybrid and modern homes are generally more likely to remain standing but may still experience significant structural failure when poorly constructed or exposed to severe wind conditions. A revised national building code introduced in 2025 aims to strengthen cyclone-resilient construction standards across Vanuatu

Electricity utilities, solar panels and distribution networks are also vulnerable to cyclone impacts, particularly from strong winds, falling vegetation, flooding, and saltwater exposure. Damage to electricity infrastructure can result in prolonged service disruptions and cascading impacts across communications, water supply, transport, businesses, and other essential services.

Marine transport infrastructure and vessels, including boats, barges, and ferries, are highly exposed to strong winds, heavy swells, and storm surge conditions. Limited availability

of sheltered mooring locations increases the likelihood of vessel damage during severe weather events.

Additionally, road networks are vulnerable to obstruction and damage from landslides, debris, erosion, and treefall associated with cyclone conditions. Vulnerabilities associated with coastal flooding, fluvial flooding, and pluvial flooding are discussed in previous sections.

Consequences

Tropical cyclones including associated wind, floods and coastal inundation) threaten critical transportation infrastructure and connectivity throughout Vanuatu, with particularly severe consequences for coastal assets and inter-island transport. Recovery is often a long process, taking years and potentially requiring imported labour and materials.

Port facilities are directly affected by cyclone impacts and associated coastal inundation, while many airports operate at vulnerable elevations. This includes airports like Anaytom, Aromai, and Lamen Bay, which are located within approximately 2m of mean sea level.

Boats and barges, which serve as the main form of transport between islands, have Boats and barges, which serve as the primary form of transport between islands, have limited sheltered locations during storms and frequently sustain damage, disrupting the movement of people, goods, and essential supplies. These disruptions create cascading consequences for industries dependent on timely transportation, particularly seafood and manufacturing sectors that rely on port and airport facilities for regional exports, imports, and tourism.

The failure of the national airline in May 2024 has further reduced transport resilience, leaving many locations accessible only by boat or ferry and heightening vulnerability when cyclones damage marine transport options.

Homes and buildings can be destroyed by high winds, coastal flooding, and associated fluvial and pluvial flooding, rendering people homeless and in need of shelter and humanitarian aid. Significant time and financial resources are likely to be required to rebuild homes and other buildings.

After Cyclone Pam in 2015 the President of Vanuatu called the cyclone a monster that had destroyed or damaged 90% of the buildings in Port Vila: “This is a very devastating cyclone in Vanuatu. I term it as a monster, a monster. It’s a setback for the government and for the people of Vanuatu. After all the development that has taken place, all this development has been wiped out” [169].

9.8 Compounding, Cascading Impacts and Interdependencies

Electricity networks, particularly transmission lines and substations, are vulnerable to climate-related hazards in Vanuatu [3]. Other systems that depend on a reliable electricity supply, including logistics and communications, are also vulnerable to both short- and long-term electricity outages. The indirect impacts of electricity loss may exceed the direct impacts, including risks to life for people dependent on electrically powered medical devices, as well as disruptions to employment, health, nutrition, and WASH services. The widespread use of Starlink systems means communications can, to some extent, be maintained during disruptions, provided devices remain charged

Central and Provincial governments may face increasing costs associated with more frequent damage to council-owned infrastructure. Higher insurance, repair, and maintenance costs are likely to place additional pressure on government budgets. Decisions regarding infrastructure investment and maintenance priorities may become increasingly complex as competing demands intensify. There may also be a need for more transformative approaches to infrastructure provision and funding, as identified in the Infrastructure Strategy

Energy supply disruptions following hazard events may affect refrigeration and other components of the supply chain, leading to reduced availability of goods, loss of export income, and cascading impacts on employment. Climate- and hazard-related impacts on communications infrastructure may also reduce the efficiency of supply chains and logistics systems

Climate change and hazard impacts may further exacerbate existing economic inequalities. Poverty rates are higher in rural areas than in urban areas, where much of the labour

Table 36. Key Interconnections and Cascading Risks

Sector	Key Interconnections and Cascading Risks
Health and WASH	Isolation of communities limiting access to healthcare and emergency services; public health risks associated with sewage exposure during system failures; disruption to sanitation services affecting homes and businesses; damage to water and sanitation infrastructure; transportation disruptions affecting access to medical facilities; need for hazard-resilient healthcare facilities and backup systems; potential property damage from surface flooding and wastewater backups.
Tourism	Reduced access to tourist destinations; disruption to freight movement and supply chains; increased transportation costs affecting tourism operations and visitor access.
Ecosystems	Environmental damage from transportation infrastructure failures, including culvert failures and associated erosion; increased sediment runoff from damaged roads affecting waterways and coastal ecosystems; wastewater overflows affecting water quality; shoreline hardening affecting coastal habitats; loss of coastal vegetation reducing natural protection from storm surge and erosion.
Education	Isolation of communities limiting access to schools and education services.

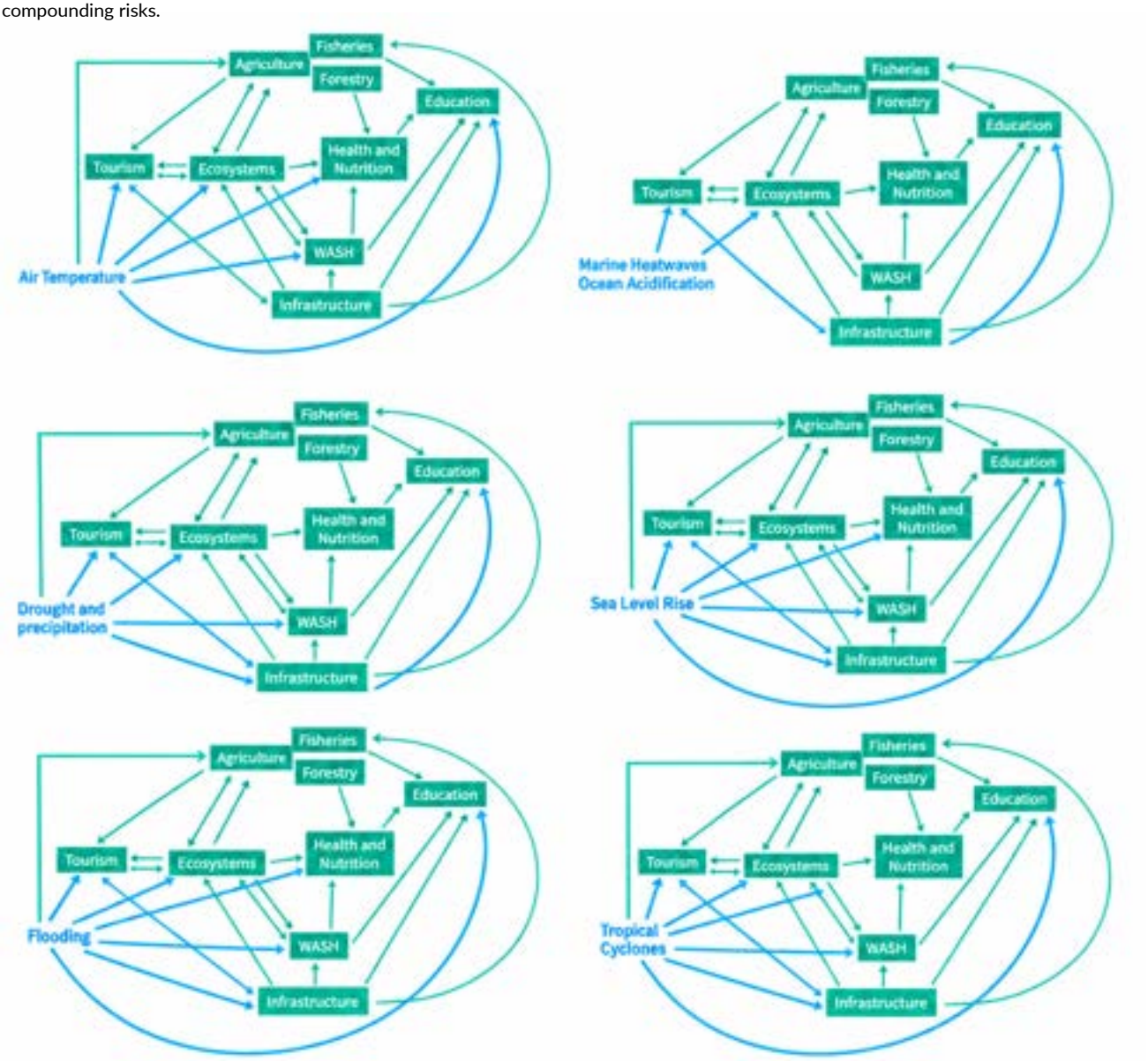
force is engaged in agriculture and traditional economic activities. Urban areas benefit from tourism, commerce, and trade, but also experience high living costs and housing pressures, contributing to intra-urban inequalities [9]. Without careful consideration of equity in infrastructure investment and adaptation planning, investment patterns may continue to favour communities with existing economic advantages. Urban areas may receive a disproportionate share of investment due to higher population densities, the concentration of existing infrastructure, and environmental challenges such as sewage contamination, which is more common in urban areas. Adaptation infrastructure may also unintentionally reinforce unequal levels of protection between communities.

There may also be significant impacts on industries employing lower-skilled workers, particularly agriculture, as discussed in the Agriculture Sector section. Climate and hazard impacts may affect the effectiveness of social support systems during and after disruptive events, while disruptions to transport networks may affect commuting patterns and social connections within and between settlements, provinces, and regions.Social interaction, community integration, and informal community connections are also likely to be affected by climate and hazard impacts on infrastructure. Public spaces and community facilities supporting social interaction are often located in hazard-prone areas, and their loss may reduce opportunities available to children and young people. Infrastructure design can influence people's sense of connection and belonging, while either supporting or excluding certain groups depending on how infrastructure is planned and delivered. Ensuring that new infrastructure is both climate-resilient and inclusive will provide multiple benefits for communities across Vanuatu.

Infrastructure is a cross-cutting sector with strong interconnections and interdependencies across all sectors considered in this CRVA, particularly health and WASH, tourism, ecosystems, and education (Figure 26). Climate impacts on infrastructure can therefore create cascading and compounding consequences across multiple sectors simultaneously. Key sector interconnections and cascading risks are summarised in Table 36.

Community consultation undertaken in Port Vila highlighted concerns regarding WASH impacts associated with poor waste management, including unmanaged dumpsites, septic tanks, and open discharge areas contributing to water quality issues. Consultation findings also identified the need for feasibility studies on waste and water solutions, improved uptake of climate-resilient infrastructure design, infrastructure inventories across transport, waste, and water sectors, and improved coordination and data sharing between sectors and ministries. Informal settlements were identified as particularly vulnerable due to limited stormwater systems and the absence of asset management plans.

Figure 26. Illustration of the interdependencies between the infrastructure sector and other sectors that create cascading and compounding risks.



9.9 Summary and Considerations

The Area Councils with the highest infrastructure risk scores include Central and South Malekula, Luganville, and West Tanna. Central and South Malekula record high risk scores for coastal flooding and associated sea-level rise, while Luganville, Central Malekula, South Malekula, and West Tanna record the highest risk scores for fluvial and pluvial flooding.

Transport, electricity, communications, and water systems are highly interconnected, meaning infrastructure failures can create widespread cascading impacts. Tropical cyclones and flooding events can damage infrastructure, disrupt transportation routes, compromise telecommunication systems and electricity networks, damage water infrastructure, and strain national and international supply chains, hampering relief and recovery efforts.

Flooding associated with heavy rainfall may affect mobility, property access, and public safety in both rural and urban areas. Coastal flooding and sea-level rise are expected to increasingly expose transportation infrastructure, buildings, and port facilities, particularly as several critical infrastructure assets, including airports, are located within 2 m of current mean sea level. Anatom, Aromai, and Lamen Bay airports are particularly exposed to progressive inundation, while maritime infrastructure supporting inter-island transport faces similar risks.

Communities may become increasingly isolated under changing climate conditions due to limitations in Vanuatu's transport network. Sealed roads, gravel roads, and footpaths each face distinct vulnerabilities from erosion, washouts, thermal cracking, landslides, and mudslides. Maritime transport, which has become increasingly important following the collapse of the national airline, continues to operate with limited cyclone-resistant mooring infrastructure, while wharf infrastructure faces increasing exposure to sea-level rise and coastal flooding.

Economic disruptions associated with infrastructure failures may exceed direct damage costs. Agricultural products may spoil without refrigerated transport, tourism revenues may decline when basic services fail, and commercial activities may be disrupted by electricity and communications outages.

Two initiatives under the Vanuatu Community-Based Climate Resilience Project [170] are of particular importance for strengthening climate resilience in Vanuatu:

- The establishment of early warning systems to reduce loss of life and damage to infrastructure through pre-emptive evacuations and measures to protect infrastructure before hazard events.
- The establishment of local disaster risk reduction committees to strengthen preparedness, support proactive recovery efforts, and improve the resilience of communities and infrastructure, with support from Vanuatu emergency services.





CHAPTER

10

Tourism

10.1 Key Findings for Tourism

Tourism infrastructure is highly exposed to climate and natural hazards due to its concentration in low-lying coastal areas, particularly around Efate, Santo, Port Vila, Luganville, and parts of Malekula. These areas face increasing exposure to tropical cyclones, coastal flooding, sea-level rise, and extreme rainfall.

Tropical cyclones remain the most immediate and destructive threat, with repeated events and limited recovery periods reducing the sector's ability to recover, maintain visitor confidence, and sustain operations.

Tourism is highly dependent on healthy marine and coastal ecosystems, which underpin activities such as diving, snorkelling, and marine tourism. Ocean acidification, marine heatwaves, and ecosystem degradation may reduce the attractiveness of Vanuatu as a destination.

The sector is closely interconnected with infrastructure, agriculture, fisheries, water supply, and transport systems. Climate impacts affecting these sectors create significant cascading effects across tourism operations, livelihoods, and the wider economy.

Water insecurity and dependence on imported goods represent growing structural vulnerabilities. Prolonged droughts, changing rainfall patterns, and supply chain disruptions may increase operating costs and reduce long-term resilience.

10.2 Overview of the Tourism Sector

Tourism is a vital economic sector for Vanuatu, yet it faces significant vulnerability to climate-related hazards [171]. Prior to recent disruptions, the sector generated substantial economic benefits, with 120,513 air arrivals and 135,357 cruise ship arrivals recorded in 2019 [171]. Tourism infrastructure spans 28 airports across the archipelago, supporting domestic connectivity where inter-island travel often depends on air transport due to the frequency and duration of some boat connections. Key tourism attractions include diving and snorkelling, volcanic landscapes, traditional kastom performances, and both white and black sand beaches. Tourism is also supported through vocational training, with 15 tourism-related courses offered through local institutions.

Natural hazards and climate-related events are among the most visible and destructive threats to the sector. Tropical Cyclone Pam, which struck Vanuatu between 12–14 March 2015, resulted in 11 fatalities and displaced approximately 75,000 people [248]. National authorities estimated total economic losses at VT 48.6 billion (approximately US$450 million), equivalent to around 64% of national GDP [248]. The tourism sector experienced extensive disruption, with many accommodation and dining establishments ceasing operations for periods of three to six months. Visitor arrivals declined by 11% in 2015, while tourism-related losses were estimated at VT 9.5 billion (approximately US$88 million), representing around 20% of total national disaster losses [248].

Beyond quantified economic losses, Cyclone Pam also caused extensive environmental damage, including impacts to coral reefs and beaches that underpin tourism activity. These ecological losses were not fully captured in official damage assessments. More recently, Tropical Cyclones Judy and Kevin, combined with an earthquake in 2023, again demonstrated the vulnerability of infrastructure, transport systems, ecosystems, and supporting services to compounding hazard events.

The Sustainable Tourism Strategy (2021–2025) recognises these risks and identifies the need to diversify tourism operations and strengthen resilience to disruptions [172]. Sustainable tourism practices can support the protection of environmental and cultural assets while strengthening local livelihoods and reducing reliance on imported goods and services. Community perspectives also reinforce this connection, with initiatives such as marine conservation areas supporting both ecosystem protection and tourism income generation [173].

Hazard Data Availability and Suitability

The assessment of climate risks to the tourism sector integrates multiple hazard datasets with varying levels of detail, temporal coverage, and spatial resolution. Overall, hazard information is suitable for identifying broad tourism risk patterns and priority areas for adaptation planning, although important limitations remain.

Key limitations include:

- limited spatial coverage for fluvial and pluvial flood modelling;
- coarse regional aggregation for drought and precipitation projections;
- limited quantitative tropical cyclone projections; and
- low-resolution ocean acidification datasets.

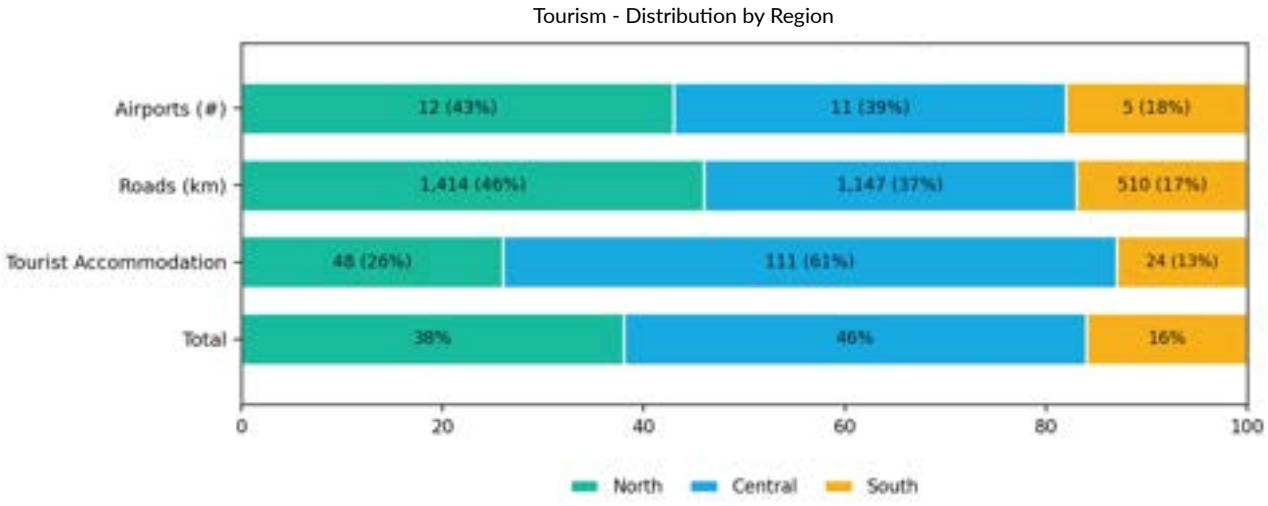
A summary of available hazard datasets and key qualitative data sources used in the assessment is presented in the appendix C-Tables 19 and 20 respectively.

National Distribution of Key Elements

The Tourism infrastructure is unevenly distributed across Vanuatu, with approximately 61% of recorded tourist accommodation located in the Central region, compared with 26% in the North and 13% in the South. Roads and airports are similarly concentrated in the North and Central regions.

This distribution places a large proportion of tourism infrastructure within low-lying coastal areas of Efate, Santo, and parts of Malekula, increasing exposure to tropical cyclones, coastal flooding, sea-level rise, and extreme rainfall events.

Figure 27. Distribution of tourism-related elements across Vanuatu



Risk Assessment for the Tourism Sector

Tourism exposure and risk are driven by the concentration of infrastructure within coastal and hazard-prone areas, combined with the sector's reliance on healthy ecosystems and supporting infrastructure systems.

Unlike damaged infrastructure, degraded coral reef systems and coastal ecosystems may require decades to recover or may not recover within tourism planning timeframes.

Coastal Flooding and Sea-Level Rise

Under present-day conditions, 19 of 183 tourist accommodations (10%) are exposed to a 1% AEP coastal flood event. This increases to 26% under 1.5 m sea-level rise. Exposure is concentrated around Efate and Santo, where tourism infrastructure is located in low-lying coastal areas.

Two airports, Lamap Airport and Lamen Bay Airport, are exposed under present and future sea-level rise conditions.

