

# THE INFLUENCE OF NUCLEAR TECHNOLOGY ON ATTAINING ENVIRONMENTAL SUSTAINABILITY

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## Abstract

*Global nuclear security is one of the global strategic challenges related to a range of threats and risks surrounding the current international security environment. The world conditions make nuclear security an urgent necessity for all countries that possess nuclear facilities in order to protect them from terrorist threats and illegal trafficking of nuclear materials, by controlling their circulation or use, providing strict oversight, and adopting systems and software that ensure the rapid response of security devices when needed.*

*The use of nuclear energy for peaceful purposes in a safe manner that achieves sustainable environmental security will remain one of the most important goals facing the international community, and the International Atomic Energy Agency seeks to frame ways to achieve it.*

**Keywords:** *Global Nuclear Security; Environmental Security; International Challenges; Nuclear Technology.*

## INTRODUCTION

The issue of security, with its economic, political, social, and cultural dimensions, has taken center stage among international issues, especially in light of the transformations that have taken place in security studies. These studies have moved beyond the traditional concepts of security, which were primarily concerned with protecting national security from internal and external dangers through the use of military force. Instead, they have shifted their focus to new and more acute challenges that are based on the triad of rights, risks, and security. This has raised a tendency among the international community to pay attention to the environment and its security, which has culminated in the holding of numerous conferences and the resulting agreements and treaties that have emphasized the need to protect the environment and ensure its sustainability as a means of promoting environmental security.

Against the backdrop of environmental, climatic, economic, and technological changes, there is an urgent need to find clean energy by harnessing modern technologies. Nuclear energy has emerged as an important alternative to oil and gas, as well as a primary source of electricity production and an essential component for industrial products. However, the excessive use of nuclear technology in uncontrolled doses has become a concern that threatens environmental sustainability, especially in light of the challenges that now confront the issue of nuclear security.

On this basis, we present the following question: To what extent does nuclear technology affect the achievement of sustainable environmental security, in light of current international efforts?

This question will be answered through a descriptive and inductive approach, according to the following plan:

- A conceptual approach to sustainable environmental security.
- The threats of nuclear technology to the natural environment.
- International efforts to address nuclear threats to sustainable environmental security.
- Nuclear terrorism and the black market as obstacles to achieving nuclear security and protecting the environment .

### 1- A Conceptual approach to Sustainable Environmental Security

The issue of sustainable environmental security is one of the most important and dangerous contemporary issues, and one of the most complex. It has become the focus of many modern scientists and thinkers, and is a goal pursued by both advanced and developing countries alike. To discuss sustainable environmental security, we must first understand the concepts of environment and sustainable development.

#### 1.1- The concept of environment.

Interest in environmental issues has increased in recent decades, both domestically and internationally. This is evident in the growing global environmental awareness, which has led to an



increase in the frequency of conferences and agreements related to the environment and the protection of its elements.

#### 1.1.1 Definition of environment.

The environment can be defined as the medium in which humans live and carry out their productive and social activities. It is the storehouse of renewable natural resources such as agricultural fields and fishing grounds, as well as non-renewable natural resources such as mines and oil wells. The relationship between humans and the environment is defined in two ways: it is a framework for life that must be protected from pollution and degradation, and it is a source of natural wealth that must be exploited with care and respect for the rights of future generations (Saber, 2000, p. 05).

#### 1.1.2 Elements of the environment

The environment is made up of basic elements that are interconnected in an interactive system. These elements are divided into three categories as follows:

- **Physical elements:** these include the space, terrain, water bodies, soil, climate, rocks, and minerals.
- **Biological elements:** these include living organisms such as humans, plants, animals, and microorganisms.
- **Cultural elements:** these include economic, social, political, and heritage activities.

### 1.2- The concept of sustainable development

In recent years, the concept of sustainable development has gained global attention, and international summits and conferences have been held for it. The issue of development is no longer just an ideological matter, but has become a fundamental requirement for achieving social justice in the distribution of natural resources among generations.

#### 1.2.1 Definition of sustainable development

The World Commission on Environment and Development defined it as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (Fellahi, 2003, p. 75).

