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The dangers of ionizing radiation that affect human safety and the environment :A review Article

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Abstract: The world is witnessing an increase in the spread of nuclear technology and the expansion of the use of radionuclide in industry, agriculture, medicine and other nuclear and radiological applications. This may be accompanied by an increase in accidents as the threat of potential risks from human exposure increases externally exposed to ionizing radiation and contamination of its internal organs with radionuclide. In order to protect people and workers from health harms associated with external exposure for ionizing radiation and indoor contamination with radionuclides, follow the principles of health prevention and control implementing rules and laws for the protection of ionizing radiation that ensure safety for humans and the environment reducing radiation risks.

Keywords: Bioradiation, Ionizing radiation, Radiation effect, The health of the organism

A review Article Problem: There is a responsibility due to environmental pollution that falls on everyone, especially with regard to all types of environmental pollution, the most important of which are (nuclear pollution and the burial of nuclear waste) and the reasons for their formation, which results in the loss of human rights, those affected because the resulting damage may appear after long periods

A review Article Objective: It is best to differentiate between types of pollution (natural), which result from volcanoes, earthquakes, and fires that occur in forests, and artificial, which is the reality resulting from human intervention. There is also a difference between pollution that is intentional and carried out voluntarily through activities that the person doing it knows or should know causes harmful and unintended effects resulting from unintended emissions associated with some human activity.

The method of the article: It is important to legislate laws to prove the occurrence of environmental errors before they occur in order to limit harm to living organisms and protect nature

1-Introduction

Radioactive contamination is one of the most important and dangerous environmental problems, as it represent an increasing danger that threatens lives. Humans, animals and plants alike due to the widespread use of radioactive materials, there are many of them in different areas of life. The World Health Organization (2001), Its published reports indicate that uranium is always present in surface water and groundwater and there are concentrations very wide or with a range ranging from 0.01 mg/L to limits exceeding 1500 mg/L of water. The concentration of uranium present in the water depends on its concentration in the rocks or soil through which it passes (Martinez-López and Hande, 2020).

During the various human activities involved in manufacturing processes or the use of different fertilizing materials involved in manufacturing processes may have changed. Or change the natural quantities available from Uranium in water, this activity includes the use of phosphate as a fertilizer (plant fertilizer), effectiveness various uranium mining, uranium manufacturing processes in nuclear fuel plants and products others use depleted uranium for various uses

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(Schultz, *et al.,* 2020). The expansion of the use of radiation at the beginning of the twentieth century, which plays a major and vital role, It causes great risks that affect humans and the environment, and studies have proven that radiation causes tumors cancer and leukemia, and the uranium concentration in mineral water is estimated at 9.20 micrograms/liter. The concentration of uranium in soil varies widely, and this reflects its concentration at the origin.

Geology of soils Uranium may become concentrated in the organic matter in the soil horizons in filming operations, it becomes concentrated in specific places, moreover, it is concentrated Uranium in the soil as a result of human activities, industry and mining, and the use of phosphate fertilizers in agriculture.

Natural levels of uranium in soil have no relationship with known sources of contamination, for example, from human activities or mining as normal concentrations range from 1-2 mg/kg. However, these differences are highly dependent on the geological sources of uranium and also reflect wide ranges related to river sediment transport at high concentrations of up to 4 ppm. High concentrations of uranium can be found in soils found in mineral environments such as those found near phosphate deposits or uranium ore deposits (Bisht, *et al.,* 2021). For example, uranium levels measured in surface soils, they are associated with phosphorus in North Africa and the Middle East. The concentration at the beginning of mining may reach 200 mg/kg in the uranium mining environment. Likewise, in the agricultural environment, there is uranium with phosphates that are used for fertilization (Singh and Seed, 2020). The variation of the distribution coefficient of uranium with the content or components of organic carbons and soil pH indicates that movement is likely to become significant in semi-arid or semi-arid areas. It is neutral in soil conditions with low levels of organic carbon during movement for uranium in water in semi-arid areas, low net turbidity may significantly reduce dispersion and mixing of depleted uranium (Szalai, *et al.,* 2022). In both cases, dispersion and mixing will result in weathering and gradually. It slows down and becomes equal or similar to the natural uranium present in the soil environment. The nature of entry Uranium to the soil surface fragmentation from collision with the target or collision with a section of the soil .It will be affected by environmental factors, especially rain, surface water, and the groundwater environment that fragmentation will increase the surface area contaminated surface area of any existing shell that is exposed for physical and chemical weathering, very small particles may enter close to the soil surface which is widespread, especially during dusty conditions when it is in the form of dustp (Marcu,*et al.,* 2021).