Table 37. Climate hazards, vulnerabilities and potential consequences for the Tourism sector

Climate Hazard	Key Vulnerabilities	Potential Consequences
Tropical cyclones, coastal flooding, sea-level rise, fluvial and pluvial flooding	Tourism infrastructure, accommodation, roads, airports, and wharves are concentrated in low-lying coastal and flood-prone areas and are exposed to wind damage, inundation, erosion, storm surge, and extreme rainfall. Damage to transport and supporting infrastructure can also disrupt visitor access, supply chains, and tourism operations.	Damage to tourism infrastructure and ecosystems, disruption to transport and tourism services, prolonged business closures, reduced visitor numbers, reputational impacts affecting Vanuatu's attractiveness as a tourism destination, and loss of income and employment.
Drought and changes in precipitation	Tourism operations and attractions depend on consistent freshwater availability for accommodation, sanitation, restaurants, and tourism activities. Freshwater attractions such as waterfalls and blue holes are also sensitive to prolonged dry periods.	Water shortages affecting tourism operations and service quality, reduced viability of freshwater attractions, increased competition for freshwater resources, and increased investment requirements for water storage and conservation infrastructure.
Ocean acidification and marine heatwaves	Marine tourism activities such as diving and snorkelling depend on healthy coral reefs, marine biodiversity, and coastal ecosystems. Ocean acidification and marine heatwaves threaten coral reef health and ecosystem stability.	Coral bleaching, ecosystem degradation, reduced visitor experiences for marine tourism activities, and potential declines in tourism demand and local tourism income.

Table 38. Normalised Risk Scores for the Tourism sector associated with coastal flooding and sea-level rise at 0.0m, 0.5m, 1.0m and 1.5m sea-level rise increments. Red arrows indicate a new entry or increased ranking position. Yellow arrows indicate a decreased ranking position.

0.0m SLR	0.5m SLR	1.0m SLR	1.5m SLR
Nguna (100)	Nguna (100)	Nguna (100)	Nguna (100)
South Malekula (87.5)	South Malekula (89.1)	South Malekula (80.6)	Port Vila (68.1)
Vermali (80.7)	Vermali (80.5)	Vermali (71.3)	South Malekula (67.2)
Port Vila (39.2)	Port Vila (53.6)	Port Vila (60.2)	Vermali (58.4)
Eratap (26.0)	Eratap (51.5)	Luganville (46.5)	Luganville (57.6)
Eton (25.3)	South-East Santo (40.7)	Eratap (46.3)	South-East Santo (40.3)
North Efate (13.9)	North Efate (27.5)	South-East Santo (37.1)	Malorua (39.2)
Malorua (13.6)	Luganville (26.4)	North Efate (25.6)	Eratap (38.6)
Erakor (13.4)	Central Malekula (14.8)	Eton (24.4)	North Efate (32.3)
Central Malekula (13.1)	Malorua (14.8)	Central Malekula (16.3)	Eton (30.1)

Risk scores derived from tourism accommodations, airports, and roads indicate that Nguna, South Malekula, and Vermali remain consistently among the highest relative risk areas across all sea-level rise scenarios, reflecting persistent concentrations of tourism-related assets exposed to coastal flooding. Port Vila and Luganville become increasingly prominent under higher sea-level rise scenarios, suggesting growing exposure within Vanuatu's major tourism and transport hubs. South-East Santo also emerges as an increasingly significant hotspot under higher sea-level rise scenarios.

Overall, these results indicate increasing tourism exposure within key coastal tourism and transport hubs, particularly around Efate, Santo, and parts of Malekula, while also highlighting smaller hotspot areas with proportionally high exposure.

Fluvial and Pluvial Flooding

Under a 1% AEP flood event, 32 of 183 tourist accommodations (17%) are exposed to fluvial and pluvial flooding. Exposure is lower under the more frequent but lower-magnitude flood events but remains concentrated in Luganville and South Malekula.

Two airports, Santo-Pekoa International Airport and Lamap Airport, are potentially exposed under all three flood return periods.

Results are likely conservative, as fluvial and pluvial flood modelling is currently limited to selected areas of Vanuatu, including Malekula, Tanna, and catchments near Port Vila and Luganville.

Risk scores derived from tourism accommodations, airports, and roads indicate that Luganville and South Malekula consistently rank as the highest relative risk areas across all flood return periods, reflecting persistent concentrations of tourism-related assets within flood-prone areas. Port Vila also maintains a relatively high ranking across all scenarios, indicating sustained exposure within a major tourism and transport hub.

Other locations, including Whitesands, West Tanna, Central Malekula, and South-East Santo, show more variable rankings across return periods, emerging as secondary hotspots depending on flood magnitude and the spatial distribution of exposed assets.

Table 39. Normalised risk scores for the Tourism sector associated with fluvial and pluvial flooding under 1%, 2%, and 10% AEP flood events. Red arrows indicate a new entry or increased ranking position while Yellow arrows indicate a decreased ranking position.

1% AEP	2% AEP	10% AEP
Luganville (100)	Luganville (100)	Luganville (100)
South Malekula (64.3)	South Malekula (68.5)	South Malekula (85.5)
Port Vila (32.1)	Port Vila (33.7)	Port Vila (36.5)
Whitesands (23.7)	Whitesands (21.0)	Whitesands (22.1)
West Tanna (15.8)	Central Malekula (12.6)	Central Malekula (10.4)
Central Malekula (12.3)	West Tanna (7.5)	South-East Santo (8.3)
South-East Santo (7.3)	South-East Santo (7.4)	Mele (6.2)
South-East Malekula (5.2)	South-East Malekula (5.3)	South-East Malekula (5.9)
North-West Malekula (5.2)	Mele (5.3)	North-West Malekula (5.5)
Mele (5.1)	North-West Malekula (5.1)	West Tanna (5.0)

Risk scores are relative and normalised to compare the concentration of tourism-related assets exposed within each administrative area under each scenario.

Overall, these findings indicate that fluvial and pluvial flood exposure is highly localised, with persistent hotspots in Luganville and South Malekula and additional variable hotspots across Tanna, Malekula, and Santo where tourism infrastructure intersects with flood-prone areas.

10.3 Compounding, Cascading Risks and Interdependencies

Vanuatu's tourism sector is exposed to multiple interacting climate hazards. Tropical cyclones pose an immediate threat, while sea-level rise, ocean acidification, marine heatwaves, extreme rainfall, and prolonged drought are likely to create increasing risks in the near to long term.

Disruptions to tourism activities create widespread cascading effects across the economy, affecting retail, transport, accommodation, and food services. When cyclone events force businesses to close, suppliers, transport operators, and communities dependent on tourism income are also affected [94].

The 2023 sequence of Tropical Cyclones Judy and Kevin, followed by an earthquake, demonstrates the compounding nature of these hazards. In addition to damage to buildings, roads, power, and communications, crop losses reduced local food supply, increasing competition for resources and limiting food available for tourism operations. Water-borne illnesses also increased due to compromised drinking water.

Such events require operators to divert resources toward recovery rather than maintaining service quality or investing in resilience. Because the sector is closely linked to agriculture, fisheries, and infrastructure, climate impacts on these sectors can generate significant knock-on effects even where tourism facilities themselves are not directly damaged [94].

Key interdependencies between tourism and other sectors are outlined below.

Fisheries and Ecosystems: Tourism activities such as diving, snorkelling, kayaking, paddleboarding, and island tours depend heavily on healthy marine and coastal ecosystems [94]. Dive industries operate at the intersection of tourism and fisheries and therefore provide an important indication of the condition of both sectors.

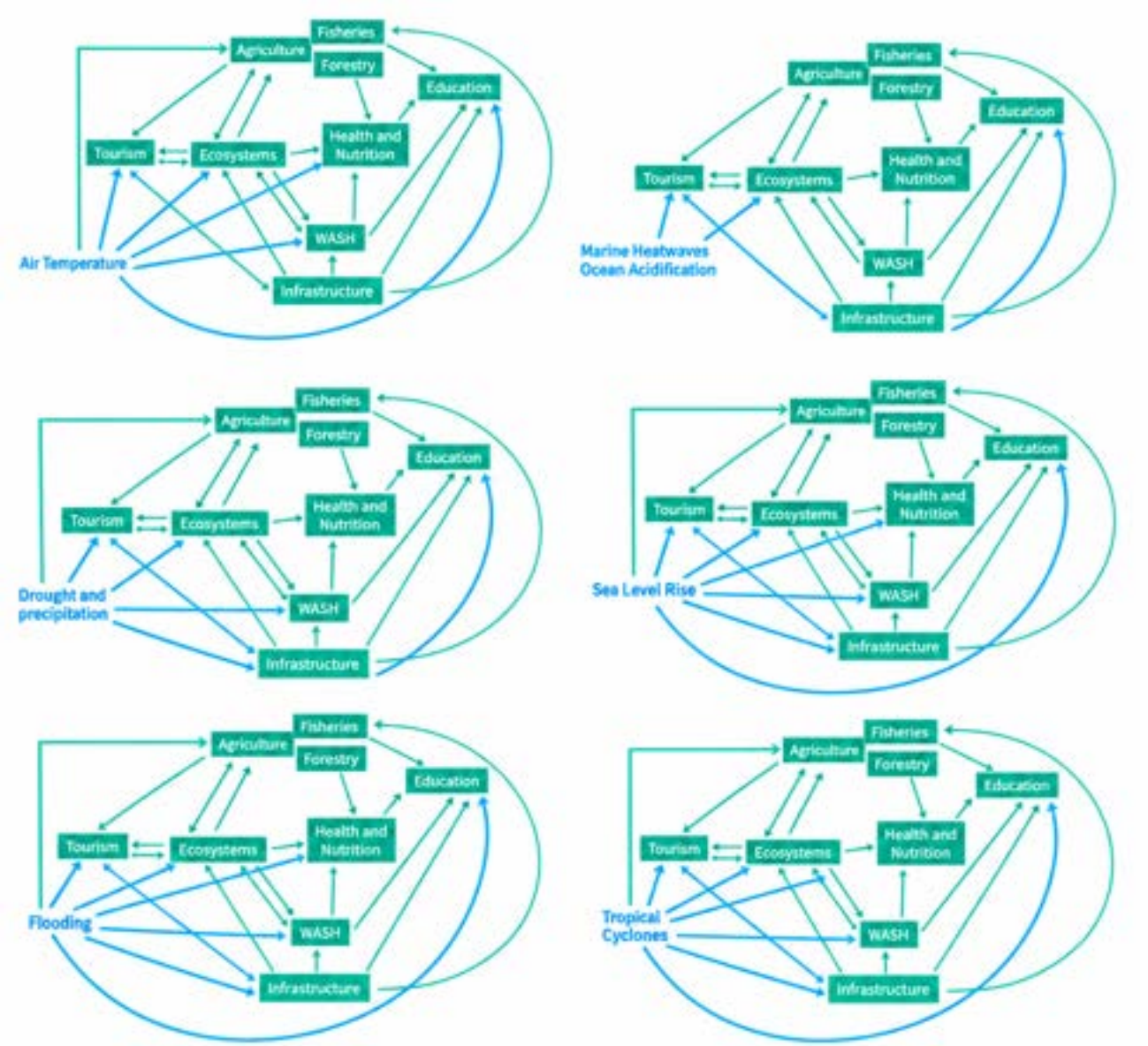
Degradation of coral reefs, seagrass meadows, mangroves, and marine biodiversity may reduce the attractiveness of Vanuatu as a destination and negatively affect local livelihoods linked to marine tourism. Stakeholders highlighted during consultations that nature-based solutions, including mangrove restoration and improved drainage systems, may provide co-benefits for both tourism resilience and ecosystem protection.

Infrastructure and Supply Chains: Tourism in Vanuatu is highly dependent on imported goods and functioning transport systems. Damage to ports, airports, roads, or utilities can disrupt access to food, fuel, and tourism supplies, affecting both operations and visitor experience.

The sector also experiences high economic leakage, with significant expenditure directed toward imported goods, travel agent commissions, and foreign airline revenues. In Port Vila, hotels spend approximately 54% of their annual food budget (approximately USD 7 million) on imported goods [175]. This dependence increases vulnerability when infrastructure and supply chains are disrupted [248].

Tourism also places additional pressure on local water, telecommunications, and electricity systems. Consultation findings indicate that while some adaptation initiatives are underway, many remain at an early stage and require sustained funding, coordination, and maintenance support. Eco-tourism may support more climate-resilient infrastructure and livelihoods; however, complex permitting processes and high participation costs can limit opportunities for local communities. Climate awareness programmes are also planned but require improved coordination, dedicated staffing, and sustained financial support.

Figure 28. Interconnections between sectors and climate hazards



Agriculture and Local Food Systems: Tourism is closely linked to local agricultural production through food supply chains supporting hotels, restaurants, and tourism services. Climate impacts such as drought and tropical cyclones may reduce food availability, increase operating costs, and increase reliance on imported food. For local communities, the disruption or loss of tourism facilities may reduce employment and income opportunities linked to tourism operations. Figure 28 illustrates the interconnectedness between the nine sectors and six climate hazards assessed in this report.

10.4 Summary and Considerations

Tourism in Vanuatu is highly sensitive to climate and natural hazards due to its dependence on coastal infrastructure, functioning transport systems, reliable water supplies, and healthy ecosystems. Tropical cyclones remain the most immediate and destructive threat to the sector, while sea-level rise, coastal flooding, changing rainfall patterns, ocean acidification, and marine heatwaves are expected to create increasing long-term pressures on tourism operations and destinations.

Exposure is concentrated around major tourism and transport hubs, including Efate, Port Vila, Luganville, Santo, and parts of Malekula, where accommodation, airports, roads, and supporting infrastructure are located within low-lying coastal areas. Repeated hazard events with limited recovery periods, such as the 2023 Tropical Cyclones Judy and Kevin, may further reduce the sector's capacity to recover and maintain visitor confidence.

Ongoing sea-level rise and coastal erosion may progressively reduce beach areas and increase damage to tourism infrastructure and supporting services. Many tourism facilities and airports are located within low-elevation coastal zones, exposing them to increasing risks from coastal inundation, storm surge, and erosion over time.

Tourism operations are also expected to face increasing water supply pressures associated with prolonged droughts and changing rainfall patterns. Extended dry periods may require tourism facilities to invest in additional water storage, conservation, and supply infrastructure to maintain operational continuity and service quality.

Marine ecosystem degradation associated with ocean acidification and marine heatwaves may reduce the attractiveness of Vanuatu as a diving and marine tourism destination. Coral bleaching, degradation of seagrass ecosystems, and broader ecosystem decline may negatively affect visitor experiences associated with diving, snorkelling, boating, and marine wildlife tourism.

Because tourism is closely interconnected with infrastructure, agriculture, fisheries, ecosystems, utilities, and transport systems, climate impacts affecting these sectors may generate significant cascading consequences across the wider economy.

Global climate mitigation efforts may also indirectly affect tourism in Vanuatu, particularly if measures to reduce emissions from international aviation increase the cost of long-haul travel and reduce demand for high-emissions tourism markets [94].

Strengthening tourism resilience will therefore require:

- climate-resilient infrastructure and transport systems;
- improved water security;
- protection and restoration of marine and coastal ecosystems;
- strengthened disaster preparedness and recovery systems; and
- more diversified and locally resilient tourism models.



CHAPTER

11

Water, Sanitation and Hygiene (WASH)

11.1 Key Findings for WASH

Climate change is increasingly undermining progress in WASH across Vanuatu. Drought, flooding, tropical cyclones, sea-level rise, and saltwater intrusion are placing growing pressure on water availability, water quality, sanitation infrastructure, and service reliability, particularly in rural and low-lying coastal communities.

Central Malekula is identified as the highest relative WASH exposure hotspot. Across all scenarios, the area consistently records the highest proportion of WASH-related assets (water infrastructure and roads) exposed to coastal flooding, sea-level rise, and fluvial/pluvial flooding. Other high-risk areas include Port Vila, West Tanna, South Malekula, Vanua Lava, and Mele.

Sea-level rise is projected to significantly increase exposure of WASH infrastructure. Under a 1.5 m sea-level rise scenario, approximately 35% of mapped water infrastructure units are exposed to a 1% AEP coastal flood event, with particularly high exposure around Norsup, Lakatoro, and Litslits on Malekula.

Rural and remote communities face heightened vulnerability. Heavy reliance on rainwater harvesting, community-managed systems, and limited alternative water sources reduces resilience to climate variability. Women, children, older people, and people living with disability face disproportionate impacts during WASH disruptions.

WASH-related risks have significant health and cascading cross-sector impacts. Unsafe water, damaged sanitation systems, and service disruptions increase the risk of diarrhoeal diseases and typhoid, contribute to dehydration and malnutrition, and create unsafe conditions in evacuation settings. These impacts can reduce food and livelihood security, disrupt education and tourism, and weaken overall community resilience.

Increased demand for water during periods of extreme heat or drought will put pressure on supply, meaning people (mostly women and children) must walk further distances to access safe water. Water scarcity may also heighten social tension.

People who become unwell due to poor WASH may be unable to take part in paid employment and subsistence agriculture and fisheries, with implications for food security, income, and for Vanuatu's economic productivity and prosperity. Children may also be unable to attend school, affecting their educational outcomes.

Populations at higher risk include older adults, children, women and adolescent girls, people with a disability, and other marginalised groups. Rural and remote communities are also more vulnerable due to having lower existing access to safe WASH infrastructure.

11.2 Overview of the WASH Sector

Clean water, sanitation and hygiene (WASH) are essential for health, livelihoods and resilient communities [176]. Access to safe drinking water and sanitation is recognised as a human right and forms part of children's right to the highest attainable standard of health [177]. Despite gradual improvements, safe, reliable and climate-resilient WASH services remain a major challenge in Vanuatu [178] [179].

Vanuatu's WASH sector is considered one of the most underfunded in the Pacific relative to need [180]. Between 2016 and 2020, government expenditure on WASH averaged approximately $5.4 USD per capita annually, compared to a regional average of $74.0 USD [180]. Less than 2% of donor funding across all sectors was directed toward WASH between 2011 and 2020 [180]. At the same time, households bear a relatively high share of WASH-related costs compared to other Pacific countries [180].

Water sources in Vanuatu include rivers and streams, groundwater, wells, and both private and communal rainwater harvesting systems [65] [156] [179] [181]. Water availability varies considerably across islands depending on topography and geology. Smaller and low-lying islands often rely heavily on rainwater harvesting due to limited groundwater and surface water availability [156] [182]. In rural areas, rainwater harvesting remains particularly important, with the 2020 Census indicating that 41.9% of rural populations relied on private or shared rainwater tanks as their primary drinking water source [4].

Although approximately 87% of the population was estimated to have at least basic access to drinking water in 2024, this does not necessarily mean that water is safely managed or reliable [183] [184]. Water reliability is a significant challenge, particularly for rainwater-dependent communities. A 2021 survey of rainwater tanks across 19 islands found that more than half did not provide sufficient water year-round [181]. Rural rainwater systems have also been associated with relatively high E. coli contamination levels compared to other water sources [185]. While groundwater systems generally perform better in terms of water security and resilience, coastal groundwater supplies are increasingly exposed to saltwater intrusion as sea levels rise [131].

Access to sanitation and hygiene services is a persistent challenge. In 2022, approximately 22% of the population had access to limited hygiene services and 27% had access to limited sanitation services [186]. Poor access to safe WASH contributes significantly to illness and preventable mortality, particularly through water- and sanitation-related diseases among children under five and populations in rural and remote areas [178].

The operation and maintenance of WASH systems in many communities depends heavily on local management capacity and community financing [178]. Seasonal labour migration can reduce local maintenance capacity, particularly where technical and management roles are male dominated. Increased participation of women and people living with disabilities in WASH governance and maintenance has been identified as an important opportunity to strengthen community resilience [178] [187].

Climate change and natural hazards are expected to place growing pressure on the WASH sector through prolonged droughts, flooding, tropical cyclones, sea-level rise and saltwater intrusion. These hazards threaten water availability, water quality, sanitation infrastructure and the long-term reliability of WASH services, particularly in rural and low-lying coastal communities.

Hazard Data Availability and Suitability

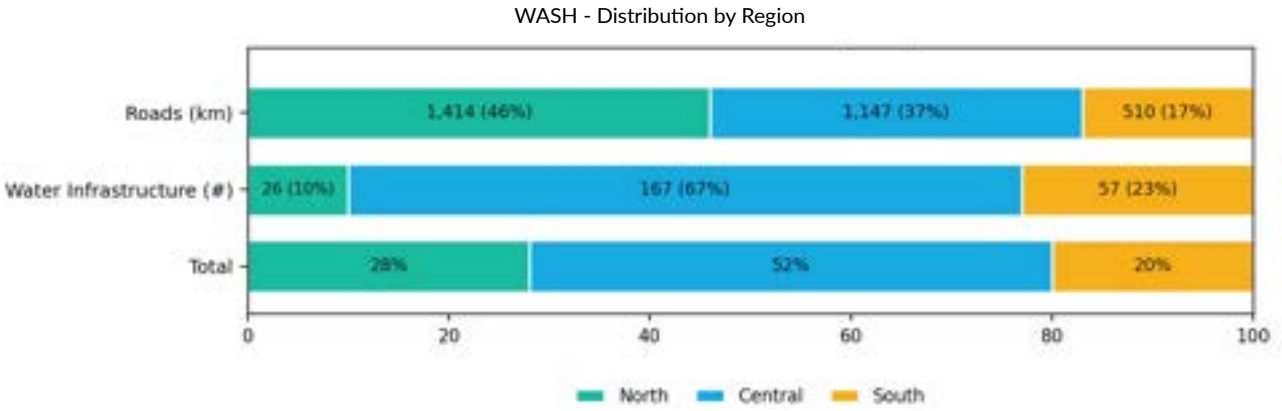
The assessment of climate risks to the WASH sector integrates multiple hazard datasets with varying levels of detail, spatial coverage and suitability for adaptation planning. Several important limitations remain across the available modelling, particularly regarding spatial granularity and future climate projections. A summary of hazard data suitability and key qualitative sources used in the assessment is provided in Annex C (Table A-20 and Table A-21 respectively).

