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# Water and Food Security in the Pacific

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## About the Authors

The Institute for Sustainable Futures, University of Technology Sydney, led this study. ISF is a sustainability research institute tasked with creating change towards sustainable futures through research, education, and partnerships.

The UNSW Global Water Institute was a core contributor to this study. GWI offers integrated water solutions and draws from experts across UNSW and the world to support sustainable development.

## Disclaimer

The authors have used all due care and skill to ensure the material is accurate as at the date of this report. ISF and the authors do not accept any responsibility for any loss that may arise by anyone relying upon its contents.

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Australian Water Partnership  
UC Innovation Centre (Bldg 22), University Drive South  
Canberra ACT 2617 AUSTRALIA  
T: +61 2 6206 8320  
E: [contact@waterpartnership.org.au](mailto:contact@waterpartnership.org.au)

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# Report 1

## Policy review: The water–agriculture nexus in Pacific Island Countries’ national policies and strategies

## Executive summary

Pacific Island countries (PICs) face a number of disruptions affecting the long-term resilience of ecosystems and communities. Many PICs are already experiencing the impacts of climate change in the form of extreme weather events, sea level rise and changes in freshwater availability. The population under the age of 35—which represents a large proportion of the population—is also facing the prospects of climate-induced migration and relocation. COVID-19 has affected economies, notably tourism-dependant ones, creating high rates of unemployment in populous countries such as Fiji and Vanuatu. To overcome these future social and environmental changes, regional partners involved in policy support and science and technology can play a catalytic role in supporting countries.

PICs are made up of a combination of five main geographic forms: high volcanic, uplifted limestone, low-lying coral island and atolls and mixed combinations of these forms (Dixon-Jain et al., 2014). Freshwater resources in PICs are generally limited and highly variable, both spatially and temporally (Falkland & White, 2020). While surface and groundwater resources are available on high volcanic islands, surface water is largely absent, and groundwater is limited on small, low-lying coral and limestone atolls, which gives rise to a high dependence on rainfall. Agriculture is largely rain fed and varies from highly productive systems in volcanic soils (Melanesia) to low-productivity systems in some atoll islands.

Water and agriculture are fundamental human rights and core to everyday livelihoods in the Pacific. As such, it is important to analyse them as integrated systems. Traditionally, both agriculture and water have been studied extensively from a diversity of disciplinary lenses, including agronomy, hydrology, climate science and socio-economic fields. Yet, in the Pacific region, there are very few studies, reports or forums documenting the water and food 'nexus' and its implications for national policies, people and resource governance.

Regional and multilateral agencies continue to play an important role in synthesising data and supporting national governments. Thus, it is important to produce materials that bring current thinking in resource governance to the region and adapt it to the specific needs of countries and communities. Two particular agencies are the target users of the material from this report: SPC and FAO. The Pacific Community (SPC) is the oldest science and technology agency in the region and supports member countries and communities in meeting their sustainable development goals and national priorities. The SPC's experts in water resource management, agriculture and forestry, gender and social inclusion and climate science work with funders and national governments to implement projects in these areas. Most notable is the region's first Integrated Programme in Food Systems, a multi-disciplinary and holistic approach to food-related activities. The Food and Agriculture Organization (FAO) has a long history of working with national governments in agriculture, technical and food security support. Traditionally the FAO have supported agriculture more than water resource management but recently supported development of food systems pathways for the region.

The Australian Water Partnership (AWP), supported by the Australian Government, has an opportunity to catalyse new partnerships and knowledge brokering to support regional organisations working to achieve sustainable development in the region. Given the vulnerable and diverse water contexts in the region, it is crucial to support thinking that links water and agriculture as an integrated system to help develop integrated solutions for the Pacific.

Our objective in this report is to start filling some knowledge gaps to facilitate the work of agencies, such as the FAO, SPC and AWP, towards integrated investments across different modalities in the Pacific. This report specifically provides novel insights into the way national strategies and policies in the Pacific frame the water–food nexus. It also provides an overview of the projects and actions

mentioned in those strategies to address the water–food nexus challenge. Those projects and actions constitute potential policy windows that can aid partners in identifying specific interventions that can help build institutional and technical bridges between the sectors and contribute to the wider development outcomes of water security, food security and improved livelihoods.

This report provides an understanding of the intersections of water and food in sectorial policies with a particular focus on agricultural production in PICs. Concurrently, it aims to bring global nexus thinking into a Pacific policy context. To prepare this report, we conducted an analysis of policies and strategies related to water, sanitation and agricultural production. The aim of the policy analysis is two-fold:

- To understand how the food–water nexus is framed in the public policies of different PICs.
- To identify the policy windows to situate potential interventions within existing national priorities in the water–food nexus.

## Methods

The method followed for this study involved firstly gathering PIC water and sanitation policy and agricultural production documents via online searches, our existing repository and through discussions with the FAO, SPC and networks in the region. As documents were not available (either publicly or addressing the required topics) for all PICs, this report focused on agricultural production and water and/or sanitation policy documents for 11 PICs of Cook Islands, Fiji, Kiribati, Federated States of Micronesia (FSM), Palau, Papua New Guinea, Samoa, Solomon Islands, Tonga, Tuvalu and Vanuatu.

## Findings Part 1: Framings of the water–food nexus in Pacific national policies and strategies

Our first findings section focused on identifying the framings of the water–food nexus in the Pacific. The most commonly observed framing of the interactions between water and agricultural production was about the way agricultural production impacts water quality and quantity (agriculture–water quality and quantity link) and ecosystems more generally. We found that there were seven sub-themes on the interactions between agriculture and water quality and quantity that were prioritised in the national policies and strategies. These sub-themes largely focused on the relationship between intensive and chemical-based agriculture on water quality, catchment level impacts and the way in which limited water is captured and used for agriculture. We also found links between the impacts of water quality and quantity on agricultural practices (water quality and quantity–agriculture link). These links were less prevalent in the documents, but there were mentions notably on water quantity and its variability and its implication for different crops in different Pacific countries.

At the country level, we found that the impacts of agriculture on water quality and quantity were rarely consistently discussed in both water, sanitation and agricultural policy documents within the 11 countries. Importantly, we found that the issues of water quality and quantity (in the context of food production) were more prevalent in agricultural policy documents than in water and sanitation documents. This may be an indicator that interventions to improve water quality and quantity may be suited to the vision of sustainable agricultural development promoted by agricultural policies. This may also signal that agricultural departments have a sense of responsibility with regard to the impacts of agricultural activities on water quality and quantity. This further indicates that water and sanitation policy documents tend not to have a strong focus on food activities—they focus on water resources or

the external drivers affecting the resource, such as climate change. Furthermore, given that PIC agriculture is mostly rain-fed, there may be an underlying assumption that the water–food links are not a priority.

We also found that, within countries, different types of policies (water and sanitation or agricultural production) may not always frame issues in the same way or may share a general frame (sub-theme) but may focus on different issues within that frame. For example, both types of policies may aim to change agricultural practices, but agricultural policy may focus on organic farming, while water and sanitation policy focuses on poor practices in animal farming. This shows a need to build consistent cross-sectorial framing of the impacts of agriculture on water quality and quantity in PICs. This could be done with on-the-ground case studies or trials.

Still, at the country level, we found that while the question of the effects of impacted water quality (sea level rise leading to seawater intrusion) and water quantity (changes in rainfall patterns leading to floods and droughts) was present in most agricultural policy documents, it remained a very rare occurrence in water and sanitation policy documents, which focused on other aspects of climate change impacts. This indicates that water policy framing may be more concerned with major external drivers, such as the impacts of climate shocks and disasters, that may require adaptation strategies to climate change, while agriculture documents are more geared towards practices that support resource management and livelihoods.

The results presented in the ‘Findings—Part I: Framing the nexus in Pacific national policies’ section (p. 13) provide a summary of how the nexus is framed. We propose two major categories of the water–food nexus framing in PICs’ national documents:

1. Agricultural policies have a clear overall frame of managing food production to reduce the impacts on water quality and quantity. This offers very pragmatic ways of reducing the impact on water resources through farming systems by looking at the way farming is done and place-based drivers of change in the water–food nexus.
2. The wider environmental drivers affecting water resource conditions will have flow-on effects on food production systems. It is largely the agricultural policies that emphasise that climate change will impact water resources and, thus, agriculture. Contrastingly, water documents focus on climate change in terms of disaster preparedness and external shocks but not on the core resource availability and quality per se.

## **Findings Part 2: Policy priority areas and typology of interventions**

We analysed water, sanitation and agricultural policies and strategies to determine the types of interventions they prioritised to address food–water nexus challenges. These priority areas are ‘policy windows’ that create an opportunity to develop interventions that speak directly to the national priorities in the countries. Six clusters of interventions emerged from the inductive analysis of the water sanitation and agriculture policies: 1) planning, legislation and regulations, 2) governance, 3) technologies and infrastructure, 4) farming systems and practices, 5) information and management tools on water and 6) capacity building. These six policy windows include specific interventions, which can be described as follows:

1. Planning, legislation and regulation: This includes items such as specific land-use plans, integrated water management plans at specific scales, targeted regulations or broader legislation, and improving farming practices and water efficiency monitoring systems.
2. Governance: This relates to improving the coordination between agencies to draw links in their work and build the capacity of extension agents to include water and food integrative practices.



3. Technology and infrastructure: This is diverse and includes things such as low-cost and context-specific irrigation systems, water harvesting and storage systems, new drainage techniques, water dikes and improved protected production methods.
4. Farming systems and practices: This includes shifting away from intensive farming practices towards those that leverage traditional crops and varieties and focus on agroforestry, agroecology and organic farming. It also includes support for implementing awareness and practice change campaigns to minimise water use and pollution and support salt-tolerant crops.
5. Water management tools: This includes developing water quality standards, assessing the availability of water for different activities, understanding water use and flows, and mapping island-specific water use contexts for agriculture.
6. Capacity building and engagement: This includes enabling collaborative trials of water-efficient farming, basic irrigation establishment, education and building capacity on nexus issues and empowering farmers and communities to manage their resources.

## Conclusion and remaining gaps

This report helps partners, donors and Pacific professionals contextualise the synergies between water and food—with an emphasis on agricultural production—in national policies. This analysis has provided a platform to contextualise the priority policy windows across selected Pacific countries across Melanesia, Micronesia and Polynesia and provides a starting point for developing place-based and context-specific projects and further research. We found, positively, that Pacific national governments do frame water–food nexus issues as important for the sustainable development of their communities. Yet, it is in the agricultural policies that most mentions of water quality and quantity impacts were mentioned, whereas water and sanitation policies did not feature those issues prominently. The rain-fed nature of agriculture in the Pacific may lead water and sanitation professionals to assume that water for food does not need to be managed. Yet, future climate projections show impacts on crop vulnerability and freshwater conditions, which makes integrative planning and action critical.

This report is limited as the research was desktop based and only drew from selected review discussions with regional partners. Further country-level ‘deep dives’ into specific policy issues (e.g., training extension officers in water-agriculture management) are necessary to nuance our findings. We also excluded analysis of value chains and logistics, which play an important role in the movement of resources between islands. Energy was omitted, as our priority was to focus on resources that play a primary role in the livelihood of Pacific people. However, its inclusion is an important aspect of future research. A focus on food security and nutrition as broader development outcomes is also important. Finally, this review only focuses on national-level policies and strategies. The Pacific region has very nuanced, community-specific approaches to governing people and natural resources, and as such, complementary analyses led by local experts in specific countries are required to determine the intersection of national policies with community governance. Some of the gaps identified start to be analysed in the briefing papers on the water–food nexus on atolls, gender and social inclusion, and future water requirements for food production complementing this report.

# 1 Introduction

Water and food—two fundamental requirements for human survival and increasingly recognised as a fundamental human right—are under increasing pressure from changes in the Anthropocene (IPCC, 2019, 2021). Global water and food demand is expected to increase over the coming decades due to population growth, urbanisation, economic development, diversifying diets and climate change (Hoff, 2011; Märker et al., 2018). Food demand is projected to increase by 60% and water withdrawals for irrigation by 10% by 2050, which will increase pressure on global planetary thresholds (Campbell et al., 2017).

This pressure will be further intensified by the interdependencies between these systems (Scanlon et al., 2017). Food production is highly water intensive, and there is uncertainty around the ability of current food production systems to produce adequate food supplies with limited water availability (D’Odorico et al., 2018). In addition, food production affects the quality of water resources, notably through the release of nitrogen and phosphates into the environment, leading to eutrophication and the nutrient enrichment of water bodies (B. Campbell et al., 2017). These interactions between water and food pose critical challenges for sustainable development, and they require novel and systems-informed governance, research and solutions (HLPE, 2015).

Regional and multilateral agencies continue to play an important role in synthesising data and supporting national governments. Thus, it is important to produce materials that bring current thinking in resource governance to the region and adapt it to the specific needs of countries and communities. Two particular agencies are the target users of the material from this report. The SPC, as the oldest science and technology agency in the region, plays a crucial role in supporting member countries and communities in meeting their sustainable development goals and national priorities. The SPC has advanced capabilities in water resource management, agriculture and forestry, gender and social inclusion, and climate science. SPC experts in those fields work with different funders and national governments to implement projects across a range of modalities. The SPC is also championing the region’s first Integrated Programme in Food Systems, which is explicitly designed to leverage the expertise and capacities of different divisions of the SPC to work towards more holistic approaches to food-related activities. Complementing the SPC, the FAO has a long history of working with national governments in supporting agriculture assessments and has provided technical support and organised food security monitoring and management mechanisms. Most recently, the FAO supported the development of food systems pathways for the region. Despite its strong history in the region, the FAO’s focus has largely been on agriculture and less on water resource management.

