Disaster Risk and Climate Change Impact Survey in the Republic of Palau, Phase I

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From the People of Japan

Executive Summary

In November 2019 and March 2020, we conducted a targeted survey of 10 significant cultural heritage sites in the Republic of Palau with the primary goal of assessing climate change-related threats to these resources and providing recommendations for mitigating these impacts. Sites were chosen not only because of their recognized value to the people of Palau, but their known susceptibility to sea level rise, erosion, and other natural processes that are recognized as causing negative impacts to the presence and integrity of associated features, archaeological assemblages, landscapes, and cultural traditions. The locations of these sites span the geographical and geological range found within the Palauan archipelago, ranging from atolls, the large volcanic island of Babeldaob, and the uplifted coralline limestone Rock Islands. The 10 sites chosen include (in alphabetical order by state): 1) Chelechol er a Orrak (burial cave and Yapese stone money quarry) in Airai; 2) Btelulachang er a Kemurrull me a Taoch er a Ngiteuai (traditional dock, stone path, platforms) in Airai; 3) Iporu (burial ground and landmark) on Tobi Island, Hatohobei; 3) Beluu er a Ngerdilong (traditional village) in Kayangel; 4) Beluu er a Ngerdimes (traditional village) in Kayangel; 5) Omedokel (Rock Island burial cave) in Koror; 6) Bul (Japanese swimming pool) in Koror; 7) Odalmelech (stone face monolith) in Melekeok; 8) Cheldeklel a Dilrengulbai (traditional stone alignment) in Ngaraard; 9) Kukau el Bad/Olketokel er a Kukau (monoliths) in Ngarchelong; and 10) Beluu er a Ngerutechei (traditional village) in Ngeremlengui. Each site was visited by members of the research team and examined, photographed, and assessed for current or potential impacts to the site's condition using a standardized form. The sites in Ngeremlengui and Tobi were mapped and recorded to provide an updated record of their current condition and serve as intervention sites as part of Phase 2 of this project. Results from the survey indicate that all 10 sites are currently under threat from a number of different processes relating to climate change, particularly sea level rise, which is—or will in the very near future based on conservative projections—inundating and/or potentially destroy most of them. Given that hundreds of archaeological and historical sites of cultural importance are found in low-lying coastal areas throughout the Palauan archipelago, there is a critical and urgent need to document, preserve, and/or protect these sites in the near future or risk losing them forever.

Enhancing Disaster and Climate Change Resilience in the Republic of Palau through Improved Disaster Preparedness and Infrastructure
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Introduction

There is a broad scientific consensus that climate change is negatively affecting our planet in myriad ways. That around 10% (800 million people) of the world's population is currently living in low-lying coastal regions is no surprise, for archaeological research clearly demonstrates that *Homo sapiens* have been attracted to - and intensively settled in marine environments for tens of thousands of years, if not longer. Given the wide propensity for humans in both the past and present to rely on the world's seas and oceans for transportation, food, and resources to sustain their livelihoods, there is an abundance of evidence from the ancient past that testify to these activities.

Over the last 15,000 years there has been a marked acceleration of human population growth and expansion to new environments that eventually led to the Age of Exploration in the 1500s and later the Industrial Revolution in the 1800s. The latter was a pivotal moment in human history, for it initiated a new reliance on coal and other fossil fuels that spurred the invention and development of steam and combustion engines, electricity to power machines, and a host of other important and novel technological innovations. It is this phenomenon that has led to massive CO_2 emissions that are now credited with warming temperatures on a global scale, resulting in the melting of the polar ice caps, rising sea levels, and a slew of other associated weather-related issues such as the intensification of tropical storms and altered rainfall regimes (e.g., Hansen et al. 2013; Solomon et al. 2009; Wu and Wang 2004). Every society around the world has been impacted by climate change in some way; however, climate change has begun to disproportionately affect small island states like the Republic of Palau (Kelman and West 2009).

Palau—an archipelago in the northwest tropical Pacific comprising hundreds of islands (*Figure 1*)—is like many other island nations around the world who are at the forefront of having to respond to the impending climate crisis that faces us today (e.g., Barnett and Campbell 2010; Kelman and West 2009). These Micronesian islands, settled millennia ago by people whose survival depended on the sea for movement and sustenance, developed unique cultural traits, which were often manifested in the physical remains they left behind. In Palau, archaeological, ethnographic, and ethnohistoric data provide rich sources of information on Palau's cultural landscapes, particularly how people lived, worked, and thrived along the coastal margins. For example, Palau's Rock Islands are home to hundreds of cultural sites making up a cultural landscape unlike anywhere else in the world. It is this unique cultural landscape that gives Palau's Rock Island Southern Lagoon the distinction of being both a cultural and natural UNESCO World Heritage Site. However, the Rock Islands are only one part of a Palau's rich cultural landscape. In an unfortunate twist of irony, it is these tangible and intangible assets to their culture that are now at risk of being lost forever as a result of activities that have always been outside of their control. These changes have impacted Palau's irreplaceable national treasures and heritage that is very precious to the unique identity of Palauan people and have compromised the very nature of their social structure and order. It is of great importance that Palau's cultural and historical sites contribute to the growth, social order, security, ownership, and well-being of the Palauan people through beliefs and cultural practices that link to past and have been passed down through generations and continue into the future.

This project—*Disaster Risk Reduction and Climate Change Impact Survey of Cultural Sites in the Republic of Palau: Reconnaissance Survey*—is the first phase of a longer-term initiative to examine archaeologically and culturally significant sites across the archipelago and assess their vulnerability to climate change, including, but not limited to, modelled projections of rising sea levels and sedimentation and erosion of sites vis-a-vis tidal inundation and rainfall. For the project, we identified 10 sites across different geographical and geological zones, ranging from Kayangel, an atoll in the far north, to the larger volcanic island of Babeldaob, the Rock Islands, and Tobi in the Southwest Islands. The overarching goals were to: 1) conduct a reconnaissance survey to assess significant sites, relics, and areas that are experiencing direct or indirect effects due to climate change; 2) provide sufficient training in archaeological methodologies to field technicians at the local state level along with community members involved in the project to self-manage their sites; 3) share the results of our findings and build community engagement with the distribution of a 28-page comic book that details the results of our project; and 4) offer disaster risk reduction and rehabilitation to vulnerable significant sites at two locations in the second phase of the project: Ngeremlengui on Babeldaob and Hatohobei in the Southwest Islands. These efforts will be community-based and help strengthen and build community resilience through the rehabilitation of important cultural sites.

During visits to each site, most of which are listed on the Palau National Register of Historic Places, we examined all of the features and other site components found within and compared them to previous reports collected by the Palau Bureau of Cultural and Historical Preservation/Historic Preservation Office (HPO) or other researchers. Photographs were taken primarily during lower tides to show exposed land and features and notes and/or measurements taken of the level at which current high tides would rise based on detritus and other natural markers (e.g., mud accumulation on vegetation). A "Cultural Landscapes Vulnerability Assessment Form" was then filled out by the project team for each site that included information as to the site's cultural significance, position on the landscape, integrity, presence of particular features, and initial recommendations for stabilizing and/or reducing sensitivity to climate change related issues (see Appendix 1).

Overall, the project found that these 10 properties are all under threat, particularly from sea level rise that is currently, or will in the very near future, inundate these sites and cause increased erosion, destruction, and accessibility issues. However, the degree of impact to each site varies widely depending on their location, site constituents, and a slew of other factors. Regardless, these sites were all deemed to provide excellent case studies for what is likely to happen across similar environments and locations in Palau, and provide important case studies on how best to mitigate the effects of climate change.

Below we provide background information as to the roles and responsibilities of the Palau HPO in this capacity, an environmental background for Palau generally, the methods used for site examination, and a synopsis of our findings for each of the 10 sites selected for this project. We then provide a summary and a list of recommendations that can be used as a guide for managing the preservation and protection of these sites to ensure that they are not lost for future generations.

Figure 1. *Map of the Palauan archipelago with location of sites investigated as part of this study*

Historic Preservation Office

The Bureau of Cultural and Historical Preservation/Palau Historic Preservation Office is one of the Bureaus of the Palau National Government under the Ministry of Human Resources, Culture, Tourism & Development (formerly Ministry of Community and Cultural Affairs), and is responsible for identifying, documenting, protecting, preserving, and managing all cultural and historical resources within the Republic.

The mission of the Bureau is to protect and preserve all the Republic's cultural and historical resources to enhance, enrich, and foster the Palauan heritage now and into the future. To achieve this mission, the Bureau has four main goals: (1) to preserve and foster cultural and historical resources for the benefit of Palauan people; (2) to preserve and educate Palauan traditions that are threatened with extinction; (3) to protect cultural and historical resources from destruction; and (4) to preserve culture and tradition in the face of inevitable increasing foreign contact and interaction.

The Bureau consists of five main sections, namely the Administration and Planning, Survey and Inventory/Archaeology, Oral History and Ethnography, Palau Register of Historic Places and Public Education sections. The Survey and Inventory/Archaeology Section is responsible for the identification and inventory of all cultural and historical resources within the Republic. To carry out this responsibility, the survey is divided into three phases: (1) Babeldaob survey; (2) Rock Island survey; and (3) underwater survey. The basis of determining and prioritizing these surveys are based on economical, developmental, and policy considerations, as well as the limitations of staff, training and funding to conduct multiple surveys at a time. Established in 1974 by the Historic Preservation Act (COM PL-3-34), the Survey and Inventory section became an integral part of historic preservation in Palau. Along with the Palau Register Section, it is the official depository and inventory of the nation's registered cultural and historic resources. Its expansion and maintenance were authorized by the Historic Preservation Act of 1978 (PPL-6-6-19), later amended to RPPL 1-48 in 1982, also known as Title 19, Chapter 1 of the Palau National Code.

Research Background

Geology and Topography

Palau is located in the Western Caroline Islands of Micronesia in the northwest tropical Pacific, approximately 600 km from the Philippines (*Figure 1*). There are hundreds of volcanic, coralline, uplifted limestone, platform-reef, and atoll islands in the Palauan archipelago that are arranged in a southwest-northeast orientation. Babeldaob is the largest island in the archipelago and has volcanic bedrock comprising basalt, andesite, and dacite that form heavily eroded, rolling hills. Soils are primarily lateritic and characterized by extreme leaching, high acidity, and rich clays (Corwin et al. 1956). Peleliu and Angaur are Pleistocene-aged raised platform-reef islands (Corwin et al. 1956; see also Colin 2009). Palau is divided into 16 states, 10 of which are found on Babeldaob and closely resemble the districts that were identified in early ethnographic accounts (Krämer 1919).

Environmental Background

Climate Variables Annual Average Temperature/Annual Average Precipitation: Rainfall averages 200-300 mm/year with an average temperature of 27 °C (Kitalong 2008; PACCSAP 2015). On average throughout the year the daily temperature in Palau is about 82.5ºF (28°C) and does not fluctuate widely (~1.5ºF or 0.8°C). Climate is also influenced by the trade winds, which shift seasonally. Monthly temperatures have gradually increased in recent years and these changes are strongly tied to changes in the surrounding ocean temperature. The main wet season is from May to October, while the driest months are February to April. Rainfall is influenced by Palau's position at the edge of the Pacific Warm Pool and the convergence of winds from the Intertropical and South Pacific Convergence Zones (*Figure 2*) (https://www.palaugov.pw/executive-branch/ministries/finance/budgetandplanning/climate-statistics/).

