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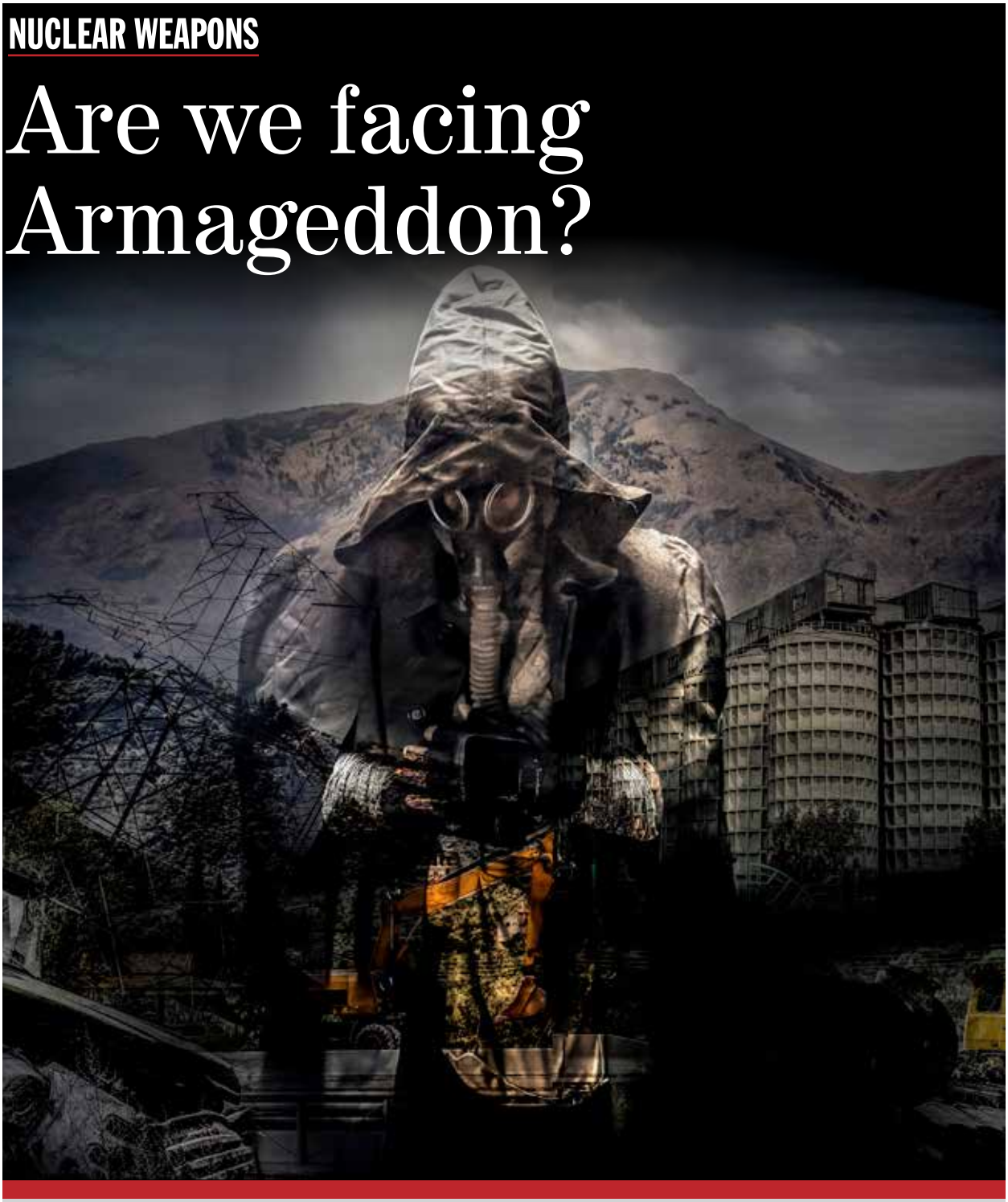
NUCLEAR WEAPONS

Are we facing Armageddon?



The central issue in both of the danger-zones described is US militarism and what form it might take coming from a commander-in-chief of US forces who is increasingly regarded by many as literally deranged.