Therefore, the concept of sustainable development can be built on the following elements:

- Meeting the basic and necessary needs and improving the standard of living for individuals.
- Consideration of the right of future generations to natural resources.
- Coordination and integration between the exploitation and investment of available natural resources in the present, and planning for their continuity for the longest possible period.

#### 1.2.2 Sustainable Development Dimensions

Sustainable development has three fundamental dimensions that relate to the economic, social, and environmental aspects, which are as follows (Hajjam & Tari, 2019, p. 131):

- **Economic dimension:** sustainability means the continuity and maximization of economic well-being for the longest possible period by providing the elements of human well-being of the best quality, such as food, shelter, transportation, clothing, health, and education.
- **Environmental dimension:** The environmental dimension of sustainable development focuses on respecting environmental boundaries, where each ecosystem has certain limits that cannot be exceeded in terms of consumption and depletion. If those limits are exceeded, it leads to environmental degradation. Therefore, limits must be set on consumption, population growth, pollution, bad production patterns, water depletion, deforestation, and soil erosion.
- **Social dimension:** The social dimension of sustainable development focuses on the fact that humans are the essence of development and its ultimate goal by caring for social justice, combating poverty, providing social services to all those in need, and ensuring democracy through transparent people's participation in decision-making.

### 1.3- The concept of sustainable environmental security

Humanity has come to the unfortunate realization that the environment must be secure enough for stability and sustainability within a world that is constantly threatened by disasters caused by the depletion of natural capital, traditional pollution, and the deadly consequences of nuclear technology.

#### 1.3.1 Definition of sustainable environmental security

The Millennium Project (1998) defines sustainable environmental security as the environmental sustainability that supports life, which is achieved through three sub-elements (Florescu & Glenn, 2015, p. 08):

- Preventing or repairing military damage to the environment.
- Preventing or responding to conflicts caused by the environment.
- Protecting the environment due to its inherent moral value.

Environmental security encompasses a range of efforts by countries and individuals to achieve well-being, social progress, and protect citizens from risks. This means protecting the environment and its resources by stopping their generation and reducing their degradation, as well as investing optimally in environmental natural resources. Ultimately, achieving the desired environmental security requires



awareness of environmental problems and their impact on the environment and its resources through an understanding of the nature and interactions of the environment and its components. This awareness leads to a change in behavior and practices towards the environment and its resources. Therefore, environmental security requires maintaining balance between environmental systems, climate cycles, and natural systems (Filipan, 2018, p. 12).

### 1.3.2 Sustainable environmental security measures

- **Food security:** In September 2015, the United Nations General Assembly adopted the 2030 Agenda for Sustainable Development to take urgent steps to transform the world onto a sustainable and resilient path. To achieve this ambition, the seventeen Sustainable Development Goals (SDGs) of the 2030 Sustainable Development Plan were officially launched in January 2016. One of these goals was to work towards achieving sustainable food security.

Sustainable food security is closely linked to the Sustainable Food System (SFS), which is a system of food and nutrition that does not harm the economic, social, and natural environmental resources to achieve food security and nutrition for future generations. This means economic sustainability, social sustainability, and environmental sustainability (Hussain, 2021, p. 567).

- **Health security:** It is enabling people to live in an environment that protects them from diseases and provides them with the right to treatment, healing, and disease prevention.

There are four steps to maintain health security in the context of striving to achieve sustainability goals. These include: redefining the definition of health and measuring it within the framework of social sustainability, Emphasizing health as a key factor in every subject. Setting comprehensive global goals for all countries at the economic level. Establishing a global infrastructure to finance and implement programs that enable countries to collaborate in achieving health and sustainable development goals (Al-Jubouri, 2019, p. 04).

- **Energy security:** It is the ability to meet the demand for energy, i.e., the ability of government agencies and public institutions in the country to meet energy-related needs.

Energy security in any country is considered a strategic issue and a priority for policymakers and implementers. Renewable resources are the primary support for energy security through their non-depletion property. They ensure current and future energy security, as well as environmental security in line with sustainable development (El-Din & Jalil, 2017, p. 168).

## 2- The Threats of Nuclear Technology to The Natural Environment

The development and proliferation of nuclear technology in a certain geographic region or area have always had many ramifications related to hindering the achievement and sustainability of environmental security, such as nuclear radiation leaks and waste, as well as the hazards posed by nuclear power plant cooling systems on environmental elements. These challenges have made concerted efforts necessary to confront the obstacles that hinder achieving nuclear security, which in turn prevents the achievement of environmental security.

