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The Waste From French Nuclear Tests in Algeria

Radioactivity Under the Sand

Analysis with regard to the Treaty on the Prohibition of Nuclear Weapons

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Foreword

When we think of nuclear testing, in our mind's eye we see pictures of big mushroom clouds hovering over the Pacific Ocean, the steppe in Kazakhstan, the desert in New Mexico or in Algeria. Most of these pictures were taken more than half a century ago, when above-ground atmospheric testing was still common practice among nuclear powers.

Things have improved significantly since then: explosive nuclear tests went underground from the mid-1960s onwards, and from 1998 onwards, only North Korea resorted to nuclear testing. All major nuclear powers – the US, Russia, France, the United Kingdom, China, India and Pakistan - declared some sort of testing moratorium before the end of the 20th century, and some of them signed or even ratified the Comprehensive Test Ban Treaty (CTBT) afterwards.

Thus, – at first glance – nuclear testing might seem as an obsolete practice of a foregone era, an aberration we left behind in the past century.

Why then re-opening this radioactive box again now? With their present case study on French nuclear tests in Algeria in the 1960s, Jean-Marie Collin of ICAN France (International Campaign to Abolish Nuclear Weapons France) and Patrice Bouveret of the French Observatoire des Armements provide ample technical and political reasons why we cannot and should not close the chapter of nuclear testing.

First, there is a radiological legacy, which applies to all former nuclear test sites. A nuclear detonation produces substantial radioactive waste streams, which represent a significant health risk for the adjacent populations for many years or even decades after the explosion. What does the local population know about these toxic remnants in the Algerian Sahara? How much information is available to civil society in general? Moreover, how did the French and Algerian government deal with this issue?

Second, the global nuclear test moratorium is in danger – at this point, we are not even able to rule out a return to large-scale nuclear testing in the 21st century. While the US has been suspecting Russia and China of conducting secret «subcritical tests» at their test sites for a few years now, there were rumors in June 2020 that the Trump Administration is planning a full-scale underground nuclear test soon. We need to assume that such a test would be followed by Russian, Chinese, Indian and Pakistani tests as well, as especially Beijing and Delhi tied their nuclear restraint to the American testing moratorium. Thus, it is vital to keep a close eye on nuclear tests in the years to come.

Third, what this case study shows once again is the power asymmetry and injustice, which we find throughout nuclear history. It is no coincidence that France tested its first nuclear weapon in Algeria, which was still a French colony in 1960. As a matter of fact, the

screenplay for nuclear testing very often followed the same pattern: the decisions to test were made in the centers of power of the industrialized world – Washington, Moscow, Paris or London – while the tests were then carried out somewhere in the «periphery», on indigenous land, where the «Wretched of the Earth» (to quote the famous political philosopher Frantz Fanon) lived.

Therefore, with our study, we aim to contribute to a discussion, which addresses all three dimensions of nuclear testing: its irresponsibility from an environmental and public health point of view, its destabilizing effects from a political standpoint, and its injustice from a post-colonial point of view.

The authors refer to the Treaty of Prohibiting Nuclear Weapons (TPNW) as an effective tool to deal with all three dimensions mentioned above, as the treaty contains positive obligations for the decontamination of affected areas and a clear prohibition of any form of nuclear testing; furthermore, the TPNW ends the nuclear double-standard practice, as its rights and obligations are the same for all state party members to the treaty.

As of June 2020, the TPNW has 81 signatories, and 38 ratifications. The treaty will enter into force once it achieves 50 ratifications.

However, the next months and years will not only be crucial for the TPNW. For the first quarter of 2021 alone, the nuclear calendar foresees the expiration of the most important bilateral arms control treaty (New START) and the 50-year-review of the most important (and most contested) multilateral non-proliferation and disarmament treaty (the nuclear non-proliferation treaty, NPT). Should the New START renewal fail, the US and Russia risk falling back into a dangerous nuclear arms race. In addition, if the NPT review process does not yield tangible results, further countries might consider acquiring nuclear weapons in the years to come.

With our study, we hope to inject some fresh ideas into the coming nuclear debate and hope to move this discussion in a positive direction.

Berlin, July 2020

Giorgio Franceschini
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Summary

The Hoggar massif is located in the west of the Algerian Sahara. Prehistoric men have left stunning rock carvings there. The men of the 20th century left nuclear waste.

Between 1960 and 1996, France carried out 17 nuclear tests in Algeria and 193 in French Polynesia. In Algeria, atmospheric and underground tests were carried out at the Reggane and In Ekker sites, in an atmosphere of secrecy and conflict between an Algerian nation under construction and a colonial power seeking strategic autonomy. A majority of the tests – 11 – were carried out after the Evian agreements (18 March 1962), which established Algeria's independence.

It was not until the 1990s that the first independent studies relating to some of the dark events of that period finally became available. Disclosure about accidents that happened during some of the tests, about the risk that populations and soldiers were exposed to, in Algeria and in Polynesia alike, led to the implementation of the law *«on 5 January 2010, granting recognition and compensation for the victims of French nuclear testings»*. But this law does not take into account any environmental consequences.

In French Polynesia, the strong mobilization of many associations has enabled the environmental consequences to be taken into account and the first remediation steps to be put in place. For Algeria, the situation is different. Due to a tumultuous Franco-Algerian relationship, the absence of archives, the absence of registers of local workers who participated in the tests, the data on the consequences of the tests remains patchy and incomplete. It was only in 2010, thanks to independent expertise, that a map from the Ministry of Defense was revealed, showing that the European continent was also affected by fallouts from the nuclear tests carried out in the south of the Sahara.

Even if today we have better knowledge of nuclear test accidents and their consequences, there is still a lack of key information as to the existence of large quantities of nuclear and non-nuclear waste to ensure the safety of populations and environmental remediation.

From the beginning of nuclear tests, France set up a policy of burying all waste in the sands. The desert is seen as an «ocean», from a common screwdriver – as it is shown in the study by «Secret Defense» documents and photos - to planes and tanks: everything that may have been contaminated by radioactivity had to be buried. France has never revealed where exactly this waste was buried, or how much of it was buried. In addition to these contaminated materials, voluntarily left on site to future generations, there are two other categories: non-radioactive waste (resulting from the operation and dismantling of the sites and the presence of the Algerian army since 1966) and radioactive materials emitted by nuclear explosions (vitrified sand, radioactive slabs and rocks). Most of this waste is left in the open, without being secured in any way, and is accessible to the local population, creating a high risk for health and environmental damage.

A 1997 report from the French parliamentary office for evaluating scientific and technological options [Office parlementaire d'évaluation des choix scientifiques et technologiques] stated «There is no precise data on the issue of waste materials which could have resulted from the series of experiments conducted in the Sahara«.

The current study «Radioactivity Under the Sand« is an initial response and thus establishes an inventory of the waste materials in these areas, particularly radioactive ones. This waste should be subject to in-depth identification and recovery work in these areas by specialised teams involving independent observers.

A work that now appears to become possible with the adoption of the Treaty on the Prohibition of Nuclear Weapons (TPNW) on 7 July 2017. The articles 6 («Victim assistance and environmental remediation») and 7 («International cooperation and assistance») include positive obligations to ensure that contaminated areas are fully known – to protect people, future generations, the environment and wildlife from this pollution. This study is therefore also part of the implementation of this right currently being created.

France and Algeria are on opposite sides in this regard. One is a «nuclear-weapon» and the other a «non-nuclear-weapon» State according to the Nuclear Non-Proliferation treaty, and they have opposing views regarding the TPNW. France has constantly denounced it. Algeria has participated in TPNW negotiations, signed the treaty and begun its ratification process. Once the treaty is ratified by the Algerian State and enforced (expected for 2020-2021), Algiers will have to start implementing its positive obligations (articles 6 and 7).

Even if France refuses to bind itself to the TPNW, it could participate in this process. Indeed, the opening of «a new chapter in their relationship«, according to Algiers› Declaration in 2012, like the ongoing initiatives (combined work group dedicated to compensation for the Algerian victims of French nuclear tests, the high-level Algerian-French intergovernmental committee) shows that this cooperative work can be carried out, without France breaking with its current position on the TPNW. There are several examples of inter-state cooperation in establishing aid programmes, even when these countries have had a turbulent history; just as there is at least one example of participation of a country in a programme for rehabilitation of the environment, even when, from a legal aspect, the country was not compelled to do so. These cases could set an example for the cooperation between France and Algeria.

This study thus proposes a set of recommendations (measures to enable discussions between the two countries in order to improve the humanitarian situation; measures concerning nuclear waste; health protection measures; actions to be taken among the local population; rehabilitation and protection of the environment) to bring about changes for this dark page of history between France and Algeria.

The «nuclear past» should no longer remain buried deep in the sand.

Introduction

Witnesses, who are still living with the humanitarian impact of nuclear weapons today, speak out and urge the international community to negotiate a treaty banning all nuclear weapons as soon as possible», December 2016.

Bruno Barrillot, co-founder of the ‹Observatoire des armements›,
recipient of the «Nuclear-Free Future Award 2010».

French political and military authorities waited almost 50 years before acknowledging the consequences for health and environment from the atmospheric and underground nuclear tests which were conducted in the Algerian Sahara and then in French Polynesia between 13 February 1960 and 27 January 1996.

The situation regarding the French nuclear test sites in the Sahara is special. Algeria is the only state to have gained independence while its «coloniser» was conducting tests on its territory. Of the 17 French nuclear tests in the Sahara, a majority (11 tests, all underground) were conducted following the Evian Accords (18 March 1962), which signalled Algeria's independence after a particularly deadly war.

In reality, Article 4 of the declaration of principles in the Evian Accords[1], dated 19 March 1962, relating to military issues, allowed France to use the sites in the Sahara until 1967: *«France will use for a period of five years the sites that comprise the installations at In Ekker, Reggane and all of Colomb-Béchar-Hammaguir, the perimeter of which is marked in the attached map, in addition to corresponding technical tracking posts.»*

However, considering the context, at the time there was no negotiation of any obligations for complete dismantling, for environmental remediation or for monitoring the health of people in the area. As a consequence, *«after seven years of varying experiences, the two sites at Reggane and at In Ekker were handed over to Algeria without providing for any procedures to control and monitor radioactivity.»*[2] It even appears that *«the political circumstances, which led to these two sites being abandoned, may explain the indifference,*

1 Published in the *Journal officiel [French Official Gazette]* no. 3019, 20 March 1962, p. 3030.

2 Christian Bataille, report no. 179 (French Senate), *L'évolution de la recherche sur la gestion des déchets nucléaires à haute activité [Developments in research into managing highly radioactive nuclear waste], Volume II: Les déchets militaires [Military waste]*, Parliamentary Office for the Evaluation of Scientific and Technological Options, 7 December 1997, p. 69.

that has been shown [by France] *in addressing these problems. Nevertheless, the fact remains that a certain lack of concern has been displayed, to put it mildly.»*[3]

The complex postcolonial relationship between these two countries has resulted in the environmental and health impacts of Saharan nuclear tests never really giving rise to official and scientific publications or to cooperation on this issue, either on the part of French or Algerian political authorities. It is therefore striking to note how little interest the environmental and health consequences from nuclear testing in Algeria have aroused over several decades, unlike what happened in French Polynesia – where France conducted 193 nuclear tests. Even today, these consequences remain a complicated subject to discuss.

However, it is necessary to take into account that, until the end of the 1990s, the priority for French and international non-governmental organisations was on stopping nuclear tests; this was achieved in 1995 when the United Nations (UN) adopted the treaty prohibiting all nuclear tests.

The first targeted research into the consequences of French nuclear tests commenced in 1990 with the work by the Observatoire des armements, under the direction of Bruno Barrillot. Faced with the lack of documentation and the power of military secrecy, the aim then was to shed some light on the nuclear testing programme and its consequences, by compiling the largest number of first-hand accounts about the different parties involved, the installation of sites, living conditions and the accidents that occurred both in the Sahara and in French Polynesia.

The adoption of the Treaty on the Prohibition of Nuclear Weapons (TPNW) on 7 July 2017 opened up a new means of legal recourse. This treaty supplemented the treaty on non-proliferation of nuclear weapons (NPT), in particular by prohibiting (article 1) the use, manufacture or acquisition by other means of nuclear weapons or threats to use nuclear weapons. Moreover, it introduces the particular feature of positive obligations with Article 6 («Victim assistance and environmental remediation») and 7 («International cooperation and assistance»).

The TPNW, which is expected to come into force by the end of 2020, is a treaty that, where its critics are concerned, cannot work without involving the nuclear powers. It is clear that, as long as those who possess nuclear weapons do not become parties to the treaty, the process of actual nuclear disarmament cannot really get underway. However, despite that, the TPNW can still start to take effect[4], with the implementation of various bans

3 *Ibid.*, p. 69.

4 The countries that have American nuclear weapons stationed on their soil (Germany, Belgium, Italy, the Netherlands, Turkey) should, as parties to the TPNW, have these weapons removed from their territory, which will constitute a real step in nuclear disarmament.