By Michael Prior

Now, at time of writing, it is 72 years and 2 months since the world first saw its possible end as Hiroshima then Nagasaki were reduced to rubble by nuclear bombs. A select group of American scientists and soldiers had been privileged to attend a rehearsal at Alamogordo, New Mexico, a few weeks previously in July, 1945. This device contained plutonium as its central ingredient and was similar to the bomb dropped on Nagasaki less than a month later. The first bomb dropped on Hiroshima was based on uranium and it is sometimes suggested that it was used essentially as a test to ensure that it actually worked. Within the first two to four months following the bombings, the acute effects of the atomic bombings had killed 90,000-146,000 people in Hiroshima and 39,000-80,000 in Nagasaki; roughly half of the deaths in each city occurring on the first day. Many more would die from radiation effects in the years to come.

The next twenty years saw the four other 'great powers' as defined by the permanent membership of the UN Security Council, the Soviet Union, the UK, France and China, each build their own nuclear capability. The USSR had begun its own programme in the early 1940s, greatly aided by intelligence about the American bomb; whilst the UK was intimately involved in the American work. The French and Chinese worked essentially independently so that it took them much longer to achieve nuclear status. The Israeli bomb, probably first made by 1966, is the interloper in this great power procession. It was developed initially with close support from the French and also benefited from the supply of sensitive materials from the UK and the USA.

In 1951 whilst this nuclear build-up went on, one significant event occurred relevant to future events. In 1951, President Truman dismissed the head of the US army fighting in Korea, General MacArthur, for exceeding Presidential instructions. There remains some controversy over the precise basis for this action but it is widely accepted that MacArthur wished to use nuclear weapons to destroy the Chinese armies which had intervened on the side of North Korean forces. One version of his intent is that he wanted to use several bombs to create an impassable radioactive belt along the north/south border.

> "This balance gave rise to this doctrine of 'mutual assured destruction' whereby no nuclear power would initiate a nuclear strike given the certainty of complete annihilation in return."

Fig. 1: Davy Crockett nuclear recoilless gun

This dismissal is well-known. Less publicised is the fact that in the years of this war, 1950-53, the US air-force conducted a massive bombing campaign in the North. Air Force General Curtis LeMay, head of the Strategic Air Command during the Korean War asserted in 1984 that *"Over a period of three years or so, we killed off – what – 20 percent of the population,"* whilst Dean Rusk, a supporter of the war and later secretary of state, said the United States bombed *"everything that moved in North Korea, every brick standing on top of another."* After running low on urban targets, US bombers destroyed hydroelectric and irrigation dams in the later stages of the war, flooding farmland and destroying crops.

This campaign received very little publicity in the outside world but its memory has remained very strong in North Korea, sustained by a massive publicity campaign in the form of museums and memorials.

The principles behind the construction of nuclear weapons are relatively simple and widely known. You take two pieces of either the U-235 isotope of uranium or the Pu-239 isotope of plutonium which together exceed the so-called 'critical mass' of either and bring them together. Under the right circumstances, they will then explode. Or possibly they will just fizzle and blow apart. (This essay has no intention of going more deeply into the physics of this. A good place to understand more is the website http://blog.nuclearsecrecy.com/2015/04/10/critical-mass/). The size of the piece of metallic plutonium required is under 10 cm and weighs less than 11kg, usually much less. The Fat Boy plutonium bomb dropped on Nagasaki contained just 6.2kg of plutonium. The triggering mechanism which puts the pieces together, usually an explosive device,

increases the size and weight and is the most complex part of the bomb and, of course, there is a need for shielding to protect operators. However, nuclear weapons can be quite small. Probably the smallest was the Davy Crockett recoilless gun developed by the USA (who else?) and deployed in Germany in the 1960s. It had a maximum range of about 2km and a yield of around 20 tonnes of high-explosive. As the 'kill zone' for the weapon was about 1km, its operators may have been rather glad that it was never used.

Most modern nuclear weapons other than these low-yield devices are usually second-generation thermonuclear fusion or hydrogen bombs which essentially use an initial fission explosion to compress the hydrogen isotopes deuterium or tritium causing a fusion explosion.

This concept was developed in the USA in the early 1950s with the first test of an H-bomb in 1952. The Soviet Union followed rapidly with a first test in 1953 followed with some delay by the other 'great powers'. It is believed that Israel, India and Pakistan also possess H-bombs. The claims by North Korea to have exploded a fusion bomb are still debated.

