

Framework Proposal for Environmental Impacts Assessment (EIA) of Nuclear Activities and their Role in Achieving Sustainable Development

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Abstract. The importance of preparing a study to assess the environmental impacts of nuclear and radiological activities to confirm its commitment to local and international requirements and standards for the practice of these activities, to identify and analyze sensitive components of the current environment, to determine the type, nature and importance of potential environmental impacts during construction, operation, accidents and emergency conditions, and to identify practical and feasible mitigation measures and recommend them to reduce of the environmental impacts, if any, and setting a general framework for the environmental management plan and the environmental monitoring plan for the facility in order to ensure that all parties concerned and affected by the activities under evaluation are taken into consideration, and the research aims to prepare a model for the steps for preparing an environmental impact assessment by proactive approach commensurate with very specific nature of nuclear and radiological activities. And to contribute to achieving sustainable development for those activities.

Keywords. Environmental Radiation Impact Assessment (REIA) - Environmental Impact Assessment (EIA) - Radiation Environmental Management Plan (REMP) - Environmental Monitoring Plan (MP) - Sustainable Development Goals (SDGs)

1. Introduction.

The environmental impact assessment process became; is an organizational process through which all the anticipated environmental impacts of any proposed projects, activities, or practices are identified and evaluated, including plans, programs, legislation, and administrative procedures related to one of the various elements of the environment, including natural, chemical, biological, civilizational, social or economic elements, which are gaining increasing attention. At the global level, where it recommends that all international organizations use environmental impact assessment studies for various projects and activities to maintain sustainable development; From here comes the importance of this system as an effective element in protecting the environment and a beacon in the hands of decision-makers and planners, illuminating for them the future of these various projects and activities, to show their impact on the environment to develop conceptions on which the development process is based to find the pros and cons [1].

The purpose of implementing the environmental impact assessment process is to ensure that any proposed activities, programs, or development plans are environmentally sound and ensure sustainability. This process is considered one of the planning tools and is used to anticipate, analyze and elaborate the significant environmental impacts of any proposal, and to provide data and information of importance at a stage. Make a decision; In addition to the process of assessing the environmental impact of projects that can reduce negative and adverse impacts on the environment, it helps to employ and utilize resources effectively and sustainably and maximize the benefits of proposed development projects as they are transferred from their international source in consideration of the international emergence of the environment to the internal Laws.

The environmental impact assessment process also aims to update and develop the designs of the proposed facilities in line with the nature of the nuclear activities and the social dimensions of the region, including taking into account the customs and traditions, in addition to improving the social aspects of the projects under evaluation, which reflects the social acceptance of citizens when making sure that the project does not catch up with them. Any damage and the environmental impact assessment can provide sufficient information for the environmental management of the activities, based on which the decision to accept the project or not and grant the environmental approval [2].

The environmental impact assessment process does not stop at the decision-making point only, but goes beyond that to the stages of implementing the proposed activities as well as the stages of site rehabilitation to avoid or reduce any adverse and negative effects, as this can be applied by applying specific and appropriate mitigation and monitoring

criteria, as it depends on the collection and analysis. All information and data related to the proposed activity so that the expected effects can be inferred when implementing this activity in a particular region, and if the implementation of the activity is inevitable or necessary; What are the necessary criteria to mitigate the environmental impacts and find possible alternatives for this project to achieve sustainable development and maintain a safe and secure environment.

It was not recognized in the past to adopt environmental and social considerations as part of the data that are relied upon to design economic development plans. However, it has become clear that placing environmental considerations in the calculations of the development plan, including assessing the environmental effects of the project before starting its implementation, gives new dimensions. The value of the resources and their use is based on a cost-benefit analysis and how they can be preserved, as well as the economic benefits that will accrue from that in addition to achieving the goals of sustainability and preserving the environment [3].

The environmental impact assessment process of nuclear and radiological activities enables to know the environmental problems and work to determine the most appropriate ways to deal with them from the beginning of the project to its end, and more than that by trying to restore the thing to its origin by rehabilitating the area under study, which made this method an integrated tool for environmental management that works to create exploitation. Optimization of material, human and moral resources to ensure sustainable development that meets the needs of present and future generations [4].

Through the global concern for environmental problems and the importance of applying sound environmental management of natural resources and achieving the concept of sustainable development, which in turn achieves economic development that plays an important role in the process of preserving the environmental balance without compromising the healthy economic life and the implementation of national nuclear projects.

Egyptian Legislation obliged the necessity of preparing a specialized study of the environmental effects of nuclear and radiological activities in all its stages, starting from the design stage, passing through the operation stage, and ending with the dismantling and rehabilitation stage of the site, to ensure that the environment is free from any harmful effects of these activities, and work to reduce the environmental impacts thereof to a minimum. Limit.

So; this article relates to the extent of benefit from studies that study the environmental effects of nuclear and radiological activities, and to ensure the preservation of the environment from any negative consequences of those activities to achieve sustainable development.

Thus, the subject of the article seeks to identify the objectives of the environmental impact assessment, the procedures through which the assessment processes are carried out, the benefits and advantages of the evaluation processes, and the approaches that are followed in implementing these processes.

The aim behind this article is to develop a proposed framework for assessing the environmental impacts of nuclear and radiological activities, through which the sustainable development of those activities can be achieved.

2. Research methods.

To achieve this goal, the mechanisms for establishing nuclear and radiological activities and the controls for their operation have been studied through work at the Nuclear Materials Authority, and the local and international standards that regulate this have been studied, represented in international agreements and bulletins issued by the IAEA, and the Egyptian Legislation governing this, to reach a specific framework that can be applied To measure the environmental impacts of these activities in all their stages.

Among the methods that have been relied upon in the preparation of an integrated plan for environmental management of the expected environmental impacts, and the preparation of many scenarios for how to apply them, obstacles or breaches of the expected implementation, and how to avoid and confront those violations or threats.

The article relied on the general descriptive, analytical and quantitative approach for all the proposed steps, to reach the desired goal represented in the proposed framework for the controls of preparing a study of the environmental effects of these activities to achieve sustainable development.

3. Results of research and discussion.

Countries have been interested in the environmental impact assessment process of nuclear and radiological activities, especially with the growing reliance on nuclear energy and nuclear technology in many aspects of life, as protecting and protecting the environment from the beginning is better than treating it from the negative effects later, which usually have very high costs compared to With the cost of evaluating the effects of activities and taking precautions in advance, especially in the early stages of it, bypassing or neglecting the environmental impact assessment of any nuclear or radiological activity may cause future problems and large financial burdens that can be avoided through the evaluation that provides strategies capable of, for example, reducing the rate of emissions of pollutants and preparing plans Environmental management in the various stages up to rehabilitating the site and trying to return the thing to its original, thus reducing the company responsible for the project from bearing costs and legal consequences in the future.

