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**A Scoping Study on Sustainable Aviation in Micronesia:
Policy Pathways for Environmental and Economic Resilience**

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Abstract

Aviation serves as a vital lifeline for the remote island nations of Micronesia, underpinning economic development, facilitating tourism and enabling access to essential services. Despite its strategic significance, the subregion continues to encounter persistent challenges in maintaining reliable and environmentally sustainable air connectivity. These challenges are primarily attributable to limited flight networks, high operational costs and geographic isolation and are further exacerbated by the growing impacts of climate change. Notwithstanding the sector's vulnerability, there remains a notable gap in the literature regarding aviation decarbonization pathways that are responsive to the unique socioeconomic and geographic circumstances of Micronesian small island developing States (SIDS). This paper seeks to address this gap by examining the current aviation landscape, assessing climate-related risks and proposing policy options to advance sustainable aviation in the subregion. Employing a data-driven methodology, complemented by a descriptive review of international flight connections and tourism flows, the study analyzes route connectivity, climate vulnerabilities and institutional constraints across five Micronesian countries: Federated States of Micronesia, Kiribati, Marshall Islands, Nauru and Palau. The findings indicate that while the subregion remains heavily reliant on international aid and bilateral partnerships to sustain minimal air links, there is considerable untapped potential to enhance the resilience and sustainability of the aviation sector through strengthened international cooperation and the adoption of emerging technologies.

Keywords: Climate and economic resilience; Micronesia; SIDS; Subregional policy; Sustainable aviation; Tourism

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1. Introduction

The aviation sector plays an essential role in facilitating connectivity, promoting economic development and supporting regional integration across the remote small island developing States (SIDS) of Micronesia. This paper focuses on five sovereign countries in the subregion, namely Federated States of Micronesia (FSM), Kiribati, Marshall Islands, Nauru and Palau, with supplementary reference to two United States territories: Commonwealth of the Northern Mariana Islands (CNMI) and Guam. In these contexts, both international and intraregional air travel are predominantly shaped by three principal markets: leisure tourism centred on “sun, sea and sand” destinations; travel by members of the island diaspora; and visits from nationals of politically and economically affiliated countries (Timothy, 2022).

The geographical isolation and small population sizes of Micronesian SIDS pose considerable challenges to the development and maintenance of viable air connectivity (Niemeier, 2019). Populations are dispersed across vast oceanic distances, and air transport serves as a critical enabler of trade, tourism and access to essential services, including healthcare and education (UNCTAD, 2014). Despite its strategic importance, the aviation sector in the Pacific is constrained by limited economies of scale, elevated operational costs and infrastructure deficiencies (Schlumberger and Weisskopf, 2014). These structural vulnerabilities, combined with limited financial and technical capacities and a high dependence on air travel, underscore the need for context-specific policy interventions and enhanced international cooperation (Rallo, 2019).

In addition to economic and logistical constraints, the aviation sector in Micronesia is increasingly exposed to climate-related risks. Key threats include sea level rise, intensified storm activity and shifting weather patterns, which undermine the reliability and safety of air transport services (Grecni et al., 2023). Many airports are located in low-lying coastal zones, making them particularly susceptible to flooding, coastal erosion and storm surges (Haga et al., 2012). The growing frequency and severity of extreme weather events pose significant risks to aviation infrastructure and operations, with the potential to disrupt connectivity and compromise long-term resilience.

Globally, aviation accounted for approximately two per cent of energy-related carbon dioxide (CO₂) emissions in 2022 and has experienced more rapid emissions growth than other transport modes, including rail, road and maritime shipping (Kim and Teter, 2023). As Micronesian countries work to meet their climate commitments under the Paris Agreement and pursue net-zero emissions by 2050 (United Nations General Assembly, 2023), addressing emissions from aviation has become increasingly urgent. Sustainable aviation strategies must therefore be tailored to local conditions, including infrastructure limitations, financial constraints and heightened environmental vulnerability (Ghina, 2003).

This paper examines the current state of aviation in Micronesia and outlines a pathway toward a more sustainable future that balances economic resilience with environmental stewardship. Employing a data-driven literature analysis, the study reviews existing flight connections across the Micronesian islands and assesses the economic significance of international tourism receipts as a key driver of aviation demand. The findings highlight the urgent need for targeted investment in decarbonized aviation, emphasizing that both environmental resilience and economic sustainability in Micronesia are contingent upon the transition toward low-emission air transport systems.

2. Climate vulnerabilities and impacts

Aviation plays a dual role in the climate justice challenges confronting SIDS, including those in Micronesia. On one hand, it serves as a critical enabler of economic survival, facilitating connectivity,

trade and access to essential services. On the other hand, it contributes to the very climate-related threats that jeopardize the long-term viability of these nations. The Micronesian subregion is situated on the front lines of climate change, experiencing disproportionate impacts despite contributing only 0.03 per cent of global greenhouse gas (GHG) emissions (Parsons, 2022).

