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Addressing the Humanitarian and Environmental Consequences of Atmospheric Nuclear Weapon Tests: A Case Study of UK and US Test Programs at Kiritimati (Christmas) and Malden Islands, Republic of Kiribati

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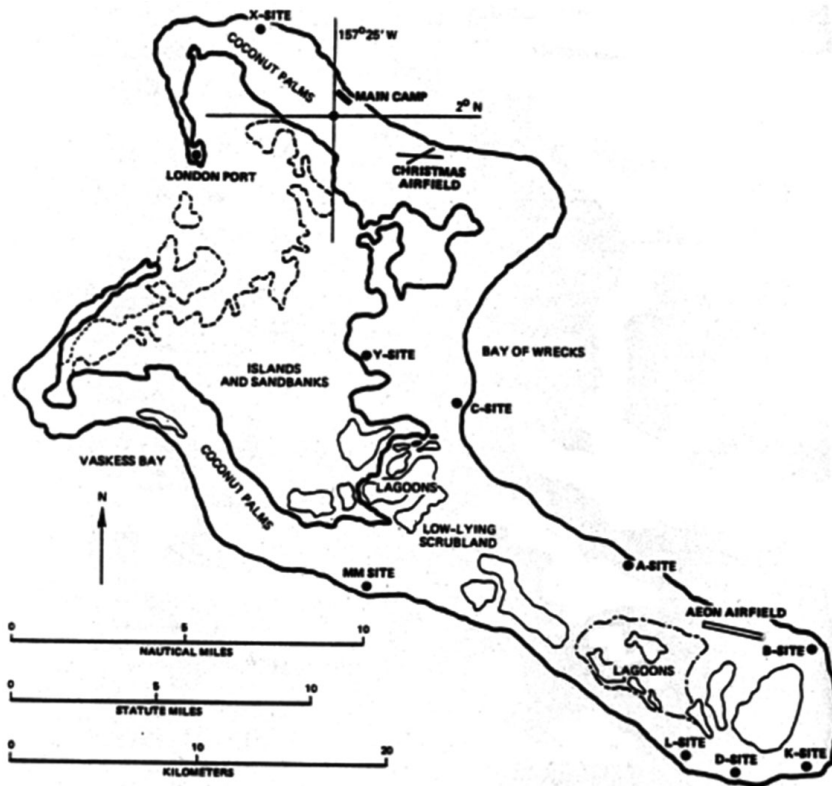
Abstract

Between 1957 and 1962, the UK and USA conducted 33 atmospheric nuclear weapons test detonations at or close to Malden and Kiritimati (Christmas) Islands (total yield 31 megatons), formerly British colonial territories in the central Pacific region, now part of the Republic of Kiribati. Some 40,000 British, Fijian, New Zealand and US civilian and military personnel participated in the test program and 500 i-Kiribati civilians lived on Kiritimati at the time. This article reviews humanitarian and environmental consequences of the UK and US nuclear weapons testing programs in Kiribati, as well as the policy measures that have addressed them. The authors contend that policy interventions to date have not adequately addressed the needs and rights of test survivors, nor ongoing environmental concerns. They argue that the victim assistance and environmental remediation obligations in the 2017 Treaty on the Prohibition of Nuclear Weapons offer an important new opportunity for addressing the consequences of nuclear detonations in Kiribati, by focusing policy attention and constituting a new field of development assistance.

Policy Implications

- Policy interventions to date have not adequately addressed the needs and rights of survivors of the UK and US nuclear test program in Kiribati, nor ongoing environmental concerns.
- The victim assistance and environmental remediation obligations in the 2017 Treaty on the Prohibition of Nuclear Weapons offer an important new opportunity for addressing the consequences of nuclear detonations.
- Humanitarian and human rights framing of the effects of nuclear testing offer an alternative both to denialism and the litigation and liability model.
- Victims of nuclear testing seek not only medical assistance, but also support for practices of recognition, acknowledgment and memorialization to address psycho-social and cultural consequences of the test programs.
- Policy interventions should acknowledge the intrinsic value many Pacific peoples place on the environment, not only its instrumental worth.

1: FUS Defense Department map of Kiritimati Atoll, Republic of Kiribati Source: DNA (1983).



Between 1957 and 1962, the UK and USA conducted 33 atmospheric nuclear weapon test detonations at Malden and Kiritimati (Christmas) Islands (see data Table S1, available online), formerly British colonial territories in the central Pacific region that are now part of the Republic of Kiribati.¹ The total yield of all detonations was equivalent to 31,122 kilotons of TNT (Johnston, 2009) – approximately 865 times the total energy released by the atomic bombs dropped by the US on Japan in 1945. Some 40,000 British, Fijian, Aotearoa New Zealand and US civilian and military personnel participated in the test program. Their work cemented Britain's status as a thermonuclear power but also placed them in harsh conditions with limited resources. About 500 i-Kiribati civilians lived on Kiritimati at the time. Many test personnel and i-Kiribati inhabitants claim their health was adversely affected by exposure to the blast, heat and radioactive energy released by the tests, as well as the psychosocial context in which they occurred. Some suggest their descendants have also suffered physically and psychologically. However, comprehensive analysis of the ongoing humanitarian and environmental impact of nuclear weapons testing at Kiritimati and Malden Islands has been inadequate. There has been little systematic radiological monitoring of the test sites and so the extent and

significance of ongoing contamination is unclear. For a map of Kiritimati, see Figure 1.

The Treaty on the Prohibition of Nuclear Weapons (TPNW), adopted by 122 governments at the United Nations in 2017, is not just a categorical ban. It also obligates provision of assistance to victims of nuclear weapons use and testing and remediation of contaminated environments (Article 6). All states parties must engage in international cooperation and assistance to support such efforts by affected states parties (Article 7). Kiribati was among the first states to sign the new treaty in September 2017 and ratified in 2019. Along with other nuclear-armed states, the UK and USA currently oppose the TPNW, as they remain committed to maintaining their nuclear arsenals. However, the other two states whose citizens participated in the tests, New Zealand and Fiji, are also states parties. The TPNW will enter into force 22 January 2021.

This article reviews humanitarian and environmental consequences of the UK and US nuclear weapons testing programs at Kiritimati and Malden Islands, as well as the policy measures and practices that have addressed these consequences, whether in Kiribati itself, or other jurisdictions where atomic veterans live. We contend the policy interventions to date have so far not adequately addressed the needs and human rights of test survivors, nor ongoing

environmental concerns. We believe the TPNW offers an important new opportunity for addressing the consequences of nuclear detonations in Kiribati, by focusing policy attention on the issue and constituting a new field of development assistance.

We compile findings from separate but mutually reinforcing research projects on the consequences of test programs in Kiribati. Dr. Becky Alexis-Martin has undertaken 144 semi-structured interviews with British nuclear test veterans and their descendants and 15 open-ended interviews with women from Kiritimati as part of her Nuclear Families and Atomic Atolls projects from 2016 to 2019. She has undertaken extensive ethnographic research of memorialization and the experience of nuclear warfare. (Alexis-Martin, 2016a; Alexis-Martin, 2016b; Alexis-Martin, 2019a; Alexis-Martin, 2019b; Alexis-Martin, et al, 2019; Alexis-Martin and Davies, 2017). Dr. Matthew Breay Bolton (2018a, 2018b) conducted field research in Kiritimati in 2018 and has also conducted related interviews and archival research in Australia, Cook Islands, Fiji, New Zealand and, with the help of Sydney Tisch, the USA, 2018–2019. This paper builds upon Bolton's (2018a, 2018b) working papers that have circulated in policy arenas. Dimity Hawkins, at Swinburne University, has been engaging in an in-depth project documenting Fiji's intersection with the history of Pacific nuclear testing. Through a combination of extant literature and archival research as well as oral histories, her project explores the emergence of anti-nuclear activism and government engagement around the time of Fijian independence and early Pacific decolonization. Talei Lusia Mangioni is a Fijian researcher in Pacific Studies at the Australian National University, her creative scholarship charts the Nuclear Free and Independent Pacific (NFIP) movement across Oceania through historical ethnography, film-making and archiving.