3.1. The concept of environmental impact assessment of nuclear activities.

The concept of environmental impact assessment is devoted to the process of prior analysis to assess the potential environmental impacts (negative or positive) of a proposed project on the natural environment, during each of its stages, starting from its establishment, through its operation, and until its termination, in order to propose the necessary measures to avoid or mitigate Adverse environmental impacts and the promotion of positive impacts, in addition to developing a systematic method for integrating sustainable environmental considerations into the decision-making process, providing the basic elements for making a decision based on knowledge, and through this process an Environmental Management Plan (EMP) is attached, aiming to determine how to implement and monitor these measures, In the past, the environmental impact assessment was applied to projects with potentially large negative environmental impacts, but with the adoption by countries of the sustainable development goals, it became necessary for all large, medium and small projects to submit a study to assess the environmental impact, but with different requirements and standards, but they all strive to achieve Environmental sustainability [5].

As for the environmental impact, it is defined as a natural, chemical, biological, cultural, or socio-economic change on the ecosystem as a result of the project's activities. As for the environmental impact assessment, it is an integrated plan for environmental management and training on what will be carried out before any project, for the main activities, or for what will be undertaken to ensure that no way can harm the environment in the short or long term. Environmental impacts resulting from an activity.

The International Association for Environmental Impact Assessment (EIA) defined it as it is the process of identifying, predicting, assessing, and mitigating biophysical and social impacts, and all impacts resulting from development proposals that are taken before major decisions and commitments are made [6].

The study of the environmental impact is considered one of the most effective legal means for its impact on the preparation and development processes that directly or indirectly affect the surrounding environment, either immediately or later, so it was necessary to control a mechanism surrounding these effects and to protect the environment from the dangers of development projects. It is used as a tool for evaluating development projects and nuclear projects. Hence, inventorying the definition of the environmental impact assessment system is considered one of the most important environmental studies in the present era because of the relationship between environmental impacts and the various economic activities its practices.

3.2. Sustainable development and its relationship to nuclear activities.

In the years following World War II, civilian technologists reoriented nuclear knowledge, which resulted under military control in the production of atomic weapons, so that their use was for peaceful energy purposes, and there were several clear benefits, which prompted proponents of nuclear energy to raise the issue. Energy as a solution to this dilemma leads us to analyze this logic and determine whether nuclear energy can represent sustainable energy, and thus it is a response to energy shortage according to sustainable development standards or not.

3.2.1. The importance of sustainable development.

The concept of sustainable development has become known and used worldwide. The World Commission for Environment and Development (WCED) has defined a special definition for it as development that meets the needs of the present, without compromising the ability of future generations to meet their own needs. Achieving sustainable development, such as: preserving the integrity of the environment, satisfying basic human needs, achieving social justice, and providing multiple community solidarity. One of the outputs of this definition was the realization that sustainable development encompasses many diverse fields, and these fields are of ecological, economic and social value [7].

Sustainable development is a difficult issue to deal with and implement, or even overcome obstacles to achieving it; because it is made up of a large bundle of homilies. The population is the main pillar that drives sustainable development forward.

The primary goals of sustainable development are numerous; Among its objectives are, for example, but not limited to: reducing the depletion of natural resources, creating a development that can be protected and sustainable without harming the environment, saving contemporary methods of development, and investing it in environmentally friendly projects.

Many international organizations, such as the United Nations and non-governmental organizations, are making great efforts to ensure the achievement of development goals for individuals in various fields, and among the most important permanent development goals set by these bodies are the following: eliminating global poverty, promoting good health and well-being, and saving Quality education for all, saving clean water and sanitation, building strong infrastructure, supporting industry, incubating innovation, enabling affordable energy access without harming the environment, and enabling gender equality [8].



Fig. 1: The seventeen Sustainable Development Goals (SDG's) (adapted from <https://www.iaea.org/about/overview/sustainable-development-goals>)

3.2.2. Nuclear energy is sustainable energy.

The main objective of sustainable development is to preserve or increase the natural and man-made assets available for future generations while minimizing the consumption of limited resources and without exceeding the carrying capacity of ecosystems, and this may correspond to the advantages of nuclear energy.

The IAEA understood the importance of this, and worked to achieve the sustainable development goals adopted by the United Nations General Assembly, especially those three goals that stress the contribution of nuclear powers to energy towards the future, namely: Goal 7 - Access to affordable and clean energy - It will focus our efforts towards achieving sustainable development as the world population grows and the demand for energy increases; Goal 9 - Industry, Innovation, and Infrastructure - cannot be achieved without sufficient energy access; Goal 13 - Take Action to Combat Climate Change - sets goals to achieve clean and environmentally friendly energy [9].

Nuclear power produces about 11% of the world's electricity with 450 nuclear reactors in operation in 30 countries, and projections show that nuclear energy will continue to play a major role in the world's energy mix for decades to come, and while the use of nuclear power is on the increase, its share of the energy mix in the world, its economic competitiveness is decreasing, and its economic competitiveness is facing challenges, and the initial cost of nuclear power plants may be high, but it is competitive when we consider the cost of producing electricity over the life of the plant, and the competitiveness of any of the priority nuclear options in achieving competitiveness, and it depends on several factors, such as availability of natural resources, environmental factors, expertise, and personnel.

3.2.2.1. Nuclear energy and the fight against global warming.

Greenhouse gas emissions from fossil fuels are the main cause of global warming, and at the end of the 1980s, when the issue of the dangers of these gases became a concern, a debate arose over the nuclear issue as a reliable and effective solution to global warming.

Nuclear energy is one of the existing energy sources and technologies that can help solve the energy and climate problem. It is mainly found in industrialized countries that possess the necessary technological, institutional, and financial resources. It is also considered necessary to achieve sustainable development, as it is noted that the electricity produced by nuclear energy is simply cleaner, more flexible, and more consumer-friendly; Nuclear energy does not produce any sulfur dioxide, nitrogen oxides, volatile organic compounds, or greenhouse gases, as is the case with renewable hydropower and wind energy [10].

The entire chain of nuclear power generation, from material extraction to waste storage, including building reactors and other facilities, releases only two or six grams of carbon equivalent per kilowatt-hour, and this value is, in fact, somewhat similar to solar and wind energy. Including building and manufacturing components, which means that the use of nuclear energy avoids annual emissions of about 600 million tons of carbon, as much as hydropower avoids it, as it produces about 600 million tons that represent approximately 8% of global greenhouse gas emissions. This is why the importance of nuclear energy in contributing to the fight against global warming stems from here.