Among the most pressing concerns is sea level rise, with projections indicating an increase of 25 to 58 centimetres along Pacific island coastlines by mid-century (Parsons, 2022). This trend poses a direct threat to low-lying islands and atolls, heightening the risks of flooding, coastal erosion and storm surges. In addition, communities across Chuuk, Kosrae, Pohnpei and Yap in FSM are already experiencing more intense typhoons and shifting precipitation patterns (Reliefweb, 2024). Although the typhoon season typically spans from July to mid-November, major storms, while still relatively infrequent, are becoming increasingly severe (World Bank, 2021).

Climate change is accelerating the degradation of marine ecosystems across the Micronesian subregion. Rising sea surface temperatures and ocean acidification have triggered widespread coral bleaching events, threatening biodiversity and coastal livelihoods (Pacific Island Climate Adaptation Science, 2024). If global temperatures rise by two degrees Celsius above pre-industrial levels, it is estimated that up to 90 per cent of coral reefs in the region could suffer severe degradation (Parsons, 2022).

Water security is also emerging as a critical concern. Saltwater intrusion into freshwater aquifers, exacerbated by sea level rise, poses a long-term threat to potable water supplies, with projections indicating that some groundwater sources may be permanently lost within the coming decades (Parsons, 2022). Economically, climate change jeopardizes key sectors such as fisheries, which contribute tens of millions of dollars annually to the Micronesian economy (Reliefweb, 2024), and traditional agroforestry systems, which are increasingly vulnerable to changing climatic conditions. Cultural heritage is similarly at risk as rising seas threaten sacred sites and traditional practices closely tied to specific geographic locations (Krupocin and Krupocin, 2020; Reliefweb, 2024).

The aviation sector itself is not immune to these impacts. Increased storm frequency and intensity disrupt flight operations, altered precipitation patterns affect visibility and airport drainage systems, and higher ambient temperatures reduce aircraft lift, necessitating longer runways for safe takeoff and landing. A World Bank study found that 55 per cent of airports in Pacific island countries are located within 500 metres of the coastline, rendering them highly susceptible to sea level rise and storm surges (Utz *et al.*, 2017). Several airports in Micronesia have already experienced flooding and erosion while low-lying atolls such as Kiribati and Marshall Islands face ongoing land loss, reinforcing their designation as “sinking nations” (Smith, 2024).

In response to escalating climate risks, Micronesian countries have initiated a range of adaptation strategies, including the establishment of protected areas and the implementation of ecosystem-based approaches. These initiatives aim to enhance local adaptive capacity and resilience by fostering community ownership of adaptation processes and strengthening the management of marine protected areas (Micronesian Conservation Trust, 2018).

However, without substantial global mitigation efforts, research indicates that many Micronesian islands may become increasingly unstable within this century, with the most vulnerable potentially facing uninhabitability in the coming decades (Connell, 2015). This underscores the urgency of advancing climate justice, which requires reconciling the subregion’s dependence on aviation for survival with the imperative to decarbonize the sector. As this paper will further elaborate, ensuring that Micronesian voices are meaningfully represented in global climate and aviation policy processes is essential to achieving equitable and sustainable outcomes.

3. Aviation decarbonization and net-zero policy in the Micronesia subregion

Aviation decarbonization refers to the systematic effort to reduce and ultimately eliminate CO₂ emissions from air transport, aligning the sector with global climate objectives, including those outlined in the Paris Agreement (Malina *et al.*, 2022). Achieving this goal requires a multifaceted approach involving operational efficiency improvements, the deployment of sustainable aviation fuels (SAFs), the development of low-emission aircraft technologies, such as electric and hydrogen propulsion, and the implementation of carbon offsetting and capture mechanisms (ITF, 2024). The sector's reliance on energy-dense liquid fuels, long aircraft lifespans and its transboundary nature make aviation decarbonization particularly complex (Alexandrou and Khatiwada, 2025).

Net-zero aviation entails balancing GHG emissions with removals to ensure no net increase in atmospheric CO₂ by 2050 (IATA, 2024b). SAFs are expected to contribute the largest share of emissions reductions, between 24 and 70 per cent, while operational and technological improvements may account for approximately 30 per cent (IATA, 2024b). Given the high cost and limited availability of SAFs, market-based measures such as carbon pricing and offsetting remain essential (ITF, 2024). The Net Zero Policy Roadmap developed by IATA emphasizes global cooperation, strategic policy sequencing and substantial investment to achieve these targets (IATA, 2024a; 2024c; 2024d).