## 1.1 Water and agriculture nexus as a guiding concept

One conceptual framework developed to acknowledge the interactions between water and food—as well as energy—is the concept of the ‘nexus’. Our focus in this report will be specifically on water and food, given that the energy dimensions of the nexus are largely associated with large-scale hydropower that does not exist at a large scale in the Pacific region. The nexus concept was introduced at the World Economic Forum in 2008 and in discussions around the Green Economy. Further events solidified the concept, such as Bonn Conference in 2011, the Sixth World Water Forum in Marseille, France, the Rio+20 negotiations in 2012 and the 2014 Stockholm Water Week (Allouche et al., 2019; Simpson & Jewitt, 2019). These high-level discussions allowed multiple actors, including the corporate sector, to frame the debate around integrated sustainability interventions using a nexus approach.

The concept is not new. Integrated management of resources has been on the agenda since the 1970s. In addition, critiques of the concept point to the arbitrary nature of selecting water, food and energy as three sectors that influence sustainability outcomes—often omitting important governance and political drivers of the nexus. For example, food is related to multiple other issues, including human labour, soil quality, biodiversity conservation and land tenure. Those would need to be considered to understand the food component of the nexus but are often overlooked. Despite criticism of the concept, scholars have noted that a contribution of the nexus concept is its focus on the multi-scalar influence each sector has on the two others, which, when intersecting with an analysis of changing socio-demographic and climate shocks, provides insights on risks and opportunities to future development (Rasul, 2016; Wichelns, 2017). We also suggest that the nexus concept can be used as a heuristic tool to think beyond silos. This is particularly relevant when considering the policy dimension of the nexus, as policies dealing with water, energy and food are often fragmented (Cai et al., 2018) and, thus, require careful examination to identify synergies.

Nexus scholarship tends to focus on the analysis of specific nexus examples (e.g., Orr et al., 2012), macro-modelling or the application of frameworks to different resources (Albrecht et al., 2018; Wichelns, 2017). Several recent reviews of empirical nexus studies have found the following (Albrecht et al., 2018; Allouche et al., 2019; Biggs et al., 2015; Wichelns, 2017):

- They often take a quantifying or modelling approach at the cost of exploring socio-economic and governance dimensions (Albrecht, et al., 2018; Allouche, et al., 2019) .
- They tend to focus on the Asian and European continents and contexts. This has meant that the 'scale' of application has often been at the scale of large river basins with large populations, or in transboundary contexts, such as the extensive nexus work done over the last decade in the Mekong region (Allouche et al., 2019; Foran, 2015; Lebel et al., 2020).

However, it is worth mentioning that case studies looking at the governance of the nexus in various large basin contexts—Germany, Sri Lanka, Vietnam, Cambodia, Laos and Ethiopia—have started to emerge (Lebel et al., 2020; Pahl-Wostl et al., 2021). In a review of nine different nexus frameworks developed by global agencies such as the FAO, IWMI and the UN, Shannak et al. (2018) found that overall, these frameworks:

- fail to address the actual linkages and connections between sectors;
- often leave out the socio-economic and livelihood dimensions, omitting cultural, political and power dimensions of resource management;
- keep the scale of application, even in policy, at the macro level, and the place-based or smaller scale aspects of the nexus are not explored in detail; and
- fail to explore the spatial and temporal variabilities, notably when historical data or future projections of changes in resources are not integrated.

Our objective in this report is to bridge three of these knowledge gaps: i) the lack of understanding of the governance dimension of the nexus, ii) the focus on Europe and Asia, at the expense of other continents, notably the Pacific, and iii) the lack of focus on the actual linkages and connections between sectors.

In this report, we contribute to the first analysis of how national strategies and policies in the Pacific frame the water–agriculture nexus. The report is an initial contribution to identifying the existing policy windows that exist to work in country-specific contexts and leverage existing framings of the nexus in the Pacific region.

## 1.2 Pacific Island Countries' water–food nexus context

Pacific countries are a combination of five main geographic forms: high volcanic, uplifted limestone, low-lying coral island and atolls and mixed combinations of these forms (Dixon-Jain et al., 2014). The freshwater resources of PICs are generally limited and highly variable, both spatially and temporally (Falkland & White, 2020). While surface and groundwater resources are available on high volcanic islands, surface water is largely absent, and groundwater is limited on small, low-lying coral and limestone atolls, which gives rise to a high dependence on rainfall. Agriculture is largely rain fed and varies from highly productive systems in volcanic soils (Melanesia) to low-productivity systems in some atoll islands.

Agriculture in the Pacific region, and water to a lesser extent, have had substantial aid investments over the last three decades. Between 2010 to 2018, 2.9% (USD\$596.86M) of all international aid funds in PICs, including those from Australia, have been directed to the water sector (Lowy Institute, 2020). These investments are targeted at specific water-related issues (i.e., rural sanitation infrastructure) on a country-by-country basis. In contrast, agricultural investments have been almost double those directed to the water sector in the same time period—approximately USD\$1.1 billion between 2010 and 2018 (USD\$362 million to Papua New Guinea alone, given its large population and agricultural system). In the agricultural sector, government departments rely on project funds to implement activities, as national budget allocations to agriculture are limited and tend to be spent on salaries and immediate operational costs. Providing support to communities in managing water and land resources continues to be a budgetary and logistical challenge in most PICs. While aid flows have been substantial, the region continues to face the increasingly interconnected challenges of water scarcity, food insecurity and increasing climate impacts (Barnett, 2011; Lowy Institute, 2020; Sharan et al., 2021). In the region, less than 5% of national budgets are allocated to the agricultural sector, with resourcing for agricultural activities coming from development partners. Water has a similar allocation; for example, in Fiji, 3% of the 2020–2021 budget was allocated to the National Water Authority (PwC, 2020).

This means that development partners have an opportunity to support the needs of public management of land and water resources. To do so, an understanding of the connections between water and sanitation and agricultural production national policies is important if development investments are to have an effect on public systems. This work aims to contribute to providing a policy baseline of the opportunities for developing integrated solutions between sectors.

## 1.3 Gap filled by policy review

The Pacific region already has valuable scientific and socio-economic information on the specific disciplines associated with water and agriculture. However, there appears to be a dearth of information on the interactions between water and agricultural production and the policy environments that exist to enable more integrated cross-sectorial resource management.

While some of the information on water and agriculture is outdated, it remains valuable given the mixed progress in policy development in some areas, such as integrated water resource management (Dixon-Jain et al., 2014; Taylor et al., 2016). There is also an abundance of information on donor-funded projects in specific sectors and academic studies into the social and scientific specifics of water and food. However, there has been limited analysis of the intersections of water and agriculture policies in the Pacific and how the nexus between the issues is framed in public policies. To our knowledge, no syntheses of policies in the region are publicly available to provide development partners with insights on the types of programs they could support to address water–food nexus challenges in light of existing policy windows. The urgency of climate change and the need for

resilient development in the region provides an imperative to bring these public policy questions together and identify pathways for future nexus governance in the region. Given that development partners operate across different modalities but retain strong bilateral relationships with independent states in the Pacific, understanding the policy context of the nexus is essential. This report aims to bridge that gap by providing an understanding of the intersections of water and food in sectorial policies (water and sanitation and agricultural production) in PICs. Concurrently, it aims to bridge the knowledge gaps evoked in section 2.1 of this report ‘Water and agriculture nexus as a guiding concept’.

To do so, we conducted an analysis of policies and strategies related to water, sanitation and agriculture. The aim of the policy analysis is two-fold:

- To understand how the water–food nexus is framed in different PICTs’ public policies.
- To identify the policy windows to situate interventions within existing national priorities in the water–agriculture nexus.

The report is structured as follows. We first describe the framework we use to think about the water–food nexus, followed by the methodology section. We then present our findings focused on both the framing of the nexus and the activities and projects identified as necessary to adequately manage the water–food nexus and provide concluding remarks.

The target audience of this policy review includes development partners, research agencies and national policy-makers in the Pacific. The scale of analysis is national and focuses on national-level policy contexts and opportunities. The focus is on the water and food production component of the nexus and does not include energy. The reason for that is that water and food production are essential components of Pacific Islanders’ livelihoods and, therefore, appeared to be a major national policy priority. The scope could be broadened in the future to include other questions related to food, notably food security and nutrition outcomes, as well as energy.

## 2 Water–food nexus frameworks

Water and food production both have their own global frameworks and approaches to tackling the challenges of climate change and the increasing pressures on both systems. Frameworks also exist, such as the one by HLPE (2015), which considers the connection between water resource management and food security outcomes. We build on the HLPE (2015) framework and our knowledge of Pacific water and agricultural systems to develop a framework that considers the interactions between water and agricultural production. We also draw on scholarship characterising the interactions between water and agricultural production to identify four specific ‘nexus links’ that provide pointers concerning the dimensions of water and agricultural production that need to be considered to understand the nexus.

### 2.1 Water and agriculture global frameworks

Water systems, for example, have increasingly been managed using the global approach of Integrated Water Resources Management (IWRM). IWRM is a well-recognised planning and management approach principle that developed through the 1990s, stimulated by the Rio 1992 Summit’s focus on sustainable development. IWRM has been adopted in multiple international, regional and national development policy systems. For example, it underpins the European Water Framework Directive, and over 80% of countries worldwide have IWRM principles embedded in their water policies (Allouche et al., 2019). IWRM is a framework designed to improve the management of

water resources based on four key principles adopted at the 1992 Dublin Conference on Water and the Rio de Janeiro Summit on Sustainable Development (GWP Consultants, 2007). These principles hold that (1) fresh water is a finite and vulnerable resource essential to sustain life, development and the environment, (2) water development and management should be based on a participatory approach involving users, planners and policy-makers at all levels, (3) women play a central part in the provision, management and safeguarding of water, and (4) water has an economic value in all its competing uses and should be recognised as an economic good. IWRM's policy relevance and focus on both resources and people make it relevant for the policy developments and strategies governments take towards their sustainable development pathways.

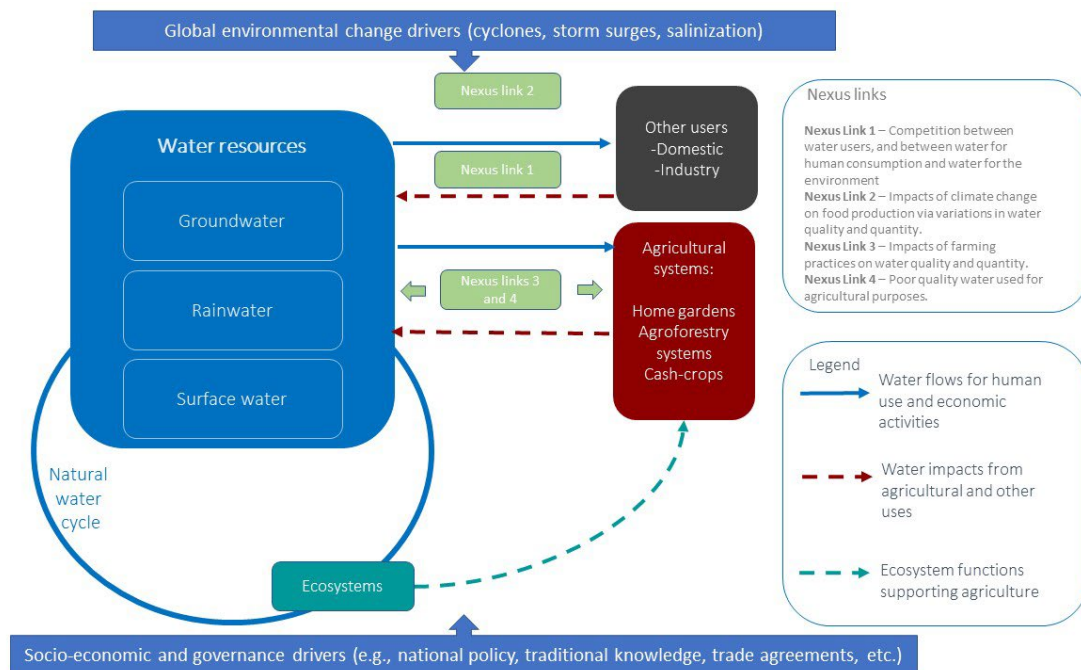
Many principles and practices have been applied to food production to mitigate the impacts of industrial farming practice on natural ecosystems. Agriculture continues to be a major provider of livelihoods and immediate food security for Asia and the Pacific, yet the region has more than 50% of the world's total undernourished people (FAO, 2021). While there is no single definition of sustainable agriculture, it is well established that the industrialised food production practices that focus on the extensive use of chemical inputs, intensive use of soil and water resources, and the consequent simplification of agro-biodiversity on farms have eroded the overall ecological integrity of farming systems. This degradation has generated many different perspectives on how to practice agriculture in a sustainable way, such as sustainable intensification, climate-smart agriculture, agroecology and organic farming. While they all have different proponents and histories, reviews of sustainable agriculture practices indicate that context-specific conditions of land and resources, and the socio-economic systems behind them, underpin how 'sustainable' food production is practised (Velten et al., 2015). Smallholder farmers, who make up the majority of Pacific farmers, apply different types of farm systems management strategies (Ricciardi et al., 2018). These systems are often based on a combination of traditional swidden and shifting cultivation combined with external industrial inputs used to support the production of market commodities (Dressler et al., 2016; Taylor et al., 2016). Agriculture's crucial role in national economic development makes it a core policy priority, and with the rapid combination of climate and socio-demographic changes, agriculture will continue to be a major driver of livelihoods in the Pacific.