3.2.2.2. Nuclear Energy and the Benefits of Environmental Sustainability.

In addition to contributing to mitigating climate change, nuclear energy has other environmental benefits, including reducing air pollutants that have harmful effects on health and the environment on a local and regional scale, as it is noted that nuclear power plants do not emit any pollutants to the air during their period of operation, Fossil fuel stations are among the most important contributors to air pollution.

Studies on the role played by nuclear energy in reducing deaths from air pollution have proven that, at the global level, nuclear energy avoided more than 1.8 million deaths related to air pollution that would have occurred due to burning fossil fuels between 1971 and 2009.

The use of nuclear energy in sectors other than electricity production, for example, water desalination and hydrogen production, represents a major enhancement in achieving climate-friendly economic and technical development around the world, at a time when one-third of the world's population lives in areas suffering from water stress, no Especially in sub-Saharan Africa, the Middle East, and South Asia.

The use of nuclear energy to produce hydrogen to replace the existing internal combustion engines with hydrogen fuel cells is a fundamental shift in the transportation sector and contributes to achieving global goals to reduce pollution by eliminating pollutant emissions resulting from modern fossil-fuel vehicles that emit carbon dioxide. In large quantities [11].

3.2.2.3. IAEA and Sustainable Development.

The IAEA, in line with its mandate of “Atoms for Peace and Development,” supports countries in their efforts to achieve the 17 Sustainable Development Goals set out in the United Nations 2030 Agenda for Sustainable Development. Many countries use nuclear science and technology to contribute to their development goals and attainment in areas including energy, human health, food production, water management, and environmental protection. The use of these technologies contributes directly to achieving nine of the 17 goals.

The 2030 Plan was approved in 2015. The plan's 17 goals and the associated 169 targets are intended to spur action over the next fifteen years in areas of critical importance to humanity and the planet. These goals and objectives are complementary and indivisible, and they balance the three dimensions of sustainable development: economic, social, and environmental.



Fig. 2: Sustainable Development Goals (SDG's) seeks to achieve by (IAEA) (adapted from <https://www.iaea.org/about/overview/sustainable-development-goals>)

3.3. The importance of assessing the environmental impacts of nuclear activities.

The environmental effects of nuclear activities are assessed through the Environmental Radiation Impact Assessment (REIA) for those activities, and this is done by conducting an environmental study of any possible radiological effects of any nuclear activity. Environmental protection requires environmental and radiological determinants approved by the IAEA, as well as relevant international and national legislation. The link before embarking on any construction of any nuclear facility in all its stages.

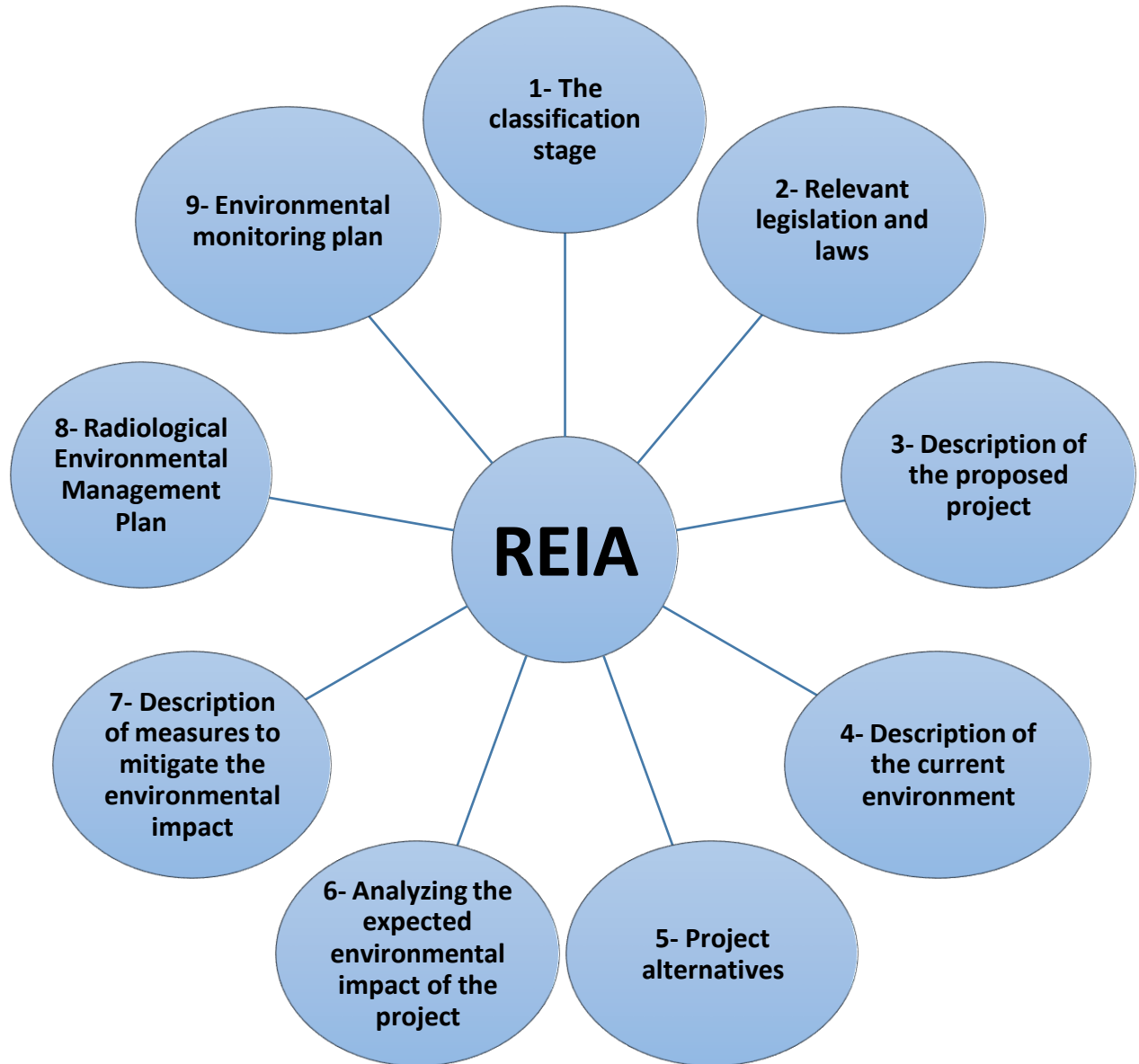


Fig. 3: Stages of (REIA) in the lifetime of a nuclear installation when a prospective radiological environmental impact assessment (prepared by the authors)

3.3.1. The purpose of assessing the environmental radiative impact.

The environmental radiological impact assessment aims to determine the potential radiological and environmental impacts of projects and programs, and the legislative measures that need to be taken, and to suggest the necessary means to avoid or reduce the importance of these effects, and then take the necessary decision regarding these potential impacts.