In the Micronesia subregion, aviation decarbonization is increasingly being integrated into broader climate and transport policy frameworks. The Micronesia Transport Strategy identifies infrastructure modernization, fuel efficiency improvements and the exploration of alternative fuels as key priorities (SPC, 2023). Subregional initiatives such as the Micronesia Challenge and Blue Prosperity Micronesia may indirectly support aviation sustainability by promoting sustainable tourism (Micronesia Conservation Trust, 2019; United Nations, 2020).

Micronesian countries have expressed support for the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA), a global initiative developed by the International Civil Aviation Organization (ICAO) to cap net CO₂ emissions from international aviation at 85 per cent of 2019 levels between 2024 and 2035 (ATAG, 2016; Schneider and Wissner, 2022). The scheme allows exemptions for SIDS, least developed countries (LDCs) and States with limited international air traffic, yet its implementation presents both challenges and opportunities for balancing development needs with climate commitments (SPREP, 2018).

At the national level, FSM has committed to achieving net-zero emissions by 2050 under its Nationally Determined Contribution (NDC) strategy (United Nations General Assembly, 2023). The National Energy Policy 2024–2050 outlines a phased approach to reducing fossil fuel use in transportation, including aviation, with a complete phase-out targeted by 2050 (Pacific Community, 2025). These commitments align with FSM's updated NDCs, which emphasize the development of resilient transport systems as part of broader climate adaptation and mitigation strategies (UNFCCC, 2021).

To complement national and subregional efforts, international partnerships are being mobilized to support low-carbon aviation initiatives. Organizations such as the Global Green Growth Institute (GGGI) are contributing to capacity-building and the implementation of climate-resilient transport solutions (GGGI, 2023). The Asian Development Bank (ADB) is supporting a feasibility study for SAF production in Fiji using sugar cane waste, which may serve as a model for similar initiatives in Micronesia (Hussain, 2024). Airlines such as Air New Zealand are also increasing their commitment to SAF procurement, reinforcing regional decarbonization efforts (Air New Zealand, 2024).

Despite these advances, progress remains slow. Most airports in Micronesia lack comprehensive climate risk assessments and adaptation plans and infrastructure upgrades have prioritized capacity expansion over resilience. Aviation-specific climate policies are largely absent from national strategies, and concrete investments remain limited. While regional platforms such as the Micronesian Islands Forum (2024) and the Pacific Islands Development Forum (2019) have identified sustainable transport as a priority, stronger coordination and resource mobilization are needed to translate commitments into action.

Human resource constraints further hinder progress. A study by Prasad and Aturi (2025) highlights the lack of technical capacity in the subregion while Bowes *et al.* (2024) found that secondary school science, technology, engineering and mathematics (STEM) curricula in CNMI, FSM and Marshall Islands are insufficiently aligned with the foundational knowledge required for aviation technical training. Strengthening STEM education is therefore essential to develop a skilled workforce capable of supporting sustainable aviation transitions.

4. The aviation landscape in the Micronesian subregion

The aviation sector serves as a vital enabler of connectivity, trade, tourism and emergency response across the geographically dispersed island nations of the Micronesian subregion. In the first quarter of 2024, IATA reported that Asia and the Pacific, including CNMI, FSM, Guam, Kiribati, Marshall Islands, Nauru and Palau, ranked among the top three regions globally for international passenger traffic growth. Passenger travel, measured in revenue passenger kilometres, increased by 52 per cent compared to the same period in 2023, reflecting a marked resurgence in regional mobility in the post-COVID-19 recovery phase (IATA, 2024d).

Despite this growth, the aviation landscape in Micronesia remains fragmented and heavily reliant on a limited number of carriers. Key airlines serving the subregion include United Airlines, Japan Airlines, Nauru Airlines, Air Niugini and several small domestic operators (Island Business, 2024). Most international flights connect through regional hubs such as Guam, Honolulu, Brisbane and major Japanese airports (Narita, Haneda, Kansai and Nagoya).

United Airlines and Nauru Airlines play a pivotal role in maintaining regional air connectivity across the Micronesian subregion. However, the environmental impact of their operations remains substantial, primarily due to long-haul flights and inter-island services that rely on conventional jet fuel (Wadud *et al.*, 2024). These carriers dominate the regional aviation market, with United Airlines holding a near-monopoly on key routes such as the Honolulu–Guam “island hopper” and intra-Micronesia flights (Caleb, 2025). As the sole consistent commercial link between Micronesia and the US mainland, United Airlines operates with limited competition, controlling nearly 99 per cent of the market share at Guam’s main airport (Leff, 2024). While Nauru Airlines offers occasional alternatives, its service frequency and network coverage fall short of United Airlines, leaving many communities with restricted options, elevated airfares and limited service quality (Caleb, 2025). This market concentration is further reinforced by the absence of competitive alternatives and indirect support mechanisms, such as Australian government subsidies to Qantas, which help sustain the broader Pacific aviation ecosystem, including carriers like Nauru Airlines (Caleb, 2025).