National Distribution of WASH related Assets

Figure 29 presents the spatial distribution of WASH-related assets across Vanuatu, based on areas for which data are available. Due to the regional aggregation of several climate hazard datasets, assets have also been grouped within the North, Central and South regions. Key infrastructure considered in the assessment includes water infrastructure assets (e.g. wells, boreholes, water tanks and pump stations) and roads that support accessibility and service delivery. A full list of assessed elements is provided in the methods section.

The distribution of WASH-related infrastructure varies across regions. Available data indicate that the Central region contains the majority of mapped water infrastructure assets (67%), followed by the South (23%) and North (10%) regions. In contrast, the North region contains the largest share of mapped roads (46%), followed by the Central (37%) and South (17%) regions. These patterns influence the relative concentration of exposure and accessibility challenges across regions.

Figure 29. Distribution of WASH infrastructure and associated road networks considered in the quantitative analysis across the North, Central and South regions of Vanuatu.



Risk Assessment for the WASH Sector

The WASH sector in Vanuatu is exposed to a range of climate-related hazards that affect water availability, quality, and service reliability. Table 40 summarises the key climate hazards, associated vulnerabilities, and potential consequences for WASH systems, drawing on spatial analysis, stakeholder consultations, and sectoral evidence. The table focuses on system-level risks, while detailed exposure patterns and relative risk scores are presented in the sections that follow.

Overall, the results highlight that climate-related risks to the WASH sector are concentrated in low-lying coastal and flood-prone areas where infrastructure exposure, water insecurity, and service disruption intersect. These risks have the potential to create cascading impacts across health, education, livelihoods, infrastructure and community wellbeing.

Exposure and Risk scores

Coastal Flooding and Sea-Level Rise

The risk scores are intended to help identify areas of higher WASH risk to support further analysis, planning, and resilience-building initiatives. It is important to note that the scores are indicative and comparative rather than absolute values. The Area Council with the highest score under each scenario is normalised to 100, while all other Area Councils are ranked against it. Consequently, a reduction in score over time does not necessarily indicate a reduction in absolute risk but may instead reflect proportionally higher exposure in other locations under the same climate scenario.

Results indicate that Central Malekula consistently records the highest concentration of WASH-related assets at risk from coastal flooding and sea-level rise among areas with available data. Table 41 presents the risk scores associated with coastal flooding under sea-level rise increments of 0.0 m, 0.5 m, 1.0 m, and 1.5 m. The scores were calculated using water infrastructure and road network layers to identify exposed assets within each administrative boundary. The results were then normalised and ranked to support comparison across Area Councils.

Central Malekula records a substantially higher proportion of WASH-related elements at risk than other areas under all scenarios. This reflects the concentration of exposed water infrastructure within low-lying coastal areas around Norsup, Lakatoro, and Litslits. From 0.5 m SLR onwards, the relative difference between Central Malekula and other areas widens significantly. For example, the next highest-ranked area, Port Vila, records declining scores from 29.4 under present-day conditions to 4.7, 2.6, and 2.1 under progressively higher sea-level rise scenarios.

Exposure analysis further highlights the scale of risk. Under present-day conditions, approximately 6 of the 250 mapped water infrastructure units (2%) are exposed to a 1% AEP coastal flood event. This increases to 32 units (13%) under 0.5 m SLR, 65 units (26%) under 1.0 m SLR, and 87 units (35%) under 1.5 m SLR. Under the 0.5 m and 1.0 m SLR scenarios, most newly exposed water infrastructure units are

Table 40. Hazards Vulnerabilities and Potential Consequences

Climate Hazard	Vulnerabilities	Potential Consequences
Air Temperature, Drought & Precipitation Variability	• Leeward (north-western/western) sides of larger islands receive lower rainfall and experience higher drought exposure • Volcanic islands have limited groundwater access and rely heavily on surface water and rainwater harvesting • Small and low-lying islands (e.g. Torres, Banks and Nguna) have limited freshwater resources and high dependence on rainwater tanks • Communities where more than 80% of households rely on rainwater harvesting are particularly vulnerable during prolonged dry periods • Increased temperatures intensify evapotranspiration, reducing soil moisture, streamflow and water quality • Heavy rainfall events increase erosion and sedimentation, degrading drinking water quality Rural and remote communities often have limited alternative water sources and long travel distances for water collection	• Reduced availability of safe water for drinking, hygiene, and agriculture • Declining water quality and increased risk of water-borne disease • Increased dehydration and reduced hygiene standards • Reduced food and livelihood security due to water stress on crops • Increased burden on women and children collecting water • Disruptions to education and health services during water shortages • Increased social tension and conflict over limited water resources
Coastal Flooding & Sea-Level Rise	• Coastal WASH infrastructure, including pipes, wells and sanitation systems, is highly exposed to inundation and physical damage • Groundwater sources, particularly unconfined and perched aquifers, are vulnerable to saltwater intrusion • Small coastal communities, schools and health clinics may struggle to maintain safe WASH services during repeated inundation events • Limited monitoring, maintenance and climate-resilient infrastructure capacity increases vulnerability • Communities already facing combined pressures from drought, salinisation and contamination are particularly vulnerable • Central Malekula contains one of the highest concentrations of exposed water infrastructure units under sea-level rise scenarios	• Salinisation and contamination of freshwater supplies • Damage and progressive loss of coastal WASH infrastructure • Increased water insecurity and dehydration risks • Reduced food security from saltwater impacts on crops • Potential displacement and overcrowding in areas with inadequate WASH services

Table 40. Hazards Vulnerabilities and Potential Consequences (continued)

Climate Hazard	Vulnerabilities	Potential Consequences
Fluvial & Pluvial Flooding	• WASH infrastructure, particularly poorly maintained or informal systems, is vulnerable to flood damage and contamination • Informal septic systems, damaged pipes and exposed sanitation infrastructure are highly susceptible to failure during flooding • High concentrations of exposed infrastructure occur around Port Vila, Central Malekula and West Tanna • Communities reliant on spring-fed systems are more vulnerable to contamination than groundwater-based systems • Rural and remote communities face significant constraints in repairing or replacing damaged infrastructure • Women, children and people living with disability face increased barriers accessing safe WASH services during flood events"	• Contamination of water supplies by sewage, chemicals, and floodwaters • Damage and disruption to water and sanitation infrastructure • Increased incidence of water-borne and hygiene-related diseases • Reduced access to safe drinking water and sanitation services • Crop contamination and associated food safety risks • Displacement and overcrowding in evacuation centres and temporary shelters • Increased household and government costs for WASH repair and recovery"
Tropical Cyclones	• Above-ground WASH infrastructure, including tanks, pipes, pumps and sanitation facilities, is highly exposed to cyclone damage • Rural and remote communities are more vulnerable due to reliance on exposed systems and limited repair access • Informal settlements and poorly constructed infrastructure increase susceptibility to service disruption • Women, children, older people and people living with disability face heightened risks during prolonged WASH disruptions and displacement • Dependence on community-managed systems may reduce resilience where local maintenance and recovery capacity is limited	• Severe damage and prolonged disruption to WASH infrastructure and services • Contamination of water sources and unsanitary living conditions • Increased disease transmission associated with poor hygiene and crowding • Displacement and reliance on shared or inadequate sanitation facilities • Increased financial pressure for infrastructure repair, maintenance, and recovery • Reduced reliability and community trust in WASH systems over time"

concentrated around the coastal areas of Norsup, Lakatoro and Litslits on Malekula. Under the 1.5 m SLR scenario, approximately 73 of the 84 mapped water infrastructure units around Norsup are exposed (87%), representing the highest concentration of exposed WASH infrastructure across assessed areas.

Other Area Councils, including Port Vila, Vanua Lava, and South Malekula, also consistently rank among higher-risk areas under all scenarios, although their comparative scores decline as exposure in Central Malekula increases. A notable change in ranking occurs in West Tanna under the 1.5 m SLR scenario, likely reflecting the exposure of a groundwater tank near Lenakel Wharf.

N.B. Scores were calculated using water infrastructure and road network layers to identify administrative boundary areas with the highest number of assets exposed to coastal flooding. Results were then normalised and ranked across Area Councils. The ten highest-risk locations are presented. Red arrows indicate a new entry or an increase in ranking position, while yellow arrows indicate a decrease in ranking position.

Table 41. Normalised risk scores for the WASH sector associated with coastal flooding and sea-level rise at 0.0 m, 0.5 m, 1.0 m, and 1.5 m.

0.0 m SLR	0.5 m SLR	1.0 m SLR	1.5 m SLR
Central Malekula (100)	Central Malekula (100)	Central Malekula (100)	Central Malekula (100)
Port Vila (29.4)	Port Vila (4.7)	Port Vila (2.6)	Port Vila (2.1)
Vanua Lava (24.7)	Vanua Lava (3.3)	South Malekula (1.9)	South Malekula (1.6)
South Malekula (18.8)	South Malekula (3.3)	Vanua Lava (1.6)	South-East Malekula (1.4)
South-East Malekula (9.1)	South-East Malekula (2.2)	South-East Malekula (1.5)	West Tanna (1.2)
South-East Santo (4.4)	South-East Santo (1.3)	South-East Santo (0.8)	Vanua Lava (1.2)
North Efate (4)	North Efate (1)	North Efate (0.7)	North Efate (1)
Aniwa (3.2)	Malorua (0.8)	Malorua (0.6)	South-East Santo (0.8)
Malorua (3)	Eratap (0.7)	Luganville (0.5)	Luganville (0.6)
Eratap (2.8)	Canal – Fanafo (0.6)	Canal – Fanafo (0.5)	Malorua (0.6)

Fluvial and Pluvial Flooding

The risk scores are intended to help identify areas of higher WASH risk to support further analysis, planning, and resilience-building initiatives. It is important to note that the scores are indicative and comparative rather than absolute values. The Area Council with the highest score under each scenario is normalised to 100, while all other Area Councils are ranked against it. Consequently, a reduction in score over time does not necessarily indicate a reduction in absolute risk but may instead reflect proportionally higher exposure in other locations under the same flood scenario.

Results indicate that, among assessed areas, Central Malekula consistently records the highest concentration of WASH-related assets at risk from fluvial and pluvial flooding. Table 41 presents the risk scores associated with 1%, 2%, and 10% Annual Exceedance Probability (AEP) flood events. An AEP represents the probability of a flood event occurring in any given year. The scores were calculated using water infrastructure and road network layers to identify exposed assets within each administrative boundary. The results were then normalised and ranked to support comparison across Area Councils.

Exposure analysis indicates that under a 1% AEP flood event, approximately 78 of the 250 mapped water infrastructure units (31%) are exposed to flooding. The highest concentrations of exposed infrastructure occur around Port Vila and Mele on Efate, where approximately 15 of 36 mapped units are exposed (42%), followed closely by Central Malekula between Norsup, Lakatoro, and Litslits, where approximately 45 of 109 units are exposed (41%). Western Tanna near Isangel also records relatively high exposure, with approximately 18 of 57 mapped units exposed (32%).

Under a 2% AEP event, approximately 68 mapped water infrastructure units (27%) are exposed, while under a 10% AEP event approximately 53 units are exposed. Although exposure decreases under lower magnitude flood events due to differences in modelled flood extents, the overall spatial distribution remains broadly consistent, with Port Vila, Mele, Central Malekula, and western Tanna continuing to represent primary exposure hotspots. No mapped water infrastructure exposure is identified around Luganville on Espiritu Santo, suggesting that water infrastructure data for Santo may be incomplete.

The relative risk scores indicate that Central Malekula consistently records the highest proportion of WASH-related assets at risk across all AEP scenarios. Under the 1% AEP event, West Tanna and Port Vila rank as the next highest-risk areas. Under the 2% and 10% AEP scenarios, Port Vila overtakes West Tanna as the second-highest ranked area. Mele, South-East Malekula, and North-West Malekula also maintain relatively elevated rankings across multiple

Table 42. Normalised risk scores for the WASH sector associated with fluvial and pluvial flooding under 1%, 2%, and 10% AEP flood events.

1% AEP	2% AEP	10% AEP
Central Malekula (100)	Central Malekula (100)	Central Malekula (100)
West Tanna (44.7)	Port Vila (32.7)	Port Vila (36.2)
Port Vila (34)	West Tanna (28.3)	West Tanna (18.2)
Mele (10.8)	Mele (11.1)	Mele (7.7)
Luganville (9.6)	Luganville (8.9)	South-East Malekula (7.2)
South-East Malekula (6.9)	South-East Malekula (6.9)	Luganville (6.8)
North-West Malekula (6.8)	North-West Malekula (6.6)	North-West Malekula (6.7)
South-East Santo (5.9)	South-East Santo (5.7)	South-East Santo (5.5)
Whitesands (5.3)	Canal – Fanafo (4.3)	North-East Malekula (4.1)
South-West Tanna (4.9)	North-East Malekula (4.2)	Whitesands (3.8)

flood scenarios, reflecting concentrations of exposed infrastructure and road networks within flood-prone areas. These results should be interpreted in the context of limited flood and water infrastructure data availability across some parts of Vanuatu. In locations where WASH infrastructure data is incomplete, risk scores are partially influenced by road exposure and associated access constraints to WASH services.

Note: The scores were calculated using water infrastructure and road network layers to identify the proportion of exposed elements within each administrative boundary area. Results were then normalised and ranked to support comparison across Area Councils. The ten highest-ranked locations are presented. Red arrows indicate a new entry or increased ranking position, while yellow arrows indicate a decreased ranking position.

11.3 Compounding, Cascading Risk and Interdependencies

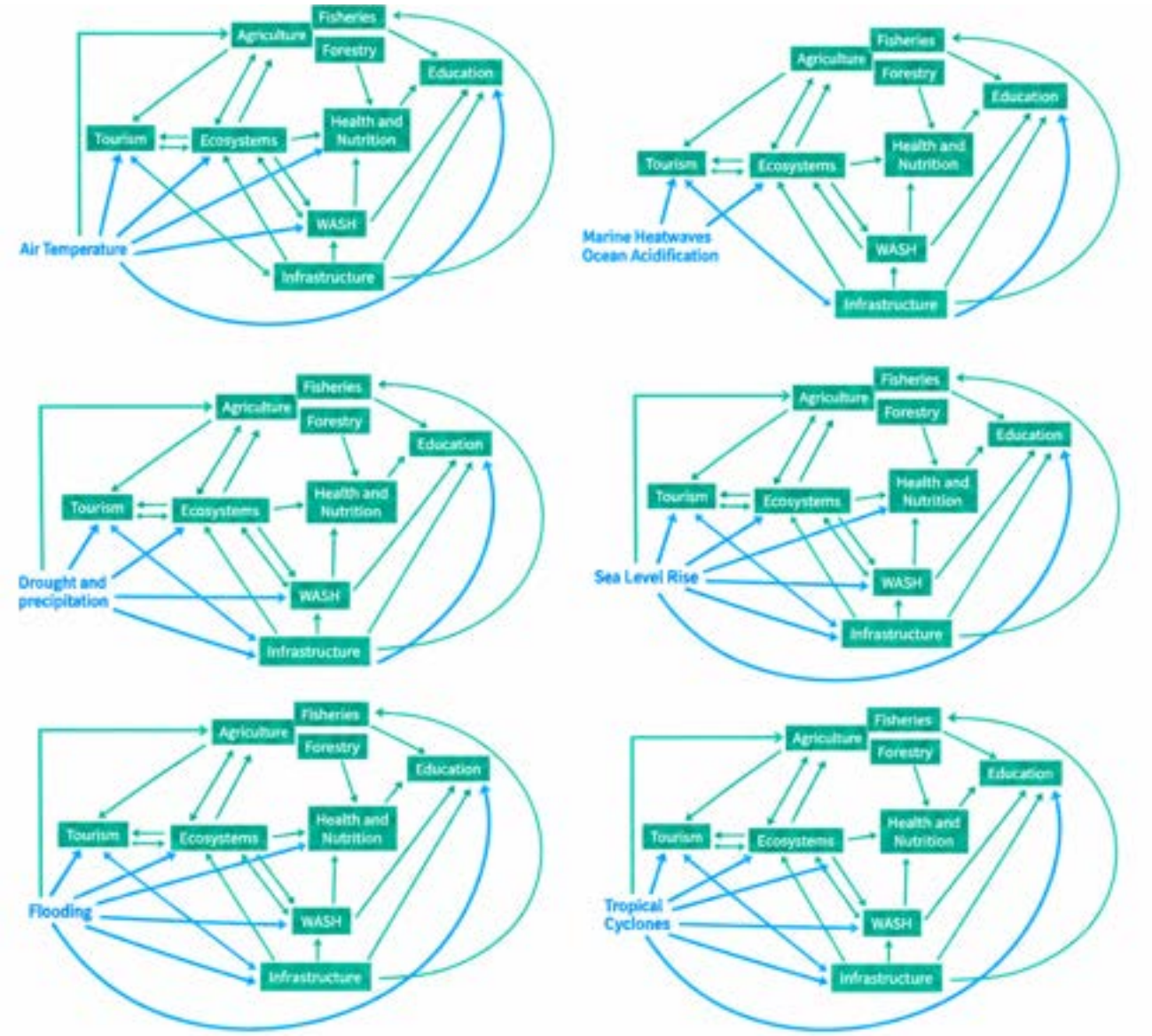
Vanuatu's WASH sector faces compounding climate risks, where multiple hazards interact to create cascading impacts across water systems, infrastructure, health, livelihoods, and related sectors. Increasing air temperatures are likely to intensify drought conditions, placing additional stress on water availability and quality. At the same time, sea-level rise is expected to increase coastal flooding and saltwater intrusion, contaminating freshwater supplies and threatening low-lying WASH infrastructure. Flooding and tropical cyclones can further damage water supply and sanitation systems, disrupt access to safe water, and increase contamination risks.

Where access to clean and safe drinking water is compromised, communities may be forced to rely on unsafe or distant water sources. Damage to infrastructure from extreme events can compound these pressures, particularly where communities rely on above-ground pipes, storage tanks, informal infrastructure, or limited alternative water sources. Combined pressures from water scarcity, contamination, infrastructure disruption, and population displacement may exceed existing adaptive capacity in some communities, particularly in rural and remote areas and among vulnerable population groups.

Uncertainty associated with future drought and precipitation projections under climate change further complicates adaptation planning and decision-making, including identifying priority areas for investment and long-term water security planning.

WASH systems are closely interconnected with a range of other sectors (Figure 30). WASH system disruptions can lead

Figure 30. Illustration of the interdependencies between WASH and other sectors that create cascading and compounding risks



to significant health and social impacts, including increased exposure to diarrhoeal and other water-borne diseases through the consumption of contaminated water or food grown in contaminated soils. Reduced access to safe water may also result in dehydration and poor hygiene conditions.

When people become sick, their ability to participate in subsistence agriculture and fisheries activities may be reduced, with implications for food security and household livelihoods. These pressures are likely to compound other climate-related impacts already affecting the agriculture and fisheries sectors, including crop failure and declining fish stocks. In addition, the spread of sewage and contaminated floodwaters into rivers, lagoons, and coastal environments can negatively affect ecosystems, fisheries, and tourism activities.

More broadly, poor health outcomes and unreliable WASH services can reduce community resilience by disrupting children's education and limiting people's ability to work across sectors including agriculture, fisheries, forestry, tourism, and informal economic activities. These impacts may reduce household income, constrain productivity, and affect wider economic wellbeing.

Consultations undertaken as part of this assessment identified concerns regarding limited coordination between

implementing partners and government agencies, as well as the absence of a centralised water resource data hub. Stakeholders also highlighted limited national-level feasibility assessments for alternative water sources. While several initiatives were recognised for strong community engagement and partnerships, implementation challenges remain, including seasonal access constraints and competing community priorities. Communities and stakeholders identified a need for strengthened technical training for engineers and builders, improved enforcement of building standards, and increased use of nature-based solutions to support water protection and long-term WASH resilience.