These fusion weapons vary enormously in size from about 50 kilotons[1] to the largest bomb ever tested, the so-called Tsar Bomba, built by the Soviet Union which had a yield of around 50 megatons though apparently it was capable of 100 megatons. 50 megatons is about ten times the power of all the explosives used in WWII. (Fig. 2).

> "The US navy detected a Soviet submarine and, despite its being in international waters, began to drop depth-charges onto it."

The problem countries face in developing nuclear weapons, both fission and fusion, is not so much one of understanding their design or even of manufacturing them. It is obtaining the fissile materials which are at the heart of nuclear weapons, that is either Pu-239 or U-235 together with the deuterium required for an H-bomb.

The beginning point is uranium obtained simply enough from some form of uranium ore, various types of which are found throughout the world though high-grade ore is found only in Canada and Kazakhstan. This century at least 19 countries have engaged in the mining of uranium, invariably processed as U3O8 or 'yellowcake' though over 60% is produced by these two countries. In 2016, three African countries, Niger, Namibia and South Africa, mined uranium. South Africa produced 490 tonnes of uranium[2] far outstripped by Niger, 3479 tonnes, and Namibia, 3654 tonnes. Uranium metal currently costs around $220/kg.

Fig 2: The Tsar Bomba mushroom cloud seen from about 160 km

Naturally occurring uranium contains about 99.3% of the isotope U-238 with the remainder being the desired isotope U-235, desired because this is the basis for both weapons and fuel for nuclear power plants. The first problem for the weapons maker is, therefore, to increase the amount of U-235 in the mined uranium. The proportion of U-235 required in most nuclear power-reactors is 3.5-5%, though one type, the Canadian CANDU system, functions using natural uranium. The desired proportion in weapons is more than 85% though crude devices can be made with less.

Modern enrichment processes use the 1% mass difference between the two isotopic forms. The most common technology, gas centrifuges, involves spinning a gaseous uranium chemical, hexafluoride, in centrifuges so that the gas separates into lighter and heavier fractions, then bleeding off the lighter, enriched fraction, passing this to another centrifuge and so on until the desired degree of enrichment is achieved and the gas can be converted back to the metallic form. The process requires thousands of centrifuges to produce the highly-enriched uranium for weapons though smaller facilities are required for power-reactors.

All the nuclear weapon states have enrichment facilities though both Israel and India appear to rely upon plutonium for weapons production and only have experimental plants. Several other countries have or had commercial or experimental enrichment plants including Argentina, Australia, Brazil, Germany, Iran, Japan, Netherlands, South Africa and South Korea whilst North Korea is believed to have some enrichment capability. The South African capability was decommissioned when the country abandoned its nuclear weapons programme in 1989 though it has some ambition to develop facilities to complete a full civil fuel-cycle. Libya, which pursued a nuclear weapons programme for some years, though it was abandoned in 2003, also probably acquired some form of enrichment plant. The Iranian enrichment plant

at Fordow has been much reduced following the nuclear agreement signed in 2016.

Enrichment plants are hard to hide as they are large and require huge amounts of electricity. The manufacture of plutonium, in contrast, is done by irradiating natural uranium with neutrons in a nuclear reactor which produces Pu-239 by the transmutation of U-238 into U-239 which quickly decays into Np-239 which then decays into Pu-239. This is normally done inside a specially-prepared reactor, which can be quite small, and allows the withdrawal of uranium rods without shutting the reactor down. In principle, it can be done inside a civil power-reactor using irradiated fuel when the reactor is shut down, one reason why these are regularly inspected by the International Atomic Energy Agency, the guardian of the Non-Proliferation Treaty signed in 1968. The plutonium has to be then chemically separated from the remaining uranium. This process is much cheaper than enrichment and requires less elaborate equipment, one reason why, in addition to its superior fissile properties, plutonium is the preferred material for nuclear weapons.

Thermonuclear weapons require a third ingredient containing the heavy isotopes of hydrogen, deuterium and tritium, the latter in the form of an isotope of lithium, Li-6, which forms tritium in a fission explosion. The key compound is lithium deuterium which, perhaps surprisingly, is not hard to obtain. The trick is putting it together. The precise configuration of a thermonuclear device is complex and secret unlike fission weapons. High yield devices, that is those in the megaton range, involve a third fusion stage.