To assess the aviation landscape and connectivity across the primary countries under study, namely FSM, Marshall Islands, Nauru, Kiribati and Palau, an analysis of relevant flight routes was conducted using data retrieved from the FlightConnections online database as of May 2025. Table 1 presents both regular and seasonal flight operations, focusing on routes originating from international airports within each country. This dataset captures a substantial portion of the subregion’s key air links and

provides a robust foundation for evaluating connectivity patterns and identifying gaps in regional air transport infrastructure.

Table 1: Flight networks in Micronesia
(excluding domestic/international connections)

Country/territory	Fly from	Airport name	Fly to	Flight route	Airlines operating these routes**
FSM	Pohnpei (PNI)	Pohnpei International Airport	Majuro (MAJ)	PNI-MAJ	Nauru Airlines United Airlines
			Guam (GUM)	PNI-GUM	
			Koror (ROR)	PNI-ROR	
			Kwajalein Island (KWA)	PNI-KWA	
			Kosrae (KSA)	PNI-KSA	
			Chuk, Wenoo (TKK)	PNI-TKK	
	Chuuk (TKK)	Chuuk International Airport	Guam (GUM) Pohnpei (PNI)	TKK-GUM TKK-PNI	United Airlines
	Kosrae (KSA)	Kosrae International Airport	Pohnpei (PNI) Kwajalein Island (KWA)	KSA-PNI KSA-KWA	United Airlines
	Yap (YAP)	Yap International Airport	Guam (GUM)	YAP-GUM	United Airlines
Marshall Islands	Majuro (MAJ)	Marshall Islands International Airport	Honolulu (HNL)	MAJ-HNL	Air Marshall Islands FlexFlight Nauru Airlines United Airlines
			Tarawa (TRW)*	MAJ-TRW	
			Pohnpei (PNI)	MAJ-PNI	
			Kwajalein Island (KWA)	MAJ-KWA	
			Aur Atoll (AUL)	MAJ-AUL	
			Kili Island (KIO)	MAJ-MJB	
			Mejit Island (MJB)*	MAJ-UTK	
			Utirik Island (UTK)*	MAJ-WTE	
			Wotje Atoll (WTE)*	MAJ-MJE	
			Majkin (MJE)*		
Nauru	Nauru (INU)	Nauru International Airport	Brisbane (BNE)	INU-BNE	FlexFlight Nauru Airlines
			Nadi (NAN)	INU-NAN	
			Tarawa (TRW)	INU-TRW	
Kiribati	Kiribati (TRW)	Bonriki International Airport	Nadi (NAN)	TRW-NAN	Air Kiribati Fiji Airways FlexFlight Nauru Airlines
			Majuro (MAJ)*	TRW-MAJ	
			Kiritimati (CXI)*	TRW-CXI	
			Abemama Atoll (AEA)	TRW-AEA	
			Kuria (KUC)	TRW-KUC	
			Nonouti (NON)	TRW-NON	
			Tabiteuea (TBF)	TRW-TBF	
			Yaren (INU)*	TRW-INU	
			Butaritari Atoll (BBG)	TRW-BBG	
			Makin (MTK)	TRW-MTK	

