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Pacific Water Security and Drought. Fostering Traditional Knowledge Concerns in the South Pacific Amidst a Climate Crisis

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Abstract

The Pacific region faces increasing challenges of water security and drought due to a current and irreversible climate crisis. This paper examines the impacts of rising temperatures, changing weather patterns, and extreme weather events on freshwater resources across Pacific Island communities. These challenges are exacerbating water scarcity and threatening the basic needs of these vulnerable populations. Traditional knowledge and community-based adaptation strategies have long played a vital role in mitigating water-related risks. However, the severity of the current climate crisis demands an integrative approach that combines scientific research, policy action, and traditional ecological knowledge. This study explores how the integration of Indigenous practices with modern scientific approaches can enhance resilience to drought and freshwater scarcity. It underscores the importance of traditional knowledge systems in sustainable water management, while also recognizing the need for greater focus on how Pacific communities experience climate impacts and respond through local community-based adaptation. By combining local knowledge with scientific data, it is possible to develop culturally appropriate, adaptive water management strategies. This approach aims to build long-term resilience in the Pacific, ensuring communities' access to clean water and safeguarding their overall well-being.

Keywords: *Traditional Knowledge, Pacific Islands, Water Security, Climate Crisis, Adaptive Management.*

Introduction

The Pacific region has long been at the forefront of the global climate crisis, facing a complex array of challenges due to rising temperatures, shifting weather patterns, and the increasing frequency and severity of extreme weather events. These climate dynamics have been particularly acute for the island nations and territories of the Pacific, which, despite their relatively small carbon footprints, disproportionately bear the consequences of global climate change. This paper explores the critical issue of freshwater security and drought, highlighting how these environmental stressors compound the difficulties in meeting the fundamental needs of Pacific communities amid the ongoing Pacific Climate Crisis.

The unique geographical and ecological characteristics of the Pacific Islands amplify their vulnerability to climate change. Comprising over 25,000 islands and a diverse array of ecosystems, this region is home to millions of people whose livelihoods and cultures are intricately connected to the land and sea. Coastal areas, where most Pacific communities are located, are increasingly threatened by rising sea levels, which not only pose a physical risk to settlements but also contribute to the degradation of crucial marine ecosystems, such as coral reefs and mangroves, which act as natural barriers against storm surges (Shiiba et al., 2023a). These ecosystems, essential for biodiversity and local fisheries, are also highly sensitive to warming ocean temperatures and acidification, both of which result from increased atmospheric carbon levels. Such degradation further destabilizes the region's water resources, as coral reefs, in particular, play a role in maintaining coastal freshwater lenses by reducing saltwater intrusion (Ali et al., 2020).

The challenges associated with freshwater scarcity and drought in the Pacific are exacerbated by limited natural freshwater sources, which are often confined to rainwater catchment systems, small aquifers, and, in some areas, desalination plants. Climate-induced changes in precipitation patterns and increased evaporation rates due to higher temperatures have led to prolonged dry spells, affecting both agricultural productivity and drinking water availability (Karnauskas et al., 2016). For example, in countries like Kiribati and Tuvalu, where freshwater is already limited, even slight reductions in rainfall can lead to

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severe water shortages, disrupting local communities' access to safe drinking water and sanitation (White et al., 2021).

Traditional knowledge and community-based adaptation strategies have long played an essential role in resilience-building across the Pacific. Communities have historically relied on indigenous practices, such as rainwater harvesting, crop rotation, and the preservation of drought-resistant plants, to withstand environmental stressors. However, the escalating scale and intensity of climate impacts necessitate a multifaceted approach that goes beyond traditional practices alone (Granderson, 2017a). An integrated approach that combines scientific research, adaptive policy frameworks, and localized action is essential for developing sustainable solutions to the water crisis. For instance, efforts to enhance freshwater security through infrastructure investment, like improved rainwater storage and distribution systems, have shown promise in bolstering resilience (Duvat et al., 2018). Additionally, regional cooperation and partnerships, such as the Pacific Islands Climate Action Plan, seek to address transboundary water management challenges and facilitate the sharing of resources, expertise, and technology across island nations (Seneviratne et al., 2021).

