Space for Survival: The Critical Role of Space Support for Small Island Nations

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Introduction

The vast maritime domains of small island nations have increasingly generated multidimensional attention. The Pacific Island of Tuvalu, for example, although only having a land area of 25.9 square kilometers, has an exclusive economic zone (EEZ) of over 751,159 square kilometers. These expansive waters are vital, containing essential resources such as fisheries, oil, minerals, and natural gas, which are crucial for the survival of these nations. However, the enormous size of these maritime areas, combined with the limited resources of small island states, poses significant challenges for effective monitoring and surveillance, rendering them particularly susceptible to activities such as dumping of toxic waste and Illegal, Unregulated, and Unreported (IUU) fishing, which not only undermine their economies but also inflict serious harm on marine ecosystems. Small island states are also faced with the challenges of climate change and natural disasters, as well as threats to their connection to the rest of the world via shipping lanes and communication lines.

While many efforts have focused on improving the management of these maritime spaces, the management of airspace and the prospects of space support above the seas have received limited attention. According to the 1944 Convention on International Civil Aviation, a country's airspace extends not only above its land territory but also over its territorial waters. Beyond the airspace lies the infinite outer space, which cannot be subjected to national sovereignty according to various United Nations Treaties and Principles on Outer Space, but can be explored and used for human benefits, including near Earth-orbiting of satellites for space-supported remote sensing, communications,

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and navigation. Therefore, airspace, outer space, and oceanic space should not be considered as discreet realms requiring independent management and uncoordinated strategies. Instead, these domains can be integrated and utilised synergistically to enhance the overall management, governance, and protection efforts of littoral states, especially in the case of small island nations.

Where oceanic and outer space meet:

Space support for remote sensing

Satellites can serve various purposes, one of which is remote sensing. In this instance, earth observatory satellite systems can support remote sensing for search and rescue missions, weather forecasting, disaster management, and monitoring climate change. One island that has developed notable capacity satellite satellite-supported remote sensing is Mauritius. In 2021, Mauritius' first satellite, the MIR-SAT1 that was produced in partnership with Japan was launched. This allows the country to monitor climate change, engage in weather forecasting, and importantly enhance its surveillance of its EEZ. The data gained from the satellite also allows the country to better assess and confront challenges such as rising sea levels. Since the launch of this satellite and its official inauguration into the community of space-faring nations, Mauritius Research and Innovation Council (MRIC) has since signed a Memorandum of Understanding (MoU) with the Indian Space Research Organisation (ISRO) for the development of a small satellite.

The benefits of using satellites for monitoring large oceanic spaces, and especially the surveilling of IUU fishing have become apparent in the Pacific, particularly through the Pacific Islands Forum Fisheries Agency (FFA) 'Operation Rai Balang.' Using Starboard - a maritime domain awareness tool - and satellite radio frequency allows the FFA to identify suspected fishing activities, confirm locations, and track their fishing activity in an area that spans over 12 million square kilometers. While monitoring IUU fishing is a central concern for the tuna-rich Pacific Islands, the threats of natural disasters and the impacts of climate change cannot be understated. In this regard the 'Digital Earth Pacific' project has been launched to help Pacific Islands monitor challenges such as climate change, food security, disasters, and illegal mineral extraction. Governments of island nations such as Fiji have struggled in the past to monitor the illegal extraction of river gravel across its 300 islands. The Digital Earth Pacific uses satellite data to track and identify where gravel is being extracted. The illegal extraction is highly harmful to the small land mass of the country and the local communities, as the gravel extraction leads to landslides, threatening the island population and killing the fish in the rivers on which the locals are reliant.

Remote sensing satellites are further relevant for precision agriculture and farming, disaster warning and emergency response, and the monitoring of the environment, amongst a plethora of other things. In the context of islands specifically, one area that could stand to benefit from satellites is the aquaculture industry. A project conducted by the EU has – using satellite data – mapped where the best places for fish farms are in Madagascar, for example. Using satellite data, scientists are able to analyse water temperature, nutrient levels, marine current speeds, and wave patterns. In this way, they can forecast the productivity of fish farms, while also being able to help fish farmers prepare for potential problems such as algae blooms.

