

Legal Perspectives on Nuclear Fallout: From Hiroshima, Nagasaki, and Chernobyl to the Blue Jerboa – An Analytical Study of Nuclear Catastrophes and Their Role in Shaping the Foundations of Global Environmental Law and Prompting the Development of Binding International Norms for Environmental Protection

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Abstract : From the scorched ruins of Hiroshima and Nagasaki to the radioactive silence of the secretive tests of the blue jerboa, this article explores how nuclear catastrophes became a turning point in the evolution of global legal environmental awareness. These disasters transcended national borders, revealing the inadequacy of existing legal frameworks and igniting an urgent call for international environmental responsibility. The study traces how legal thought responded to radioactive threats, prompting new treaties, principles, and norms that elevated environmental protection from a peripheral issue to a core concern of international law. The article". concludes with forward-looking recommendations to strengthen global legal safeguards against future nuclear risks.

Keywords : nuclear fallout/ Catastrophes/Hiroshima-Nagasaki/Chernobyl / blue Jerboa/ International law / International agreement/ Safeguarding the planet/environmental awareness.

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Introduction

The twentieth century witnessed radical transformations in the course of humanity, the most prominent of which was the world's entry into the nuclear age. Wars were no longer measured solely by the number of soldiers or conventional weapons, but rather, nuclear bombs came to represent the pinnacle of mass destruction. For the first time, the world experienced the catastrophic face of nuclear energy, not just as a scientific achievement, but as a destructive force that left behind what is known as "nuclear fallout."

Nuclear bombs were not just military inventions that caused immense, instantaneous destruction in specific places around the world. They were a loud wake-up call that shook the conscience of humanity and opened up new discussions about the fate of the planet and the urgent need to protect it. From Hiroshima and Nagasaki in 1945 to the Chernobyl disaster in 1986 and finally to the French "Gerboise Bleue" nuclear tests in the Algerian Sahara in 1960, these dark nuclear chapters represent significant milestones in human history. They not only led to immense human tragedies but also created catastrophic environmental impacts whose echoes still resonate today.

The radiation and long-term pollution that accompanied these disasters revealed the fragility of the environmental balance in the face of unregulated technological development. It proved that military victories can turn into environmental defeats that threaten the biological security of all humanity. The toxic effects of nuclear fallout and radioactive materials spread to the air, water, and soil, crossing geographical and political boundaries, making the danger a global environmental one, and not just a local or national crisis.

The recurrence of these incidents and the severe environmental and health imbalances they caused contributed to the crystallization of what is known as the global environmental awakening. The voices of scientists, thinkers, and human rights activists began to rise, demanding the necessity of including the environmental dimension in military and diplomatic policies and reconsidering the principle of absolute state sovereignty when dealing with a threat that endangers all of humanity. Thus, these nuclear experiences, with all their tragedies, helped spark the need to establish and consecrate an international legal framework that guarantees environmental protection during armed conflicts and holds states responsible for cross-border damages.

This article seeks to analyze this profound shift in the perception of the environment in light of major nuclear disasters and how these tragedies helped establish the environment as a central issue within the international legal system and as a strategic pillar of global human security. It also sheds light on international legal efforts, from nuclear disarmament treaties to multilateral environmental initiatives that aim to make peace not only the absence of war but also the protection of the Earth and life in all its forms.

Based on the preceding information, the problem that can be posed is as follows: To what extent have major nuclear disasters constituted a turning point in global environmental awareness, and has international law been able to keep pace with the magnitude of the environmental challenges unleashed by nuclear fallout through effective mechanisms to protect the environment and humans from the remnants of nuclear wars?

To answer the posed problem, we have decided to adopt a descriptive-analytical approach by dividing the article's plan into two main sections. The first section includes major nuclear disasters and their negative impact on the environment and humanity, while the second section

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is dedicated to legal vigilance and the formation of international environmental awareness. We will conclude our article with a summary of the study that includes the most important findings and proposed recommendations.

Firs Axis: Major Nuclear Disasters and Their Negative Impact on the Environment and Humans

Major nuclear disasters have marked a dangerous turning point in the course of human history. Their effects were not limited to the military or political aspects, but extended to strike the environment at the very core of its balance on one hand, and humans on the other. With every nuclear explosion or radiation accident, the world witnessed a catastrophe that could not be measured by lives alone, but by the toxic ash and long-term effects it left behind on the natural surroundings.