Literature Review

The sources examined in this paper provide valuable insights into the complex and multifaceted challenges of freshwater security and drought in the Pacific highlighting the particular vulnerability of freshwater resources on small islands, where limited size and susceptibility to climate change impacts like saltwater intrusion and decreased aquifer recharge pose significant threats to water security. This underscores the urgent need to address these challenges and develop sustainable strategies to ensure reliable access to clean water for Pacific communities.

The sources also emphasize the important role of traditional knowledge and community-based adaptation strategies in building resilience to climate change impacts, including water scarcity. By incorporating local knowledge, experiences, and practices into climate adaptation and water management efforts, Pacific Island communities can develop more holistic and effective solutions that are tailored to their unique contexts.

However, the sources also indicate that while there has been significant research on the biophysical impacts of climate change in the Pacific, there is a need for more focused attention on how communities are experiencing and responding to these changes, and how traditional an d local knowledge can be effectively integrated into adaptation planning and implementation.

By exploring more recent literature on the importance of water security in the South Pacific (Avolio et al., 2009) and the role of traditional knowledge systems in building adaptive capacity, enables us to build a more comprehensive understanding of the challenges and potential solutions for addressing the impacts of climate change on freshwater resources in the region.

Water Security and Drought in the Pacific

The Pacific region is no stranger to water scarcity and drought, with many island nations (islets, atolls, higher islands) and coastal communities historically facing challenges in accessing reliable and clean freshwater sources. (Chourasia & Jhariya, 2020) However, the impacts of climate change have exacerbated these existing vulnerabilities, leading to a growing water crisis across the Pacific.

A recent study estimates that almost 5 billion people globally live in areas where threats to water security are likely, a situation that will only be further compounded by climate change, population growth, and unsustainable human activities (Rodell et al., 2018). The Pacific Islands, with their limited land area and fragile freshwater resources, are particularly susceptible to these threats.

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Freshwater resources on small islands are especially vulnerable to climate change, as they are limited in size and easily compromised by factors such as saltwater intrusion, drought, and contamination. The Sixth Assessment Report of the Intergovernmental Panel on Climate Change has identified widespread and rapid changes in the climate and ocean environments, with significant implications for the Pacific region (IPCC, 2021). In the South Pacific, the intensity of the strongest tropical cyclones is projected to increase, while the number of tropical cyclones is likely to decrease.

Climate projections indicate that while some islands in the western Pacific and Indian Ocean may experience increased aquifer recharge, the majority of islands in the Pacific are expected to see a decrease in groundwater recharge by up to 58% (Holding et al., 2016). This poses a significant challenge for communities that rely on groundwater as their primary source of freshwater.

The impacts of water scarcity and drought can have far-reaching consequences for the basic needs of Pacific communities, including access to safe drinking water, food security, and overall human health and well-being.

A Climate Crisis in the Pacific Islands

The Pacific region stands at the epicenter of the global climate crisis, experiencing some of the most severe and immediate effects of climate change. Comprising numerous small island developing states (SIDS), including countries like Fiji, Vanuatu, Tuvalu, Kiribati, and the Solomon Islands, the Pacific faces a unique set of climate-related challenges that threaten its environment, infrastructure, and population. Although these islands contribute minimally to global greenhouse gas emissions, they bear a disproportionate share of climate-related consequences (Mackay & Russell, 2023). This heightened vulnerability has placed the Pacific at the forefront of international discussions on climate change and adaptation.

Rising Sea Levels and Coastal Erosion

One of the most pressing issues in the Pacific is rising sea levels, a direct consequence of global warming. The Intergovernmental Panel on Climate Change (IPCC) projects that global sea levels could raise by as much as 1.1 meters by the end of the century if emissions remain unchecked (IPCC, 2021). For many Pacific Island nations, even a modest rise in sea levels presents existential threats, as their highest points are often only a few meters above sea level. For instance, in countries like Tuvalu and Kiribati, rising tides and frequent flooding have already led to the loss of arable land, the salinization of freshwater resources, and the displacement of communities from low-lying coastal areas (Albert et al., 2021).