(assistance, investment, renouncing the advantages of «protection» from an allied nuclear power) and also with countries fulfilling their positive obligations.

By drawing on these first-hand reports, various sources of information and the archives, this study compiles an inventory of all the waste materials, in particular those which are radioactive, that were left by France in the Algerian zones of Reggane and In Ekker. The presence of this waste entails considerable risks to the health of local people and future generations; the environment and wildlife are also affected over the long term.

A 1997 report from the French parliamentary office for evaluating scientific and technological options [Office parlementaire d'évaluation des choix scientifiques et technologiques] stated «There are no precise data on the issue of waste materials, which could have resulted from the series of experiments conducted in the Sahara[5]«. This study is an initial response.

5 Christian Bataille, op. cit., p. 69.

1. French nuclear test sites

France launched a military nuclear programme with the creation of the Atomic Energy Commission (CEA - *Commissariat à l'énergie atomique*) in October 1945. A search was quickly undertaken at that time to find a site for experiments. The Kerguelen Islands, Clipperton Island or the Tuamoto Archipelago were mentioned, but these territories were considered too remote for technical reasons. After several reconnaissance missions were carried out in 1957, the Algerian Sahara was selected, despite growing troubles, on account of its proximity and its huge areas of desert that were sparsely populated. On 5 November 1959, Jules Moch, the French delegate to the United Nations, made the following statement about the choice of this site: *«The populations in all the countries bordering the Sahara: Morocco, Tunisia, and Libya, will be exposed to less risk than the inhabitants of California and Siberia who will not be at risk at all. The Sahara, more than any other region, is most suitable for this experiment, because the chosen site is both desert and much closer to France than the islands in the South Pacific.»* Two zones (Reggane and In Ekker) were designated as the sites for these experiments. Seventeen nuclear tests were conducted, as well as «supporting tests» that, while not involving a chain reaction, entailed dispersal of plutonium. A third zone (Colomb-Béchar-Hammaguir) was used for chemical tests and for propulsion of the missiles. Having been forced to leave Algerian territory when it became independent in 1962, the French authorities had to find a new location. This would be French Polynesia.

After decades of misleading statements, it was not until 2016 that a French president, François Hollande, while on a visit to French Polynesia, the backdrop for 193 nuclear tests, declared: »I recognise that the nuclear tests that took place between 1966 and 1996 in French Polynesia had an impact on the environment, and caused a plethora of health issues among its populace.»[6] Algerians are still waiting for France to issue such a statement acknowledging the impact of nuclear tests.

French nuclear testing in Polynesia

French Polynesia became the second site for France's nuclear tests as a result of it having to leave the Sahara as part of Algerian decolonisation. 193 atmospheric and underground nuclear tests would be conducted on the atolls of Moruroa (main nuclear test site from 2 July 1966 to 27 December 1995) and Fangataufa (from 19 July 1966 to 27 January 1996).

The islands of Moruroa, Fangataufa and Hao were going to become the backdrop for the gigantic works at the Pacific Test Centre (CEP): ports, airfields, bunkers and

6 Speech by the French President François Hollande in Tahiti, 22 February 2016.

housing would replace the coconut groves. While nature was changed, social fabric overall was completely disrupted with the arrival of several thousand people from mainland France.

From the outset, there were opponents of this «French bomb» in French Polynesia, such as the deputy John Teariki who gave an acrimonious speech during the visit by General de Gaulle on 7 September 1966: «Mr President, would you re-embark your troops, your bombs and your planes. Then, later on, our people suffering from leukaemia and cancer will be unable to accuse you of being the cause of their misfortune. Then, future generations of our people will not be able to reproach you for the birth of monsters and children with birth defects.»

The atmospheric nuclear tests would be halted, in 1974, partly because of the pressure from New Zealand and the legal action taken by this country at the International Court of Justice. Subsequently, until 1996, the Pacific Test Centre (CEP) went on to conduct 147 underground explosions on Fangataufa and Moruroa. On 25 July 1979, part of the Moruroa reef ridge crumbled into the ocean following the Tydeus *launch accident causing a tsunami, which swept away people who were working on the reef. The last nuclear tests were conducted between September 1995 and January 1996, following the decision by President Jacques Chirac to break off the moratorium agreed in April 1992 by President François Mitterrand.*

Over 25 years later, the islands have been certainly «cleaned» of visible waste, but radioactivity remains in the dozens of shafts that were dug. The Moruroa atoll will require constant monitoring from now on. As it is, a geo-mechanical monitoring system (Telsite program) continuously analyses seismic movements in the lagoon, as this is no longer stable as a result of the nuclear blasts. The risk is a real one. Apart from the fact that an astronomical quantity of radioactivity would be released into the Pacific, there is also the risk to civilian populations living on the shores of the Tureia lagoon (located 100 kilometres away) that a giant 3-metre wave could surge up within less than 10 minutes.

The Polynesian associations Moruroa e tatou *and* 193 *are working actively so that the story is not forgotten and the populations affected are finally recognised as victims.*

Law no. 2010-2, dated 5 January 2010, concerning recognition and redress for victims of French nuclear testing, covers all the tests, irrespective of whether they took place in Algeria or in French Polynesia, and applies to both civilian and military populations. However, the environmental aspect was removed from the draft legislation introduced in November 2008 by the Minister for Defence Hervé Morin. Yet the various parliamentary members› bills introduced from 2002 on – including the «joint» cross-party members› bill – cover the environmental consequences. Taking this aspect into consideration would,

however, have necessitated negotiating a bilateral agreement for the Saharan sites with the Algerian government. In the absence of genuine political will on either side of the Mediterranean, this would have led to the entire compensation process being blocked.

The Morin law

«Any person suffering from an illness caused by radioactivity as a result of exposure to the ionising radiation from French nuclear tests and registered on a list determined by decree of the Conseil d'État [Council of State] in accordance with the work recognised by the international scientific community can obtain full compensation for the harm suffered» *according to Article 1 of the French law regarding recognition and compensation for victims of nuclear tests or accidents, termed the Morin Law and adopted on 5 January 2010, after dozens of years of campaigns led by victims› associations and their supporters. Adoption of this law by the French parliament represents an important first step, as it constitutes an official admission that the French atmospheric and/or underground nuclear tests have caused health problems.*

According to figures from the French Ministry of Defence, 150,000 civilians and military took part in the nuclear tests between 13 February 1960 and 27 January 1996, not counting the populations of the Sahara and French Polynesia. This participation entitles people to compensation in the case of recognition of an illness caused by radiation due to being present in the Sahara or in French Polynesia during the test series. With decree no. 2014-1049, dated 15 September 2014, the law now recognises 23 illnesses (compiled from reports by Unscear, the United Nations Scientific Committee on the Effects of Atomic Radiation) instead of just 18.

In all, 1,476 files (submitted by people in Metropolitan France, French Polynesians and Algerians) were registered between 2010 and 31 March 2019 by the Comité d'indemnisation des victimes des essais nucléaires *[Committee for compensation of victims of nuclear testing] (Civen). This overall number is rather low in relation to the total number of victims. This is primarily explained by the lack of information and the difficulty of gaining access to documents in order to prove participation in the tests. Out of 1,476 files, only 49 are from people who were residents of Algeria at the time of the tests.*

Since the law was amended in December 2013 (no. 2013-1168 from 18 December 2013), the French Polynesia zone is no longer limited to an exact perimeter (the islands of Moruroa and Fangataufa and the «nearby exposed areas») but covers all of French Polynesia.[7] *This does not yet apply to the Sahara, where the areas said to be affected have been defined very narrowly.*

7 Thus the administrative court in Papeete has processed 31 cases during 2019 – that is the same amount as during the first eight years of application of the law.

The number of victims who have received compensation between 2010 and 31 December 2018 is 217.[8] *We do not have the figures yet, but the amount of compensation has increased greatly in 2019, thanks to the removal of the concept of «negligible risk» in 2017, paving the way for the principle of the presumption of law.*

While 47 files representing French civilians and military who were present in Algeria have resulted in compensation, one single claim for compensation has been awarded to an Algerian in almost 10 years! This considerable difference in treatment can largely be explained by the impossibility for the residents and the «working populations of oases»[9]*, the name given to the Algerian workers recruited to carry out various jobs, to prove that they were present*[10] *by means of written documents (wage slip, contract, proof of residency), in the areas defined by the law, not forgetting the lack of documents in Arabic for submitting requests for compensation.*

The treaty signed between Algeria and France in 2012 included the establishment of a Franco-Algerian commission dedicated to the issues of compensation for victims of nuclear tests. This committee met on one occasion only, on 3 February 2016.[11] *This clearly demonstrates the absence of political will (French and Algerian) to speed up the compensation process for Algerian victims.*

We now have more detailed knowledge of radioactive contamination at the different facilities[12] that belonged to the Pacific Test Centre (CEP). Of course, the fact that these 193 tests were conducted on territory that was still French made raising awareness about both the environmental and health risks easier. However, this is primarily the result of action taken by some whistle-blowers[13] and passed on by well-known figures and organisations on

8 *2018 annual activity report* from the Compensation Committee for victims of nuclear testing (Civen).

9 In Reggane, the term «working populations of Bas-Touat» was used to designate non-specialist workers (assigned to the job of unloading lorries, moving rocks, digging trenches), the majority of whom were Touareg people from Touat or even from the north of Adrar.

10 According to Article 2, they need to have been resident or stayed *«either between 13 February 1960 and 31 December 1967 at the Saharan Centre for Military Testing, or between 7 November 1961 and 31 December 1967 at the Oasis Military Test Centre or in the areas surrounding these centres»*.

11 *2015 annual activity report* from the Committee for Compensation of Victims of Nuclear Testing (Civen).

12 Since 2013, the National Agency for Management of Radioactive Waste (Andra) has drawn up a geographical inventory that lists the three legacy storage sites (Fangataufa, Hao and Moruroa), where the Ministry of Defence has stored waste and/or disposed of waste at sea.

13 In this regard, credit needs to be given to the pioneering work done by Bengt and Marie-Thérèse Danielsson in Polynesia, Bruno Barillot, co-founder of the Observatoire des armements, John Doom, who managed the Pacific region for the World Council of Churches, Roland Oldhamm, chairperson of the Moruroa e tatou association, and also to the work undertaken by the Observatoire des armements and by the Commission for Independent Research and Information on Radioactivity (CRIIRAD), not forgetting the actions by the activists from *Fri* and the different Greenpeace crews in the Pacific.

national and international levels, including by certain countries,[14] local public and political demonstrations and lastly, incidents mixing secret actions and military intervention.[15]

This is not the case where the test sites located in Algeria, an independent country, are concerned. According to the data available in a 266-page report dated from 1996 and classed as «classified defence», which is kept in the French Ministry of Defence archives and not declassified: *«No memorandum and no report have been found that provide information about the radiological condition of the launch bases when they were returned»*[16] *to the Algerian authorities* [in 1967]. This sentence expresses the situation in which we still find ourselves, sixty years on from 13 February 1960, the date of the first French nuclear test.

The «nuclear past» remains buried deep in the sand. The sites are not subject to checks for radioactivity and are even less the subject of campaigns to raise awareness among local residents about the health risks.

Nuclear testing across the world

Development of a nuclear weapon requires the use of extremely complex scientific knowledge. Once the scientific hypotheses have been applied to the construction of a nuclear device, it is necessary to validate them by experimenting on several models. In fact, one launch alone is generally not sufficient to ensure that the device will function properly. Several tests are necessary to validate the series of calculations, ensure safety of the bomb (safety tests), refine new scientific hypotheses, continue research and ultimately to proceed to the final test, that for qualification. However, political reasons (such as for Indian and Pakistani nuclear tests in 1998 in particular) have been added to these technical and military goals. Apart from the Algerian Sahara and French Polynesia, there are a total of over 60 sites throughout the world (including Semipalatinsk in Kazakhstan, the New Zemble island in the Arctic, the Marshall and Maralinga islands in Australasia, Xinjiang in China etc.) that have been used to explode more than 2000 nuclear devices for military or peaceful purposes.

14 In particular at the International Court of Justice «Nuclear Test Cases New Zealand v France», 9 May 1973.

15 cf. sabotage of the Greenpeace ship, the Rainbow Warrior, on 10 July 1985 by the French secret service, while it was docked in Auckland in New Zealand, which caused one death: that of the Portuguese photographer Fernando Pereira.

16 *Report on French nuclear tests 1960 -1996, volume 1: La genèse de l'organisation et les expérimentations au Sahara CSEM et Cemo, [The origin of the organisation and the experiments in the Saharan Centre for Military Testing (CSEM) and Cemo [Oasis Military Test Centre]]*, p. 236. This report will be quoted numerous times and in order to make it easier to read, it will be quoted in the text as: «confidential defence report». It does not belong to the documents that have been declassified following legal recourse by test victims› associations (Aven and Moruroa e tatou).