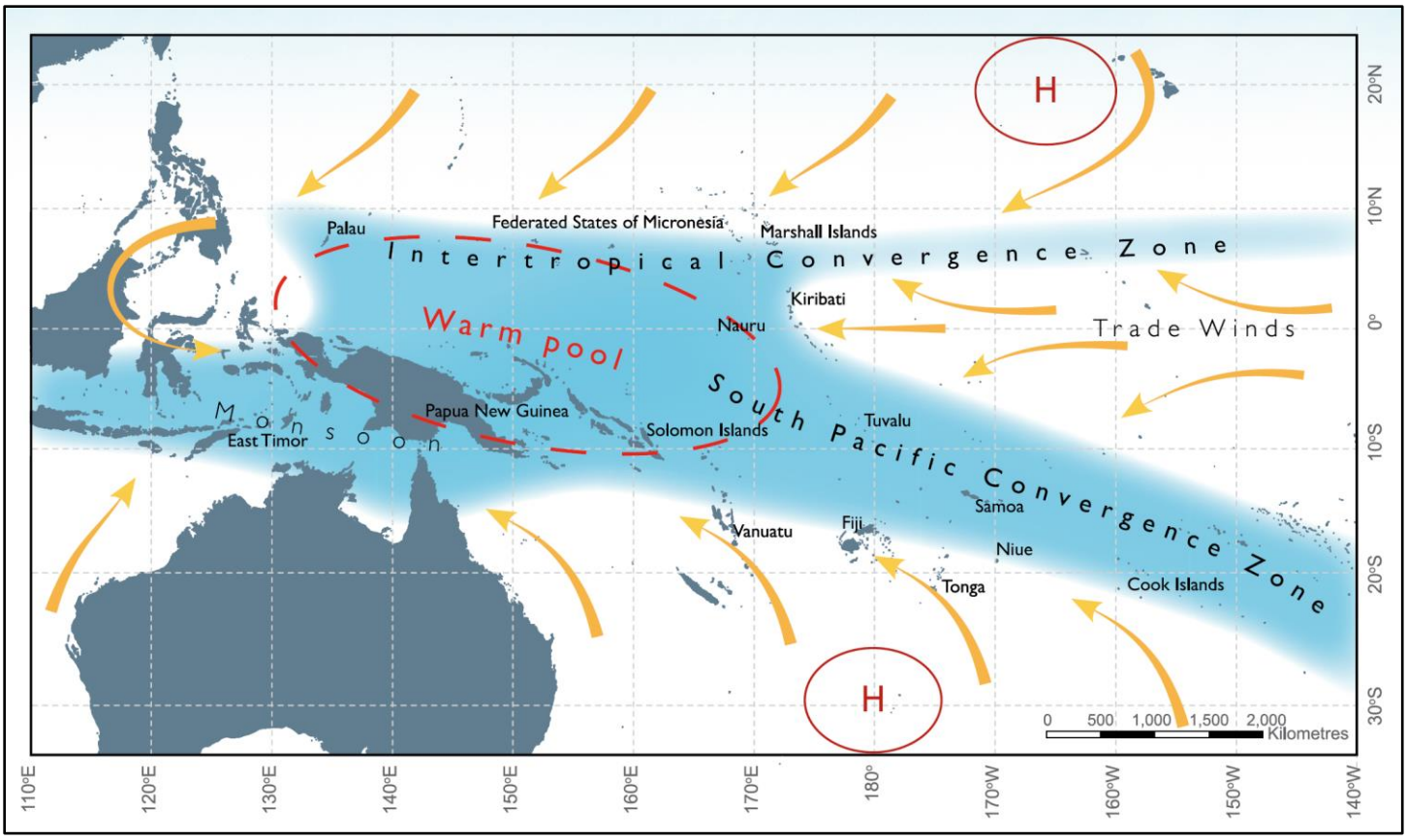

Figure 2. *Average positions of the major climate features in November to April. The arrows show near surface winds, the blue shading represents the bands of rainfall convergence zones, the dashed oval shows the West Pacific Warm Pool and H represents typical positions of moving high pressure systems (taken from Pacific-Australia Climate Change Science and Adaptation Planning Program Partners [2015] Current and Future Climate of Palau).*

Sea Level Rise

There is little debate as to the inevitability of sea level rise due to climate change, though the exact degree to which this will occur in specific locations is still unknown, with predictive models suggesting a range of possibilities. Much of this rise is due to two primary factors: the melting of polar ice (glaciers, sheets) and the expansion of sea water as it warms. These changes to sea level are largely measured by satellites and tidal gauges. As satellite data has shown, since 1993, sea level in Palau has risen by about 0.35 inches (9 mm) every year (or about 9.5 inches total), which is larger than the global average of 0.11–0.14 inches (2.8–3.6 mm) per year (2.97 – 3.78 inches total). While scientists are not entirely certain as to why this is the case, the higher rate of rise in Palau could be related to different natural processes such as El Niño-Southern Oscillation (ENSO) events that occur every 3-7 years. The natural variation in sea level can be seen in Figure 3, which includes the tide gauge record since 1969 and the satellite data since 1993.

Sea Surface Temperature

The stable tropical climate of Palau, the absence of seasonal mixing of oceanic waters, and the thermocline all contribute to a relatively constant sea-surface temperature (SST) that ranges annually between 28.5°C and 31.0°C (Coral Reef Research Foundation n.d.; Jew and Fitzpatrick 2019). The barrier lagoon that surrounds much of the archipelago provides a temperature buffer, maintaining a SST inside the reef consistently warmer than adjacent waters outside (Colin 2000). This natural barrier protects against strong currents and rapid water circulation, effectively insulating the area and creating calmer waters. The lagoon environment contains slight tidal action that can influence SST, but only subtly, by about ±0.5°C (Colin 2000).

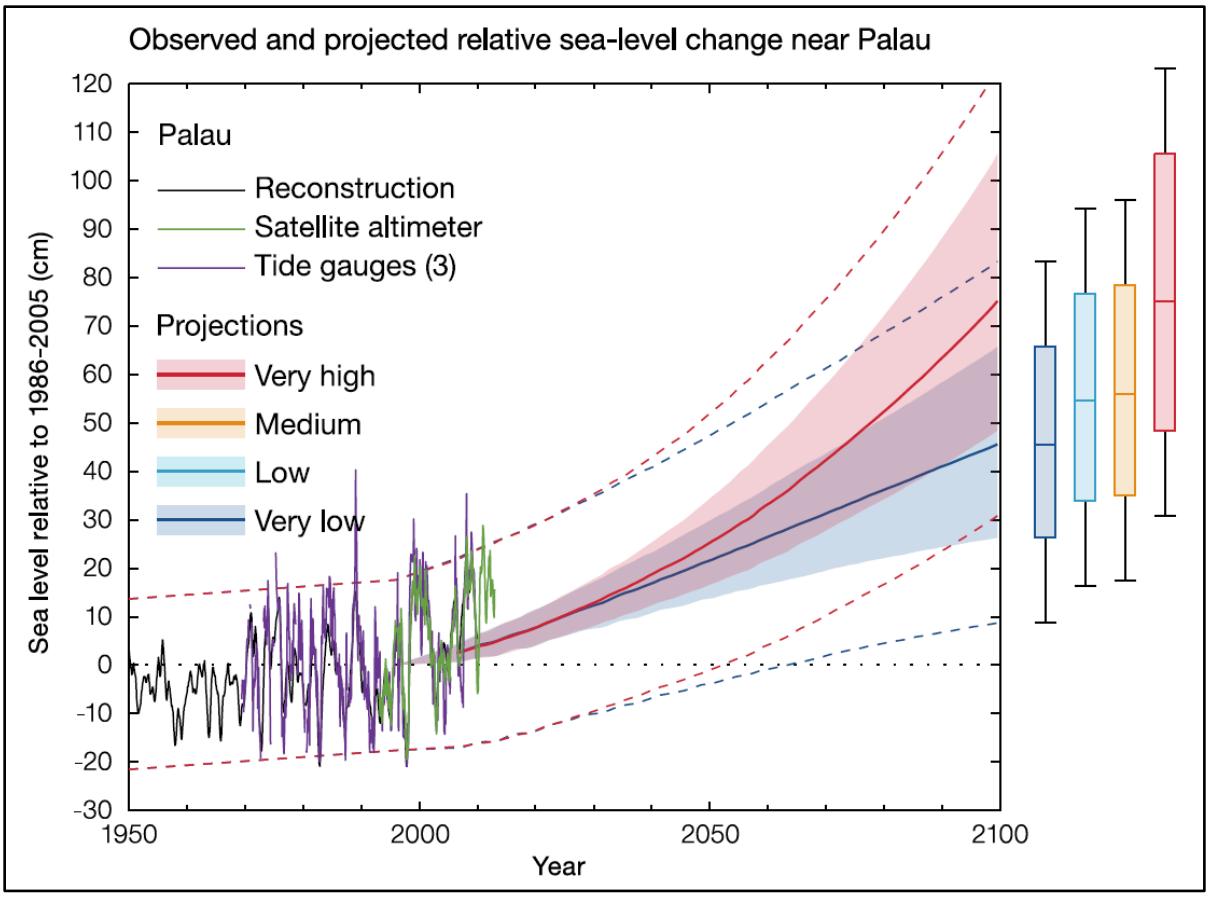

Figure 3. *Tide-gauge records of relative sea level (since 1969) are indicated in purple, and the satellite record (since 1993) in green. The reconstructed sea level data at Palau (since 1950) is shown in black. Multi-model mean projections from 1995–2100 are given for the very high (red solid line) and very low emissions scenarios (blue solid line), with the 5–95% uncertainty range shown by the red and blue shaded regions. The ranges of projections for the four emissions scenarios by 2100 are also shown by the bars on the right. The dashed lines are an estimate of year-to-year variability in sea level (5–95% uncertainty range about the projections) and indicate that individual monthly averages of sea level can be above or below longer-term averages (taken from Pacific-Australia Climate Change Science and Adaptation Planning Program Partners [2015] Current and Future Climate of Palau).*

Ocean Acidification

The world's oceans absorb approximately 25% of the carbon dioxide that are emitted from human activities each year. While oceanic water is an important reservoir for these emissions, the resulting effects cause the extra carbon dioxide to become more acidic. This then leads to hindered growth of corals and other organisms that rely on carbonate for skeleton construction and which are necessary components to the health and diversity of tropical reef ecosystems. Historical data going back to the 18th century indicate that waters surrounding Palau have become slowly, but increasingly acidic (see also Pacific-Australia Climate Change Science and Adaptation Planning Program Partners [2015] Current and Future Climate of Palau).

Typhoons

While the main Palauan archipelago lies south of the typhoon belt, when they do occur it is often between June and November. Between 1969 and 2010, 97 typhoons developed in or crossed into the Palau Exclusive Economic Zone, averaging about 23 typhoons per decade. However, the number of typhoons on an annual basis can vary significantly, with some years having none and others up to seven (see also Pacific-Australia Climate Change Science and Adaptation Planning Program Partners [2015] Current and Future Climate of Palau). Back-to-back typhoons—Bopha in 2012 and Haiyan in 2013—caused extensive damage to coral reef systems, lagoons, culturally significant sites, modern residences, and infrastructure. A more recent one in April 2021—Typhoon Surigae—passed north of Palau and was one of the strongest ever recorded before May in the northern hemisphere, reaching sustained wind speeds of up to 136 km/hour and waves up to 23 meters (75 feet) high that also caused millions of dollars in damage to the archipelago.

Threats to Intangible Cultural Heritage Sites

Research from a wide range of disciplines has shown that climate change is an ongoing process that will affect humans in a variety of ways, but that is now disproportionately affecting island populations. For example, coral reefs play a critical role in protecting Palau—and many other island nations—from storm and wave activity. Increases in sea temperature slows the rate of coral growth, changes the composition of reef structures, and renders them unable to keep pace with sea-level rise (Perry et al. 2012; van Woesik and Cacciapaglia 2018). This is partly responsible for triggering well-publicized, large-scale coral bleaching and die offs. The loss of this important habitat increases the vulnerability of low-lying coastal zones to destructive storm wave activity (Ferrario et al. 2014; Harris et al. 2018). In this process, coral reef growth is unable to keep pace with rising sea levels. In Palau, inner coral reefs along southeast Babeldaob, Oreor (Koror), and Nguruktabl Islands are experiencing the lowest rates of coral reef growth, consequently increasing the vulnerability to sea-level rise and storm activity (van Woesik and Cacciapaglia 2018).

Climate change has also altered weather conditions within the northwestern tropical Pacific, including unpredictable weather conditions such as increased rainfall, droughts, typhoons, sea level rise, and high ocean acidity. These patterns in conjunction are already leading to visible anomalous conditions, ranging from a decline in coral reef health and habitats, unusual and unpredictable rainfall and tidal regimes, and amplified sea level rise that is 3x what is seen on a global average. For Palau, the culmination of these effects is causing irreparable damage to many culturally significant sites, and is projected to continue.

Culture History

Palau's culture history goes back more than three millennia and is generally separated into five major periods: the Expansion Era (ca. 3200-2400 cal BP), the Earthwork Era (ca. 2400-1200 cal BP), the Transitional Era (ca. 1200-700 cal BP), the Stonework era (ca. 700-150 BP), and the historic period that began after sustained contact with Europeans in 1783 (Liston 2009; Lucking 1984; Lucking and Parmentier 1990). The oldest evidence for human activity in Palau comes from occupation and burial sites in the Rock Islands and date to ca. 3300-3000 cal BP (Clark 2005; Fitzpatrick 2003b; Fitzpatrick and Jew 2018; Stone et al. 2017) (see Table 1).

During the Earthwork Era, settlement of Babeldaob's interior increased. Radiocarbon dates for this period come primarily from ridgeline settlements where groups began extensive large-scale landscape modification (Welch 2001). Terrace and other earthwork constructions are extensive on Babeldaob and parts of Koror. It is estimated that 20% of Babeldaob has earthwork formations, including bermed basins, earth platforms, embankments, leveled plains, modified gullies or swales, platform terraces, raised earth paths, ridgelines, transverse and lateral ditches, step-terraces, ring-ditches, and steep-sided and flat-topped hills known as "crowns" (Liston 2009:57).

Liston (2009) divides this period into three groups: Early, Middle, and Late. The Early Earthwork Era (ca. 2300-2150 cal BP) marks the beginning of earthwork construction including stepped terraces, modified ridgelines, and small platforms. These have been interpreted as primarily defensive structures (Liston and Tuggle 2006). The Middle Earthwork Era (ca. 2150-1500 cal BP) is considered the peak of earthwork construction with platform and crown construction (Liston 2009). There is evidence for burials within the crowns and for wood structures that were built on top of the crown, which may have been elite residences (Phear 2007). The Late Earthwork Era (ca. 1500-1200 cal BP) was marked by a decline in growth and expansion of earthworks.

The later Stonework Era is a brief, but active period of expansion in Palauan history. During this period, the northern atoll Kayangel and the reef-islands of Peleliu and Angaur appear to have been occupied for the first time (Clark and Wright 2005). Village sites across the Palau islands were built with elaborate stone pathways, platforms, bathing pools, communal houses, docks, and shrines. On the volcanic islands, basalt and andesite were primarily used in construction, whereas on the Rock Islands, Kayangel, Peleliu, and Angaur, coral slabs were used instead.