Across all these research projects, there are noteworthy challenges in interdisciplinary qualitative research, due to its inherently subjective, extensible and complex nature. While interview-based approaches offer rich insights into the human experience of the nuclear, the qualitative has an inherently intuitive element and has been described as an art rather than a rigorous scientific process (Miles et al., 2019). Regardless, there is considerable intrinsic value to the qualitative domain, as it can amplify the voices of people who may otherwise not be heard by the establishment and/or state (Weiss and Fine, 2004). For this reason, personal stories and testimonies of both islanders and veterans provide vital insights into the long-term consequences of US and UK Pacific nuclear weapon testing.

There are additional complications involved in assessing health risks and health outcomes resulting from exposure to ionizing radiation. While a certainty is presented by the very detonation of the nuclear weapon tests themselves, a militarized culture of secrecy surrounds the extent, capacity for exposure and long-term consequences to local inhabitants of the spaces used for testing – and the young men and women who undertook nuclear weapon testing work. The circulation of radioactive particles through ecosystems and human bodies occurs in complex and nonlinear ways.

Ambiguities about risk are exacerbated by limited research and active denial by the governments that carried out the tests, especially the UK (see the Sanders-Zakre and Van Duzer commentary in this Special Section for further comparison of the US and UK approaches to documentation, compensation and litigation; also, Maclellan, 2017a; Roff, 2018). Exposures have not been comprehensively assessed through all the potential pathways, including external exposure, inhalation and ingestion. Measuring multiple health conditions, each with changing multifactorial causation, accurately over long timeframes is difficult, and attribution even more difficult (UNSCEAR, 2015). This creates challenges for those seeking to establish clear lessons for policy and practice in victim assistance and environmental remediation. This article thus summarizes evidence the authors have been able to gather but in no way purports itself to be comprehensive in scope. Rather, we hope that our work prompts further, more in-depth and technical efforts to understand and ameliorate the suffering resulting from the test programs.

A further concern arises from the colonial history of Kiribati and its relationship to military powers that have sought to use its ecosystems, oceans and people for their own ends. Nuclear test programs represented a nadir of Western scientific exploitation, with disastrous consequences for the environments and people in the marginalized zones chosen as sites of experimentation (Baniivanua Mar, 2016; DeLoughrey, 2013; Teaiwa, 2008). The authors are not residents of Kiribati. We ourselves did not participate in the test program. We have sought to be conscious, reflexive and careful about the implications of our social locations by circulating drafts of our research widely with officials, scholars and civil society advocates in and from the region for feedback. We see the role of this article not as recommending policy *per se*, which must be the preserve of the people most affected, but rather highlighting concerns and offering potential tools for addressing them.

The next section provides background on the UK and US nuclear weapons test programs in Kiribati. This is followed by an overview of the humanitarian consequences of the test programs in Kiribati itself; among atomic veterans from the UK, USA, Fiji and New Zealand; and potential effects elsewhere in the Pacific. A similar section then considers the environmental consequences of the tests. We then outline the various policy responses to the humanitarian and environmental consequences to the tests, in Kiribati, as well as jurisdictions responsible for atomic veterans. We conclude with reflections on the potential contribution the TPNW might play in supporting effective policy responses to the consequences of nuclear test detonations in Kiribati and beyond.

UK and US nuclear weapons tests in Kiribati

From 1957 to 1958, almost 15,000 British, New Zealand and Fijian personnel (see online data Table S2) participated in Operation Grapple – a series of nine UK atmospheric nuclear weapons test detonations – at Kiritimati (then Christmas)

and Malden Islands, then part of the Gilbert and Ellice Islands Colony (GEIC), in the central Pacific. The total yield of all UK tests in Kiribati was 7,869 kilotons. British control of Kiritimati was disputed by a US territorial claim, but both countries proceeded with tests, agreeing that they would not prejudice the outcome of the dispute. The first three tests, in 1957, were nuclear bombs air-dropped over Malden Island, 636 km from Kiritimati. However, to simplify logistics and under pressure to achieve a 1 megaton yield before the potential negotiation of a ban on atmospheric testing, the remaining six Grapple tests occurred above Kiritimati itself (or just offshore), including two tests attached to balloons tethered at the southeastern point. (MacLellan, 2017a). The choice of the new Kiritimati test site was literally chosen by officials while 'knocking back a gin and tonic' in the military camp (Wilfrid Oulton, in Ross, 1991). (For background on Operation Grapple see: Arnold, 2001; MacLellan, 2017a; Walker, 2010).

During the British tests, military and scientific personnel were posted at military camps on Kiritimati, as well as on British and New Zealand naval ships (Alexis-Martin, 2016a; Oulton, 1987). A number of US military personnel also participated as observers or in Operation Miami Moon, in which they flew 'sniffer' aircraft through mushroom clouds from UK tests (Miller, 1994). At least 30 spouses and 31 children of the soldiers visited Kiritimati, as well as dignitaries, such as the Duke of Edinburgh – who was instructed not to drink water served him by the troops (Boniface, 2008). Ratu Sir Penaia Ganilau, a distinguished military officer who later served as Fiji's Deputy Prime Minister, Governor General, President and *Tui Cakau* (customary High Chief) visited Malden Island and witnessed the 1957 Orange Herald test (MacLellan, 2017a).

There is evidence of early settlement on both Kiritimati and Malden, both atolls of the Line Islands located south of Hawai'i. They are just two of the 33 low lying-islands constituting Kiribati, but Kiritimati, as the largest coral atoll in the world, consists of 70 per cent of country's total land mass (Streets, 1877). Kiritimati and Malden are among the many islands that early Pacific peoples occupied and passed through in Oceania. Contemporary i-Kiribati people continue to articulate creation stories about revered gods and forbearers who settled their islands (Talu, 1979; Uriam, 1995). However, Western scientific and archeological reconstructions of the settlement of Kiribati indicate that there was cross-fertilization of predominately Micronesian but also some Polynesian influences (Macdonald, 1982). It has been suggested that Kiritimati and Malden islands were first settled by Pacific voyagers as a resting spot between Southwest Polynesia and Hawai'i, or because of the multiple castaway hypothesis (Anderson, 2000). This reflects a long and intentional history of indigenous mobility through wayfinding and traditional navigation across the Pacific for over thousands of years prior to European arrival (DeLoughrey, 2007; Hau'ofa, 2008; Kelman, 2018; Nixon and King, 2013). The British established a protectorate over these and other Central Pacific islands in 1892 and later GEIC in 1916. During

World War II Japan seized part of GEIC; battles with Allied forces devastated many islands.

By the beginning of the UK test program, 258 i-Kiribati civilians lived on Kiritimati, employed by a copra plantation and Operation Grapple (MacLellan, 2017a). The number increased to almost 500 civilians by the end of the tests (Office of Te Beretitenti, 2012). The Kiritimati islanders were described as 'migrants', pressured to relocate from elsewhere in the GEIC by British authorities in the early 20th century to work on copra plantations harvesting coconut kernels for oil (Anderson, 2000). Despite archaeological records of previous inhabitation of Kiritimati by Pacific peoples, the islanders were treated as a non-native community by British authorities, who insisted there was no population indigenous to the islands (MacLellan, 2017).

In October 1958, the UK, USA and USSR, agreed to a nuclear weapons testing moratorium. The UK halted its Pacific tests, maintaining a presence of about 300–400 troops on Kiritimati. The moratorium collapsed with a Soviet test in 1961 and the US detonated a further 24 atmospheric tests at or close to Kiritimati in 1962's Operation Dominic I, with a total yield of 23,253 kilotons. During May and June 1962, there was an average of one detonation over or near Kiritimati every three days. Operation Dominic I was carried out by Joint Task Force 8 (JTF8), with 28,000 personnel on Kiritimati, Johnston Atoll (a US territory) and ships and submarines in the surrounding ocean. JTF8 drew from all branches of the US armed forces, as well as civilians from the Department of Defense, Atomic Energy Commission (AEC), Public Health Service and private contractors. JTF8 received 65 VIP visitors to Kiritimati and Johnston (See online data Table S2; DNA, 1983; DTRA, 2015; Nuclear Weapon Archive, 2005; Whitman, 2004). One report suggests that Soviet Navy and Intelligence personnel may have been on boats and submarines in the hazardous zone during Dominic I tests (Smith, 2015).