While those frameworks are useful tools to conceptualise water management or agricultural production in isolation, they do not provide an understanding of the interactions between the two.

## 2.2 Understanding the water–food nexus

There is abundant knowledge of the quantitative dimensions of water and food production interactions, usually focusing on specific aspects such as irrigation and surface water use. Broader frameworks exist, such as the one by HLPE (2015), which focuses on water resources management and food security outcomes—not the core practice of growing food. Therefore, we adapted this framework to develop a visual representation of the interactions between water resources and different water uses, including agricultural production, in the Pacific context (see Figure 1). The framework is a general visual tool and focuses solely on core resources (e.g., groundwater) and core agriculture activities (e.g., home gardens). The focus on these activities allows us to embed the water and agriculture policy visions into this general framework and situate them within the broader environmental and socio-economic drivers that are influencing food activities and water resources.





**Figure 1. Framework for analysing water resources and agricultural systems**

Using international literature describing the nature of the interactions between water resources and agricultural production, we then attempted to characterise those interactions by identifying ‘Nexus Links’ (Holden et al., 2015; Mateo-Sagasta & Burke, 2010; Rosegrant et al., 2009; Zia et al., 2013). These Nexus Links are transferable to different contexts and are likely to be relevant to a broad range of contexts across the world. In some cases, we provided additional information on the Nexus Links that more specifically focus on how that Nexus Link would manifest in the Pacific context. We identified four ‘Nexus Links’, which are as follows:

- **Nexus Link 1—Competition between water users, and between water for human consumption and water for the environment.** Due to economic development and population pressure, there is increasing competition for limited water between agriculture, industry and domestic use. This increase in demand is leading to enhanced competition between uses: agriculture, industry and domestic. It also means that less water remains or is returned to the environment, impacting freshwater resources. This can have long-term implications for biodiversity and, therefore, livelihoods dependent on estuaries and marine ecosystems. This is an existing nexus issue in the Pacific, with competition for water and land a continuing challenge in light of population growth, urbanisation and climate change.
- **Nexus Link 2—Impacts of climate change on food production via variations in water quality and quantity.** Climate change is having a range of impacts on water availability and quality, which will affect agriculture in the future. In the Pacific, changes in the volume, intensity and variability of precipitation will lead to more frequent and severe floods and droughts, which will directly impact agricultural productivity (IPCC, 2021). In addition, sea level rise manifested through an increased frequency of storm surge and wave inundation events will lead to increased salinity of fresh groundwater, impacting the limited but important agriculture that occurs in low-lying carbonate islands (e.g., atolls) and along the coastal fringes of raised limestone and volcanic islands (White et al., 2007). Finally, higher temperatures will also mean that the water needs of livestock and crops will increase (Taylor et al., 2016).

- **Nexus Link 3—Impacts of farming practices on water quality and quantity.** Farming practices, particularly the intensive forms, can lead to the concentration of nitrates, salts and heavy metals in soils and run-off from the farm of fertilisers, pesticides and manure sediments. This is particularly evident in Southeast Asia with a large export of commodity crops. Poor irrigation practices have caused water logging and salinisation, while the pumping of groundwater can lead to the lowering of the groundwater table and saltwater intrusion. In the Pacific, there is increasing regional interest in revitalising traditional farming systems based on low-input and agroecological practices that maximise natural resources (SPC, 2021). This, however, will need to be done in a way that complements the everyday livelihood and food needs of agricultural communities.
- **Nexus Link 4—Poor-quality water used for agricultural purposes.** Due to urbanisation and population growth, wastewater is increasingly used for agricultural production in some parts of the world. The use of sodic or saline water for agricultural production, as well as arsenic-laden waters, is also occurring. While these specific practices may not be present in Pacific countries, it is nevertheless important to see whether the question of the quality of the water used in agriculture is considered in water and agricultural policies.

These four links inform the interactions between the blue (water) and red (agriculture) boxes in Figure 2. We use them to investigate how existing policy documents tackle these issues and the opportunities that policy windows offer for future development activities.

## 3 Methodology

### 3.1 Collection of policy documents and selection of PICs for analysis

The first step of our policy analysis was to collect policy documents related to water and sanitation and agricultural production in PICs. To do so, we conducted online searches and used our existing repository of publicly available water and sanitation policy documents.

We identified both agricultural production and water and/or sanitation policy documents for 11 PICs. For a further three PICs (Marshall Islands, Nauru and Niue), we only identified one of the two types of policy documents. We did not find any public documents for eight PICTs that happened to be overseas territories. As a result, for the remainder of the text, we will use the term ‘PICs’ rather than ‘PICTs’. For this report, we focused only on the 11 PICs for which we identified both agricultural production and water and/or sanitation policy documents. This helped to narrow the focus and provide a more targeted lens for the framing. Most of these countries are either high islands with more available water resources, with the exception of the more water-scarce countries such as Kiribati, Cook Islands and Tuvalu. Table 1 presents a summary of the selection of the policy documents used in this analysis.



**Table 1. Selection of policy documents for analysis<sup>1</sup>**

Countries	Water and sanitation related documents	Agriculture and food-related documents
<b>Two types of policy documents were identified</b>		
Cook Islands	✓	✓
Fiji	✓	✓
Kiribati	✓	✓
FSM	✓	✓
Palau	✓	✓
PNG	✓	✓
Samoa	✓	✓
Solomon Islands	✓	✓
Tonga	✓	✓
Tuvalu	✓	✓
Vanuatu	✓	✓
<b>One type of policy document was identified</b>		
Marshall Islands	✓	✗
Nauru	✓	✗
Niue	✗	✓
<b>No document was identified</b>		
American Samoa	✗	✗
French Polynesia	✗	✗
Guam	✗	✗
New Caledonia	✗	✗
Northern Mariana Islands	✗	✗
Pitcairn Islands	✗	✗
Wallis and Futuna	✗	✗
Tokelau	✗	✗

Note.

FSM = Federated States of Micronesia, PNG = Papua New Guinea.

<sup>1</sup> No documents identified for overseas territories: American Samoa, French Polynesia, Guam, New Caledonia, Northern Mariana Islands, Pitcairn Islands, Wallis and Future, Tokelau.

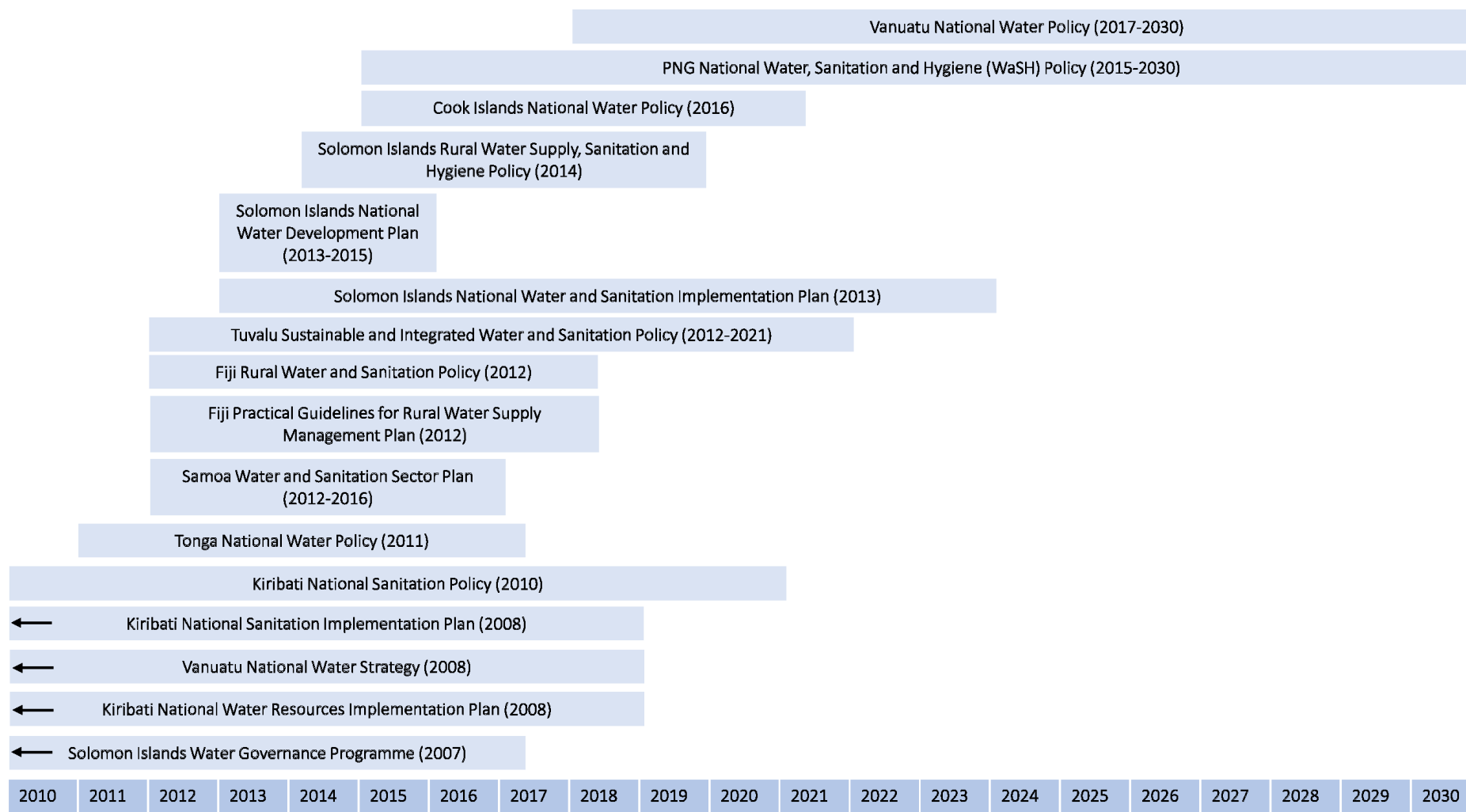
### 3.2 Overview of water, sanitation and agricultural production policy documents

In this section, we provide a brief overview of the policy documents identified for the water and sanitation sector and the agricultural sector. For the water and sanitation sector, a great variety of documents were identified, including strategies, policies, sector management or implementation plans and governance programs. Water policy documents focused on water for agriculture, sanitation and integrated water resource management. For most countries, we were able to identify at least one document addressing both questions of water as a resource (and sometimes integrated water resources management) and sanitation (Cook Islands, Fiji, Kiribati, FSM, Papua New Guinea, Samoa, Solomon Islands and Tuvalu), while for a few countries (Palau, Tonga and Vanuatu<sup>2</sup>), we only found documents related to water in general. A list of water and sanitation policy documents can be found in Appendix 1.

Most of the documents for which we have a publication year or a time frame for implementation—seven do not provide dates—were published between 2010 and 2015. Three are older (2007/8), and one is more recent (2018) (see Figure 2).

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<sup>2</sup> Note there are some water documents for Vanuatu, focused on sanitation, we are yet to explore: National Water Policy (2017-2030). Port Vila, Department of Water Resources.  
National Water Strategy (2018-2030) Port Vila, Department of Water Resources.  
Vanuatu National Implementation Plan for Safe and Secure Community Drinking Water Port Vila, Department of Water Resources.  
National Drinking Water Quality Standards. Port Vila, Department of Water Resources