As noted, thermonuclear devices are the weapon of choice, except at the smallest sizes, for nuclear powers and all except Pakistan claim to possess them. Israel certainly has them though it refuses to comment and India may have a fully effective device. North Korea claims to have exploded a thermonuclear device, though this is debatable.

So, where is the world now in terms of possession of nuclear warheads?

Ploughshares, a US organisation devoted to eliminating nuclear weapons provides the following estimates:[3]

	No. of warheads
Russia	7000
U.S.A.	6800
France	300
China	260
U.K.	215
Pakistan	130
India	120
Israel	80
North Korea	<15

Ploughshares also reports on the delivery capability of these countries, showing that all, with the exception of the UK, possess a full range of capability including aircraft, cruise-missiles and ballistic missiles. The UK relies solely upon its Trident submarines and their missiles, one of which is always cruising the world. Increasingly the UK resembles a drunk in a bar, threatening everyone and no-one with nuclear destruction whilst onlookers look away, embarrassed, similar in some respects to its Brexit policy. No one, including its military leaders, has any coherent idea as to why Britain still spends vast sums on its nuclear weapons. The other countries are a different matter as they all, except North Korea, possess sophisticated delivery systems over both tactical and strategic distances. All could bring down the world.

> “Stanislav Petrov was the duty officer at the command centre for the Soviet nuclear early-warning system when the system reported that a missile had been launched from the United States followed by up to five more. Petrov judged the reports to be a false alarm and failed to pass on the warning.”

In the fifty years after the Hiroshima bomb, the main concern over nuclear war came from a potential conflict between the USA and the Soviet Union and, to a lesser extent, between the latter and China. The huge number of nuclear weapons systems still possessed by both epitomises this fear. It was widely feared that nuclear havoc could stem from a relatively small incident which would spark escalation. It was also feared that some kind of accident could trigger mass destruction given that both parties had sophisticated early warning systems designed to provide sufficient time for either to launch their missiles in response to a first-strike by the other. This balance gave rise to this doctrine of ‘mutual assured destruction’ whereby no nuclear power would initiate a nuclear strike given the certainty of complete annihilation in return. This doctrine may have given military strategists some sleep at night but was flawed by various problems, notably unauthorised actions by overseas nuclear carriers and failure of the early-warning systems.

The first was illustrated on 27 October 1962 during the Cuban missile crisis which involved efforts by the Soviet Union to install medium-range missiles in Cuba. The US navy detected a Soviet submarine and, despite its being in international waters, began to drop depth-charges onto it. The captain of the submarine, a diesel-powered, nuclear-armed Foxtrot-class submarine, B-59, which had had no contact with home for some days, believed that this attack suggested that war had broken out between the two countries and wanted to fire a nuclear torpedo at the attackers. This decision required the agreement of two other senior officers on board, and one, Vasili Arkhipov, refused. The submarine surfaced and proceeded back to Russia.

An example of the second occurred on 26 September 1983, just three

weeks after the Soviet military had shot down Korean Air Lines Flight 007, creating a major international incident. Stanislav Petrov was the duty officer at the command centre for the Soviet nuclear early-warning system when the system reported that a missile had been launched from the United States followed by up to five more. Petrov judged the reports to be a false alarm and failed to pass on the warning. His decision is credited with having prevented an erroneous retaliatory nuclear attack on the United States and its NATO allies that would have resulted in large-scale nuclear war as the recipients would only have had a couple of minutes in which to decide whether or not to launch retaliatory missiles. Investigation later confirmed that the Soviet satellite warning system had indeed malfunctioned because of sunshine on clouds. Petrov was never rewarded for his actions and was later reprimanded for filing incomplete documentation.

Arkhipov died in 1998 and Petrov died in May, 2017. Let us hope that they both rest in peace having both saved the world.

One episode in the course of this long cold-war promised an end to the nuclear arms-race; the signing of the Non-Proliferation Treaty which entered into force in 1970. Opinion is divided as to whether this Treaty achieved one of its main components, the further proliferation of nuclear weapon states. Dire forecasts at the time that anything up to forty more countries could go nuclear have been dispelled. But four more countries have acquired such weapons whist one other, Israel, has refused to sign the Treaty and abide by its conditions. These four countries, India, Pakistan, Israel and North Korea, have either not signed the treaty or have withdrawn. Oddly, one other UN country, South Sudan, has also not signed, presumably an oversight.