The impacts of rising sea levels are compounded by coastal erosion, which is accelerating due to higher wave activity and increased storm frequency. Many island nations depend on coastal areas for their livelihoods, especially through tourism and fishing. The degradation of coral reefs, which provide natural coastal protection, exacerbates erosion and exposes communities to more frequent and severe storm surges (Kench et al., 2020). As the protective barriers of coral reefs deteriorate due to ocean acidification and warming, the rate of coastal erosion accelerates, further threatening infrastructure and livelihoods.

Extreme Weather Events

In addition to rising sea levels, the Pacific is experiencing more frequent and intense extreme weather events, such as cyclones, droughts, and heavy rainfall. Climate models indicate that the frequency of intense cyclones—category 4 and 5 storms—has increased and is expected to continue rising with global temperature increases (Walsh et al., 2016). Cyclone Winston, which struck Fiji in 2016, serves as a stark example; it was one of the strongest tropical cyclones ever recorded in the Southern Hemisphere, causing extensive damage and loss of life (Climate Council, 2022).

These extreme weather events have significant social and economic impacts on Pacific Island nations. Infrastructure, agriculture, and water resources are particularly vulnerable, affecting food security, public health, and economic stability (Nunn et al., 2019). The repeated destruction of crops and infrastructure has

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led to a cycle of rebuilding that diverts resources from long-term development and adaptation strategies, placing further strain on limited national budgets (Basel et al, 2020).

Freshwater Scarcity and Drought

Freshwater availability in the Pacific is closely linked to rainfall patterns, which have become increasingly unpredictable due to climate change. Prolonged periods of drought, such as those experienced in the Marshall Islands and Tuvalu, have underscored the fragility of water resources in the region. Drought conditions affect not only drinking water supplies but also agricultural productivity, compounding the food security challenges already present in these island nations (Lal et al., 2020). As freshwater resources become scarcer, countries must rely on costly desalination technology or import water supplies, adding economic burdens to already strained budgets (White et al., 2021).

Loss of Biodiversity and Ecosystem Services

The Pacific region is renowned for its rich biodiversity, including unique marine and terrestrial species that contribute to the ecological and cultural heritage of the islands. However, climate change poses a severe threat to this biodiversity, particularly marine ecosystems such as coral reefs, which are highly sensitive to temperature increases and acidification (Hoegh-Guldberg et al., 2018). Coral bleaching events have increased in frequency and intensity, leading to significant declines in reef health. This, in turn, impacts fish populations and the livelihoods of those who depend on fishing for sustenance and income (Bell et al., 2018).

The loss of biodiversity also affects ecosystem services such as coastal protection, water purification, and carbon sequestration. Mangroves, seagrass beds, and coral reefs play vital roles in stabilizing coastlines and providing habitat for marine species. As these ecosystems degrade, the resilience of island communities to climate impacts diminishes, increasing their vulnerability to disasters and economic shocks (Alongi, 2018).

Adaptation Strategies and International Support

Pacific Island nations have developed various adaptation strategies to combat the challenges posed by climate change. These include building sea walls, enhancing water storage and desalination facilities, developing early warning systems for extreme weather events, and promoting climate-resilient agriculture (McIver et al., 2022). Additionally, traditional knowledge and community-based adaptation practices, such as the use of drought-resistant crops and rainwater harvesting, remain integral to resilience efforts (Granderson, 2017).

However, the scale of the climate crisis in the Pacific requires substantial international support, both in terms of funding and technical assistance. Global frameworks, such as the Paris Agreement, have recognized the specific vulnerabilities of small island developing states (SIDS) and have pledged to provide climate financing to support adaptation and mitigation measures (UNFCCC, 2022). While some progress has been made, Pacific leaders continue to call for more ambitious action from the international community to limit global temperature rise to 1.5°C and to increase financial support for adaptation (Mackay & Russell, 2023).

The Pacific region's climate crisis, therefore exemplifies the disproportionate impact of global warming on vulnerable populations. As these island nations face rising sea levels, extreme weather events, ocean acidification, coastal erosion, water scarcity, invasive species proliferation and biodiversity loss. This serves as a critical reminder of the urgent need for global climate action. Addressing the climate crisis in the Pacific requires a combination of local resilience-building strategies and robust international support to protect these unique and vulnerable communities.