11.4 Summary and Considerations

Climate change and its associated hazards risk undermining gains that have been made in improving WASH in Vanuatu, with significant implications for health, livelihoods, and community wellbeing. Contamination of water supplies, disruption to WASH services, damage to infrastructure, disrupted supply chains, and increasing pressure on limited water resources are among the primary pathways through which climate change may affect WASH outcomes.

Several key considerations emerge from this assessment:

- Critical infrastructure resilience: Climate risks to WASH infrastructure should be a central consideration in adaptation planning. Without resilient infrastructure and effective adaptation measures, climate change is likely to increase the risk of poor health outcomes associated with unsafe WASH. This includes ensuring safe WASH services in emergency shelters and evacuation facilities.
- Rural and urban needs: Existing WASH conditions vary significantly across urban, peri-urban, and rural communities. Rural communities often experience more limited access to safe WASH services, increasing vulnerability to climate-related hazards. Adaptation planning should therefore reflect the differing needs and service realities across communities.
- Vulnerable populations and equity: Children, older people, people living with disability, and women and girls often face disproportionate risks associated with climate hazards and WASH disruptions. Adaptation approaches should therefore prioritise equity and inclusive access to safe WASH services.
- WASH education and awareness: Continued efforts are needed to strengthen community awareness of the importance of safe WASH for health and wellbeing, while also incorporating community knowledge and priorities into resilience planning.

Interconnected risks: WASH is closely interconnected with the Health and Nutrition, Ecosystems, Agriculture, Fisheries, Tourism, Education, and Infrastructure sectors. Effective adaptation planning will therefore require integrated approaches that address risks across sectors rather than in isolation.



CHAPTER

12

Conclusions and Recommendations

This section summarises the key findings of the Climate Risk and Vulnerability Assessment across the nine assessed sectors and highlights the major climate-related risks facing Vanuatu.

Summary and Conclusions

The climate risks facing Vanuatu can broadly be grouped into four interconnected categories:

- Risks to natural ecosystems
- Risks to productive sectors
- Risks to infrastructure
- Risks to human health and wellbeing

12.1 Risks to Natural Ecosystems

Natural ecosystems support biodiversity, livelihoods, cultural practices, and daily life across Vanuatu. Climate change is increasingly affecting terrestrial, freshwater, coastal, and marine ecosystems through sea-level rise, rising temperatures, changing rainfall patterns, drought, marine heatwaves, ocean acidification, and tropical cyclones.

Coastal ecosystems, including coral reefs, mangroves, and seagrass meadows, are particularly vulnerable to warming oceans, marine heatwaves, ocean acidification, and coastal flooding. Coral reef degradation is expected to reduce biodiversity, fisheries productivity, coastal protection, and tourism value. Mangroves and seagrass ecosystems are also at risk of decline due to coastal squeeze associated with sea-level rise. Terrestrial ecosystems are likely to experience increasing stress from prolonged drought, changing rainfall patterns, invasive species, pests, and land degradation.

The degradation of ecosystems has implications beyond the environmental sector. Declining ecosystem health is likely to affect food security, water availability, fisheries, tourism, livelihoods, and cultural wellbeing, including the ability to maintain kastom practices and traditional knowledge systems. Reduced ecosystem resilience may also increase the exposure of settlements and infrastructure to coastal hazards and erosion.

12.2 Risks to the Productive Sectors

The productive sectors of agriculture, forestry, and fisheries are highly climate-sensitive and face increasing risks from drought, rising temperatures, flooding, tropical cyclones, marine heatwaves, and ocean acidification.

Agriculture and forestry are likely to experience reduced productivity due to heat stress, water scarcity, flooding, cyclone damage, and increased pest and disease pressures. Fisheries are expected to be affected by warming oceans, habitat degradation, coral reef decline, and shifting fish distributions, particularly for coastal and reef-associated fisheries.

Declining productivity across these sectors may reduce food security, household income, access to materials and fuel, and economic opportunities, particularly in rural communities that rely heavily on subsistence and natural resource-based livelihoods. Increasing pressure on land, forests, and marine resources may also contribute to overharvesting and further ecosystem degradation, creating reinforcing cycles of environmental and livelihood stress.

12.3 Risks to infrastructure

Infrastructure systems in Vanuatu are highly exposed to a range of climate hazards, particularly flooding (coastal, fluvial, and pluvial), tropical cyclones, sea-level rise, drought, and increasing temperatures.

Flooding and sea-level rise pose the most significant risks, with exposure increasing under higher sea levels. Infrastructure in low-lying coastal areas and flood-prone catchments is particularly vulnerable, with key hotspots including Port Vila, Luganville, Malekula, and parts of Tanna. These areas contain a high concentration of critical assets, including transport networks, electricity infrastructure, communication systems, and public services.

Transport infrastructure, especially roads and bridges, is widely exposed and vulnerable to flooding and physical damage. Impacts on transport networks are likely to isolate communities, restrict access to essential services, and limit the movement of goods and people. Airports located in hazard-prone areas further increase the risk of disruptions to national and inter-island connectivity during extreme events.

Electricity, communication, water, and wastewater systems are also vulnerable to flooding and cyclone impacts. Failures in these systems may affect service delivery across multiple sectors, including health, education, tourism, and water and sanitation services. Urban centres such as Port Vila

and Luganville face elevated risks due to the concentration of infrastructure and population. Rural and outer island communities face heightened risks of isolation and reduced access to services during infrastructure failures.

Buildings, including residential, public, and commercial structures, are widely exposed to flooding, particularly in urban and peri-urban areas, increasing risks to housing, service delivery, livelihoods, and economic activity.

Climate change is expected to intensify infrastructure impacts through sea-level rise, expanding flood exposure, and continued extreme weather events. At the same time, data limitations in some sectors and locations suggest that current assessments may underestimate infrastructure exposure and risk in some areas.

Overall, climate risks to infrastructure in the country are systemic and interdependent. Damage to critical assets can trigger cascading impacts across sectors, disrupt livelihoods and essential services, and disproportionately affect vulnerable populations. Strengthening the resilience of infrastructure systems will be essential to maintaining connectivity, supporting economic activity, and protecting wellbeing under future climate conditions.

12.4 Risks to Human Health and Wellbeing

Climate change poses both direct and indirect risks to health, nutrition, education, water security, safety, and overall wellbeing. Human wellbeing is closely linked to the condition of ecosystems, the reliability of infrastructure and services, and the productivity of agriculture and fisheries systems.

Climate-related hazards are expected to increase the risk of injuries, dehydration, heat stress, malnutrition, water-borne diseases, vector-borne diseases, respiratory illness, mental health impacts, and displacement. Drought and water shortages may weaken WASH services and increase illnesses such as diarrhoeal disease, typhoid, leptospirosis, respiratory infections, and skin infections. Reduced agricultural and fisheries productivity may also worsen food insecurity and nutrition outcomes.

Schools, healthcare facilities, and WASH infrastructure are highly vulnerable to flooding, tropical cyclones, coastal inundation, and sea-level rise. Damage to these facilities may disrupt access to essential services when they are most needed and may increase long-term pressures on communities and government systems.

Women, children, older people, people living with disability, low-income households, and rural and remote communities are likely to experience disproportionate impacts due to existing social and economic vulnerabilities. Disruptions to education, healthcare, transport, and livelihoods may further compound inequalities and reduce long-term resilience.

12.5 Concluding Statement

The assessment demonstrates that climate change presents a systemic development challenge for Vanuatu, affecting ecosystems, livelihoods, infrastructure, health, food security, water security, and social wellbeing. Climate risks are interconnected and often cascading, meaning that impacts in one sector may intensify vulnerabilities in others.

While climate risks are expected to increase across the country, several areas repeatedly emerge as exposure hotspots, particularly low-lying coastal communities, flood-prone urban centres, and rural communities with limited adaptive capacity. Malekula, Port Vila, Luganville, and parts of Tanna consistently show elevated exposure across multiple hazards and sectors.

The findings also highlight that climate impacts on natural ecosystems and climate-sensitive sectors such as fisheries, forestry, and agriculture may be particularly difficult to manage due to the dependence of many livelihoods on natural systems and the limits of adaptation under worsening climate conditions.

Overall, the assessment reinforces the importance of integrated and long-term adaptation planning that strengthens ecosystem resilience, protects critical infrastructure and essential services, improves food and water security, and addresses the needs of vulnerable populations. Strengthened coordination, improved data availability, locally informed planning approaches, and sustained investment in climate resilience will be critical to supporting Vanuatu's ability to adapt to a changing climate.

12.6 Recommendations

The recommendations below are intended to support future climate risk assessment, adaptation planning, resilience-

building, and climate-informed decision-making across Vanuatu.

Strengthen national climate and risk data governance. Undertake a coordinated national stocktake of climate, hazard, exposure, vulnerability, and resilience-related datasets across government agencies, ministries, development partners, and relevant organisations to identify priority data gaps and improve long-term accessibility, management, and use.

Improve data sharing and centralised data management. Establish national data-sharing protocols and strengthen centralised data storage and management systems for spatial and non-spatial climate risk information to support future CRVAs, adaptation planning, and resilience decision-making.

Address priority hazard and exposure data gaps. Prioritise the development of nationally consistent hazard and exposure datasets, including fluvial and pluvial flood modelling, groundwater salinisation and emergence mapping, sector-specific spatial datasets, and Pacific-relevant vulnerability and damage functions.

Standardise future climate risk assessment approaches. Apply consistent scenarios, timeframes, and methodologies across climate and hazard modelling to improve comparability and support integrated national and provincial risk assessments.

Strengthen locally grounded and community-informed assessments. Incorporate stronger engagement with provinces, communities, and traditional knowledge holders to improve understanding of local risks, vulnerabilities, priorities, and adaptation options.

Expand the use of local qualitative hazard information. Use community-based and qualitative hazard mapping approaches to complement quantitative modelling, particularly in areas where limited hazard information exists or where detailed modelling is not currently feasible.

Strengthen sector-based climate risk planning and coordination. Use CRVA findings and Resilience Explorer® outputs to identify priority risks, guide adaptation planning, support investment decisions, and strengthen the resilience of critical infrastructure and services.

Strengthen integrated cross-sector adaptation planning. Strengthen collaboration across government agencies, sectors, provinces, and partners to address shared climate risks and interdependencies, particularly in relation to ecosystem resilience, critical infrastructure, food and water security, rural resilience, and long-term settlement patterns and infrastructure planning.

Areas for Future Analysis. Additional research could be undertaken to better understand how future population growth, urbanisation, land-use change, and economic development may influence climate risk and vulnerability across Vanuatu.

Further assessment of transitional and external risks associated with the shift toward a low-emissions and climate-resilient future may support long-term planning. This may include consideration of changing migration patterns, supply chain disruptions, external economic pressures, and regional or global climate-related impacts beyond Vanuatu's borders.

Glossary

Adaptation	The process of adjustment to actual or possible climate change and its effects. In human systems, adaptation seeks to moderate or avoid harm or exploit beneficial opportunities [188].
Adaptive Capacity	The ability of systems, institutions, humans, and other organisms to adjust to potential or actual climate impacts, take advantage of opportunities, or respond to consequences. This includes access to resources, information, skills, and social networks that enable adaptation actions [188].
AEP	Annual Exceedance Probability. The probability that an event of a certain size will occur in a given year. Note that a 1% AEP event has approximately a 1-in-4 (26%) chance of occurring at least once within a 30-year period.
Cascading Consequences	Consequences that propagate through interconnected systems, triggering impacts across different sectors, geographical areas or timeframes beyond those initially affected.
Cascading Hazards	A sequence of hazards where an initial hazard triggers or exacerbates subsequent hazards, creating a chain reaction of events.
Cascading Risk	Risk that travels across interconnected systems, sectors, or geographies through chains of cause and effect, often amplifying in scope and scale beyond the initial impact, over time. Cascading risks are much more representative of how hazards and climate change will affect communities.
Climate Variability	Climate variability refers to the natural variation in the climate system.
Compound Hazards	The occurrence of multiple hazards affecting the same region simultaneously or in close succession, potentially creating impacts greater than the sum of individual hazards.
Compound Risk	Risk that arises when an element is exposed and vulnerable to multiple hazards or changes occurring simultaneously or in close succession.
Compounding Consequences	Consequences that intensify as multiple impacts interact, creating effects that are more severe than if each impact occurred in isolation.
Consequences	The outcome of an event or change, which may be positive or negative, direct or indirect.
Criticality	The relative importance of a system aspect (e.g. road, electrical substation, etc.) to the desired function or level of service.
Direct Risk	Risk that arises when an element of value is directly exposed and vulnerable to a specific hazard or change.
Sector	A grouping or categorisation of our world and the things we value within it. Nine key priority sectors were established for this report, with sector CRVAs written for each.
Element	The assets, people, places, and specific systems that may be at risk.

Expert Judgement [Qualitative Risk Methodology]	A structured methodology for generating and synthesising knowledge based on the informed opinions of domain specialists. In climate risk assessment, expert judgment involves systematically gathering and integrating the views of professionals with relevant expertise to evaluate hazards, vulnerabilities, and system interactions. Often used when empirical data is limited, uncertain or unavailable, or when complex system interactions cannot be fully modelled quantitatively.
Exposure	The state or condition of being subjected to or encountering a risk source, which can occur in a binary manner where one is either exposed or not, or in a continuous manner where the level or intensity of exposure varies [189].
Fluvial Flooding (River Flooding)	Flooding caused by rivers overflowing their banks due to heavy or prolonged rainfall, snowmelt, or blockages in river channels.
Fragility	The system's likelihood to experience negative consequences, given some amount of exposure.
Hazard	A potential source of harm, which may be a natural process or phenomenon or human activity that may cause loss of life, injury, or other health impacts, property damage, social and economic disruption, or environmental degradation.
IPCC	The Intergovernmental Panel on Climate Change
Isolation	The state of property temporarily or permanently losing access to one or more essential services (e.g. school, hospital, or fire station) due to hazard/change impacts on the transportation network or other essential infrastructure, e.g. power supply.
Mitigation (Climate Change)	The process of reducing the severity of climate change through emissions reduction or carbon sequestration. Contrast with: Risk Mitigation.
NAP	National Adaptation Plan.
Pluvial Flooding (Rainfall Flooding)	Flooding caused by intense rainfall that exceeds the drainage capacity of the land, stormwater systems, or urban surfaces, leading to localised water accumulation.
RCP	Representative Concentration Pathways - A suite of future scenarios of additional radiative heat forcing at the Earth's surface by 2100 (in Watts per square metre), which is the net change in the balance between incoming solar radiation and outgoing energy, radiated back up in the atmosphere. Each RCP can be expressed as a greenhouse gas concentration (not emissions) trajectory.
Relative Sea-level Rise (RSLR)	The increase in sea-level relative to a local land benchmark, incorporating both global sea-level rise and local land movement.
Resilience	The capacity of social, economic, and environmental systems to absorb disturbances and reorganise while maintaining essential function, identity, and structure, as well as the capacity for adaptation and transformation.
Resilient	A state where a system can withstand, recover from, and adapt to climate hazards and stresses while maintaining its essential functions and structure. A resilient system has sufficiently reduced vulnerability and enhanced adaptive capacity to manage climate risks at levels deemed acceptable by stakeholders.
Retreat	The planned relocation of assets, infrastructure, or communities away from areas of high risk.

Risk	The potential for and severity of consequences on things we value in the presence of uncertainty [189]. Risk exists when there is uncertainty about how something we care about might be affected, recognising that different individuals and communities may have diverse priorities and objectives.
Risk Assessment	Systematic process to comprehend the nature of risk, express and evaluate risk, with the available knowledge.
Risk Mitigation	The process of identifying, assessing, and prioritising risks, followed by the coordinated application of resources to minimise, monitor, and control the probability or impact of adverse events. Risk mitigation strategies include avoidance, reduction, transfer, and acceptance of risks. Contrast with: Mitigation (Climate Change).
Risk Source	An action, sub-activity, component, system, or event which alone or in combination with other elements has the potential to give rise to some specified consequences (typically undesirable consequences) [189]. Often referred to within this report as hazard/change.
Scenario	A plausible description or representation of future events, conditions, or situations used for analysis or planning.
Sensitivity	The degree to which a system is affected, either adversely or beneficially, by a hazard or climate-related stimuli.
Shock	A sudden, disruptive event that affects a system, community, or asset, typically occurring with limited warning and requiring immediate response. Examples include floods, storms, and heatwaves.
Social Vulnerability	The susceptibility of social groups to the adverse impacts of hazards and changes, influenced by factors such as socioeconomic status, age, disability, housing characteristics, and access to resources.
SSP	Shared Socioeconomic Pathways. Scenarios of projected socioeconomic global changes up to 2150 and 2500, used to analyse how societal choices will affect greenhouse gas emissions and climate change mitigation challenges.
Stressor	A chronic or ongoing pressure that gradually affects a system, community, or asset over an extended period. Examples include sea-level rise, changing rainfall patterns, and increasing temperatures.
Sustainable	The capacity to endure and thrive over time, balancing social, economic, and environmental considerations.
Uncertainty	A state of incomplete knowledge that can result from multiple sources: natural variability or randomness in systems being studied, limitations in our current knowledge that could be reduced with more research, and differing interpretations of available information. It may arise from imprecise data, measurement limitations, ambiguously defined concepts or terminology, or the inherent unpredictability of complex human and natural systems.
Values	What communities care about and want to protect or enhance; the qualities, principles, or objects (e.g. assets, parks, places of significance) considered important or beneficial.
Vulnerability	The propensity or predisposition to be adversely affected, encompassing sensitivity to harm and lack of capacity to cope and adapt.
Vulnerable Populations	Individuals or collectives that have characteristics that would traditionally represent a lower adaptive capacity or ability to cope and respond to different events. Also referred to as underserved populations. Vulnerability exists across all segments of society, as climate hazards can affect anyone, though in different ways and to varying degrees.

References

1 J. H. M. Roger and B. Pelletier, "A brief history of tsunamis in the Vanuatu Arc," Nat. Hazards Earth Syst. Sci., vol. 24, no. 10, pp. 3461–3478, Oct. 2024, doi: 10.5194/nhess-24-3461-2024.

2 Vanuatu National Statistics Office, "2020 National Population and Housing Census Basic Tables Report Vol 1," Vanuatu National Statistics Office. [Online]. Available: https://vnso.gov.vu/index.php/en/census-and-surveys/census-report

3 Department of Strategic Planning and Aid Coordination, "Post Disaster Needs Assessment Vanuatu Tropical Cyclones Judy and Kevin 22 June 2023," 2023. [Online]. Available: https://dsppac.gov.vu/images/roc/roc_23/pdna/tc-judy-and-tc-kevin-pdna.pdf

4 Vanuatu Bureau of Statistics and Pacific Community, "Vanuatu 2020 National Population and Housing Census Analytical Report Vol 2," Vanuatu Bureau of Statistics & Pacific Community, 2022. [Online]. Available: https://sdd.spc.int/digital_library/vanuatu-2020-national-population-and-housing-census-analytical-report-volume-2

5 Vanuatu Bureau of Statistics, "Urban-Rural Population," Vanuatu Bureau of Statistics, 2021. [Online]. Available: https://vbos.gov.vu/sites/default/files/Urban_Rural.pdf

6 Vanuatu Bureau of Statistics, "Vanuatu Population," Vanuatu Bureau of Statistics, 2020. [Online]. Available: https://vbos.gov.vu/sites/default/files/VANUATU_National.pdf

7 D. Doan, M. Dornan, and R. Edwards, "The Gains and Pains of Working Away from Home: The Case of Pacific Temporary Migrant Workers in Australia and New Zealand," World Bank and Development Policy Centre (Australian National University), 2023. Accessed: July 16, 2025. [Online]. Available: https://devpolicy.org/publications/reports/Pacific-temporary-migrant-workers-Nov2023.pdf

8 Vanuatu Bureau of Statistics, "2020 National Population and Housing Census: Analytical Report Volume 2," 2022. [Online]. Available: https://sdd.spc.int/digital_library/vanuatu-2020-national-population-and-housing-census-analytical-report-volume-2

9 L. Drake, H. M. Liunakwalau, and Hango Hango Community Association, Port Vila, "Locating the traditional economy in Port Vila, Vanuatu: Disaster relief and agrobiodiversity," Asia Pac. Viewp., vol. 63, no. 1, pp. 80–96, Apr. 2022, doi: 10.1111/apv.12333.