Following signature of the 1963 Partial Nuclear Test Ban Treaty, US and UK troops withdrew from Kiritimati. Nevertheless, they maintained a small military and civilian presence during Operation Hard Look, which monitored French atmospheric testing in Maohi Nui/French Polynesia (Langston, 1993).

In 1979 the Republic of Kiribati became independent and acknowledged some of the grievances brought on by colonialism, including the detrimental impacts of phosphate mining, World War II and nuclear testing on their lands (Shaw, 1980). Negotiations with the US confirmed that Christmas, now Kiritimati (pronounced ki-ris-mas), and Malden Islands were part of the new country (Van Treese, 1993).

Humanitarian consequences

The consequences of the nuclear weapons tests in Kiribati have been insidious acts of slow violence (cf. Nixon, 2011). Compared to other historic atrocities, the effects of nuclear testing appear different, due to the delayed nature of health concerns, mental health challenges and radiation-related

illnesses. Humanitarian consequences are often diffuse, including social effects like displacement, disruption to traditional food-growing and gathering practices and loss of unfettered access to lands and waters and their products (Ruff, 2015). Uncertainty and an inability to derive the exact outcomes of a perceived exposure risk drive the nuclear anxieties of the atomic veteran community and civilian i-Kiribati survivors.

Military life for personnel of the test programs was difficult. The effect on both the short-term and long-term mental and physical health of personnel was significant: outbreaks of dysentery and food poisoning were common, as was sunburn and heatstroke (Alexis-Martin, et al., 2019). Morale was low, and several servicemen died by suicide (Alexis-Martin, 2017). The danger of life on the island was intensified by the nuclear tests, and veteran descriptions of protective clothing, line-up drills, and radiation sampling provide a vivid narrative of the realities of nuclear tests, and expose how these experiences shaped the day-to-day lives of personnel (Tubanavau-Salaluba, 1999). A culture of secrecy surrounded the tests that compounded existing issues. Since their time on Kiritimati, many UK servicemen have developed conflicted feelings about their role in creating Britain's nuclear deterrent, as social, psychological and general health issues began to manifest.

The United Kingdom Ministry of Defence, 2008, p. 2) claims that 'Almost all the British servicemen involved in the UK nuclear tests received little or no additional radiation as a result of participation'. The British Government has described test procedures and safety measures as 'meticulous', but, often, the experiences of veterans contest these official claims (Miller, 1986). According to Ruff (2015, p. 787), 'radiation exposures for service personnel ... were not systematically monitored, and personal protection was minimal'. During early UK tests, military personnel were given protective suits and film badges to monitor their exposure to radiation. However, protective and monitoring measures declined over the course of the testing program. Contemporary film footage of the *Grapple X* test depicts military personnel in only their uniforms (CRTukker, 2008). Even those who wore film badges later discovered in lawsuits with the British government that the film was never processed. Some veterans claim the lack of precautionary measures was intended to use them as 'guinea pigs', to study the impact of radiation on people. They point to military memos that suggest the UK wanted to understand the 'effects of nuclear explosions on personnel and equipment' (RAF, in Maclellan, 2017a, p. 109). In 2020, *The Daily Mirror* obtained documents showing that a UK pilot tasked with flying through the mushroom clouds received in one flight doses of 18 Roentgen (168 mSv) to the head and 8.8 Roentgen (82 mSv) to the genitals; after the flight, he 'vomited for 48 hours,' a potential symptom of acute radiation sickness (Boniface, 2020).

Many veterans of the British tests have since criticised their treatment, and some believe that a systematic cover-up has occurred within the British Government. A 2008 cross-party inquiry into Operation Grapple by Members of

UK Parliament John Baron (Conservative, Billercay) and Dr. Ian Gibson (Labour, Norwich North) 'heard clear personal testimony that makes us question whether adequate radiological safety standards were followed for the tests.' Baron said the inquiry 'saw little evidence that fallout and the dangers from ingested radioactive particles were taken seriously ... Servicemen were free to move around the island, drinking local water, eating local fruits, bathing in the lagoons and breathing in dust, all of which could have been contaminated. That is worrying, because ingested radioactive particles from fallout can remain in the body and continue to harm for many years'. The inquiry heard testimony from witnesses who 'described their experience of a heat wave of extraordinary intensity, leading in some cases to temporary blindness or a sensation of blood boiling within their bodies. Others developed skin rashes and flu-like symptoms immediately after the detonations' (Baron, 2008).

The British military did not monitor the health of many service personnel following the end of their service in the testing program. One RAF memo raised concerns about collecting airmen's blood samples because if they 'later developed leukaemia, it might be difficult to refute the allegations that this is due to radiation received at Christmas Island' (W.R. Stamm in Maclellan, 2017a, p. 109). Concern has arisen among the British atomic veterans about the invisible genetic integrity of their community, with some members believing that their 'exposed' genes will transmit new pathologies to future generations. It is notable that further genetic testing is currently being undertaken in the UK to 'diagnose' chromosomal aberrations in this community (Trundle, 2011).

Fijian soldiers and sailors were treated with even less regard than their British and New Zealand counterparts during the UK test program. They were 'often allocated dirty, difficult or dangerous tasks', subjected to a color bar, and less pay and R&R than British soldiers (Maclellan, 2017a). According to a statement by Fiji to the UN, Fijian soldiers and sailors also 'participated in gathering and dumping dead, injured and blinded birds after the tests' (Prasad, 2018; also Maclellan, 2017a). Additionally, the RAF flew 'sniffer' planes through the mushroom clouds of the UK tests to obtain samples; many personnel of these crews report that they received dangerous exposures to radiation. As they transited through Fiji on their way from the UK nuclear test site in Australia to Kiritimati, the crews were instructed not to inform the Nadi civil airport of the radiation risk (Maclellan, 2017a).

Paul Ah Poy (2018), President of the Fiji Nuclear Veterans Association until his passing in 2020, said that while posted to Kiritimati, he 'never saw any protective gear at all' and was 'never issued with a badge' to measure radiation. He and many other Fijian veterans told journalist Nic Maclellan that they supplemented their meals by catching fish, lobsters and crabs that they now fear were contaminated by the tests. Many speak of their own and intergenerational health troubles, the denial and obfuscation of responsibility around harm suffered. (Tubanavau-Salaluba, 1999). Ratu Ganilau recalled the Malden Island test he observed as 'too

awesome to describe'. Following the detonation, he was invited to inspect the island, which he did without footwear as the British Navy claimed not to have a pair of rubber boots large enough for him to wear. He was flown back to Kiritimati where it was said his feet were 'very hot' and he had to be washed down; his legs later began to swell (MacLellan, 2017a; Tarte, 1993; Tubanavau-Salaluba, 1999). As a representative of the Fijian government, Ratu Ganilau later spoke strongly against nuclear weapons testing. He died of leukaemia in 1993. Two of his children born after the visit to Malden Island suffered from health problems the family attribute to the effect of the tests. Adi Sivo Ganilau, Ratu Penaia's daughter, continues to work for the rights of nuclear veterans in Fiji (MacLellan, 2017a).