In 2020, due to the scientific and financial complexity, only five countries possessing nuclear weapons will conduct simulation programmes for nuclear tests in order to guarantee the safety, technology and modernisation of their nuclear missiles. These programmes rely on supercomputers and laser systems (Mégajoule in Barp (Landes) and Épure in Valduc (Côte-d'Or) for France, National Ignition Facility for the United States, ISKRA-6 for Russia). France[17] is the first nuclear power in the world to have designed a nuclear warhead, the airborne nuclear warhead for the medium-range air-to-ground [ASMP-A] cruise missile, with its simulation programme.

Nuclear tests since 16 July 1945

Countries	First nuclear test	Final nuclear test	Atmospheric tests	Underground tests	Total
United States	16 July 1945	23 September 1992	215	817	1032
USSR	29 August 1949	24 October 1990	221	494	715
France	13 February 1960	27 January 1996	50	160	210
China	16 October 1964	29 July 1996	23	22	45
United Kingdom	3 October 1952	26 November 1991	21	24	45
India	18 May 1974	13 May 1998	-	3	3
Pakistan	28 May 1998	30 May 1998	-	2	2
North Korea	9 October 2006	3 September 2017	-	6	6
Israel and South Africa	22 September 1979	22 September 1979	1	-	1
			531	1528	2059

The Hamoudia zone for atmospheric nuclear tests: 13 February 1960 – 25 April 1961

Installation of the Saharan centre for military testing (CSEM) covering an area of 108,000 km² was decided in early 1957. This site was intended to accommodate, in the middle of the desert:

- really a small town – Reggane town – including a runway, a hospital, a water-pumping station (producing 1200 cu metres a day), administration buildings and accommodation etc.);
- site facilities, called Reggane plateau (12 km to the east of Reggane town) and mainly consisting of a construction camp, swimming pool, military command post from where the launch commands were given, and an Atomic Energy Commission

17 2007 report from the French Atomic Energy Commission: *«The functional safety and reliability will have been demonstrated without nuclear tests, using the simulation programme.»*

building, where all information relating to the nuclear experiment was received; part of the installations was below ground, excavated from deep within the cliff;

– the Hamoudia base, which included a power station, but mainly comprised offices and technical installations, decontamination facilities and various barracks.[18] The launch range is some 15 kilometres away.

The four atmospheric nuclear tests (Gerboise bleue, blanche, rouge, verte [blue, white, red, green jerboa]) caused deposits of radioactive particles in the Sahara Desert, but also, as revealed[19] in 2014, over North Africa in its entirety and even in sub Saharan Africa. In fact, the European continent was even affected, since 13 days after the first nuclear test (13 February 1960), radioactive fallout reached the Spanish coast and *«hot particles in precipitation and in the air in south-western Sweden»*[20] were also detected in early March 1960.

The main goal of the first nuclear test *(Gerboise bleue, 13 February 1960)* was to validate the French bomb. But this experiment was also intended for observation and demonstration of the behaviour of the many materials used by the different armies in the face of the effects of the blast and heat. According to one witness, the three armies spread the material out over the test zone: *«mannequins, tanks, all kinds of armoured vehicles, cannons* [were found on] *the ground zone*. [In the] *air zone, planes ready for take-off or parked behind mounds of sand*. [In the] *marine zone: warship superstructures with their turrets and cannons.»*[21] This list can be found in the confidential defence report.[22] Material was put into position in this way for each of the four atmospheric nuclear tests.

18 Confidential defence report, op. cit., p. 66 and 67.

19 *Le Parisien*, «Le document choc sur la bombe A en Algérie» [*Shock document about the A-bomb in Algeria*], 14 February 2014.

20 Gunnar Lindblom, *Advection over Sweden of Radioactive Dust from the First French nuclear Test Explosion*, Tellus, 13:1, 106-112, 15 November 1960.

21 Jean Chaussat, in *La guerre d'Algérie, Témoignages [The Algerian War, Eyewitness Accounts]*, Fnaca, 1989, p. 505.

22 *Op. cit.*, p. 54.

Ill. 1: List of material subjected to the effects of the first French atomic bomb

CONFIDENTIEL DÉFENSE

B - EXPERIMENTATIONS SUR LES MATERIELS MILITAIRES (Essais Militaires) :

Les essais à effectuer au cours de la première explosion sont limités à ceux nécessaires à la préparation des explosions ultérieures et à ceux estimés extrêmement urgents.

Les principaux matériels, ouvrages ou animaux exposés ou expérimentés sont les suivants :

1 - Armée de Terre :

- 10 pièces d'artillerie, du 57 U.S. au 155 Mle 195C,
- 32 véhicules, blindés ou non,
- des postes radio, et du matériel téléphonique,
- des matériels, armes, équipements divers,
- des mines,
- des vivres,
- des éléments de tranchée,
- des épurateurs d'eau.

2 - Marine :

- 1 élément de superstructure,
- des éléments de surface métallique protégée par diverses peintures marines,
- 2 roquettes inertes, avec leur système de lancement.

3 - Armée de l'Air :

- 5 abris à personnel,
- 2 abris avions,
- 4 avions, ou parties d'avions.

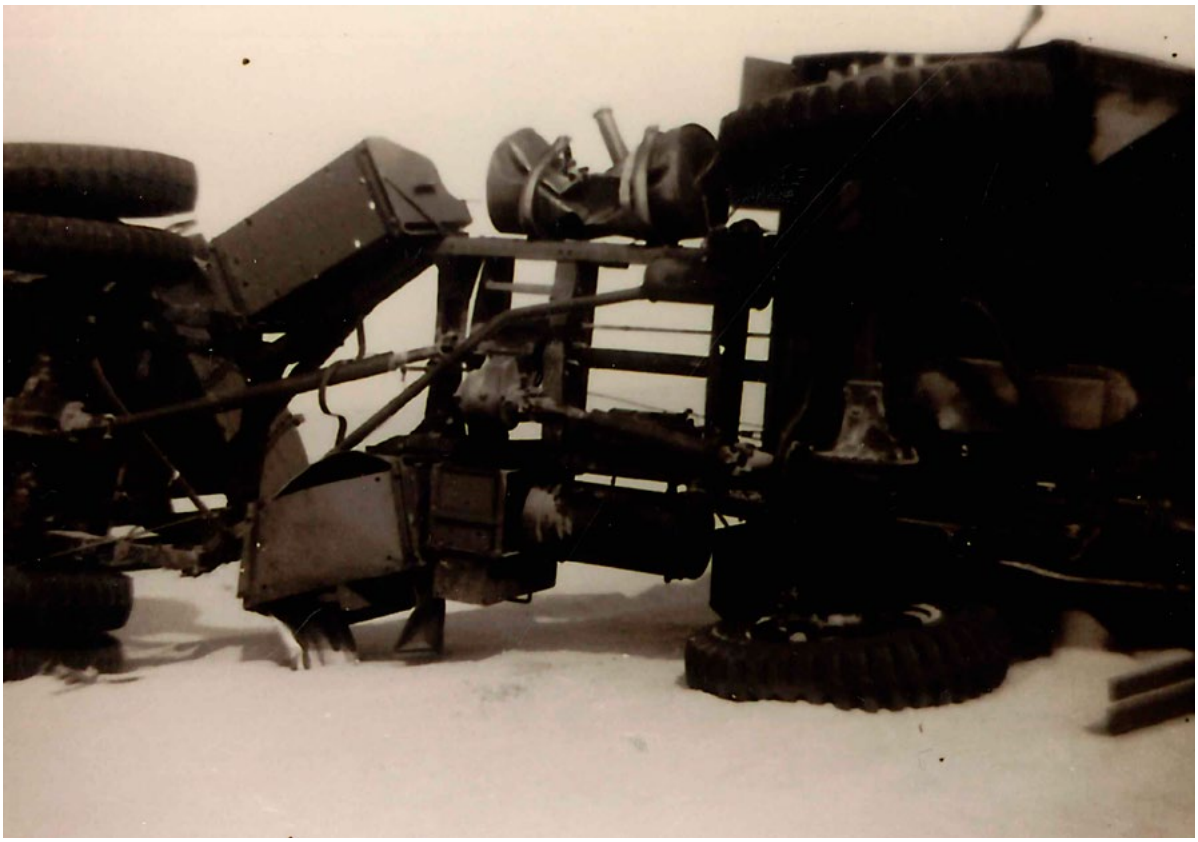
4 - Service de Santé :

- 16 groupes de petits animaux (rats, souris, cobayes),
- 12 grands animaux (chèvres, porcs),
- des produits biologiques,
- des dosimètres personnels.

CONFIDENTIEL DÉFENSE

54

Ill. 2A and B: Effects from a nuclear blast on the material placed in a launch zone



The second nuclear test (Gerboise blanche, 1 April 1960) caused significant contamination, as witnessed by General Ailleret: *«The device was placed on a concrete base [...] It was necessary to wait until a sufficiently sizeable crater had formed and there was very considerable contamination from fallout of heavy particles in the area surrounding the aforementioned crater.»*[23] It should also be noted that, as was the case during the third test *(Gerboise rouge, 27 December 1960),* live animals were present: *«One thousands rats and mice and some goats»*, positioned around ground zero to see *«how they withstood the test. Examinations were concerned with the condition of their blood cells in particular.»*[24]

The intention behind the explosion of *Gerboise verte* (25 April 1961) was to go as far as simulating nuclear war. *«Right after the blast, tank manoeuvres, but also foot drills, were organised in the vicinity of ground zero* [...] *to test protective equipment but also and above all to establish the reaction of the enlisted men in an environment with high levels of radioactivity.»*[25] 195 men were thus intentionally exposed to radioactive fallout.

In addition to these «nuclear tests», further nuclear experiments entailing dispersal of plutonium were carried out, without causing the release of nuclear energy. These were the experiments called *Augias* and *Pollen*. Thirty-five *Augias* experiments were conducted on the site of *Gerboise rouge* between 1961 and 1963, each using a maximum quantity of 25 grams of plutonium.

- Twelve experiments were conducted in steel tanks, *«in order to be able to eventually recover the plutonium from the first series»*.[26] A first series of six experiments was carried out between 28 April and 7 May 1961, half-filling the tanks with sand and then closing them with a sealed cover. In the second series, between 14 April and 28 April 1962, it was noted that *«the sand was replaced by sodium carbonate in order to, in theory, better recover the plutonium»*. The use of the terms *«eventually»* and *«in theory»* proved particularly appropriate, given that these tanks were quite simply buried in the ground!
- 23 experiments were conducted (between 21 April and 14 May 1963) *«outdoors on a stool, above a hole that had previously been dug in the ground towards which the plutonium was projected»*.

23 Charles Ailleret, L'aventure atomique française [*The French nuclear adventure*], Paris, Éditions Grasset 1968, p. 385.

24 *Le Monde*, «Les animaux soumis aux effets des radiations vont être examinés dans la région parisienne [*Animals subjected to the effects of radiation will be examined in the Paris area*]», 31 December 1960.

25 Vincent Jauvert, «Sahara : les cobayes de Gerboise verte [*Sahara, the guinea pigs of green jerboa*]», *Le Nouvel Observateur* no. 1735, 5 February 1998.

26 Military secrets report, *op. cit.*, p. 113 and 114.

Five Pollen[27] experiments (pollen, rose, red, saffron, daffodil) were conducted between 1964 and 1966 at the Cemo site (north-west of the Taourirt Tan Ataram plateau), this time with amounts of plutonium between 20 and 200 grams. The goal, as reported by the International Atomic Energy Agency (IAEA)[28], was to *«simulate an accident involving plutonium, to gauge the consequences, including the level of contamination that could occur in the vicinity»*. The purpose of these tests[29] was therefore to establish, on the one hand, how a nuclear weapon behaved[30] without its chain reaction being actuated and, on the other hand, to check the reactions between nuclear materials and conventional explosives and monitor the process of dispersal of these different materials.

The In Ekker zone for underground nuclear tests: 7 November 1961 – 16 February 1966

The Oasis Military Test Centre (CEMO), the location for 13 underground nuclear tests, is located on the Hoggar mountain plateau (in the granite mountain of Tan Afella), in the vicinity of the bordj [*citadel*] of In Ekker, situated 150 kilometres north of Tamanrasset. Personnel were housed at the site facility located 30 kilometres south of In Ekker (called «Oasis 1»); later a second site, «Oasis 2», would be built 10 kilometres to the south of In Ekker. The tests were conducted in galleries, entrenched at a depth of 800 to 1200 metres, to end in a spiral shape.

Date	Underground nuclear tests - code name	Explosive power in kilotons of TNT
7 October 1961	*Agate*	10 kt
1 May 1962	*Beryl*	40 kt
18 March 1963	*Emerald*	10 kt
30 March 1963	*Amethyst*	2.5 kt
20 October 1963	*Ruby*	52 kt
14 February 1964	*Opal*	3 kt
15 June 1964	*Topaz*	2.5 kt
28 November 1964	Turquoise	10 kt
27 February 1965	Sapphire/Monique	127 kt
30 May 1965	Jade	2.5 kt
1 October 1965	Corundum	2.5 kt
1 December 1965	Tourmaline	10 kt
16 February 1966	Garnet	13 kt

27 *Ibid.*, pp. 198 à 203.