Liston and Tuggle (2006) interpreted the terraces and stonework villages as features of fortified polities which "had a practical defensive component, but were also symbolic statements of power and prestige." The larger earthwork complexes, which are typically comprised of multiple structures of modified terrain "extending from the coastal hills up to the central ridgeline….[and] found from one end of Babeldaob to the other…[with] the largest ten clusters roughly

[corresponding] to a modern political state" (Liston 2009:57), were clearly a monumental effort that likely had profound influence on the structuring of Palauan politics and economy over centuries.

Historically, Palau has experienced complex and torrid periods of colonialism that first began with a comparatively late contact with Europeans when the British packet the *Antelope* wrecked on the reef surrounding Ulong Island in 1783. Later, the Spanish took control of Palau for almost 15 years between 1885 until 1899. Palau then came under the purview of Germany until 1914 after the Japanese seized control of German possessions in Micronesia after the outbreak of WWI. On October 18 of that same year, Japanese warships entered Malakal harbor, which began four years of military control over the islands before a civilian administration was established in 1918. Palau then became the capital of the Japanese South Seas Government (Nanyo Cho) and later became a hub of imperialism in their attempt to take over vast swathes of the Pacific.

Toward the end of WWII, American forces began the invasion of Palau as part of Operation Forager that also included liberation of the Mariana Islands. From March 30-31, 1944, American planes from carriers attacked numerous Japanese fortifications across the archipelago, including Babeldaob, destroying nearly all of their airborne and grounded aircraft, and sank more than two dozen ships, including two destroyers. The attacks continued several months later on July 25-28, 1944 when U.S. planes sank a destroyer and six aircraft (see Bailey 1991; Ehrlich 1984). Major strikes then took place at the end of August and early September just prior to the American landing on Peleliu, which lasted for two months and became known as one of the bloodiest battles in the Pacific theater (see Sledge 2007). After the Japanese were defeated in 1945, the U.S. Naval Administration then took over the region, which became known as the Trust Territory of the Pacific until Palau formally claimed independence in 1994.

Table 1. *Cultural periods of Palau from first colonization to the modern day.*

Date cal BP or AD	Cultural Stages
ca. 3300(?)-2800	**Colonization/Early Settlement:** Evidence from Ulong Island and Chelechol er a Orrak site shows occupation and use of some Rock Islands for burial sites
ca. 3100-2400	**Expansion Era:** Coastal settlement, inland use for horticulture; population growth; burials on some Rock Islands
ca. 2400-1200	**Earthwork Era:** Growth and decline of large earthworks in volcanic island interiors; chiefly power and territorial districts; intensive interior settlement; dryland cultivation; later coastal and Rock Island settlement
ca. 1500-1200	**Late Earthwork Era:** Movement out of interior larger volcanic islands to coasts and Rock Islands; decline of districts and of earthwork construction and use; inland cultivation continues; emergence of ring-ditch palisades suggests conflict and defense
ca. 1200-700	**Transitional Era:** Little evidence for cultural activity, coastal and Rock Island occupation, limited use of interior, potential overharvesting of inshore resources
ca. 700-150	**Stonework Village Era:** Compact complexes of coastal villages behind defensive barrier of mangrove forests and terraces; monumental stone architecture and paving, welfare; extensive wet and dryland agriculture; taro pondfield cultivation; interaction with Yap as part of stone money quarrying
AD 1783	**European Contact:** Captain Wilson and the British packet the *Antelope* wrecks off of Ulong Island, Koror
AD 1885-1899	**Spanish colonial rule**
AD 1899-1914	**German administration**
AD 1914-1945	**Japanese administration**
AD 1945-1994	**U.S. Naval administration**
AD 1994-pr.	**Republic of Palau established as an independent nation**

Project Goals and Objectives

The primary objectives of this project were to:

1. Assess and evaluate the level of impact of climate change on coastal heritage sites of Kayangel, Babeldaob, selected Rock Islands and Hatohobei.
2. Provide disaster risk reduction and mitigation to the most vulnerable sites.
3. Site rehabilitation and intervention, if necessary.
4. Acquire the skills and ability to manage cultural and historic sites and related properties.
5. Acquire skills of basic mapping, GPS, site analysis, and related attributes to complete site assessment.
6. Identify management priorities using survey data collected and processing to help make decisions regarding existing national and state plans and preservation of historic properties.
7. Update the existing Palau National Register file(s) for significant cultural sites threatened by climate change.

The results of this project will include:

1. Production of a *Disaster Risk Reduction and Climate Change Impact Survey of Cultural Sites of Republic of Palau: Reconnaissance Survey Phase I* report.
2. Local state government staff trained in mapping techniques and photographic recording and the appropriate equipment to conduct surveys of archaeological properties.
3. An understanding and application for how site recording can assist management decisions for historic cave properties.
4. Anticipates 10 properties recorded and assessed across different geographical and geological zones.
5. A list of management priorities to assist with future management of historic properties.
6. An update to the existing National Register file for sites or properties that demonstrate the history of use and significance of sites.
7. Information derived can be used by Palau government in their existing policies i.e. Protected Areas Network, and policies under development (i.e., Palau National Climate Change Policy).
8. Production of *Preserving Palau's Future*, comic book that will be printed and distributed to Palauan community members and made available online as a free download.

Methods

The survey methods included pedestrian survey, visual documentation, photography, mapping, and recordation of the cultural landscape. The survey started in the North of Palau beginning in Kayangel State and ending in the Southwest in Hatohobei State which follows the traditional methodology on how to conduct work in Palau. The field method was guided by the Cultural Landscape Vulnerability Assessment Form, which captures the historical and cultural significance of the site, landscape characteristics, climate variables, threats, and actions to address or mitigate the threats. The details recorded for each site using this form can be seen in Appendix 1.

Site Assessments

The site assessment was conducted at ten (10) different locations in eight (8) states of the Republic of Palau. These states included: Airai, Hatohobei, Kayangel, Koror, Melekeok, Ngarchelong, Ngaraard, and Ngeremlengui. Of the 10 sites assessed, two were selected for intervention to mitigate the impact of climate change that threaten the integrity of the site. These two intervention sites are: Beluu er a Ngerutechei (B:NM-3:6) in Ngeremlengui State and Iporu (B:TO-1:1), a children's burial ground in Hatohobei State.

Airai State

Site Name: Chelechol er a Orrak
Site Type: Yapese Quarry/ Burial Cave
Site Location: Southeastern coast of Airai State
Registered: May 15, 2003
Site No.: B:IR-1:23

Figure 4. *(Left) Area of Chelechol er a Orrak where archaeological excavations have taken place (photo by Matthew F. Napolitano). (Right) Beach leading up to Chelechol er a Orrak. From this photo, you can see that sea level is just slightly below the current surface and would be level with subsurface deposits (photo by Jessica Stone).*

Site Description

Chelechol er a Orrak (B:IR-1:23), listed in the Palau Register of Historic Places, is a burial cave and a Yapese quarry site located on Orrak Island off the southeastern coast of Babeldaob in Airai State. The site includes numerous limestone caves and a rock-shelter on the western side of the island. A beach runs parallel to the site with fringing mangroves along the northern and southern areas of the beach and areas of secondary vegetation are scattered throughout the area (*Figure 4*). The majority of site use is most evident in limestone cave and rock-shelter features, including unfinished stone money disks, ceramic sherds, and human bone fragments found within cave features located behind the beach. Feature 6 contains a possible stone platform at the front of the cave. Evidence for limestone quarrying activity including unfinished stone money disks, intact stalagmites with visible tool marks and shaping that would have allowed for later disk construction and removal (*Figure 5*). The rock-shelter faces west providing a view of the lagoon (*Figures 6* and *7*).

The site was initially investigated for its use as a Yapese stone money quarry by Blaiyok (1993). Since 2000, the largest central rock-shelter has been the primary focus of archaeological excavation, beginning with Fitzpatrick's (2003a) dissertation, which focused on the construction and exchange of stone money. As research has continued, a total of 15 m^2 have been excavated; however, the base of the site has not yet been reached and excavations are planned to continue. There are multiple components to the site demonstrating human use that spans at least the last 3000 years (Fitzpatrick 2002, 2003a, 2003b, Fitzpatrick and Jew 2018). The upper layers of the site reflect episodic habitation from ca. 1700 BP. The rich artifactual record includes stone and shell adzes, pottery, bone needles, glass beads, and shell ornaments. Pearl shell (*Pinctada margaritifera*) scrapers have been recovered in association with human remains as a likely grave good.

Burial deposits are primarily found below ~1m depth, and continue through the deepest known portions of the site (Nelson and Fitzpatrick 2006). To date, the remains of more than 55 individuals have been excavated from the site that represent males and females ranging in age from fetal to older adult, and research involving these remains has begun to shed light on the early diet, behavior, and origins of these people (Stone et al. 2019, Stone 2020, Stone et al. 2020).

Radiocarbon dates indicate that the mortuary component of the sites dates to at least 3000 BP and continued until ~1700 BP, making this portion of the site contemporary with the earliest archaeological sites in Palau, and the individuals interred here likely representatives of the first 10-12 generations of occupation (Fitzpatrick and Jew 2018).

Aspects of the original and natural landscape have been maintained, but over the course of site use, quarrying of limestone for stone money would have modified the flowstone deposits. During World War II, people from Airai used Orrak as a refuge, and about 10 years ago, a modern dock was built on the beach to the west of the site, and modern structures (*Figure 6*), including a summer house and benches, are located along the beach. The site is also listed on Palau's Register of Historic Places.

Figure 5. *Unfinished stone money (photo by Jessica Stone).*

Figure 6. *Aerial photo of Chelechol ra Orrak. Notice recently constructed dock extending from access beach and boat to left for scale (photo by Scott M. Fitzpatrick).*

Assessment and Projections

Overall, the site has good integrity with intact unfinished stone money and archaeological subsurface deposits, with the exception of those that have been excavated as a part of ongoing research. There are moderate impacts to the condition and integrity of the site due to sea level rise and construction of the modern dock ~10 years ago. The dock runs perpendicular to the existing beach and has increased sediment load and affected wave action, resulting in impacts to the beach and surrounding shallow marine habitats, including the adjacent seagrass beds *(Figure 6*). At high tide, archaeological deposits at the deepest areas of the site are already inundated, which will continue to be affected. The effects of sea level rise on the deepest archaeological deposits are particularly alarming, and during archaeological excavations in 2015, burials in the lowest portions of the site were already underwater during the highest high tides, which compromised preservation of bone and proper recovery.

Recommendations

Based on observations of current impacts affecting Chelechol er a Orrak, it is recommended that the modern dock be removed, which would restore natural wave action and beach formation processes. Currently, the dock creates a sediment sink that negatively impacts offshore seagrass beds that aid in coastline stabilization and reduce storm surge and tidal impacts. Restoration, maintenance, and protection of these ecosystems will lend further protection to the onshore cultural resources.

As sea levels and high tides become higher, archaeological deposits will become inundated. The deepest deposits, which contain human remains, are currently the most at risk for damage. During the 2015 archaeological excavations, the deepest burials in portions of the site where excavations have taken place were already underwater during the highest high tides, which compromised preservation of bone and proper recovery. If *in situ* human remains are to be preserved, they will need to be removed and relocated. However, if the burials are to remain in place, documentation and mapping of those that are still at the site is recommended, along with osteological analysis if requested by the stakeholders.

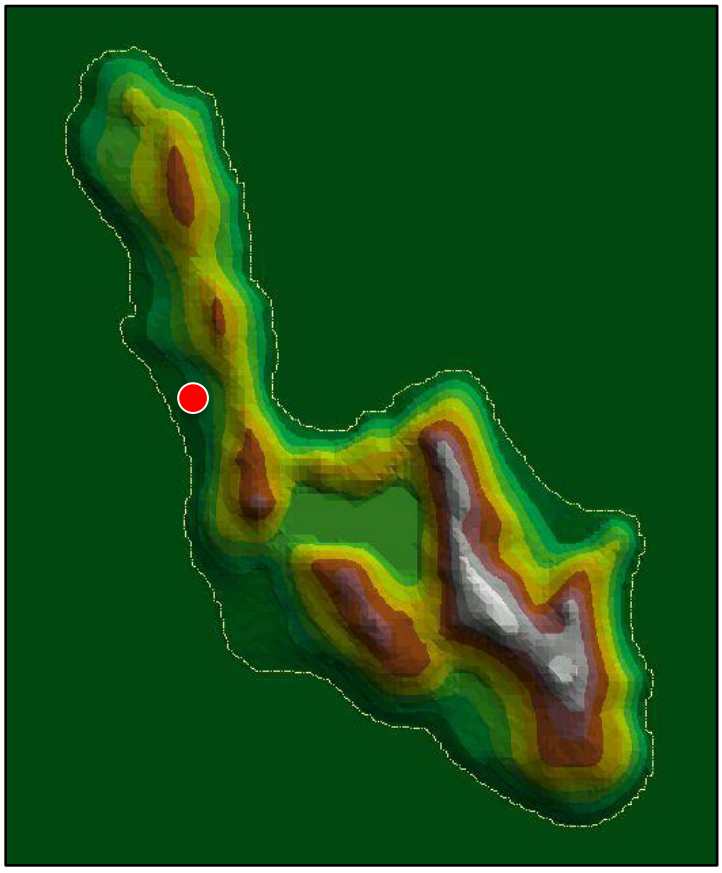

Figure 7. *Digital elevation model of Orrak Island showing the location of Chelechol er a Orrak.*

Site Name: Btelulachang er a Kemurrull me a Taoch er a Ngiteuai
Site Type: Stone Path/ Platform
Site Location: Ngerusar Traditional Village
Registered: May 31, 2007
Site No.: B:IR-2:1

Figure 8. *Images of Feature 12 and the surrounding mangrove channel (photos by Jessica Stone).*

Site Description

Btelulachang er a Kemurrull me a Taoch er a Ngiteuai (B:IR-2:1), listed in the Palau Register of Historic Places, comprises the southernmost portion of the Ngerusar traditional village site located on the southern coast of Airai state. The site contains multiple features, including a stone pathway (Feature 11), stone platforms (Feature 12), dock, and modified mangrove channels that are located at the base of a hill and are surrounded by mangroves and secondary vegetation. Feature 11 is a stone pathway (*Btelulachang er a Kermurrull)* that leads down the hill to the other features and is designed to mimic the shape of a stingray tail. Two stone platforms (Feature 12, *Taoch er a Ngiteaui*) served as foundations for two structures: a *diangel* (boathouse) and a *bai* that currently are at or slightly above (~1-2 meters) sea level. Mangroves surrounding the area were cut to create clear channels and waterways that loop around the dock and platform features and would have allowed both the *bai* and *diangel* to be visible from the channel (*Figure 8*). The *bai* platform extends from east to west and reaches the channel's edge on both sides to create a narrow loop that surrounds the *bai*. The *bai* was home to the *Ngaraklasekl* men's club of Ngerusar and positioned so that canoes would first pass the *bai* on the western side and encounter the eastern side shortly thereafter, allowing local people to collect *okesodel* (small gift offerings) twice from any outsiders passing through the area when entering *Ngerusar* and exiting *Ngeruluobel*.