From this perspective, the first step is to consider the concept of major nuclear disasters and the most famous of them, then secondly to address their negative impact on the environment and humans, as follows:

First: The Concept of Major Nuclear Disasters and the Most Famous of Them

Major nuclear disasters represent a defining moment in human history, due to the widespread destruction and far-reaching effects they created on humans, the environment, and even on international law. These disasters were not just passing accidents, but tragic milestones that revealed the danger of the uncalculated use of nuclear energy, whether in war or peace. For this reason, we have decided to discuss the definition of nuclear disasters and then address the most famous ones ¹.

Definition of Major Nuclear Disasters:

Major nuclear disasters are considered among the most dangerous technological disasters of the modern era due to the severe repercussions they have on human health and the environment, and the legal, ethical, and scientific issues they raise that transcend the geographical and political borders of states. They are defined as those accidents or explosions that occur in civil or military nuclear facilities and lead to the leakage of huge quantities of radioactive materials into the environment, causing widespread environmental, health, and social destruction that may last for decades or even centuries ².

The International Atomic Energy Agency (IAEA) defined a nuclear disaster as: a serious nuclear or radiation accident that leads to the uncontrolled release of large quantities of radioactive materials into the environment and requires an emergency response at the local, regional, or international level to protect human health and the environment. This agency also approved the International Nuclear and Radiological Event Scale (INES) to classify the severity

¹ Rafael Grossi, Nuclear safety and the responsibility of the international community. I.A.E.A, 2020 p 198

² Mansour Samir, Radioactive Pollution and Nuclear Dangers, The Egyptian General Book Authority, Cairo, 2015, p 67

of nuclear accidents, where a Level 7 is classified as the highest degree of disaster, as occurred, for example, in the Chernobyl disaster in 1986³.

As for the United Nations Environment Programme (UNEP), it did not provide a single literal definition, but it describes a major nuclear disaster as one of the most dangerous forms of technological disasters due to the long-lasting radioactive contamination that extends across generations and threatens the environmental, health, human, and global environmental security systems⁴.

The World Health Organization (WHO) focuses on the health aspect and defines major nuclear disasters as events that cause widespread radiation leakage, leading to an increase in the rates of radiation-related diseases such as cancer and congenital malformations, and imposing immense challenges on public health systems and emergency response⁵.

Greenpeace defines nuclear disasters from an environmental perspective as: "an expression of the catastrophic failure of nuclear technology, where the peaceful or military use of nuclear energy turns into a global tragedy affecting humans and nature alike, as a result of a loss of control over radioactive forces"⁶.

The International Committee of the Red Cross (ICRC) focuses on the humanitarian aspects and defines major nuclear disasters as profound humanitarian catastrophes that require an emergency response to protect civilians and provide health care and psychological support for those affected by nuclear radiation⁷.

Academic researchers have provided multiple definitions highlighting the technological and environmental dimensions of these disasters. In this context, the German sociologist **Ulrich Beck** argues that a nuclear disaster represents a tragic embodiment of the risks of modernity, where technology has moved beyond human control, transforming from a means of progress into a comprehensive source of destruction.

These definitions show that nuclear disasters are not just accidental occurrences, but an expression of a **structural failure** in managing dangerous technology within systems that are unprepared to handle risks of this magnitude.

The term "major nuclear disaster" also includes explosions resulting from the use of nuclear weapons in wars, as occurred, for example, in Hiroshima and Nagasaki in 1945, which left hundreds of thousands of victims and generated radioactive fallout whose health and environmental effects are still present today⁸.

After clarifying the concept of major nuclear disasters and demonstrating their destructive nature and long-lasting effects, it becomes necessary to look at the most prominent historical events that embodied this type of disaster in its worst forms and showed the fragility of

³ See International Atomic Energy Agency, User Guide for the International Nuclear and Radiological Event Scale (INES), First Edition, Vienna, 2009, p. 5.

⁴ See United Nations Environment Programme (UNEP) in International Cooperation to Address and Mitigate the Effects of Major Nuclear Accidents (Nairobi 2, UNEP, February 1993, pp. 2-3).

⁵ Manuel on Public health action in radiation emergencies 1994, I.C.P/EHAZ-94-13/PB-01 P20.