The process of assessing the environmental impact of nuclear activities went through many stages. The great use of nuclear energy, and the subsequent significant deterioration in preserving the environment, was evident in the Chernobyl disaster in the Soviet Union in 1986 [12], and then in the Fukushima accident in Japan in 2011 [13].

The persons involved in the design and planning of facilities related to nuclear and radiological activities must be fully aware of the controls of the environmental radiative impact assessment and how it works in their local area so that the necessary decision can be taken to address or prevent any effects of those activities to achieve Environmental sustainability.

The environmental radiological impact assessment is a systematic process used to assist in making decisions that take into account the assessment of the environmental impact of radiation activities and their impact on society, workers, and the environment, and this process helps to include environmental factors in the project proposal, and the environmental radiological impact assessment includes an assessment of the potential impacts of the project on Ecosystem, in the environmental radiative impact assessment, current data related to the environment are collected based on forecasts about levels of radiation emissions and pollution from the proposed projects and development activity, where these expected values are imposed on the current values using different models to predict the level of radiative impact and environmental pollution after the start of the project. Thus the future values help in deciding whether the proposed project will be environmentally sustainable in the area or not, since other sustainable factors are also taken into consideration in the environmental radiative impact assessment, it gives a complete picture of the area after the implementation of the project.

3.3.2. Periodic review and assessment of the environmental radiation impact.

The operating organization or facility undertakes a periodic review of all external natural and anthropogenic hazards and site conditions within the framework of the periodic safety review and as appropriate over the life of the nuclear facility, with due regard being paid to operational experience and emerging safety information [14].

As part of the periodic safety review of nuclear activities (or as part of safety assessments undertaken under alternative arrangements), external natural and anthropogenic hazards and site conditions over the life of the nuclear facility are reviewed with the help of updated information. These reviews are carried out at regular intervals (usually at least once every ten years), and in any of the following cases:

Table 1: Cases in which an amendment is made to assess the environmental radiative impact

A	An update of regulatory requirements has been issued;
B	Signs of inadequate design in the face of external dangers;
C	Reaching new technical inferences, such as discovering weaknesses in specific structures, systems, and components that make them vulnerable to external hazards;
D	Extracting new information, experiences, or lessons from external events that have already occurred and affected the safety of another nuclear facility or industrial facility;
E	Hazards change over time and new information and assessments become available.
F	The need to provide more confidence in the presence of adequate margins to prevent cliff-edge effects;
G	As part of a long-term operation program, or in support of an application to extend the operating license of a nuclear facility;
H	The development of new risk analysis methods that greatly improve previous estimates.

The external hazards of the site and the site conditions are reassessed, as appropriate, based on the conclusion of the periodic review of the hazards of the site, or because of the acquisition of new data related to the assessment of the radiological environmental impact or the safe operation of the nuclear facility.

3.4. Legislative Determinants for Assessing the Environmental Effects of Nuclear Activities.

Pollution of the environment with radioactive materials is considered one of the most dangerous types of environmental pollutants that have prompted the international community to conclude international agreements and treaties to assess the environmental impacts of these activities, and many national legislations have obligated the operators of these activities to measure their environmental impacts before authorizing them to practice these activities.



Fig. 4: Legislative determinants to assess the environmental impacts of nuclear activities in Egypt (prepared by the authors)

3.4.1. Determinants of the assessment of the environmental effects of nuclear activities in International Law.

The 1963 Partial Test Ban Treaty plays a major role in preserving the environment, and in setting determinants for assessing the environmental effects of nuclear activities. The treaty prohibits the implementation of any test explosion for a nuclear weapon or any other nuclear detonation as it stipulates the prevention of experiments: A- In the atmosphere B- In any other environment, if such detonation leads to the presence of radioactive debris outside the territorial borders of the state under whose authority the detonation is taking place. Or its control’.

The Partial Test Ban Treaty was not, in its essence, a treaty to prevent nuclear weapons or improve and modernize nuclear arsenals that were still at the beginning of their development. Rather, it was an (environmental treaty) to calm the world opinion, which began to realize the dangers of these experiments on the environment and the radiation they left behind [15].

Although the Partial Test Ban Treaty was an important achievement at the international level to prevent nuclear tests, after the world became aware of the danger of these tests on humans and the environment, these efforts were not sufficient. The treaty did not prevent conducting experiments in the ground, or this is what some countries have interpreted, which is reflected in the conduct of experiments underground.

This means that the nuclear tests did not stop, which prompted developing countries and non-alignment to stop these experiments and encouraged them to sign the Treaty Banning Nuclear Tests, and then not to continue environmental pollution resulting from nuclear tests because they have negative effects on the environment and public health and carry serious effects on the population, which It affects the surface of the earth through the dense layer of atomic dust resulting from the explosion and is capable of wiping out life from the area of the explosion, as well as causing climatic effects that destroy the ozone layer that causes diseases Serious.

The Comprehensive Nuclear Test Ban Treaty of 1996 also plays in preserving the environment, and in setting determinants for assessing the environmental effects of nuclear activities. The treaty was signed after long efforts of negotiations to complete the shortfall that occurred in the field of banning atomic tests, as the previous treaty (Treaty The partial ban on atomic tests in 1963) has banned atomic experiments in the air and under the surface of water and space only, stating that: “1 - Each state party to the treaty undertakes not to carry out any detonation from any detonation of nuclear weapons test explosions or any other nuclear detonation And to prohibit and prevent any such nuclear detonation anywhere under its jurisdiction or control [16].

This ban stipulated in the treaty suggests that it has a comprehensive character in the sense that it bans all weapons tests in all environments, meaning that the nuclear explosions that were prohibited in the treaty, the partial ban, has been broadly expanded to include underground tests as well.

One of the purposes of the treaty, which is one of the main motives for signing it, is that it can contribute to protecting the environment. The international public opinion considered banning nuclear weapons as the primary task of all countries to protect the environment from pollution due to the continuation of nuclear tests, especially after the radioactive fallout killed someone. Individuals of the owners of Japanese fishing boats in the Pacific region and this incident constituted an impetus for increasing international public opinion on the importance of banning atomic experiments to preserve the environment, as the ban on experiments will prevent or prevent pollution of the

atmosphere from atomic dust, which prevents similar accidents as an accident. The aforementioned Japanese fishing boat, as the ban prevents the continued development of nuclear weapons, and thus will reduce the possibility of using these weapons and relying on them, which ultimately contributes to preserving the environment.

For the treaty to implement its objectives, according to which the Organization for the Prohibition of Nuclear Tests was established to solve the issues of compliance with the Treaty and as a platform for consultation and cooperation between the States Parties. Transfer the data to the International Data Center of the Treaty [17].