The lower standard of protection applied to Fijian soldiers, airport workers and even a dignitary, was indicative of a colonial racism that also pervaded the UK government's attitude toward the i-Kiribati civilians living on Kiritimati. Local workers were given no opportunities for self-determination before nuclear weapon testing was undertaken, and continue to experience the cultural, environmental and health repercussions, and subsequent developmental neglect. The AWRE considered the likelihood of exposure to local communities with racist terminology, a report citing that 'for civilised populations, who [are] assumed to wear boots and clothing, and to wash, the amount of activity to produce this dosage is more than is necessary to give an equivalent dosage to primitive peoples who are assumed not to possess these habits ... It is assumed that in the possible regions of fallout at Grapple there may be scantily-clad people in boats to whom the criteria of primitive peoples should apply'. A 1956 military report suggested only a 'very slight health hazard would arise, and that only to primitive peoples' (MacLellan, 2005, pp. 113–114, 363). The lack of regard to Indigenous peoples was a pattern already well established by the British nuclear test program. A Royal Commission inquiry into the British nuclear tests in Australia made significant findings of negligence when it came to the safety and protection of Aboriginal peoples within the zones of the tests (Hawkins, 2017; Royal Commission into British Nuclear Tests in Australia, 1985).

In the early UK tests, i-Kiribati civilians living on Kiritimati were evacuated to other islands or sheltered on boats offshore. Suitupe Kiritome, who was 25-years-old and pregnant at the time of the *Grapple Y* test, remembered being taken offshore on a British ship. When rain began to fall following the explosion, she was standing on the deck. 'Although the crew were wearing protective clothing over their heads, she was in her everyday clothes when the rain fell', according to a report by the *Sunday Herald*. She remembered her face getting wet. Later, her hair began to fall out and she developed burns on her 'scalp and face' which left a scar. In 1998, a doctor told her that it could have been caused by radiation. (Edwards, 2006; also Tubanavau-Salaluba, 1999).

In later tests, i-Kiribati civilians remained on Kiritimati. Teeua Tetua, President of the Kiritimati Association of Cancer Patients Affected by the British and American Bomb Tests, was a child at the time of the UK tests. She

remembers gathering on the tennis courts in London village in the middle of the night. She said 'the people were really afraid'. The British authorities gave them blankets and some eye protection, 'but not enough glasses for everyone'. When the countdown began, everyone was instructed to hide under the blankets and cover their eyes: 'The babies were crying because they don't like the blanket and some kids ran away from their families and their eyes were blinded because the light was so strong'. She describes the blast as very hot and so loud that 'people tried to put their fingers in their ears'. When they returned to the house, glass bottles were broken. The detonations caused considerable anxiety: 'we felt uncomfortable every day' (Tetua, 2018; Other survivors also remember children developing eye problems during the tests: MacLellan, 2017a).

The US government located its test detonations 'as close as possible to the surface stations at Christmas Island without damaging the sites with the blast pressures'. It claimed that devices 'were exploded at such an altitude that the fireball formed did not touch the ocean surface, and thus no local fallout was formed' (DNA, 1983, p. 140; see also DTRA, 2015). However, it acknowledged that 'device debris' for lower altitudes detonations 'was carried in a west-southwest direction', including toward Jarvis island, a US territory; for higher altitude shots, it 'was carried east to southeast', toward Malden. The US claimed that 'The natives who wished to be evacuated were moved to *USS Cabildo* (LSD-16), which remained in the harbor area during the shot ... About 175 of the natives were aboard for each of the shots' (DNA, 1983, p. 143). However, secondary reports and Association members suggest that during most of the US tests, most i-Kiribati inhabitants were not evacuated (IPPNW, n.d.). One US naval officer recalled that while his ship was supposed to 'load up the Islanders [and] take them safely to sea', after the 'first experience the native people didn't show up again to be taken to safety and many of them suffered severe retina burns' (Smith, 2015).

The US government claims that all Dominic I personnel who were stationed on Kiritimati and Johnston Atolls were issued with film badges for monitoring radiation. It reported that 'In general, film badge readings were low' – and calculated an average exposure of about 0.2 Roentgen (1.9 mSv) per person – see online data Table S3. The highest exposures were among Air Force personnel involved in 'cloud sampling'; the highest, 17.682 Roentgen (165.0 mSv). (DNA, 1983; see also DTRA, 2015). The most recent and thorough review of the literature on low-level exposure to ionizing radiation has shown that there is no threshold below which exposure is safe. It always increases the statistical risk of cancer at the rate of about 1 person in 10,000 for every additional individual effective dose commitment of 1 mSv (National Research Council, 2006). Note that there is no record of the US issuing film badges to the i-Kiribati population of Kiritimati.

After gaining independence from the UK in 1979, Kiribati is considered one of the least developed countries in the world and is expected to be among the countries most adversely affected by loss of territory due to rising seas

caused by climate change. In June 2008, the Kiribati President Anote Tong said that the country had reached 'the point of no return'. He added, 'To plan for the day when you no longer have a country is indeed painful, but I think we have to do that' (Teatao, 2015). Resources for research into the consequences of the nuclear weapon tests, victim assistance and environmental remediation are therefore severely limited. In 2015, Kiribati's then Permanent Representative to the UN, Ambassador Makurita Baaro (2015) stated, 'Today, our communities still suffer from the long-term impacts of the tests, experiencing higher rates of cancer, particularly thyroid cancer, due to exposure to radiation'. Nevertheless, 'In Kiribati, no studies have been done on the effects of these nuclear tests on our people – we do not have the medical facilities nor the capacity to do this'.

Kiritimati's Survivor Association has identified 48 survivors who experienced the tests first hand, as well as 800 descendants. Members of the Association report numerous health problems which they attribute to the testing, including blindness, hearing problems, cancers, heart disease and reproductive difficulties. They also report that their children and grandchildren have suffered similar illnesses. Survivors are 'worried about the disease in their bodies', said Teeua Tetua (2018). In 2006, 300 i-Kiribati survivors, led by former president of the Association Suitupe Kiritome, submitted a petition to the European Parliament's Petitions Committee 'accusing the British government of breaking the law by failing to protect' the health of the indigenous civilians (Edwards, 2006).

The physical health consequences of ionizing radiation exposure from UK tests have been disputed by the British state. UK government-commissioned studies reveal a 'healthy soldier' effect, while often neglecting psychosocial experiences of veterans, and completely ignoring i-Kiribati inhabitants' rights to understand their health (Kendall et al., 2004; Miles, et al., 2011; Muirhead et al., 2003a, 2003b; Muirhead, 2004). Some independent research has been undertaken to consider the impacts to British nuclear test veterans and their descendants, and this work has revealed physical, social and cultural consequences to this community (Alexis-Martin et al., 2019; Jacobs, 2013; Roff, 1999; Trundle, 2011).

In New Zealand there has been more independent research. One project found elevated levels of blood cancers among New Zealand veterans of the UK tests in Kiribati (Pearce et al, 1990 and Pearce et al., 1996); another found that New Zealand veterans experienced a 'highly elevated frequency' of genetic damage ... most likely attributable to radiation exposure' (Wahab et al., 2008, p. 86).

Research to consider these health outcomes for i-Kiribati residents has been extremely limited (Alexis-Martin, 2019; Duffield, 2018; Maclellan, 2017a). This reflects the unbalanced power levied by the nuclear weapon possessor states, and the subaltern nature of former colonial island communities who have been affected by nuclear warfare (Banivanua Mar, 2016; Fry, 2019). For instance, Alexis-Martin's ethnographic field notes from Kiritimati include numerous descriptions of anxiety and harm to health by

Kiritimati's residents, that are in need of further formal consideration.

While there are many challenges associated with the documentation of health effects from low levels of ionizing radiation exposure, a global perspective reveals that the cultural and social consequences are undeniable. Research for a doctoral dissertation at Massey University found that New Zealand test veterans suffered 'psychological fallout', exhibiting 'more depressive symptoms' than a control group. The study suggested anxiety about the ongoing and potential health implications of their exposure to the tests caused a form of 'chronic anxiety' (Johnson, 2009). Fijian veterans speaking to Maclellan (2017a) and Tubanavau-Salaluba (1999) reported that the fear and stress experienced during the tests caused psychological distress. In interviews, i-Kiribati civilians similarly recall the terror induced by the nuclear explosions, which has caused some to feel persistent anxiety (e.g. Tetua, 2018).