Integrating Traditional Knowledge and Adaptation Strategies Geared to Water Security and Droughts.

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Traditional knowledge and community-based adaptation strategies have long played a critical role in helping Pacific Island communities navigate the challenges of water scarcity and adapt to climate change. (Granderson, 2017) These knowledge systems, often passed down through generations, offer valuable insights into sustainable water management practices, ecosystem conservation, and resilience-building measures that are tailored to the unique cultural and environmental contexts of the Pacific.

While there has been significant research into the impacts of climate change and the vulnerabilities of biophysical systems and various economic sectors in the Pacific Islands, there has been less focus on how or why island communities experience climate change, identify relevant adaptation options, and mobilize their capacity to deal with impacts, including traditional knowledge (Granderson, 2017b).

Drawing on existing ecosystem-based management principles and programs, governments and nongovernmental organizations in the Pacific are increasingly incorporating climate change science into management plans and taking action to increase the resilience of both natural and social systems. This includes initiatives to strengthen traditional water management practices, promote community-based monitoring and decision-making, and integrate local knowledge with scientific data to develop more holistic and culturally-appropriate adaptation strategies.

Access to water and sanitation are recognized by the United Nations as human rights – fundamental to everyone's health, dignity and prosperity (UN, 2024). Anecdotal to this is the importance of water security; as a critical issue facing many regions around the world. Water security is particularly pressing in the face of climate change and increasing droughts, and especially in small isolates atolls or islets in the South Pacific. To address this challenge, it is essential to integrate both traditional knowledge and adaptation strategies that can help communities become more resilient to water-related risks.

Traditional knowledge systems, often developed over generations, can provide valuable insights into sustainable water management practices. For example, Indigenous communities in India and Africa have long-standing traditions of conserving and managing water resources, such as through the construction of community ponds and the use of indigenous crop varieties that are drought-resistant. These traditional practices have been shown to be highly effective in addressing local water security challenges, as they are tailored to the specific environmental and cultural contexts of the communities that developed them. (Mbilinyi et al., 2005); (Mahlangu & Garutsa, 2014).

Integrating(or interweaving) traditional knowledge with modern scientific approaches can yield powerful synergies, yet often difficult to understand or comprehend, especially within local cultures, as placed-based knowledge (Orcherton, 2023) . By combining the contextual understanding and practical wisdom of local communities with the analytical tools and technical expertise of scientific researchers, it is possible to develop more holistic and sustainable water management strategies. This approach can help to address the limitations of purely top-down, technocratic solutions, which may fail to account for the nuances of local environmental and social dynamics. One such example of this integration is the concept of adaptive management, which emphasizes the importance of flexibility, learning, and stakeholder engagement in water management decision-making. This approach recognizes that water systems are complex and dynamic, and that management strategies must be able to adapt to changing conditions, such as those brought about by climate change (Stakhiv & Stewart, 2010).

Methodology

This research paper is based on a review of existing literature on the topic of freshwater security and drought in the Pacific region, with a particular focus on the role of traditional knowledge and community-based adaptation strategies. The sources used in this paper were selected based on their relevance to the research question, their methodological rigor, and their contribution to the current understanding of the topic.

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The research process involved a systematic search of academic databases, such as Google Scholar and ScienceDirect, using keywords such as water security, drought, Pacific Islands, and traditional knowledge. The sources were then critically analyzed, with the key findings and insights synthesized into a coherent narrative that addressed the research question.

The paper draws on a range of sources, including peer-reviewed journal articles, reports from international organizations, and academic books, to provide a comprehensive overview of the challenges and potential solutions related to freshwater security and drought in the Pacific region.

Results & Discussion

The literature review highlights several key findings:

Water supply is expected to be an ongoing and increasing problem in the Pacific, with water resources threatened by naturally small reserves in some islands, climate change impacts, and population growth and rapid urbanization (Rapid Review of Water Knowledge for Pacific Small Islands Developing States, 2018).

Climate change, together with behavioral changes, are negatively affecting the availability and access to clean freshwater, with implications for household economies, food security, and human health in Pacific Island communities. The literature also brought out a need for greater monitoring and accessible information regarding the extent and quality of water resources during drought periods.