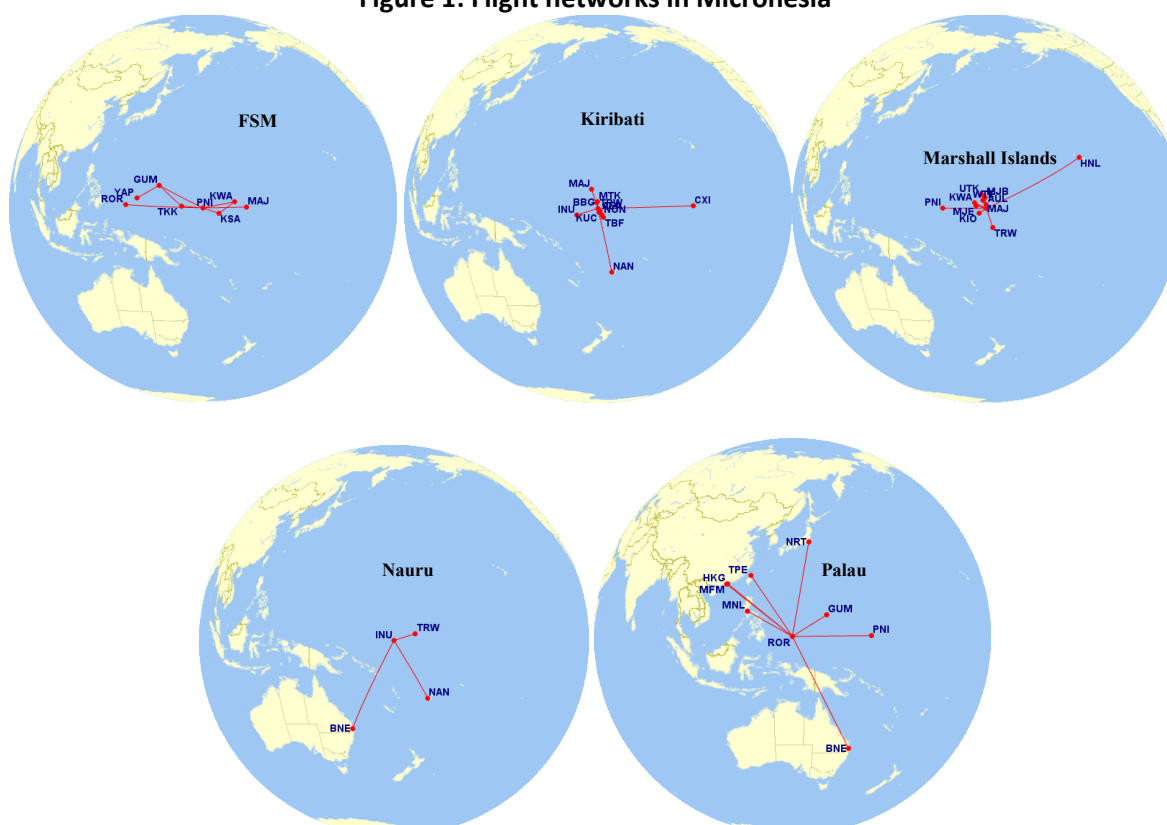
Palau	Koror/Babeldaob (ROR)	Roman Tmetuchl International Airport (also known as Palau International Airport)	Hong Kong (HKG)* Taipei (TPE) Manila (MNL) Brisbane (BNE)* Macau (MFM)* Guam (GUM) Pohnpei (PNI)* Tokyo (NRT) effective October 2025	ROR-HKG ROR-TPE ROR-MNL ROR-BNE ROR-MFM ROR-GUM ROR-PNI ROR-NRT	Cambodia Airways China Airlines FlexFlight Hong Kong Airlines Nauru Airlines Qantas United Airlines
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Sources: Based on FlightConnections (2025), retrieved in May and June 2025, except for Tokyo (NRT) flights due to start in October 2025.

Notes: Airport codes are in brackets. * Seasonal flights. ** Airlines listed operate one or more of these routes; not all airlines serve all routes, on either a regular or seasonal schedule.

To enhance clarity and facilitate interpretation, each flight pair listed in table 1 has been visualized using the Great Circle Mapper (2019), which graphically illustrates the routes between airports. As depicted in figure 1, these routes are mapped according to the five countries under study, FSM, Kiribati, Marshall Islands, Nauru and Palau. By converting tabular data into a visual format, the complex network of regional air connections becomes more accessible, enabling a clearer understanding of connectivity patterns and geographic constraints across the subregion.

Figure 1: Flight networks in Micronesia



Sources: FlightConnections (2025) and Great Circle Mapper (2019).

The Micronesian subregion is defined by vast oceanic distances and relatively small, dispersed populations, making air connectivity a persistent and complex challenge. A review of current flight routes (see table 1 again) reveals that direct air links between countries such as FSM, Kiribati, Marshall Islands, Nauru and Palau are limited. Most international and inter-island travel relies on a small number of regional hubs or distant gateways, often requiring transit through cities such as Brisbane,

Guam and Honolulu, which significantly increases travel time and logistical complexity (FlightConnections, 2025).

FSM's primary airports, Chuuk, Kosrae, Pohnpei and Yap are connected mainly to Guam, Majuro and Koror, along with a few other Micronesian destinations. However, these connections are not comprehensive, and many routes are circuitous. For instance, travel from FSM to Nauru or Kiribati typically necessitates transit through third countries or distant hubs, underscoring the lack of direct regional connectivity. Similarly, Kiribati's Bonriki International Airport in Tarawa maintains links to Nadi, Majuro and several domestic atolls but offers few direct connections to neighbouring countries. Nauru International Airport provides flights to Brisbane, Nadi and Tarawa, yet inter-island connectivity remains minimal or non-existent (table 1). Marshall Islands' Majuro is relatively better connected domestically and maintains links to Honolulu and Pohnpei although its international reach is limited and dependent on a small number of carriers. Palau's Roman Tmetuchl International Airport stands out for its relatively diverse connections to Asian cities such as Guam, Hong Kong, Manila and Taipei, as well as Brisbane. Nonetheless, direct flights to other Pacific islands are rare, with only a weekly service to Pohnpei.