Assessment and Projections

The site was recently restored and listed on the Palau Register of Historic Places on May 31, 2007, along with features 11 (stone pathway) (*Figure 9*) and 12 (stone platforms). It is still actively maintained; additions have been made to extend the existing dock feature for continued use of the site, and the dock has also been built up with sediment and rock.

Figure 9. *Btelulachang er a Kermurrull (Feature 11), the stone pathway looking uphill (Photo by Matthew F. Napolitano).*

Overall, the site has good integrity. The dock, platforms, and pathway were recently restored and have been well-maintained. Some modern changes have been made; for example, the modern road cuts off the stone pathway at the top of the hill away from other village features, and the dock has been built higher for continued use. There is a high potential for future impacts to this site due to sea level rise and destabilization from drainage located uphill from the site. Currently, the presence of the modern road that cuts through the stone pathway combined with the downhill slope are resulting in water drainage that deposits water directly on to the platforms. The lack of a deeper drainage system also results in erosion of the soil on either side of the path and keeps moisture on the path itself, decreasing stabilization. Higher tides already inundate the lowest portions of the platforms and dock and with higher sea levels, will impact a broader area of the site (*Figure 9*). This is further compounded by the abovementioned drainage issues.

Recommendations

Based on the high potential for future impacts to the site, it is recommended that measures be taken to offset stress to the site by improving resilience and resistance to exposure, and to manage the already changing exposure. This can be achieved by improving the drainage system that moves water from the modern road towards the site. Deeper culverts or pipes that redirect water away from the stone path and platforms would allow for continued drainage from the modern road and improved stabilization of the site.

Hatohobei State

Site Name: Iporu
Site Type: Landmark (Still-born babies burial site)
Site Location: Tobi Island
Registered: Dec. 19, 1996
Site No.: B:TO-1:1

Figure 10. *Reconstructed menstruation house on Tobi Island (Photo by Matthew F. Napolitano).*

Site Description

Tobi Island (Hatohobei State) is an atoll that is part of Palau's Southwest Islands. There are currently about 30 people that live on the island, although the population was once as high as 1,000 (Eilers 1936). There are no rivers or streams on the island, but the Ghyben-Herzberg lens provides a source of freshwater to island residents. The island was modified during the German administration when the site was mined for phosphate. Five sites from the island are on the Palau Register of Historic Places, including the phosphate mine loading dock, which does not appear to be maintained.

Iporu (B:TO-1:1), listed in the Palau Register of Historic Places, is a mounded area that was a habitation area during the initial permanent settlement of Tobi Island that was later the location of the childbirth house (*matari feri gasafa*),

menstruation house (*materi maripar*), and children's cemetery (Eilers 1936; Hunter-Anderson 2000). The site is located just north from the main dock facing the Philippine Sea and adjected to the main path that runs the length of the island and where Remohoparu, the first inhabitant of the island, lived. The traditional place names for Iporu are *Mower* ("toward the beach") and *Repeiy* (Hunter-Anderson 2000). The site was the former location of the island dispensary, which has been relocated across the road and away from the eroding edge. According to oral history, this was the highest part of the island and had the only large tree. There is a rebuilt menstruation house currently on top of the remaining part of the mound (*Figure 10*). A chiefly area called *Ferhuheh* was located several meters to the north of Iporu although access to this area was later obscured by phosphate mining activities (Hunter-Anderson 2000).

In addition to being an occupational area to the early inhabitants of Tobi Island, Iporu is a significant cultural heritage site because it contains two burial areas, one for still-born infants and the other for very young children who were not old enough to be buried as adults (Hunter-Anderson 2000). Shell fishhooks and lures were buried with boys and shell necklaces and bracelets were interred with girls, while turtle shell arm bands, wooden bowls, and necklaces have also been reported to have been seen in the burial ground (Eilers 1936; Hunter-Anderson 2000: figure 5). During an archaeological survey in the 1990s, bracelets, lures, and fishhooks were observed eroding from the burial ground with skeletal remains of children and infants (Hunter-Anderson 2000). Historically, when objects and human remains were recovered, they were stored in the chief's house, just south of *Ferhuheh*; however, this part of the island has since eroded (Hunter-Anderson 2000).

The exposed profile was mapped in the 1990s and a single radiocarbon determination was produced from a *bonum* (earth oven); however, the sample was taken from bulk soil and should not be considered reliable. Periodic collections of eroded human remains and burial items have occurred when encountered.

Assessment and Projections

Iporu is a significant cultural heritage site for the people of Tobi and Palau. It provides information critical to understanding the early permanent settlement of Tobi and is extremely sensitive given its use as a burial ground. The site is well known by the community and still recognized as an important place and significant part of one cultural landscape.

Erosion of the site has clearly been taking place at the site for decades. In addition to local sea-level rise, king tides, and catastrophic storm activity, Japanese phosphate mining activity in the early 20th century amplified the erosion. These activities also involved blasting through the coral reef that acted as a buffer to erosion and storm activity in order to build a shipping channel, resulting in strong lateral currents that have eroded the shoreline where Iporu is located (Hunter-Anderson 2000; see van Woesik and Cacciapaglia 2018).

This site is a mound with multiple layers of deposition (*Figure 11*). There are no individual features at Iporu as the site is considered one intact cluster. The remaining portion of the site appears to be stratigraphically intact, but significant portions of the site have been lost (*Figure 12*). An estimated 34 ft (10.3 m), or approximately 75% of the site, has eroded and human remains were observed falling out of the exposed profile. Large trees can also be seen falling off of the bank's edge and root systems continue to pull down large chunks of the site. The landscape has been and is currently maintained by the local community, and there is a reconstructed menstruation house at the site that is in good condition. When encountered, human remains are collected after they erode from the bank. The exposed profile was mapped on March 9, 2020 to facilitate future monitoring and adverse effects (*Figure 13*).

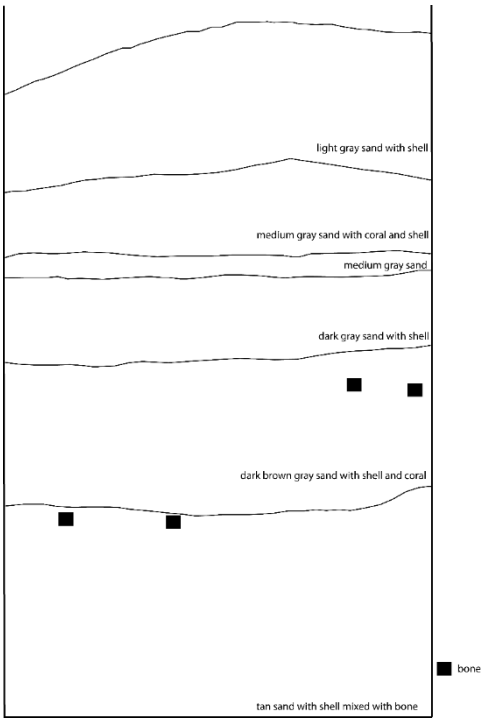

Figure 11. *Iporu stratigraphic profile.*

Figure 12. *Coastal profile at Iporu.*

During a site visit in March 2020, we met with residents who showed us recently eroded bone and associated burial items. The objects appear to be consistent with what was reported by Hunter-Anderson (2000). Shell beads, bracelets or arm bands, and fishing lures were recently recovered with bone (*Figures 14* and *15*). A large coral pestle was also recovered.

Figure 13. *BCHP staff measures how much of the Iporu site has been lost to erosion (Photo by Matthew F. Napolitano).*

Figure 14. *Shells beads and bracelets or arm bands.*

Figure 15. *Shell fishing lures from Tobi (Photos by Matthew F. Napolitano).*

Recommendations

Tobi is one of the two intervention sites in the survey given its high level of vulnerability. For this intervention, the house made for housing eroded remains—originally located south of *Ferhuheh*—will be reconstructed. Based on our field assessments, we recommend the following additional actions to manage the changing exposure of the site and improve the resilience/resistance to the exposure:

- Consultation with stakeholders so that they can guide the mitigation process.
- Regular survey and collection of eroded human remains and burial objects (e.g., beads, pendants).
- Regular documentation of the exposed profile, especially after tropical storms or if trees fall from the edge.
- If requested by the residents of Tobi, osteological or other types of analysis could be conducted on the human remains.
- Controlled excavation of the site to recover any remains in a systematic way, which will help keep individuals articulated and other associated archaeological materials recorded *in situ*.

It should be noted that threats from erosion extend beyond Iporu as all cultural sites on Tobi are at low elevation (3-4 m and below) and at risk for inundation.

Kayangel State

Site Name: Beluu er a Ngerdimes and Beluu er a Ngerdilong
Site Type: Traditonal Village
Registered: *Multiple features*
Site No.: B:NH-1:1 and B:NH-1:2

Site Descriptions

The sites of Beluu er a Ngerdimes (B:NH-1:1) and Beluu er a Ngerdilong (B:NH-1:2) are the main components of a traditional village system located in the southern half of Kayangel island. Apart from the main island of Kayangel, there are four other islets (Ngerbelas, Iungs, Orak, and Ngeruangel), which are inhabited, but are culturally significant based on oral traditions that discuss the creation of the island.

The first site of Beluu er a Ngerdimes (B:NH-1:1) comprises numerous features, ranging from coral stone platforms, a bathing pool, stone alignments, pathways, and scattered rocks stretching for more than 350 m north-south and around 300 m east-west. Several of these features are unique, including: Feature 1, which is a platform containing burials; Feature 4, a large stone platform for a *bai* structure that is now the foundation for a two-story, the Kayangel State office; and Feature 7, a large bathing pool called *Olekang*. There is also a sacred *cheremall* tree (*Hibiscus tillaceus*) (Feature 20) that no one is allowed to visit and a burial area (Feature 21). New modern houses and relief shelters from Taiwan have recently been built. The relief shelters do not provide much long-term protection. Some modern buildings have been constructed on top of traditional platforms (state office, *bai*). There is a reservoir for the aquifer, bathing areas (e.g., *Diong er a Dokou* and *Diong er a Orukei*), and areas to collect drinking water.

The Beluu er a Ngerdilong (B:NH-1:2) traditional village site has an extensive array of 36 recorded features, including stone platforms, bathing pools, rock piles, pathways, monoliths, artifacts (e.g., pottery, shell tools), and human remains. The southern part of the main village complex alone stretches for about 500 m north-south and 350 m+ east-west. The largest of these is Feature 6 (*Meduu el Bai*) that measures 23.9 × 36 m where an altar, burial, and *bai* slots are still intact. Other important associated features include a dock (Feature 8) and public cemetery (Feature 10). There is a sacred path called *Chadesechelid* (path of the spirits). Feature 30 is known as *blebaol* and there is another sacred place where a spirit walked, but this feature number has also been assigned to Bai ra Ngerbesang, a chiefs meeting house for the Ngerilong chiefs.

There is also a basalt monolith known as *Kabekel* (canoe) (Feature 14). Feature 15 is a group of basalt stones that may include *Mlai* (canoe), *Desomel* (outrigger), and *Osebek* (canoe decorations). There is also a group of boulders that may refit and was once a monolith. Another small prehistoric monolith that is now broken into two pieces, was brought from *Odesongel ra Kelau*, clan burial platform, and now rests on an elevated platform that was built in the early 1970s (Feature 26). Feature 29 is an elongated coral rock known as *Dechus*, which means wart or mole. Children are not permitted to play in this area or else according to legend they will be covered in warts or moles.

Assessment and Projections

The overall condition and integrity of Beluu er a Ngerdimes (B:NH-1:1) and Beluu er a Ngerdilong (B:NH-1:2) is moderate to good, largely because they are maintained by local residents on a semi-regular basis, though it would be beneficial to clear more frequently. Today, both traditional villages have modern, contemporary dwellings, many of which are constructed using concrete and built on some of the limestone platforms.