While Malden Island was uninhabited during the nuclear tests, and remains so (except for authorized visitors), it is a site of important cultural heritage. It has prehistoric Polynesian ruins, including *marae* (shrines), considered 'the best preserved relics from the pre-European period' (Living Archipelagos, 2007; also Resture, 2012). Also home to remarkable bird and fish biodiversity, Malden Island is part of the Kiribati's Southern Line Islands Marine Reserve; commercial fishing is banned in its waters (Howard, 2014; National Geographic, 2018). A 2017 Chatham House report argues that compliance with international norms on cultural heritage requires addressing the risks and impact of nuclear weapons (Aghlani, et al., 2017). Thus, even though Malden Island is uninhabited, there is value in assessing the potential impact of the nuclear tests on the island's cultural and environmental heritage. There are also ancient Polynesian burial sites on Kiritimati (Langston, 1993).

The potential humanitarian effects of the UK and US tests may not have been limited to the test participants and residents of Kiritimati. Residents of Tongareva/Penrhyn (750 miles from Kiritimati), Rakahanga (850 miles) and Manihiki (900 miles) atolls in the Cook Islands recall seeing flashes from nuclear tests at Kiritimati during the UK nuclear tests. Tauariki Meyer, who grew up on Rakahanga later wrote that when she was 10 in 1957, she saw a 'flash of light brighter than the sun. Shortly after the ground shook ... That evening the whole sky turned red [and] it stayed like that for about a week ... A few days after the blast our lagoon changed colour and all of the fish died floated to the surface...' (Bolton and Mason, 2020).

Displaced i-Kiribati people now resettled on Wagina Island in Solomon Islands believe their forced relocation, 1963–1964, was administered by the British 'to escape the aftermath impacts of Britain's nuclear activities on Christmas Island' (Tabe, 2019, p. 5). They report that while living in the Phoenix Islands, about 1,000 to 1,300 miles southwest of Kiritimati, they saw 'a huge bright light in the sky', which 'caused many of the coconut trees to die' (Tabe, 2011, p. 31). The group of 1,000 people 'encountered many challenges when they arrived on Wagina given the

geographical, environmental, and cultural differences' (Tabe, 2019, p. 8). Colonial archives on the relocation, ostensibly motivated by drought, are fragmented and difficult to access.

In 1957 the New Zealand National Radiation Laboratory (NRL) began establishing a fallout radiation monitoring network across the Pacific. The network became fully operational in 1960. From 1989 to 1994, the NRL published a comprehensive multi-volume history of fallout from atmospheric testing on countries in the South Pacific and New Zealand. During the period of the 1962 US tests at Kiritimati, NRL detected low levels of fallout deposition in Cook Islands, Kiribati (Tarawa), New Zealand, Niue, Samoa, Tokelau (a non-self-governing territory administered by New Zealand) and Tuvalu (see online data Tables S4 and S5; Matthews, 1992/1993, 1994). Notably, the NRL detected that 'debris reached Penrhyn [in Cook Islands] within 3h of detonation', following the 670 kiloton *Questa* shot in the US Dominic I series, registering the highest gamma radiation levels in the network that year. This undermines the US government claim that Dominic I caused 'little or no fallout problem' (DNA, 1983, p. 3).

NRL repeatedly stated that low-level exposure to ionizing radiation from fallout from UK, US and French tests in the South Pacific 'constituted no public health hazard'. But given that there is no threshold below which radiation is safe, a 1993 NRL report distanced itself from its earlier certainty, estimating an individual effective dose commitment of ionizing radiation of 1.1 mSv in the South Pacific from all fallout from all atmospheric tests (not just the ones in Kiribati). According to the most widely used scientific BEIR VII model (National Research Council, 2006), this dose would increase the cancer rate by about 1.1 per 10,000 people alive in the South Pacific during the period of atmospheric testing. NRL did not report the dose specifically resulting from fallout only from the UK and US atmospheric tests in Kiribati. (Matthews, (1992/1993); see also Matthews, 1989, 1994). As Ruff (2015, p. 805) notes, within the Pacific, the 'heightened vulnerability to radiation exposure as a result of traditional indigenous lifestyles and food sources adds further layers of jeopardy, dispossession and pressures on cultural well-being to the discrimination of indigenous people being disproportionately put in the front-line of harm's way by nuclear testing'.

Environmental consequences

Kiritimati and Malden Islands are sites of great biodiversity. Kiritimati has a large lagoon and reefs that are home to '83 species of coral, 235 species of fish, two marine reptiles and marine mammals'. It is known worldwide by sports fishing enthusiasts for its abundance of bonefish, which spawn in the area. Kiritimati hosts an 'estimated bird population of 6 million made up of 18 species of sea birds, two land bird species and 18 species of migratory birds' (Office of Te Beretitenti, 2012, p. 2). Indigenous conceptions of the environment in the Pacific see the land, wildlife, plants and waters as more than simply a backdrop for human life or its

instrumental uses for people (Qilo, 2005; Teaiwa, 1994). The environment has an intrinsic, sacred worth.

There has never been a sufficiently comprehensive, public, and independent analysis of the environmental impact of nuclear testing at Kiritimati, nor Malden Island. The scale of contamination and its potential long-term impact are in dispute (See online data Table S6). Nevertheless, there is extensive evidence that the tests killed and maimed wildlife and damaged vegetation at the time (MacLellan, 2017a). Ernest Cox, a civilian who worked for the UK AWRE recalled flying to Malden Island following the 1957 Orange Herald test: 'We noticed no flies, no movement of lizards and no booby birds. We found several dead birds and, in the distance, we heard one of the three wild pigs ... It was badly burnt and was going around in circles, blind'. Returning to camp after spending two days on Malden Island, he found he had received a dangerously high dose of radiation: 'Two thirds of my body was covered in blisters'. According to MacLellan, the tests on Malden Island left 'significant hotspots of fallout' (MacLellan, 2017a, pp. 150–151). Eyewitness reports suggest that one of the 1957 tests killed fish as far away as the Cook Islands (MacLellan, 2017a).

An official report by US military observers of the 1957 *Grapple X* test records visiting the southeastern point of Kiritimati after the explosion: 'timber and debris thrown up onto the beach were burning with a great deal of flame ... [B]irds were observed to have their feathers burnt off, to the extent that they could not fly. Dead fish were reported to have washed ashore' (quoted in MacLellan, 2017a, pp. 213–214). Contemporary film footage of the *Grapple X* test depicts scorched vegetation (CRTukker, 2008). UK test veteran Kenneth McGinley says that following the *Grapple X* test, 'Before we went off duty, we were ordered to kill the birds which had been injured by the explosion. Some were still flying around but they were blind as their eyes had been burnt out' (CTBTO, 2012). Fijian veteran Anare Bakale also remembers visiting the southeastern point two weeks after a test: 'The whole place look dry and black. Dead fish were floating in the sea. It was so horrifying ... The plants were ... withered as if they had been watered with boiling water. Nothing was left. Everything from the stem to the leaves disappeared. Only the sand was left' (MacLellan, 2017a, p. 214).

The US government flew 'rabbits and monkeys' in the vicinity of its test detonations at Kiritimati 'for experiments on the effects of the bursts on the eye' (DNA, 1983, p. 145). They also sank rafts used for targeting the offshore airdrops 'if they were radiologically hot, although they were generally only slightly above the background' radiation' (DNA, 1983, p. 145).