Overall, flight connectivity within the Micronesian subregion remains sparse, fragmented and heavily reliant on a limited number of carriers operating across vast oceanic distances (ADB, 2015). This fragmented network often necessitates multiple layovers and detours through non-Pacific hubs, resulting in longer travel times, higher costs and increased logistical complexity (Miles and De Marchi, 2020). Such limitations not only constrain regional mobility but also impede economic integration, tourism development and timely emergency response. The absence of robust inter-island connectivity underscores the subregion's vulnerability to disruptions in airline services and highlights the urgent need for coordinated regional aviation strategies to enhance resilience and accessibility.

In addition to limited connectivity, the prevalence of longer and indirect flight routes in the Micronesian subregion contributes to increased fuel consumption and elevated carbon emissions, thereby undermining efforts to promote sustainable aviation (Balasundhararm and Hunter, 2021). Irregular flight schedules and constrained seat capacity further exacerbate accessibility challenges for both residents and tourists. As reflected in table 1, inter-island connectivity remains a critical issue, with some islands relying on infrequent charter services or seasonal flights operated only a few times per month (Miles and De Marchi, 2020).

Many of these routes are sustained through bilateral agreements or international aid, highlighting the limited commercial viability of serving low-demand, remote destinations (Hunter *et al.*, 2021). These structural constraints hinder regional mobility, weaken emergency response capabilities and constrain the development of tourism. Addressing these challenges requires coordinated policy interventions and targeted infrastructure investments to strengthen the resilience and inclusivity of the aviation sector across the subregion.

Micronesian countries are actively working to enhance aviation infrastructure and connectivity, often with support from regional partners and international organizations. A key example is the Pacific Regional Aviation Strategic Plan 2022–2032, which promotes a harmonized regional vision for a safe, secure and sustainable aviation system across the Pacific (ICAO, 2019). In support of this vision, the US Federal Aviation Authority (FAA) provides funding for airport improvements in CNMI, FSM, Marshall Islands and Palau, alongside technical assistance in airport design, planning, environmental management and construction (Ngirairiki *et al.*, 2024).

Further investment in aviation infrastructure is being mobilized under the United States' Indo-Pacific Strategy, with a focus on enhancing strategic connectivity and operational capacity in the Micronesian

subregion. Notably, the US Air Force has announced plans to invest approximately USD 400 million to expand aviation facilities and extend runways on the island of Yap in FSM, enabling the accommodation of larger aircraft for military operations, training exercises and humanitarian missions (Hadley, 2024). While the initiative also aims to strengthen civilian aviation capacity and improve subregional connectivity, it reflects a broader trend of infrastructure development being shaped by strategic geopolitical considerations (Hook, 2024).²

The intensification of geopolitical competition in the Pacific, particularly among major powers, raises important questions about the long-term implications of such investments for regional stability, development priorities and the autonomy of SIDS. As aviation infrastructure becomes increasingly dual-use in nature, balancing strategic interests with the developmental needs of Micronesian SIDS will be critical to ensuring that infrastructure investments contribute meaningfully to sustainable growth, resilience and inclusive regional integration.

5. Aviation and tourism

Aviation serves as the backbone of the tourism industry in the remote and geographically dispersed island nations of FSM, Kiribati, Marshall Islands, Nauru and Palau, providing the primary means of international access for visitors (JICA, 2022). Reliable air connectivity is essential not only for facilitating tourist arrivals but also for enabling trade, employment and the delivery of essential services that underpin economic development and community well-being (Zhang and Yarde, 2024). A substantial body of academic literature affirms the strong positive correlation between air connectivity and tourism growth (Duval, 2013; Trajkov *et al.*, 2021). Enhancements in air connectivity, such as increased flight frequencies and the introduction of direct routes, can significantly boost international tourist arrivals by improving accessibility and reducing travel-related barriers (Papatheodorou, 2021; Tang *et al.*, 2023).

In recent years, the resumption and expansion of air services have contributed to notable increases in visitor arrivals across several Micronesian islands, particularly as international travel resumed following the COVID-19 pandemic. The recovery of the tourism sector, and its contribution to gross domestic product (GDP) and livelihoods, is closely linked to the strength and reach of aviation connectivity in the subregion. To better understand the economic relevance of tourism, it is instructive to examine trends in international tourism receipts by country. According to the International Monetary Fund (IMF), tourism, including that enabled by air connectivity, accounts for over 40 per cent of Palau's GDP (IMF, 2023). Table 2 presents international tourism receipts, measured in US million dollars, from 2010 to 2020, based on available data from ADB (2023).