Water running over dry land from falling rain or melting snow will, It causes physical movement of particles in the water. The complete burial of depleted uranium weapons in the soil over time, it will lead to contamination of groundwater sources through dissolution and migration to surfaces water (Schultz, *et al.*, 2020 ; Ladjouze and Donaldson, 2019). The movement of uranium in the area near the surface is controlled by several factors, such as: Hydrogen (pH), soil minerals and water adsorption to soil minerals will lead to binding strong attachment of uranium to soil particles or on the surface (such as iron oxides, clay minerals, or organic carbon, this depleted uranium is released into the water present in the soil and is transferred to the water subterranean (El Adham , *et al.,* 2022). The primary factors affecting soil exposure, assuming that the uranium is mobile, the depth of the unsaturated zone, such as (adjacent to the groundwater area) and the filtration rate ratio, for example, water sources in river areas with gravel are exposed to pollution, the percentage will be high due to proximity to the surface, while the rate of exposure to deeper water is lower (Martinez-López and Hande, 2020 ; Hassan, *et al.,* 2022).

1-1 How radioactive elements are transmitted in nature

After particulate reach the soil, they are deposited dry from the air or washed off with water rain may move slowly, penetrating the soil downwards penetration (or spread in any other way, and this movement is estimated by the diffusion coefficient or number index Leaching (for example, it is known about uranium It has a very low diffusion coefficient that does not exceed 2 10 cm /second, so the element remains in scientifically speaking, this immobility is due to the low solubility of water on the one hand, and to the formation of chemical complexes on the other hand (Eid, *et al.,* 2021). The operations of moving and turning the soil, as in agriculture or the

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movement of machinery, help increase , the spread of pollutants in the environment, and floods and surface runoff transfer particles from its place and transport it to other areas, including waterways, and the winds also work to restore flying particles and transporting them in the air to other areas. Plants can be contaminated with uranium depleted, as studies indicated that wheat plants and some weeds were of clear importance, that depleted uranium accumulates first in the roots sometimes it directly causes the death of the plant or then in the leaves and then into the seeds of those plants (Saleh, *et al.*, 2021).

Among the studies conducted by researchers on three types of weeds, they are considered ideal for Uranium absorption. These plants are buffalograss (*dactyloids Buchloe*) and Aristido puprurea (*purple, schizachyrium scoparium* bluestem (*threeawn*), as it was found from this study that depleted uranium is relatively non-toxic to these weeds and vegetables, and that depleted uranium has a final impact on wheat productivity. Noticeable growth, which included a decrease in the number of seeds per spike, and a decrease in the number of plants. It does not produce ears and there is a small number of leaves (Dawoud, *et al.*, 2022). The results of the study indicated that there were no ears in the irrigation water. The container contains 625 micrograms of depleted uranium per liter. WHO, 2013 indicated that plants growing on areas contaminated with depleted uranium may contains depleted uranium located mainly in contact with the surface of the roots or leaves, and in this case, much of it can be removed by washing or peeling . For all edible surfaces, any membrane or rough outer wall must be removed as for foods dried and sourced from soil contaminated with depleted uranium, one must stay away from it (Abdelhamid, *et al.*, 2023).

Southern Iraq was exposed to the Second Gulf War in 1991 and 2003 war led to anti-machine and armor shells coated with depleted uranium alloy, which is a radioactive chemical compound, when leaked into the soil, causes complex double pollution and is present in the form of atomic dust. It threatens human safety when inhaled and consumed in food or liquids. The amount of uranium was estimated depleted soil that seeped from 290 to 2,200 tons in the last two wars, according to estimates by the Institute Nuclear policy research in New York by finding pollution rates radioactive analysis of uranium, bull day, and radon in plants, soil and water, giving an idea about radioactive contamination and informing the responsible authorities so that they can act (Saleh, *et al.*, 2020). To clean polluted areas that affect living organisms, the environment, soil and water for some elements in some fish and shrimp in Iraqi waters using atomic absorption technology.