⁶ Greenpeace international: The nuclear disaster that's far from over, Greenpeace Report, 2012.pps-10.

⁷ International Committee of the red cross (ICRC), Nuclear weapons: Averting a global catastrophe. Appeal by Peter Maurer, President of the (ICRC), 23 April, 2018.

⁸ See World Nuclear Association: The Nuclear Accidents Charitable, A Historical Review, 223, available at: <https://www.world-nuclear.org>

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environmental and human security in the face of the unsafe use of nuclear energy. These nuclear disasters marked the beginning of a new era of nuclear devastation, recorded not only as war crimes but as open wounds in human memory due to the victims, deadly radiation, and environmental effects they left behind that still exist today. For this reason, we decided to address the most famous major nuclear accidents as follows:

B. The Most Famous Major Nuclear Disasters in the World

Since humanity crossed the threshold of the nuclear age, the course of history has changed radically, and a new force has emerged that is unparalleled in its destructive power and long-term impact on humans and the environment. Wars are no longer limited to conventional weapons, as nuclear bombs have become a symbol of potential annihilation and mass destruction. This bitter reality has been embodied in a series of famous nuclear disasters whose evidence remains alive in the world's collective memory. From the hell of Hiroshima and Nagasaki in Japan to the radiation disaster in Chernobyl, Ukraine, and reaching the French nuclear test conducted in the Algerian desert, known as "Gerboise Bleue" (Blue Gerbil). These dark milestones were pivotal moments that revealed the dark side of nuclear technology and sounded early alarms about the dangers of meddling with a power that exceeds humanity's ability to control.

In August 1945, the United States, in a reckless decision, bombed the Japanese city of Hiroshima using an atomic bomb, declaring the occurrence of the most heinous crime in human history. This came after America, in cooperation with the United Kingdom and Canada, designed and built the first nuclear bomb during their secret project "Manhattan." The American physicist **Robert Oppenheimer** managed the scientific research, which resulted in the creation of the Hiroshima bomb, a gun-type fission bomb called "Little Boy," which used Uranium-235, a rare isotope of uranium. The bomb was dropped on Monday, August 6, 1945, marking the greatest catastrophe ever known to history. The bomb was released at 8:15 AM Hiroshima time, carrying 60 kilograms of Uranium-235. The bomb took 57 seconds to fall from the plane and reach the altitude where it would explode, which was about 600 meters above the city. This resulted in an explosion equivalent to about 13 kilotons of TNT and fires over an area of 11 cubic kilometers⁹.

The Nagasaki Bombing

The Nagasaki bomb was the second nuclear bomb used in war, dropped by the United States on the Japanese city of Nagasaki on August 9, 1945, just three days after the bombing of Hiroshima. A B-29 American military aircraft named "Bockscar" took off from the "Tinian" airbase in the Pacific Ocean. It was carrying a nuclear bomb called "Fat Man," a plutonium bomb that was more powerful than the Hiroshima bomb. At 11:00 a.m., the bomb fell silently before it exploded at an altitude of about 500 meters above the city. It was a type of fission bomb that relied on Plutonium-239. It weighed about 4,670 kilograms, was larger in size, and more complex than the Hiroshima bomb. Its explosion was massive, carrying an explosive

⁹ See The Encyclopedia Britannica, Hiroshima Bomb, Arabic Edition, Al-Noor Foundation, Beirut, 2009, p. 126.

energy equivalent to about 21,000 tons of TNT. In a single moment, parts of the city were engulfed in flames¹⁰.

The Chernobyl Disaster

As for the Chernobyl incident, it occurred in the early hours of April 26, 1986. While the power plant workers were conducting a routine test to verify the functionality of the water cooling system during a power outage, an operational error led to the failure of the water turbine. This raised the temperature of the uranium in the fourth reactor to ignition point, resulting in the meltdown of the reactor's core. This caused a nuclear fireball of radioactive materials to rise to a height of one kilometer into the sky. Soviet rescue teams intervened to extinguish the terrifying fire but without wearing radiation protection equipment because the authorities had not informed the rescuers about the leakage of dangerous materials such as uranium, plutonium, cesium, and iodine. This prompted experts to recommend throwing sand, lead, and nitrogen from helicopters to extinguish the fire and reduce the radiation level, while continuing to recruit 600,000 people for the fire extinguishing operation and the removal of explosion debris saturated with radiation. The explosion was equivalent to about 400 times the radioactive power of the Hiroshima bomb, as it ejected about 9 tons of nuclear materials and radioactive fuel into the sky¹¹.