There are four (4) bathing pools (*Figures 16* and *17*) within the village are listed on the Palau Register of Historic Places and were recently restored through funding assistance from the U.S. National Park Service. As can be seen, many areas and features associated with these sites are also still being used (public cemetery, some platforms) (*Figure 18*). Over the years, vehicles driving on pathways has led to parts being damaged and some features have been altered or impacted from the purposeful or accidental removal of stones for reuse or from storm activity such as Typhoon Mike in 1990. Because these sites (and the island itself) are situated only a few meters above sea level at their highest point, inundation from sea water is an increasing concern, not only for structures, but for taro patches that are sensitive to salinity. For example, giant taro fields on Kayangel are still visible, but no longer used at present, probably due to saltwater inundation after Super Typhoon Bopha in 2012 (*Figure 19*). While the presence of the Ghyben-Herzberg (freshwater) lens has been a critical resource for peoples living on atolls around the world, rising sea levels will not only increase the salinity of this freshwater source but also prevent proper drainage of rainwater that can lead to more frequent periods of standing water, flooding, and other issues.

In addition, the island is covered mostly by secondary ground vegetation of mainly coconut palm trees (*lius*), Alexandrian laurel tree (*btaches*), seeded breadfruit (*chebiei*), tree with brittle leaves; grand devil's claw (*mesbesibech*), unknown English name (*doko*), pine tree (*ngas*), tree heliotrope (*rirs*), pandanus (*such*), and others. The island also has a number of invasive species that were spread widely during Bopha, primarily the aptly named "mile-a-minute-weed/vine" (*kebeaschol*).

Overall, however, the integrity of the island's landscape and the two traditional villages is good. Most of the features are maintained and still used with some features that are now abandoned or reconstructed with missing limestone slabs that have been or are currently used as foundations for modern water catchment tanks.

Figure 16. *Bathing area at B: NH-1:1 (Feature 7) (Photo by Scott M. Fitzpatrick).*

Figure 17. *Bathing area (Photo by Scott M. Fitzpatrick).*

Figure 18. *Stone house platform and intersecting pathways at B:NH-1:1 (Photo by Scott M. Fitzpatrick).*

Figure 19. *Standing water near a modern residential structure (Photo by Scott M. Fitzpatrick).*

Recommendations

Because Kayangel is a low-lying atoll, key natural threats include king tides, tidal surges, and storm/typhoon surges. As a result of Super Typhoon Bopha in 2012 and Typhoon Haiyan in 2013 striking Palau back-to-back, there was a massive accumulation of coral reef, beach rock, and other debris that transformed the coastline, inundation of the interior with saltwater that affected gardens and homes, and destruction of various features, both prehistoric and modern. Most recently, in April 2021, Kayangel was flooded because of Super Typhoon Surigae. It is recommended that the area around the bathing pools be cleared of vegetation and other debris to help clear the water. Clearing vegetation along the pathways and around features would also help to identify areas that have been disturbed due to natural and/or cultural processes as would limiting how pathways are used. Importantly, plans also need to be put in place if or when freshwater catchment systems are depleted. Given that there are several locations (platforms, cemetery) where human remains have been interred, the shallow depth of the island's soils are likely to negatively impact these features. Overall, while many of the cultural features on Kayangel are relatively intact, in some cases this is due to modern structures being built on top of them. It is recommended that there be a concerted effort to map and excavate sites on the island to help mitigate future climate related impacts.

Koror State

Site Name: Omedokel
Site Type: Ancient Burial Cave
Registered: *Eligible*
Site No.: B:OR-15:18

Site Description

Omedokel (B:OR-15:18), eligible for inclusion in the Palau Register of Historic Places, is a burial cave within the UNESCO Rock Islands Southern Lagoon World Heritage Site. The site is a natural limestone cave structure that has two entrances at the northern and southern ends. (*Figures 20* and *21*). The site is locally known as *Iil ra Rechiklau* and refers to an oral tradition about an important *rubak* (elder) named Rechiklau who buried a child in the cave (Osborne 1966). Today, the cave is inhabited by populations of bats and possibly birds, and the site is periodically visited by guided tourist groups. Flowstone and rockfall are present throughout the cave. Portions of the northeastern area of the cave are lower in elevation and are approximately at sea level. The remainder of the cave is slightly higher, at an elevation of ~0-2m above sea level.

The majority of the cultural material at *Omedokel* comprises human remains with some additional traditional ceramic sherds scattered throughout. Human remains can be found scattered across the cave floor, but many appear to be clustered along the cave walls. Some of these clusters are marked by modern pin flags (likely placed by tour guides) and may have been intentionally placed in these areas by tour guides to avoid trampling by visitors. During his survey of the Rock Islands, Osborne (1966) noted that bones were present to a depth of about 40 cm (16 inches) below surface. Previous researchers also collected a sample of the human remains in 2006 and 2007 that are currently housed at the Belau National Museum. Results of that research included radiocarbon dating, which indicated that the remains at *Omedokel* date to 2300-940 cal BP and are representative of some of the earliest Palauan people (Berger et al. 2008). During this period, there is a tradition of mortuary practice involving placement of remains in Rock Island caves and rockshelters, and Omedokel is one such example of this practice (Fitzpatrick and Nelson 2008).

Assessment and Projections

Human remains are fragmented and appear scattered, but have likely been moved due to a combination of modern tourist activity and possible wave action or storm surges washing water into the cave. Currently, there is a moderate impact to the condition, integrity, and cultural value of the site, as portions of the cave floor already show a shallow level of seawater seeping up through the cave floor, and in portions of the site, remains can already be seen underwater (*Figure 22*). This

impact will likely become more severe in the future, as storm surges and rising sea levels will continue to flood the cave floor, disrupting and further damaging human remains.

Figure 20. *Cave entrance to Omedokel, accessible only by boat from an entrance on the northern side or a small opening on the opposite side (Photo by Matthew F. Napolitano).*

Figure 21. *The cave entrance to Omedokel (Photo by Matthew F. Napolitano).*

Figure 22. *The interior of Omedokel showing tidal inundation of cultural remains (Photo by Matthew F. Napolitano).*

Recommendations

If the intention is to ensure long-term preservation of the remains that are currently in place, removal and relocation will likely be necessary. However, if the burials are to remain *in situ*, it is recommended to manage the changing exposure with documentation and mapping of those that are still at the site. If requested by the stakeholders, osteological analysis could be conducted. Documentation and mapping of the cave is also recommended, as it may not be easily accessible once the cave floor is submerged. Two possible approaches are to use photogrammetry to create a three-dimensional model of the cave for a permanent record of the cave by building a digital model using overlapping high-resolution photographs or a 3D total station.

Site Name: Bul

Site Type: Japanese Swimming Pool
Registered: *Eligible*
Site No.: B:OR-5:9

Site Description

The Japanese Swimming Pool (*Bul*), eligible for inclusion in the Palau Register of Historic Places, is located on the T-Dock facility at Arkamais in Meketii village, Koror State (*Figure 23*). Previous site designations are OR-5-J2 by Ehrlich (1984:94) and B:O-5:9 (Snyder 1985). The modern dock was built into the water at Koror Harbor during the Japanese Administration and used throughout World War II. It was later expanded during the American Administration after the war. The site includes the entire T-Dock facility and extends from the shore for hundreds of meters. The facility includes a seaplane ramp (Feature 2), the western wharf (Feature 3), the eastern wharf with the swimming pool (Feature 4), and the concrete piers in the water on the west side of causeway south of T-Dock (Feature 5) (Ehrlich 1984; Snyder 1985). The pool was built at the end of the facility and faces northwest (*Figure 23*). As most of the facility is concrete, there is minimal secondary vegetation at the site, except for some trees.

Assessment and Projections

The Japanese swimming pool is still intact, but some of T-Dock has recently been raised because of rising sea level at the dock (*Figure 24*). The road that connects all the site features is still intact; however, at high tide and during king tides, the water spills onto the road (*Figures 25* and *26*). To ameliorate the problem, the site was recently raised 3 feet, though this has had only a temporary positive effect, and will need to be addressed again in the near future.

The features at the T-dock facility are all part of a single cluster. There is a good integrity of the site overall; however, there are moderate impacts to the site because the water is at ground level at high tide and during king tides. Features 2-4 are water features, but Feature 4 (the pool) is not built into the water. When rising sea level eventually inundates the concrete, the entire cluster will be compromised because the connecting walkway will be lost. The site is maintained and cleaned regularly. With the exception of a new boathouse built at the end of the facility, the site looks roughly the same as it was when mapped by Erlich (1984).

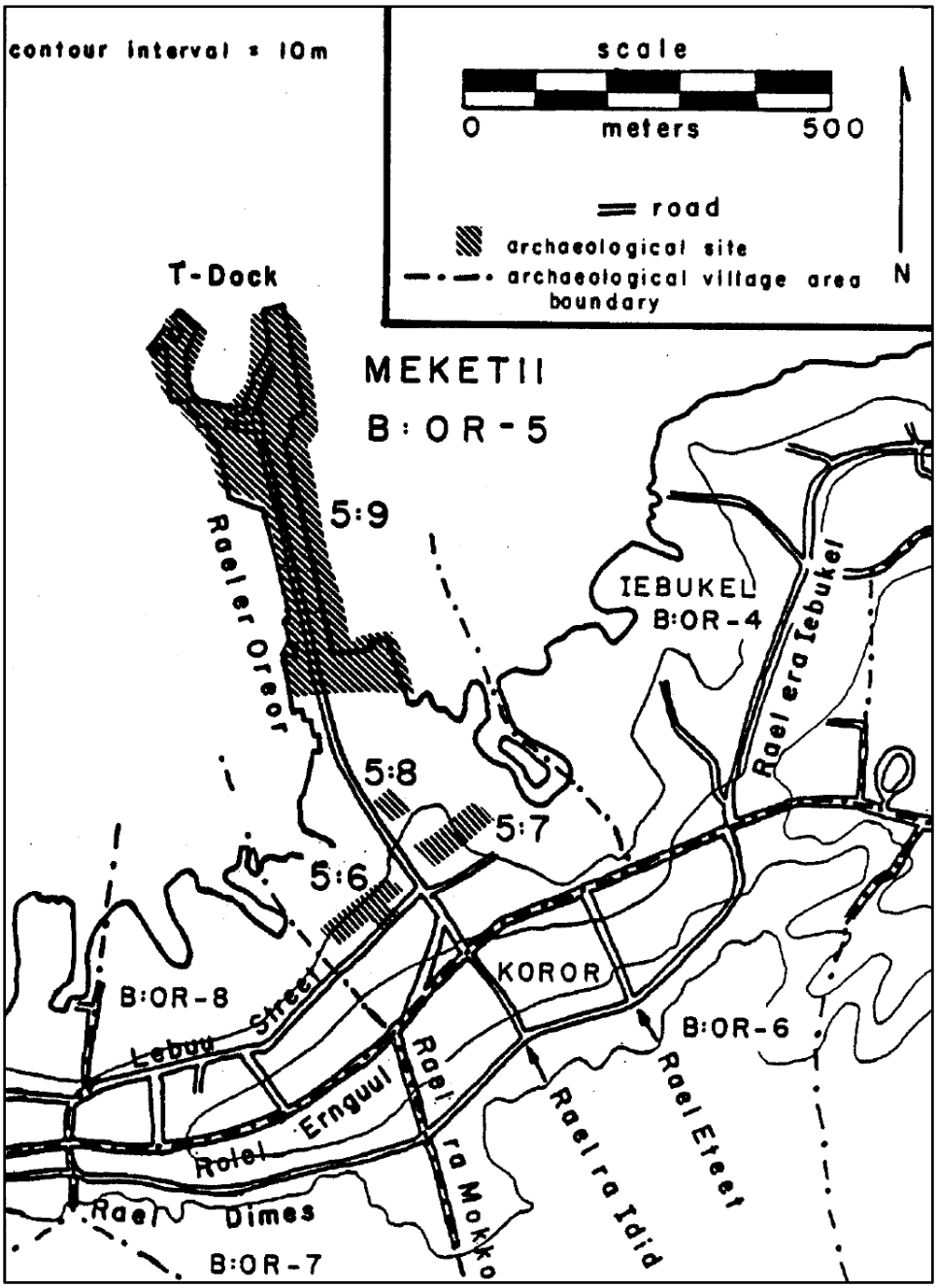

Figure 23. *Pool.1 Map of T-Dock facility including the Japanese pool (Snyder 1985).*