1-2 Effects of nuclear radiation on humans

There is a hidden danger. Nuclear radiation is invisible and has no taste or smell, but it can be fatal. Nuclear radiation enters the body through breathing or skin, and may infect humans with thyroid cancer, tumors, leukemia, eye diseases, psychological disorders, and other serious diseases. If the body is exposed to large amounts of these rays and receives a very large dose of them, it may die within a few hours or days. For example, exposure to iodine is one of the diseases that frequently appears after a nuclear accident, which is thyroid cancer. The reason for this is the radioactive isotopes of iodine 131 and iodine 133. These two substances are abundant in the first days after the nuclear accident and are responsible for causing radiation damage to the body (Saleh, 2014).

To avoid exposure to radioactive isotopes of iodine and their contamination of the thyroid gland, a large dose of concentrated iodine pills can be taken. The body gets what it needs and the thyroid gland becomes saturated with iodine and is no longer able to store other quantities of it. Thus, the body automatically gets rid of the dangerous radioactive isotopes of iodine. Currently, the Japanese government is distributing concentrated iodine pills to citizens in areas near damaged nuclear power plants. However, the effect of these pills only lasts for a few days and is beneficial for people whose bodies are not yet contaminated with radioactive iodine, the elements cesium and strontium N are the most dangerous elements to which the body is expose the radionuclides, the radioactive isotopes strontium 90 and cesium 137, settle in bone tissue, the risk of cancer increases. The body confuses these dangerous substances with calcium and introduces them into

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the bone marrow and muscle and bone tissue. But the bone marrow is responsible for the formation of new blood cells, and this process can be disrupted by ionizing radiation, and if this happens, the person will be afflicted with the deadly disease leukemia.

Finally, massive genetic damage may occur in the body that is exposed to nuclear radiation, as happened after the atomic bombs were dropped on Hiroshima and Nagasaki, where a large number of deformed children were born. After the Chernobyl disaster in April 1986, and despite the passage of 25 years since the accident, there is a noticeable increase in the percentage of people suffering from cancer, reaching 40 percent. There are estimates that 25,000 people in Russia died because they participated in cleaning the reactor after its explosion (Saleh and Koller, 2021). It is almost impossible to provide medical assistance to those exposed to nuclear radiation. But experts differentiate between pollution and fusion. In the event of contamination, radioactive materials collect on the surface of the body and can be washed with water and soap. But in the case of fusion, radioactive materials enter the body and become embedded in it and can never be eliminated. The unit of measurement for nuclear radiation is called the millisievert. If the body is exposed to 250 millisieverts or 0.25 millisieverts for a short period of time, it can develop one of the diseases caused by radiation. According to the Federal Office for Radiation Protection in Germany, we are exposed to 2.1 millisieverts from nature per year, while exposing the body to 400 millisieverts leads to certain death (Bisht, *et al.,* 2021 ; Acevedo, *et al.,* 2008).

1-3 Types of ionizing radiation and some of their propertiesaccording (Akleyev, 2016).

There are two types of ionizing rays that interest us: **1- Particle rays** , called mass carriers, are of two types: They either have a charge, whether negative or positive, the most important of which is: alpha rays. It carries two positive charges and is symbolized by the letter and rays Beta, symbolized a particle like an electron on the one hand. The weight, its charge is either negative which is the majority or positive, or the type. The second particle with a neutral charge is the neutron with the letter “n”.

2- **Electromagnetic rays,** which have no mass, and are therefore called carriers energy, which is X-rays, sometimes called x-rays “Rentgen” is named after its discoverer, and gamma rays are symbolized by the letter. (Note: Gamma rays emanate from the nucleus, while x-rays do It usually comes from nuclear).

General properties of types of ionizing radiation all ionizing rays emanate from the nucleus and rarely from the atom itself including :

X-rays emanate - mainly - from the atom as a result of imbalance forces in the fields of electron rotation around the nucleus, and sometimes, it is released as a result of the interaction of an electron with the force field around the nucleus.

Alpha particle: heavy in mass (4 atomic mass units), and therefore it is cannot penetrate the skin, and it is considered ineffective on the exposed person. It has external exposure, but its risk exceeds beta and gamma the exposure was internal

Beta particle: very similar to an electron in terms of mass but it is released from the nucleus very quickly, and its charge is either negative, for example electrons are the majority, and sometimes positive, some of which have the ability. It penetrates the skin for different distances, and affects the person exposed to it externally and internally to different degrees.