The UK Ministry of Defence claims that environmental monitoring was adequate during the time of the British tests, confirming 'that levels of radioactivity on land and sea were negligible and not a danger'. The monitoring effort included 'pumped air, sticky paper, rainwater collectors and fish sampling' of an area within 2,500 km from Kiritimati. The 2016 Decision of the *UK Ministry of Defence vs. Abdale et al.* case in the UK War Pensions and Armed Forces

Compensation Chamber (WPAFCC), backed the Ministry of Defence's claims. Nevertheless, it acknowledged that sticky paper samples taken during the *Grapple Y* and *Z* found high contamination readings tests at the Decca Master Site, Vassess Bay, two sites 'on the uninhabited southern coast of the island' and at the Main Camp (now the site of the Captain Cook Hotel). (WPAFCC, 2016). Former UK Ministry of Defence official John Large has analyzed the many reports of fallout from the *Grapple Y* test, concluding that it contaminated an area of 80 to 160 kilometers from ground zero – including Kiritimati and naval ships anchored offshore – with irradiated water and debris (European Court of Human Rights, 1998).

Similarly, a review by the US Defense Nuclear Agency asserted that environmental monitoring during Operation Dominic I was sufficiently rigorous, taking samples of air, water, coconuts, fish, crab and lobsters, particularly in the inhabited areas of Kiritimati (DNA, 1983). In denying a US veteran's compensation claim in 2004, a judge with the Board of Veterans' Appeals stated, 'no fallout from any of the DOMINIC nuclear detonations was detected at Christmas Island or the surrounding waters' (Lyon, 2011). Nevertheless, US monitoring did detect fallout from the tests dispersed as far as Penrhyn Island (now in the Cook Islands), as well as Palmyra, Washington and Fanning Islands (now in Kiribati) (DNA, 1983; see also the New Zealand NRL reports: Matthews, 1989, 1992/1993, 1994).

Members of the Kiritimati Survivors Association fear that there may be contamination in the fish that they eat and desire verified information on the potential risks. Long-time residents of Kiritimati recall that 'in the 1980s', people avoided eating reef fish and land crabs, fearing contamination risks. However, they say that many people now eat them (interviews of government officials with Matthew Bolton, Kiritimati, Kiribati, January 2018). In other Pacific contexts, research has shown dangers of ciguatera fish poisoning resulting from damage to coral reefs caused by nuclear testing, with subsequent 'nutritional, social and economic implications, interfering with local inshore, largely subsistence, traditional fishing and increasing dependence on imported foods, with their exacerbation of risk factors for chronic disease' (Ruff, 2015, p. 793).

There have been several environmental studies of radiological conditions since the end of the UK and US tests, which have varied in scope, methodology and conclusions. The more comprehensive surveys have found 'traces of residual contamination ... in a few localised areas' particularly where aircraft and clothes had been washed on Kiritimati (McEwan et al., 1981, p. 11) and at the tethered balloon test site, including plutonium, at the southeastern tip of the island (1998 Aspinwall and 2004 Enviro reports, summarized in: WPAFCC, 2016). In inhabited areas, studies 'are consistent in not disclosing significant radioactive contamination' (1998 Aspinwall and 2004 Enviro reports, summarized in: WPAFCC, 2016). A 1981 survey by New Zealand's NRL estimated that the individual effective dose from ionizing radiation for a resident of Kiritimati was 0.1 mSv a year, from all sources, consistent with 'global fallout levels' and

'cosmic radiation'; that is, not specifically due to the UK and US tests on the atoll (McEwan, et al., 1981).

However, all of the major technical studies were paid for by the UK and US governments, rather than an independent party and there is no ongoing radioactive monitoring effort. None of the studies are available on the internet (in preparing this article the authors have uploaded the McEwan et al., 1981 study to Pace's International Disarmament Institute website). Nor were they available at the office of the Kiritimati Wildlife Conservation Unit, which collects scientific and cultural research on the island. Therefore, the methodology, scope and detailed findings of these studies are currently unavailable to Kiritimati's people, relevant government agencies, academia and civil society. In addition, it appears that the surveys focused on the inhabited areas of Kiritimati, neglecting detailed consideration of the rest of the atoll, or of Malden Island. At the southeastern point of Kiritimati, the location of the two UK tethered balloon tests, satellite images available on Google Maps today reveal craters. The southeastern point is currently uninhabited and located 50 km from the nearest population center in the northern part of the island. During, and for some time after the testing period, access to the military areas and testing zones of the island was restricted (Pickford, 2013). Today, though far from the inhabited areas and a wildlife reserve, there are no restrictions preventing Kiritimati residents and/or tourists from visiting the southern tip of the island. A road passes close to the craters but few local people know that this place was where devices tests were tested.

Appellants in the *Abdale* case challenged the International Commission on Radiological Protection (ICRP) standards used by the UK Ministry of Defence to determine acceptable risk levels of radiation exposure, summoning expert witnesses who argued that the ICRP model inadequately accounted for long-term exposure to low levels of radiation, particularly as a result of ingestion or inhalation of radioactive materials. In their Decision, the Judges were unconvinced by this evidence, suggesting that the Appellants' expert witnesses were biased by association with civil society initiatives questioning the ICRP model (WPAFCC, 2016). A good review of the debate on ICRP standards as applied to low levels of ionizing radiation is available from Ruff (2017).

However, the court cases have drawn attention to the potential harm to people who were on Kiritimati during the UK nuclear tests. The level of proof required in a civil court case may not be the appropriate standard for determining whether governments should take mitigating and remediating measures to protect the public from risk. A precautionary approach to the potential health and environmental risks at Kiritimati and Malden Island might examine emerging scientific research offering nonlinear models of radiation effects as supplementary to the ICRP model (e.g. Alexis-Martin, 2016b; UNSCEAR, 2017). Kiritimati is becoming an increasingly popular destination for sports fishing and bird-watching. Any future assessment of environmental contamination might consider the implications for visiting tourists.

Beyond potential radioactive contamination, the military presence on Kiritimati left other toxic legacies. The British military regularly sprayed the island (including service personnel) with DDT from airplanes (DNA, 1983; Maclellan, 2017a). At the end of the British and US deployment, vehicles, equipment, waste and toxic chemicals were abandoned on the island and reefs. There is also unexploded ordnance (UXO) contamination on Kiritimati in areas of former firing ranges, including publicly accessible beaches (Francis, et al., 2011; also, Matthew Bolton's January 2018 conversations with government officials).

Policy responses regarding victims

Policy responses addressing the humanitarian consequences of UK and US nuclear weapons tests in Kiribati have been haphazard. At worst, the UK and US governments have had policies of systematic denial, providing little assistance to victims. At best, Fiji and New Zealand have provided recognition of the harm to survivors and provided limited assistance.

Most i-Kiribati survivors who have remained in Kiritimati live in the village of Tabwakea (one of the earlier local settlements on the island). About 20–30 of them formed the Association of Cancer Patients Affected by the British and American Bomb Tests. Leaders of Kiritimati's Association have travelled widely around the world to raise awareness of the legacies of the UK nuclear weapons testing program. The Association has also conveyed the story of the nuclear tests to younger generations and has communicated with academics at universities in Australia, Germany, Japan, New Zealand, UK and USA. These scholars have tried to communicate survivors' concerns to authorities and the public outside Kiribati. The Association advocates for compensation from the British and American governments. Given the lack of response from the US and UK, they have called on the government of Kiribati to step in with support. Teeua Tetua (2018) said the desire for compensation was 'not about money, but about doctors and medicine' – they desire help to address their health problems. At a workshop held in Kiribati's capital, Tarawa, in 2005, the Pacific Conference of Churches and Kiribati Protestant Church called for 'proper procedures and mechanisms regarding compensation, health insurance and medical treatment for the victims and their families' (Pacific Conference of Churches, 2005, pp. 7).

At the September 2017 Pacific Islands Forum meeting in Samoa, Kiribati's President Taneti Maamau acknowledged the growing calls for compensation by victims of nuclear weapons testing, stating that he has 'taken up the issue of Christmas Island with the proper authorities' (Maclellan, 2017b). In Kiribati's 2020 Universal Periodic Review in the Human Rights Council (HRC), Marshall Islands recommended Kiribati 'Address the human rights impacts of nuclear testing by monitoring, assessing and responding to continuing rights issues' (HRC, 2020a, p. 14, recom. 80.44). Kiribati 'noted' the recommendation rather than accepting it, but it will be subject to HRC monitoring (HRC, 2020b). The World

Council of Churches (WCC) made similar, though more detailed, recommendations (HRC, 2020c).