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There is no such doubt over the failure of the second key component of the Treaty, Article VI which states:

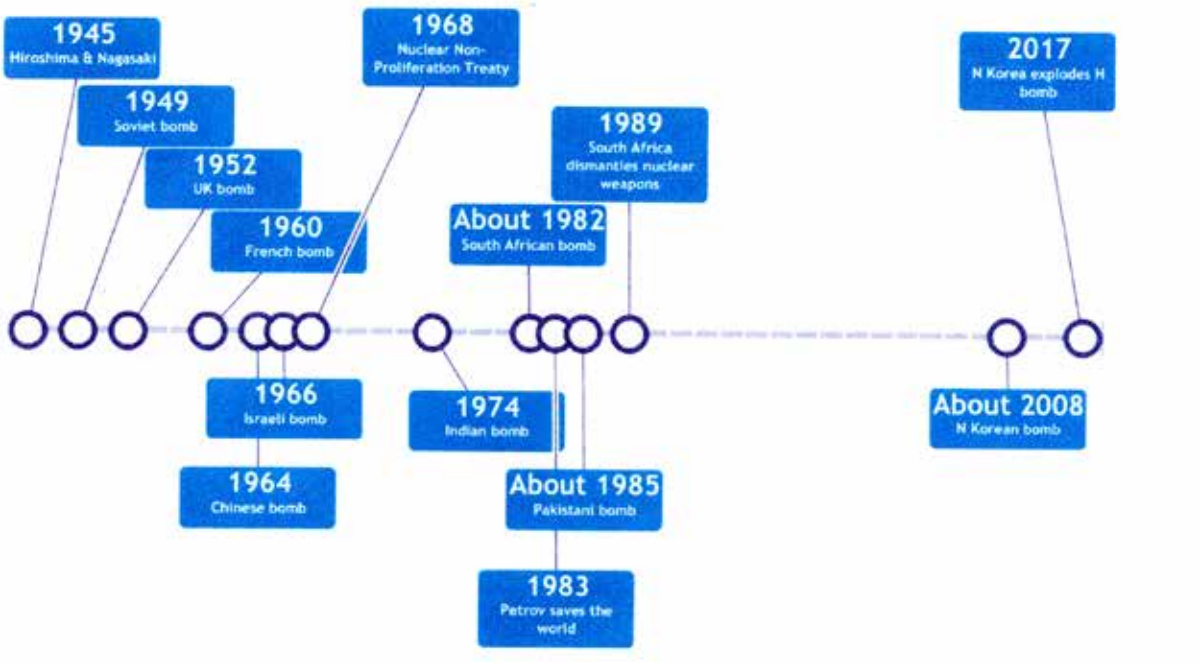
Each of the Parties to the Treaty undertakes to pursue negotiations in good faith on effective measures relating to cessation of the nuclear arms race at an early date and to nuclear disarmament, and on a treaty on general and complete disarmament under strict and effective international control.

A glance at the table above suggests that after 47 years, movement towards nuclear disarmament has been at best glacial whilst ‘good faith’ negotiations have effectively dried up.

One further aspect of this Treaty is important. Article IV states that:

1. Nothing in this Treaty shall be interpreted as affecting the inalienable right of all the Parties to the Treaty to develop research, production and use of nuclear energy for peaceful purposes without discrimination and in conformity with Articles I and II of this Treaty.

2. All the Parties to the Treaty undertake to facilitate, and have the right to participate in, the fullest possible exchange of equipment, materials and scientific and technological information for the peaceful uses of nuclear energy. Parties to the Treaty in a position to do so shall also co-operate in contributing alone or together with other States or international organizations to the further development of the applications of nuclear energy for peaceful purposes, especially in the territories of non-nuclear-weapon States Party



to the Treaty, with due consideration for the needs of the developing areas of the world.