Neutron: A particle with a neutral charge emitted from the nucleus result Its disintegration or a specific nuclear reaction, so it has a penetrating property an obstacle in front of him for long distances depending on the type of material of the obstacle .It is considered highly dangerous to humans according to their speed, whether in case of external or internal exposure.

Gamma rays: carry energy and are emitted from the nucleus as a result of the exit ordecomposition of any of its components, or any other change in the strength of the nucleus it leads to its temptation, and it - often - follows the exit or entry of particles to the nucleus, it leads to a change in its components, such as the exit of beta and alpha rays from the nucleus. Gamma rays have a high ability to penetrate materials according to its energy and therefore its radioactive sources are usually kept in containers of Lead, and the user uses these sources with caution on the

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one hand prevention, as it has a major negative impact on those who are exposed to it. It has an external or internal effect, while the following table shows some of the properties ionizing rays:

1-4 Isotopes and radioisotopes

The word theoretical is an expression for a chemical characteristic of an element, and it is used for example, an element "x" is theoretically similar to an element "x1" if they are similar are identical from a chemical standpoint, and differ from a physical standpoint atomic weight. Chemical similarity depends on the number of protons in the nucleus, any elements that have the same number of protons are isotopes and have same name, but different in the number of neutrons, for example elements Hydrogen are according to (Botkin and Keller, 2011).

1-**1H; -2H; -3H**; The first has one proton in its nucleus most natural hydrogens contain a proton + a neutron , Its weight = 2, and the third carries a proton + 2 neutrons, and its weight = 3, all of them. It reacts chemically with any other elements in the same way, the only one. The radioactive substance is H-3 and it is called tritium, and it radiates beta with weak energy. Heavy filling an ordinary water molecule contains 2H1, two atoms of -1H and one atom is oxygen O, while heavy water contains 2H2 any two H-2 atoms are heavier than 1H-atom.

2 - Nuclear rays and radioactive materials: according (Streffer, 2008).

There is a slight difference between "ionizing rays" and "radioactive materials"

A - In the case of nuclear explosions, various resulting nuclear rays are emitted of nuclear reactions, including neutrons, and may continue or a short period of time a temporary phenomenon, and it affects humans external influence in the case of neutron bombs, the effect is fatal.

B- In radiological or/and nuclear accidents, radioactive materials spread throughout all parts of the accident site and afterwards depending on the circumstances (atmospheric) and it has two properties: it radiates ionizing rays and affects rays and their effect on humans externally, and it also affects people internally when it enters the body as it remains for different periods and may enter the formation of various cells, these parts of the body are radiated constantly waiting for her to get out of it.

3 - Nuclear fallout : Nuclear fallout is radioactive material that was suspended in the atmosphere for any of the reasons we will mention below, and under the circumstances a certain amount of air that falls on the surface of the Earth, carried either by dust or droplets flour called solid fallout, water mist moisture, or drops rain water, for example, and it is called wet or wet fallout.

The possibilities of nuclear fallout caused by the explosion of a live nuclear weapon such as Hrushiya: The explosion occurs at a distance of not less than 3 kilometers from the surface of the earth, and remaining most of the radioactive material mostly from nuclear fission is suspended in the air (adhering to fine dust resulting from the explosion is why it is called radioactive dust, and it lasts for a short time after the explosion wave calms down, then it begins to fall to the surface of the Earth. In the direction of the wind and sometimes - depending on weather conditions , they fall radioactive dust reaches the ground over long periods ranging between weeks and months, delay in the fall of these radioactive materials is talk. Its influence is greatly reduced for two reasons:

A-These radioactive materials remain suspended in the air for long periods of time to distribute it over vast areas, and therefore when it falls less dense and therefore less dangerous.

B- The intensity of radioactive materials resulting from fission nuclear bomb explosions or nuclear reactor accidents are decreasing rays and their effects brilliantly, and thus the doses of external exposure to it decrease, This decrease follows a rule called: Seven of Rul"

1-5 Biological effects of radiation on living cells according (Wall, *et al.*, 2010).