28 IAEA, «Radiological Conditions at the Former French Nuclear Sites in Algeria: preliminary assessment and recommendation», *Radiological assessment reports series*, 2005.

29 The military nuclear catastrophes at Palomares in Spain (17 June 1966) and Thule in Greenland (21 January 1968), with far greater quantities of radioactive materials «reproduced» this type of test.

30 The first two French atomic bombs AN11 and AN21 were tested during these experiments.

The mountain of Tan Afella is riddled with holes that were dug all over to conduct the 13 underground nuclear tests. Four tests (*Beryl, Amethyst, Ruby, Jade*) were not completely contained or confined, resulting in the release of radioactive gases, aerosols and lava into the environment.[31]

The *Beryl* accident that took place on 1 May 1962 was the most critical accident in terms of contamination of the soil and of personnel. We now have precise and well-documented details, thanks to numerous first-hand accounts collected by the Observatoire des armements in conjunction with the Association of Veterans of Nuclear Testing (Aven): *«Around 12.30 we heard an enormous blast coming from opposite us. At first, the immediate sight was very beautiful, the mountain changed colour, it was transparent but suddenly, almost opposite us, towards the right, we saw a ‹plug› that came out accompanied by very black smoke.»*[32]

A collection of data concerning the pollution caused by this underground test, which led to an «atmospheric test» is available. As a consequence, *«one part equal to 5 to 10% of the radioactivity was released through the gallery in the form of projected lava and slag which solidified on the floor of the gallery.»*[33] The quantity of lava and slag amounted to *«around 700 m³»*[34] and solidified at the exit from the gallery called «E2». According to the same data, the zone with the highest level of radioactivity represents a *«surface area of around 2.5 ha, contamination was fixed in the lava (average thickness of flows 40 cm) and in the blocks of slag»*. However this pollution also extended over *«an intermediate area strewn with fragments of lava and slag over a surface area of about 15 ha»* and over a third and *«greater area covering 135 ha* [including] *with not very large slag debris»* where, according to the data collected in 1965 (therefore three years after the blast), *«radioactivity was reportedly far less»*. While this remains to be confirmed on site, this report certainly records that *«the radioactivity trapped in the lava and slag, about 5000 Ci in 1962, may be estimated at 25 Ci of plutonium in 1994 and at 100 Ci of caesium-137 or strontium-90. It is closely confined to a zone covering several hectares on the E2 grid square and the adjoining area»*. These figures are horrific in terms of radioactive pollution and degree of danger.

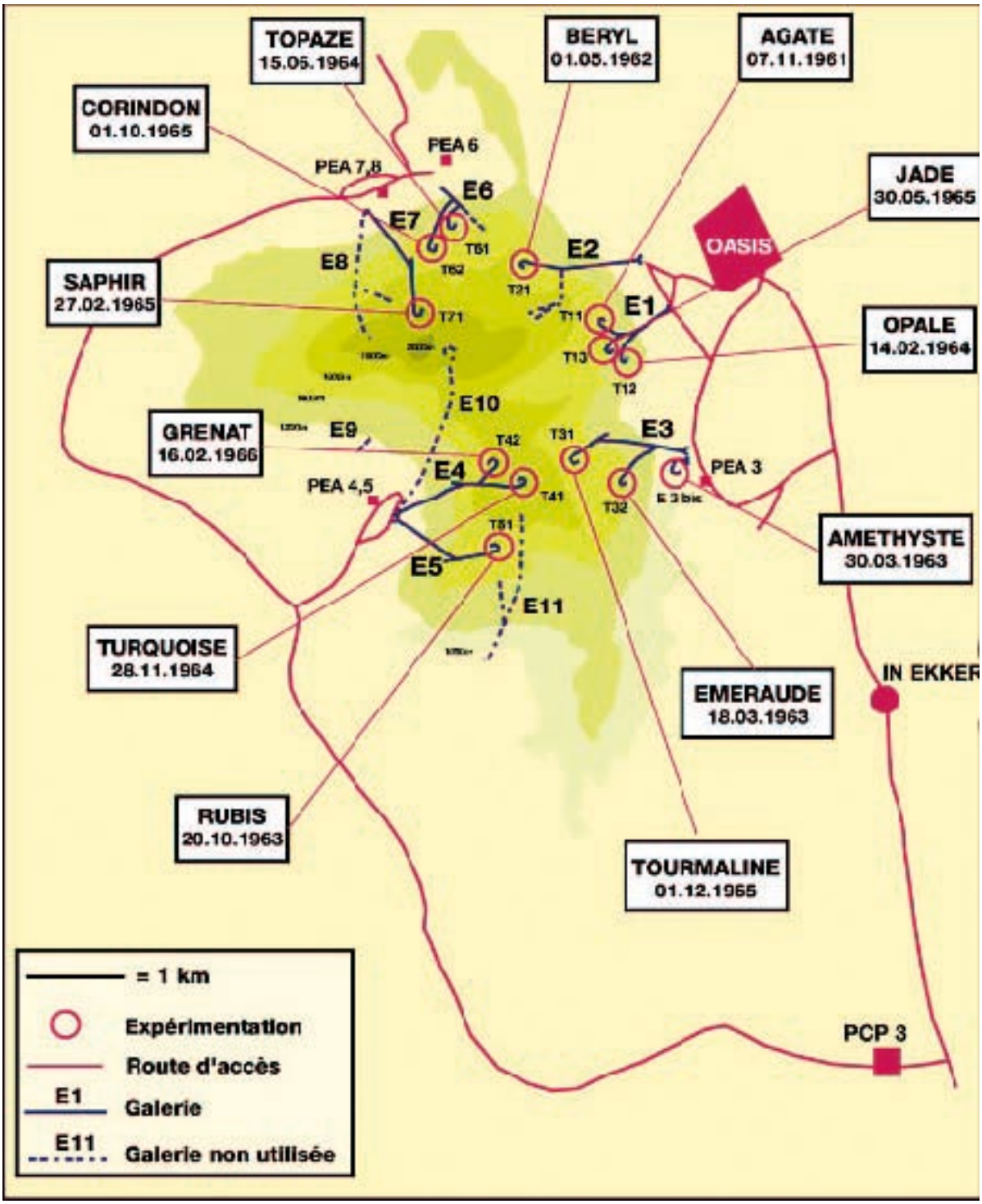
31 Christiane Taubira, Report no. 1264 on the member's bill (no. 1258) regarding recognition and compensation for victims of nuclear tests or accidents, 19 November 2008, [*French*] National Assembly, p. 10.

32 Eyewitness account by Jean-Pierre P., letter dated 2 February 2004, archive at the Observatoire des armements.

33 Henri Revol and Christian Bataille, *Les incidences environnementales et sanitaires des essais nucléaires effectués par la France entre 1960 et 1996 et les éléments de comparaison avec les essais des autres puissances nucléaires [The environmental and health incidents during nuclear tests conducted by France between 1960 and 1966 and comparative aspects with testing by other nuclear powers]*, report no. 207 (French Senate), Parliamentary Office for the Evaluation of Scientific and Technological Options, 6 February 2001, p 35.

34 Confidential defence report, *op. cit.*, p. 195.

Ill. 3: Map representing the mountain plateau of Tan Afella, the zone for underground nuclear tests. The various galleries that have been installed, with their entrances, are represented by the letter E (E1, E2, E3, etc.). Note the entrance to tunnel E2, which is the zone contaminated by the *Beryl* blast accident.



The French Ministry of Defence has also acknowledged that the *Amethyst* test (30 March 1963) caused the emission of a large quantity of slag and molten rock from the mountain (through the E3 gallery entrenched in order to deposit the bomb).

Failure to recognise the organisations representing Algerian victims

In Algeria on 24 January 2020, on the occasion of the 49th Friday of the hirak[35]*, demonstrators*[36] *brandished placards which said:* «The residents of the Sahara are not guinea pigs. No to shale gas. Gang government, you are no different to France and what it did in Reggane.» *Or elsewhere:* «In 2020, they want to test the gerboise noire by fracking.» *The memory of the repercussions from nuclear testing are still alive in Algeria. However, victims› organisations have difficulty in obtaining concrete responses to their claims.*

In the early 2000s, as was the case in Metropolitan France or in Polynesia, several organisations were founded in Algeria. They include, in particular, the Association 13 février 1960 *[13th February 1960 Association] in Reggane, the* Association des victimes des essais nucléaires de Taourirt *[Association for Victims of Nuclear Testing in Taourirt] in In Ekker (founded in 2011) and* Association algérienne des victimes des essais nucléaires *[Algerian Association for Victims of Nuclear Testing] on the initiative of Mr Bendjebbar, an Algerian officer who closed the French test sites and who subsequently became critically ill.*

Ties have been established between the different Algerian and French associations despite the obstacles resulting from the distance and the difficulty in holding direct discussions.[37]

These associations are attempting to engage with the authorities despite a lack of attention. They are also conducting an information campaign and a survey of victims. They are seeking «redress from France for the damage it has caused».[38] *Their main claims are:*

35 Arab word meaning «movement». This campaign was launched on 16 February 2019 in protest of the candidacy of President Abdelaziz Bouteflika for a fifth term of office as president.

36 Mustapha Benfodil, «49e vendredi de mobilisation populaire : le Hirak rejette énergiquement le gaz de schiste [*49th Friday of popular action: the Hirak emphatically rejects fracking*]», El Watan, 25 January 2020.

37 On the occasion of several symposiums organised by the Observatoire des armements in Paris, in particular at the French National Assembly or the Senate, the French embassy refused to issue visas for Algerian delegates.

38 Berriah, «41 ans après la bombe atomique de Reggane. Une association demande réparation à la France [*41 years after the Reggane atomic bomb. An association demands indemnification from France*]», *El Watan*, 13 February 2001.

- *Establishment of a monitoring post for the sites used in the nuclear tests in order to measure the changes in levels of radioactivity;*
- *Decontamination of the soil and the groundwater where the presence of radioactivity represents a «ticking time bomb» for public health;*
- *Establishment of a health facility specialising in treating illnesses caused by radiation, close to the affected areas to avoid victims having to travel to Algiers (1,500km away);*
- *Transfer of the classified defence archives and opening of a memorial centre.*

The law adopted by France in 2010 for recognition and compensation was rejected as inadequate: «It will take more than a few pennies for us to resolve a problem that affects several generations in succession» *declared Mr L. Abderrahmane, chairman of the* «13 February 1960» *association, in February 2010. As far as Mr Waer, chairman of the Taorirt association, is concerned,* «the priority is recognition by France of the status as victims for about 500 workers registered from the region». *Since* «the radioactive and nuclear fallout from the tests [...] spared no one, neither humans, nor fauna, nor flora. Outside Algeria, the whole of North Africa and Sub-Saharan Africa were victims of a nuclear policy, for which France denies both responsibility and the aftermath.»[39]

Other parties are trying to make progress on this subject, for instance, the hospital in Reggane, has alerted the authorities on several occasions and organises events with the El Amel[40] *association to warn of the difficulties, in particular on 13 February, the anniversary of the first French nuclear test. The Algerian Federation for Human Rights (LADDH), also involved alongside these associations, is* «convinced that the victims of nuclear explosions by France in the Algerian Sahara need to be discussed more than just once every 13 February.»[41]

The problems faced by these Algerian organisations in getting the issue of the consequences from nuclear testing to appear on the political agenda is doubtless one of the reasons why, sixty years after the first French nuclear test, just one Algerian has been recognised as a victim and compensated by France in this regard!

39 «Essais nucléaires : l'Algérie a ficelé le dossier [*Nuclear tests: Algeria makes its case*]», *El Watan*, 16 February 2018.

40 This campaign is organised jointly by the National Advisory Commission for the Promotion and Protection of Human Rights and the El-Amel du CPMC association. This travelling exhibition has been running since 2011 to promote prevention and provide information about cancer. In 2012, it succeeded in getting the Ministry for National Education to organise a national course about the nuclear tests on 13 February every year. See: «La caravane El-Amel à Adrar et Reggane la semaine prochaine [*The El-Amel travelling exhibition in Adrar and Reggane next week*»], Liberté-Algérie, 13 February 2012 and «La Caravane El-Amel sillonne le Sud [*The El-Amel caravan is travelling around the south*»], *Liberté-Algérie*, 14 February 2016.

41 Houari Kaddour, «Essais nucléaires en Algérie : la Laddh exige des réponses de la France» [*Nuclear tests in Algeria: Laddh demands answers from France*], Le Matin d'Algérie, 20 August 2014.

2. Waste under the sand

The French army set up at the Reggane site from 1957 on, then at the In Ekker site, and abandoned them in 1967. Following this, the Algerian army[42] took possession of one section of the installations (that had not been dismantled), such as the site facilities at In Amguel (consisting of barracks, solid buildings, etc.). Likewise, the Algerian National Company for Mineral Exploration and Production (Sonarem) was established there. It should be mentioned that this geographical location is ideal for surveying the territory, in particular the trans-Saharan route, which connects the Niger border at Tamanrasset, then continues towards the north and runs alongside the Tan Afella mountain, with its heavily contaminated zones...