The "Gerboise Bleue" Bomb

In the aftermath of the Second World War, France, like other great powers, realized that possessing nuclear weapons was the key to global superiority, after being preceded by the United States, then the Soviet Union, and Britain. France wanted to join this nuclear club to prove its military and political independence, especially after its humiliating defeat in 1940 and its occupation by Germany. In 1954, actual work began on a military nuclear program under the supervision of General **Charles de Gaulle**, with the assistance of the French Atomic Energy Commission. The Algerian desert was chosen as an ideal site for the tests due to its vastness and its distance from French population centers. France chose the **Reggane** area, located in the deep south of Algeria, within a desolate desert close to the "Ain Iker" area, where a huge secret base known as the "Sahara Military Testing Center" was established. Observation and control centers were built, and experimental villages were set up with human-sized dummies and houses to test the effect of the explosion on them. The local Algerian population was used in the research indirectly and without their knowledge as human samples in the vicinity of the explosion.

On February 13, 1960, at exactly 7:04 AM, the first nuclear bomb was detonated. It was the result of 17 atmospheric and underground nuclear tests conducted in the "Reggane" area and in the cavities of the Hoggar mountains. It was named "Gerboise Bleue" (Blue Gerbil) and had a power of **70 kilotons**, which is three to four times the destructive power of the bomb the United States dropped on Hiroshima. A 100-meter-high metal tower was set up to suspend the bomb. Suddenly, at 9:04 AM, a light ignited in the sky, a light brighter than the sun. The tower instantly exploded and completely vanished. A massive fireball of red and yellow flames rose, followed by a giant nuclear mushroom cloud that ascended hundreds of meters into the sky.

¹⁰ Nagasaki," Encyclopedia Britannica, 15th ed., Encyclopedia Britannica, Inc, 2010.

¹¹ Chernobyl Disaster," Encyclopedia Britannica, Bed, Encyclopedia Britannica, Inc, 2021.

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The sound of the explosion was thunderous, like an earthquake tearing through the earth's core¹².

Nuclear explosions are not just decisive military moments; they are pivotal moments in the history of humanity and nature. When the Hiroshima and Nagasaki bombs were dropped, the disaster did not end with the echo of the explosion. Instead, a long-term tragedy began, extending into human bodies and souls, spreading through the air, soil, and water. When the Chernobyl explosion resounded, it was not merely a technical malfunction but a declaration of radiation's ability to silently penetrate the boundaries of time and space, leaving its destructive effects. And in the heart of the Algerian desert, the "Gerboise Bleue" exploded the sands of Reggane, leaving behind a radioactive environment and exhausted bodies without the world hearing them as it should have. Despite the different circumstances and contexts of these disasters, they all reveal the dark side of nuclear energy, turning it into a tool that destroys both life and the environment. This is what we will address in the following section:

Second: The Impact of Major Nuclear Disasters on the Environment and Humans

Major nuclear disasters represent significant milestones in human history, not only for the horrific human losses they caused but also for the catastrophic environmental effects, some of which are still tangible today. From the ashes of Hiroshima and Nagasaki to the dust of Chernobyl and "Gerboise Bleue," the environment remains the silent and longest-lasting witness to these environmental tragedies. Hence, it is necessary to study these disasters from two main angles: their impact on the environment and then their impact on humans, to understand the depth of the tragedy left behind by nuclear weapons when used without awareness or controls.

The Impact of Major Nuclear Disasters on the Environment

Regarding Hiroshima and Nagasaki, when the "Little Boy" and "Fat Man" atomic bombs were dropped on these two cities in 1945, the environmental effects were not part of the military calculations. However, the result was devastating. The heat, explosion, and radiation completely destroyed vegetation and turned the land to ash. Radioactive materials leaked into the soil, halting agriculture for long periods, and water sources were contaminated, threatening plant and animal life. In addition, the nuclear fallout rose into the atmosphere and temporarily affected the local climate in what was known as a "**mini nuclear winter**." Many species of insects and animals went extinct over a wide area due to the radiation and extreme heat¹³.