The human body consists of organs, every organ is a tissue, a tissue is a group of cells, and the basic building block for building cells is DNA.

There are 3 types of radiation that may affect living cells:

1 - Ultraviolet rays: They are non-ionizing rays whose length is the wavelength is between 200 and 400 nanometers. It is divided into A, B, and C. The ozone layer absorbs all of the ozone layer

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in the atmosphere. Type B, and these types may cause skin burns, and some types of skin cancer such as melanoma.

2 - Rays emanating from electromagnetic fields: these rays are also non-ionizing, and none of the studies that types of radiation were used to confirm the existence of a relationship between them and the high rates of leukemia.

3- Ionizing rays for the third and most important type, which is the focus of our discussion today, it is ionizing rays such as:- Alpha rays, - Beta rays,- Gamma rays, - Neurotons - and others.

Rays affect cells living things that form tissues and the organs in the body. It leads to cell death or affects the division process chromosomes. The genetic material in the cell happens are mutations hereditary and may be transmitted to generations. Mechanism of radiation damage to the cell mechanism radiation injury. The acute effect of radiation ranges from direct cellular death in doses greater than 10 Gy, or death of dividing cells (Ladjouze and Donaldson, 2019).

Doses between 1-2 gray, there is no noticeable effect. for doses less than 0.5 Gy. The DNA is directly affected by medium and low doses, and the cells, it has ways to adapt and repair this type of damage, but if the mark is large on the DNA, the cell through programmed cell death mechanism and is called apoptosis some cells affected by low doses of radiation appear.

It has late effects of radiation, such as: mutations, imbalances chromosomal, gene instability, these cells may become malignant, and most cancers are the result of exposure to ionizing radiation in doses more than 5 Gray.

Acute effect: Ionizing rays may lead to disruption of DNA, such as:

1- Binding protein to DNA

2 - Or linking the strands of DNA together.

3- Oxidation of nitrogenous bases.

4- Break the bond between sugar and phosphate

5- A break in the DNA

These acute effects may occur directly from ray-X or indirectly with radical free atoms. Low doses of ionizing radiation lead to changes in gene expression process where the gene (DNA) is transformed into a protein, such as an increase in the conversion of genes such as fos-c, myc-c, and jun-c. These genes are considered to be from the oncogene-proto group, these genes are responsible for the occurrence of many types of diseases cancers. Also, low doses lead to a reduction of cytokines such as α-TNF tumor factor, the radical free atoms generated by the impact radiation leads to a defect in the genetic transformation process. However, DNA has a gene called 53P, which performs a correction process. If there is an error in the DNA, then he can stop the process.

Division with the help of other genes or cell suicide, it is called the guardian of the human genome and fibrosis happens mostly when the doses radiology treatment for the injured with cancer, It leads to my change natural tissue to fibrous tissue distorted and therefore lost function (Bisht, *et al.*, 2021 ; Saleh, 2014).

1-6 The effect of radiation on tissues

The tissues found within the human body are diverse, with their diverse functions and it varies sensitivity. These tissues to radiate with a different rate splitting speed its empty, and it has been proven that tissue responsible for blood manufacturing and tissues reproductive according (Saleh, *et al.*, 2021).

The blood and lymphatic system are most sensitive to radiation for doses of 500-1000 rads: it leads to a decrease in cells red and white blood due to:

- Direct destruction of these cells.
- Loss of cells due to bleeding
- Cell production stops.

A-Lymph nodes: They are usually resistant to radiation, but the cells which inhabit these nodes are affected at low doses, exposure to 10 rads leads to cell decline immune system in the lymph nodes, where the lymph nodes belong to normal after 3 weeks.