Thus, the treaty has addressed every deficiency that was present in the previous treaty, because this treaty recognized these dangers and took precautions for these matters, so preserving the environment must become a joint action on the part of the countries of the world, and it is one of the main objectives of the treaty, as the treaty came to complement the international effort and achieve important steps In the field of nuclear disarmament and environmental preservation, by limiting these nuclear tests.

3.4.2. Determinants of the Environmental Impact Assessment of Nuclear Activities in the IAEA Safety Manuals.

The IAEA is the international umbrella for all nuclear and radiological activities, and confirming its role in this regard, the agency issued three safety guides in the matter of assessing the environmental effects of nuclear activities, which were recently published in cooperation with the United Nations Environment Organization, as these publications help national experts and governmental organizations to strengthen Protect people and the environment from the harmful effects of radiation. These guides guide implementing the requirements outlined in the International Basic Safety Standards.

The recommendations in the three safety guides, along with the requirements contained in the Agency's General Safety Requirements No. (GSR Part 3), provide a basis for incorporating environmental considerations into the assessment of radioactive emissions and their management.

- Issue GSG-8 of the IAEA Safety Standards Series, Protection of the Public and the Environment from Radiation, includes high-level/general guidance regarding the protection of members of the public and the environment in cases of planned exposures, existing exposures, and emergency exposures. The aforementioned issue provides key stakeholders from governments, regulatory agencies, and operating organizations with a systematic approach to controlling exposure to radiation from the operation of facilities and environmental pollution from accidents [18].
- Issue GSG-9 of the IAEA Safety Standards Series, Regulatory Oversight of Radiation Discharges into the Environment, includes specific guidance on the application of radiation protection principles and safety objectives associated with regulatory oversight of radiation discharges from facilities and activities, and on the process for issuing their authorizations. The recommendations and guidance focus on the process of granting disposal permits, including the determination of disposal limits, and means of verifying compliance, which will contribute to controlling the radiological effects on the public and the environment [19].
- Issue GSG-10 of the IAEA Safety Standards Series, Assessment of Potential Radiation Environmental Impact on Facilities and Activities, provides details of general frameworks and methodologies for assessing potential radiative environmental impact. This number identifies the various types of methodologies that can enhance the assessment of the potential radiative environmental impact, which are usually undertaken in the pre-operation and operation phases of a facility or activity, as a condition for obtaining the necessary permissions. The methodologies also apply to government decision-making processes, such as the environmental impact assessment process included in many national and international regulatory frameworks [20].

The IAEA cooperates with many relevant international bodies and is encouraged to apply and use these recommendations to promote and develop national regulations on protecting the environment from the harmful effects of ionizing radiation. And enable effective national infrastructure for radiation protection, including existing ones and those under preparation, to benefit from the aforementioned new safety guides that promote the establishment of optimal levels of prevention and protection of societies and the environment.

3.4.3. Determinants of the assessment of the environmental effects of nuclear activities in Egyptian legislation.

The Egyptian legislature established determinants for assessing the environmental impact of nuclear activities in both the Egyptian Environmental Law 4 of 1994 and its executive regulations, and Law No. 7 of 2010 regarding the regulation of nuclear and radiological activities and its executive regulations.

Concerning the environmental Law; the Egyptian legislator entrusted the Environmental Affairs Agency with setting the standards and requirements that the owners of projects and establishments must adhere to before construction and during operation. As well as laying down the foundations and procedures for assessing the

environmental impact of projects, obligating the owner of the facility to keep a record of the effect of the facility's activity on the environment, and identifying the facilities that are subject to the provisions of the environmental impact assessment, including the nuclear facilities [21].

The legislature has defined the data that must be available in the record of the impact of the nuclear facility's activity on the environment, or the so-called environmental status register, which includes:

- Data about the facility, its address, the name of the person responsible for editing the registry, his job, the period covered by the current data, the type of activity, the nature of raw materials and production during the corresponding period, the legislation to which the facility is subject, and the special requirements issued by the Environmental Affairs Agency of the facility.
- A statement of the types of emissions, their rates of disposal, and how to dispose of them.
- Rates of testing for each type of emissions from the facility.
- Abducted samples (date, time, and location of each sample, sample collection rate, and a statement of the indicators to be measured).
- Compound samples (date and time of sample collection, places and percentages of mixing the compound sample, and a statement of the indicators to be measured).
- Outputs after processing.
- The efficiency of the treatment methods.
- The date and signature of the official.

The EEAA also identified several procedures that the projects will go through to assess the "environmental impact", which is to ensure the protection and preservation of the environment and natural resources, including aspects related to human health from the effects of development that lack control, explaining that the goal is "long-term" for this. Evaluation is to ensure continued economic development that meets the needs of the present without diminishing the ability of future generations to meet their own needs.

The environmental impact assessment is an important tool for an integrated environmental management method that must be conducted for new facilities and projects or expansions and renovations of existing facilities under the provisions of the Environmental Law, and it is represented in [22]:

- The owner of the project or his designee submits a request to the competent administrative authority to carry out the project, which is classified on List (A). The application shall be attached to the Environmental Classification Form.
- The concerned administrative authority shall register the documents and ensure the correct selection of the classification and the conformity of the information provided to the required information.
- The concerned administrative authority shall review the documents and submit them in an official capacity to the Environmental Affairs Agency for evaluation.
- The EEAA shall evaluate the documents, express its observations, and present them to the concerned administrative authority and present possible suggestions for measures that need to be taken to ensure the protection of the environment, within 30 days of the agency's receipt of the documents in full, and if the agency fails to do so, this will be considered his approval of the evaluation.
- The EEAA shall record the documents, opinions, and proposals submitted by it in the environmental impact assessment register of the agency.
- The concerned administrative authority shall notify the project provider, according to a registered letter with acknowledgment of receipt, of the final result of the evaluation, which results in one of the following two results:
 - Approval provided that the project provider fulfills all legal environmental requirements (specified in the approval). The project may not be approved for reasons other than environmental.
 - Issuing instructions to the project provider to follow the procedures for the list (B) or (C) for projects, depending on the nature of the project.
- The concerned administrative authority sends a copy of the decision to the EEAA, which registers it in the EIA register.
- The concerned administrative authority undertakes to ensure the implementation of this decision.

Concerning regulating nuclear and radiological activities Law; The Egyptian legislature required obtaining the approval of the Nuclear and Radiation Control Authority (the Regulatory Authority) before authorizing the initiation of any activity related to materials and raw materials from which ionizing radiation emits, as follows [23]:

- Uranium or thorium exploration and evaluation processes.
- Extraction or transportation of discovered uranium or thorium ores for testing and extraction purposes.