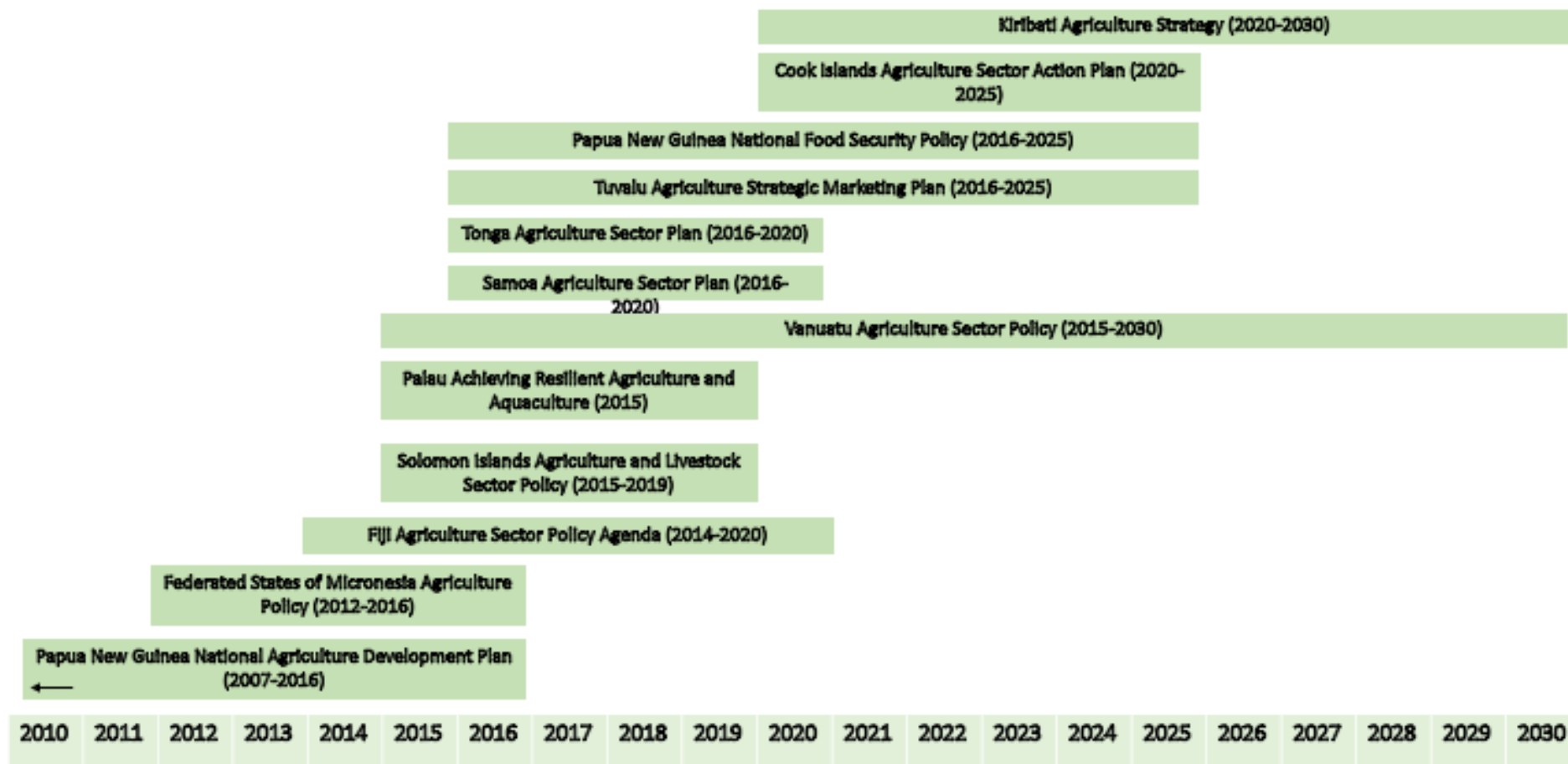


**Figure 2. Time frames for water and sanitation policy documents**

Note. In light blue are the policy documents for which a publication date is provided. In dark blue are the policy documents for which a timeframe is provided. PNG = Papua New Guinea.

In contrast to the water and sanitation sector, policy objectives and related activities for the agricultural sectors are usually consolidated in one document: a plan, a strategy and the policy or agenda for the agriculture sector or development plan. Two countries had slightly different agriculture documents. For Tuvalu, no document was found concerning the agriculture sector. Instead, an Agriculture Strategic Marketing plan was identified, which has a narrower focus on marketing. For Papua New Guinea, two documents were identified: the National Agriculture Plan (2007–2016) and the Papua New Guinea National Food Security Policy (2016–2025).

We ultimately focused only on the agriculture plans because food security is a bigger issue beyond production—it relates to consumption and health outcomes. Most of the documents for which we have a publication year or a time frame for implementation—one does not provide dates—were published between 2012 and 2016. One document is older (2007), and two are more recent (2020). Figure 3 provides a timeline for the implementation of the different documents analysed.



**Figure 3. Time frames for agricultural production policy documents**

Note. In light green are the policy documents for which a publication date is provided. In dark green are the policy documents for which a timeframe is provided

### 3.3 Analysis

The objective of our analysis was to:

- i) Understand how the food–water nexus is framed in food- and water-related policies in PICs.
- ii) Identify the activities or projects PICs are planning to conduct to tackle food- and water-related challenges.

To do so, we identified:

- content related to agriculture in water and sanitation documents using the following search terms: ‘agriculture’, ‘agricultural’, ‘farm’, ‘farming’.
- content related to water in agriculture documents: ‘water’, ‘sanitation’.
- content related to climate change in both water and sanitation and agriculture documents: ‘climate’, ‘flood’, ‘drought’, ‘saltwater’, ‘seawater’, ‘salinity’, ‘salinisation’.

Climate change was included because it plays an essential role in the articulation of the water–food nexus.

Once we identified the relevant content for each document, we analysed the content based on whether it provided insights into the way the nexus is framed in PICs or on the activities and projects identified as necessary to tackle nexus issues.

## 4 Findings—Part I: Framing the nexus in Pacific national policies

In this section, we present how the water–agriculture nexus is framed in the national policies and strategies reviewed. We then discuss differences in the framing between countries and between water and sanitation policies and agricultural policies. We first focus on how agricultural practices and their impact on water resources are discussed. We then focus on how the impact of water resources agriculture is framed. Within both sections, we provide examples of the specific agriculture practices and water management systems mentioned. Note that all analysis here is exclusive to the 11 countries of focus summarised in Table 5 in the methodology section (p. 8).

### 4.1 Impacts of agriculture on water: General framing

In the water, sanitation and agricultural sector policies and strategies, the most commonly observed framing of the interactions between water and agricultural production was about the way agricultural production impacts water quality and quantity and ecosystems more generally. This impact relates to Nexus Link 3 identified above (Impacts of farming practices on water quality and quantity) and Nexus Link 1 (Competition between water users, and between water for human consumption and water for the environment).

#### 4.1.1 Water quality

The ***impact of agricultural production on water quality*** is the theme that was the most commonly cited as a major developmental challenge in policies. It was discussed in 22 of 35 (62%) of the water, sanitation and agriculture policies analysed. This issue was framed around two sub-themes:

1. How agriculture and forestry (which are often integrated in PICs), as well as urbanisation, continue to degrade water quality and/or undermine long-term ecosystem resilience.
2. How specific farming systems impact water quality. In most cases, intensive agriculture with large chemical inputs and the importance of using more sustainable agricultural systems was discussed. To a lesser extent, they discussed the impact of raising livestock on water quality.

These different framings can all be loosely categorised as belonging to Nexus Link 3—Impacts of farming practices on water quality and quantity. The remainder of Section 5.1.1 provides examples of the way the two sub-themes are visible in PICs policies. The emphasis of each framing in these examples is added.

### First sub-theme: The impacts of agriculture, forestry and urbanisation on water quality

The first sub-theme is the most commonly discussed. Agriculture—among other land uses, including forestry and residential developments—was discussed as negatively affecting water quality in 11 out of the 35 (31%) documents analysed. Some emphasised the impact of agriculture on water quality, including:

*Catchment development, forestry, and **agriculture**, as well as the growth of urban areas, can all cause the quality of water to deteriorate. (Fiji, Initial draft: National Water Resources Policy for the Fiji Islands, 2005. p1)*

*Land clearance due to logging (mostly in the past) and **agricultural developments** (to date) and recently a growing trend in land subdivisions have been identified as the main culprits in watershed degradation and declining water quality. (Samoa, Water and Sanitation Sector Plan 2012-2016, p16)*

### Second sub-theme: the impacts of farming systems on water quality

The second sub-theme was present in 10 out of 35 (28.5%) documents. Some documents specifically focused on how agricultural practices are a direct cause of water quality deterioration. Intensive farming and its associated use of chemical fertilisers, pesticides and heavy machinery were discussed in 5 documents out of 35 as a source of degradation of water quality. For example, the Cook Islands' agriculture action plan acknowledged that current intensive agricultural practices had negative impacts on the environment:

*The current method of agriculture in the Cook Islands is characterised by **high input of chemical based fertiliser and pesticides, utilisation of heavy machinery and intensive tilling and ploughing**. Environmental impacts from chemical use and soil run-off have been evident. (The Cook Islands, Agriculture Sector Action Plan 2020-2025, p11)*

Policy documents from Tonga and the FSM explained that avoiding the intensification of agriculture was essential to maintain water quality. They emphasised that preserving natural vegetation cover could benefit water systems, which implies that more environmentally sustainable forms of agriculture could benefit water resources:

*With a narrow focus on addressing immediate needs for economic growth there could be an **intensification of agriculture** with consequent depletion of groundwater resources, long-term degradation of soils, and **further pollution of lagoons**. (Tonga Agriculture Sector Plan 2016-2020, p16)*

*The natural vegetative cover is dense on all islands and has not generally been disrupted for **intensive agriculture use**. Whether planned or fortuitous, this has protected watersheds, helping to reduce the rapid runoff and maintaining a reasonable recharge opportunity for the aquifers that are important to each State for a portion of its water supply. (Framework National Water and Sanitation Policy for the Federated States of Micronesia, 2011, p4)*

The lack of sustainable farming practices or the need to use them more to reverse the negative impacts was discussed in 3 documents out of 35. Palau's document mentioned the need to use organic practices, Samoa's referred to agroforestry, and Papua New Guinea's National Food Security Policy simply talked about sustainable land, soil and water management. While these concepts themselves have very long histories and methods (Thaman, 1994), it is an important narrative window in these countries to challenge the norm of intensive farming. Documents in these three countries' policies stated:

*Farming activities can also negatively impact **ecosystem health** if best management practices, especially **organic practices**, are not employed. (Palau, Achieving Resilient Agriculture and Aquaculture; 2015, p11)*

***Agroforestry practices** can diversify farm outputs, improve productivity and reduce inputs, while mitigating some of the environmental damage caused by the past processes of deforestation and the removal of trees from the landscape. Agroforestry can also be a useful land management approach in buffer zones to Protected Areas of conservation and watersheds. (Samoa Agriculture Sector Plan 2016-2020, p25)*

*PNG's land and water resources must be managed to avoid further degradation and to minimize the risk of environmental damage and loss of biodiversity. Forest protection, reforestation **and sustainable land, soil and water management** remain high priorities. (PNG National Food Security Policy 2016-2025, p11)*

Finally, the impacts of raising livestock on water quality were discussed in 2 documents out of 35. In the case of Kiribati, the document outlined two main issues: raising animals near water sources and lacking appropriate waste management. The Cook Islands' policy simply mentioned the need for 'best animal farming practices' without providing insights on current practices and their impact on water quality:

***Raising of domestic animals** near water sources, and lack of appropriate waste management at farm levels threaten to pollute the water table. (Kiribati Agriculture Strategy 2020-2030, p5)*

*[C]onsideration of best **animal farming practices** is critical to the implementation of this policy in light of their potential impact on water quality. (The Cook Islands Sanitation Policy, 2013, p2)*

#### **4.1.2 Water quantity**

The second focus was **the impact of agricultural production on water quantity**. It was included in fewer documents than water quality: in only 13 out of 35 (37%) policy documents. Here, four main sub-themes were used to frame the issue:

1. The impacts of agriculture on water quantity and water for ecosystems.



2. Agriculture as a major water user.
3. Competition or conflicts between agricultural and domestic water use.
4. Indirect references to the impact of agriculture on water quantity through the importance of land-use planning and sustainable management of natural resources to manage limited water resources.

These different frames can all be loosely categorised as belonging to Nexus Link 3—Impacts of farming practices on water quality and quantity, and secondarily to Nexus Link 1—Competition between water users, and between water for human consumption and water for the environment. While points 2, 3 and 4 clearly belong to Nexus Link 3, point 1 (the impacts of agriculture on water quantity) relates to both Nexus Link 1 and Nexus Link 3, as it relates to both the impacts of agriculture on water quantity and questions of competitions between water use for agriculture and water for natural ecosystems.

### First sub-theme: The impacts of agriculture on water quantity

The impacts of agriculture on water quantity were discussed in 5 out of 35 documents (14%). Two focuses emerged.

The first was on how specific agricultural practices, such as intensive agriculture in the case of Tonga could affect ground and surface water quantity (with no reference to natural ecosystems):

*As things stand Tongan agriculture is at a crossroads. With a narrow focus on addressing immediate needs for economic growth there could be an **intensification of agriculture...** with **consequent depletion of groundwater resources.** (Tonga Agriculture Sector Plan 2012-2016, p16)*

The second focus was on the potential for agriculture to negatively impact the health and resilience of ecosystems or how the non-use of intensive agricultural practices has protected the health of ecosystems. However, with regard to the latter, the policy documents did not explicitly refer to the way the over-use of water in agriculture may diminish the quantity of water in the environment and, therefore, affect its health and resilience. Instead, they broadly referred to ‘agriculture’ or ‘farming activities’ as affecting ‘ecosystem resilience’ or ‘ecosystem health’, which could refer to both water quantity and quality:

***Expansion of agriculture** into upland watersheds, land degradation and pollution are issues that further contribute to undermine **ecosystem resilience** in FSM. (Federated States of Micronesia Agriculture Policy 2012-2016, p17)*

***Farming activities** can also negatively impact **ecosystem health** if best management practices, especially organic practices, are not employed. (Palau, Achieving Resilient Agriculture and Aquaculture; 2015, p11)*

### Second sub-theme: Agriculture as a major water user

Agricultural production was identified as needing more efficient water usage in 2 out of 35 documents (6%). These two documents—water and integrated water policies in the Cook Islands—explained that agriculture is the main water user and that it should limit its water use:

*Agriculture is estimated to be the **largest single sector user of water** on Rarotonga with approximately 40% of water usage attributed to agricultural and horticultural practice [...] the agriculture industry, not only in Rarotonga but across the country, **must improve the usage of water**. (The Cook Islands National Integrated Water Resource Management Policy, p 19 & The Cook Islands National Water Policy, p12)*

### **Third sub-theme: Competition or conflicts between agricultural and domestic water use**

The importance of allocating water in a way that avoids competition or conflicts between agricultural consumption and domestic consumption was identified in 2 out of 35 (6%) documents. Within these, the focus was on competition or conflicts between water for agriculture and water for domestic consumption. The Kiribati agricultural strategy mentioned that: '[i]n the outer islands, limited water availability can lead to competition for water supply between crop and livestock production, and household use' (Kiribati Agriculture Strategy 2020-2030, p5). The initial draft of the national water resources policy for Fiji also identified the need to allocate water effectively between user types to minimise the likelihood of conflicts: 'to allocate water to all types of use as effectively as possible with the minimum of conflict between water users.'