Disputes over Iranian nuclear development have always centred around just what this Article implies, with Iran arguing that it has complete authority to develop facilities for the full uranium fuel-cycle required for an independent nuclear power programme, whilst its opponents, effectively the U.S.A. and Israel, argue that such a fuel-cycle will inevitably contain the potential for weapons-grade uranium enrichment and thus has to be curtailed in countries it regards as, potentially, engaged in weapons production. Similar arguments, though with less force, can be used with regards to the reactors used for plutonium productions as these may also be used for the manufacture of radioactive isotopes used in medical and scientific research.

The period when nuclear confrontation was almost wholly concerned with the US/Soviet engagement passed in the early 1990s with the collapse of communism and of the Soviet Union. Presumably, the grim US missile-silo sites and their counterparts in Russia are still maintained in some state of readiness, though some have been decommissioned, and both countries still have patrolling nuclear missile submarines. However, the danger posed by these is largely that they will collide with the British Trident lone nuclear-missile submarine as it drunkenly roams around threatening anyone and no-one.

In recent months, however, the spectre of nuclear war has appeared in two parts of the world.

The most obvious of these concerns North Korea and the belligerent actions threatened by President Trump as a consequence of the Korean apparent acquisition of nuclear weapons. On 17 October, North Korea's deputy UN ambassador warned the UN disarmament committee that the situation on the Korean peninsula "has reached the touch-and-go point and a nuclear war may break out any moment". He went on to claim that all nuclear states were accelerating the modernisation of their weapons and "reviving a nuclear arms race reminiscent of [the] cold war era". He noted that the nuclear weapon states, including the United States, boycotted negotiations for the Treaty on the Prohibition of Nuclear Weapons that was approved in July by 122 countries at the United Nations.

Dates are important given that events may have overtaken even these comments by the time this article is published, perhaps catastrophically.

It is often taken for granted, certainly by the major nuclear states, that North Korea has no right to develop nuclear weapons and certainly there seems little real reason for it do so. On the other hand, the question seldom asked is by what right the USA maintains an enormous military presence so far away from its home territory. The most important of these is Guam, an island acquired by the US after victory in 1898 after the Spanish/American war. Legally in US law, it is an 'unincorporated and organized territory' of the United States situated in Micronesia in the western Pacific Ocean. In short, it is a colony, one of the 17 currently listed by the UN. It is over 9,600 km from California and has some 160,000 indigenous inhabitants.

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According to Wikipedia, US bases in the territory cover approximately 16,000 ha. or 29% of the island's total land area of 540 km^2. The military bases on Guam include a major base for the US 7th Fleet, the largest of the forward-deployed US fleets, with 60 to 70 ships, 300 aircraft and 40,000 Navy and Marine Corps personnel. It also houses the Anderson Air Base, which is the most important US air base west of Hawaii. Andersen is the only one in the Western Pacific that can permanently base US heavy strategic bombers. The number based there is unknown but, as Fig. 5 shows, they are there.

The US Marine Corps has several thousand personnel permanently based in Guam and there other army soldiers present. The US also maintains a large military presence in Japan, specifically Okinawa, probably as high as 50,000 personnel and has some 37,000 soldiers in South Korea. The 7th Fleet certainly has nuclear weapons as does Anderson Air Base. The presence of US nuclear weapons in Japan and South Korea is uncertain. Guam was an active base for the near-obliteration of North Korea in the early-50s and, presumably, together with its ability to threaten China, that remains as one of the reasons why it is still maintained at huge cost. Threats breed counter-threats and counter-counter-threats. However, the initial reason why North Korea fears America is fairly clear.

The second flashpoint for nuclear war is the Middle East, specifically the bellicose position of President Trump towards Iran and his allegations that, despite all evidence to the contrary, it is using its enrichment facilities to produce highly-enriched uranium, breaking the deal struck in 2015 between Iran and six world powers – the US, UK, Russia, France, China, and Germany – to curtail its enrichment. All other signatories refuse to accept that Iran is in breach of the agreement but Trump seems adamant. His argument appears to be based upon allegations about Iranian non-nuclear military involvement in the Middle East and this appears to be the key to the threats of fire-and-brimstone, though in an indirect way.