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- Construction and operation of mining and processing facilities for ores and materials that emit ionizing radiation.
- Suspend permanently or temporarily the licensed activity in the mining or ore processing facility.
- The Authority determines the documents necessary to obtain the aforementioned approval, provided that they include:
 - A study to assess the environmental impact of radiation.
 - Radiation safety management systems.
 - Description of the design and construction methods.
 - Quality assurance plans and project operation.

The legislator also subjected the licensing of a nuclear or radiological facility to the conditions and rules that the authority specifies in the technical systems issued by it and per the potential risks that may result from the establishment of the nuclear or radiological facility or its activities and other conditions and obligations imposed by the law and this regulation, systems, standards, rules and technical requirements for safety requirements All of which are committed by the licensee, and in particular the following:

- Submit safety analysis reports for the various establishments and their ongoing operations on the scheduled date before the activity is declared.
- The radiation doses to which workers and the public are exposed, including the doses resulting from cases of emission of radiation into the environment, shall not exceed the dose limits permitted by the systems, standards, rules, and technical requirements issued by the authority.
- Provide a sufficient number of qualified workers to manage the facility through appropriate education and training programs per a continuous plan throughout the work of the facility and take the necessary measures to protect their health and the safety of the public, property, and the environment.
- Taking the necessary measures to ensure the safe and secure construction, operation, and dismantling of the facility.
- Reducing the generation of radioactive wastes resulting from the operation of the facility to the minimum that can be practically achieved for the concerned generation process in terms of both activity and volume and ensuring that effective arrangements are in place for the safe and secure disposal of these wastes.
- Taking the necessary measures to enable the Authority's inspectors to carry out their jobs and to review the relevant documents and records under the licensing conditions.
- Take the necessary measures after the end of the operational life of the facility to ensure its preservation in a safe and stable condition, and to ensure that the radiation emissions are within the limits established in the systems and standards issued by the authority.
- Inform the Authority of his intention to introduce any modifications to the nuclear facility or the nuclear and radiological practices, radiation devices and sources, radioactive materials, places and facilities for which it is licensed, and it is not permissible for him to make these modifications except after obtaining prior authorization from the authority.

It also obligates the licensed legislator to prepare an environmental impact assessment study, including a risk assessment study, provided that it is approved by the Environmental Affairs Agency under the Laws, regulations, standards, rules, and technical requirements issued in this regard.

3.5. Framework proposal for assessing environmental impacts on nuclear activities.

To prepare a general framework for assessing the environmental impacts of nuclear activities, it is necessary to review the stages that a nuclear facility has gone through; That is, the age of the nuclear facility, so that the assessment of the anticipated radiological environmental impact provides inputs into the licensing process for nuclear facilities, for example, nuclear power plants and nuclear fuel reprocessing facilities. Radiation environmental impact with more specific data obtained; the applicant or the organization operating the facility must ensure that updates of the results of the radiological environmental impact assessment are submitted at each stage, for consideration by the regulatory body.

The IAEA Safety Standards Series No. SSG-12 related to the licensing process for nuclear installations is based on a schematic form of the life stages of a nuclear facility, where the radiation environmental impact assessments made before and during the operation of the nuclear facility are very similar, although they are It will respectively include more details and specific data to reduce the level of uncertainty, if applicable, and revise models and assumptions used, when deemed necessary [24].

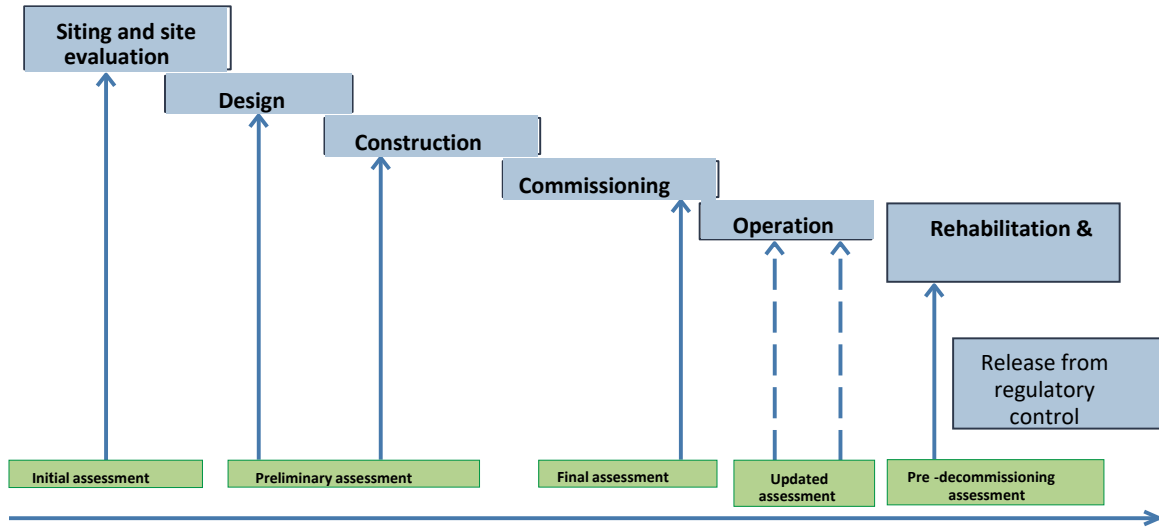


Figure (5): Stages in the lifetime of a nuclear installation when a prospective radiological environmental impact assessment might provide input into the authorization process (adapted from SSG-12 [25])

3.5.1. Objectives of the Environmental Impact Assessment of Nuclear Activities.

Through the environmental impact assessment process of nuclear activities, multiple objectives can be achieved, including [26]:

- Providing the sustainability of the nuclear facility, and ensuring that the development options made are sound, environmentally, socially, and economically sustainable.
- Full knowledge of any potential harmful radiological environmental consequences, taking into account their consideration early in the nuclear project, to make the necessary adjustments and improvements to its design or operation.
- Determine measures to monitor and manage environmental radiative impacts, and identify ways to environmentally improve projects and reduce negative radiative impacts. Ensure the efficient use of environmental resources to achieve sustainable development of the nuclear project.
- Improving the social impact of the nuclear facility, and maximizing the benefit to society from that nuclear facility. Determining, measuring, and minimizing the main radiative effects of the project, through the use of fixed and mobile monitoring devices.
- Informing decision-making officials, and assessing the situation from time to time, so that they can take appropriate decisions on time and before any radiation leak or possibility occurs.
- To prevent, by all means, and methods, any irreversible radiation damage to the environment.