### **Fourth sub-theme: Land-use planning and sustainable management of natural resources to manage limited water resources**

Finally, in 2 out of 35 (6%) documents, the problem of water depletion was framed as being broader than agriculture alone, and it was explained that 'land use planning' and 'sustainable management of the natural resource base'—which both most likely includes agriculture—is necessary to address water depletion:

*land use plans as well as **land capability and carrying capacity** in various areas will be determined to prevent land degradation, soil erosion, **depletion of water resources**, and encroachment on forests. (Solomon Islands Agriculture and Livestock Sector Policy 2015-2019)*

*Poor land use practices, **increasing demands on limited water resources** [...] make **the sustainable management of the natural resource base** critical to food security and agricultural productivity. (Agriculture Sector Plan, Samoa, 2016-2020)*

#### **4.1.3 Synthesis**

This analysis of framing the impacts of agriculture on water quality and quantity in PICs' water, sanitation and agriculture policy documents showed that the focus was primarily on Nexus Link 3 (Impacts of farming practices on water quality and quantity) and secondarily on Nexus Link 1 (Competition between water users, and between water for human consumption and water for the environment). This analysis also clearly showed that water quality-related issues appear to be more of a concern than water quantity issues, which are discussed less often and are less directly addressed.

The main areas of focus that were identified in those policies are:

- The will to adopt more sustainable agricultural practices to minimise their negative impacts on water quality. This shows that there is a clear need to invest in sustainable agricultural production systems that reduce the impact of agriculture on water quality and quantity.
- The need to minimise the use of water for agriculture and to better manage the competition between water users and for water for the environment. However, it is worth noting that while the issue of increased competition between water users was explicitly stated, the question of environmental water was only indirectly implied; it was explained that agriculture could negatively impact 'ecosystem health' and 'resilience' more generally. This points towards a potential need for further enquiries regarding the impacts of agricultural practices on water quantity.
- The need to focus on questions of land use more generally and to develop land-use plans able to protect water resources, both their quality and quantity.

Finally, one gap has been identified in this analysis. Livestock was only rarely mentioned in policy documents (2 out of 35 documents). However, livestock is an important economic and nutritional asset for rural families throughout the Pacific. Specific livestock management programs exist in the region, but their omission from the agricultural strategies and plans is important as it indicates that interventions for water quality may need to work across different policies and programs managed by different institutions.

#### 4.1.4 Impacts of agriculture on water: Country-specific findings

This section provides a more granular, country-specific overview of how issues related to the impacts of agriculture on water quality and quantity are embedded in the policy documents reviewed. Table 2 provides a summary of the impacts of agriculture on water quality and quantity. We specifically focused on: i) whether the documents focused on water quality, water quantity, both or none, and ii) whether the documents discussed water quality and quantity in the same way by using the seven sub-themes identified in the previous sections:

Water quality:

1. Impacts of agriculture, forestry and urbanisation on water quality.
2. Impacts of farming systems on water quality.
3. Impacts of land uses in general on water quality.

Water quantity:

1. Impacts of agriculture on water quantity and water for ecosystems.
2. Agriculture as a major water user.
3. Competition or conflicts between agricultural and domestic water use.
4. Land-use planning and sustainable management of natural resources to manage limited water resources.

**Table 2. Framings of the impact of agriculture on water by country**

Country	Food to water	Agriculture documents	Water and sanitation documents
The Cook Islands	Water quality	Impacts of intensive farming on the environment.	Impacts of land-based activity on water quality.
			Impacts of the lack of best animal farming practices on water quality.

Country	Food to water	Agriculture documents	Water and sanitation documents
	Water quantity	No mention	Agriculture as the largest single-sector user.
<b>Fiji</b>	Water quality	Impact of improper land-use practices on water quality.	Impacts of catchment development, forestry, agriculture and growth or urban areas on water quality, notably groundwater.
	Water quantity	No mention	Competition between water uses: farming, commercial, industrial, mining and tourism.
<b>FSM</b>	Water quality	Impact of agriculture on ecosystem resilience.	Presence of vegetative cover and absence of intensive agriculture led to little impact on water quality.
	Water quantity	Impact of agriculture on ecosystem resilience.	Presence of vegetative cover and absence of intensive agriculture led to little impact on water quantity.
<b>Kiribati</b>	Water quality	Impact of lack of best practice for domestic animals on water quality and water tables.	No mention
	Water quantity	Competition between water uses: livestock, cropping and domestic use.	No mention
<b>Palau</b>	Water quality	Impact of lack of use of organic farming ecosystem health.	Impacts of agriculture, construction and wastewater on water quality.
	Water quantity	Impact of lack of use of organic farming on ecosystem health.	No mention
<b>PNG</b>	Water quality	Impact of large plantations on water systems, rivers and environment.	No mention
	Water quantity	No mention	No mention
<b>Samoa</b>	Water quality	Using agroforestry to reverse negative impacts on the environment.	Impacts of logging and agriculture on watershed degradation and water quality.
	Water quantity	Increasing water demand shows need for sustainable management of natural resources.	No mention
<b>Solomon Islands</b>	Water quality	No mention	Impacts of mining, forestry, agriculture and urban and peri-urban development.
			Impact of logging and traditional slash-and-burn agriculture on surface water resources.

Country	Food to water	Agriculture documents	Water and sanitation documents
	Water quantity	Need for land-use planning to minimise water resources depletion.	Impact of logging and traditional slash-and-burn agriculture on surface water resources.
Tonga	Water quality	Potential impacts of intensive agriculture on pollution of lagoons.	No mention
	Water quantity	Potential impacts of intensive agriculture on the depletion of groundwater resources.	No mention
Tuvalu	Water quality	No mention	No mention
	Water quantity	No mention	No mention
Vanuatu	Water quality	Need for land-use planning to minimise water degradation.	Impacts of agriculture and mineral extraction on water quality.
			Impact of poor farming practices on health of rivers and marine life.
	Water quantity	No mention	No mention

Note. FSM = Federated States of Micronesia, PNG = Papua New Guinea.

Legend	
<b>Impacts of agriculture on water quality</b>	
	Sub-theme 1 Impacts of agriculture, forestry and urbanisation on water quality
	Sub-theme 2 Impacts of farming systems on water quality
	Sub-theme 3 Impacts of land uses in general on water quality
<b>Impacts of agriculture on water quantity</b>	
	Sub-theme 1 Impacts of agriculture on water quantity and water for ecosystems
	Sub-theme 2 Agriculture as a major water user
	Sub-theme 3 Competition or conflicts between agricultural and domestic water use
	Sub-theme 4 Land-use planning and sustainable management of natural resources to manage limited water resources

Based on an analysis of Table 6, three main observations were made:

- Agricultural policies appear to address the impacts of agriculture on water quality and quantity more consistently than water and sanitation policies.

Overall, it appears that agricultural policies (and, therefore, the agriculture departments and programs) more consistently addressed questions of the impacts of agricultural production on water quality and quantity than the water and sanitation documents, which then lie within the scope of water departments. Overall, water quality was discussed in the agricultural policies of 9 out of the 11 countries, and water quantity was discussed in 6 out of the 11 countries. In comparison, water quality was discussed in the water and sanitation policies of 7 out of the 11 countries and 4 out of 11 for water quantity.

- Agriculture and water and sanitation policies rarely addressed both water quality and quantity issues.

Agricultural policies tackled the question of the impacts of agriculture on both water quality and quantity in the policies of 5 countries out of the 11 and 4 out of the 11 countries for water and sanitation policies.

- When compared, agriculture and water and sanitation policies rarely focused on the same issue (quality or quantity). This is particularly true for water quantity.

The question of water quality was discussed in both types of documents for 6 out of the 11 countries, while water quantity is discussed in both types of documents only 2 times out of 11.

- When water quality and/or water quantity were considered in both types of policies, they did not always focus on the same aspects of the problem.

Sometimes—The Cook Islands, Fiji, Palau, Solomon Islands and Vanuatu—the issues were not framed around the same sub-themes. For example, in the case of The Cook Islands, the agricultural policy document framed the question of the impact of agriculture on water quality around sub-theme 2 (Impacts of farming systems on water quality), while the water and sanitation document focused, among other things, on sub-theme 3 (Impacts of land uses in general on water quality). In the case of

Palau, the impact of agriculture on water quality was framed in the agricultural policy document around sub-theme 2 (Impacts of farming systems on water quality), while the water and sanitation documents framed it around sub-theme 1 (Impacts of agriculture, forestry and urbanisation on water quality).

Other times—The Cook Islands, FSM and Samoa—both types of documents focused on the same sub-theme, yet they offered different areas of priority within that sub-theme. For example, both types of policies for FSM framed water quality issues around sub-theme 2 (Impacts of farming systems on water quality) but pointed towards different conclusions. The FSM agricultural policy explained that it was the expansion of agriculture into watersheds that led to pollution and land degradation. In contrast, the FSM water and sanitation document stated that the vegetation cover was well preserved and that watersheds were not impacted. This discrepancy may be explained by the fact that the water and sanitation document only focused on ‘four focal islands’, which may have been less affected than other islands. In the remaining cases, the difference in priorities was less stark. If we take the example of The Cook Islands again, the impact of agriculture on water quality was framed in both water and agriculture documents as being related to sub-theme 2 (Impacts of farming systems on water quality). However, different parts of farming systems were suggested as the drivers. The Cook Islands agricultural policy document focused on the negative impact of intensive agricultural practice on the environment—notably through chemical use and run-off—and the decline in the use of more resilient traditional agricultural practices. The Cook Islands sanitation policy document focused on the impact of animal farming on water quality. In the case of Samoa, both types of documents framed the issue of water quality around sub-theme 2 (Impacts of farming systems on water quality). However, the agricultural policy document focused on solutions and identified agroforestry as a practice that could reverse negative environmental impacts, while the water and sanitation policy simply identified the problem by explaining that logging and agriculture impacted water quality.

#### 4.1.5 Synthesis

This country-specific section showed that the impacts of agriculture on water quality and quantity are rarely consistently discussed in both water and sanitation and agricultural policy documents within the 11 countries. Importantly, we found the issues of water quality and quantity (in the context of food production) were more prevalent in agricultural policy documents than in water and sanitation documents. This may be an indicator that interventions to improve water quality and quantity may be suited to the vision of sustainable agricultural development promoted by agricultural policies. This may also signal that agricultural departments have a sense of responsibility with regard to the impacts of agricultural activities on water quality and quantity. This further indicates that water and sanitation policy documents tend not to have a strong focus on food activities. This is likely due to agriculture being largely rain-fed and not a major water user in the Pacific. This could, however, change with population pressures and changes in farming systems.

It also showed that both types of policy documents within countries may not always frame issues in the same way or may share a general frame (sub-theme) but focus on different issues within that frame. For example, both may aim to change agricultural practices, but one may focus on organic farming, while the other focuses on poor practices in animal farming. This shows a need for building consistent, cross-sectorial framing of the impacts of agriculture on water quality and quantity in PICs. This could be done with on-the-ground case studies or trials.



## 4.2 Impacts of water (quality and quantity) on agriculture: General framing

This section focuses on how water (quality and quantity) can impact agricultural production, which complements the earlier sections focused on the impact of agriculture on water quality and quantity. In terms of how water impacts agricultural production, there was rarely any discussion of this aspect of the nexus in water and sanitation and agriculture policy documents alike. Instead, the impacts of water (quality and quantity) and agriculture were framed as resulting from climate change. As a result, the question of the impacts of water on agriculture focused principally on Nexus Link 2—Impacts of climate change on food production via variations in water quality and quantity and only marginally on Nexus Link 4—Poor-quality water used for agricultural purposes. Indeed, 12 out of 35 (34%) policy documents provided information on the impacts of climate change on water quality and quantity and how it will impact food production, while only 1 document mentioned risks related to the use of poor-quality water for agriculture.

With regard to water quality, only one water and sanitation document (Kiribati) mentioned the potential impacts of poor water quality, due to poor sanitation, on agricultural production and subsequent food consumption:

*Health impacts of poor sanitation and resulting **poor quality water** on domestic, industrial and **agricultural use patterns**, [...] are poorly reported and sadly deficient. (National Sanitation Implementation Plan, Effective sanitation for healthy communities, environments and sustainable development. A 10-year plan, Kiribati, 2010)*

Of the 35 documents, 8 (23%) mentioned how sea level rise increases the salinity of low-lying growing areas and leads to the intrusion of saltwater in groundwater. Increasing water salinity was considered to potentially affect food production through the loss of crops. For example, in the Cook Islands Agriculture Sector Action Plan, it was identified that salinity is already, and will increasingly, affect low-lying growing areas:

*Sea level rise will increase **salinity of low-lying growing areas** such as taro swamps around the coastal fringe of islands. **Sea-level rise, salt spray and sea water intrusion** have **already impacted on agricultural activities** on the low-lying atolls of the Northern Group. (The Cook Islands Ministry of Agriculture, 2020, p12)*

With regard to water quantity, 9 out of 35 (25%) documents discussed how variation in rainfall patterns leads to flooding or droughts, which have the potential to affect agricultural productivity. This was notably the case for Kiribati, for which the Kiribati Agriculture Strategy (2020-2030) stated:

***Changes in rain patterns and extreme weather events** can both **cause flooding and drought**, also **reducing productivity**, and increase the incidence of food-borne diseases. (Kiribati Agriculture Strategy 2020-2030, p5)*

### 4.2.1 Synthesis

This section illustrated that the question of the impact of water on agriculture is overall less discussed than the question of the impact of agriculture on water, and that the discussion is nearly entirely framed around, and mediated by, climate change. It also showed that, contrary to the question of the impacts of agriculture on water quality and quantity, which primarily focused on water quality, the question of the impacts of water (quality and quantity) on agriculture focused equally on quality and



quantity. Finally, it showed that the question of the impact of poor water quality—beyond salinisation caused by climate change—was not considered in water, sanitation or agricultural policies.