When requesting Fijian troops' participation in Operation Grapple, the UK government indemnified the colonial-era 'Government of Fiji against claims for pensions to which the men of the Fijian Military Forces or their dependents may become entitled to as a result of death or injury sustained by them during their service on the Nuclear Weapons Testing Base at Christmas Island' (Maclellan, 2017a, p. 105). However, to date, the UK government has refused to provide pensions, cover health costs or provide compensation to the Fijian test veterans. Now that Fiji is independent, the UK asserts it is not legally-bound to honor commitments made to the colonial administration. However, Maclellan (2017a, p. 226) argues the colonial-era policies 'have a clear moral force, showing that the British authorities understood that they had an ongoing responsibility to address any injury or illness to the Fijian military personnel ... as well as to their families, widows and orphans'.

The Fiji Nuclear Veterans Association was established in 1999 by 300 test ('Kirisimasi' in Fijian transliteration) veterans and family members and is registered as a Fijian NGO. It maintains records on all the test veterans, spouses and descendants (Ah Poy, 2018). Also in 1999, the Pacific Concerns Resource Centre in Suva published the first collection of testimonies of Fijian test veterans in 1999 (Tubanavau-Salaluba, 1999). Research for the book later developed into Maclellan's (2017a) definitive history of the UK nuclear weapons tests at Kiritimati and Malden Islands, *Grappling with the Bomb*. Maclellan is now collaborating with the filmmaker Torika Bolatagici (2018) to produce an hour-long documentary on the Kirisimasi veterans. The PCRC also supported the participation of Kirisimasi veterans in global meetings on the rights of survivors of nuclear weapons use and testing.

Given the strong tradition of loyalty to the British Crown among Fijian veterans of the colonial military, the 'sense of betrayal' is 'palpable' (Maclellan, 2017a, p. 5). 'I can say that Britain murdered us', said former Able Seaman Pita Rokaratu, a test veteran who died in 2012 (Maclellan, 2017a, p. 312). Paul Ah Poy (2018) stated, 'We want recognition and a proper pension' from the UK government. He served the Queen, he said, now 'I expect her and her great people to help. Children are dying, soldiers and sailors can't have children. We don't know what's wrong with them'.

In 2015, after decades of Fijian veterans' advocacy, the Fijian government provided one-off grants of about US \$5,000 for each veteran (or their surviving family). Veterans also receive a US\$50 monthly pension and help with medical bills (Maclellan, 2017a). Speaking at the ceremony announcing the grants, Fiji's Prime Minister Josaia Voreqe Bainimarama said, 'Fiji is not prepared to wait for Britain to do the right thing ... We need to erase this blight on our history. We need to lift the burden on our collective conscience ... [T]hese men have been denied justice long enough' (Maclellan, 2017a, p. 324). The Fijian government stressed that the payments were a form of assistance, not compensation, which remained the responsibility of the UK

government. However, Paul Ah Poy (2018) said that many veterans living in Fiji's 'outer islands' have difficulty accessing government clinics. In 2017, in a statement to the UN, Fiji lamented the 'tragic health circumstances' of Fijian test veterans, who have been 'denied support and recognition from colonial authorities'. (Prasad, 2018). In recommending ratification of the TPNW, the Fijian Standing Committee on Foreign Affairs and Defence (2020, p. 10) noted 'Fiji's position is the result of our first-hand experience of the destruction ... and long lasting effects that nuclear weapons have had on Fijians who remain without victim assistance and reparation, as well as environmental degradation'. Fiji ratified the TPNW on 7 July 2020.

Similarly, in the Cook Islands, Tauariki Meyer engaged in a long but ultimately unsuccessful campaign for compensation from the British government for health problems she attributed to fallout on Rakahanga atoll from Operation Grapple tests (Bolton and Mason, 2020).

Nuclear veterans in the UK, US and New Zealand have also engaged in a long struggle pushing for information, recognition, compensation and support, with varying results. The government of New Zealand has funded independent medical research on the effects of radiation, recognized the Kiritimati and other nuclear veterans with a special service medal, as well as health, war pension and other benefits (MacLellan, 2017a; New Zealand Veterans' Affairs, 2017b; New Zealand Veterans' Affairs, 2017a, pp. 218-219).

The US government recognizes US troops who participated in aboveground nuclear tests as 'Atomic Veterans'. They, and American civilians who participated in the tests, are eligible for compensation without providing evidence of their dose of radiation, if they develop any of a list of 21 'presumptive cancers'. They may also be eligible for compensation for a 'nonpresumptive cancer or condition', depending on the evidence of exposure they can provide (United States Department of Veteran Affairs, 2012). Nevertheless, US test veterans and their families report difficulties with the paperwork to make claims (Young, 2011). The US National Association of Atomic Veterans (NAAV) has supported test veterans applications for compensation (Smith, 2015). US veterans who were not 'onsite participants' at tests but were tasked with cleaning up nuclear fallout after the tests are not considered 'Atomic Veterans' and are not covered by the Radiation Exposure Compensation Act. i-Kiribati citizens are not eligible for US compensation, even if they develop the presumptive cancers.

'Here in Britain we lag shamefully behind', asserted John Baron (2008), Conservative Member of UK Parliament for Billercay, following a 2008 review of the UK's policy toward its nuclear test veterans. The British government still refuses to offer compensation to the overwhelming majority of personnel – military or civilian – who were negatively affected by its nuclear weapons tests in Kiritimati and Malden Islands. Illustrating the high standard of proof required by the UK government, in 2006 the US granted compensation to Roy Prescott, a British soldier who was seconded to the US Dominic I testing program, for his lung cancer. The UK persisted in denying that his cancer was caused by radiation

(MacLellan, 2017a). Following a campaign by the British Nuclear Test Veterans' Association (BNTVA, 2017), in April 2016 the UK government provided £25 million to the Aged Veterans Fund, some of which will finance a new Nuclear Community Charity Fund (NCCF, 2017), supporting research, care, education and memorialization efforts for British nuclear test veterans and their descendants. British atomic veterans have recently stepped up advocacy efforts, seeking recognition in the form of special medals. *The Daily Mirror* newspaper has supported their campaign, publishing a lengthy expose titled 'The Damned', which includes a virtual memorial and document archive (Boniface, 2020).

In April 2018, the 60th anniversary of *Grapple Y*, the heads of the New Zealand and Fiji test veterans associations wrote an open letter to the Commonwealth Heads of Government Meeting (CHOGM) in London, calling on the British government to 'provide compensation, medical support and environmental remediation to all people affected by Operation Grapple' (Sefton and Ah Poy, 2018).

Beyond compensation and health assistance, survivors of the UK and US tests in Kiribati have worked for other forms of acknowledgement of their suffering. In 2017, Kiritimati's Survivors' Association held a commemoration at the tennis courts where residents had gathered and sheltered under blankets during the tests (Tetua, 2018). The following year, Association members joined with British atomic veterans in unveiling a monument to those affected by the tests (Alexis-Martin, 2019c). Other sites of memory on Kiritimati (with the exception of a Peace Pole) commemorate the military institutions that carried out the tests – such as a British regimental marker at the turnoff for the Captain Cook Hotel – not those who were most affected by them.

Fijian test veterans express a desire for the testimony of their suffering to be heard and remembered. Paul Ah Poy (2018) said, 'I would like to tell those outside of Fiji that eventually one day we will succeed but we need everybody's help. Keep the issue alive – we will tell our children, you must tell your children'. Many Fijian test veterans are upset that the British government failed to conduct for them the appropriate customary practices – *Qusi ni Loaloa* ('wiping off the black paint') – that ritually end and express appreciation for a soldier's service (MacLellan, 2017, p. 156). In removing war paint from the soldier, said Paul Ah Poy, the ceremony would ritually 'remove all the ill feeling that that goes along with what we are suffering from' (Ah Poy, 2018). Similarly, New Zealand atomic veterans have called for apologies from the governments that participated in the tests (MacLellan, 2017).