As for the Chernobyl disaster, it was the most severe nuclear accident in civilian history and led to the contamination of vast areas. A 30 km radius was declared uninhabitable and turned into a "**Red Forest**" due to the death of trees from radiation. Deformities were also observed in animals and plants, and reproductive patterns and ecological balance changed. Many radioactive clouds traveled to Europe, contaminating rivers, forests, and farms. To this

¹² See International Committee of the Red Cross Report, *The Negative Effects of French Nuclear Tests in Algeria*, Geneva, 2013, p. 7. **See also:** Report of the Algerian Center for Research on French Military Nuclear History in Algeria, *A Crime Without Recognition*, Algiers, 2018, p. 11.

¹³ Hiroshima and Nagasaki Bombings: Environmental effects, *Encyclopedia Britannica*, 2021 edition.

day, many areas remain contaminated with elements like **Cesium-137** and **Strontium-90**, which will take centuries to decay¹⁴.

The "Gerboise Bleue" bomb, which was France's first successful nuclear test in 1960 and the result of 17 nuclear tests in the Algerian desert, had devastating environmental effects. Nuclear dust was released into the air and spread for thousands of kilometers, reaching neighboring countries. The lack of containment technologies also led to the leakage of radiation into the soil and groundwater, and many animals were afflicted with unknown diseases¹⁵.

The Impact of Major Nuclear Disasters on Humans

When the bomb exploded over Hiroshima, the bodies of thousands of people turned into shadows imprinted on walls, and tens of thousands vaporized in heat exceeding 4,000°C. Around 70,000 people died in the first moment, and the number rose to more than 140,000 in the following months. There were also severe physical and psychological effects, as survivors suffered from extreme burns where their skin melted from the heat. There were not enough doctors or medicines to treat the injured, and many died in the streets. **Radiation sickness** spread with many symptoms such as bloody cough, hair loss, internal bleeding, and vomiting. Cases of **leukemia** appeared in the following years, especially among children. The survivors were called "**Hibakusha**" and faced societal discrimination, as people avoided them for fear of contagion. The sight of charred corpses, dead children, and screams remained etched in the memory of the survivors, many of whom suffered from post-traumatic stress disorder, depression, and isolation until their death.

Regarding the Nagasaki disaster, even though the mountainous terrain reduced the number of victims compared to Hiroshima, the impact on the population was devastating. More than 70,000 people died, and the number continued to increase after the incident due to radiation. There were also delayed deaths, as many of the injured initially seemed healthy, but after a few days, the deadly symptoms of radiation began to appear. This phenomenon led to medical confusion and widespread anxiety, and high rates of birth defects, mental disabilities, and heart diseases were observed. The children of survivors also faced challenges in marriage and employment due to genetic fears. Most hospitals were destroyed, and many medical staff died, leading to a paralysis of healthcare¹⁶.

As for the Chernobyl disaster, the explosion did not just destroy a city; it detonated a future. The impact was not immediate but extended for decades, with more than 600,000 people exposed to direct and indirect radiation, including workers, residents, and military personnel who participated in the evacuation and cleanup operations. While 31 people died instantly, thousands of others died later due to radiation sickness. Thyroid cancer, in particular, became widespread among children in Ukraine, Russia, and Belarus. In addition, many women suffered miscarriages, and some gave birth to deformed babies. Cases of children born with missing or deformed limbs were found, and some suffered from severe immune deficiency. The number of displaced and homeless people also increased, with more than 350,000 people displaced from the areas surrounding the reactor. These people lived in new cities without an identity, pursued by the fear of sickness, ostracism, and permanent homelessness. Many suffered from constant

¹⁴ See United Nations Environment Programme, *Environmental Effects of the Chernobyl Accident*, Nairobi, 2006, p. 9. See also: International Atomic Energy Agency Report, *The Environmental Effects of the Chernobyl Accident, a Comprehensive Scientific Assessment*, Vienna, 2006, p. 14.

¹⁵ Bouziane Mohamed, *The Environmental Effects of French Nuclear Tests in Algeria*, *Journal of Environmental Sciences*, No. 12, 2009, pp. 45-60.

¹⁶ See International Committee of the Red Cross Report, *The Human Cost of Nuclear Weapons*, 2011, pp. 8-15.

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anxiety about the future, as well as depression, sleep disorders, and suicide. The mental health of the population was neglected, and many suffered in silence for years¹⁷.