Table 2: International tourism receipts in Micronesia

International tourism receipts (US million dollars)	2010	2016	2017	2018	2019	2020
FSM	24	--	--	--	--	--
Kiribati	4	3	4	3	3	0
Marshall Islands	4	5	7	9	4	4
Nauru	1	3	4	2	--	--
Palau	73	121	106	98	86	47

Source: ADB (2023)

Note: -- data not available

² In 2025, FSM is also expected to make significant strides in its aviation sector, with an initial USD 96 million investment earmarked for the Yap airport upgrade (Cagurangan, 2024).

Among the five Micronesian countries examined, Palau consistently emerged as the top performer in terms of international tourism receipts, peaking at approximately USD 121 million in 2016. However, a marked decline followed, with receipts falling to USD 47 million by 2020, partially reflecting the impacts of the COVID-19 pandemic. Palau's historical outperformance relative to its regional counterparts can be attributed to its established reputation as a premium diving destination and comparatively superior air connectivity.

In contrast, Marshall Islands recorded gradual growth in tourism receipts, increasing from USD 4 million in 2010 to USD 9 million in 2018, followed by a modest decline, stabilizing at around USD 4 million by 2020. Kiribati's tourism earnings fluctuated between USD 3 million and USD 4 million from 2010 to 2019, before falling to zero in 2020, due to stringent border closures and travel restrictions. Nauru demonstrated a low but upward trend in receipts until 2017, followed by a decline in 2018; however, the absence of data for 2019 and 2020 limits further analysis. Similarly, for FSM, only a single data point is available, USD 24 million in 2010, with no subsequent figures reported, likely due to gaps in data collection or reporting mechanisms.

These findings underscore the vulnerability of small island economies to external shocks, particularly those with high dependence on tourism. Palau's post-2016 decline in tourism receipts illustrates the sector's sensitivity to geopolitical shifts, such as reduced arrivals from China, and global disruptions, notably the COVID-19 pandemic. The absence of recent data for FSM and Nauru highlights the urgent need to strengthen tourism data systems across the subregion to support more robust monitoring and evidence-based policy planning. More broadly, all countries in the subregion experienced significant volatility in both tourist arrivals and revenues during the pandemic, reaffirming the importance of resilient aviation and tourism systems in safeguarding economic stability.

Despite the positive contributions of tourism and air travel to economic development in the Micronesian subregion (Trajkov *et al.*, 2021), the sustainability of air transport operations is challenged by small population sizes and vast geographic dispersion (Bugayko *et al.*, 2021). Kiribati, for example, depends on Bonriki International Airport (TRW) to maintain both international and domestic connectivity across its widely scattered atolls. However, the country faces significant operational constraints, including elevated costs and infrastructure limitations that hinder the efficiency and reliability of air services (Graham, 2016).

Across the subregion, additional constraints, such as elevated ticket prices, limited flight frequencies and inadequate aviation infrastructure, continue to hinder mobility and restrict tourism growth (Wensveen, 2023). Addressing these structural barriers is essential to unlocking the full potential of sustainable air transport and enhancing regional connectivity and economic resilience.

In summary, the reliance on aviation to support tourism development in Micronesian island nations underscores the need for sustained investment in airport infrastructure, route expansion and affordable air travel options (Ghina, 2003). Limited air connectivity not only constrains tourism growth but also impedes broader economic and social development by restricting access to goods, services and opportunities for local communities. Strategic planning and coordinated efforts among governments, airlines and relevant stakeholders are therefore essential to optimise air connectivity in a sustainable manner and to maximise the economic benefits derived from tourism.

6. Policy recommendations

As the Micronesian subregion endeavours to enhance its economic resilience and environmental sustainability, policy interventions must address both the persistent challenges in air connectivity and

the pressing need for aviation decarbonization. The subregion remains heavily reliant on a limited number of foreign carriers. This dependence, compounded by infrastructure deficits and regulatory constraints, renders these island nations particularly vulnerable to service disruptions and external shocks. Concurrently, evolving international standards, such as CORSIA, and increasingly stringent carbon emissions regulations necessitate the adoption of more sustainable aviation practices, including the use of SAFs and enhanced emissions monitoring.