The final months while French soldiers were still there were spent entirely on dismantling the sites and on returning military equipment to France or to African countries. Some military equipment was also handed over to the Algerian authorities. Almost sixty years after this withdrawal, after several thousand men had stayed there, some sites look like huge landfill sites, containing waste that can be classed into three categories:

- non-radioactive waste related to the French occupation, to the dismantling of the sites and to the presence of the Algerian army since 1966;
- material contaminated with radioactivity that was buried intentionally;
- radioactive material emitted by nuclear explosions.

Non-radioactive waste

All involved parties (journalists, researchers, scientists [43]) who have visited the nuclear test sites over the past fifteen years give similar accounts regarding the presence of large amounts of waste (canisters of bitumen, aluminium, sheet metal etc.). Bruno Barrillot, for example, who visited the Reggane site between 13 and 19 November 2007, reports that *«the roadside below, which leads to the entrance to the CSEM, shows a flagrant disregard for the environment. Hundreds of metal drums, probably of bitumen, have been abandoned there, since the 1960s, covering an enormous area and simply enclosed with barbed*

42 Between 1992 and 1995, the army used many of the barracks on the sites at In Amguel and Reggane as prisons for anyone connected with the Islamic Salvation Front (Islamic opposition party). This information was disclosed by the director Elisabeth Leuvrey and the journalist Bruno Hadjih in the documentary «At(h)ome» (widescreen release 2016).

43 Larbi Benchiha, journalist, Roland Desbordes, a scientist belonging to CRIIRAD, Bruno Barrillot and Patrice Bouveret, researcher and director at the Observatoire des armements.

wire.»[44] The majority of this waste has, without question, come from the time of the occupation by France; however we cannot rule out that part of it also stems from occupancy by the Algerian army. He adds that former facilities belonging to the Atomic Energy Commission, which are below the cliff of the Reggane plateau, *«reveal numerous remains: electric cables, scrap metal, ductwork and water pipes are scattered over the ground covering several hectares.»*

In addition to this waste, which is left on the sand and can be removed fairly easily, there are also two enormous bunkers (the advance command post and a second called the Sphinx), which mainly housed measuring instruments. It would require greater resources to dismantle these buildings (*see photo below*).

44 Bruno Barrillot, «Visite du site d'essais français de Reggane au Sahara algérien» [*Visit to the French test site of Reggane in the Algerian Sahara*], *Damoclès*, newsletter from the 'Observatoire des armements, no. 121, 2007.

Ill. 4: Laying of underground cables on the nuclear site of Hamoudia, 1959

Even if recent descriptions still indicate the presence of waste, the amount has decreased greatly. This is mainly due to the fact that people living in these areas – or travelling across them – have recuperated ferrous items over the course of the years (*see following photos on the next page*) in order to make fences, roofs for houses and other buildings, and copper, a metal that fetches high prices for resale. Dozens, perhaps even hundreds, of kilometres of copper wire were used to carry out the nuclear tests. Some sections were mostly buried underground, while others were placed on the sand and contain high levels of radioactivity.

There are numerous accounts about people who went to recover this copper, such as Moustapha from Im Amguel[45] who says that *«most of the barbed wire was ripped out by copper traders who came from around Béchar and sold it in Morocco. They stole the electrical equipment that had been exposed to radiation in order to recover the copper. I know some old men in In Amguel, major traders who come as far as Béchar. They fill petrol canisters with copper in order to have lorries for transport. They take them to Adrar and Béchar to sell them to Moroccan traders.»*

You would think that this recuperation of metal had long finished; however, there are recent first-hand accounts[46] that indicate that this is still an ongoing practice.

This is without any doubt a grave omission committed by the French state. In failing to recover this waste and in failing to provide any information about the potential danger to health from this waste, it is certain that people have been contaminated since the end of the tests.

Contaminated material deliberately buried in the sand

The situation regarding radioactivity at the various sites has never – in the light of information currently available – been fully assessed with the Algerian authorities. For instance, Mohamed Bendjebbar, engineer officer in charge of dismantling the base at Reggane, learned in May 1967 – as a result of «mutual liking» and «esprit de corps» [a spirit of «we»] that appeared to connect him with his French counterpart – *«that the French authorities had buried equipment, tooling equipment and mechanical equipment that had been used and was likely to have been contaminated at two sites: the first was ten kilometres to the north-east of the plateau where the site facilities were and the second was five kilometres away from ground zero. As far as the remaining highly radioactive waste was concerned, they had reportedly been placed in concrete bunkers.»*[47] This information confirms not only the burying of nuclear waste on a massive scale but also demonstrates more generally that the adopted policy was to bury radioactive material. Even if safety guidelines at this time were not particularly restrictive, the CEA nevertheless had storage facilities in France. It needs to be underlined that France has always been wary of raising this subject

45 Solange Fernex, Essais nucléaires en Algérie, recueil de témoignages [*Nuclear tests in Algeria, compilation of testimonies*], Brussels, the Greens in the European Parliament, 1992.

46 Conversation with the scientist Roland Desbordes, who was president of CRIIRAD at the time and who visited In Ekker in 2007, and Larbi Benchiha, journalist and director of several documentaries about the nuclear tests, who has been to the Saharan sites several times.

47 Bruno Barrillot, *Les irradiés de la République : Les victimes des essais nucléaires français, prennent la parole [People exposed to radiation by France: the victims of French nuclear tests speak out]*, Les Livres du GRIP collection, joint publication from GRIP-Editions Complexe, Observatoire des armes nucléaires/CDRPC, 2003, p. 45.

and, what is more surprising, the IAEA[48] failed to make any mention of this contaminated equipment following its visit in 1999.

The accounts below highlight the fact that these operations were mainly conducted with some precautions (such as burying the *Vautour* planes), leading one to believe that the military, and no doubt more specifically, the division for military applications at the Atomic Energy Commission [*CEA*], had plans available for storage facilities.

Testimony from Jean-Pierre D., who was in Reggane between 17 November 1960 and 21 February 1962, clearly illustrates this method of «concealing things» in the desert: *«I was assigned to the equipment office as a typist, I typed the department notes and records of equipment. When a man was working on scaffolding and dropped a hammer or a screwdriver, it was often impossible to find it in the sand. Anything that was lost was therefore classed as: ‹buried in the sand›. I noticed that often sizeable objects and sometimes enormous ones were also classed as ‹buried in the sand›. So I realised that earth-moving machinery was «contaminated material that was intentionally buried in the sand.»*[49]

The note by the air testing group, dated 8 June 1961, see below, with regard to the «contamination of tooling equipment», confirms an action which at the time seemed to be normal, as Jean-Pierre D. explains, for both very small-sized equipment (screwdrivers), and equally for entire vehicles. This policy seems to be based on the idea that the desert would absorb all waste material.

André F. explains that in 1963 *«all the planes, canons, lorries and helicopters had remained in the launch zone after the last explosion* [Gerboise verte, 25 April 1961] *waiting to be buried.»*[50] The fact of having abandoned these vehicles, which had been deliberately exposed to nuclear explosions, on the Gerboise verte site in this way for two entire years (photos dated 1963) confirms that there were no exact instructions relating to their final destination, apart from burying them.

48 IAEAs, «Radiological Conditions at the Former French Nuclear Sites in Algeria: preliminary assessment and recommendation», *Radiological assessment reports series*, 2005.

49 Letter dated 6 September 2002, archive at the Observatoire des armements.

50 Information obtained in a telephone interview on 6 February 2004 between Mr Foudriat and Bruno Barrillot, researcher at the Observatoire des armements.

Ill. 5: Note relating to contaminated tooling equipment («the following equipment [...] turned out to be heavily contaminated, and, not being usable anymore, was buried onsite»)

GROUPEMENT DES ESSAIS "AIR"

N° 5 5 3 /GEAR/MT/A

S.P. 89.369/B, le - 8 JUIL 1961

NOTE

relative à la contamination d'outillage.

Certaines contaminations s'étant révélées, après examen du personnel du G.E.A.R. au spectromètre γ corps humain, par Monsieur CHIVOT, pharmacien du service social et médical de la D.A.M., il a été procédé à la vérification des boîtes à outils utilisées par le personnel ayant travaillé sur matériel contaminé.

L'outillage suivant, appartenant au Sergent CHAUMARD, s'est avéré fortement contaminé et n'étant plus utilisable, a été enfoui sur place.

Le Lieutenant MARCELLESI,
Commandant PVT le G. E. A. R.

DESTINATAIRES :

- C.E.A.M. DE/A - 1 ex.
- C.E.A.M. EG - 2 ex.

- ANNEXE -

1 brosse à manche 5 rangs

1 clé plate 8 x 10

1 " 9 x 12

1 " 11 x 13

1 clé à douille 9/32

1 " 10/32

1 " 11/32

1 poignée coulissante 9/32

1 cliquet réversible 9/32

1 cardan 9/32

1 petite rallonge 9/32

1 grande rallonge 9/32

1 poignée coulissante 3/8

1 pince tire-goupille à becs longs droits L = 180

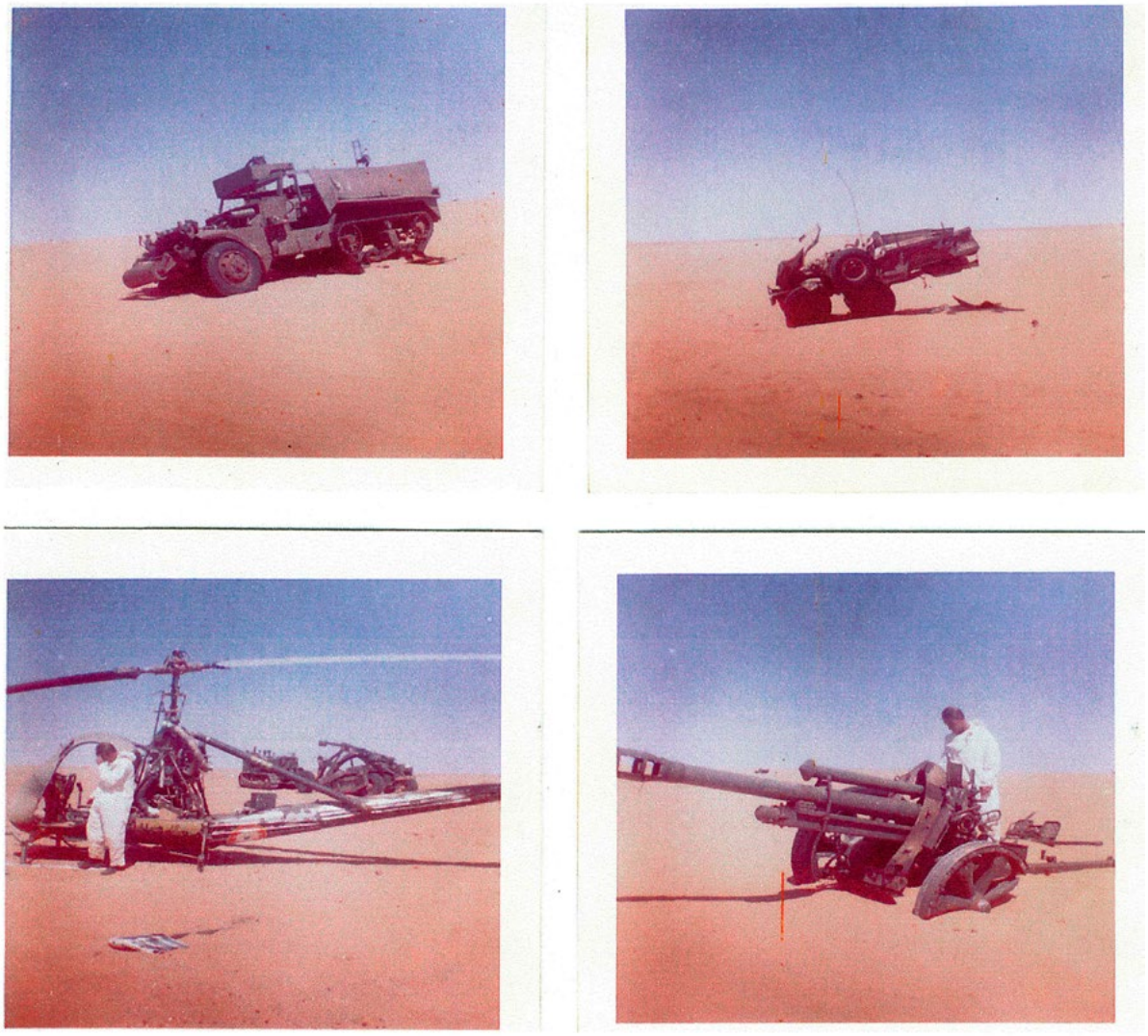
1 poignée pour lame de scie

1 marteau rivoir

1 lime plate ½ douce de 150

1 pince extensible L = 250

Ill. 6: Abandoned military vehicles on the nuclear test site of Hamoudia, 1963



Operations to bury equipment on the site of the CSEM would have started during 1963. Daniel B., who was more or less present the whole time during the tests in Algeria from November 1957 to 30 March 1964, mentions the *«start of operations to bury equipment in the launch zone and destruction of the Hamoudia base»*[51] on 16 September 1963.