Regarding the "Gerboise Bleue" bomb, which was detonated in 1960 in the "Reggane" desert in southern Algeria during the pre-independence era, despite being in a relatively sparsely populated area, the impact on humans was tragic. Algerian residents were placed near the test site without adequate protection and were exposed to direct radiation. Their names were not registered, and they were not recognized. Instead, some were used in secret medical experiments. In the following decades, strange diseases appeared among the residents of "Reggane," including cancers, infertility, congenital defects, and repeated miscarriages. Many children were born with severe skin diseases and deformities that had no explanation other than radiation. The residents did not receive any compensation or treatment, and a feeling of betrayal and bitterness grew among generations. Hope vanished as the number of victims increased¹⁸.

These major nuclear disasters show how science can transform from a means of progress into a tool of annihilation. In the face of these bombs, humans were not just a victim of a single moment but a victim for decades. Their lives, psychology, social relationships, and even their dreams changed. These disasters, despite their horror, taught us that playing with nuclear fire leaves not only ash but also tears, lingering souls, and a history that bleeds forever.

These major nuclear disasters revealed the catastrophic face of nuclear energy when it is used or managed without responsibility and oversight. These events left behind destructive environmental effects and widespread health and human consequences whose repercussions extended for many years and even crossed geographical and political borders. Through these disasters, the inability of the international system at the time to deal with cross-border environmental threats became clearly evident, raising genuine questions about the necessity of developing international legal rules to protect the environment.

In this context, these disasters contributed to sounding the alarm, triggering a wave of global awareness of the need to establish international legal mechanisms to seriously deal with environmental threats, especially those resulting from nuclear technology. Thus, environmental protection became a pre-eminently international issue, and international environmental law began to take shape and become established, driven by the harsh lesson that these disasters taught all of humanity. This is what we will address in the second chapter as follows:

Second Axis: From Tragedy to Legal Awakening: Towards the Formation of an International Environmental Consciousness

Major nuclear disasters have proven beyond any doubt that environmental threats resulting from the military or civilian use of nuclear energy do not stop at the borders of the responsible state. Their effects extend to other regions and countries, thereby violating the traditional principle of state sovereignty over its territory and resources. With the escalation of the scale of damage and the recurrence of accidents, it became clear that the environment, as a

¹⁷ See World Health Organization Report on the Health Effects of the Chernobyl Accident, 2006, pp. 12-24.

¹⁸ See Report of the Association of Sons of the Algerian South, French Nuclear Crimes in Algeria, an International Report, 2018, pp. 33-41.

common heritage of humanity, could no longer be handled with a country-specific approach but rather required a collective international approach¹⁹.

From this perspective, a growing conviction began to crystallize that environmental protection cannot remain confined to the national scope and that global environmental threats, foremost among them nuclear dangers, necessitate a rethinking of the concepts of sovereignty, responsibility, and international cooperation. The disaster transformed from a limited tragic event into a revealing and pivotal moment that pushed the international community to include the environment among the priorities of collective action and paved the way for the internationalization of the environmental issue as a matter that transcends narrow geopolitical calculations²⁰.

First: Major Nuclear Disasters as a Catalyst for the Internationalization of the Environmental Issue and the Transcendence of National Sovereignty

A. Hiroshima and Nagasaki: The Birth of Nuclear Terror

In 1945, the United States dropped two atomic bombs on the cities of Hiroshima and Nagasaki in Japan. For the first time in history, a nuclear weapon was used against humans, with catastrophic results: more than 200,000 people were killed, most of them civilians, and the health, psychological, and social effects lasted for decades. The disaster wasn't merely a military victory or a strategic shock; it was a painful declaration of humanity's entry into a new era of global danger that transcends the borders of nations and armies.

The radioactive effects weren't confined to the Japanese cities alone; scientific and humanitarian voices began to warn of the long-term consequences of radiation on public health and the environment. Over time, Hiroshima and Nagasaki emerged as moral milestones in human history, contributing to the launch of anti-nuclear weapons movements that later evolved into various forms of cross-border environmental activism²¹.