In this context, targeted policy measures are essential to ensure that aviation continues to support tourism, trade and essential services while advancing climate objectives and fostering regional and international cooperation. To promote low-carbon and sustainable aviation in the Micronesian subregion, while supporting environmental and economic resilience, as well as inter-island and global connectivity, the following policy actions are recommended:

- *Formulate a regional strategy for sustainable aviation fuels (SAFs):* Feasibility assessments should be undertaken to explore SAF production from locally available feedstocks, such as coconut oil and algae. Policy incentives and infrastructure support are needed to establish regional SAF supply chains. In alignment with global trends, the gradual introduction of SAF blending mandates, targeting a three to five per cent blend by 2030, is also recommended (ATAG, 2021).
- *Modernize aircraft fleets:* Airlines operating in the subregion should be encouraged to transition to newer, more fuel-efficient aircraft through mechanisms such as preferential landing fees and route allocation incentives. Joint procurement arrangements may be explored to leverage economies of scale (Karadeniz, 2023). In the medium term, the adoption of electric and hybrid-electric aircraft for short-haul routes should be considered as technologies mature.
- *Strengthen local capacity development:* Investment in education and training, particularly in science, technology, engineering and mathematics (STEM), is critical to building local expertise in sustainable aviation. Partnerships with regional and international universities and technical institutions should be established to develop relevant curricula and vocational programmes.
- *Promote eco-friendly tourism partnerships:* Integrated tourism packages should be designed to minimize environmental impact while showcasing the subregion's natural and cultural heritage. Community-based and indigenous-led tourism initiatives, such as village-led cultural tours, can ensure that tourism revenues support local livelihoods, preserve traditional knowledge and enhance environmental stewardship. These initiatives also align with the growing demand for authentic, low-impact travel experiences among environmentally conscious tourists.
- *Upgrade airport infrastructure:* Investments should be directed towards energy-efficient terminal buildings, electrified ground support equipment and advanced air traffic management systems to reduce emissions from airport operations. Climate-resilient design standards should be adopted for runways, drainage systems and coastal protection. The deployment of renewable energy systems, including solar panels, at airport facilities is also recommended in accordance with ICAO guidelines.
- *Explore innovative aviation solutions:* The subregion should investigate the potential of emerging technologies, such as electric seaplanes and autonomous cargo drones, that are well-suited to Micronesia's unique geography and connectivity needs. Pilot projects should be initiated to assess the feasibility and environmental benefits of such innovations.

- *Implement economic instruments:* The introduction of carbon pricing mechanisms, such as emissions trading schemes or offsetting requirements, should be considered, with revenues earmarked for sustainability initiatives. Tax incentives may also be offered to airlines and airports investing in emissions-reduction technologies.
- *Enhance regional and international cooperation:* A Micronesian Sustainable Aviation Task Force could be established to coordinate policy development, share best practices and mobilize resources across the subregion. Engagement with ICAO and development partners, including ADB, IATA and the World Bank, can facilitate access to technical assistance and climate finance.
- *Align with global climate goals and local priorities:* Regional and international stakeholders should establish inclusive and transparent consultation mechanisms that actively engage Micronesian governments, civil society organizations and technical experts. Such mechanisms are essential to ensure that aviation investments reflect local development needs, environmental objectives and long-term resilience.

The successful implementation of these recommendations will require sustained political commitment, robust institutional frameworks and strategic partnerships with development actors. By proactively advancing sustainable aviation, Micronesian countries can position their aviation sectors as enablers of long-term economic resilience and environmental sustainability.

7. Conclusions

This study underscores the pivotal role of sustainable aviation in enhancing the economic and environmental resilience of the Micronesian subregion. Given the subregion's geographic isolation and acute vulnerability to climate change, the development of a robust and sustainable aviation network is essential to support continued economic growth, particularly in key sectors such as tourism and trade. The policy recommendations presented herein, including the formulation of a regional SAF strategy, modernization of aircraft fleets and targeted capacity-building initiatives, offer actionable pathways to align Micronesia's aviation sector with global sustainability objectives.

Furthermore, the promotion of low-impact tourism activities and the establishment of strategic partnerships can contribute to both environmental preservation and inclusive economic development. International cooperation and the adoption of emerging technologies, such as electric seaplanes and autonomous drones, present additional opportunities to tailor sustainable air transport solutions to the subregion's unique geographic and socioeconomic context.

Nevertheless, this study is subject to several limitations. First, its scope is confined to a select group of Micronesian countries, which may limit the generalizability of the findings across the broader Pacific region. Second, the analysis relies primarily on secondary data sources, which may not fully capture the nuanced perspectives of local stakeholders or reflect the most recent developments on the ground.

Future research should aim to broaden the geographic scope to include a wider range of Pacific island nations and conduct in-depth feasibility assessments of the proposed policy measures. Incorporating primary data through fieldwork and stakeholder consultations would provide a more comprehensive understanding of local needs, capacities and constraints. Additionally, further exploration of financing mechanisms, such as climate finance instruments, public-private partnerships and blended finance models, would strengthen the policy framework for advancing sustainable aviation in the subregion.

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