Policy responses regarding the environment

Field research in Kiritimati revealed inadequate dissemination of information about the testing program and limited knowledge about the effects of ionizing radiation, even among government officials. Posters placed at Kiritimati's Captain Cook Hotel by companies contracted by the UK Ministry of Defence to cleanup toxic waste at Kiritimati elided key information about the testing program. For

example, one poster implied that the tests were 'carried out some 450 miles south' of Kiritimati (Enviros, n.d.). While this is true of the Malden tests, many tests were much closer to Kiritimati, even tethered to southeastern point of the island itself.

Suppression of information by the UK and USA has contributed to survivors' distress, many of whom long for recognition. 'If you hurt someone you should help them, because we are human beings', says Teeua Tetua (2018). 'It should be known by the world, the cruel things that have been done'. She says that there are few systems in Kiritimati for archiving and disseminating information about the impact of the nuclear tests and the potential health risks for those who may have been exposed to radiation. The Survivors Association have disseminated some information on the testing program and the potential health effects of ionizing radiation to residents of Kiritimati (Teatata, 2018).

As shown in online data Table S6, there have been several surveys of radiological conditions at Kiritimati. In 1964, after the completion of the test programs, the UK government conducted a 'final radiological survey and decontamination operations' at Kiritimati; it concluded that 'there were no areas presenting significant radiation or radioactivity hazards to human occupation' (summarized in McEwan et al., 1981, pp. 1–2). However, it is worth noting that in a parallel situation – at the Australian test sites – the UK government's transparency and thoroughness in assessing and remediating radioactive contamination was woefully inadequate (Hawkins, 2017; Royal Commission into British Nuclear Tests in Australia, 1985). This should at least lead researchers to examine carefully the UK government's claims. In 1977, the University of Washington Radiation Biology Laboratory found 'trace quantities' of 'eleven fallout radionuclides' at Kiritimati (summarized in WPAFCC, 2016, p. 65) and the following year, a University of the South Pacific study raised 'concern about risk and radiological hazard on Christmas Island' (Medford, 1978, p. 5).

In 1981, at the request of the UK government, New Zealand's NRL published its radiological survey of Kiritimati. The study's authors asserted that 'No site on the island was found to present a risk to the health of the resident population from radioactive contamination' (McEwan et al., 1981, Summary). However, there were weaknesses in the study's methodology. Samples for gamma radiation were taken at two-mile intervals along the road, instead of at smaller intervals and off-road. The number of fish (one each of 5 species) and land crab (two) samples collected were too low to offer statistically valid results. The study relied heavily on counts of radiation from Caesium-137 and long-lived Strontium-90, failing to measure other isotopes, such as Thorium-230, often found to be taken up by coral. Since 1981, there have also been technical advances in the scientific equipment used in radiological monitoring. Ideally, environmental assessment and monitoring should include both terrestrial and marine environments, include physical and biological samples and include all relevant radionuclides and persistent toxic chemicals. The authors of this article are unaware of any such surveys at Malden Island.

Given the weakness of these studies, in 1992, the inter-governmental Pacific Regional Environment Program asserted that it was 'critical to have Kiritimati Island reassessed for radioactive contamination' (Thaman and Neemia-MacKenzie, 1992, p. 89). In 1998, Kiribati raised concerns about the environmental contamination on Kiritimati with the UK government (Pacific Islands Report, 1998). The UK Ministry of Defence then commissioned environmental surveys by private environmental contractors Aspinwall, in 1998, and Enviros, in 2004. The UK Ministry of Defence funded private contractors in 2004 to conduct hazardous waste remediation on Kiritimati. However, other than disposing of radium dials on equipment, this cleanup effort did not deal with radioactive or UXO contamination, despite finding traces of plutonium in former military areas and the southeastern tip of Kiritimati (WPAFCC, 2016; see also Defence Estates, 2004; Kerr, 2009; Mater Environmental, n.d.). Residents of Kiritimati claim that additional military detritus remains offshore or buried underground (Matthew Bolton's interviews with governmental officials, January 2018, Kiritimati).

It is important to note that none of the policy responses to potential environmental contamination resulting from the UK and US test programs have addressed the sense of spiritual harm caused to the land and ocean as sacred entities in i-Kiribati and other Pacific traditional cultures.

Conclusions and the TPNW's policy implications

The global and national policy response to the humanitarian and environmental legacies of UK and US nuclear weapons tests in Kiribati have been patchwork and inadequate at best. Survivors – whether i-Kiribati residents of Kiritimati or atomic veterans from the UK, USA, New Zealand and Fiji – have struggled for appropriate recognition and assistance. The UK, and to a lesser extent, the USA, have avoided acknowledging the humanitarian and environmental costs of their test programs in Kiribati in part because they have seen survivors' stories as inconvenient to the deterrence narrative that nuclear weapons kept the 'free world' safe. Meanwhile, the lives of atomic veterans and residents of Kiritimati were profoundly disrupted by their encounter with the system of nuclear deterrence – it would be hard to argue their lives were made safer by nuclear weapons. The hegemony of the deterrence narrative, and the position of the UK and USA in the global system, has suppressed stories of test victims and environmental concerns.

However, the TPNW placed humanitarian and environmental considerations at the center of global policymaking on nuclear weapons. Kiribati's President Taneti Maamau (2020) said his country ratified because its 'atmosphere, ocean and land were heavily damaged, contaminated' by nuclear testing. The TPNW's prohibitions undermine the deterrence narrative, condemning nuclear weapons as morally, ethically and legally indefensible. The TPNW's positive obligations on victim assistance, environmental remediation and international cooperation and assistance (Articles 6 and 7) offer an opportunity to focus global and national

policy attention on the ongoing suffering caused by the nuclear tests in Kiribati, as well as the need for renewed assessment and monitoring of potential radiological hazards. The provisions will obligate Kiribati to assess the scope of radiological contamination of Kiritimati and Malden Islands and engage in appropriate remediation activities. They will also obligate Kiribati, New Zealand and Fiji to provide appropriate victim assistance to survivors of the nuclear tests under their jurisdiction. All states parties should engage in international cooperation and assistance – whether financial resources, scientific expertise, archival records, diplomatic support, recognition and acknowledgement – to help communities affected by the testing that took place from 1957–1963 in Kiribati.

Because Kiribati, New Zealand and Fiji are states parties and the UK and US are not, the TPNW affords an opportunity for affected states – rather than nuclear-armed states – to shape global victim assistance and environmental remediation policy. In an encouraging step, the 2019 Pacific Islands Forum called on regional institutions to ‘coordinate assistance ... addressing ongoing impacts of nuclear testing, including inter alia, human rights, environmental contamination, and health impacts’ in Kiribati and the Republic of the Marshall Islands (PIF, 2019, para. 31). At the time of writing, the Forum Secretariat was collaborating with other regional institutions to establish a Taskforce on Nuclear Legacy Issues in the Pacific.

The TPNW thus provides a humanitarian and human rights framing of the effects of nuclear testing, an alternative both to denialism and litigation model that has dominated UK and US approaches to addressing the consequences of nuclear testing in Kiribati.

Note

1. Unless used in direct quotations, this article generally uses post-independence names of people groups and places, i.e. Kiribati instead of Gilbert, i-Kiribati instead of Gilbertese, Kiritimati instead of Christmas. Where there is significant ongoing dispute over the name, we use an amalgam of the indigenous name and internationally-recognized name in the first instance (e.g. Aotearoa New Zealand, Maohi Nui/French Polynesia), though use the internationally-recognized legal name from then on, not to comment on the territorial status of colonial authority, but rather to assert that the currently-existing state has a legal and ethical responsibility for the, human rights of the people who live under its jurisdiction.

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Supporting Information

Additional supporting information may be found online in the Supporting Information section at the end of the article.

Table S1–S6

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