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B-Thymus: It is also resistant to radiation in relation to the rest of the organs but immune cells are affected by radiation and return to normal after 4 weeks.
C-Spleen: At moderate doses, the immune cells in the spleen decrease, the spleen loses half its size, but at high doses, the spleen shrinks and immune cells are lost significantly.
D-Bone marrow: The cells that produce red cells in the marrow are most sensitive to radiation (Erythroblast).
E-Blood cells: when exposed to a moderate dose for 15 minutes, it leads to a decrease in immune cells, within a few hours it decreases dramatically.
F-Plasma: The radiation effect is slight, and plasma proteins decrease lightly.
Circulatory system: The heart, veins, and rhinestones are resistant to radiation, but are affected and arteries result from the sensitivity of the endothelial tissue Endothelium for radiation through various mechanisms:
A- Swelling of endothelial cells and blockage of blood vessels, low doses lead to the death of some cells.
B-Endothelium, which stimulates the excessive proliferation of some of them,it leads to vascular obstruction.
C- Possibility of clots.
Nervous system: Consists of the nervous system
Central CNS, It contains the brain and the spinal cord. It is considered a resistive device to radiate rays and their effects
A-Nerves that transmit
B-Neurological signals
Eye : One of the most important changes what happens to the eye when the head is exposed for small doses from ray-X, minor changes occur in the lens of the eye that may appear at the stage of subsequently within months or years. Strong changes in the lens of the eye appear as a result of moderate exposure for x-rays, symptoms appear after 6 months. neutrons cause cataracts.
The change in the lens of the eye is the result of the cessation of cell division **A-Eye lens and B-Rays and their effects**
Respiratory system : All parts of the device denial is sensitive for radiation and materials radioactive, as it may lead to the occurrence of infections that would affect gas exchange process in the bronchial tubes, as well as the occurrence of types of lung cancer such as:
A-Large cell carcinoma -
B-Small cell carcinoma –
Digestive System : Mouth: Swells and ulcerates when exposed to high doses, the esophagus: relatively resistant to radiation stomach: after 30 minutes from exposure to a dose medium begins to be affected on the sorting cells pepsin enzyme. In contrast to secretary cells for hydrochloric acid HCl (resistance). For radiation, with the possibility an ulcer occurs small intestine more rays and their effects by the stomach, 30 minutes after a moderate dose the following occurs:
A- Swelling and cellular degeneration in the intestine.
B- Stopping cell division and regeneration. It returns to its normal state faster than the stomach Liver, Resistant to radiation due to its regenerative property pancreas: also resistant to radiation, but pancreatic secretions affected for 1-2 days with average exposure of 30 minutes.
The urinary system: Consisting of the kidneys, ureters and bladder, the kidney is considered resistant to radiation, but the long-term impact would affect on the blood vessels of the kidney, the bladder is more sensitive, the male reproductive system. It consists of the testis and somniferous tubules and prostate. The prostate and seminiferous tubules are resistant to radiate in the testicle there are two types of cells: Leydig cells and Cells Sertoli when exposed to radiation in low dosesmoderate, it leads to chromosomal abnormalities and stops division cellular.
Bones, muscles and skin : Bones develop more a bunch of bones stunted growth, the effects include: Destroy and corrode bone cells and the grove, divisions stop for these cells. The occurrence of some types bone cancer at the doses asaliyah, such as –Os teogenic Sar- .coma.

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About muscles , It is considered from parts resistance but more from 50 thousand rad it leads to weakness in the bites and difficult in motion fiber muscle.

On skin rays and their effects outer layer of the skin, the epidermis, is the most affected by radiation 35 rad affects the speed of cell division.

Higher doses lead to cell death medium doses at varying intervals affect the layer dermis interior.

2- Conclusions and Recommendations

Regulating environmental safety from natural and unnatural radioactive pollutants is an important responsibility that falls on everyone. Many countries have decided to implement an environmental safety system to limit the spread of pollutants that cause radioactive accumulations that are transmitted to humans, animals and plants. These standards apply throughout world to promote safety in nuclear power generation and in nuclear energy related applications, Medicine, industry, agriculture and research for the purpose of protecting people at all times by assessing and controlling the risks associated with ionizing radiation without unduly limiting the contribution of nuclear energy to Governments, regulatory bodies and employers must promote equitable and sustainable development to ensure that nuclear materials and radioactive sources are used in a beneficial, safe and ethical manner. As the crime of environmental pollution resulting from the use of nuclear energy and its waste, and environmental damage in general and nuclear damage in particular, then the adequacy of traditional rules for compensation.

Victims and those affected through the legislation of the Victims' Compensation Law and the appropriateness of the relevant law to the provision harmful action to apply to damage caused by environmental pollution and its suitability. The law applied to the harmful act to determine liability for environmental damage and liability the state abstains from nuclear testing in light of the international commitment not to pollute the environment as well responsibility for nuclear testing and how body tissues are affected by this type of pollution.

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