3.5.2. Stages of assessing the environmental impact of nuclear activities.

There are basic stages to which the environmental impact assessment processes of nuclear activities go through, which are [27]:

- **Screening:** At this stage, the nuclear facilities that require an environmental impact assessment study are identified, and a decision is taken to implement the assessment based on national legislation, the nature of the facility, and the sensitivity of the environment.
- **Baseline:** The description of the environment is considered one of the important steps in defining the current situation and includes a comprehensive description of the environment surrounding the project, starting from the natural environment and includes air, water sources, soil, weather conditions ... etc. As well as the vital environment of plants and animals.
- **Scoping:** Scoping is done by identifying potential radiological impacts related to the assessment based on legislative requirements, international agreements, specialized knowledge, and public involvement, then identifying alternative solutions that provide compensation or limit negative impacts on biological diversity. Solutions Find alternative designs or sites, provide guarantees when designing the project, then define the jurisdiction or field of environmental radiative impact assessment.
- **Assessment:** The positive and negative environmental radiative impacts of the proposed project or development are evaluated, and then details of the alternatives are provided.
- **Prediction & Mitigation:** This is done through monitoring the assessment of environmental impacts and by collecting the blueprint and methods of environmental data to meet specific environmental goals and needs.

- **Submitting the report:** Any assessment report or statement of the environmental radiative impact, including the environmental management plan, and a simple and clear summary for the public.
- **Review:** Review the statement of the environmental radiative impact based on public participation, the terms of reference, and the ranges that have been identified.
- **Decision-making:** Deciding on approving or rejecting the project, and determining the conditions included in the approval.
- **Monitoring and verification:** At this stage, it is monitored whether the expected effects and the proposed measures are proceeding according to the environmental management plan, taking into account the verification of the extent of adherence to the plan to address unforeseen impacts and unsuccessful measures on time.

3.5.3. Environmental impact assessments of nuclear activities.

The economic value of any nuclear project is always compared with the damage it produces, which is a very sensitive issue, because the issue of assessing the radiological environmental effects of a highly polluting activity should take into account the economic value of job opportunities and compare it with the value that is given to combat the increase in diseases resulting from that pollution, and this can only be done through a careful procedure and examination of the following [28]:

- Technical, scientific information on the structure and performance of the nuclear facility about the environment.
- Data on the economic and technological advantages of the nuclear project.
- Predicting the behavior of the environment and the interaction between the nuclear project and the environmental elements.
- Technical and administrative procedures related to its operation.
- Participation of the competent population in decision-making.
- A summary and comparison of the cost of the nuclear project, its effects, and its direct and indirect benefits.
- The assessment of environmental radiative impacts should take into account direct or indirect, short or long term, permanent or temporary, individual or cumulative effects.
- The assessment of environmental radiative forcing should take into account the following factors, including their association:
 - Humans, animals, and plants.
 - Soil, water, air, climatic factors, and landscapes.
 - Property and cultural heritage.

3.5.4. Methodologies for assessing the environmental impact of nuclear activities.

The environmental impact assessment process of nuclear activities and the set of studies that will be carried out to develop expectations about environmental radiative effects is directly related to the size of the project and the sensitivity of the area in which it will be established. To be studied.

To get logical ideas when studying these main factors, some methodologies and guidelines must be followed, and although following these methodologies is not necessary for small projects where general logic and good experience in practicing EIA may be sufficient, they are necessary for projects. There are several methods and methodologies available to assess the environmental radiative impact, including [29]:

- **Checklist method.**

The check-lists method or the environmental radiative impact assessment method is widely used in developing countries, while the EIA type method is used in developed countries, and the principle of these two methods is based on defining a reference system or framework. For those in charge of the environmental radiological impact assessment process, so that no important factor is overlooked, and this method is sufficient for small projects, but it does not take into account all the special cases that may be encountered during the environmental radiological impact assessment, and these methods can be combined with environmental guidelines, and provide lists A reference for various nuclear activities.

- **Matrix method.**

The Leopold matrix is the best matrix for assessing the radiative impact of a nuclear project on the environment (Matrix method), and it is a two-dimensional matrix, as it defines the activities associated with the project on one of the axes, which are supposed to have a radiative effect on humans and the environment, such as The production of radioactive elements, gaseous emissions, noise, waste treatment, and others, while the other axis includes the environmental and social conditions that may be affected by the project, as these conditions are divided into three main groups:

- Physical conditions: such as soil, water, and air.

- Biological conditions: such as animals, plants, and ecosystems.
- Social and cultural conditions: such as land use, historical and cultural issues, population, and the economy.

After creating the matrix, the environmental radiative impact assessment provides a precise description of each important factor in it, and attention must be paid to the columns and rows that contain large numerical values, as they illustrate activities or elements that have a significant impact on the environment, and the Leopold Matrix suggests a systematic framework, but it may be imprecise. For some projects, the matrix method can be more efficient if a custom matrix is developed for each project as needed.

- Patel method.

The Battelle Method was designed for the first time for water resources development projects, but it can be easily used to measure the environmental radiative impact of nuclear activities. The principle of this method's work is to divide the environmental radiative effects into four main categories:

- Ecology: includes different types of living organisms, populations, natural habitats, societies, and ecosystems.
- Radioactive pollution: includes water, air, and soil pollution, and noise pollution.
- Aesthetics: includes the nature of the earth, air, water, living things, and the aesthetic of man-made structures.
- Human interest: includes educational, scientific, historical, cultural, and lifestyle fields.

Table 2: The proposal Framework for assessing the radiological environmental impact

Framework steps		Details
1	Classification stage	An introduction to the project, the general objectives of the environmental radiological impact assessment, the assessment methodology, the two stages of classification, the determination of the scope of work, the status quo studies, the working team in charge of the study, and the role of each of them
2	Relevant legislation and laws	It includes the legislative framework for the study of environmental radiological impact assessment, including the Egyptian environmental law and the law regulating nuclear and radiological activities, taking into account all international requirements and legislation, as well as regional and international agreements related to the activities of the project.
3	Description of the proposed project	It mainly presents the project site with its designs, components, and a description of the project phases including a description of the operations in both the construction phase and the operational phase in addition to a description of the facilities and services. This part also includes the project schedule, labor requirements, and proposed implementation plans.
4	Description of the current environment	This includes the assessment of the current situation of the project area and the surrounding area in addition to the comprehensive review of the studies on the project, and it should include radioactivity activities and their impact on the area, field surveys, and surveys of the terrestrial plant and animal environment. This step of the study includes analyzing the climate data in the project area in general, and this step includes recording the coordinates of the sites of the proposed work through the Global Positioning Systems (GPS).
5	Project alternatives	In terms of the presence of more promising places and reserves of nuclear raw materials in more concentrations and quantities, and in terms of ease of establishing and rehabilitating administrative, residential, and service buildings and returning the site to what it was before the operations.
6	Analyzing the expected environmental impact of the project	It includes a detailed classification of the potential positive and negative impacts resulting from the various stages of the proposed project, including the radiological effects of the surrounding environment of the project, as well as the effects of accidental and unusual events (accidents). The main negative impacts identified before applying any mitigation measures are attributed to the impacts on geological areas, and the potential for increased ambient noise. In addition to the effects resulting from accidents such as fire, explosion, and vehicle accidents, the positive effects of the project are expected during the pre-construction, construction, and operation phases. These positive effects are limited to the economic effects mainly as a result of the following activities: purchase/lease of supplies, services, and job