B. Chernobyl: When Radiation Crossed the Walls of Sovereignty

In 1986, the fourth reactor at the Chernobyl nuclear power plant in Ukraine, then part of the Soviet Union, exploded. Authorities initially tried to cover up the incident, but radioactive clouds spread rapidly through the atmosphere, reaching Scandinavian countries and Western Europe, forcing Moscow to admit the accident. Chernobyl was not merely an industrial accident; it was a collapse of confidence in the ability of a nation-state to fully control nuclear technology within its borders.

The radiation led to the evacuation of more than 100,000 people and caused widespread environmental contamination, the effects of which are still present today. It also resulted in injuries and birth defects in the affected areas and sparked waves of fear across the world.

The Chernobyl disaster made it impossible to ignore the transnational nature of environmental risks. Many countries and international organizations began to demand stronger

¹⁹ See United Nations Environment Programme, *Nuclear and Environmental Disasters*, an International Report, 2014, pp. 21-35.

²⁰ Abbas, Layla: *International Environmental Security in the Face of Nuclear Dangers*, *The International Journal of Law and the Environment*, Issue 7, 2021, pp. 66-83.

²¹ Yamamoto Akino, "From the Ashes of Hiroshima and Nagasaki: The Memory of War and the Voice of the Survivors," *Journal of International Studies*, No. 34, 2018, pp. 102-118.

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international oversight mechanisms and greater transparency in dealing with nuclear energy. Environmental protection became a collective responsibility that no single state could claim to have exclusive ownership of²².

C- The Blue Gerboise: Colonialism and Radiation in the Algerian Sahara

The "Blue Gerboise" nuclear tests in the Algerian Sahara were a significant event due to their connection between colonialism and environmental danger. France conducted these tests with a disregard for the local population and environment, keeping the harmful effects, such as cancer and birth defects, a secret for many years.

This event, along with other nuclear disasters like the 1986 Chernobyl accident, highlighted that nuclear risks aren't just a military issue but also a danger in civilian applications. The French tests, particularly "Blue Gerboise," were an extreme example of this disregard for safety and the local populace, leading to long-term health and environmental consequences.

These incidents have led to a global understanding that nuclear threats transcend borders and require international legal frameworks focused on prevention, oversight, and transparency. This has prompted the development of a legal system to ensure the safe use of nuclear energy and to protect both people and the environment.

Second: From Awareness to Regulation: The Emergence of International Environmental Legal Rules as a Reaction to Nuclear Disasters.

A. The Bombing of Hiroshima and Nagasaki: The Beginning of Awareness of Nuclear Destruction:

When the United States dropped the two atomic bombs on Hiroshima and Nagasaki in 1945, it led to the deaths of hundreds of thousands of civilians and widespread environmental destruction whose effects remain to this day. At that time, there was no international legal framework to prevent the use of nuclear weapons or regulate their environmental effects. However, this disaster was a pivotal moment in human history, as it led to:

- The emergence of peace and nuclear disarmament movements.
- The rise of a global awareness of the long-term environmental dangers of nuclear radiation.
- The beginning of thought about the need for international legal controls to govern the use of nuclear energy, not just militarily, but also in terms of its environmental and human effects.
- This awareness led to the formation of the first legal building blocks, such as:

²² See: United Nations Environment Programme, "Chernobyl's Legacy: Impact on the Anti-Nuclear Movement," Special Report, 2006, pp. 17-28.

◦ The establishment of the **International Atomic Energy Agency (IAEA)** in 1957 to ensure the peaceful use of nuclear energy.

◦ The creation of the **Nuclear Non-Proliferation Treaty (NPT)** in 1968, which formed the general framework for dealing with nuclear technology²³.

B. The Chernobyl Disaster in 1986: The Turning Point Towards Environmental Regulation:

This disaster highlighted the absence of early warning mechanisms and international cooperation in nuclear emergencies, as well as the importance of transparency and accountability in managing nuclear accidents. It also underscored the necessity of regulating the use of nuclear energy according to safety standards. This resulted in several important legal consequences, the most important of which are²⁴:

- The **Convention on Early Notification of a Nuclear Accident** in 1986, which obliges states to immediately inform the IAEA of any nuclear accident that may affect other countries.

- The **Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency** in 1986, which establishes mechanisms for providing technical and humanitarian assistance to affected states.

- The **Convention on Nuclear Safety** in 1994, which obligated member states to establish independent regulatory authorities and commit to transparency and oversight in the operation of nuclear reactors²⁵.

Based on the provided Arabic text, here is the English translation.