The main American allies in the region are Israel and Saudi Arabia, both of which have their fears about Iran. As Assad appears to be winning the civil-war in Syria and Iraq acquires a largely Shia government, Israel fears a corridor of support for Hezbollah, the main organisation representing Shia Muslims in Lebanon. As a political party, Hezbollah holds two seats in the Lebanese cabinet and conducts important social security measures in

the areas of Lebanon where it is strong. Its military wing has been engaged in numerous armed conflicts with Israel which have often resulted in, at best for Israel, rough equality. Hezbollah has been an important ally of Assad in the current civil war providing crucial military support. There is no doubt that its position in Lebanon will be greatly strengthened if Assad is victorious and it has an important ally in Iran

Israel has in the past never hesitated to attack facilities in other countries which it regards as inimical to its security particularly these connected with nuclear power. It has conducted numerous air-strikes against Syria in recent months whilst in 2007 it destroyed suspected nuclear facilities there. In 1981, it destroyed the partially-constructed Iraqi reactor at Osirak.

Meanwhile, Saudi Arabia is conducting its own war of extermination in Yemen against Shia rebels. Over 3 million civilians have been displaced in this war and there are reports of mass cholera outbreaks. A blockade of Yemeni ports has resulted in widespread starvation as Yemen imports 90% of its food. The U.S.A. is involved in the war, making airstrikes on what are claimed to be extremist Islamic targets; and it has admitted to having a small number of troops on the ground.

Naturally, the U.S.A. maintains a large military capability in the region, notably the 5th fleet based at Bahrain handily over the Gulf from Iran. It contains two carrier battle-groups, presumably nuclear-armed, as well as large marine forces. As with the 7th fleet, American eyes would probably glaze over if asked just why they maintain such a large military force in the area. Well, 'because… we're America' would no doubt be the answer. It also maintains a large airbase at Incirlik in Turkey which functions as part of NATO as well as other airbases in Kuwait, Bahrain and Saudi Arabia. Although unreported, at least some of these will support nuclear weapons in various forms.

It remains unclear just what military action Donald Trump proposes against Iran. It seems unlikely that it would initially involve nuclear weapons.

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However, Israel's propensity to destroy another country's nuclear facilities even if only led for civilian activity might encourage it to break cover with its own nuclear armoury given that Iranian sites are believed to be well-protected by ground-to-air defences. It is also possible that non-nuclear US attacks could provoke counter-attacks by the Iranian navy on the 7th Fleet. Although small in comparison with the mighty carrier-groups, it includes modern submarines, missile boats and a fleet of fast attack-boats carrying torpedoes which could inflict significant damage. What this might result in is hard to predict as is anything inside the head of Trump.

The other potential nuclear hotspot remains Kashmir where India and Pakistan are still locked in an apparently irreconcilable dispute. As both countries' governments edge towards different forms of religious extremism this could become another nuclear confrontation; but not yet, not yet.

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The central issue in both of the danger-zones described is US militarism and what form it might take coming from a commander-in-chief of US forces who is increasingly regarded by many as literally deranged. Would any US officer follow Arkhipov and refuse to obey an instruction to drop a nuclear missile on North Korea? Or Iran? How far will America go in reacting to Israeli and Saudi prodding over Iran? How will Trump react if Iran manages to drop a missile on to the USS George Washington? The answers to some or none of these many be clear before this piece is printed.

Meanwhile, my choir tries to find some hope in song. It is currently singing Hamish Henderson's Freedom Come All Ye, written in 1960 for the British Campaign for Nuclear Disarmament, a body which still functions, still campaigns. Henderson was a Scottish poet, socialist and soldier who fought with the Highland Division in North Africa and Sicily and became a passionate ant-war campaigner. It is set to a pipe-tune *The Bloody Fields* of Flanders which Henderson first heard played on the beachhead at Anzio.

It is written in Lallans, a British language of the Scottish lowlands and rejoices in a day when Britain will no longer send its army to kill overseas. Instead:

In yer hoos aa the bairns o Adam
Will find breid, barley-bree an paintit rooms

and

An the black lad frae yont Nyanga
Dings the fell gallows o the burghers doun.

We're still waiting for the black lad from Nyanga to come to our rescue. Just hoping. ■

References

1 1 kiloton equals the power of thousand tonnes of TNT. A megaton is a million tonnes
2 Data obtained from the World Nuclear Association Website at http://www.world-nuclear.org
3 https://www.ploughshares.org/world-nuclear-stockpile-report?