### 4.3 Impacts of water on agriculture: Country-specific findings

The previous section provided an overview of the way the question of the impacts of water on agriculture is framed in water, sanitation and agriculture policies in PICs. However, it did not provide a more granular understanding of how frames vary by country. In this section, we provide a description of the distinct ways in which PICs frame the question of the impacts of water quality and quantity on agriculture. We specifically examine i) whether water, sanitation and agricultural policy documents focus on water quality, quantity, both or none, and ii) whether they discuss water quality and quantity in the same way. In Table 3, we summarise how each country framed the water–agriculture links across both types of documents.





**Table 3. Framings of the impacts of water on agriculture by country**

Country	Impacts of water quality and quantity on agriculture	Agricultural policy documents	Water and sanitation policy documents
The Cook Islands	Water quality	Increased salinity in low-lying areas (has already impacted agricultural activities on low-lying atolls).	Not mentioned
	Water quantity	Changes in rainfall patterns affect agriculture.	Not mentioned
Prolonged droughts affect agriculture.			
Fiji	Water quality	Not mentioned	Not mentioned
	Water quantity	Flooding impacts inland water (agriculture is not directly mentioned).	Not mentioned
		Drought impacts inland water (agriculture is not directly mentioned).	Not mentioned
FSM	Water quality	Saltwater inundation of groundwater impacts agricultural production.	Not mentioned
	Water quantity	Rainfall patterns impact agricultural production.	Not mentioned
Kiribati	Water quality	Saltwater inundation of groundwater impacts agricultural production.	Health impacts of poor sanitation and resulting poor-quality water on domestic, industrial and agricultural use patterns.

Country	Impacts of water quality and quantity on agriculture	Agricultural policy documents	Water and sanitation policy documents
	Water quantity	Rainfall patterns impact agricultural production.	Not mentioned
Palau	Water quality	Management of saltwater intrusion.	Rising sea levels threaten some freshwater supplies and some agricultural areas.
	Water quantity	Changes in rainfall area a threat to food security.	Not mentioned
PNG	Water quality	Not mentioned	Not mentioned
	Water quantity	Frequency of droughts impacts food production.	Not mentioned
Tonga	Water quality	Salinity of water identified as a phenomenon to monitor but is not directly related to climate change.	Not mentioned
	Water quantity	Recent droughts discussed and the need to use groundwater for irrigation. Also, droughts are likely to decrease slightly in the future.	Not mentioned
		Changes in rainfall patterns.	
Tuvalu	Water quality	Drought is affecting pulaka pits, and climate change is mentioned. No connection is made between climate change and drought.	Not mentioned
	Water quantity	Drought is affecting pulaka pits, and climate change is mentioned. No connection is made between climate change and drought.	Not mentioned
Samoa	Water quality	Not mentioned	Not mentioned
	Water quantity	Not mentioned	Not mentioned
Solomon Islands	Water quality	Not mentioned	Not mentioned
	Water quantity	Floods and drought cause damage to agriculture.	Not mentioned

Country	Impacts of water quality and quantity on agriculture	Agricultural policy documents	Water and sanitation policy documents
Vanuatu	Water quality	Not mentioned	Not mentioned
	Water quantity	Not mentioned	Data on rainfall patterns and rainfall trends is necessary for the agricultural sector and communities vulnerable to drought. It would provide forecasts of periods of above- or below-average rainfall for water availability, particularly important with recent changes in climatic conditions.

Note. FSM = Federated States of Micronesia, PNG = Papua New Guinea.

Legend	
	Increased water salinity due to climate change
	Changes in rainfall patterns due to climate change, may lead to floods or drought
	Link between climate change, water quality/quantity and agricultural production is not expressed
	Poor water quality due to factors other than climate change

Based on the analysis of Table 3, we made the three following observations:

- Water and sanitation policy documents rarely address the question of the impacts of water quality and quantity on agriculture, while agricultural policy documents nearly always do.

With regard to whether water, sanitation and agricultural policy documents focused on water quality and quantity in relation to agriculture, the first observation is that water and sanitation documents only rarely tackled this question: only 3 out of 11 countries mentioned water quality or quantity. Instead, they focused on other challenges posed by climate change on water and sanitation, such as improving the disaster preparedness of water and sanitation systems by designing and installing climate-proofed infrastructure and technologies and mainstreaming climate change and disaster risk considerations into water planning and policies, among other things. In contrast, agricultural policy documents in 9 out of 11 countries mentioned water quality or quantity, and often both.

- As a result of the first point, very few countries approached the question of the impacts of water quality and quantity on agriculture addressed in both types of documents. When it was the case, they did not necessarily frame the issue in the same way.

Only two countries—Kiribati and Palau—tackled the impact of water quality on agriculture in both water and sanitation and agricultural policy documents. In the case of Palau, the conclusion was the

same (sea level rise is threatening agricultural production); this was not the case for Kiribati. The question of water quality was linked to the destruction of crops due to seawater intrusion in its agricultural policy document. In Kiribati's water and sanitation policy document, it was the potential impacts of poor water quality on agricultural and human health that was identified as an issue. Eight countries mentioned the impact of water on agriculture in one type of document, most often agricultural policy documents, while one country (Samoa) did not address the question in either type of policy document.

- Overall, the framing of the impacts of water quality and quantity made the connection between climate change, water quality/quantity and agriculture clear, with a few exceptions.

In contrast to the diversity of framings identified concerning the impact of agriculture on water quality and quantity, the framing of the impacts of water on agriculture was mostly consistent across the documents, with increased salinity, drought and floods negatively affecting (rain-fed) agricultural production. However, in three cases—Fiji, Tonga and Tuvalu—agricultural policy documents did not explicitly mention the link between climate change, increased salinity, drought, floods and impacted agricultural production. Indeed, in the case of Fiji, flooding and drought were said to impact inland water without directly mentioning their impact on agricultural production. In the case of Tonga, salinity was mentioned as a phenomenon that should be monitored, but it was not linked to climate change. Drought and changes in rainfall patterns were mentioned, but they were not linked to impacts on agricultural production. Finally, in the case of Tuvalu, climate change was mentioned, and droughts were mentioned as affecting pulaka pits, but no connection was drawn between droughts and climate change.

### 4.3.1 Synthesis

This section illustrated that, while the question of the impacts of water quality (sea level rise leading to seawater intrusion) and water quantity (changes in rainfall patterns leading to floods and droughts) were present in most agricultural policy documents, it remained a very rare occurrence in water and sanitation policy documents, which focused on other aspects of climate change impacts. This indicates that water policy framing may be more concerned with major external drivers, such as the impacts of climate shocks and disasters, that may require adaptation strategies to climate change; agriculture documents are more geared towards practices that support resource management and livelihoods.

The results presented in Section 5, 'Findings—Part I', provide a summary of how the water-food nexus is framed. We propose two major categories of the water–agriculture nexus in PICs' national documents:

1. Agricultural policies have a clear overall frame of managing food production to reduce its impact on water quality and quantity. This offers very pragmatic ways of reducing impacts on water resources through farming systems by looking at the way farming is done and place-based drivers of change in the water–food nexus.
2. Wider environmental drivers affect water resource conditions, which will have flow-on effects on food production systems. It is largely the agricultural policies that emphasise climate change that will impact water resources and, thus, agriculture. Contrastingly, water documents focus on climate change in terms of disaster preparedness and external shocks, but not on the core resource availability and quality per se.

## 5 Findings—Part 2: Policy priority areas and typology of interventions

This section provides insights into the types of interventions that water, sanitation and food policies in PICs are offering to address food–water nexus challenges. Identifying those areas of intervention may enable development partners to better target their technical, social and research investments. Six clusters of interventions emerged from the inductive analysis of the water, sanitation and agriculture policies: 1) planning, legislation and regulations, 2) governance, 3) technologies and infrastructure, 4) farming systems and practices, 5) information and management tools on water and 6) capacity building. A summary table of the types of intervention per country is provided in Appendix 1, Table A1.

### 5.1 Planning, legislation and regulations

Planning, legislation and regulations were considered tools to manage the water–food nexus in six agricultural production documents and in seven water and sanitation documents. The countries that mention them are the Cook Islands, Fiji, Palau, Papua New Guinea, Samoa, Solomon Islands and Vanuatu.

**Planning** was mentioned in the agricultural documents of six countries—Fiji, Palau, Papua New Guinea, Samoa, Solomon Islands and Vanuatu—and the water and sanitation sector plan of one country—Samoa. Firstly, **land-use plans** are considered useful for the management of the water–food nexus. They can i) enhance synergies, notably at the water–food nexus (e.g., traditional taro farming and wetlands conservation) (Palau), ii) help identify suitable locations for the development of agricultural activities based on climate change projections (Palau), land capability and carrying capacity studies (Solomon Islands) and growing conditions, including water (Papua New Guinea). This, in turn, is expected to mitigate the impacts of climate change on agriculture (Palau, Vanuatu), as well as the impacts of agriculture on water resources (Solomon Islands, Vanuatu). Secondly, **integrated water use plans** (Fiji) or **watershed management plans** (Samoa) are considered to need to reduce the impact of agricultural activities on water quality (as is the case of Fiji) and to regulate agricultural activities in critical water resource zones to mitigate the impacts of climate change (Samoa).

The use of **laws and regulations** for the governance and management of the water–food nexus is mentioned in the water and sanitation documents of the Cook Islands, Fiji and Solomon Islands, as well as in the agricultural documents of Fiji, Kiribati and Palau. They vary considerably in terms of focus and scope. For example, in the case of the Cook Islands, Kiribati and Palau, the focus is on **compliance with regulations concerning the management of waste from domestic and commercial animal farms (the Cook Islands) and stormwater run-off (Palau)**. While Fiji and Palau refer to the need to comply with existing regulations, Kiribati stresses the need to develop a national animal waste management strategy to enhance the sustainability of small-animal livestock production systems.

In contrast, Fiji has a broader objective. Indeed, its agricultural production document states the need to **consolidate the 33 pieces of legislation that govern agriculture into one piece of legislation**, or an omnibus law, including matters related to the use of water resources, such as the use of water for irrigation. Fiji's initial draft of its National water resources policy also offers an ambitious objective: **the investigation by the government on the requirements for water legislation** (Initial draft: National Water Resources Policy for the Fiji Islands, 2005). This includes elements of the framing of the food–water nexus explored earlier, notably **mechanisms to ensure all types of water users have water entitlements and certainty around access to water, and that water is allocated in a**

**way that avoids or minimises conflicts.** Finally, the Solomon Islands water and sanitation policy and implementation plan only refer to the need to have laws, regulations, ordinances and practices that protect water sources from pollution, misuse or over-use. While they do not explicitly mention the food–water nexus, the question of pollution or over-use does most likely include concerns related to agriculture.

### 5.1.1 Synthesis

In this section, we saw that questions of land-use planning were more readily tackled in agricultural production documents than in water and sanitation documents, while questions of laws and regulations were equally considered in both types of documents.

We also observed that land-use plans, water-use plans and watershed management plans, along with laws and regulations, were considered a way to mitigate the impacts of agriculture (and potentially other activities) on water, and a way to mitigate the impacts of climate change on agriculture. With regard to laws and regulations, it appears that, in some cases, the focus was on managing and controlling a specific impact of agriculture on water (effluent from farms), while in other cases, a broader overhaul of the legislation was proposed.

It is also important to notice that while those planning, legislative and regulatory proposals did tackle aspects of the food–water nexus, they may not necessarily do it in a holistic fashion, as the **food–water nexus was not explicitly mentioned as a priority.**

Finally, we observed that when both types of documents (agricultural production documents and water and/or sanitation documents) tackled questions of planning, laws and regulations, they often did it in different ways. Indeed, the agricultural production document in Solomon Islands focused primarily on the development of land-use plans to prevent land degradation, while the water and sanitation document focused on the importance of laws, regulations and ordinances for the protection of water resources. In the case of Fiji, the ‘water’ component of the potential omnibus law appeared to be focused on the use of water for agriculture, notably irrigation, while the water legislation appeared to more broadly focus on avoiding the pollution, misuse and over-use of water sources, most likely by a wider range of users. Similarly, to what was observed with regard to the framing of the water–food nexus, the ‘interventions’ identified by water and sanitation documents and agricultural documents in the same country may not strongly align.

## 5.2 Governance

Governance—how policies are implemented and used by people and institutions—is not generally addressed in detail in the documents analysed. This is because we analysed policies, which provide high-level normative visions rather than detailed descriptions of the institutional arrangements and instruments that could make them possible. Studies focusing on institutional arrangements and instruments have been conducted recently by others, notably with regard to water for sanitation in the Solomon Islands and Fiji (Love, Beal, et al., 2020a; Love, Souter, et al., 2020b) and water governance in eight selected PICs (Dore, 2021). Despite the focus of policies on high-level normative visions, seven of the policies we analysed did provide some degree of insight into governance (the Cook Islands, Fiji, Kiribati, Palau, Samoa, the Solomon Islands and Vanuatu), which focus on the lack of coordination and collaboration, potential institutional arrangements and the need to upskill extension providers.