These satellites can also support biodiversity, through the survey and protection of endangered species. At the 9th Our Oceans Conference in Athens, Greece, Marine Protected Areas (MPAs)[1] garnered substantial attention, with over 469 new pledges totaling more than $11.3 billion dedicated to ocean protection. These commitments reflect a strong focus on expanding and enhancing MPAs and other initiatives aimed at safeguarding marine environments. MPAs form a part of the 30x30 ocean conservation target, that was initiated at the 2022 COP15 United Nations Biodiversity Conference and aims to protect 30% of marine and terrestrial ecosystems by 2030. However, MPAs leave much to be desired, since despite their protected status, destructive practices such as bottom trawling still occur due to a lack of surveillance.

While such efforts on MPAs are valuable, it must be noted that oceans are fluid spaces and it is difficult to protect what is in the ocean in the same way land areas could be protected. On land, boundaries can be established with fences and walls, but in the ocean, such measures are impractical. This raises a critical question: what happens when marine protected areas can no longer contain the species they are meant to safeguard, as these species potentially migrate to colder waters in response to rising ocean temperatures? Such issues call for an ocean governance framework that is dynamic and treats ocean spaces as the fluid spaces they quite literally are. In establishing such a dynamic framework, satellites play an essential role. One study demonstrates how satellites can be used to protect the collision of ships with whales, by combining data gained from satellites to map out areas with a high presence of whales, and areas with a low presence of whales. There are an increasing number of cases where whales migrate in unusual manners since they are following prey that is now moving to warmer waters, therefore putting whales directly in the routes of some of the busiest shipping lanes in the world, resulting in often fatal blunt force trauma and propeller cuts. By integrating satellite support into ocean governance, the management of MPAs can become far more dynamic and these fluid ocean spaces become more secure.

Space support for Communication

Apart from the observational benefits of satellite, it is also crucial, especially in the context of small islands and their connectivity to the rest of the world. Communication satellites support telecommunication, tele-education, telemedicine, e-governance, and e-commerce. While there are more than 1.3 million kilometres of undersea internet cables that crisscross the world's seabed, very few connect most remote islands globally. Tonga, for example, has only one undersea communication cable (see **Figure 1** and **Figure 2** below for a visual that demonstrates the number of subsea cables running past islands, versus past other countries). Should there be any disruptions to the operation of these cables, such as cable sabotage or natural disasters, islanders will be unable to connect and communicate with other people.

This is exactly what happened in January 2022, when a volcano near Tonga erupted and severed its cable. Tongans had no internet access and could not contact neighbouring countries. Similarly, Islands, such as the Cook Islands, Marshall Islands, Niue, Palau, Solomon Islands, and Vanuatu only have one internet cable, making them highly vulnerable. Undersea or submarine cables have become increasingly critical (and recognised as critical infrastructure by most governments across the world) considering their vulnerability to maritime sabotage or damage as a result of industrial shipping vessels. On the 7th of January 2022, one of the subsea fiber cables between Svalbard and Harstad (in Norway) lost signal, with some suggesting it had been cut. In other cases, there have been numerous instances of fishing trawlers damaging cables when they engage in scallop fishing where they dredge the seabed.

In these instances, satellites could mitigate some of the negative impacts of the damaged or severed cables and minimise the vulnerability of islands. While satellite connectivity cannot currently replace the vast amounts of data that travel through subsea cables on a daily basis, it can mitigate against a complete 'blackout' as the Tongans recently experienced. One successful example of this is when Kacific – a broadband satellite operator – was able to restore communications to the Solomon Islands after its undersea cable was damaged by a foreign-flagged vessel's anchor.