10 Vanuatu National Statistics Office, "Statistics Release: Gross Domestic Product 2020," Vanuatu National Statistics Office, July 2022. [Online]. Available: https://vnso.gov.vu/sites/default/files/Gross_Domestic_Product_2020_Highlights.pdf

11 World Bank Group, "Climate Risk Country Profile: Vanuatu," World Bank Group, 2021. [Online]. Available: https://climateknowledgeportal.worldbank.org/sites/default/files/country-profiles/15825-WB_Vanuatu%20Country%20Profile-WEB.pdf

12 FAO, SPC, and VNSO (VBoS), "Vanuatu food security profile," Vanuatu Bureau of Statistics and SPC, Port Vila, 2021.

13 A. Dansie, H. Alleway, and B. Boer, The Water, Energy, and Food Security Nexus in Asia and the Pacific. in Water Security in a New World. UNESCO, 2024. [Online]. Available: https://doi.org/10.1007/978-3-031-25463-5

14 United Nations, "Specific country data: Vanuatu," United Nations. Accessed: July 16, 2025. [Online]. Available: https://hdr.undp.org/data-center/specific-country-data

15 International Labour Organisation, "Cyclone PAM causes devastating impact on employment and livelihoods," International Labour Organization, Geneva, 2015. Accessed: July 18, 2025. [Online]. Available: https://www.ilo.org/resource/news/cyclone-pam-causes-devastating-impact-employment-and-livelihoods

16 CSIRO and SPREP, "Current and Future Influence of Tropical Cyclones on Agricultural Production in Vanuatu," Report prepared for the Vanuatu Meteorology and Geo-hazards Department, 2023. [Online]. Available: https://www.vanclimatefutures.gov.vu/assets/docs/Tropical%20Cyclones%20and%20Agriculture%20Infobyte.pdf

17 Development Services, "Vanuatu Barriers to Education Study," Report prepared for the Ministry of Education and Training, 2018. [Online]. Available: https://education.gov.vu/docs/policies/20181114%20EN%20Barriers%20to%20Education_2020.pdf

18 UN Women, "Gender Equality Brief for Vanuatu," UN Women, 2022. Accessed: Aug. 19, 2025. [Online]. Available: https://asiapacific.unwomen.org/sites/default/files/2022-12/UN_WOMEN_VANUATU.pdf

19 UNCTAD, "Harnessing Agricultural Trade for Sustainable Development: Vanuatu," UN Trade and Development, Geneva, UNCTAD/DITC/TED/2019/1, 2020. [Online]. Available: https://unctad.org/system/files/official-document/ditcted2019d1_en.pdf

20 ILO, "Vanuatu: The employment - environment - climate nexus," International Labour Organization, Bangkok, 2022. Accessed: July 21, 2025. [Online]. Available: https://www.ilo.org/sites/default/files/wcmsp5/groups/public/%40asia/%40ro-bangkok/documents/publication/wcms_862817.pdf

21 Government of Vanuatu, "Vanuatu Post-Disaster Needs Assessment Tropical Cyclone Pam March 2015," Government of Vanuatu, 2015. [Online]. Available: https://dsppac.gov.vu/images/docs/PDNA/PDNA_Cyclone_Pam.pdf

22 S. Block, J. Emerson, D. Esty, A. de Sherbinin, and Z. Wendling, "Environmental Performance Index," Yale Center for Environmental Law & Policy, New Haven, 2024. Accessed: July 21, 2025. [Online]. Available: https://epi.yale.edu/

23 UNDP, "Gender Inequality Index." 2025. Accessed: July 16, 2025. [Online]. Available: https://hdr.undp.org/sites/default/files/2025_HDR/HDR25_Statistical_Annex_GII_Table.pdf

24 FAO, "Country Gender Assessment of Agriculture and the Rural Sector in Vanuatu," FAO, Port Vila, 2020.

25 Ministry of Climate Change Adaptation, Meteorology and Geo-hazards, Environment, Energy and Disaster Management, "Republic of Vanuatu: State of the Environment Report," SPREP, Apia, 333.720959 5, 2023. [Online]. Available: https://library.sprep.org/sites/default/files/2024-11/Vanuatu-SOE-2022.pdf

26 Government of the Republic of Vanuatu, "National Gender Equality Policy 2020-2030." Government of the Republic of Vanuatu, 2021. Accessed: July 16, 2025. [Online]. Available: https://mjcs.gov.vu/images/reporting/National_Gender_Equality_Policy_2020-2030_ADD_1.pdf

27 SOPAC, "National Integrated Water Resource Management Diagnostic Report: Vanuatu," SOPAC, 648, 2007. [Online]. Available: https://vanuatu-data.sprep.org/resource/national-integrated-water-resource-management-diagnostic-report

28 UNICEF and WHO, "Progress on Household Drinking Water, Sanitation and Hygiene 2000-2022," 2023. Accessed: Oct. 01, 2025. [Online]. Available: https://washdata.org/reports/jmp-2023-wash-households

29 Margaret Jolly, Women of the Place. Routledge, 1997.

30 Ralph Regenvanu, "The Changing Face of Custom in Vanuatu," People Cult. Ocean., vol. 20, pp. 35–46.

31 A. A. Granderson, "The Role of Traditional Knowledge in Building Adaptive Capacity for Climate Change: Perspectives from Vanuatu," Weather Clim. Soc., vol. 9, no. 3, pp. 545–561, July 2017, doi: 10.1175/WCAS-D-16-0094.1.

32 S. Mael, "Climate change and agriculture in Vanuatu: a study of crops and farming system.," FAO, Port Vila, 2013.

33 Government of the Republic of Vanuatu, "Protection of Traditional Knowledge and Expressions of Culture." Government of the Republic of Vanuatu, 2020. Accessed: July 16, 2025. [Online]. Available: https://www.wipo.int/wipolex/en/legislation/details/19529

34 O. C. Warrick, "Local Voices, Local Choices? Vulnerability to Climate Change and Community-Based Adaptation in Rural Vanuatu," Doctoral Thesis, University of Waikato, 2011. [Online]. Available: https://hdl.handle.net/10289/5828

35 Government of Vanuatu, "Vanuatu Infrastructure Strategic Investment Plan 2015-2024." Government of the Republic of Vanuatu, 2015.

36 Brendan Mackey et al, "Ecosystem and Socio-Economic Resilience Analysis and Mapping," Secretariat of the Pacific Regional Environment Programme (SPREP), Apia, Samoa, 2017. [Online]. Available: https://www.griffith.edu.au/__data/assets/pdf_file/0023/528080/vanuatu-ecosystem-socio-economic-resilience-analysis-mapping.pdf

37 J. R. Brown et al., "South Pacific Convergence Zone dynamics, variability and impacts in a changing climate," Nat. Rev. Earth Environ., vol. 1, no. 10, pp. 530–543, Oct. 2020, doi: 10.1038/s43017-020-0078-2.

38 Simon McGree, Grant Smith, Elise Chandler, Nicholas Herold, Zulfikar Begg, Yuriy Kuleshov, Philip and Malsale and Mathilde Ritma, "Climate Change in the Pacific 2022: Historical and Recent Variability," SPC, Suva, Fiji, Sept. 2023.

39 University of Hawaii, CSIRO and Climate Comms, "Vanuatu's Climate: Current and future variability and change. A report to the Van-KIRAP project," Melbourne, Australia, Commonwealth Scientific and Industrial Research Organisation (CSIRO) Technical Report, 2023.

40 CSIRO, SPREP, and VMDG, "Vanuatu North: sub-national historical and projected climate overview," Commonwealth Scientific and Industrial Research Organisation (CSIRO), Secretariat of the Pacific Regional Environment Programme (SPREP) and Vanuatu Meteorology and Geo-hazards Department (VMGD), 2023. [Online]. Available: https://www.vanclimatefutures.gov.vu/assets/docs/Regional%20Summary%20Vanuatu%20North.pdf

41 CSIRO, SPREP, and VMGD, "Vanuatu Central: Sub-national historical and projected climate overview," Commonwealth Scientific and Industrial Research Organisation (CSIRO), Secretariat of the Pacific Regional Environment Programme (SPREP) and Vanuatu Meteorology and Geo-hazards Department (VMGD), 2023. [Online]. Available: https://library.sprep.org/sites/default/files/2024-07/Vanuatu-Central-Historical-and-Projected-Climate.pdf

42 CSIRO, SPREP, and VMGD, "Vanuatu South: Sub-national historical and projected climate overview," Commonwealth Scientific and Industrial Research Organisation (CSIRO), Secretariat of the Pacific Regional Environment Programme (SPREP) and Vanuatu Meteorology and Geo-hazards Department (VMGD), 2023. [Online]. Available: https://library.sprep.org/sites/default/files/2024-07/Vanuatu-South-Historical--Projected-Climate.pdf

43 S. C. Moser, “Reflections on climate change communication research and practice in the second decade of the 21st century: what more is there to say?,” Wiley Interdiscip Rev Clim Change, vol. 7, no. 3, pp. 345–369, May 2016, doi: 10.1002/wcc.403.

44 N. Dawes, R. Franklin, L. McIver, and J. Obed, “General and post-disaster mental health servicing in Vanuatu: A qualitative analysis,” Int. J. Disaster Risk Reduct., vol. 40, no. 101256, 2019, [Online]. Available: https://doi.org/10.1016/j.ijdrr.2019.101256

45 John Handmer and Hannah Iveson, “Cyclone Pam: Learning from the low death toll,” Aust. J. Emerg. Manag., vol. 32, no. 2, p. 61, Apr. 2017.

46 Ministry of Health, “Tropical Cyclone Harold Vanuatu National Health Situation Report #3 22 April 2020,” Ministry of Health, 3, Apr. 2020. [Online]. Available: https://moh.gov.vu/images/TC-Harold/Vanuatu_TC_Harold_NHEOC_SitRep3_22042020.pdf

47 Department of Strategic Planning and Aid Coordination, “Post-Disaster Needs Assessment TC Harold & COVID-19 Vanuatu Volume A Summary Report,” Government of Vanuatu, 2020. [Online]. Available: https://dsppac.gov.vu/images/roc/pmo001-post-disaster-needs-assessment-volume-a_hr-single-pages__p41044.pdf

48 International Federation of Red Cross and Red Crescent Societies, “Final Report Vanuatu: Tropical Cyclone Harold,” International Federation of Red Cross and Red Crescent Societies, Jan. 2021. [Online]. Available: https://reliefweb.int/report/vanuatu/vanuatu-tropical-cyclone-harold-final-report-dref-n-mdrvu008

49 Reliefweb, “Asia Pacific Region: Weekly Regional Humanitarian Snapshot (11 - 17 March 2014).” Accessed: Dec. 08, 2025. [Online]. Available: https://reliefweb.int/report/vanuatu/asia-pacific-region-weekly-regional-humanitarian-snapshot-11-17-march-2014

50 Government of Vanuatu., “Response & Early Recovery Humanitarian Action Plan Tropical Cyclone Hola & Ambae Volcano,” Apr. 2018. [Online]. Available: https://ndmo.gov.vu/images/download/VolcanoActivity2018/High-Res-TC-Hola-and-Ambae-Volcano-Response-and-Early-Recovery-Plan-April-2018-1.pdf

51 Reliefweb, “Two Vanuatu children drowned in flooded river during Cyclone Hola.” Accessed: Dec. 08, 2025. [Online]. Available: https://reliefweb.int/report/vanuatu/two-vanuatu-children-drowned-flooded-river-during-cyclone-hola

52 Reliefweb, “Pacific: Drought - 2015-2017.” [Online]. Available: https://reliefweb.int/disaster/dr-2015-000127-fji#:~:text=Vanuatu%20has%20been%20grappling%20with,OCHA%2C%2006%20Jun%202016)

53 L. Fox, “Vanuatu drought: Toddler’s death believed to be country’s first fatality linked to worsening crisis,” ABC News, Sept. 23, 2015. [Online]. Available: https://www.abc.net.au/news/2015-09-23/drought-toddler-dies-from-severe-diarrhoea-in-vanuatu/6796808

54 L. Fox, “Young children hardest hit in Vanuatu drought driven by El Nino,” ABC News, Nov. 03, 2015. [Online]. Available: https://www.abc.net.au/news/2015-11-03/young-children-hardest-hit-in-vanuatu-drought-driven-by-el-nino/6906560

55 ABC, “Six people missing after Tropical Cyclone Lusi hits Vanuatu.” Accessed: Dec. 14, 2025. [Online]. Available: https://www.abc.net.au/news/2014-03-14/an-vanuatu-cyclone/5320662

56 UNOCHA, “OCHA Flash Update Vanuatu | Paama Flooding & Landslides 1 November 2013.” [Online]. Available: https://www.unocha.org/publications/report/vanuatu/ocha-flash-update-vanuatu-paama-flooding-landslides-1-november-2013

57 Smithsonian Institute Naturak Museum if Natural Histiry Global Volcanism Program, Vanuatu Volcanoes. Accessed: Dec. 08, 2025. [Online]. Available: https://volcano.si.edu/volcanolist_countries.cfm?country=Vanuatu

58 UN Office for the Coordination of Humanitarian Affairs, "Pacific Humanitarian Team - Vanuatu: Earthquake - Situation Report (26 December 2024)," UN Office for the Coordination of Humanitarian Affairs, Dec. 2024. [Online]. Available: https://reliefweb.int/report/vanuatu/pacific-humanitarian-team-vanuatu-earthquake-situation-report-26-december-2024

59 New Zealand Red Cross, "Vanuatu communities face long recovery after earthquake."

60 World Health Organization, "On the path to recovery: three months after the earthquake in Vanuatu." [Online]. Available: https://www.who.int/westernpacific/newsroom/feature-stories/item/on-the-path-to-recovery--three-months-after-the-earthquake-in-vanuatu

61 Rovins, J.E., Stewart, C., Brown, N, "Learning from population displacement in the Pacific: case study of the 2017-2018 eruption of Ambae volcano, Vanuatu. SWOT Analysis and Recommendations," Massey University, Wellington (NZ), Disaster Research Science Report 2020/04.

62 CSIRO, Federation University, and Climate Comms, "Tropical Cyclone Observations, Trends and Projections for Vanuatu," CSIRO, 2023. [Online]. Available: https://vanclimatefutures.gov.vu/assets/docs/Tropical%20Cyclone.pdf

63 RK Hoeke et al, "National extreme sea level modelling and analysis under current and future sea level rise scenarios for Vanuatu.," Climate Information Services for Resilient Development in Vanuatu (VAN-CIS-RDP), Australia, 2023. [Online]. Available: https://library.sprep.org/sites/default/files/2024-07/VanKIRAP_Sea-Leve-lCoastal-Hazards.pdf

64 CSIRO, Federation University, and Climate Comms, "Extreme Rainfall and wind speed projections for Vanuatu. A report to Van-KIRAP project.," Commonwealth Scientific and Industrial Research Organisation (CSIRO), Melbourne, Australia, 2023. [Online]. Available: https://vanclimatefutures.gov.vu/assets/docs/Extreme%20Rainfall%20Explainer.pdf

65 CSIRO and SPREP, "Climate Change Impacts on Water Security in Vanuatu," Infobyte prepared for the Vanuatu Meteorology and Geo-hazards Department, 2023. [Online]. Available: https://library.sprep.org/sites/default/files/2023-09/TC-Water-Security-Infobyte.pdf

66 Vanuatu Climate Futures, "Current and Future Drought Climatology for Vanuatu," 2023. [Online]. Available: https://vanclimatefutures.gov.vu/assets/docs/Drought.pdf

67 N. J. Holbrook et al., "Impacts of marine heatwaves on tropical western and central Pacific Island nations and their communities," Glob. Planet. Change, vol. 208, p. 103680, Jan. 2022, doi: 10.1016/j.gloplacha.2021.103680.

68 CSIRO, SPREP and VMGD, "Historical, current and future marine heatwave climatology for Vanuatu. A report to the Van-KIRAP project." CSIRO Technical Report, Melbourne, Australia, 2023.

69 CSIRO, "Ocean acidification Factsheet." [Online]. Available: https://vanclimatefutures.gov.vu/assets/docs/Ocean%20Acidification.pdf

70 VBoS, "Statistical Development Plan for Vanuatu Disaster-Related Statistics." Vanuatu Bureau of Statistics, 2024. Accessed: July 21, 2025. [Online]. Available: https://vbos.gov.vu/sites/default/files/NSDS%3B%20Disaster%20Related%20Statistics%202024-2028.pdf

71 Government of the Republic of Vanuatu, "Vanuatu's Revised and Enhanced 1st Nationally Determined Contribution 2021–2030."

72 Ministry of Climate Change & Adaptation, "Vanuatu Climate Change & Disaster Risk Reduction Policy 2022-2030." Government of the Republic of Vanuatu, 2022. Accessed: Mar. 23, 2025. [Online]. Available: https://www.nab.vu/sites/default/files/documents/National%20CCDRR%20Policy%202022-2030.pdf

73 Government of Vanuatu, "Vanuatu 2030 The People's Plan: National Sustainable Development Plan 2016-2030," Government of Vanuatu, 2016. [Online]. Available: https://vbos.gov.vu/sites/default/files/Vanuatu2030-EN-FINAL-sf.pdf

74 Department of Agriculture and Rural Development, "Vanuatu Agriculture Sector Policy 2015–2030." Department of Agriculture and Rural Development, Port Vila, 2015. [Online]. Available: https://agriculture.gov.vu/images/documents/policy/arg_policy.PDF

75 Department of Climate Change, "Vanuatu Loss and Damage Policy." Ministry of Climate Change, 2025. Accessed: Sept. 01, 2025. [Online]. Available: https://docc.gov.vu/index.php/lnd/lnd-policy

76 SRA, "Glossary," International Society of Risk Analysis, 2024. doi: https://www.sra.org/resources.

77 Australian Climate Service, "Australia's first National Climate Risk Assessment," Australia National Government, Australia, 2025. Accessed: Oct. 09, 2025. [Online]. Available: https://www.acs.gov.au/pages/national-climate-risk-assessment

78 World Health Organization, "Public Health Risk Assessment And Interventions Tropical Cyclone Pam Vanuatu," World Health Organization, 2016. [Online]. Available: https://iris.who.int/bitstream/handle/10665/254640/9789290617495-eng.pdf?sequence=1

79 Gillett, R. E., & Fong, M., Fisheries in the economies of Pacific Island countries and territories (Benefish Study 4). 2023. Accessed: Sept. 28, 2025. [Online]. Available: https://www.spc.int/DigitalLibrary/Doc/FAME/Manuals/Gillett_23_Benefish4.pdf

80 VBoS, "2022 Vanuatu National Agricultural Census: Preliminary Report," Vanuatu Bureau of Statistics, Port Vila, 2023. Accessed: Aug. 19, 2025. [Online]. Available: https://vbos.gov.vu/images/Public_Documents/Census_Surveys/Census/Agriculture_Census_2022/VNAC_PRELIMINARY_REPORT_2022.pdf

81 P. Judge, "Cultivating Change: Challenges and Opportunities in Vanuatu's Agriculture," Financial Centre Association of Vanuatu, Apr. 2024. Accessed: Aug. 19, 2025. [Online]. Available: https://fca.vu/cultivating-change-challenges-and-opportunities-in-vanuatus-agriculture/

82 H. A. Jones and K. E. Charlton, "A cross-sectional analysis of the cost and affordability of achieving recommended intakes of non-starchy fruits and vegetables in the capital of Vanuatu," BMC Public Health, vol. 15, p. 301, Mar. 2015, doi: 10.1186/s12889-015-1644-2.

83 Ministry of Health, "Vanuatu Food Safety, Security & Nutrition Policy 2022-2030," 2022. [Online]. Available: https://moh.gov.vu/images/health_policies/policies/Vanuatu_Food_Safety_Security_&_Nutrition_Policy_2022-2030_Oct_web.pdf

84 A. Savage, H. Bambrick, and D. Gallegos, "From garden to store: local perspectives of changing food and nutrition security in a Pacific Island country," Food Secur., vol. 12, pp. 1331–1348, 2020.

85 Vanuatu Bureau of Statistics and Ministry of Agriculture, Livestock, Fisheries, Forestry and Biosecurity, "2022 Vanuatu National Agriculture Census," Volume 1.

86 United Nations Development Programme (UNDP), "Positive partnership for Vanuatu's bio-diversity, environmental conservation and climate adaptation." [Online]. Available: https://www.undp.org/pacific/news/positive-partnership-vanuatus-bio-diversity-environmental-conservation-and-climate-adaptation

87 Mary Taylor, Andrew McGregor, and Brian Dawson, Eds., Vulnerability of Pacific Island agriculture and forestry to climate change. New Caledonia: the Pacific Community, 2016.