		creation, And subcontracting, and hiring experienced employees during the operating period, in addition to indirect employment.										
7	Description of measures to mitigate the environmental impact	Mitigation measures are required to reduce or reduce negative impacts, and the application of appropriate mitigation measures ensures that there are no cumulative radiative effects of the project. Most of the cumulative impacts resulting from the project are considered minimal or small. However, few medium cumulative impacts will result from impacts on the soil as a result of establishing infrastructure facilities, increased noise levels during project operation, and accidental events such as fire, explosion, and vehicle accidents. Emergency response plans will be implemented in all areas. Accidents for immediate handling of the incident, as all personnel will receive appropriate training to implement emergency response plans.										
8	Radiological Environmental Management Plan	A guiding framework for developing appropriate environmental radiation management practices, ensuring compliance with environmental legislation and IAEA standards, and promoting effective environmental management of the project during various stages.										
9	Environmental monitoring plan	<p>The work of the environmental monitoring plan for the project requires any corrective measures to be taken, whereby the work environment is divided according to the radiation level and the expected dose of handling samples and sources during the measurement time, and the areas are divided into (general area - supervised area - controlled area - restricted area).</p> <p>Monitoring Plan Environmental According to The Radiation Level and the Expected Dose</p> <table border="1"> <thead> <tr> <th>Restricted Area</th> <th>Under Control Area</th> <th>Under Supervision Area</th> <th>Public Area</th> <th>Area</th> </tr> </thead> <tbody> <tr> <td>>10 mSv</td> <td>3-10 mSv</td> <td>0.5- 3 mSv</td> <td>0-0.5 mSv</td> <td>Dosage Limits</td> </tr> </tbody> </table>	Restricted Area	Under Control Area	Under Supervision Area	Public Area	Area	>10 mSv	3-10 mSv	0.5- 3 mSv	0-0.5 mSv	Dosage Limits
Restricted Area	Under Control Area	Under Supervision Area	Public Area	Area								
>10 mSv	3-10 mSv	0.5- 3 mSv	0-0.5 mSv	Dosage Limits								

3.6. Discuss the Article results.

Countries, as well as the IAEA, have been interested in studying the environmental impact assessment of nuclear activities because of their important effects in preserving and protecting individuals, society, and the environment from the harmful effects of those activities and the resulting ionizing radiation, and this has been demonstrated through the development of international agreements, codes of conduct and guidelines that It calls for the necessity to prepare these studies before starting the implementation of any of the nuclear activities, and to be prepared per specific standards, which include clearly and transparently a statement of the potential positive and negative effects resulting from the activity in all its stages, in addition to all necessary measures to reduce or reduce the negative effects. To a minimum, to ensure that there are no cumulative radiative effects of nuclear activity [30].

Desiring Egypt to manage its nuclear program through frameworks and standards to ensure that there are no radiological effects of its nuclear activities; Egypt issued Law No. 7 of 2010 to regulate nuclear and radiological activities, to explicitly require licensees to prepare a detailed study of the environmental impacts of the activities and practices that they carry out per the data and procedures contained in Environmental Law No. 4 of 1994 and to be prepared by qualified and accredited offices to prepare those studies. It also includes not granting licenses for nuclear and radiological facilities unless those studies have been completed and reviewed by the Nuclear and Radiation Supervision Authority entrusted with issuing the license.

We have discussed through the article the extent of the importance of preparing these specialized studies to achieve the desired and targeted sustainable development of those activities that are important and dangerous as well, and the many positive effects that they entail.

Conflict of interest declaration.

The authors declare that they have no known competing financial interests or personal relationships that could appear to influence the work presented in this paper.

4. Conclusions.

Energy has become the common denominator of life in our contemporary world, there is no life without energy, and we cannot imagine achieving development, prosperity, and development without changes in the extent or nature of energy flows, and each change of those changes in energy flows may lead to profound environmental impacts, and we have no choice. Finally, all options are complex and involve trade-offs, but some options and some trade-offs seem categorically better than others in that they provide the greatest amount of development and the least amount of environmental damage, as is the case with clean development mechanisms or what is known as renewable energy.

With the prosperity of nuclear energy and the expansion of its uses, as one of the available development options, its compatibility with the concept of sustainable development in economic, ecological, and social criteria, which represents a real contribution to development for all, has become an urgent requirement. Due to the material impossibility, it entails curbing its proliferation, reaching a final zero or weak inventory of materials and high-level wastes harmful to the environment and future generations, and achieving environmental sustainability.

Through the article, we concluded that this sustainability of nuclear energy can be achieved by preventing or limiting the harmful impact of potential radiation resulting from it, through prior assessment of the potential environmental radiative effects of nuclear activities, both positive and negative, and by making decisions regarding mitigation measures required to reduce negative impacts or Reducing them, so that the application of appropriate mitigation measures ensure that there are no cumulative radiative effects of the facility [31].

We also clarified through the article that the strength and effectiveness of the study related to assessing the environmental impacts of nuclear activities depend on the ability of legislative determinants to set the rules, procedures, and standards necessary for the evaluation process, the effectiveness of the evaluation methodology and re-evaluation from time to time, and the effectiveness of the bodies authorized to enforce those standards, and the bodies Supervision to monitor its proper implementation.

We also clarified through the article that the Egyptian legislature has obligated those authorized to practice nuclear and radiological activities to prepare a study to assess the environmental effects of the activities, per specific standards that ensure the accuracy and safety of their application, and their monitoring by the competent authorities.

Recommendations:


There are many benefits to society through assessing the environmental radiative effects of nuclear activities, the most important of which are:


- **Environmental project planning and design;** A well-designed project can prevent or reduce the risks and potential impact on the environment and people, in this way, the cost associated with the project and remediation overhaul or compensation for losses can be avoided.
- **Ensure compliance with environmental standards;** Compliance with environmental standards prevents or reduces environmental damage and confusion in societies and achieves environmental sustainability.
- **Saving capital and rationalizing expenditures;** Environmental radiative impact assessment can avoid the unforeseen and unnecessary cost of environmental radiative effects.
- **Reducing the time and cost of validating the development application;** All environmental radiative impacts must be appropriately considered before project approval, so the decision-maker should not delay requesting additional information or resorting to environmental radiative impact mitigation measures.
- **Increasing acceptance of the project from the public;** the completion of the project can be accepted through environmental radiological impact assessments openly and transparently while providing opportunities for the public participation of the most directly influential people interested in the project.
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