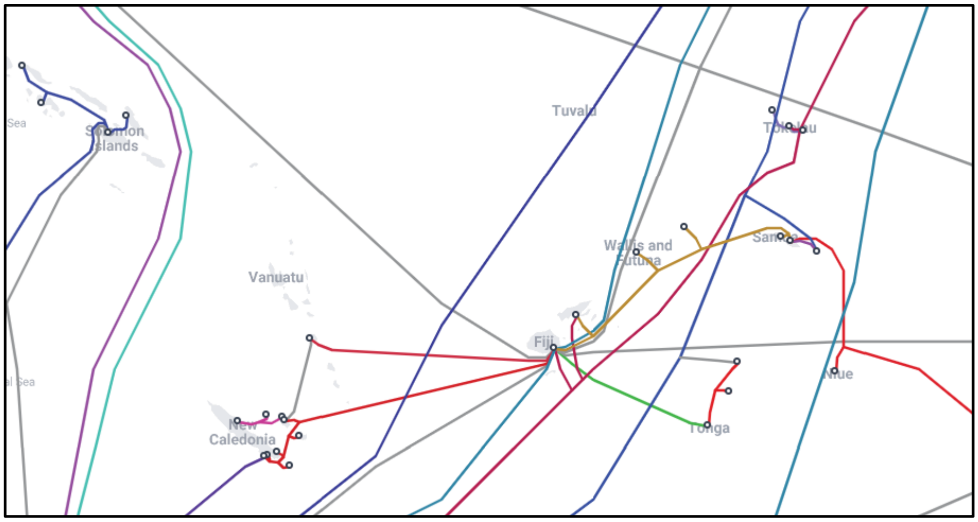

***Figure 1**: Subsea cables running to and past small islands in the Pacific.*

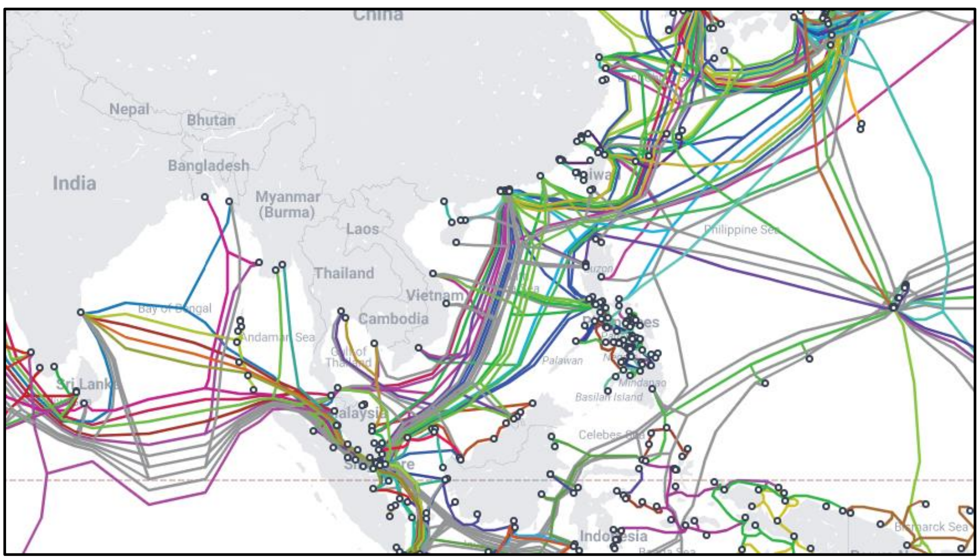

***Figure 2**: Subsea cables running to and past countries such as India, China, and Indonesia.*

Space support for Navigation

Finally, satellites can serve navigation purposes, such as in geo-positioning and tracking. There are Global Navigation Satellite System (GNSS), such as the US Global Positioning System (GPS), Russia's Global Navigation Satellite System (GLONASS), China's BeiDou Navigation Satellite System (BDS), and the European Union's Galileo as well as regional systems, such as Japan's Quasi-Zenith Satellite System

(QZSS) and Indian Regional Navigation Satellite System (IRNSS). These satellites play important roles in determining traffic and drivable roads for cars (an indispensable feature of autonomous driving cars), flight path of aircraft, sea route of ships, trajectories of spacecraft and guidance for missiles. The relevance of navigation satellite systems cannot be overstated for islands, considering that the movement of goods and human in and out of such nations or territories exclusively in most cases are by air and sea routes, which rely on space support. This is even more important in emergency situations in or around islands, which require urgent international humanitarian support.