Figure 24. *Japanese pool (looking west/northwest) (Photo by Jessica Stone).*

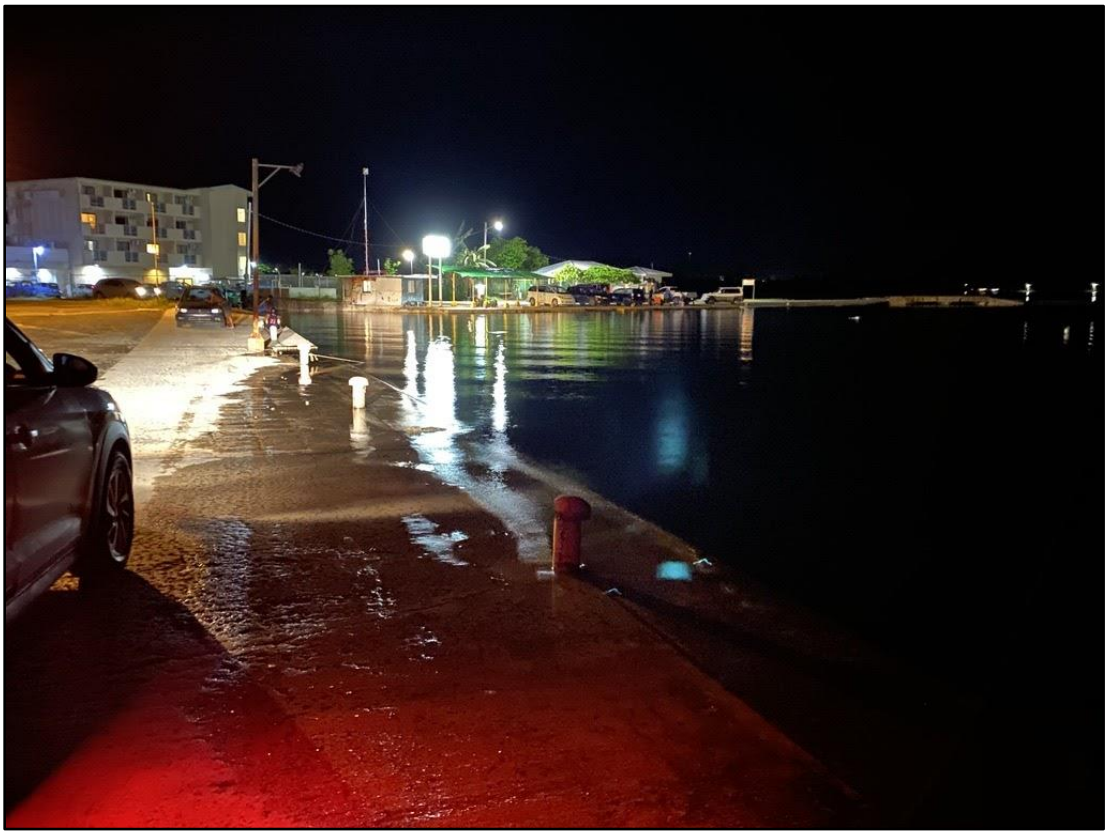

Figure 25. *View of T-dock (looking east) at high tide on October 30, 2019 showing spillage and inundation (Photo by Jessica Stone).*

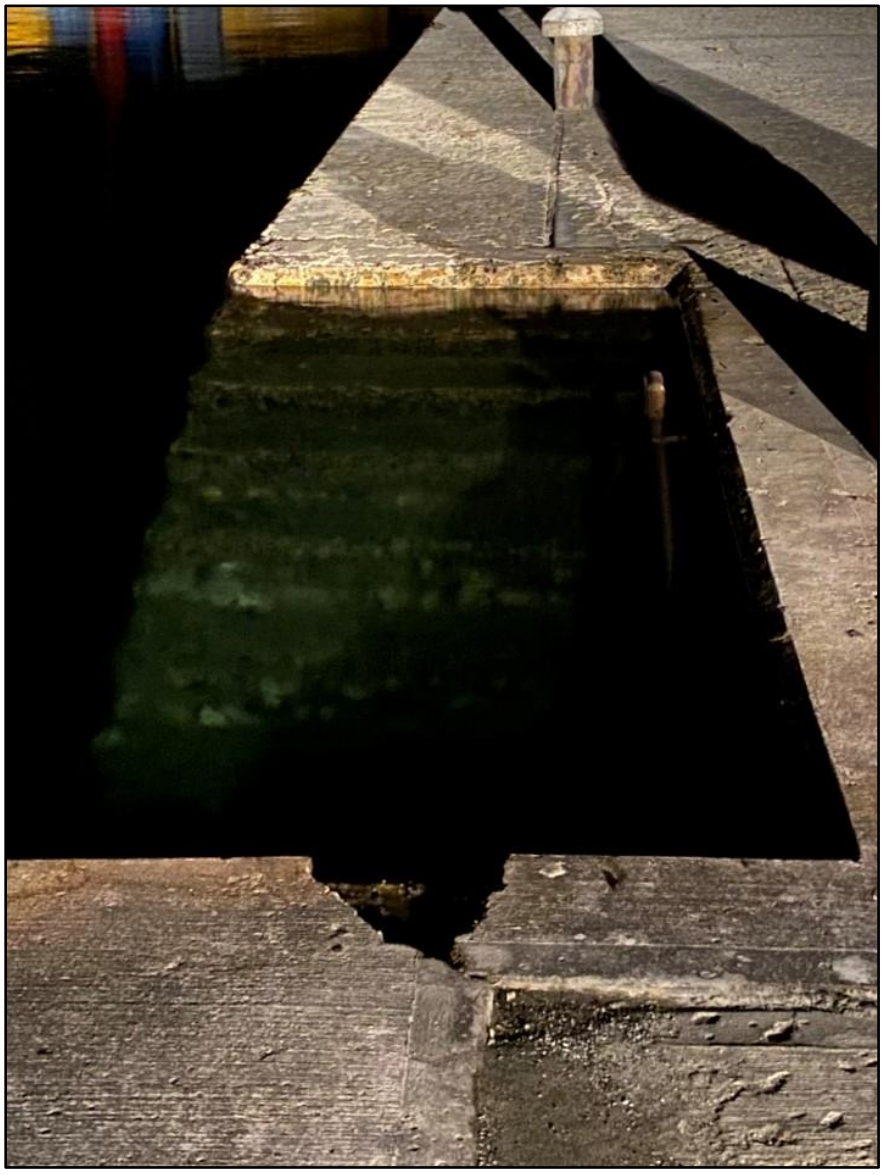

Figure 26. *B:OR-5:9 at high tide on October 30, 2019 (Photo by Jessica Stone).*

Recommendations

The site should be continue being kept clear of debris and detritus. Increasing sea level around the T-Dock facility will inundate the pool and cause property damage. The T-Dock facility will have to be raised again within the next decade, which will be a large and costly construction project, but does not offer a permanent solution. A protective retaining wall build around the pool may be another temporary solution, but could disrupt shipping access to the dock.

In fall of 2021 Koror State Government through a separate funding from UNDP was secured to rehabilitate the site to its original form through the assistance of the Melekeok traditional men's club, Ngaramecherocher. The project aims to clear the sludge buildup inside the pool and replace the damaged coral rocks and the pool wall. This project will ensure that the site integrity is maintained so that the shape and form of the original pool is kept.

Melekeok State

Site Name: Odalmelech
Site Type: Stone Face Monolith
Registered: September 13, 1989
Site No.: B:ME-4:2

Site Description

Odalmelech (B:ME-4:2) listed in the Palau Register of Historic Places is a stone face monolith situated on a stone platform in Melekeok across the road (western side) from the beach. Literally meaning the "face of the God Melech", this monolith is almost 3 m in height and more than a meter in diameter. It is one of five (formerly six after one was removed) monoliths that are found here. The others, which are his councilmen, are known as *Iwaiuch* (Sargent at Arms or Sleepiness), *Orrengschas* (one who hears and informs), *Btanch* (Btanch upright stone), *Mengachui* (man or hair eater), and *Obadebusch* (trumpeter, or public information man). An abbreviated version of the oral traditions indicates that Odalmelech, who was the leading god of Melekeok, was fishing with his friend Ngirngchesar, decided to build stonework across the village. After enlisting his councilmen and not finishing the job before the morning sun, he became upset and ordered his men to carve the monoliths.

Today, there are seven monoliths that are near a dock, but the ground under the eastern monoliths has eroded and four are now on the beach in a tidal area. The monoliths were originally resting on the surface. There are additional traditional stonework features around the stones that are still in their original place. A road now goes through the center of the monolith arrangement (*Figures 27-29*). There might be vegetation removal around the monoliths. There is a modern culvert between the road and the monoliths to direct water flow.

Figure 27. *Coastline east of main Melekeok road showing disturbed monolith features (Photo by Scott M. Fitzpatrick).*

Assessment and Projections

The monoliths on the beach are between 1-2 m in elevation and within the tidal area while the monoliths on the other side of the road are about 5-6 m above mean tide. The monoliths are located adjacent to terraces and residential gardens and are all located together with a paved road bisecting the site, though there was probably a traditional path that connected the monoliths and led from the village to this site. The monoliths that are still present are in good condition. However, two are missing and it is unclear for how long. The site appears to be maintained somewhat regularly. The primary issue is that four of the monoliths have been undercut by erosion and are now resting on the beach.

Recommendations

Given the significance of the monoliths and surrounding area, as well as its close proximity to the sea, the area east of the road should be restored and reinforced with concrete so that the monoliths can be placed on the same level surface and in their former positions as seen in Morgan's (1988) map. The monoliths themselves appear to be in good shape, but they should be restored to their original place. Secondary vegetation should continue to be cleared from around the monoliths prior to restoration and the culvert should be kept clean to maintain good water flow. The area east of the road should be constructed similarly to the concrete parking spot nearby. Building a protective wall out of concrete would offset the stress of wave action although it will be necessary at some point to raise the road.

Figure 28. *Odalmelech monolith (Photo by Matthew F. Napolitano).*

Figure 29. *Two of the "councilman" monoliths in Melekeok (Photo by Matthew F. Napolitano).*

Ngaraard State

Site Name: Cheldeklel a Dilrengulbai
Site Type: Underwater Fortress
Registered: *Eligible*
Site No.: B:NA-4:1

Site Description

The site of Cheldeklel a Dilrengulbai (B:NA-4:1), eligible for inclusion in the Palau Register of Historic Places, is located in Ungellel, Ngaraard State and is an extensive coral rock construction situated in front of the Klebeang channel that runs roughly parallel alongside a causeway in a north-south direction from Ungellel point to the Urung dock (*Figures 30-32*). The site is a deliberate placement of stonework in proximity to a traditional village site. Traveling inland towards the village through nearby mangrove channels would have required passing through the site, which also has some periodic gaps in the main structure that diffuse wave action. A modern road and causeway run parallel to the site and is also contributing to the site's protection from wave action and storm surges.

The site itself is referred to as an "underwater fortress" that is roughly 3 m in width and extends for 500 m. According to oral traditions it was built by peoples from Aimeliik under the direction of the matriarch lady of the village of Aimeliik, Dilrengulbai.

Assessment and Projections

This “fortress” or traditional causeway is today covered in mangrove vegetation and is not currently maintained. At low tide, the coral block construction is exposed, but becomes inundated at higher tides. Generally, the integrity of the site is fair to good as features are more or less intact, but not currently maintained. The mangrove vegetation growing on top and surrounding the site has likely aided in holding some of the coral blocks in place when the site is inundated at higher tides.

Recommendations

Though the site itself is inundated daily by tidal action given its coastal location, the placement was purposeful to manage access and traffic by local villagers and appears robust. It is unclear how the establishment of mangrove vegetation has affected the integrity of the structure (or whether ancient Palauans expected this growth, which would have been part of the overall design incentive). Regardless of whether the growth of mangroves here was intentional or not, their forced removal would likely lead to damage. It is recommended that occasional monitoring take place to ensure that the structure has not been damaged by storm surges, etc.

Figure 30. *View of Cheldeklel a Dilrengulbai (looking south) (Photo by Calvin Emesiochel).*

Figure 31. *View of Cheldeklel a Dilrengulbai (looking south/southwest) (Photo by Calvin Emesiochel).*

Figure 32. *View of Cheldeklel a Dilrengulbai (Photo by Calvin Emesiochel).*

Ngarchelong State

Site Name: Kukau el Bad/ Olketokel er a Kukau
Site Type: Monoliths
Registered: February 26, 2004
Site No.: B:NE-9:6 F1

Site Description

The site of Kukau el Bad, listed in the Palau Register of Historic Places, is located in Iungel, Ollei along the northern tip of Ngarchelong State. In the 1930s, Hijikata recorded a total of 16 monoliths in and around the platform and that some had grooves. Later, the BCHP survey noted 19 monoliths that were still standing. Though the site is part of a traditional village with stone platforms, this particular site is in Itoi (Feature 1) and away from the main village. The site is located in a relatively flat, tidally active area at the bottom of a slope and is only about ca. 1-2 m in elevation within a mangrove channel that goes through the traditional village; however, the channel is almost closed (*Figures 33* and *34*). The site has good irrigation and is ideal for taro patches. The sea is to the west, but is not clearly in view. There is also a nearby dock that allows boat access and a nearby stone pathway leads past a taro patch to the main village (Iungel).

The site is sacred and is still in use for women. There is a nearby place named Orateruul where elderly women would bring taro to roast over a fire with coconuts as an offering to the gods when too many *uek* (swamp hens) would feed on the taro or when the taro was not healthy enough. The monoliths themselves are said to have been a former taro that have turned to stone after Uab died. Alternate accounts recorded by the HPO suggested that this area was established as an altar for offering *kukau* (*Colocasia esculenta*) when disease or pests caused damage to the crop. The taro that are now stone were apparently brought to Ollei from all over Palau with the largest taro/stones being brought from Kayangel and Angaur.

Assessment and Projections

The integrity of the site is moderate. Because it is situated within a tidal area, the features are regularly inundated. As a result, some of the monoliths have moved slightly, though many are still in their original location. Other monoliths have been moved slightly back in their original position instead of lying down when Hijikata mapped them. The site was recently repaired and cleaned, which facilitated visibility and mapping during our survey.

Recommendations

It is recommended that the site receive regular cleaning and monitoring to ensure that the monoliths remain upright. Given the importance of the site and relative accessibility, it will need to be determined whether there is any potential for tourism (e.g., walking tours through the traditional village or boat rides). Overall, the condition of the site is fair to good. There needs to be maintenance and community engagement to keep the mangrove channel clear and monitoring secondary vegetation that could obscure the site and needs to be fairly well documented with photos and mapping. There is a high potential for further damage given regular tidal influx.