88 Bouchet P., Le Guyader H., and H. & Pascal, Eds., The Natural History of Santo. Paris: MNHN.

89 "Biodiversity," Department of Environmental Protection and Conservation. Accessed: Oct. 08, 2025. [Online]. Available: https://environment.gov.vu/index.php/biodiversity-conservation/biodiversity

90 "Critical Ecosystem Partnership Fund," Department of Environmental Protection and Conservation. Accessed: Oct. 08, 2025. [Online]. Available: https://environment.gov.vu/index.php/projects/critical-ecosystem-partnership-fund

91 "Vanuatu National Biodiversity Strategy and Action Plan (NSAP) 2018-2030," Vanuatu. [Online]. Available: https://environment.gov.vu/images/Vanuatu_NBSAP_2018-2030.pdf

92 "About VESS," Vanuatu Environmental Science Society. Accessed: Oct. 09, 2025. [Online]. Available: https://www.vanuatuconservation.org/about-vess/

93 E.S. Brondizio, J Settle, S Diaz, and HT Ngo, "The global assessment report on Biodiversity and Ecosystem Services," IPBES, Bonn Germany, 2020. [Online]. Available: https://www.ipbes.net/system/files/2021-06/2020%20IPBES%20GLOBAL%20REPORT(FIRST%20PART)_V3_SINGLE.pdf

94 One Earth and RESOLVE, Ed., "Vanuatu Rainforest Ecoregion Snapshots: Descriptive Abstracts of the Terrestrial Ecoregions of the World, 2021." Sept. 23, 2020. Accessed: Oct. 08, 2025. [Online]. Available: https://www.oneearth.org/ecoregions/vanuatu-rainforests/

95 Penelope Figgs, Brendan Mackey, James Fitzsimmons, and Jason Irving, Valuing Nature: Protected Areas and Ecosystem Services. Australia: Australian Committee for IUCN, 2015.

96 D. Kalfatak, "Directory of Wetlands of Vanuatu 2014," Report to the Secretariat of the Pacific Regional Environmental Program, Government, 2014.

97 Peter C Gehrke et al., "Vulnerability of freshwater and estuarine fish habitat in the tropical Pacific to climate change.," in Vulnerabiity of Tropical Pacific FIsheries and Aquaculture to Climate Change, New Caledonia: Secretariat of the Pacific Community, 2011.

98 Ma W, Wang W, Tang C, Chen G, Wang M., "Zonation of mangrove flora and fauna in a subtropical estuarine wetland based on surface elevation.," Ecol. Evol., vol. 10, no. 14, June 2020, doi: 10.1002/ece3.6467.

99 "Vanuatu Fisheries Resource Profile," Port Vila, Vanuatu. [Online]. Available: https://library.sprep.org/sites/default/files/96_2.pdf

100 "What is Seagrass," Seagrass Watcj. Accessed: Oct. 09, 2025. [Online]. Available: https://www.seagrasswatch.org/seagrass/

101 Len McKensie et al, "Seagrass ecosystem contributions to people's quality of life in the Pacific Island Countries and Territories," Mar. Polution Bull., vol. 167, 2021, [Online]. Available: https://doi.org/10.1016/j.marpolbul.2021.112307

102 CSIRO SPREP, "Marine heatwave impacts on seagrass in Vanuatu. Infobyte prepared for the Vanuatu Meteorology and Geo-hazards Department as part of the Van-KIRAP project." CSIRO: Melbourne, Australia, 2023.

103 D. Kirono et al., “National and sub-national climate projections for Vanuatu: A report to the Van-KIRAP project,” Commonwealth Scientific and Industrial Research Organisation, Melbourne.

104 J Maynard, S Heron, and R van Hooidonk, “Past and projected future impacts of coral bleaching on the reefs of Vanuatu.,” Secretariat of the Pacific Regional Environment Programme (SPREP), Apia, Samoa, Government.

105 Government of the Republic of Vanuatu and Blue Prosperity, “Vanuatu Coral Reef Study 2023: Final Science Report,” Government of the Republic of Vanuatu and Blue Prosperity, Vanuatu, Science Report, July 2025. Accessed: Nov. 11, 2025. [Online]. Available: https://www.blueprosperityvanuatu.org/coralreefstudy

106 CSIRO and SPREP, “Climate change impacts on gender ratios of Hawksbill turtles. Infobyte prepared for the Vanuatu Meteorology and Geo-hazards Department as part of the Van-KIRAP project.” CSIRO: Melbourne, Australia, 2023.

107 Ministry of Education & Training, “Vanuatu Education and Training Sector Strategy 2020-2030,” Ministry of Education & Training, 2020. [Online]. Available: https://www.globalpartnership.org/content/education-and-training-sector-strategic-plan-2020-2030-vanuatu

108 Ministry of Education & Training, “Education Statistics: Basic Tables of 2023,” Ministry of Education & Training, 2023. [Online]. Available: https://moet.gov.vu/docs/statistics/MoET%20Statistical%20Report_2023.pdf

109 F. Kagawa and D. Selby, “Surging Seas and Escalating Risks: Enhancing Education System Resilience in Vanuatu,” Sustainability Frontiers, United Kingdom, Sept. 2024.

110 Department of Strategic Planning and Aid Coordination, “Post-Disaster Needs Assessment TC Harold & COVID-19 Vanuatu Volume B Sector Reports: Disaster Effects & Recovery Needs,” Government of Vanuatu, 2020. [Online]. Available: https://dsppac.gov.vu/images/roc/pmo001-post-disaster-needs-assessment-volume-b_hr-single-pages__p16608.pdf

111 Department of Women’s Affairs, CARE Vanuatu, and Ministry of Justice and Community Services, “Tropical Cyclones Judy & Kevin Gender & Protection Analysis,” Version 3, Mar. 2023. [Online]. Available: https://reliefweb.int/report/vanuatu/tropical-cyclones-judy-kevin-gender-protection-analysis-22-march-2023-version-3

112 Save the Children, “A second chance at education.” [Online]. Available: https://www.savethechildren.org.au/our-stories/a-second-chance-at-education

113 Vanuatu National Statistics Office, “Food Security in Vanuatu 2019–2020 NSDP Baseline Survey,” Vanuatu National Statistics Office, 2021. [Online]. Available: https://vbos.gov.vu/sites/default/files/Food_security.pdf

114 FAO, “Fishery and aquaculture country profiles - the Republic of Vanuatu,” FAO, Bangkok, 2018. [Online]. Available: https://www.fao.org/fishery/en/facp/VUT?lang=en

115 M. W. Rosegrant, M. M. Dey, R. Valmonte-Santos, and O. L. Chen, “Economic impacts of climate change and climate change adaptation strategies in Vanuatu and Timor-Leste,” Mar. Policy, vol. 67, pp. 179–188, May 2016, doi: 10.1016/j.marpol.2015.12.010.

116 M. Lang, “Report of the Pacific fisheries study tour to Papua New Guinea, Vanuatu and Samoa November 2008,” Commonwealth Policy Studies Unit, 2008.

117 N. Pascal, G. Leport, and V. Molisa, “National marine ecosystem service valuation summary report: Vanuatu,” Marine and Coastal Biodiversity Management in Pacific Island Countries, 2015.

118 FAO, “An assessment of the impact of climate change on agriculture and food security: A case study in Vanuatu,” FAO, Rome, Unknown. Accessed: July 25, 2025. [Online]. Available: https://www.fao.org/4/i0530e/i0530e02.pdf

119 A. Rarai, E. Weber, J. Ruben, and M. Parsons, “Indigenous knowledge with science forms an early warning system for ciguatera fish poisoning outbreak in Vanuatu,” Commun. Earth Environ., vol. 5, p. 761, 2024.

120 “Forests of the Pacific Islands,” Secretariat of the Pacific Community, 2011.

121 V. A. Cevik, “Impacts of Climate Change on Logistics and Supply Chains,” J. Disaster Risk, vol. 7, no. 2, pp. 368–391, 2024.

122 Ministry of Health, “Health Facility Readiness and Service Availability (HFRSA) Assessment: Republic of Vanuatu,” Ministry of Health, May 2021. [Online]. Available: https://www.sistalibrary.com.vu/wp-content/uploads/2021/12/FINAL-HFRSA-Assessment-Vanuatu.pdf

123 Ministry of Health, “Vanuatu Health Sector Strategy 2021-2030 Wan Strong Helt Sistem Blong Yumi Evriwan,” 2021. [Online]. Available: https://moh.gov.vu/images/Strategic_Plan/Health_Sector_Strategy_HSS_2021-2030_.pdf

124 World Health Organization, “Health worker density: Data by country.” [Online]. Available: https://apps.who.int/gho/data/node.main.UHCHRH?lang=en

125 Ministry of Health, “Ministry of Health Workforce Development Plan 2019-2025,” 2019. [Online]. Available: https://moh.gov.vu/images/health_policies/plans/Workforce_Development_Plan_MoH_2019-2025-_Final.pdf

126 Global Nutrition Report, “Country Nutrition Profiles.” [Online]. Available: https://globalnutritionreport.org/resources/nutrition-profiles/oceania/melanesia/vanuatu/

127 World Health Organization, “Malnutrition.” [Online]. Available: https://www.who.int/news-room/fact-sheets/detail/malnutrition/

128 UNICEF, World Health Organization, and World Bank, “Joint Child Malnutrition Estimates: Malnutrition Data.” UNICEF Data, May 2023. [Online]. Available: https://data.unicef.org/resources/dataset/malnutrition-data/

129 World Health Organization Regional Office for the Western Pacific, “Climate Change and Health in Small Island Developing States: A WHO Special Initiative Pacific Island Countries and Areas,” World Health Organization, 2018. [Online]. Available: https://www.who.int/publications/i/item/9789290618669

130 G. Cissé et al., “Health, Wellbeing, and the Changing Structure of Communities.,” in Climate Change 2022: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change, H. O. Pörtner, D. C. Roberts, M. Tignor, E. S. Poloczanska, K. Mintenbeck, A. Alegría, M. Craig, S. Langsdorf, S. Löschke, V. Möller, A. Okem, and B. Rama, Eds., Cambridge University Press, 2022, pp. 1041–1170. [Online]. Available: doi:10.1017/9781009325844.009

131 R. Root, “‘The wells are salty’: how the invading ocean is contaminating Vanuatu’s water,” The Guardian, Aug. 14, 2024. [Online]. Available: https://www.theguardian.com/environment/article/2024/aug/14/the-wells-are-salty-how-the-invading-ocean-is-contaminating-vanuatus-water

132 World Health Organization, “Heat and health.” [Online]. Available: https://www.who.int/news-room/fact-sheets/detail/climate-change-heat-and-health

133 Internal Displacement Monitoring Centre, "Disaster displacement: Vanuatu country briefing," Internal Displacement Monitoring Centre, 2022. [Online]. Available: https://api.internal-displacement.org/sites/default/files/publications/documents/Vanuatu_country_briefing.pdf

134 Internal Displacement Monitoring Centre, "Tropical Cyclone Harold and COVID-19: a double blow to the Pacific Islands." [Online]. Available: https://www.internal-displacement.org/expert-analysis/tropical-cyclone-harold-and-covid-19-a-double-blow-to-the-pacific-islands

135 J. T. Spickett, D. Katscherian, and L. McIver, "Health Impacts of Climate Change in Vanuatu: An Assessment and Adaptation Action Plan," Glob. J. Health Sci., vol. 5, no. 3, pp. 42–53, 2013, doi: https://doi.org/10.5539/gjhs.v5n3p42.

136 World Meteorological Organization, "WMO Air Quality and Climate Bulletin," World Meteorological Organization, 3, Sept. 2023. [Online]. Available: https://library.wmo.int/records/item/62090-no-3-september-2023

137 S. Datzberger, L. Howard-Merrill, J. Parkes, and S. K. Iorfa, "How do extreme weather events contribute to violence against children?," Child Abuse Negl., vol. 158, p. 107093, Dec. 2024, doi: 10.1016/j.chiabu.2024.107093.

138 R. Mahendran, R. Xu, S. Li, and Y. Guo, "Interpersonal violence associated with hot weather," Lancet Planet. Health, vol. 5, no. 9, pp. e571–e572, Sept. 2021, doi: 10.1016/S2542-5196(21)00210-2.

139 National Disaster Management Office, "Gender & Protection Cluster (G&P)." [Online]. Available: https://ndmo.gov.vu/resources/clusters?view=article&id=91

140 A. Imamovic, "The climate paradox: adaptation and resilience," The Junction. [Online]. Available: https://junctionjournalism.com/2023/02/02/the-paradox-of-climate-change-adaptation-and-resilience/#:~:text=As%20the%20only%20psychiatrist%20in,disability%2C%E2%80%9D%20Dr%20Obed%20said

141 D. M. Benedek, C. Fullerton, and R. J. Ursano, "First responders: mental health consequences of natural and human-made disasters for public health and public safety workers," Annu. Rev. Public Health, vol. 28, pp. 55–68, 2007, doi: 10.1146/annurev.publhealth.28.021406.144037.

142 N. Lakhani, "United Nations adopts landmark resolution on climate justice," The Guardian, Mar. 29, 2023. [Online]. Available: https://www.theguardian.com/environment/2023/mar/29/united-nations-resolution-climate-emergency-vanuatu

143 World Health Organization Regional Office for the Western Pacific, "World Mental Health Day: In Vanuatu, communities are key to making mental health care for all a reality." [Online]. Available: https://www.who.int/westernpacific/about/how-we-work/pacific-support/news/feature-stories/detail/world-mental-health-day-in-vanuatu-communities-are-key-to-making-mental-health-care-for-all-a-reality

144 C. Ibell, S. Sheridan, P. Hill, J. Tasserei, M.-F. Maleb, and J.-J. Rory, "The individual, the government and the global community: sharing responsibility for health post-2015 in Vanuatu, a small island developing state," Int. J. Equity Health, vol. 14, no. 102, 2015, [Online]. Available: https://doi.org/10.1186/s12939-015-0244-1

145 World Health Organization, "Mortality rate attributed to unsafe WASH services (per 100 000 population)." [Online]. Available: https://data.who.int/indicators/i/C123B15/ED50112?m49=548

146 C. Wilson, "Waterborne diseases surge among Vanuatu children after cyclones," Al Jazeera, Apr. 04, 2023. [Online]. Available: https://www.aljazeera.com/news/2023/4/4/waterborne-diseases-surge-among-vanuatu-children-after-cyclones

147 Ministry of Health, "Sanitation and Hygiene Policy," 2017. [Online]. Available: https://moh.gov.vu/images/health_policies/policies/Sanitation_and_Hygiene_policy-_Final.pdf

148 World Health Organization, "Vanuatu: Protecting children from diarrhoea." [Online]. Available: https://www.who.int/westernpacific/about/how-we-work/pacific-support/news/detail/08-04-2015-vanuatu-protecting-children-from-diarrhoea

149 World Health Organization, "Epidemics that didn't happen: Leptospirosis in Vanuatu." [Online]. Available: https://www.who.int/westernpacific/newsroom/feature-stories/item/epidemics-that-did-not-happen-leptospirosis-in-vanuatu#:~:text=Leptospirosis%2C%20caused%20by%20the%20Leptospira,Organization%20(WHO)%20in%20Vanuatu.

150 World Health Organization, "Disease surveillance system helps detect potential outbreaks." [Online]. Available: https://www.who.int/westernpacific/about/how-we-work/pacific-support/news/detail/12-06-2015-disease-surveillance-system-helps-detect-potential-outbreaks#:~:text=The%20network%20has%20detected%20other,pre%2Dcyclone%20disease%20surveillance%20system.

151 World Health Organization, "Burden of disease attributable to unsafe drinking-water, sanitation and hygiene: 2019 update," World Health Organization, 2023. [Online]. Available: https://www.who.int/publications/i/item/9789240075610

152 G. E. Banna et al., "Climate Change: An Unrecognized Threat to Yaws Eradication," Int. Soc. Dermatol., pp. 1–3, 2025.

153 Early Childhood Scientific Council on Equity and the Environment, "A Cascade of Impacts: The Many Ways Water Affects Child Development," 2024. [Online]. Available: https://developingchild.harvard.edu/resources/working-paper/water-affects-child-development/

154 World Health Organization, "Climate-resilient water safety plans: Managing health risks associated with climate variability and change," World Health Organization, 2017. [Online]. Available: https://www.who.int/publications/i/item/9789241512794

155 The European Climate and Health Observatory, "Drought and water scarcity." [Online]. Available: https://climate-adapt.eea.europa.eu/en/observatory/evidence/health-effects/drought-and-water-scarcity#:~:text=Drought%20conditions%20can%20lead%20to,et%20al.%2C%202020).

156 Love, M, K. Molitambe, S. Shrestha, and R. T. Souter, "Decentralisation and rural water service delivery in Vanuatu Final Report," International WaterCentre, Griffith University; The University of the South Pacific, 2024. [Online]. Available: https://watercentre.org/wp-content/uploads/2025/01/Van-Decentralisation-wrt-IWC-USP-FINAL-24.pdf

157 UNICEF, "Rural water supply services in Vanuatu in need of significant improvements," UNICEF, TP/13/2020, 2020. [Online]. Available: https://www.unicef.org/pacificislands/media/2121/file

158 I. Mactaggart, et al., "Water, women and disability: Using mixed-methods to support inclusive WASH programme design in Vanuatu," Lancet Reg. Health - West. Pac., vol. 8, p. 100109, 2021.

159 World Health Organization, "Vanuatu." [Online]. Available: https://data.who.int/countries/548

160 Public Work Department, "Vanuatu Rural Roads Design Guide Incorporating Climate Resilient Design - Version 3.0." Vanuatu Public Works Department, 2017. [Online]. Available: https://pwd.gov.vu/images/PWD_Documents/Technical_Documentation/170531_VRRDG_signed.pdf

161 "Workshop notes,"

162 "VAN: Port Vila Urban Development Project," Final Draft 8, Nov. 2015. [Online]. Available: https://www.adb.org/sites/default/files/project-documents/42391-013-emp-02.pdf

163 WWTF Assessment Team, "Port Vila Waste Water Treatment Plant Assessment Report 2025," Port Vila, Vanuatu, June 2025. [Online]. Available: https://coastalwater.vu/port-vila-waste-water-treatment-plant-assessment-report-2025/

164 Patience Mawa (VBTC), "Government May Extend Lagoon Use Ban as Water Tests Confirm High Bacterial Levels," VBTC Blong Yami Evriwan.

165 I. Ahmed and T. McDonnell, "Prospects and constraints of post-cyclone housing reconstruction in Vanuatu drawing from the experience of tropical cyclone Harold," Prog. Disaster Sci., vol. 8, p. 100126, Dec. 2020, doi: 10.1016/j.pdisas.2020.100126.

166 State of the Tropics, "Sustainable Infrastructure for the Tropics.," James Cook University, Townsville, Australia., 2017.

167 Meghan Bartels, "The Hidden Ways Extreme Heat Disrupts Infrastructure," Sci. Am., Aug. 2024, [Online]. Available: https://www.scientificamerican.com/article/how-extreme-heat-harms-planes-trains-water-mains-and-other-crucial/

168 J. Hughes, K. Cowper-Heays, E. Olesson, R. Bell, and A. Stroombergen, "Impacts and implications of climate change on wastewater systems: A New Zealand perspective," Clim. Risk Manag., vol. 31, p. 100262, Jan. 2021, doi: 10.1016/j.crm.2020.100262.

169 Nick Perry and Elaine Kurtenbach, Vanuatu struggles to account for cyclone damage, deaths. [Online]. Available: https://apnews.com/weather-general-news-weather-forecasts-0f7a2ce3c61a4222b8dd60bef822fb01

170 "Green Climate Fund," Vanuatu community-based climate resilience Project (VCCRP). [Online]. Available: https://www.greenclimate.fund/project/fp184

171 The Pacific Private Sector Development Initiative (PSDI), "Vanuatu Pacific Tourism Sector Snapshot," Nov. 2021. Accessed: Sept. 23, 2025. [Online]. Available: https://pacificpsdi.org/assets/Uploads/PSDI-TourismSnapshot-VAN2.pdf

172 "Vanuatu Sustainable Tourism Strategy (2021-2025)." Accessed: Sept. 23, 2025. [Online]. Available: https://tourism.gov.vu/images/DoT-Documents/Plans/Vanuatu_Sustainable_Tourism_Strategy_LR.pdf

173 Live and Learn, "Conservation areas coming soon to Vanuatu," Conservation areas coming soon to Vanuatu | Live & Learn. Accessed: Dec. 11, 2025. [Online]. Available: https://livelearn.org/stories/conservation-areas-coming-soon-to-vanuatu/

174 Australian Government, "A triple disaster event series in Vanuatu: Cascading and compounding impacts of climate change." United Nations. Accessed: Sept. 23, 2025. [Online]. Available: https://unfccc.int/documents/627999

175 "Vanuatu Agri-Tourism Linkages: A Baseline Study of Agri Demand from Port Vila's Hospitality Sector," Dec. 2015. Accessed: Nov. 30, 2025. [Online]. Available: https://tourism.gov.vu/images/DoT-Documents/Reports/VIVS/Vanuatu_Agri-Tourism_Linkages_A_Baseline_Study_of_Agri_Demand_from_Port_Vilas_Hospitality_Sector_2015.pdf

176 World Health Organization, "Water, sanitation and hygiene (WASH)." [Online]. Available: https://www.who.int/health-topics/water-sanitation-and-hygiene-wash#tab=tab_1

177 United Nations, “Convention on the Rights of the Child.” Nov. 20, 1989. [Online]. Available: https://www.ohchr.org/en/instruments-mechanisms/instruments/convention-rights-child

178 L. Faerua, M. Grant, K. Fullerton, A. Chaplin, P. Lee, and A.-M. Nobelius, “Evaluation of the New Zealand Government Funded Vanuatu Water Sector Partnership 2022,” Report prepared for Tetra Tech International Development, 2022.