With the limited human resources that are available to small island nations, navigation satellites can also provide relevant support in maritime situation awareness through space-supported monitoring and management of ship traffic around the ports and within the fast territorial waters and EZZ. This can also yield critical intelligence on ships that are in danger and suspicious ships. In cases of emergency, navigation satellites support ships in locating the nearest land or port in open seas, while communication satellites help relay distress calls to such locations. In return, space support provides island nations with the capacity to receive such distress calls, locate the ships and possibly provide the required help. Equally, navigation satellites can further support the radar capacity of island nations to track suspicious ships that are involved in IUU fishing, piracy, trafficking, illegal mining and other illicit activities in their maritime domain.

Understanding the limitations of satellites

As suggested above, the support that satellites can provide island nations is numerous. However, it is also important not to overstate such benefits. For example, in the case of Mauritius, the satellite it launched in 2021 is likely to have reached its operational lifespan, which was only two to three years. Furthermore, the effectiveness of the satellite depends, in part, on how often it orbits around the earth (its revisit frequency). For example, the European Union’s Sentinel-1 satellite has a higher revisit frequency than Mauritius’ MIRSAT-1 satellite, which means it can provide more up-to-date information. Apart from this is the obvious fact that entry into the satellite market can be expensive, especially for small island nations that have limited resources. Consequently, small island nations will in all likelihood have to rely on the data that is produced by satellites belonging to other countries or organisation. This, of course, has its own set of potential challenges such as technological and data sovereignty. In the Russia-Ukraine conflict, there are fears that the services provided by satellites, could be intercepted by the enemy. In 2022 the EU, for example, launched a programme aimed at establishing its own constellation of low earth orbit satellites so that it does not have to rely on other providers, especially during times when sensitive data is being shared.

For small island nations, establishing their own constellation of satellites might not be an option. As such, they will, for the foreseeable future, be reliant on the satellite services provided by other states. However, important for these islands is to be cognizant of both the benefits and challenges of using satellites. Notably, Maldives also recently hosted the Space for Island Nations Conference (SINC) in May 2024 with the theme 'Space for Space, Space for Oceans and Space for Climate' and an apt slogan reading 'We need Space to Survive.' One pertinent observation made at the SINC conference was that "small island nations are in a particularly vulnerable position with regard to the dangers of the proliferation of counterspace capabilities" especially in an era where there is significant jostling for influence over small island nations in regions such as the Indo-Pacific. This hints towards an understanding of the geopolitics that accompany satellites and outer space generally.

Conclusion

While small island nations have made some strides in leveraging space-based technologies for survival, there is significant room for space to be used more optimally to advance their national interests. For many of these nations, therefore, space technologies are not a luxury, but part of the critical assets required to guarantee their survival in the face of climate change, natural disasters, and threats to their connection to the outside world, as well as illicit maritime activities in their EZZs. Consequently, it is important not to see space endeavours as separated from ocean governance but rather as interconnected strategic domains, especially for these island nations. Notwithstanding the limited resources that are available to these the small island nations to pursue their desires for space capabilities, international collaboration could offer the opportunity to enjoy affordable space support.

This Research Brief was compiled by Daniela Marggraff and Samuel Oyewole within the context of the Ocean Regions Research Programme of the Department of Political Sciences, University of Pretoria. The opinions and findings expressed in this Report are those of the author(s) and the NIHSS accepts no liability in this regard.

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