At the same time, Pacific Island communities have long-standing traditional practices and knowledge systems for managing water resources that can serve as a foundation for building resilience to climate change impacts (Yang & Liu, 2020). By integrating traditional knowledge with scientific data and community-based decision-making, Pacific Island nations can develop more holistic and culturally-appropriate adaptation strategies.

However, the literature also indicates that there has been less focus on how island communities experience climate change impacts, identify relevant adaptation options, and mobilize their capacity to deal with impacts, including through the use of traditional knowledge.

Limitations

This research paper has several limitations. Firstly, the scope of the review was limited to the Pacific region, and the findings may not be fully generalizable to other island regions or contexts. Additionally, the available literature on the integration of traditional knowledge into climate adaptation and water management strategies in the Pacific is still relatively limited, and more in-depth research may be needed to fully understand the opportunities and challenges in this area.

Moreover, the paper relied on secondary sources, and did not include primary data collection or fieldwork. As a result, the findings may not fully capture the nuances and complexities of the local contexts and community experiences.

Conclusion

Freshwater security represents a critical and growing challenge for Pacific Island communities, a challenge that is increasingly exacerbated by the impacts of climate change. Due to their small landmasses, limited freshwater resources, and dependence on rainwater and groundwater, Pacific Islands are especially vulnerable to changes in climate variables. With many communities relying on shallow aquifers, rainwater catchments, and small-scale groundwater extraction, any disruption to precipitation patterns or increase in saltwater intrusion can significantly impact freshwater availability and quality (Granderson, 2017; Pearce et al., 2017). In recent years, climate-induced shifts in rainfall and rising sea levels have led to reduced aquifer

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recharge and higher salinity in water sources, deepening the freshwater crisis for many Pacific communities (Rapid Review of Water Knowledge for Pacific Small Islands Developing States, 2018).

Climate Change and Freshwater Vulnerabilities

The climate challenges facing Pacific Island nations are multifaceted. Changes in rainfall patterns, largely due to altered weather systems and rising global temperatures, have created more frequent and prolonged droughts in regions such as the Marshall Islands, Kiribati, and Tuvalu. These dry spells impact not only drinking water but also agriculture, livestock, and the broader ecosystem, placing considerable strain on already limited resources (Lal & Harasawa, 2020). In periods of drought, reliance on groundwater increases, causing concerns about over-extraction and the subsequent depletion of aquifers. Moreover, declining aquifer recharge, which is vital for maintaining groundwater levels, is compromised as precipitation becomes more irregular (White et al., 2021).

Another significant challenge is saltwater intrusion, which occurs as rising sea levels push seawater into freshwater systems and coastal aquifers. This intrusion reduces the availability of potable water, forcing communities to rely on costly desalination processes or imported water, both of which are unsustainable in the long term (Albert et al., 2021). Coastal communities that depend on shallow wells are especially vulnerable, as these wells are highly susceptible to contamination from saltwater, rendering them unusable for drinking or agriculture (Kumar & Taylor, 2020).

Integrating Scientific Knowledge and Traditional Ecological Wisdom

Addressing freshwater security in the Pacific Islands requires a comprehensive approach that blends scientific research with traditional ecological knowledge and community-driven practices. Traditional knowledge has long been a cornerstone of Pacific Island communities, providing valuable insights into resource management and resilience-building. For example, rainwater harvesting and water conservation practices, which have been passed down through generations, remain essential for supplementing freshwater supplies during dry periods (Granderson, 2017b). These traditional practices, while effective, need to be supported by scientific advances, such as climate modeling and hydrological assessments, to develop adaptive strategies that are responsive to future climate scenarios (Nunn, 2018).

In recent years, there has been a growing recognition of the importance of integrating traditional knowledge with modern climate science. Studies suggest that blending these two knowledge systems can enhance the effectiveness of water management strategies, making them more context-specific and culturally appropriate (McNamara & Prasad, 2020). For instance, the use of traditional crop varieties that are drought-resistant and the restoration of mangroves to buffer against coastal erosion are examples of how local knowledge can contribute to broader climate adaptation efforts (Lal et al., 2020) (McNamara et al, 2020).