Nuclear energy research has been varied since World War II, and its scope of use has expanded for both peaceful and military purposes. Its use is continuously increasing due to the need for energy in all aspects of life, especially in light of the depletion of non-renewable energy sources. Human ingenuity looks to this type of energy as a cornerstone for research. However, nuclear technology has become a significant threat to the natural environment, to the extent that it almost ravages all of its elements.

### 2.1- Nuclear Radiation

Environmental laws in various countries around the world have emphasized the dangers of nuclear radiation, working to prevent its leakage, as it leads to disruption of environmental elements and harm to living organisms.

#### 2.1.1 Definition of Nuclear Radiation

Nuclear radiation is the energy released by an unstable nucleus, which has the ability to penetrate the bodies that obstruct its path, causing a disturbance in their natural components. Biological and chemical processes in these bodies are disrupted as a result of nuclear radiation penetration.

Nuclear radiation is considered one of the biggest pollutants affecting the environment, and it can have a natural source resulting from cosmic changes and the partial fusion of particles in the universe, as well as industrial sources such as factories that use nuclear fuel or nuclear weapons (Hassan, 2013, p. 159).

#### 2.1.2 The danger of nuclear radiation leaks on environmental security

Although the prevailing legal trends in the international community tend to ban nuclear testing due to its negative effects on the environment resulting from nuclear reactions, the practical application of this ban is moving at a slow pace that does not match the speed and strength of the danger that threatens the environment with every nuclear interaction, regardless of its purpose.

Nuclear radiation has led to changes in the climate of areas that have been subjected to nuclear tests, as well as distortion of animal species in these areas, resulting in a significant decline in agriculture and crops due to the burning of vast areas of land by radiation. Radioactive soil pollution is considered



one of the most dangerous pollutants that the soil is exposed to, as it cannot be smelled, seen or felt. Plants absorb the nuclear radiation from the organic matter they feed on from the soil. Many trees have become either sterile or produce strange-looking fruits.

Water pollution is one of the oldest environmental problems that human beings have known on the surface of the earth. Therefore, water pollution with nuclear radiation is the introduction of strange radioactive elements to the physical and chemical components of the water element, resulting in the unsuitability of the latter for its natural uses.

Air pollution with nuclear radiation results from the mixture of natural air components of oxygen and nitrogen with radioactive pollutants that exceed the maximum limit that should not be exceeded. Therefore, pollution of the air with radioactive materials is one of the most dangerous forms of air pollution, as atomic dust particles quickly fall and are carried by the winds to distant distances, spreading the danger in wide areas of the earth's surface, causing many diseases to humans, the most important of which are lung cancer and skin cancer (Mustafa, 2020, pp. 341-342).

## **2.2- Nuclear waste**

One of the drawbacks of modern technology in its various aspects, especially nuclear technology, is the human mind's inability to think about the consequences resulting from it. This leads to excessive and competitive demand for it, which leads to unexpected results in a short time, in addition to the accumulation of nuclear waste in a way that makes it difficult to control, manage, and treat.

### **2.2.1 The concept of nuclear waste**

The International Atomic Energy Agency defined it as: "Any material containing radioactive nuclei or contaminated with radioactive nuclei at concentration levels higher than the exempted quantities specified by the competent authorities and not expected to be used for any purpose."

### **2.2.2 The danger of nuclear waste to environmental security**

Radioactive waste is generated from the production of electricity in nuclear power plants, as well as from the processes of the nuclear fuel cycle, such as fuel manufacturing and other activities in the nuclear fuel cycle, such as mining and processing of uranium and thorium ores. In some countries, spent nuclear fuel is declared as radioactive waste, as it is not expected to be reused, while in other countries, nuclear fuel is considered a dedicated resource for reprocessing. Reprocessing itself generates heat, which is usually adapted in a high radiation matrix and molten glass, in addition to other types of radioactive waste, such as metal cladding removed from fuel elements before processing. Radioactive waste is also produced from a wide range of industrial, medical, research and development, and agricultural activities, and most of this type of waste is sealed radioactive sources that are discarded. Sealed sources are used in various applications.