Figure 33. *View of Kukau el Bad (Photo by Calvin Emesiochel).*

Figure 34. *View of Kukau el Bad showing many of the feature's monoliths (Photo by Scott M. Fitzpatrick).*

Ngeremlengui State

Site Name: Beluu er a Ngerutechei
Site Type: Traditional Village (Sacred)
Registered: August 18, 2021
Site No.: B:NM-3:6

Site Description

Beluu er a Ngerutechei (B:NM-3:6), is listed on the Palau Register of Historic Places, is a traditional village site that also contains World War II features in Imeong, Ngeremlengui. Spanning multiple ecological zones, the site is located on a small peninsula at the base of *Etiruir* Mountain and *Taoch ra Ngerutechei*, a natural stream that leads to the mangrove. Beyond the mangrove is a fringing reef. The main pathway of the village follows the hill contour and the stream and allows access to marine foods from the reef. The stone paths lead to Ulechetong to the northwest and Nglabang to the northeast. Most of the vegetation is secondary. Elevation at the site is ca. 10-30 m above sea level.

Significant features at the site include *Diong ra Imeched*, a stone-lined bathing pool (*Figure 35*), three *uang* (canoe landings), monoliths including *esuch* (owl), multiple stone paths, platforms, and a bridge. The *esuch* faces the water and offers protection to the village. The site's original bridge, *Did ra Ibai*, has recently been restored (*Figure 36*). According to informants at the site, *Did ra Ibai* was more than 100 years old. The landscape has been modified in numerous ways, including the bathing pool, which was built into the stream, diversion of waterways, including the construction of multiple culverts to facilitate irrigation, terraced landscapes, and mangrove removal and modification to create channels to allow for canoe travel and to connect to the fringing reef. *Klekat* (smoke signal locations) face the other villages. At the time the village was constructed, it was likely coastal and had a view of the seascape.

Figure 35. *Diong ra Imeched, a stone-lined bathing pool at Ngerutechei (Photo by Matthew F. Napolitano).*

Figure 36. *NM.2. Did ra Ibai is the site's original bridge that allows access to the site (Photo by Matthew F. Napolitano).*

Figure 37. *Olekelek a Meducherutechei (Photos by Matthew F. Napolitano)*

One of the most striking aspects of the site is the degree to which water features were constructed into and around the landscape. Culverts were built under the raised paths to irrigate agricultural fields and to prevent water from washing over the stone paths and platforms. The channels that were built into the mangrove allowed canoe travel to the reef to collect marine resources such as clams and fish.

There are numerous photographs of the site and oral histories are well documented. The village site is considered to be the oldest and most sacred in Palau. Several features are included on the Palau Register of Historic Places, although the entire site is not designated. *Uchul a Rebong* is an elevated platform that is significant because it is the place where Milad gave the chiefly titles for Imeungs. Feature 15 (stone platform with a fallen monolith) is called *Olekull er a Ruchel*, which is the sacred site considered to the burials of the demigods. Feature 20, *Olekelek a Meducherutechei* (stone platform), is said to be the burial place of *Meducherutechei*, a brave warrior from Ngerutechei (*Figure 37*).

Assessment and Projections

The Ngerutechei Traditional village is a cultural site that provides essential information regarding the social structure that formulates the essence of social order for protection, security, ownership, identity and wellbeing of the people of Palau. This site is well known by the community and still being used for traditional practices and as a place for medicinal, food, and wood collection. It also provides a space to the people for self-mediation, ownership, and reflection of self-identity that nurtures and fosters our future generations.

The site is moderately intact and has high integrity; however, there are moderate impacts to the condition, integrity, and cultural value due to its current condition. Even though it is currently maintained and was recently cleaned by the state and the community, increased mitigation is needed before conditions and impacts of the site worsen. Overall, the village site is on the coastal area and has been uninhabited for many years so it has become overgrown and covered with secondary vegetation. This has caused the buildup of silt and dirt that blocks and covers all of the site's irrigation systems, forcing the buildup of sediment that has covered features. The overgrowth of vegetation on top of features has also dislodged rocks. Overgrown mangroves have covered stone paths and blocked waterways as well as the mangrove channel. Sea level rise has inundated features, causing them to fall apart.

Individual features at the site will be differentially impacted. Below is a list of features and potential impacts:

- Feature 10 - *Bai ra Ibangellei* (stone platform): Will be inundated soon by rising sea levels.
- Feature 11-13 – *Bteluachang ra Ibangellei* and the other two docks and *uang* (canoe landing site): Will be inundated along with the stone path that leads to the dock from *Bai ra Ibangellei*.
- Feature 14-16 – *Debellir ar Ruchel* (stone platform): although not at immediate risk for inundation, they may be inundated given that those in other villages are currently.
- Feature 19 (stone platform): will be inundated
- Feature 21 – *Iliud (*resting stone platform with monolith): will be inundated, which places the monolith at risk as well (*Figure 38*).
- Feature 24 – *Did ra Ibai* (bridge): Will be inundated as well as *Emeracech* (*Figure 38*); the pathway leading to it (B: NM-3:1, Feature 10) and away from it (Feature 22).

All other features will be subject to inundation as the sea level rise continues due to the site location and elevation on the coastal area.

Figure 38. *Left: v, the stone pathway (Feature 22). Right: a monolith with thin grooves on it is located on top of the Iliud (Feature 21) (Photos by Matthew F. Napolitano).*

Recommendations

Based on our assessment in the field, we recommend intervention to manage the changing exposure of the site and improving the resilience/resistance to the exposure through the following stabilization measures:

- Detailed mapping of the site including individual features
- Feature 10: Restore feature and clear out the mangrove
- Feature 11-13: clear away mangroves and restore features; attempt to clear out the channels to improve waterway function.
- Features 14-16: clear the mangrove and initiate site reconstruction.
- Feature 21: stone platform should be raised and restored.
- Feature 24: to prevent the feature from being inundated, the mangrove channels should be cleaned and possibly be resurfaced with mangrove wood for protection.
- Removal of secondary vegetation (excluding edible plants) and invasive plants along the paths and platforms and surrounding area
- Development of a maintenance schedule and planned community engagement for larger tasks such as mangrove cleaning.
- If possible, supplement the list of feature and place names included at the end of this report.
- Clear vegetation that has disturbed features and create open areas to provide sufficient drying.
- Clear dirt and debris that has covered features.
- Clear and restore all culverts and irrigation systems so that water can run smoothly and cleanly.
- Nomination of the site to the Protected Areas Network (PAN).

If the state is interested in tourism, the site will need to be made more accessible to facilitate visitors, yet minimize the impact and modification of the site that would compromise its integrity and authenticity. The following should be considered:

- Adding interpretive signs at significant features.
- The impacts of visitors and carrying capacity.

- The type of tourism envisioned (e.g., large groups and low number of visitations versus smaller groups and more frequent visitations).
- Management plan to ensure responsible use and access of the site.

Public Awareness and Outreach

Public awareness and engagement are critical components in the fight to protect intangible cultural heritage sites from climate change. To increase the visibility of this study, we have created a 28-page comic book that details the cultural significance of each site (*Figures 39* and *40*). Comics are an extremely effective vehicle that can be used to convey how scientific research is conducted, their results, and how findings are interpreted without simplifying the research questions (e.g., Bouchard et al. 2019; Swogger 2015). Although typically thought of a tool for children (e.g., Tatalovic 2009), comics have proven to be an effective means to communicate complex ideas to multiple age groups and literacy levels without distilling them (Connors 2013; Jacobs 2007; Swogger 2012, 2015). In addition to scientific communication, comics are also a novel way to engage with traditional stories. The comic was illustrated and authored by Mr. John G. Swogger, who has done similar work for archaeological projects around the world, museums, and related organizations (http://johngswogger.wordpress.com).

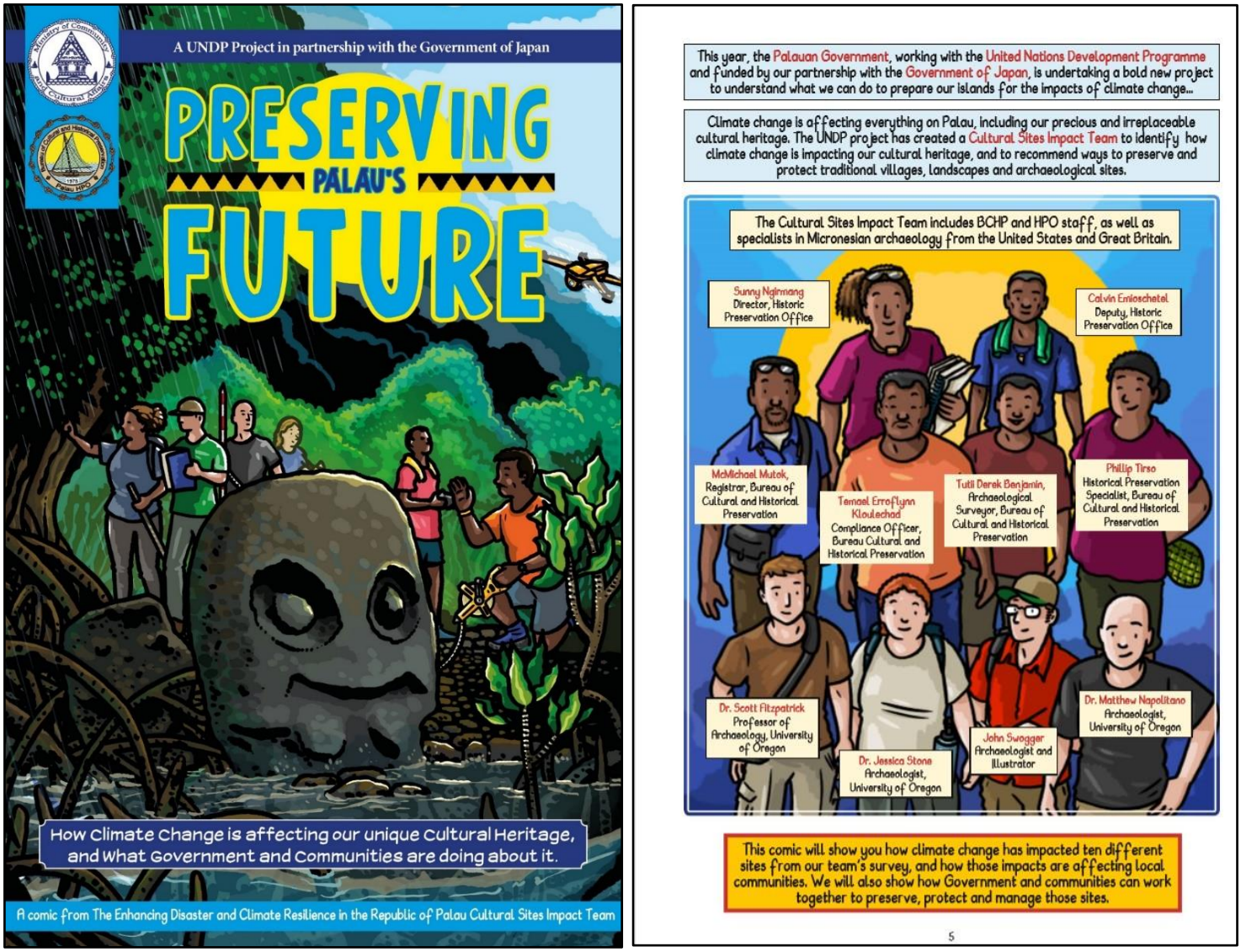

Figure 39. *Comic book panels created to increase the impact of our findings and engagement with Palauan communities (Illustrations by John G. Swogger).*