The main challenge identified in governance was coordination and collaboration between agencies or ministries for the management of water resources and/or the enhancement of food security. This

issue was raised in water and sanitation documents, notably in Fiji, where the need to strengthen the coordination arrangements between water use sectors and the various administrative units that deal with water resources was noted. This was also the case of the Solomon Islands, for which it was mentioned that water resources management ‘lacks proper coordination, featuring fragmented control as well as duplication and negligence in functional roles’ (KEW Consult Ltd, 2007, p.10). Vanuatu made a similar observation by explaining that coordination with regard to disaster preparedness and response was improving, but that little coordination between ministries existed with regard to the ‘prediction, planning and investment to respond to changes in the supply of rain, ground and surface water resources to secure sufficient safe water in the fact of change in water demand from agricultural, industrial and municipal users’ (Vanuatu National Water Policy 2017–2030, p. 8). Going further, Samoa mentioned that this lack of coordination could lead to the development of conflicting messages between the water and agricultural agencies or ministries on questions of watershed development in critical areas.

Rather than describing the problem, other documents focused on the development of potential **institutional arrangements**. The agricultural document for Kiribati—the only document that explicitly mentioned the need for food and water integration—simply states the need to develop **integrated and sector-specific approaches to increase water and food security**. In the case of the Cook Islands and Palau, potential institutional arrangements were discussed. The 2015 Cook Islands National Water Policy mentioned that while water resources management is a shared responsibility—which includes the Ministry of Agriculture—the coordination of the national integrated water resource management system should be conducted by one agency to ensure consistency in its implementation. Taking a different approach, the agricultural production policy of Palau envisioned the development of a National Food Security Council to tackle food security issues. This council would bring together a variety of agencies, including the Bureau of Agriculture and the Bureau of Marine Resources, among others.

The last element of governance, which was mentioned only by two countries, Fiji and Samoa, in their agricultural production document, was the need to **develop the skills of extension providers**—including NGOs and private providers—in sustainable resource management practices, including water conservation in the case of Fiji.

### 5.2.1 Synthesis

In this section, we saw that issues related to coordination and collaboration between agencies were more readily mentioned in water and/or sanitation documents than in agricultural production documents. In contrast, the question of upskilling extension providers was mentioned in agricultural production documents rather than water and/or sanitation documents. The need for new institutional arrangements was mentioned in both water and sanitation and agricultural policy documents.

Here again, the water–food nexus and the need to think about food and water in conjunction was **nearly never mentioned explicitly**—except in the case of Kiribati—when discussing elements related to governance. Instead, it was evoked indirectly. For example, agricultural agencies were often mentioned as key stakeholders of the water sector, and vice versa.

Finally, it is important to mention that here again, when the question of governance was considered in both agricultural and water and/or sanitation documents for one country, it was rarely addressed in the same way. In the cases of Fiji and Samoa, their agricultural production document focused on upskilling extension providers, while their water document focused on the lack of coordination between agencies with regard to water management and the need to strengthen it.



## 5.3 Technologies and infrastructure

Several technologies and infrastructures were identified that can mitigate issues related to how agriculture affects both water quality and water quantity, and vice versa. This question is addressed by seven countries—the Cook Islands, FSM, Fiji, Kiribati, Palau, Tonga and Vanuatu—primarily in their agricultural production documents. Only the Cook Islands discussed these issues in both agriculture and water and sanitation documents.

With regard to water quantity, three technologies were mentioned:

- **Irrigation systems to manage water variability:** Kiribati, Tonga and Vanuatu.
- **Water harvesting and storage systems:** the Cook Islands, Fiji and Palau.
- **New drainage techniques to remove flood waters:** Fiji.

Technologies were discussed that can help minimise impacts on water quality:

- **Water dikes and pathways** to avoid saltwater intrusion: Palau.
- **Efficient waste management systems for livestock farms:** FSM.

With regard to climate adaptation, the possibility of using covered production methods, notably hydroponics, to increase resilience to climate change was mentioned in the Cook Islands' agricultural production document without an explicit focus on the water-related impacts of climate change.

### 5.3.1 Synthesis

In this section, we saw that the use of technologies and infrastructures to manage the water–food nexus was mainly mentioned in agricultural production documents, with the exception of the Cook Islands. However, in the case of the Cook Islands, the agricultural production and water and sanitation documents focused on different aspects of technologies. The agricultural production document suggests the development of hydroponics, while the water and sanitation document mentions the need to install tank storage to capture rainfall.

Most of the technologies and infrastructures focused on mitigating the impacts of climate change on agricultural production, notably i) rainfall variability and floods (i.e., irrigation systems, water harvesting, new drainage techniques) and saltwater intrusion (i.e., water dikes and pathways). One technology focused on mitigating the negative impact of agriculture, and more specifically, livestock, on water quality through the implementation of efficient waste management systems on farms.

## 5.4 Farming systems and practices

In the previous section, which focused on the framing of the water–food nexus in agriculture, water and sanitation documents, we saw that the negative impact of (intensive) agricultural practices on water quality and the important use of water by the agricultural sector were central components of the water–food nexus framing in PICs. We also saw that the effects of climate change, notably saltwater intrusion, were framed as the main impact of water on agricultural production. As a result, six countries—the Cook Islands, FSM, Fiji, Kiribati, Palau and Samoa—mentioned the importance of adopting more sustainable and water-efficient production systems, as well as climate-resilient crops.

Some documents made explicit reference to specific sustainable agricultural systems, such as agroecology (the Cook Islands), agroforestry (FSM, Fiji, Palau) and integrated pest management and organic farming (Palau and Samoa). Agroforestry, which was mentioned most often, was considered



an adequate buffer around conservation areas and watersheds and a means to reverse the negative effects of past deforestation. This farm system is common to the Pacific and has a long history as a traditional farming system (Taylor et al., 2016; Thaman, 1994). The other production systems—agroecology, integrated pest management and organic farming—were often considered less impactful for the environment, notably for water and river systems.

Other documents focused on the use of climate-resilient crops. This is the case for Kiribati, which advocated for the use of traditional crops that are adapted to atoll conditions and the potential impacts of climate change. Palau mentioned the need to propagate and plant salt-tolerant and climate-resilient crops. Finally, the need to use practices and techniques that minimise the use of water for agriculture, as well as the negative impacts of agriculture on water quality, were mentioned in the Cook Islands and Palau documents.

### 5.4.1 Synthesis

Unsurprisingly, the adoption of new farming systems and practices to mitigate the impact of agriculture on water quality and quantity and to adapt to climate change was mainly addressed in agricultural production documents. Water and sanitation documents mentioned the need to adopt techniques that minimise water use in agriculture, as well as the need to adopt ‘best practices’, without mentioning specific production systems to minimise the negative impacts of agriculture on water quality.

## 5.5 Information and management tools on water

Several documents in five countries—the Cook Islands, Fiji, Palau, Tonga and Vanuatu—referred to the importance of using various water management tools to ensure adequate quality and quantity of water for the agricultural sector.

With regard to water quality, water and sanitation documents for the Cook Islands and Palau mentioned the importance of **establishing water quality standards for agriculture**, as well as for other water users. Fiji also mentioned the importance of avoiding extracting water from sites with known contaminants, including agricultural areas, as well as the necessity to conduct technical studies considering environmental and economic dimensions when developing a legislative agenda for the agricultural use of rivers and groundwater. However, no further information was provided on the nature of those studies.

With regard to water quantity, Tonga and Vanuatu mentioned the need to **assess the availability of water resources for various activities and land uses**, including agriculture. The second element mentioned concerning water quantity was to **better allocate and prioritise water use** (the Cook Islands, Vanuatu) and to **ensure secure water entitlements to major water users** in the economy, which would include the agricultural sector (Fiji). Finally, Vanuatu also mentioned the importance of having **better information on the water available**, as well as **on flood and rainfall**, to inform the strategic planning of the agriculture departments, among others, and to mitigate flood hazards to provide flood warnings and forecasts for water availability.

### 5.5.1 Synthesis

The water management tools were mostly mentioned in water and sanitation documents rather than agricultural production documents; only agricultural production documents for Fiji and Tonga

mentioned water management tools, notably the importance of developing a water allocation system in Fiji and the development of information on water availability in Tonga.

## 5.6 Capacity building and engagement

Capacity building and engagement with farmers was identified as important in five countries: the Cook Islands, Fiji, Kiribati, Palau and Samoa. In some cases—the Cook Islands and Fiji—the focus was on the collaboration of farmers with government (the Cook Islands) or researchers, non-governmental organisations and other partners (Fiji) to develop smarter solutions for water provision (the Cook Islands) or to develop more resilient cropping systems (Fiji).

In other cases—Kiribati, Palau and Samoa—the objective was to educate or build the capacity of farmers on specific issues. For example, in Kiribati, the goal was to build the capacity of a specific demographic—women farmers—on a set of practices, notably water conservation. In Palau and Samoa, the focus was on enabling adaptation to climate change by providing extensions on the prevention of saltwater intrusion and the use of climate-resilient plants (Palau) and adaptation measures that enhance resilience to climate change and natural disasters (Samoa). There was also a focus on ‘getting farmers on board’ and getting them to participate in watershed management (Samoa and the Solomon Islands) or to accept or negotiate changes to water use for agriculture (Tonga).

### 5.6.1 Synthesis

The question of capacity building and engagement was tackled in more agricultural production documents (five countries) than water and sanitation documents (three countries). Only Samoa tackled this question in both types of documents. It is important to mention that these questions were tackled very differently, as the Samoa agricultural production document focused on capacity building for climate change adaptation and natural disasters, while the water and sanitation document focused on managing to engage communities in watershed conservation.

## 6 Conclusion and remaining gaps

This report helps partners, donors and Pacific professionals contextualise the synergies between water and food—with an emphasis on agricultural production—in national policies. This analysis has provided a platform to contextualise the priority policy windows across selected Pacific countries across Melanesia, Micronesia and Polynesia and provides a starting point for developing place-based and context-specific projects and further research. We found, positively, that Pacific national governments do frame water–food nexus issues as important for the sustainable development of their communities. Yet, it is in the agricultural policies that most mentions of water quality and quantity impacts were found, whereas water and sanitation policies did not feature those issues prominently. The rain-fed nature of agriculture in the Pacific may lead water and sanitation professionals to assume that water for food does not need to be managed. Yet, future climate projections show impacts on crop vulnerability and freshwater conditions, which makes integrative planning and action critical.

This policy review points towards two important areas for futures funders, researchers and practitioners looking to work within policy windows in the Pacific natural resources space:

1. The water–food nexus is prevalent in policies and strategies, and there is an explicit window to work within this space. Agriculture departments and ministries may be the most suitable places to start, but including water resource departments in designing interventions early will

be important. Policy support to identify specific island-level ways of working across the policies is an important area of work.

2. There are six major policy windows in the analysis where the AWP, SPC and FAO can work to develop future projects. These policy windows lend themselves to different types of partners, methodologies and time horizons for interventions. Working across windows may be necessary; for example, water-efficient farming systems development will go hand-in-hand with capacity building. The six windows provide the contextual conditions for future activities.

This report is limited as it was desktop based and only drew from selected review discussions with regional partners. Further country-level 'deep dives' into specific policy issues (e.g., training extension officers in water-agriculture management) are necessary to nuance our findings. We also excluded an analysis of value chains and logistics, which play an important role in the movement of resources between islands. The energy sector was omitted, as our priority was to focus on resources that play a primary role in the livelihood of Pacific people. However, its inclusion is an important aspect of future research. A focus on food security and nutrition as broader development outcomes is also important. Finally, this review only focuses on national-level policies and strategies. The Pacific region has very nuanced community-specific approaches to governing people and natural resources, and as such, complementary analysis led by local experts in specific countries is required to determine the intersection of national policies with community governance. Some of the gaps identified start to be analysed in the briefing papers complementing this report.

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## Appendix 1: Supporting data tables

**Table A1. Water and sanitation documents analysed**

<b>Countries</b>	<b>Water &amp; Sanitation related documents</b>
<b>The Cook Islands</b>	The Cook Islands National Integrated Water Resources Management Policy
	The Cook Islands National Water Policy 2015 (draft)
	The Cook Islands Sanitation policy
<b>Fiji</b>	Fiji rural water and sanitation. Practical guidelines for rural water supply management plan 2012
	Rural water and sanitation policy
	Initial draft: National water resources policy for Fiji Islands
<b>Kiribati</b>	National Sanitation Policy - Effective Sanitation for Healthy Communities, Environments and Sustainable Development (2010-2020)
	National Sanitation Implementation Plan Effective Sanitation for Healthy Communities, Environments and Sustainable Development. A 10-Year Plan (2008-2018)
	National Water Resources Implementation Plan - Sustainable Water Resource Management, Use, Protection and Conservation - A 10 Year Plan (2008-2018)
	National Water Resources Policy Water for Healthy Communities, Environments and Sustainable Development (2008-2018)
<b>Federated States of Micronesia</b>	Framework National Water and Sanitation Policy for the Federated States of Micronesia
<b>Palau</b>	Palau National Water Policy
<b>PNG</b>	PNG national water, sanitation and hygiene (WaSH) policy (2015-2030)
<b>Samoa</b>	Water and Sanitation Sector Plan (2012-2016)
<b>The Solomon Islands</b>	The Solomon Islands rural water supply and sanitation policy
	National water resources and sanitation policy (2011-2020)
	The Solomon Islands National Water and sanitation implementation plan 2013
	The Solomon Islands rural water supply, sanitation and hygiene policy 2014
	The Solomon Islands Water governance program - Final report 2007
<b>Tonga</b>	National Water Policy 2011
<b>Tuvalu</b>	Sustainable and integrated water and sanitation policy (2012-2021)



Countries	Water & Sanitation related documents
Vanuatu	Vanuatu National Water Strategy (2008-2018)
	Vanuatu National Water Strategy (2018-2028)
	Vanuatu's national drinking water quality standards - 2016
	Vanuatu national water policy 2017-2030
	Vanuatu National Implementation Plan for Safe and Secure Community Drinking Water. A Guide to the Plan 2018

Note. PNG = Papua New Guinea.