Dumping waste in seas and oceans has various effects on marine life in the short and long term, like other types of marine pollution. Many specialists believe that disposing of high-activity waste in improperly sized containers can lead to the explosion or corrosion of these containers due to seawater, causing radiation to spread in the water and raise its temperature, which can harm marine organisms and disrupt the food chain (Krudem & Hanawi, 2017, p. 02).

## **2.3- Water cooling system for nuclear reactors**

The effects of nuclear pollution are not limited to its direct impact on human life and health, but also extend to the contamination or poisoning of all aspects of the environment. The water cooling system for nuclear reactors is a dangerous threat to water resources.

### **2.3.1 Definition of the water cooling system**

When building a nuclear reactor, the cooling system must be taken into consideration. Cooling involves the removal of excess heat generated by nuclear reactions. This is usually done by providing a pool of water in which the hot water from the reactor core circulates (first cooling). Cold water is continuously pumped into the pool, causing some of it to evaporate and absorb heat from the core water. This steam is then used to turn the turbines that generate electricity. The steam is then condensed and sent back to the bottom, where it is cooled again (second cooling) by passing it through a stream of water coming from the cooling towers (third cooling). The hot steam rises from the cooling towers and cools in the air before descending back into the tower. Therefore, reactors are often built near the sea or rivers to use them as heat sources for cooling (Muhammed, 2011).

### **2.3.2 The environmental risk of water cooling systems**

Cooling systems are used to prevent nuclear power plants from deteriorating and being exposed to high temperatures. There are two types of environmental problems associated with cooling systems in nuclear power plants. The first relates to the withdrawal of water from rivers or oceans, where living organisms are captured during the transfer of water to the plant by sucking small fish, eggs, and larvae. The second relates to the use of this water for cooling and then returning it to the same source, where it is warmer than the normal water in its natural environment. This causes a change in the ecosystem and the death of plant and animal organisms in their natural environment due to the increase in water temperature. The US Department of Energy's report indicates that one of the main



effects of the Clean Water Act in the United States is cooling systems, especially those that use freshwater once, which will lead to increased water consumption. Recently, there have been some environmental problems in Japan due to a malfunction in the cooling system that led to the leakage of radiation into the sea while cooling nuclear plants (The World Nuclear Association, 2020).

Therefore, the environmental impact of withdrawing massive amounts of water, heating it up, discharging it, and releasing sediment and waste into the water causes significant damage to the aquatic ecosystem and negatively affects the biodiversity and water quality in those waterways.

### **3- International Efforts To Address Nuclear Threats to Sustainable Environmental Security**

The issue of nuclear security has become a strategic dimension based on enhancing the concept of common security. This is because no state alone can confront nuclear threats to the natural environment. Thus, the process of continuing to push for international cooperation and coordination and enhancing its mechanisms is the optimal way to address the problems and challenges that hinder the building of a global nuclear security system that contributes to preserving the environment and achieving sustainable development.

#### **3.1- International instruments related to nuclear security and environmental protection**

Since the beginning of the nuclear age, a large number of treaties on nuclear weapon proliferation and disarmament have been concluded with the aim of achieving nuclear and environmental security.

##### **3.1.1 Definition of international instruments**

International instruments are those instruments adopted by the United Nations or the International Atomic Energy Agency (IAEA), which are classified into two categories: declarations adopted by bodies such as the United Nations General Assembly, which are not legally binding, although they are politically binding, while agreements are legally binding instruments concluded under international law.

##### **3.1.2 Major agreements and instruments to combat nuclear threats to the natural environment**

The international legal framework for nuclear security consists of legal instruments and recognized principles aimed at preventing, detecting and countering criminal acts and other unauthorized activities involving or directed against nuclear materials or other radioactive materials and related facilities or activities.

Compliance with these international instruments and coordinated national legal and regulatory frameworks will make a significant contribution to combating nuclear terrorism. The agency informs member states of relevant international legal instruments and provides advice and urges them to comply with and implement them.

The main international legal instruments adopted under the auspices of the agency are the Convention on the Physical Protection of Nuclear Material and its 2005 Amendment, as well as the Code of Conduct on the Safety and Security of Radioactive Sources, in addition to its supplementary guidance (International Atomic Energy Agency, 2018).