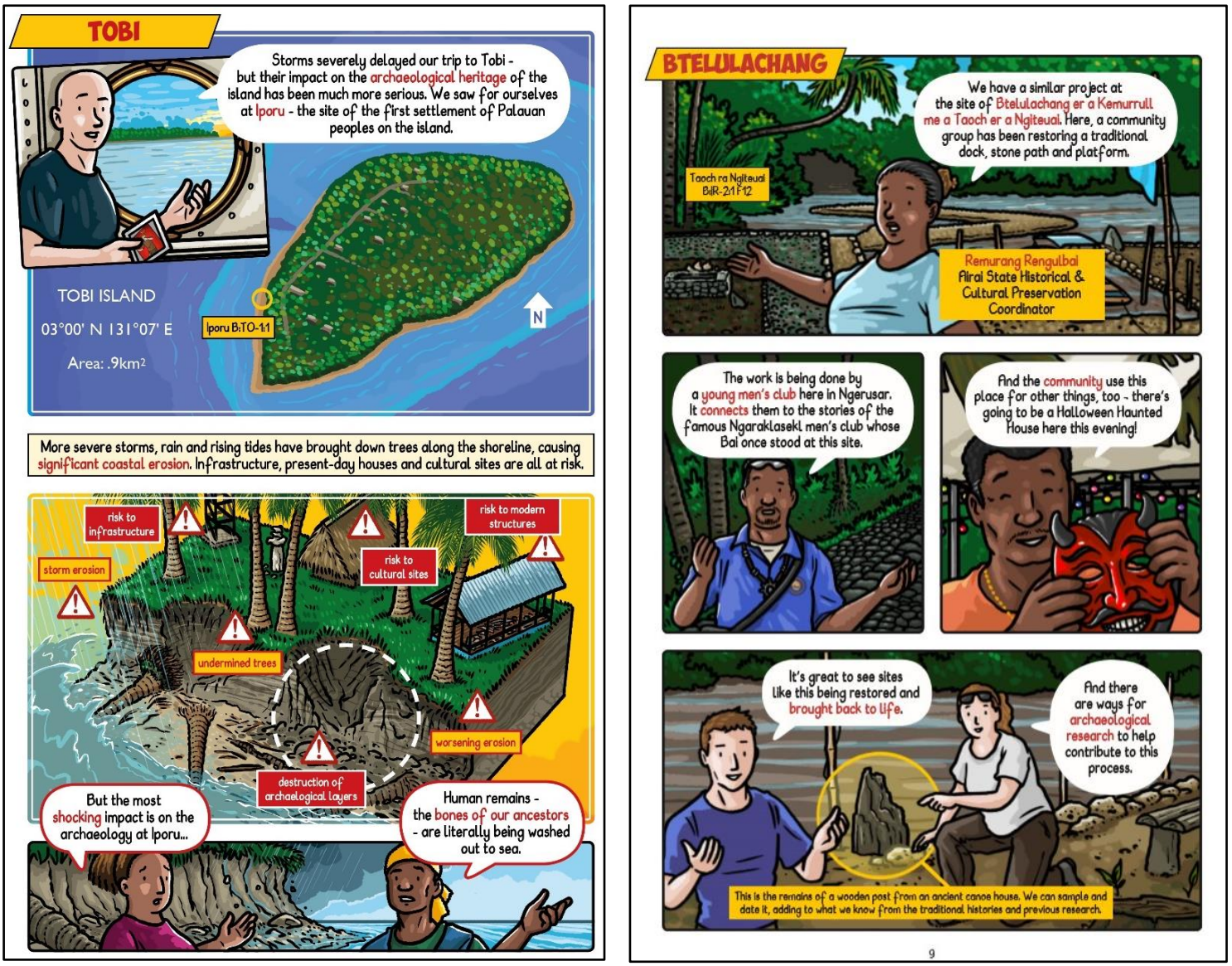

Figure 40. *Select comic book panels related to the project (Illustrations by John G. Swogger).*

Conclusions

The 2019-2020 Palau Disaster Risk and Climate Change Impact Survey identified 10 sites across the archipelago that were ideal case studies for examining both current and future impacts to culturally and historically significant properties. Visitations to each of the sites, recording of their composition and integrity, and assessment of their susceptibility to climate change, has provided important details about the level of threat that each site faces.

While each of the 10 sites are unique in their own way—and require different levels of preservation, restoration, and protection—what is clear from this study is that none are immune from the ongoing climate crisis. A host of human and natural processes, particularly sea level rise, are already causing significant damage and destruction to the 10 sites we investigated. However, it is important to remember that there are hundreds of other sites that are equally susceptible to these phenomena. What we hope to have accomplished is wider public recognition of the issues that Palau faces in protecting both their tangible and intangible cultural heritage as the climate crisis continues to unfold. Based on our findings presented here, it will be no easy task to develop ways to mitigate these potential impacts. However, we have made substantial progress in how to effectively manage these issues for future generations and ensure that Palau's unique cultural resources are preserved.

Recommendations

The *Disaster Risk Reduction and Climate Change Impact Survey of Cultural Sites in the Republic of Palau: Reconnaissance Survey* project investigated and assessed 10 archaeologically, culturally, and historically significant sites on numerous islands within the Republic of Palau and revealed a host of impacts that have occurred as a result of climate change and associated effects (Table 1).

Overall, our preliminary study provides an important baseline for establishing the degrees to which various site types (e.g., traditional villages, burials, stonework features, etc.) are, or could be, susceptible to the effects of climate change. These findings indicate that significant impacts are already occurring, largely due to sea level rise and the inundation of landforms. At particular risk are the two burial sites of Chelechol er a Orrak and Iporu, both of which hold vital clues about when and how Palau was settled in the ancient past. However, many other sites within or directly adjacent to the coastal zone are currently under moderate threat.

The addressing of these issues will eventually require various types of adaptive measures to help remove or offset stress (e.g., sandbags, retaining walls); improve resilience or resistance (e.g., treatment of structural materials, finding alternative storage of materials); manage change (e.g., replacing diseased trees with new ones); or move/relocate various resources in part or whole as part of the preservation process.

In addition, to investigation and assessment efforts, we also developed illustrated materials in the form of comics that outline the underlying reasons and strategies behind the project. When completed, these will be printed and distributed to local communities, government agencies, and other stakeholders who have a vested interest in preserving and protecting Palau's unique cultural heritage.

Site Name	Site No.	Location	Site Type	Vulnerability Level	Adaptation Option	Comments
Chelechol ra Orrak	B:IR-1:23	Airai State	Rock Island/cave shelter	High	Offset Stress/Improve Resilience/Relocate	Buried remains threatened; inundation due to new dock construction
Btelulachang er a Kermurrull me a Taoch er a Ngiteuai	B:IR-2:1	Airai State	Traditional village	Moderate	Offset Stress/Improve Resilience	Stone architectural remains threatened; inundation imminent
Iporu	B:TO-1:1	Hatohobei State	Ancient cemetery	High	Offset Stress/Improve Resilience/Manage Change/Relocate	Buried remains threatened; coastal profile exposed to wind, rain, tidal action, and sea level rise
Beluu er a Ngerdimes	B:NH-1:1	Kayangel State	Traditional village	Moderate	Offset Stress/Improve Resilience	Some buried remains threatened; low-lying landscape vulnerable to flooding and sea level rise
Beluu er a Ngerdilong	B:NH-1:2	Kayangel State	Traditional village	Moderate	Offset Stress/Improve Resilience	Some buried remains threatened; low-lying landscape vulnerable to flooding and sea level rise
Omedokel	B:OR-15:18	Koror State	Burial cave	Moderate	Offset Stress/Improve Resilience/Manage Change/Relocate	Surface remains threatened
Bul - Japanese Swimming Pool	B:OR-5:9	Koror State	Historic	Moderate	Offset Stress/Improve Resilience	Architectural integrity threatened; vulnerable to flooding and debris
Odalmelech	B:ME-4:1	Melekeok State	Monolith and platform	Moderate	Offset Stress/Improve Resilience/Manage Change/Relocate	Architectural integrity threatened; coastal profile exposed to wind, rain, tidal action, and sea level rise
Cheldeklel a Dilrengulbai	B:NA-4:1	Ngaraard State	Rock alignment/defensive fortification	Moderate	Offset Stress/Improve Resilience	Architectural integrity threatened; coastal profile exposed to wind, rain, tidal action, and sea level rise; inundation imminent
Kukau el Bad/Olketokel er a Kakau	B:NE-9:6 F1	Ngarchelong State	Monoliths	Moderate	Offset Stress/Improve Resilience/Manage Change/Relocate	Architectural integrity threatened; coastal profile exposed to wind, rain, tidal action, and sea level rise; inundation imminent
Beluu er a Ngerutechei	B:NM-3:6	Ngeremlengui State	Traditional village	Moderate	Offset Stress/Improve Resilience/Manage Change/Relocate	Architectural integrity threatened; coastal profile exposed to wind, rain, tidal action, and sea level rise; inundation imminent

Table 2. *List of sites examined as part of this study and their vulnerability levels and adaptation options.*

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Appendix A: Cultural Landscapes Vulnerability Assessment Form

Name of Cultural Landscape:
Name of Associated Cultural Landscape:
Location:
Prepared By:
Date:

Historical Significance Summary
Themes/contexts:

Period(s) of significance:

Historical Integrity Summary
Comparison of historic and current periods:

Aspects of Integrity:

Landscape Characteristic Summary
Natural Systems and Features:

Spatial Organization:

Land Use:

Cultural Tradition:

Topography:

Vegetation:

Circulation:

Building or Structure:

Cluster Arrangement:

Views and Vistas:

Constructed Water Feature:

Archeological Sites:

Condition of Cultural Landscape Summary
Describe overall condition:

Identify specific impacts to individual features or landscape characteristics (use impacts list):

Recommended stabilization measures:

Landscape Sensitivity Summary

- ☐ No Sensitivity
- ☐ Low (Minor impacts to condition, integrity, and cultural value)
- ☐ Moderate (Moderate impacts to condition, integrity, and cultural value)
- ☐ High (Significant impacts to condition, integrity, and cultural value)

Description:

Actions to Reduce Sensitivity

- ☐ Off-set stress by improving resilience/resistance to the exposure
- ☐ Manage the changing exposure
- ☐ Relocate the feature or facilitate movement of the feature

Description:

Needs for Future Research or Documentation

Description:

Appendix B: U.S. National Park Service Climate Change Strategy Adaptation Options

NPS Cultural Resources Climate Change Strategy, pages 36-37.

Adaptation Options

1. No Active Intervention
Taking no action is a decision. This may be an appropriate decision in situations of low vulnerability (no action warranted) or when, due to one or more of a range of constraints, including lack of technological or economic feasibility, no action can be taken. This decision may include assessment of the need for monitoring of resource condition, with a plan to revisit a no-action decision at a future point in time.

2. Offset Stress
Removing or deflecting stress is one or more actions taken at some distance from the resource to reduce or remove the environmental or other force(s) acting on the resource. The goal of this option is to enhance survival while minimizing physical or material changes to the resource. Constraints on this option are likely to include impacts of actions to surrounding resources, such as natural habitat or infrastructure.

Examples include: temporary measures such as sandbags or levee plugs; an offsite retaining wall, living shoreline, or engineered logjam to reduce shore erosion; upstream re-vegetation to reduce flood hazards, or changes in adjacent forest management to reduce wildfire risk.

3. Improve Resilience/Resistance
Improving resilience/resistance consists of one or more actions that change the nature and/or setting of a resource that are designed to make a resource better able to withstand or be recovered from environmental or other forces. The goal of this option is survival of the resource, despite possible impacts of actions on integrity of the resource, although this option does not necessarily mean the resource will be impaired.

Examples include: treatment of structural materials to better withstand increased moisture, wind, or an invasive species; elevation of a building to raise it above projected flood levels; addition of a cap over an archeological site; changes in landscape plantings or soil treatments; and alternate storage arrangement of museum materials.

4. Manage Change
Managing change is an action or set of actions that incorporate change into the form of the resource and/or into its management plan. The goal of this option is to maintain character-defining features of a resource, even if original specific materials or individual species are no longer part of the resource.

Examples include: change in tree species on cultural landscapes by removing an original species that has died and replacing it with a species that is healthy in that environment and will provide similar visual characteristics including shade and foliage conditions.

5. Relocate/ Facilitate Movement
Relocating/facilitating movement includes two types of action: (a) moving a resource, and (b) allowing movement to happen.

(a) Moving a resource is an action or set of actions to relocate all or a portion of a resource that cannot move on its own to a less vulnerable location.

Examples include: moving the Cape Hatteras Lighthouse inland from the coast. Another example is the temporary relocation of the NPS collections from Ellis Island following Hurricane Sandy to a facility in Maryland. Assisting with relocation of a human community to a safer location and assisted migration of a culturally important species to a refugium it would not have been able to reach on its own (for instance, salmon species to a new watershed) are also examples of this option. Movement is not feasible for some cultural resources such as cultural landscapes; in such instances movement may be an appropriate choice for components of a landscape once a decision has been made that the whole can no longer be saved.

(b) Allowing movement to happen involves action(s) either to enable movement or otherwise remove impediments to movement of living portions of resources to less vulnerable or more stable locations.

Examples include: allowing ecosystems such as a marsh or barrier island with cultural significance or which contains culturally significant species to migrate inland, or a given species with cultural significance to shift ranges. Such shifts may move all or components of a resource outside of documented resource or park boundaries.

6. Document and Prepare for Loss
Any action modifying a resource includes appropriate documentation. "Document and Prepare for Loss" is a set of actions to record a resource and then subsequently allow the geographic location of the resource to undergo full effects of environmental or other forces that are likely to destroy or remove all or portions of the resource.

Documentation may be exhaustive, such as data recovery (full excavation) of an archeological site, or detailed recording of a building or structure or cultural landscape (such as HABS/HAER/HALS photographic, drawing, and laser scanning documentation, or a Cultural Landscape Inventory). Documentation also may be done at a less than exhaustive level. This may be appropriate when exhaustive approaches are infeasible (due to limitations in access, time, or financial constraints), not warranted (due to nature and scale of impacts), or there is merit in not recovering or preserving the whole of the resource (such as an archeological site may become inaccessible, but is not anticipated to be destroyed). This option differs from the data recovery in that it requires consideration and documentation of the sampling and preservation approach. Other examples of documentation techniques that may be used in either approach include collection of pollen and seeds or plant cuttings, and oral histories and video.

7. Interpret the Change
Climate change is the heritage of the future. Interpreting the Change is an action or set of actions that acknowledges and then serves to engage people in the future with the effects of climate change on a resource. This option may be used on its own or in combination with any of the other options.

Examples include: dramatic approaches such as preservation of a coastal resource such that its location and form remains either intact or otherwise visible from the coast once it is offshore or partially submerged. A hypothetical example would be Dry Tortugas National Park's Fort Jefferson encased in a large dome to protect it from rising seas and storm damage. Other examples include interpretive signage of freeze-thaw cracking in historic bricks, or photo series of changes in garden phenology or vegetation across a landscape. While interpretation may be developed across any of the adaptation options on this list, for this option, interpretation addresses not only preservation issues and history of the cultural resource, but also climate change itself, and seeks to tell the story of the place and climate change and how they are interacting.