Community-Based Adaptation Strategies

Community-based adaptation is essential to ensuring that climate solutions are tailored to the unique needs and challenges of Pacific Island nations. These strategies often involve local stakeholders in decision-making processes, ensuring that adaptation measures reflect the priorities and values of the communities themselves. One successful example is the implementation of water catchment systems in Fiji, which involves both local communities and governmental support. These systems are designed to capture rainwater efficiently, providing a sustainable source of drinking water that reduces dependence on overdrawn groundwater (McIver et al., 2022).

Additionally, the construction of small-scale desalination plants powered by renewable energy sources, such as solar power, is increasingly seen as a viable adaptation strategy in regions with limited freshwater sources. These plants, however, require ongoing investment and maintenance, underscoring the importance of financial and technical support from international agencies (United Nations, 2022). Building partnerships with international organizations and climate funds can provide essential resources, allowing Pacific Island nations to implement these technologies while respecting local knowledge and practices.

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The Path Forward: Holistic and Sustainable Solutions

Ensuring freshwater security in the Pacific requires a multi-dimensional approach that is as resilient as it is adaptive. Collaborative efforts that bring together local communities, governments, scientific experts, and international organizations are essential to developing sustainable water management practices. By empowering Pacific Island communities to incorporate traditional knowledge into water management, the region can build adaptive capacity and resilience against climate-related challenges (Seneviratne et al., 2021).

Investing in both traditional and innovative water management technologies, such as enhanced rainwater catchment systems, renewable-powered desalination, and aquifer recharge initiatives, offers a path forward for these vulnerable nations. Such investments not only safeguard access to clean water but also contribute to the overall health, well-being, and resilience of Pacific Island populations.

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Appendix 1

In the South Pacific, islands are typically classified into three main types: islets, atolls, and high islands. Each type has distinct geological, ecological, and physical characteristics that affect their environment, resources, and vulnerability to climate change.

Islets

Definition: Islets are very small islands, often less than one square kilometer in area. They are generally found as small landmasses in larger island groups, near atolls, or along coastal reefs.

Characteristics: Islets often have limited vegetation, thin soil layers, and few freshwater resources. Due to their small size and low elevation, islets are especially vulnerable to sea-level rise, erosion, and extreme weather events.

Examples: Islets are commonly found as part of larger atoll formations or adjacent to larger islands, such as the many small islets surrounding Tuvalu's main atolls.

Atolls

Definition: Atolls are ring-shaped coral reefs, islands, or series of islets that encircle a central lagoon. They typically form on the remains of submerged volcanic islands, with coral reefs growing over and around the remnants.

Characteristics: Atolls are usually low-lying, with most land area close to sea level. Their sandy, porous soil limits freshwater storage, so they rely heavily on rainwater or shallow aquifers, which are easily affected by drought and saltwater intrusion. The ecosystems on atolls are fragile and highly susceptible to climate-related changes, such as rising sea levels and increased storm surges.

Examples: Some well-known atolls in the South Pacific include the islands of Kiribati, the Marshall Islands, and parts of Tuvalu.

High Islands

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Definition: High islands, also known as volcanic islands, are larger islands with mountainous terrain, formed from volcanic activity. They are typically higher in elevation than atolls and islets, with some reaching several hundred or even thousands of meters above sea level.

Characteristics: High islands often have rich, fertile soils, extensive vegetation, and more diverse ecosystems compared to atolls and islets. Their topography enables the collection of surface water in rivers and streams, and they generally have more robust freshwater resources. High islands are less vulnerable to sea-level rise than atolls and islets due to their higher elevation, although they are still affected by extreme weather and natural erosion.

Examples: Examples of high islands include Fiji, Samoa, and Tahiti in French Polynesia.

Summary of Key Differences:

Elevation: High islands have significant elevation, whereas islets and atolls are low-lying.

Size and Freshwater Resources: High islands are typically larger with more freshwater resources, while atolls and islets are smaller, with limited water storage capabilities.

Formation: High islands are volcanic in origin; atolls are coral formations on submerged volcanoes, and islets are small land extensions in or around these formations.

These distinctions have important implications for each type's resilience to climate change, especially regarding freshwater availability and vulnerability to rising sea levels.