There are many other international instruments that focus on nuclear security, including (Inter-Parliamentary Union, 2016, pp. 08-09):

- The 1968 Nuclear Non-Proliferation Treaty (NPT), under which non-nuclear-weapon states agreed not to acquire nuclear weapons.
- The Comprehensive Nuclear-Test-Ban Treaty (CTBT) and the establishment of the Preparatory Commission for the Comprehensive Nuclear-Test-Ban Treaty Organization (CTBTO) to facilitate universal adherence to the treaty, bring it into force, and build a verification system.
- The 2005 International Convention for the Suppression of Acts of Nuclear Terrorism, designed to criminalize nuclear terrorism and enhance police and judicial cooperation to prevent and investigate such acts and punish their perpetrators.
- The 1998 Convention on the Physical Protection of Nuclear Material.
- The International Convention for the Suppression of Acts of Nuclear Terrorism, which entered into force in July 2007, and which details crimes related to the unauthorized or intentional possession or use of radioactive material or a radioactive nuclear device, the use of nuclear facilities, or damage to them. The convention aims to enhance cooperation among countries through the exchange of information, assistance in investigations, and the extradition of criminals.
- The Convention on Nuclear Safety, which was extended in 2012, aims to reduce the risks of nuclear weapons-related accidents.

#### **3.2- The role of the International Atomic Energy Agency in achieving nuclear security and protecting the environment**

The International Atomic Energy Agency (IAEA) is one of the international organizations that helps in the peaceful use of atomic energy. It operates in all areas related to the peaceful use of nuclear energy. The agency is tasked with encouraging and facilitating research on the peaceful use of nuclear energy, developing and applying this use scientifically, promoting the exchange of relevant scientific and technical information, and contributing to the training of scientists and experts in this regard.



However, due to the insistence of all countries on possessing nuclear weapons and defending them, the international community has made more efforts and interest in establishing many international agreements and treaties to establish the governing controls to control this problem of using nuclear energy for peaceful purposes only and subject it to strict international supervision. On this basis, the Treaty on the Non-Proliferation of Nuclear Weapons was formulated in 1968, and the Statute of the International Atomic Energy Agency was established.

### **3.2.1 The objectives of the International Atomic Energy Agency (IAEA):**

The IAEA aims to achieve two main objectives: firstly, to promote the peaceful uses of atomic energy in the fields of health and economics for the prosperity of the world, and secondly, to ensure that these uses are not used for military purposes, by controlling these uses to ensure that they are not diverted for military purposes, thus achieving nuclear security and environmental security.

### **3.2.2 The areas in which the International Atomic Energy Agency carries out its activities to achieve nuclear and environmental security:**

The IAEA has worked to open multiple fields for the peaceful uses of nuclear energy and not using it for any military purpose. It has also established many rules, regulations, and provisions to ensure that fissile materials, services, equipment, facilities, and projects under its supervision are not used for military purposes, and to use them for peaceful purposes to achieve nuclear security and ensure environmental security.

Based on that, the basic system of the International Agency has defined its special powers in the use of nuclear energy in the following areas (Ahmed, 2019, pp. 312-313):

- Encouraging and facilitating research on the use of atomic energy for peaceful purposes worldwide, developing this use and its scientific application, and promoting the exchange of scientific and technical data and information related to the use of atomic energy for peaceful purposes in accordance with what is stated in Article 8, Paragraph (a). Each member state of the agency is to provide the agency with useful information and data, and each member state of the agency is to provide all scientific information about the assistance provided by the agency for Article 11, Paragraph (b). Accordingly, the agency takes necessary measures to encourage the exchange of scientific and technical data and information on the use of atomic energy for peaceful purposes among member states.
- Providing the necessary materials, services, tools, facilities, and projects for research on the use of nuclear energy for peaceful purposes, developing this use and practically applying it, including in the fields of medicine and agriculture. To achieve this, the eighth and ninth materials include electricity, industry, and other needs of countries. The tenth and eleventh methods followed by the agency in providing services, materials, equipment, facilities, and projects, making it an intermediary in the exchange of materials and services between member states of the agency, if requested. Additionally, it commits to distributing fissile materials, raw materials, equipment, and facilities, taking into account the special needs felt by different regions of the world. Providing fissile materials and raw materials is a voluntary process carried out by individuals.
- Encouraging the exchange and training of scientists and experts in the field of using atomic energy for peaceful purposes, establishing or possessing facilities and machines that the agency uses to perform its functions if what is available is insufficient, in addition to establishing and implementing guarantees aimed at ensuring that fissile materials and other materials are not used for military purposes.
- Establishing the necessary safety regulations to protect health and the environment and to minimize, as far as possible, the risks of exposure to radiation, and this is done through cooperation with the relevant United Nations bodies and specialized agencies to establish health protection rules for atomic radiation hazards and protect lives and property during the transport of radioactive materials and work on addressing the legal aspects of nuclear risks.