Another first-hand report was made by Lucien V.,[52] who was conscripted and assigned to the 3rd Sahara transport group in Reggane. He would have been at the site from early 1967, when he was involved in dismantling all the bases at Hoggar. *«We destroyed or transported equipment or vehicles* [...]. *After engineering had excavated enormous pits, we buried a lot of equipment and vehicles (where the limit of radioactivity had supposedly been exceeded).»*

51 Archives at the Observatoire des armements.

52 Letter dated July 2002, archive at the Observatoire des armements.

In the light of the description by Lucien V., the engineers in charge of *«excavating enormous pits»* did not need to wear full protective equipment against radioactivity. On the other hand, as can be seen in the photos of «burial of the Vautour planes», the men are certainly wearing protective suits for radioactivity, underlining the presence of very high levels of radioactivity. The procedure described by Jacques G. involves the use of bulldozers to dig wide and deep trenches in the sand. The Vautour planes were destroyed with explosives prior to, as he says, *«a civilian burial»*.

Ill. 7: Burying the Vautour planes

These planes are undoubtedly those that were used to record the various effects of the explosion of an atomic weapon. Their number is unknown. However, were other planes contaminated too? In particular, one might consider the planes that carried out different types of sampling in the clouds that formed following the atmospheric tests. André L., who was at Reggane from 7 February 1960 until 8 March 1961, mentions that *«in an area at some distance from the Reggane airfield, there was a prohibited zone where one Vampire or Mistral plane was stationed, this machine was the one that had flown unmanned through the radioactive material. There were also the Vautour jet engines that had flown close to the radioactive cloud. If the rumour is true, this airborne equipment was disposed of here because it was impossible to decontaminate it.»*[53]

In addition to this military equipment, a collection of other radioactive «waste» needs to be accounted for, whose steel tanks (and their contents) were used as part of supplementary tests (Augias). According to the «confidential defence report» on the CSEM zone, *«the tanks for the plutonium pellets were cemented and buried underground.»*[54] Obviously, care was taken to indicate that *«as long as, once the launch zone was abandoned, no action was taken to open them up, they did not constitute a significant risk for people and wildlife in the Sahara.»* During a visit by Bruno Barrillot to the Reggane site in 2007, while he was at the site of *Gerboise rouge,* he noted that *«there are enormous metal tanks, surrounded by dozens of lumps of concrete, the size of a football, and scattered around randomly.»* Were these tanks the ones used during the Augias tests?

Finally, it should be noted that the *Beryl* accident made it necessary to carry out decontamination, according to a statement from the French Ministry of Defence, of 1675 people and 120 vehicles and other equipment. Part of the equipment was also buried in the sand. As a consequence, according to the information collected on the subject of this incident *«400 kg of military equipment have been sent to Reggane to be decontaminated. Not all this equipment will be decontaminated and some equipment will have to be buried at the CSEM.»*[55]

The Hamoudia zones and those at Reggane in general are unfortunately not the only places where radioactive material was buried.

Other eyewitness accounts also indicate that equipment was buried around the Tan Affela mountain. For instance, Patrice C.34,[56] who belonged to the 621st Groupe d'armes spéciales [special weapons group] from April 1965 to April 1966, mentions that, following an explosion close to the exit from the E3 tunnel (probably for the Amethyst launch), *«the gallery was closed off by three reinforced doors, each weighing four tons, and was stuffed*

53 Letter dated 12 March 2003, archive at the Observatoire des armements.
54 Confidential defence report, *op. cit.*, p. 237.
55 *Ibid.* p. 159.
56 Archives at the Observatoire des armements.

with sandbags. After the launch, they were all found on the opposite hill, at a distance of about 100 metres. It was all buried under more than a metre of concrete.»

Ocean disposal of nuclear waste in French Polynesia

«The use of radioactivity in countless sectors causes the production of radioactive waste, which has the distinctive feature of emitting radiation that may constitute a risk for man and the environment. It cannot therefore be managed as conventional waste is and must be taken care of using a special process. One of the first methods for managing this waste and keeping it separated from humans was to dispose of it in the oceans.»[57] *It can be assumed that burying nuclear waste in the Sahara was the result of a similar line of reasoning, since the desert was regarded as a «sea of sand».*

This clearly illustrates to what extent environmental factors were completely beyond the line of thought for politicians and the military during the period 1960-1980.

France dumped – or used «ocean disposal» according to the official term – a total of 3,188 tons of nuclear waste (packed in concrete drums or in bulk form) in the Pacific, close to the Moruroa and Hao atolls, between 1972 and 1982 on the Hôtel, Novembre *and* Oscar *sites. This waste came from the various series of tests conducted at the Pacific Test Centre. Following the work at Grenelle de la Mer, which was carried out in 2009, a decision was made to implement improved monitoring and more efficient checks of the areas where this waste was located and to* «consolidate the inventory of nuclear waste disposed of underwater, evaluate the level of danger and to set priorities for conducting analyses of the resident flora and fauna and of sediments.» *Completion of a comprehensive report on* Les déchets radioactifs immergés [Radioactive waste that was disposed of at sea] *was the first measure to be taken. This act of transparency could serve as a model in the case of radioactive waste in the Sahara.*

Nuclear waste from tests and other experiments

This category includes the waste (vitrified sand, radioactive slabs) that was created by the different atmospheric nuclear tests as well as by the *Beryl* (1962) and *Amethyst* (1963) underground nuclear tests. Waste stemming from the physical reaction of the fissile material contained in the nuclear devices and objects in the surrounding area, in particular sand and structures (towers, machinery etc.).

57 *Les déchets radioactifs immergés - Dossier thématique de l'Inventaire national des matières et déchets radioactifs* [Radioactive waste disposed of at sea – special report on the national inventory of radioactive materials and waste], French national agency for managing radioactive waste (ANDRA), March 2017.

In the zone of the Hamoudia atmospheric test site, the ground is covered in black fragments of vitrified sand, which result in a «leopard skin» pattern formed by the patches of yellow and black sand. The *Gerboise blanche* site is special since the blast created a crater. However, in 2007, according to a first-hand report from Bruno Barrillot, this is no longer visible, which confirms accounts by the IAEA during its visit in 1999. However, the report from this organisation states that if this crater was subsequently filled, *«the remaining radioactivity is in the equipment buried under several metres from ground zero.»*[58]

The situation at the In Ekker site is without question of most concern. On the one hand, the zone has been contaminated at its centre by the tests, but there are also, according to the report from a meeting of the safety commission that took place on 3 October 1961, *«stores of radioactive waste from contaminated rocks extracted from the galleries in the southern face of Tan Afella, in an area surrounded by a rough enclosure.»*[59] It can be surmised that the CEA has in its possession documents that provide an assessment (from that time) of the radioactivity contained in the mountain plateau.

It is obvious that the French authorities were aware of the high level of pollution caused by the failed *Beryl* test. According to the figures, the contaminated *Beryl* zone *«originally was the equivalent of 250 hectares»,*[60] covering 2.5 hectares situated on the mountainside of Tan Afella (the famed lava flows and slags), the areas that *«were not [processed] and are certainly still in the same state as they were then»,* as admitted in the report by the French Ministry of Defence from 1996.[61]

The Commission for Independent Research and Information on Radioactivity (CRIIRAD) conducted a series of analyses[62] (29 and 30 October 2009) on the site, taking a sample of a piece of lava which proved to be *«highly contaminated»* and very dangerous, due to a *«high level of caesium-137 contamination»* and by the presence of a transuranic element, americium-241, which indicates *«the presence of plutonium-241»*. Other radiometric measurements, taken one kilometre from the exit shaft for the *Beryl* launch in order to check the level of residual radiation (analysis of camel droppings and ash) justify precautions on the site to limit people's exposure.

58 IAEA, *op. cit.*, p. 9.

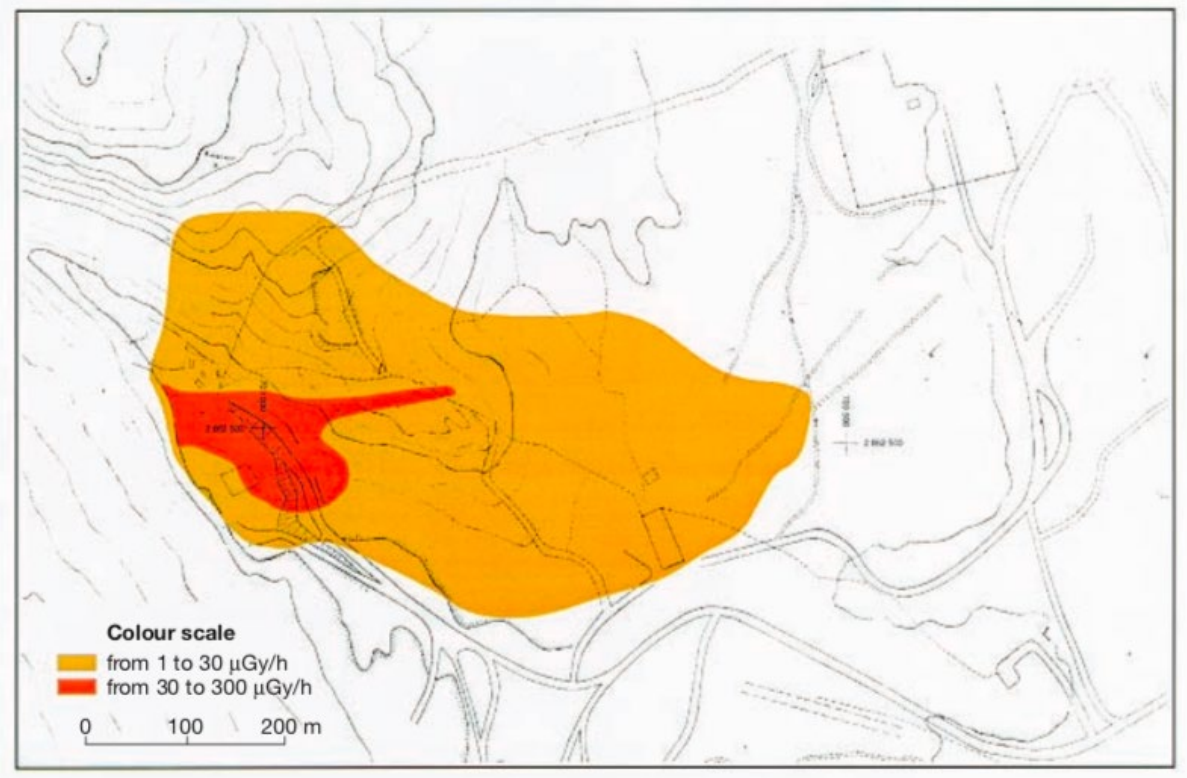
59 *Ibid.*, p. 238.

60 *Ibid.*, p. 238.

61 Confidential defence report, *op. cit.*, p. 238.

62 CRIIRAD, *Analyses radiologiques de matériaux prélevés sur l'ancien site d'essais nucléaires d'In Ekker (Algérie) [Radiological analyses of material sampled from the former In Ekker nuclear test site (Algeria)]*, Note no. 09-113, 11 February 2010.

Ill. 8: Map of the zone corresponding to the dispersion of the radioactive cloud following the Beryl launch, illustrating the average residual activity (Activity from 5-10 Tbq of caesium-137) - IAEA map



As regards the *Amethyst* test, which led to a release of material, it must be noted that decontamination of the soil was carried out. This is doubtless the only real operation of this kind carried out by France in the Sahara. This operation[63], which was spread out over six months, was carried out by the 620th *Groupement des armes spéciales* [special weapons group]. It *«collected the equipment found there, cleaned it with a pressure washer, with the water draining off into the sand»* and it also recovered the contaminated grass. Furthermore *«on flat ground, the areas with the highest levels of radioactivity were covered with a roughly one-metre thick layer of sand. The zones with the highest level of contamination were scraped off to a depth of 5 to 10 cm, covered with healthy materials and then tarmacked.»*[64] The question arises of what happened to the *«5 to 10 cm»* of earth that were probably buried...

It is extremely difficult to make an assessment of the health of local people. At that time, there was no monitoring of these people's health nor were there any medical studies listing the number of cases of cancer (that were possibly due to the nuclear tests). Added to this is

63 All the first-hand accounts of this operation were collected by Bruno Barrillot, *Les essais nucléaires français 1960-1966 : conséquences sur l'environnement et la santé, [French nuclear tests 1960-1966: consequences for the environment and health]* Lyon, Édition CDRPC, p. 75.