179 Ministry of Lands & Natural Resources, “Vanuatu National Water Policy 2017-2030,” 2017. [Online]. Available: https://leap.unep.org/en/countries/vu/national-legislation/vanuatu-national-water-policy-2017-2030

180 UNICEF Pacific, “Financing Water, Sanitation & Hygiene in the Pacific,” 2023. [Online]. Available: https://www.unicef.org/pacificislands/media/4066/file/Financing%20WASH%20in%20the%20Pacific.pdf

181 T. Foster, E. C. Rand, K. K. Kotra, E. Sami, and J. Willetts, “Contending With Water Shortages in the Pacific: Performance of Private Rainwater Tanks Versus Communal Rainwater Tanks in Rural Vanuatu,” Water Resour. Res., vol. 57, no. 11, p. e2021WR030350, 2021.

182 FAO, “Country Profile - Vanuatu Islands,” Food and Agriculture Organisation of the United Nations, Rome, Italy, 2016. [Online]. Available: https://openknowledge.fao.org/server/api/core/bitstreams/89cf1c98-d34c-42e0-bbac-c809637e8b11/content

183 WHO/UNICEF Joint Monitoring Programme for Water Supply, Sanitation and Hygiene, “Vanuatu.” [Online]. Available: https://washdata.org/data/household#!/table?geo0=country&geo1=VUT

184 WHO/UNICEF Joint Monitoring Programme for Water Supply, Sanitation and Hygiene, “Drinking Water.” [Online]. Available: https://washdata.org/monitoring/drinking-water

185 T. Foster and J. Willetts, “Multiple water source use in rural Vanuatu: are households choosing the safest option for drinking?,” Int. J. Environ. Health Res., vol. 28, no. 6, pp. 579–589, 2018, doi: 10.1080/09603123.2018.1491953.

186 WHO and UNICEF, “Joint Monitoring Programme for Water Supply, Sanitation and Hygiene.” Accessed: July 21, 2025. [Online]. Available: https://washdata.org/data/household#!/table?geo0=country&geo1=VUT

187 B. Mommen, K. Humphries-Waa, and S. Gwavuya, “Does women’s participation in water committees affect management and water system performance in rural Vanuatu?,” Waterlines, vol. 36, no. 3, pp. 216–232, 2017.

188 Intergovernmental Panel on Climate Change (IPCC), “IPCC AR5 Report on Climate Change,” Geneva: IPCC, 2014.

189 SRA, “Society of Risk Analysis Glossary,” 2022. doi: https://www.sra.org/resources.

Appendices

Appendix A – Summary of Sector Workshop Representations

Risk assessments benefit significantly from incorporating multiple worldviews and localised knowledge, including lived experiences of communities. This approach ensures that technical data is enriched by on-the-ground understanding of how hazards impact different groups, sectors, infrastructures, and natural and cultural systems. The following Table 43 lists the organisations and related representatives invited to participate in these workshops

Table 43. Invited workshop representatives (*Contributed attendee as per workshop registration form)

May 2025 - Organisation Present
Abt/ABD/MoH
Abt/MoH
Department of Environmental Protection and Conservation (DEPC)
Department of Local Authorities (DLA)
Department of Climate Change (DoCC)
Department of Tourism (DoT)
Department of Water Resources
DOWR (VCAPZ)
Expanding Conservation Areas Reach and Effectiveness (ECARE – IUCN)
Food and Agriculture Organization of the United Nations (FAO)
Fisheries Department
Global Green Growth Institute (GGGI)
International Organization for Migration (IOM)
IsraAID Vanuatu
MACFB (PMU)
MACFFB (PMU)
Ministry of Agriculture, Livestock, Forestry and Biosecurity (MALFB)
Ministry of Education and Training (MoET) (Policy and Planning Directorate)

May 2025 - Organisation Present
Ministry of Health (MoH) (Public Health)
NAB Sec/MOCC
Pacific Community (SPC)
PEPC
Port Vila Operators Association
Public Works Department (PWD)
Save the Children VCCRP PMU
Sea change Lodge
TOAV
United Nations Development Program (UNDP)
United Nations Food and Agriculture Organization (UNFAO)
United Nations Children's Fund (UNICEF)
Vanuatu Hotels and Resorts Association
Vanuatu Scube Operators association
Vanuatu Tourism Office
Vanuatu Coastal Adaptation Project Phase 2 (VCAP 2)
VCAPZ
Vanuatu Community-Based Climate Resilience Project (VCCRP)
Vy (VPPA)
World Health Organization (WHO)

Figure A-01. Comparison of old and new filterable regions in Vanuatu Resilience Explorer® – new regions shown. Regions shown in yellow have greater than 50% similarity with old regions; regions shown in brown have less than 50% similarity with old regions.



Appendix B - Sectorial Reference Tables

This Appendix contains sectorial reference tables. Table A-01 below is a summary of the Hazard availability. Each sector tables appear under the sector headings below table A-01.

Table A-01. Hazard availability and data gaps for Vanuatu, based on data provided for this assessment.

Hazard	Coverage	Event Likelihood (Return Period)	Environmental Change/Scenario
Tropical Cyclones	National	Historic	N/A
Sea-level rise projections	National	2030, 2050, 2070, 2090	RCP4.5, RCP8.5
Coastal erosion	-	-	-
Coastal flooding	National	100 ARI (1%AEP)	0m, 0.5m, 1.0m 1.5m
Tidal flooding	-	-	-
Saltwater intrusion	-	-	-
Pluvial and Fluvial flooding	Regional	10,50,100ARI	Present day
Landslides	-	-	-
Shallow groundwater flooding	-	-	-
Marine Heatwaves	National	2030,2050	SSP 5-8.5
Precipitation Change	National	2030,2050,2070, 2090	RCP4.5, RCP8.5
Drought	National	2030,2050,2070, 2090	RCP8.5
Wildfire	-	-	-
Fracture rift zones	North, Central	N/A	N/A
Volcanic craters	North, Central	N/A	N/A
Surface Air Temperature	National	2030,2050,2070, 2090	RCP4.5, RCP8.5
Ocean acidification	National	2030, 2050	RCP4.5, RCP8.5

Agriculture (Chapter 3)

Table A-02. Summary of key quantitative hazard sources for the Agriculture sector

Hazard	Suitability	Description
Air Temperature	Medium	Quantified as a change in surface air temperature, with respect to a baseline period of 1986–2005. Due to the lack of seasonal variation, annual values are analysed under both RCP4.5 and RCP8.5. Values have been aggregated for North, Central, and South regions, and averaged over a 20-year period. This severely limits the granularity of the risk assessment.
Drought	Medium	Drought severity has been categorised as moderate, severe, and extreme based on SPI (Standardised Precipitation Index) values. For each severity, three metrics have been used to quantify drought: frequency (events per time period), duration (months), and intensity (unitless, derived from the SPI value over the period of drought). All projections were assessed under RCP8.5. Values have been averaged for North, Central, and South regions, and aggregated over a 20-year period. This severely limits the granularity of the risk assessment.
Precipitation	Medium	Quantified as a change in mm of rainfall, with respect to a baseline period of 1986–2005. To track seasonal variation, wet and dry seasonal trends have both been explored under RCP4.5 and RCP8.5. Values have been aggregated for North, Central, and South regions, and averaged over a 20-year period. This severely limits the granularity of the risk assessment.
Sea-Level Rise and Coastal Flooding	Medium	Quantified as the extent and depth of coastal flooding associated with a 1% AEP (1 in 100-year) event at four sea-level rise increments: present day, 0.5 m, 1.0 m, and 1.5 m.
Fluvial/Pluvial Flooding	Medium	Quantified as present-day flooding extent and depth for Malekula, Tanna, and two catchments near Port Vila and Luganville for 10%, 2%, and 1% AEP events. These are the only models available, and they lack a climate change component.
Tropical Cyclones	Medium to Low	Described qualitatively based on model projections as increasing intensity, but potentially decreasing frequency. However, the quantitative dataset provided only includes historical cyclone tracks.

Table A-03. Summary of key qualitative sources for the Agriculture sector

Source	Suitability	Description
Sector Workshop 1 (May 2025)	High	Reliance on cash crops, as local markets are important income earners for families. Notable changes in seasonality mean the traditional seasonal calendar is no longer functioning as effectively as in the past. Pests such as the rhinoceros beetle are impacting crops, and food production is closely linked to cultural practices.
CRVA Validation Workshop (October 2025)	High	Workshop participants provided additional information on the tolerance of different crop types to climate change impacts. New land use information was obtained from FAO, but this could not be decoded at the time this report was written.
2022 Vanuatu National Agricultural Census: Preliminary Report and Main Tables Report	High	Published in 2023 and supported by the European Union, the Food and Agriculture Organization of the United Nations (FAO), and the Vanuatu Bureau of Statistics. The Preliminary Report provides snapshots of the agriculture sector, while the Main Tables Report contains extensive statistical data across approximately 700 pages.
Country Gender Assessment of Agriculture and the Rural Sector in Vanuatu	Medium	Published in 2020 to inform the regional work of FAO and SPC, based on desk and field research undertaken in 2018.
Vanuatu Agriculture Sector Policy	Medium	Provides a roadmap to fulfil government priorities relating to agriculture as a key driver of economic growth and employment.
Vanuatu Agricultural Climate Risk Profile	Medium	Published in 2020 by the APEC Climate Centre. Provides an overview of the agriculture sector and broad insights into how climate change is likely to impact the sector.
A Cross-Sectional Analysis of the Cost and Affordability of Achieving Recommended Intakes of Non-Starchy Fruits and Vegetables in the Capital of Vanuatu	Medium	A research article published in 2015 in BioMed Central aimed at understanding the cost and affordability of consuming recommended amounts of non-starchy fruits and vegetables in Vanuatu.
International Court of Justice, Book of Exhibits	High	Includes impact statements from Werry Narua, Dr. Vincent Lebot, and Antoine Ravo (Director of the Department of Agriculture). These statements were submitted as evidence in the case Obligations of States in Respect of Climate Change before the International Court of Justice.

Ecosystems (Chapter 4)

Table A-04. Summary and suitability of hazard information available for the Ecosystems sector

Hazard	Suitability	Description
Drought	Medium	Drought severity has been categorized as moderate, severe, and extreme based on SPI (Standardised Precipitation Index) values. For each severity, three metrics have been used to quantify drought: frequency (events per time period), duration (months), and intensity (unitless, derived from the SPI value over the period of drought). All projections assessed under RCP8.5. Values have been averaged for North, Central and South regions, and aggregated over a 20-year period. This severely limits the granularity of the risk assessment.
Precipitation	Medium	Quantified as a change in mm of rainfall, with respect to a baseline period of 1986-2005. To track seasonal variation, wet and dry seasonal trends have both been explored under RCP4.5 and RCP8.5. Values have been aggregated for North, Central and South regions, and averaged over a 20-year period. This severely limits the granularity of the risk assessment.
Air Temperature	Medium	Quantified as a change in surface air temperature, with respect to a baseline period of 1986-2005. Due to the lack of seasonal variation, annual values are analysed under both RCP4.5 and RCP8.5. Values have been aggregated for North, Central and South regions, and averaged over a 20-year period. This severely limits the granularity of the risk assessment.
Coastal flooding/ SLR	Medium	Quantified as the extent and depth of coastal flooding associated with a 1% AEP (1-in- 100yr) event at 4 sea-level rise increments – present day, 0.5m, 1m, and 1.5m.
Ocean Acidification	Medium	Quantified as the 50th percentile of projected change in pH relative to baseline. Values are displayed on a 100 km × 200 km grid resolution and aggregated over a 20-year period. This severely limits the granularity of risk assessment.
Marine Heatwaves	Medium	Quantified as the average number of days per year experiencing a marine heatwave. The two most severe heatwave categories have been explored - Category 3 and Category 4. The classification is derived from how sea surface temperatures relate to the local mean and 90th percentile.
Fluvial and Pluvial Flooding	Medium	Quantified for as present-day flooding extent and depth for Malekula, Tanna, and two catchments near Port Vila and Luganville for 10%,2% and 1% AEP events. These models lack a climate change component.
Tropical Cyclones	Medium to Low	Described qualitatively based on model projections as increasing intensity, but potentially decreasing frequency. However, the quantitative data set provided only includes historical cyclone tracks

Table A-05. Summary of key qualitative sources for the Ecosystems sector

Hazard	Suitability	Description
Sector workshop 1 (May 2025)	High	Confirmation of key climate hazards and potential direct and indirect impacts on ecosystems. Identification of additional direct, in-direct, and cascading impacts.
National Biodiversity Strategy and Action Plan 2018-2030	High	Key insights regarding biodiversity, threats to ecosystems and communities
The Republic of Vanuatu State of the Environment Report 2022	High	"A stock check of the state of the environment in Vanuatu, including all natural systems. IUCN status of many native and endemic species"
Van-KIRAP project resources	High	Fact sheets on climate change impacts for Turtles, seagrass and coral with detailed climate projections and ecosystem and species impacts.
Directory of Wetlands of Vanuatu	High	Inventory of and details regarding freshwater and coastal wetlands in Vanuatu, produced in 2014.
CRVA Validation Workshop (October 2025)	High	Local-scale information on specific concerns at the local scale
Government of the Republic of Vanuatu & Blue Prosperity Vanuatu. (2025). Vanuatu Coral Reef Study 2023: Final Science Report	High	"Health of coral reef systems. Types of species at risk under different possible futures"

Education (Chapter 5)

Table A-06. Summary and suitability of hazard information available for the Education sector

Hazard	Suitability	Description
Drought	Medium	Drought severity has been categorised as moderate, severe, and extreme based on SPI (Standardised Precipitation Index) values. For each severity, three metrics have been used to quantify drought: frequency (events per time period), duration (months), and intensity (unitless, derived from the SPI value over the period of drought). All projections assessed under RCP8.5. Values have been averaged for North, Central and South regions, and aggregated over a 20-year period. This severely limits the granularity of the risk assessment.
Precipitation	Medium	Quantified as a change in mm of rainfall, with respect to a baseline period of 1986-2005. To track seasonal variation, wet and dry seasonal trends have both been explored under RCP4.5 and RCP8.5. Values have been aggregated for North, Central and South regions, and averaged over a 20-year period. This severely limits the granularity of the risk assessment.
Air Temperature	Medium	Quantified as a change in surface air temperature, with respect to a baseline period of 1986-2005. Due to the lack of seasonal variation, annual values are analysed under both RCP4.5 and RCP8.5. Values have been aggregated for North, Central and South regions, and averaged over a 20-year period. This severely limits the granularity of the risk assessment.
Sea-level rise and Coastal Flooding	Medium	Quantified as the extent and depth of coastal flooding associated with a 1% AEP (1 in 100yr) event at four sea-level rise increments – present day, 0.5m, 1.0m, and 1.5m.
Fluvial and Pluvial Flooding	Medium	Quantified as present-day flooding extent and depth for Malekula, Tanna, and two catchments near Port Vila and Luganville for 10%, 2% and 1% AEP events. These models lack a climate change component.
Tropical Cyclones	Medium to Low	Described qualitatively based on model projections as increasing intensity, but potentially decreasing frequency. However, the quantitative data set provided only includes historical cyclone tracks.

Table A-07. Summary of key qualitative sources for the Education sector

Hazard	Suitability	Description
Sector workshop 1	High	"Concerns over damage to infrastructure from cyclones, repairs are difficult as there is a reliance on ferries to move materials, and absenteeism of students and teachers is common during the recovery phase. Concern also over the impacts of the RSE schemes during recovery, as many young, strong people leave for work. Resources like books, paper are lost and hard to replace. Water access at schools can be problematic, as it is often shared with the village. Schools also act as refuges during the cyclone, so resuming school is delayed."
Sector workshop 2	High	Additional information on the location of coastal schools and a broad indication of drought-prone areas.
Surging Seas and Escalating Risks: Enhancing Education System Resilience in Vanuatu [109]	High	Insights into the impacts of climate change on the Education sector.
Vanuatu Education and Training Sector Strategy 2020-2030 [107]	High	Insights into Vanuatu's Education sector.
Vanuatu Barriers to Education Study report [17]	High	Insights into barriers to Education in Vanuatu.
Education Statistics Basic Tables of 2023 [108]	Moderate	Education statistics, including Net Enrolment Rates.
Vanuatu Post-Disaster Needs Assessment Tropical Cyclone Pam March 2015 report [21]	High	Insights into the impact of tropical cyclones on the Education sector.
Post-Disaster Needs Assessment TC Harold & COVID-19 Vanuatu Volume B Sector Reports: Disaster Effects & Recovery Needs [110]	High	Insights into the impact of tropical cyclones on the Education sector.

Ecosystems (Chapter 6)

Table A-08. Summary and suitability of hazard information available for the Fisheries sector

Hazard	Suitability	Description
Ocean Acidification	Medium	Quantified as the 50th percentile of projected change in pH relative to baseline. Values are displayed on a 100 km × 200 km grid resolution and aggregated over a 20-year period. This severely limits the granularity of risk assessment.
Marine Heatwaves	Medium	Quantified as the average number of days per year experiencing a marine heatwave. The two most severe heatwave categories have been explored - Category 3 and Category 4. The classification is derived from how sea surface temperatures relate to the local mean and 90th percentile.
Sea-Level Rise and Coastal Flooding	Medium	Quantified as the extent and depth of coastal flooding associated with a 1% AEP (1 in 100yr) event at four sea-level rise increments – present day, 0.5m, 1.0m, and 1.5m.
Tropical Cyclones	Medium to Low	Described qualitatively based on model projections as increasing intensity, but potentially decreasing frequency. However, the quantitative data set provided only includes historical cyclone tracks.

Table A-09. Summary of key qualitative sources for the Fisheries Sector

Hazard	Suitability	Description
"Sector workshop 1 (15 May 2025)"	High	• Concerns include sedimentation of reef communities, water quality salinity issues, mostly collated via the Van-KIRAP project. • More fish species are becoming toxic (ciguatera), in different places and with different species. • There are considerable health impacts for local communities due to the impacts. • Fish is a large part of the traditional diet and the dominant protein consumed. • Fish is harvested from polluted environments because people need to eat, and imported food may be hard to get. • Recognised Seasonal Employment (RSE) also affects fishers - many have left, affecting the availability of fish. • An inability to harvest a certain fish species means that the knowledge associated with the fish cannot be passed on, so it is lost.
Sector workshop 2	High	Confirmation of key climate hazards and potential direct and indirect impacts on the fisheries sector. Identification of additional direct, indirect, and cascading impacts.
Fisheries in the Economies of Pacific Island countries and Territories (Benefish Study 4) (Book)	High	A comprehensive assessment of the role of fisheries in food security and economies for Vanuatu, and the wider Pacific Region. Published in 2023.
Food Security in Vanuatu 2019-2020 NSDP Baseline Survey	Medium	A baseline survey report from the Vanuatu National Statistics Office was published in 2021.
State of the Environment Report	High	Published in 2022, a report focusing on the meteorology, geohazards, environment and disaster management for Vanuatu. Published by SPREP.
Vanuatu Coral Reef Study 2023 (2025): Final Science Report. Government of Vanuatu and Blue Prosperity Vanuatu.	High	Coral, fish, and invertebrate data collected nationwide provides information of the diversity and health of the inshore fishery. Published in 2025.

Forestry (Chapter 7)

Table A-10. Summary and Suitability of Hazard Data for the Forestry Sector

Hazard	Suitability	Description
Drought	Medium	Drought severity has been categorised as moderate, severe, and extreme based on SPI (Standardised Precipitation Index) values. For each severity, three metrics have been used to quantify drought: frequency (events per time period), duration (months), and intensity (unitless, derived from the SPI value over the period of drought). All projections assessed under RCP8.5. Values have been averaged for North, Central and South regions, and aggregated over a 20-year period. This severely limits the granularity of the risk assessment.
Precipitation	Medium	Quantified as a change in mm of rainfall, with respect to a baseline period of 1986-2005. To track seasonal variation, wet and dry seasonal trends have both been explored under RCP4.5 and RCP8.5. Values have been aggregated for North, Central and South regions, and averaged over a 20-year period. This severely limits the granularity of the risk assessment.
Air Temperature	Medium	Quantified as a change in surface air temperature, with respect to a baseline period of 1986-2005. Due to the lack of seasonal variation, annual values are analysed under both RCP4.5 and RCP8.5. Values have been aggregated for North, Central and South regions, and averaged over a 20-year period. This severely limits the granularity of the risk assessment.
Sea-Level Rise and Coastal flooding	Medium	Quantified as the extent and depth of coastal flooding associated with a 1% AEP (1 in 100yr) event at four sea-level rise increments – present day, 0.5m, 1.0m, and 1.5m.
Fluvial and Pluvial flooding	Medium	Quantified for as present-day flooding extent and depth for Malekula, Tanna, and two catchments near Port Vila and Luganville for 10%, 2% and 1% AEP events. These models lack a climate change component.
Tropical Cyclones	Medium to Low	Described qualitatively based on model projections as increasing intensity, but potentially decreasing frequency. However, the quantitative data set provided only includes historical cyclone tracks.