## ***4- Nuclear Terrorism and The Black Market: Obstacles to achieving Nuclear Security and Environmental protection***

Nuclear terrorism and illicit trafficking in nuclear and other radioactive materials threaten the security of all nations.

### **4.1- Nuclear Terrorism**

The use of nuclear materials or other radioactive materials in terrorist acts poses a serious threat to security in all its dimensions, especially nuclear and environmental security. The possession of radioactive materials is not subject to regulatory control, which can lead to criminal and destructive acts that affect the natural elements of the environment. This can be done by (International Atomic Energy Agency, 2015, p. 01):

- Using nuclear materials to build an improvised nuclear device.



- Intentionally spreading radioactive materials by building a device to disseminate radiation or a device for radiological exposure.
- Carrying out any sabotage action in a facility that uses or stores nuclear and other radioactive materials, or during the transportation of nuclear and other radioactive materials.

#### 4.2- The Black Nuclear Market

The black nuclear market for trading nuclear resources and equipment represents one of the main sources that have contributed to accelerating the proliferation of reactors and nuclear weapons in an illegal manner. As a result, its exploitation has expanded in an unregulated and uncontrolled manner, without adhering to protective procedures and measures, which prevents achieving nuclear security and causes damage to environmental sustainability.

The concept of the black nuclear market refers to trafficking in expertise, technologies, or materials related to the nuclear field, which are sought for non-peaceful purposes, often in an illegal manner.

The realistic image of this market has become clear since 2003, with the discovery of the Iranian uranium enrichment program in Natanz. It has become more apparent when developments reached Pakistan, which has already admitted to widespread nuclear leaks within its borders (Ghaffar, 2015, p. 27).

#### CONCLUSION

Since this research paper was entitled "The Impacts of Nuclear Technology on Achieving Sustainable Environmental Security" and addressed the concept of sustainable environmental security, threats of nuclear technology on natural environment, international efforts to address nuclear threats to sustainable environmental security, and finally, the challenges to achieving this, a number of results and recommendations have been reached and are presented as follows:

- The global concern for environmental security against nuclear pollutants will contribute to organizing and providing safeguards through globally adopted safety measures in all nuclear power plants to achieve nuclear security, but despite following these precautions, there are no guarantees to prevent incidents that threaten both nuclear and environmental security.
- The escalation of international crises in various countries around the world provides a breeding ground for global nuclear terrorism, which almost undermines nuclear security and hinders the achievement of environmental security.
- Developments related to the possibilities of possession and use of nuclear materials by terrorist groups have created a serious and integrated problem, but it is still in a transitional stage and will not take on integrated dimensions until actual nuclear terrorist acts occur. In this case, the concern of the nuclear terrorism threat will turn into a major and real threat that shakes international nuclear and environmental security, and threatens human life on Earth.
- Nuclear experiments carried out for scientific research purposes, with the aim of developing the use of atomic interactions in generating energy for peaceful uses, and which are conducted within reactors and nuclear power plants specially prepared for this purpose, are also fraught with risks that threaten the environment, just like nuclear military use.

#### RECOMMENDATIONS


Although prevailing legal trends in the international community tend to achieve nuclear security by banning nuclear tests due to their negative environmental effects resulting from nuclear reactions radiation, the practical application of this ban is moving at a slow pace that does not correspond in speed to the speed and strength of the danger that threatens environmental security with every nuclear reaction, regardless of its purpose. Therefore, the responsibility of ensuring nuclear security and facing its challenges falls on all states, and remains a shared responsibility that the international community shares, with the necessity of addressing it by encouraging membership in agreements and international treaties involved in this field.

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