**Table A2. Agriculture documents analysed**

Countries	Agriculture & Food-related documents
The Cook Islands	Agriculture Sector Action Plan (2020-2025)
Fiji	Agriculture Sector Policy Agenda (2014-2020)
Kiribati	Kiribati Agriculture Strategy (2020-2030)
Federated States of Micronesia	Federated States of Micronesia Agriculture Policy (2012-2016)
Palau	Achieving Resilient Agriculture and Aquaculture: A national policy for strengthening food security in Palau as a priority climate change adaptation measure (produced in 2015).
PNG	National Agriculture Development Plan (2007-2016)
	PNG National Food Security Policy (2016-2025)
Samoa	Agriculture Sector Plan (2016-2020)
The Solomon Islands	Agriculture and Livestock Sector Policy (2015-2019)
Tonga	Tonga Agriculture Sector Plan (2016-2020)
Tuvalu	Tuvalu Agriculture Strategic Marketing Plan (2016-2025)
Vanuatu	Vanuatu Agriculture Sector Policy (2015-2030)

Note. PNG = Papua New Guinea.

**Table A3. Overview of types of interventions in the policy documents organised by cluster of intervention type**

Clusters	Specific interventions	Objectives	Countries	Document
<b>Planning, legislations &amp; regulations</b>	Land-use plan and sustainable land management	Integrated land-use planning can enhance synergies, such as traditional taro farming and promoting the conservation of wetlands. It can also determine suitable farm location based on climate change projection.	Palau	Achieving Resilient Agriculture and Aquaculture: A national policy for strengthening food security in Palau as a priority climate change adaptation measure (produced in 2015)
		Feasibility studies for extension of agricultural activities based on growing conditions, notably soil, climate and water availability.	PNG	National Agriculture Development Plan (2007-2016)
		Land-use plans based on land capability and carrying capacity, notably to prevent depletion of water resources.	The Solomon Islands	Agriculture and Livestock Sector Policy (2015-2019)
		Micro- and meso-land-use planning to reduce land and water degradation and minimise the impacts of climate change, while maximising local production.	Vanuatu	Vanuatu Agriculture Sector Policy
		Enhancing the sustainable management of the land by matching cropping systems to land capability (with no specific mention of water).	Samoa	Agriculture Sector Plan (2016-2020)
	Integrated water use plans or watershed management plan	Integrated water use plan to reduce the impacts of agricultural uses—irrigation, aquaculture - on river systems and take into consideration the multiple uses of the river (i.e., irrigation, energy, fish production, potable water).	Fiji	Agriculture Sector Policy Agenda (2014-2020)
		Watershed management plans and restriction of residential and agricultural activities in critical zones for water resources, to mitigate climate change impacts.	Samoa	Water and Sanitation Sector Plan (2012-2016)

Clusters	Specific interventions	Objectives	Countries	Document
	Application of specific regulations	Compliance with policies, legislation and regulations on waste from domestic and commercial animal farming.	The Cook Islands	The Cook Islands National Water Policy 2015, Cooks Islands Sanitation policy
		Development and adoption of an animal waste management strategy.	Kiribati	Kiribati Agriculture Strategy (2020-2030)
		A permit from the Environmental Quality Protection Board is required for all farming—except traditional subsistence farming -. This permit includes considerations on how to ensure storm water run-off is controlled.	Palau	Achieving Resilient Agriculture and Aquaculture: A national policy for strengthening food security in Palau as a priority climate change adaptation measure (produced in 2015)
	Legislative reform	Consolidating legislation that govern agriculture, including matters related to water resources.	Fiji	Agriculture Sector Policy Agenda (2014-2020)
		Assessing the need for water legislation. One component would be focusing on water allocation and the need to ensure that water entitlements are provided to all types of uses, ensure certainty around access, minimises conflict and ensure that water exploitation is maintained at sustainable levels.	Fiji	Initial draft: National water resources policy for Fiji Islands
		Laws, regulations, ordinances and practices that protect water sources from pollution and avoid over-use should be implemented.	The Solomon Islands	National water resources and sanitation policy (2011-2020) and Solomon Islands National Water and sanitation implementation plan 2013
<b>Governance</b>	Lack of coordination and collaboration between agencies	Need to strengthen coordination arrangements between water use sectors and the various administrative units that manage water resources.	Fiji	Initial draft: National water resources policy for Fiji Islands
		The water and agriculture sectors provide conflicting messages to the population with regard to watershed development within critical areas.	Samoa	Water and Sanitation Sector Plan (2012-2016)

Clusters	Specific interventions	Objectives	Countries	Document
		The present institutional framework to manage water lacks coordination, features fragmented control, as well as duplication and negligence of functional roles.	The Solomon Islands	Solomon Islands Water governance program - Final report 2007
		Coordination between ministries is missing with regard to prediction, planning and investment to respond to changes in the supply of rain, ground and surface water resources to secure sufficient safe water in the fact of change in water demand from agricultural, industrial and municipal users.	Vanuatu	Vanuatu National Water policy (2017-2030)
	Institutional arrangements	Proposes that while water resources are a shared responsibility between various ministries, one agency should be in charge of the overall coordination of the national water resources management system to ensure coherence in its implementation.	The Cook Islands	The Cook Islands National Water Policy 2015
		Increasing water and food security with integrated and sector-specific approaches and promoting healthy and resilient ecosystems.	Kiribati	Kiribati Agriculture Strategy (2020-2030)
		Creating a National Food Security Council to facilitate effective collaboration between agencies, as well as with civil society.	Palau	Achieving Resilient Agriculture and Aquaculture: A national policy for strengthening food security in Palau as a priority climate change adaptation measure (produced in 2015)
	Skilling up extension providers	Building the capacity of 'trainers', notably with regard to knowledge on soil, land, water conservation technologies, effective use of fertiliser and agroforestry.	Fiji	Agriculture Sector Policy Agenda (2014-2020)
		Building the capacity of extension providers—NGOs and private sector providers—to promote sustainable management practices in agriculture. There is no specific mention of water-related management practices.	Samoa	Agriculture Sector Plan (2016-2020)

Clusters	Specific interventions	Objectives	Countries	Document
<b>Technologies &amp; infrastructures</b>	Irrigation systems	Identifying and implementing cost-effective and sustainable irrigation technologies.	Kiribati	Kiribati Agriculture Strategy (2020-2030)
		As rainfall cannot be relied on for agricultural production, irrigation may be required for vegetable production.	Tonga	Tonga Agriculture Sector Plan (2016-2020)
		Putting irrigation systems in place to improve productivity.	Vanuatu	Vanuatu Agriculture Sector Policy
	Water harvesting & water storage	Identifying water sources for agriculture—notably tank storage for rainfall capture.	The Cook Islands	The Cook Islands National Water Policy 2015 and The Cook Islands National Integrated Water Resources Management Policy
		Installing rainwater harvesting systems in dry areas.	Fiji	Agriculture Sector Policy Agenda (2014-2020)
		Increasing water catchment and storage systems in preparation for extreme events.	Palau	Achieving Resilient Agriculture and Aquaculture: A national policy for strengthening food security in Palau as a priority climate change adaptation measure (produced in 2015)
	New drainage techniques	Implementing new drainage techniques to remove flood waters.	Fiji	Agriculture Sector Policy Agenda (2014-2020)
	Water dikes	Effectively managing saltwater intrusion with dikes and pathways.	Palau	Achieving Resilient Agriculture and Aquaculture: A national policy for strengthening food security in Palau as a priority climate change adaptation measure (produced in 2015)

Clusters	Specific interventions	Objectives	Countries	Document
	Efficient waste management system for livestock	Promoting efficient waste management system for livestock manure and wastewater on livestock farms.	FSM	Federated States of Micronesia Agriculture Policy (2012-2016)
	Covered production methods	Using covered production methods, notably hydroponics, to enhance resilience to climate change. No explicit focus on water.	The Cook Islands	Agriculture Sector Action Plan (2020-2025)
<b>Farming systems &amp; practices</b>	Sustainable agricultural systems	Adopting less impactful farm practices, notably agro-ecology.	The Cook Islands	Agriculture Sector Action Plan (2020-2025)
		Replacing poor farming practices by agroforestry, to preserve soil fertility, as well as water and river systems.	Fiji	Agriculture Sector Policy Agenda (2014-2020)
		Agroforestry systems can be productive while providing environmental services, notably clean water.	FSM	Federated States of Micronesia Agriculture Policy (2012-2016)
		Encouraging the use of integrated pest management and organic agriculture to lower soil erosion. (The impact on water is not directly mentioned; however, soil erosion can have negative impacts on water quality). Using agro-forests as buffer zones to farms.	Palau	Achieving Resilient Agriculture and Aquaculture: A national policy for strengthening food security in Palau as a priority climate change adaptation measure (produced in 2015)
		Promoting best practices to minimise the presence of contaminants in water supplies.	Palau	Palau National Water Policy
		Promoting the use of integrated pest management and organic farming. Agroforestry can be used as a buffer to protect conservation areas and watersheds.	Samoa	Agriculture Sector Plan (2016-2020)
	Climate-resilient crops	Selecting varieties, notably traditional crops, that are adapted to atoll conditions and the impacts of climate change.	Kiribati	Kiribati Agriculture Strategy (2020-2030)

Clusters	Specific interventions	Objectives	Countries	Document
		Increasing the use of salt-tolerant and climate-resilient crops.	Palau	Achieving Resilient Agriculture and Aquaculture: A national policy for strengthening food security in Palau as a priority climate change adaptation measure (produced in 2015)
	Minimising use of water	Encouraging farmers to adopt practices that minimise water use while maintaining productivity.	The Cook Islands	The Cook Islands National Water Policy 2015 and Cook Islands National Integrated Water Resources Management Policy
		Promoting water management techniques.	The Cook Islands	Agriculture Sector Action Plan (2020-2025)
<b>Water management tools</b>	Water quality standards	Establishment of objectives with regard to water quality and provision for agricultural use and establishment of safety standards for water for agriculture.	The Cook Islands	The Cook Islands National Water Policy 2015 and The Cook Islands National Integrated Water Resources Management Policy
		Avoiding the extraction of water from sites with known contaminants.	Fiji	Fiji rural water and sanitation. Practical guidelines for rural water supply management plan 2012
		Establish standards of water quality for agricultural use.	Palau	Palau National Water Policy
	Assessment of the availability of water for various activities and/or allocating water	Developing information on water availability, by doing a hydrogeological study.	Tonga	Tonga Agriculture Sector Plan (2016-2020)
		Coordinating the use of water resources for commercial and agricultural use.	The Cook Islands	The Cook Islands National Water Policy 2015

Clusters	Specific interventions	Objectives	Countries	Document
	between different users	Mapping ground, surface and rainwater resources to enable investment in diversified water sources, determine land uses around rivers and mitigate flood hazard. Prioritising rain and groundwater for drinking and surface water for agriculture and industrial uses.	Vanuatu	Vanuatu National Water policy (2017-2030) and Vanuatu National Water Strategy (2018-2030)
		Establishment of a water allocation system to provide secure water entitlements to water users.	Fiji	Initial draft: National water resources policy for Fiji Islands
<b>Capacity building</b>	Encouraging collaborations between farmers and other stakeholders	Doing research with farmers and government to find appropriate solutions for the provision of water for agriculture and horticulture.	The Cook Islands	The Cook Islands National Water Policy 2015 and The Cook Islands National Integrated Water Resources Management Policy
		Farmers, researchers, NGO and other partners to work together to find cropping systems that can improve food security and resilience.	Fiji	Agriculture Sector Policy Agenda (2014-2020)
	Educating/building capacities of farmers on specific issues	Building women farmers capacity, notably on water conservation.	Kiribati	Kiribati Agriculture Strategy (2020-2030)
		Providing extension on techniques to prevent saltwater intrusion and encourage the use of climate-resilient plants.	Palau	Achieving Resilient Agriculture and Aquaculture: A national policy for strengthening food security in Palau as a priority climate change adaptation measure (produced in 2015)
	Building resilience of farmers and communities to the impacts of climate change. The focus is on climate change rather than on water management more specifically.	Samoa	Agriculture Sector Plan (2016-2020)	
Obtaining the support of farmers	Obtaining the support of communities with regard to the implementation of conservation measures in critical watersheds. Farmers are not specifically mentioned as a targeted group.	Samoa	Water and Sanitation Sector Plan (2012-2016)	



Clusters	Specific interventions	Objectives	Countries	Document
		Engaging communities to socialise changes in water use.	Tonga	Tonga Agriculture Sector Plan (2016-2020)

Note. FSM = Federated States of Micronesia, PNG = Papua New Guinea.