C. The Blue Gerboise Tests 1960: Nuclear Colonialism and the Aftermath of Occupation

Although this disaster was not met with an effective international legal response at the time, it later contributed to strengthening international pressure for:

- The recognition of the historical environmental responsibility of nuclear states.
- Prompting France to sign the **Comprehensive Nuclear-Test-Ban Treaty (CTBT)** in 1996.

- Raising awareness within the international system about the responsibility of states for transboundary environmental damage, an initiative that emerged at the **1972 Stockholm Conference on the Human Environment** and the **1992 Earth Summit in Rio**.

Following this, new legal instruments appeared, including:

²³See : Keller, William France's Nuclear Testing in Algeria and the rise of Anti-Nuclear Activism," *Journal of Nuclear History*, vol. 5, No. 2, 2017, pp (88-102).

²⁴ Mahdawi, Abdelkader, *The Peaceful Use of Nuclear Energy between Peoples' Right to Development and the Requirements of International Environmental Security*, PhD Thesis in Public Law, Faculty of Law and Political Sciences, Abu Bakr Belkaid University, 2014-2015, p. 132.

²⁵ See the Treaty on the Limitation of Underground Nuclear Weapons Tests, Moscow, July 3, 1994, United Nations, Volume 1714, p. 123.

Legal Perspectives on Nuclear Fallout: From Hiroshima, Nagasaki, and Chernobyl to the Blue Jerboa – An Analytical Study of Nuclear Catastrophes and Their Role in Shaping the Foundations of Global Environmental Law and Prompting the Development of Binding International Norms for Environmental Protection

- The **Partial Test Ban Treaty of 1963**.
- The **Comprehensive Nuclear-Test-Ban Treaty (CTBT) of 1996**, which prohibits all nuclear explosions, though it has not yet entered into full force.

International principles also emerged, such as:

- The **Nuclear Safety Forum** of the IAEA.
- International environmental networks for monitoring radiation and nuclear pollution²⁶.

Conclusion

In conclusion, based on the entirety of our study, we can say that major nuclear disasters have revealed humanity's fragility in the face of a world unbridled by law and the terrible price the environment pays whenever conscience is absent behind a weapon. These tragedies have transformed into turning points, not only in the history of wars but also in humanity's collective consciousness, as they have awakened the need for an international legal system to protect the planet from similar wounds.

Therefore, the results have shown that:

1. Nuclear disasters have strongly pushed for the internationalization of environmental issues and the establishment of the principle of precautionary protection in international law.
2. The gap between science and law was wide, but these disasters have closed the distance and forced nations to act.
3. The environment is no longer a legal luxury but an existential right that transcends the boundaries of sovereignty.

Based on the above, and in light of these tragedies, we **recommend** the following:

1. The necessity of strengthening the rules of **international environmental law**, especially concerning legal accountability for nuclear disasters, with the activation of binding mechanisms that guarantee prevention, accountability, and compensation.
2. The adoption of a comprehensive international convention specifically for nuclear activities with **transboundary environmental impact**.
3. Working to establish a specialized **international court for environmental crimes** that includes nuclear disasters within its jurisdiction, considering them a grave violation of human and environmental rights.

²⁶ See: IAEA: Assessment of former nuclear test sites: Technical guidelines and recommendations, 1st edition, Vienna 2018, P55.

4. Encouraging countries to seriously engage in developing **alternative energies** and reducing reliance on nuclear energy, which carries high environmental risks.

5. The necessity of integrating the **human-environmental dimension** into all nuclear research and development policies.

6. Strengthening the role of **international judiciary and oversight mechanisms** in holding those responsible for nuclear pollution accountable.

7. The necessity of reinforcing **international agreements on nuclear safety**, while also strengthening the role of civil society and environmental organizations in cross-border oversight and accountability.

Despite all the legal gains and international awareness, the world still stands at a dangerous crossroads, where nuclear tensions are renewed, technology accelerates, and threats do not recognize borders.

For how long will we continue to bury the lessons of history in the pits of political silence? For how long will treaties remain prisoners, signed after the catastrophe, not before it? For how long will the law stand behind the explosion, not in front of it? For how long will science advance faster than humanity without us grabbing its reins and asking it: "Where are you going?" For how long will we act? Only when the air becomes toxic, the water radioactive, and the soil dead?