64 Confidential defence report, *op. cit.*, p. 238.

the low number of files on Algerian residents submitted to the Civen (Committee for compensation of victims of nuclear testing). However, as various investigations by journalists have shown (in particular that by Larbi Benchiha and Elisabeth Leuvrey), the radioactive cloud created by the Beryl accident reached the village of Mertoutek (some sixty kilometres away), where many people (17) died suddenly following this incident. The residents of this village are still suffering from the presence of radioactivity.

Following the additional *Pollen* experiments conducted in the Cemo zone, *«an area of three hectares close to ground zero was covered with healthy soil and then fixed with tarmac. The recovered waste and debris from the facilities in the zone were buried in trenches that were then filled with healthy soil.»*[65]

France would therefore have concealed the areas that were severely contaminated. If the Algerian authorities are to some extent aware of the information (at least since the visit by the IAEA in 1999, and then the publication of its report in 2005) regarding the risk of radioactivity in some of these areas, it is clear that nothing has been undertaken to protect the population and the environment.[66]

65 *Ibid*. p. 236.

66 cf. Patrice Bouveret, «13 février 1960-13 février 2020 : des réparations qui tardent» [*13 February 1960-13 February 2020: Reparations are a long time coming*], *Damoclès* no 155, 1/2020, p. 3 to 7.

3. Environmental and health issues in relation to the treaty on the prohibition of nuclear weapons

On 7 July 2017, the United Nations conference on negotiating a binding legal instrument to prohibit nuclear weapons adopted, with a large majority (122 countries in favour; 1 vote against, the Netherlands; one abstention, Singapore), the Treaty on the Prohibition of Nuclear Weapons (TPNW).[67] The TPNW, which is based on International Humanitarian Law (IHL) and human rights, will create, once it comes into force, a new international standard. It incorporates and underpins the standards established by the Treaty on the Non-Proliferation of Nuclear Weapons (NPT), regional treaties regarding the creation of nuclear-weapon-free zones as well as the Comprehensive Test Ban Treaty (CTBT). The standards for verification are equivalent to or higher[68] than those adopted in the NPT and regulated by the IAEA. This treaty therefore paves the way for nuclear disarmament to strengthen nuclear non-proliferation and international security.

In its preamble, the TPNW mentions (paragraph 6) that the State Parties are *«mindful of the unacceptable suffering of and harm caused to the victims of the use of nuclear weapons (hibakushas), as well as of those affected by the testing of nuclear weapons»*. In addition to demonstrating a willingness to pay tribute to these people, this reference constitutes acknowledgement of their suffering. Article 1 bans the development, production, possession, use and threat to use nuclear weapons, as well as assistance or encouragement of anyone engaging in any activity related to military nuclear power.

Furthermore – and it is for this reason that it is classed in the category of treaties termed humanitarian disarmament – it includes positive obligations, which are a direct result of the conclusions from the three humanitarian conferences on nuclear weapons (Oslo in 2013, Nayarit and Vienna in 2014)[69] and the Anti-Personnel Mine Ban and Cluster Munitions Conventions, which came into force in 1999 and in 2010 respectively. These

67 Jean-Marie Collin, «Transparence et désarmement nucléaire» [*Transparency and nuclear disarmament*], GRIP *Éclairage*, 28 December 2019.

68 The term *«future additional instruments»* is included in Article 3, Paragraph 1, regarding safeguards. This also allows for the possibility of establishing a more stringent standard in the future than the additional protocol, at this time the most rigorous standard currently in effect.

69 Jean-Marie Collin «The humanitarian impact of nuclear weapons: a new disarmament forum», Grip *Analysis* [Group for Research and Information on Peace and Security], 25 April 2013; «Nayarit conference on the humanitarian impact of nuclear weapons: a point of no return!», GRIP *Analysis*, 5 May 2014; «The third conference on the human impact of nuclear weapons, a new series of actions», GRIP *Analysis*, 3 February 2015.

obligations are found in Articles 6 and 7, which stipulate that each State Party in a position to do so shall provide assistance for the victims of the use or testing of nuclear weapons and to endeavour to clean up the environment in the areas contaminated by the detonation of nuclear weapons. They also permit State Parties to request and receive assistance from other State Parties.

It has been open for signing since 20 September 2017. As of 20 May 2020, the TPNW counts 81 signatories and 37 nations have ratified it. This treaty will enter into force 90 days after the fiftieth ratification, in accordance with Article 15.

Future generations

International awareness of the need to protect our environment is at the root of a new legal concept, that of the right of future generations. «For lawyers, including future generations in the law means achieving a Copernican revolution»*, according to Alexandre Kiss, a professor of international environmental law.*

The Treaty on Non-Proliferation of Nuclear Weapons (NPT), the cornerstone of the programme for nuclear non-proliferation, is limited according to the first paragraph in its preamble «to the devastation that would be visited upon all mankind by a nuclear war»*; or to an immediate effect on life. The Treaty on the Prohibition of Nuclear Weapons (TPNW) records the first occasion in law for a treaty governing a weapon of mass destruction by including this new concept that intends to protect future populations. This is part of a line of reasoning that is both intellectual and legal, as the lawyer Émilie Gaillard stresses*[70]*:* «The right of future generations is a right that is increasingly gaining in recognition. It is possible to regard it as a force consistent with the overall drive to protect the environment, or even the future fate of mankind.»[71]

Nuclear weapons cause long-term effects in all stages of their production or use:

– *During production and testing, they create radioactive waste that needs to be processed and stored over the very long term; the contaminated areas are no longer fit for human activity.*

70 Émilie Gaillard, Générations futures et droit privé. Vers un droit des générations futures, [*Future generations and private law. In pursuit of a right for future generations*], LGDJ, 2011, 673 p.

71 Émilie Gaillard, «La question des générations futures» [*The issue for future generations*], in Agathe Euzen, Laurence Eymard and Françoise Gaill (ed.) *Le développement durable à découvert [Investigating sustainable development]*, Paris, CNRS Éditions, 2013, pp. 208-209.

– *When they are used, large numbers of survivors are faced with health problems due to radiation.*[72] *Contamination of the bombed areas or the areas that were used as nuclear test sites remains and often will remain high for thousands of years.*
– *Finally, generations who are born after production, tests and use of these weapons, may also see illnesses caused by radiation transmitted to them*[73] *by a transgenerational link or from living in zones that have not been decontaminated.*

The TPNW is a legal text that is the latest in a series of treaties termed humanitarian disarmament[74]*, aiming to regulate and prohibit entire classes of weapons. As a result of the long-term impact of these weapons and the awareness of the need to protect future generations, it was logical that the TPNW should introduce legal considerations on this subject.*

The English term «future generations» *appears indirectly several times in the preamble and the articles of the treaty banning nuclear weapons:*

– *Paragraph 4 contains the first direct reference to the concept of «future generations»:* «Cognisant that the catastrophic consequences of nuclear weapons[…] pose grave implications for […] the health of current[75] and future generations.»
– *It should also be noted that there is an indirect acknowledgement in this paragraph of this aspect of war*[76]*: the impact of nuclear weapons is more severe for women and girls. It is thus clear that there is a wish to protect their health and their ability to give birth to new generations.*
– *Paragraph 23 is the third direct reference:* «Recognizing also the importance of peace and disarmament education in all its aspects and of raising awareness of the risks and consequences of nuclear weapons for current and future generations, and committed to the dissemination of the principles and norms of this Treaty […].»

The concept of «future generations» is thus directly linked with articles 6 and 7 which concern the positive obligations. There was certainly a wish on the part of the authors to guarantee that people now and in future can again live in a healthy environment, without suffering from the radioactive contamination found in nuclear test zones throughout the world.

72 As demonstrated by the numerous cases of hibakushas and people who have taken part in nuclear tests.

73 Bruno Barrillot, «Nos enfants marchent sur du plutonium» [*Our children are walking over plutonium*], *Les notes de l'Observatoire*, no. 4, Observatoire des armements, February 2016.

74 Anti-Personnel Mine Ban Convention (1999) and the Convention on Cluster Munitions (2010).

75 The word «current» was added at the request of Egypt during discussions of the preamble. The delegate intended to underline the fact that health problems already afflict populations.

76 This is the first time that this has been mentioned in a treaty concerning weapons of mass destruction.

Positive obligations: Articles 6 and 7[77]

Article 6 («Victim assistance and environmental remediation») of the TPNW consists of three sections. It requires that *«Each State Party shall, with respect to individuals under its jurisdiction who are affected by the use or testing of nuclear weapons, in accordance with applicable international humanitarian and human rights law, adequately provide age- and gender-sensitive assistance, without discrimination, including medical care, rehabilitation and psychological support, as well as provide for their social and economic inclusion.»* The definition of «victim» is therefore very broad, including both issues of physical health (illness caused by radiation for instance) and psychological (for women who have become infertile or suffered miscarriages, for instance) and economic problems (water may have been polluted and be unfit for farming).

The second section specifies that the State Party *«shall take necessary and appropriate measures towards the environmental remediation of areas [under its jurisdiction contaminated as a result of activities related to the testing or use of nuclear weapons] so contaminated.»* There is indirect recognition of changes to the environment after tests or use of nuclear weapons, since the legislator mentions «necessary» measures. Moreover, a lack of details on time frames can be noted, which stresses the imprescriptible nature of these obligations for «cleaning», which are long-term in nature.

Article 7 («International cooperation and assistance») grants the right to State Parties to seek and receive assistance from other State Parties to the Treaty, and all State Parties who are in a position to do so have a duty to provide assistance to the others in meeting their positive obligations. Indeed, section 3 states that *«each State Party in a position to do so shall provide technical, material and financial assistance to States Parties affected by nuclear-weapons use or testing, to further the implementation of this Treaty»*. This assistance (both financial and technical) may take the form of rehabilitation of the environment or help for people, as specified in section 4: *«Each State Party in a position to do so shall provide assistance for the victims of the use or testing of nuclear weapons or other nuclear explosive devices.»* Note that these two sections use the term «in a position to do so» with the aim of encouraging State Parties to implement such measures. However it also means providing an opportunity for these processes to get started promptly. Indeed, if assistance was only to come from the States with nuclear weapons (France, the case of interest to us) and who are already parties to the TPNW, the wait could take a very long time. This would only increase the suffering of people and the dangers to which they are exposed.

Assistance may also be provided by various organisations (including the UN or the International Committee of the Red Cross), which are listed in section 5. This model for action

77 Harvard Law School International Human Rights Clinic, *Victim assistance and environmental remediation, the Treaty on the Prohibition of Nuclear Weapons: Myths and Realities*, April 2019.

already works very well in numerous areas (health, protection of civilians etc.) and can certainly be implemented quickly.

Nonetheless, the authors of the TPNW set store on naming those responsible for these humanitarian and environmental situations. This is why section 6 stipulates that *«a State Party that has used or tested nuclear weapons or any other nuclear explosive devices shall have a responsibility to provide adequate assistance to affected States Parties, for the purpose of victim assistance and environmental remediation.»* Of course, it was also stipulated that *«the obligations»* of this State Party (hence a nuclear power) *«shall be without prejudice to any other duty or obligation that it may have under international law»*.

The TPNW recognises the principle of ‹the polluter pays›.[78] This is the first time that «an accusing finger» has been pointed at nuclear powers in a treaty on nuclear weapons and that, secondly, the international community has required them to make reparations for their actions.

Application of Articles 6 and 7 in Algeria

Algeria took part in the negotiations for TPNW, unlike France which has not ceased objecting to it[79] since it was adopted. The treaty was opened for signing on 20 August 2017 and Algeria was one of the first states that decided to sign the text, setting the process of ratification in motion. There is no doubt about Algeria's wish to ratify this text, given the countless political reports.[80] Once it has become a State Party and once the treaty comes into force, Algeria will then have to discharge its obligations, in particular those relating to Articles 6 and 7.

According to Article 6, it is the affected State Party (in this case Algeria) on whom it is initially incumbent to provide assistance for victims, or at the very least to genuinely make a start on an action plan for the victims. As indicated in the *Recommendations (page 49)*, the measures implemented may be related to health or economic in nature. As it is, if the land or the palm groves have indeed been contaminated and if this contamination prevents agricultural production (as it possibly poses a risk to human and animal health), this will risk endangering the livelihoods of many families.

78 The principle of «the polluter pays» was adopted as a general principle in international environmental law for the first time with the Rio Declaration from 1992 on development and the environment by means of principle No 16.

79 Press statement from the permanent representatives from the United States, the United Kingdom and France to the United Nations following the adoption of a treaty banning nuclear weapons - New York, 7 July 2017.

80 Speech by Mr Mohammed Bessedik, Algerian Ambassador, general debate at the First Committee at the UN, 74th session of the General Assembly, 11 October 2019.

Algiers can request international assistance, in particular from the International Federation of the Red Cross and Red Crescent Societies and also the national Red Crescent Society. These organisations, which are already on the ground in this country, could therefore record the witness statements and produce an initial health assessment fairly swiftly.