Table A-11. Summary of key qualitative sources for the Forestry sectors

Hazard	Suitability	Description
Sector workshop 1	N/A	Workshop cancelled by participants.
Forests of the Pacific Islands," Secretariat of the Pacific Community, 2011	Medium	Published in 2011 by the Secretariat of the Pacific Community.
Global Forest Resources Assessment	Medium	Published in 2005 by The Forest Resources Assessment Program.
Climate Change and Cultural Loss in Vanuatu	High	Published in 2025 by the International Court of Justice, expert opinion of Anna Naupa and Dr. Chris Ballard.
Native forests, plantation forests and trees outside forests: their vulnerability and roles in mitigating and building resilience to climate change	Medium	Chapter in a book giving descriptions of stress and expected impacts of climate change throughout the Pacific Island Region. Does not contain detailed assessment or quantification of trees in Vanuatu.

Health and Nutrition (Chapter 8)

Table A-12. Summary and suitability of quantitative hazard information available for the Health and Nutrition sector

Hazard	Suitability	Description
Drought	Medium	Drought severity has been categorised as moderate, severe, and extreme based on SPI (Standardised Precipitation Index) values. For each severity, three metrics have been used to quantify drought: frequency (events per time period), duration (months), and intensity (unitless, derived from the SPI value over the period of drought). All projections assessed under RCP8.5. Values have been averaged for North, Central and South regions, and aggregated over a 20-year period. This severely limits the granularity of risk assessment.
Precipitation	Medium	Quantified as a change in mm of rainfall, with respect to a baseline period of 1986-2005. To track seasonal variation, wet and dry seasonal trends have both been explored under RCP4.5 and RCP8.5. Values have been aggregated for North, Central and South regions, and averaged over a 20-year period. This severely limits the granularity of risk assessment.
Air Temperature	Medium	Quantified as a change in surface air temperature, with respect to a baseline period of 1986-2005. Due to the lack of seasonal variation, annual values are analysed under both RCP4.5 and RCP8.5. Values have been aggregated for North, Central and South regions, and averaged over a 20-year period. This severely limits the granularity of risk assessment.
Sea-Level Rise and Coastal Flooding	Medium	Quantified as the extent and depth of coastal flooding associated with a 1% AEP (1 in 100yr) event at four sea-level rise increments – present day, 0.5m, 1.0m, and 1.5m.
Fluvial and Pluvial Flooding	Medium	Quantified as present-day flooding extent and depth for Malekula, Tanna, and two catchments near Port Vila and Luganville for 10%, 2% and 1% AEP events. These models lack a climate change component.
Tropical Cyclones	Medium to Low	Described qualitatively based on model projections as increasing intensity, but potentially decreasing frequency. However, the quantitative data set provided only includes historical cyclone tracks

Table A-13. Summary of key qualitative sources for the Health and Nutrition sector

Hazard	Suitability	Description
Sector workshop 1	High	• High reliance on rural community services to reach those away from main centres, can be challenging during cyclones as both the buildings and staff houses can suffer structural damage. • Post-cyclone impacts include outbreaks of leptospirosis, along with mental health and food security challenges. • Sector stakeholders report rising concern about undernutrition in Vanuatu over the past decade, with recent surveys indicating that progress on reducing child stunting and other forms of malnutrition has stalled or worsened in some groups. There are concerns that imported, calorie-dense but nutrition-poor food may replace locally grown food. • Workforce shortages and loss of coordination across the government is also a concern.
Post-Disaster Needs Assessment Vanuatu Tropical Cyclones Judy and Kevin [3]	High	Health impacts of TC Judy and Kevin 2023.

Table A-13. Summary of key qualitative sources for the Health and Nutrition sector (continued)

Hazard	Suitability	Description
Post-Disaster Needs Assessment TC Harold & COVID-19, Vanuatu [47]	High	Health impacts of TC Harold and COVID-19, 2020.
Vanuatu Post-Disaster Needs Assessment Tropical Cyclone Pam [21]	High	Health impacts of TC Pam 2015.
Public Health Risk Assessment and Interventions Tropical Cyclone Pam: Vanuatu [78]	High	Health impacts of TC Pam 2015.
Climate Change and Health in Small Island Developing States: A WHO Special Initiative Pacific Island Countries and Areas [129]	High	Physical health impacts of climate change.
Health, Wellbeing, and the Changing Structure of Communities [130]	High	Direct and indirect health impacts of climate change. Part of the Sixth Assessment of the IPCC.
Food Security in Vanuatu 2019-2020 NSDP Baseline Survey [113]	High	Health impacts of food insecurity.
Vanuatu Food Safety, Security & Nutrition Policy 2022-2030 [83]	High	Context regarding food safety, security and nutrition in Vanuatu.
Tropical Cyclones Judy & Kevin Gender & Protection Analysis [111]	High	Inequities in experiences for women, girls and other at-risk or marginalised groups.

Infrastructure (Chapter 9)

Table A-14. Summary and suitability of hazard information available for the infrastructure sector

Hazard	Suitability	Description
Air Temperature	Medium	Quantified as a change in surface air temperature, with respect to a baseline period of 1986-2005. Due to the lack of seasonal variation, annual values are analysed under both RCP4.5 and RCP8.5. Values have been aggregated for North, Central and South regions, and averaged over a 20-year period. This severely limits the granularity of the risk assessment.
Drought and Precipitation	Medium	Quantified as a change in mm of rainfall, with respect to a baseline period of 1986-2005. To track seasonal variation, wet and dry seasonal trends have both been explored under RCP4.5 and RCP8.5. Values have been aggregated for North, Central and South regions, and averaged over a 20-year period. This severely limits the granularity of risk assessment.
Coastal flooding and sea-level rise	Medium	Quantified as the extent and depth of coastal flooding associated with a 1% AEP (1 in 100yr) event at four sea-level rise increments – present day, 0.5m, 1.0m, and 1.5m.
Pluvial/Fluvial Flooding	Medium	Quantified for as present-day flooding extent and depth for Malekula, Tanna, and two catchments near Port Vila and Luganville for 10%, 2% and 1% AEP events. These models lack a climate change component.
Tropical Cyclones	Medium to Low	Described qualitatively based on model projections as increasing intensity, but potentially decreasing frequency. However, the quantitative data set provided only includes historical cyclone tracks

Table A-15. Summary of key qualitative sources for the infrastructure sector

Hazard	Suitability	Description
Sector workshop 1	High	Focus, key insights around the structure and function of wastewater, water supply, and stormwater systems, transportation, and the importance of infrastructure to economic, social, and cultural activity.
Vanuatu Loss and Damage Policy	Moderate	Outlines ways of addressing the impacts of climate change on Vanuatu, 2024, Recommends governance reforms, stakeholder engagement, and enhanced capacity for climate finance.
Vanuatu Infrastructure Strategic Investment Plan	Moderate	A strategic framework for infrastructure development in Vanuatu, 2015, VISIP emphasizes leveraging private sector involvement, community contributions, and development partner support to address infrastructure gaps, improve service delivery, and foster inclusive economic growth.
Vanuatu Coastal Adaptation Project Phase II	Moderate	Focused on preserving and maintaining natural systems, with consideration of integrated approaches to sustain livelihoods, food production and ensure biodiversity conservation, 2024.
Vanuatu Community-Based Climate Resilience Project	Moderate	Focus on local climate adaptation in agriculture and fisheries sectors, but also considers early-warning systems, 2022-2028, Involves establishment of local disaster risk reduction committees, and focus on climate-resilient agriculture practices.

Table A-16. Length of road (km) exposed to a 1% AEP coastal flooding event at present-day sea level and 0.5 m, 1.0 m and 1.5 m sea-level rise increments for Efate, Malekula and Santo (annex).

Island	Present Day	0.5 m SLR	1.0 m SLR	1.5 m SLR
Efate	12	23	34	48
Malekula	16	26	38	51
Santo	5.3	11	17	24

Table A-17. The number of buildings on Efate exposed to a 1% AEP coastal flooding event at present sea level, 0.5m 1.0m and 1.5m increments of sea-level rise for the most affected area councils. Numbers in brackets are the percentage of buildings exposed relative to the total number of buildings in the administrative area.

Area	Total Number of Buildings	Present	0.5m SLR	1.0m SLR	1.5m SLR
Efate Island	35,380	2,299	3,190	4,128	4,947
Pango	1,460	284 (19%)	403 (27%)	468 (32%)	549 (37%)
Ifira	435	97 (22%)	102 (23%)	112 (26%)	120 (28%)
Port Vila	14,816	684 (5%)	949 (6%)	1101 (7%)	1272 (9%)
Malorua	2480	217 (8%)	305 (12%)	453 (18%)	555 (22%)
Erakor	3,880	265 (7%)	329 (8%)	377 (10%)	417 (11%)
Mele	2,457	111 (5%)	184 (7%)	275 (11%)	378 (15%)
North Efate	1,559	219 (14%)	330 (21%)	514 (33%)	667 (42%)
Eton	2,525	72 (2%)	102 (4%)	160 (6%)	196 (8%)
Nguna	1,146	133 (12%)	160 (14%)	232 (20%)	315 (27%)
Emau	448	42 (9%)	65 (15%)	77 (17%)	80 (18%)
Eratap	4106	111 (3%)	189 (5%)	284 (7%)	324 (8%)

Malekula Island has approximately 24,501 buildings, of which approximately 22% (5,425) will be exposed to a 1% AEP coastal flood event at 1.5m of sea-level rise. The majority of the buildings affected are located in South Malekula (36% of buildings exposed), South-West Malekula (36.4% of buildings exposed), and Central Malekula (35.3% of buildings exposed).

Table A-16. The number of buildings on Malekula exposed to a 1% AEP coastal flooding event at present sea level, 0.5m 1.0m and 1.5m increments of sea-level rise for all area councils. Numbers in brackets are the percentage of buildings exposed relative to the total number of buildings in the administrative area.

Area	Total Number of Buildings	Present	0.5m SLR	1.0m SLR	1.5m SLR
Malekula Island	24,501	1,478	2,563	4,048	5,425
South Malekula	2,239	535 (24%)	665 (30%)	746 (33%)	808 (36%)
South-West Malekula	2,471	277 (11%)	424 (17%)	646 (26%)	900 (36%)
South-East Malekula	2,480	104 (4%)	244 (10%)	390 (16%)	499 (20%)
Central Malekula	6,269	382 (6%)	888 (14%)	1,679 (27%)	2,214 (35%)
North-West Malekula	4,266	27 (0.6%)	63 (1%)	116 (3%)	216 (5%)
North-East Malekula	6,733	137 (2%)	262 (4%)	448 (7%)	789 (12%)

Table A-18. The number of buildings on Santo exposed to a 1% AEP coastal flooding event at present sea level, 0.5m 1.0m and 1.5m increments of sea-level rise for all area councils. Numbers in brackets are the percentage of buildings exposed relative to the total number of buildings in the administrative area.

Area	Total Number of Buildings	Present	0.5m SLR	1.0m SLR	1.5m SLR
Santo Island	42,801	611	1,008	1,400	1,779
South Santo	6,697	15 (0.2%)	18 (0.3%)	26 (0.4%)	31 (0.5%)
East Malo	1,340	3 (2%)	3 (2%)	4 (3%)	7 (5%)
Canal-Fanafo	4,155	103 (2%)	147 (4%)	205 (5%)	254 (6%)
Luganville	9,142	243 (3%)	400 (4%)	590 (6%)	815 (9%)
West Santo	3,048	10 (0.3%)	15 (0.5%)	15 (0.5%)	15 (0.5%)
North-West Santo	1,486	3 (0.2%)	3 (0.2%)	3 (0.2%)	3 (0.2%)
North Santo	4,537	No exposure			
East Santo	4,262	15 (0.4%)	53 (1%)	105 (2%)	172 (4%)
South-East Santo	5,526	169 (3%)	298 (5%)	375 (7%)	401 (7%)

Tourism (Chapter 10)

Table A-19. Summary and suitability of hazard information available for the Tourism sector

Hazard	Suitability	Description
Drought	Medium	Drought severity has been categorized as moderate, severe, and extreme based on SPI (Standardized Precipitation Index) values. For each severity, three metrics have been used to quantify drought: frequency (events per time period), duration (months), and intensity (unitless, derived from the SPI value over the period of drought). All projections are assessed under RCP8.5. Values have been averaged for North, Central and South regions, and aggregated over a 20-year period. This severely limits the granularity of the risk assessment.
Precipitation	Medium	Quantified as a change in mm of rainfall, with respect to a baseline period of 1986-2005. To track seasonal variation, wet and dry seasonal trends have both been explored under RCP4.5 and RCP8.5. Values have been aggregated for North, Central and South regions, and averaged over a 20-year period. This severely limits the granularity of the risk assessment.
Sea-Level Rise and Coastal Flooding	Medium	Quantified as the extent and depth of coastal flooding associated with a 1% AEP (1 in 100yr) event at four sea-level rise increments – present day, 0.5m, 1.0m, and 1.5m.
Fluvial and Pluvial Flooding	Medium	Quantified as present-day flooding extent and depth for Malekula, Tanna, and two catchments near Port Vila and Luganville for 10%, 2% and 1% AEP events. These models lack a climate change component.
Ocean Acidification	Medium	Quantified as the 50th percentile of projected change in pH relative to baseline. Values are displayed on a 100 km × 200 km grid resolution and aggregated over a 20-year period. This severely limits the granularity of risk assessment.
Marine Heatwaves	Medium	Quantified as the average number of days per year experiencing a marine heatwave. The two most severe heatwave categories have been explored - Category 3 and Category 4. The classification is derived from how sea surface temperatures relate to the local mean and 90th percentile.
Tropical Cyclones	Medium to Low	Described qualitatively based on model projections as increasing intensity, but potentially decreasing frequency. However, the quantitative data set provided only includes historical cyclone tracks

Table A-20. Summary of key qualitative sources for the Tourism sector

Hazard	Suitability	Description
Sector workshop 1	High	• "Concerns over the evacuation of tourists not being done very well. Population booms of crown of thorns are impacting dive areas. Business insurance for cyclones is very expensive, rebuilds are relatively inexpensive and so insurance is not taken up. Concerns over loose boats during storms."
Sector workshop 2	High	Additional information on tourist behaviour while in Vanuatu.
Vanuatu Rapid Climate Risk Assessment Framework Tourism Case Study Report [94]	High	BECA, 2023. A desktop case study designed to understand the climate risk needs for Vanuatu.
The Pacific Private Sector Development Initiative (PSDI) 'Vanuatu Pacific Tourism Sector Snapshot' [171]	High	Published in 2021, key statistics from the tourism sector.
A Triple Disaster Event Series in Vanuatu: Cascading and Compounding Impacts of Climate Change [174]	High	Published by the Australian Government in support of Vanuatu for workshops in Bonn, Germany.
Post Disaster Needs Assessment Vanuatu Tropical Cyclones Judy and Kevin [3]	High	Published by the Department of Strategic Policy, Planning and Aid Coordination, 2023.
Prospects for the Post-pandemic Tourism and Economic Recovery in Vanuatu [248]	High	Published in 2022 by the United Nations.

Water, Sanitation and Hygiene (WASH) (Chapter 11)

Table A-21. Summary and suitability of hazard information available for the WASH sector

Hazard	Suitability	Description
Drought	Medium	Drought severity has been categorised as moderate, severe, and extreme based on SPI (Standardised Precipitation Index) values. For each severity, three metrics have been used to quantify drought: frequency (events per time period), duration (months), and intensity (unitless, derived from the SPI value over the period of drought). All projections assessed under RCP8.5. Values have been averaged for North, Central, and South regions, and aggregated over a 20-year period. This severely limits the granularity of risk assessment.
Precipitation	Medium	Quantified as a change in mm of rainfall, with respect to a baseline period of 1986-2005. To track seasonal variation, wet and dry seasonal trends have both been explored under RCP4.5 and RCP8.5. Values have been aggregated for North, Central and South regions, and averaged over a 20-year period. This severely limits the granularity of risk assessment.
Air Temperature	Medium	Quantified as a change in surface air temperature, with respect to a baseline period of 1986-2005. Due to the lack of seasonal variation, annual values are analysed under both RCP4.5 and RCP8.5. Values have been aggregated for North, Central and South regions, and averaged over a 20-year period. This severely limits the granularity of risk assessment.
Sea-Level Rise and Coastal Flooding	Medium	Quantified as the extent and depth of coastal flooding associated with a 1% AEP (1 in 100yr) event at four sea-level rise increments – present day, 0.5m, 1.0m, and 1.5m. This is limited to a single AEP.

Table A-21. Summary and suitability of hazard information available for the WASH sector (continued)

Hazard	Suitability	Description
Drought	Medium	Drought severity has been categorised as moderate, severe, and extreme based on SPI (Standardised Precipitation Index) values. For each severity, three metrics have been used to quantify drought: frequency (events per time period), duration (months), and intensity (unitless, derived from the SPI value over the period of drought). All projections assessed under RCP8.5. Values have been averaged for North, Central, and South regions, and aggregated over a 20-year period. This severely limits the granularity of risk assessment.
Precipitation	Medium	Quantified as a change in mm of rainfall, with respect to a baseline period of 1986-2005. To track seasonal variation, wet and dry seasonal trends have both been explored under RCP4.5 and RCP8.5. Values have been aggregated for North, Central and South regions, and averaged over a 20-year period. This severely limits the granularity of risk assessment.
Air Temperature	Medium	Quantified as a change in surface air temperature, with respect to a baseline period of 1986-2005. Due to the lack of seasonal variation, annual values are analysed under both RCP4.5 and RCP8.5. Values have been aggregated for North, Central and South regions, and averaged over a 20-year period. This severely limits the granularity of risk assessment.
Sea-Level Rise and Coastal Flooding	Medium	Quantified as the extent and depth of coastal flooding associated with a 1% AEP (1 in 100yr) event at four sea-level rise increments – present day, 0.5m, 1.0m, and 1.5m. This is limited to a single AEP.
Fluvial and Pluvial Flooding	Medium	Quantified as present-day flooding extent and depth for Malekula, Tanna, and two catchments near Port Vila and Luganville for 10%, 2% and 1% AEP events. These models lack a climate change component.
Tropical Cyclones	Medium to Low	Described qualitatively based on model projections as increasing intensity, but potentially decreasing frequency. However, the quantitative data set provided only includes historical cyclone tracks.

Table A-22. Summary of key qualitative sources for the WASH sector

Hazard	Suitability	Description
Sector workshop 1	High	• No Central wastewater system, and discharge is often directly into nearby lagoons. Rural areas are less likely to have septic tanks. Wastewater leakage and septic tank overflows directly affect food security and general health. • Water supplies are a mix of rainwater tanks, surface water abstractions, and a few groundwater bores. Testing for bacteria requires expertise not readily available. Larger urban areas do have a Centrally organised system for water supplies. Rural areas are more likely to have rainwater tanks. • Complex mechanised systems are not preferred as they fail, and the knowledge and resources to fix them are not present. The lifespan of most harvesting systems is 15 years. • Groundwater can become contaminated from ash fall or saltwater intrusion. It can also be contaminated from nearby septic tanks. • Access to water can be problematic for smaller communities, schools, and health clinics, creating a concentration of water needs that communities under stress can struggle to service. • Water sources can place extra burdens on women and girls if located far from villages. • Hygiene can be a challenge related to water shortages.
WHO/UNICEF Joint Monitoring Programme for Water Supply, Sanitation and Hygiene [183]	High	Data on WASH for Vanuatu.
Vanuatu National Water Policy 2017-2030 [179]	High	Insights into Vanuatu's water sector.
Evaluation of the New Zealand Government- Funded Vanuatu Water Sector Partnership 2022 [178]	High	Insights into Vanuatu's water sector.
Financing Water, Sanitation & Hygiene in the Pacific [180]	High	WASH funding in the Pacific.
Decentralisation and rural water service delivery in Vanuatu Final Report [156]	High	Insights into rural water supply in Vanuatu.

Notes