Where France is concerned, it does not intend to sign and ratify the TPNW. But does this prevent it from providing humanitarian and technical assistance to Algeria? No. In fact, as demonstrated by some acts of international cooperation between countries with a troubled history, positive actions for the population and the environment can be undertaken.

Furthermore, there are many ties between these two countries, in particular where nuclear energy for peaceful means is concerned. For instance, the Algerian Atomic Energy Commission (Comena) and the French Atomic Energy Commission (CEA) are running various programmes together, evidence of mutual trust and understanding between the parties. Discussions could be initiated on the subject of the nuclear waste currently found in the Sahara.

All the more so as a start has already been made on discussions, namely following the visit by President Nicolas Sarkozy to Algeria in December 2007 with the establishment of a joint Franco-Algerian commission. This was assigned responsibility for civilian expertise at the polluted sites and for compiling all the data and research in order to determine the radioactivity at the polluted sites and to evaluate the risks for the residents and to the environment. Apparently, this commission did meet, namely in 2009, according to the remarks made by the Algerian Minister for Foreign Affairs in 2010. In any case, it operated under the utmost secrecy: no report was publicised before it finished its work.

Resumption of discussions could very easily be included as part of the high-level Algerian-French intergovernmental committee (CIHN), established following the Algiers declaration in 2012. According to the joint Franco-Algerian press releases (from 2012, 2014 and 2017), during the sessions of the CIHN the question of works in connection with the nuclear tests arose. It was therefore decided on 11 December 2017 to *«establish specific lines of communication as promptly as possible»*[81] in order to continue with the initiatives from the combined working group on compensation for the Algerian victims of French nuclear tests in the Sahara or their dependents. To date just one meeting has been held, on 3 February 2016.

81 Communiqué from the French government, Fourth Session of the High-Level Franco-Algerian Intergovernmental Committee (CIHN), 11 December 2017.

Cases of assistance for victims and of environmental remediation among states

There are several examples of inter-state cooperation in establishing aid programmes, even when these countries have had a turbulent history; just as there is at least one example of participation by a country (in this instance the United States) in a programme for rehabilitation of the environment, even when, from a legal aspect, this country was not under a legal obligation to do so. This case could serve as a model to be followed in the relationship between France and Algeria.

The United States/Vietnam are two countries which were involved in a deadly conflict. Between 1962 and 1971, the United States used very powerful chemical substances (over 80 million litres) with the deliberate goal of destroying forests in order to identify the places and transport routes used by soldiers of the South Vietnam National Liberation Front. Almost two million hectares were burnt in this way, causing an immense environmental catastrophe and considerable humanitarian consequences (burns). A culture of mutual hatred became widespread in these two countries, before – with the passing of time – a new era dawned. While Washington has never acknowledged direct responsibility for this contamination, despite unequivocal demands from Hanoi, decontamination measures have been carried out since 2011, such as, for example, the project of cleaning up Danang airport. In 2019, the American Agency for International Development (USAID)[82] launched a ten-year programme (with investment of 183 million dollars) to clean up the Bien Hoa airport, which is considered as the most polluted site in the country. Furthermore, a letter of intent was signed so the governmental agencies in these two countries could work together to help Vietnamese citizens who have a disability as a result of exposure to this chemical agent.

The Soviet Union/Russia and Kazakhstan: 456 nuclear tests (340 atmospheric and 116 underground) were conducted on the Semipalatinsk site in Kazakhstan. Once the country gained independence in 1991, its President Nazarbayev decided to close this test site and to commit to an aid programme for people living in the contaminated zones. Even if Russia was for a long time reluctant to introduce a programme of direct medical aid targeting the Kazakh population, international aid was set up with the Cooperative Threat Reduction programme. This agreement, which was concluded between the United States, Kazakhstan and Russia secures nuclear materials in order to prevent proliferation of radioactive material that is liable to be used in the production of nuclear weapons or dirty bombs.

82 Press release, The United States and Vietnam Strengthen Partnership to Address War Legacies, USAID, 5 December 2019.

Kazakhstan also decided to create a research centre[83] whose remit is to examine and process the health and environmental legacy from the contamination, thus acknowledging its obligation to protect its citizens.

The United States and their policy of aid in mine-removal campaigns: While the United States have not ratified the conventions banning anti-personnel mines and cluster weapons, this country is one of the main donors (having started with 113.5 million dollars in 2013 to progressively reach a contribution of 309 million dollars in 2017) ensuring operations for mine removal throughout the world.

Lastly, we need to mention the secret cooperation, initiated in 2012, between France and Algeria with respect to the repercussions from tests of French chemical weapons in the Sahara. This demonstrates that it is possible to address the subject of waste buried in the Sahara:

France/Algeria: According to the EVIAN Accords dated 19 March 1962, France was authorised to use the sites in the Sahara (In Ekker, Reggane and Colomb-Béchar-Hammaguir) for a period of five years until 1967. In reality, the secret B2 Namous base (in the Beni Ounif region) that was used for testing chemical weapons and germ warfare, would be retained by France until 1978 with the agreement of the Algerian authorities. The existence of this base would only be made public in 1997.[84] On 19 and 20 December 2012, President Hollande met President Bouteflika to turn the page and start a new era of cooperation and friendship between the two countries. During this visit, they signed *«a confidential agreement on a commitment to decontaminate a former chemical weapons testing site»*[85]; in other words, the B2 Namous site. This secret agreement illustrates that cooperation is indeed possible between these two countries on an extremely delicate subject. However, the «secret» nature of the agreement makes it difficult to ensure monitoring of this decontamination process as well as providing information to civilian residents of this area. To date, it is only possible to confirm that it is the research centre at le Bouchet, a *Direction générale pour l'armement* (DGA or French Defence Equipment and Support Agency) establishment, specialised in chemical and bacteriological risks, that is in charge of this decontamination. We can confirm that nothing was undertaken during 2013 and 2014. In fact, according to an internal document (dated 20 March 2013) from the committee on safety, hygiene and working conditions (CHSCT) at the DGA, it is mentioned that

83 The main area of activity at the Republic of Kazakhstan National Nuclear Centre, which was founded on 21 January 1993, is to support the programme of non-proliferation and environmental safety.

84 Vincent Jauvert, «Nom de code : B2-Namous. Quand la France testait des armes chimiques en Algérie» [*Code name: B2-Namous. When France tested chemical weapons in Algeria*], *Le Nouvel Observateur*, no 1720, 23 October 1997.

85 Jean-Dominique Merchet, «Exclusif : la France va dépolluer un ancien site d'essais d'armes chimiques en Algérie» [*Exclusive: France is going to clean up a former chemical weapons test site in Algeria*], *Marianne*, blog on Military Secrets, 25 February 2013.

«on 23 January 2013, the CGT [French confederation of trade unions] objected to sending 10 members of staff from the DGA to Algeria» on account of the risk from terrorism. One year later, on 4 December 2014, according to a document from the network technical committee, it is mentioned this time that the CHSCT had managed to *«abandon sending civilian staff (DGA-TT Bourges et DGA-MNRBC site at Vert-le-Petit) on assignment to the B2 Namous site in Algeria (Pb of chemical/pyrotechnical pollution) following nuclear tests in the 1960s.»* Has this mission been carried out since then? There is no way of corroborating this.

Recommendations

This report underlines/emphasises the fact that the zones in the Sahara (Reggane and In Ekker) that served France as the testing grounds for 17 nuclear explosions have been left with remains, which pose a far from negligible danger for both people and for flora and fauna. In order to ensure health security for the local people and to create a healthier environment, an extensive investigation of the area should be undertaken to locate and salvage the non-radioactive waste or waste from nuclear tests (contaminated vitrified sand, rock and lava) as well as the tools and other machinery that are potentially radioactive and were abandoned by the French authorities and military at the time, who simply had them buried in the sand.

The obstacles that have to be overcome in order to put an end to over sixty years of secrecy and taboos between France and Algeria are numerous. However, it is certain that if the Algerian and French authorities took a step towards resolving this humanitarian problem, this would be proof of implementation of the first clause in the Algiers declaration: *«France and Algeria are determined to open a new chapter in their relationship, fifty years after Algerian independence.»*

As regards France, the law of 15 July 2008[86] greatly strengthens secrecy covering the archives relating to nuclear power. As stipulated by article 17 of this law: *«there is no consultation allowed of public archives, where disclosure is liable to result in dissemination of information that enables the design, manufacture, use of nuclear, biological or chemical weapons or any other weapons, which directly or indirectly cause destruction on a similar scale, or to establish the location of the same.»* However, it is significant that interpretation of this law is in line with its primary aim, which is to combat nuclear proliferation. Indeed, access to certain archives (especially maps that allow the buried waste to be located) would allow security to be strengthened.

The proposed recommendations are not exhaustive and others may be added:

Measures to enable discussions between the two countries in order to improve the humanitarian situation

- As part of the CIHN sessions, both governments should *establish specific lines of communication* (announced in 2017) based on the work undertaken by the combined working group on compensation for the Algerian victims of French nuclear tests in the Sahara or their dependents.

86 Law no. 2008-696 dated 15 July 2008 regarding the archives, article L. 213-2. II.

- As recommended by Civen (2018 report), the French state needs to improve access for Algerian citizens to the medical archives held by the Department for army hospital medical records.
- With an eye to speeding up the process of compensation for Algerian people affected by the nuclear tests, the recommendation is that details of the process of compensation are made available in Arabic and accessible to those concerned on the Civen website; likewise, Civen missions – similar to those it conducted in French Polynesia on several occasions – should be carried out in the areas concerned to make it easier to prepare the files with the requests for compensation.
- It would also be essential to amend the decree delineating the affected areas in the Sahara so that they can be expanded, as was done for French Polynesia.
- It is important for those involved (French civilians and military and Algerian people) to include their witness accounts in a «collective memory» for the benefit of future generations. Creation of this «joint memory» could be commissioned by organisations in the two countries with the help of academics from these countries.
- Any measures and actions taken should be recorded in the official languages of France and Algeria.

Measures concerning nuclear waste

- France should provide the Algerian authorities with a full list of sites where contaminated waste was buried, in addition to the precise location of each of these sites (latitude and longitude), a description of this material, as well as the type and thickness of the materials used to cover them;
- Details should be published relating to the areas contaminated by slag and lava and treated by simply covering them over (sand, layer of asphalt, layer of tarmac, etc.);
- France should provide Algeria with the plans of the CEA's underground installations under the Reggane plateau military base, as well as the plans of the various galleries excavated in the Tan Afella mountain.

Health protection measures

- Algerian authorities should improve communications about the prohibited access to these areas by using straightforward measures: reinforcing fences, installing a number of information boards in Arabic and French at the sites, displaying information in town halls and in health facilities in the towns and villages in these areas.

Actions to be taken among the local people

- Conduct an independent study[87] of children and grandchildren in order to establish whether there is a transgenerational risk;
- Conduct an investigation among the local population to identify any contaminated material that is currently being used;
- Implement health measures initially targeting the inhabitants of the village of Mertoutek, and other local populations after that.
- Provide information and raise awareness in the population (in schools, in community groups) about the risks from radioactivity.

Rehabilitation and protection of the environment

- Despite the impossibility of returning it to an entirely natural state, an initial evaluation should be carried out to determine possible options for environmental rehabilitation of the nuclear test sites, and regular monitoring of the contaminated zones must be ensured with the participation of independent scientists.
- The zones with the highest level of contamination (primarily the lava flow located on the mountainside of Tan Afella) should be cleaned up or, at the very least, covered over to restrict the scattering of radioactive particles in the wind and rain. Regular monitoring (annually) should be set up.

Use of new technologies

- The authorities should make use of new technologies in order to improve safety for the population:
  1) Use of drones[88] equipped with ground/soil-penetrating radar and a gamma-ray detector to identify buried waste.
  2) Use of satellite images to ensure monitoring and allow comparison of the test zones over time.

87 A similar study was conducted for French Polynesia by doctor Christian Sueur, a psychiatrist and hospital clinician: *Conséquences transgénérationnelles des essais nucléaires réalisés au CEP de Polynésie française durant la période 1966-1974, sur la descendance (F2) des ‹vétérans'(F0) [Transgenerational consequences from the nuclear tests conducted at the Pacific Test Centre (CEP) in French Polynesia during the period from 1966 to 1974 on descendants (F2) of ‹veterans› (F0)]*, 2018.

88 Ikechukwu K. Ukaegbu, Kelum A. A. Gamage, and Michael D. Aspinall, *Non Intrusive Depth Estimation of Buried Radioactive Wastes Using Ground Penetrating Radar and a Gamma Ray Detector, Remote Sensing*, 12 January 2019.

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Illustrations

In order to protect the photographers' identities, no names are given in this document.

Ill. 1: Report on French nuclear tests 1960–1996, volume 1: La genèse de l'organisation et les expérimentations au Sahara CSEM et Cemo [The origin of the organisation and the experiments in the Saharan Centre for Military Testing (CSEM) and Cemo (Oasis Military Test Centre)], p. 54

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