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Processing of Radioactive Materials to Maintain Ecological Balance in Abu Rusheid, Eastern Desert, Egypt, Under Environmental Management Standards and Legislation

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Abstract

The article aims to study the possibility of protecting nature reserves, Preserving the environmental balance by ridding them of radioactive elements under environmental management standards and legislation to preserve them, and extending protection to include providing in-depth scientific research and activities necessary for its vital maintenance through removing everything that harms it according to the Egyptian law of Protecting natural reserves and Protecting the environment, to determine the possibility of practicing activities related to the treatment of radioactive materials to maintain the environmental balance.

We have reached a conclusion: Carrying out these activities will preserve the biological diversity of the Abu Rusheid area, which is located within Wadi El-Gemal Reserve, in the Eastern Desert, Egypt, and will not prejudice the geological diversity of the reserve by returning things to their places after purification, by returning the rubble, preserving the geological diversity and the engineering features of rockets.

Keywords

Ecological balance, Natural reserves, Processing of radioactive materials, Environmental management systems, biodiversity, geodiversity.

1. Introduction.

The term nature reserves were not common in the sixties of the last century, but with the rotation of the wheel of global industrial development, means of transportation, and the expansion of the use of virgin lands, feeling that the living creatures living in the wilds of a free animal, bird or plant have become threatened by their natural habitats, food sources, or Extensions of their spread and multiplication, and many of them have already begun to decline or extinction, which means a threat not only to rest of species, but to food and energy supply, cycles of oxygen and water formation, disturbance of the balance of natural elements, quality of air and water, and health of human-environment itself, which prompted governments to take strict legal procedures to preserve natural reserves. [1]

A nature reserve is defined as an area of land devoted to preserving nature, conducting scientific research related to it, and protecting (fauna and flora) wildlife from plants and animals, through the application of various means and methods that contributed to making lands rich in wildlife in past, and legislation imposed strict legal protection against Other uses of nature reserves, as visitors are restricted in part or completely. [2]

Natural reserves preserve a wide range of genes that can be used in the future because the needs of the world's population are constantly changing, so scientists and researchers can use

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 4, 2021, Pages. 4115 - 4133
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these genes in hybridization or genetic modification techniques to cultivate new food sources that the world may need, as well as preserving biological diversity in environment, which brings great benefits to humans, as it provides them with many natural services.

Nature reserves also preserve the ecosystem; as healthy biological diversity plays an important role in stabilizing the earth's climate to be suitable for human life, it also contributes to maintaining continuity of the water cycle and thus preserving water resources that people use for several purposes such as drinking and others. Nitrogen, which increases the fertility of agricultural soils, as biodiversity provides many varieties of food for humans, as well as many natural remedies that contribute to improving his health, in addition to raw materials that are used to make products that people need such as paper.

So, natural reserves can achieve all these benefits to humans, it is important to protect these reserves and the cessation of human hands from all that they obtain and from carrying out activities that affect them. [3]

Abu Rusheid area is located in South of the city of Marsa Alam in the Eastern Desert of Egypt, about 50 km from the entrance of Wadi El-Gemal to the west, and Wadi El-Gemal Reserve (protectorate) - Hamata, which surface area of 7,450 square kilometers, was declared a desert reserve (protectorate) according to Prime Minister Decree No. 143/ 2003 under Law No. 102 of 1983 related to natural reserves.

Abu Rusheid area, which is located in Wadi El-Gemal Reserve (protectorate), is considered one of the promising areas, as it is rich in many economic materials needed for nuclear industries and others, which are divided into three sections:

- Nuclear fuel materials: These include uranium and thorium ores.
- Accompanying nuclear elements: These include ores zirconium, niobium, and gallium.
- Materials used as coolants, sedatives, and control rods in nuclear reactors: These include boron (the main component of tourmaline), beryllium (the main component of beryl), and tantalum.

Processing of radioactive materials in the Abu Rusheid area requires research, exploration, prospecting, dissolution, and extraction of nuclear ores and their accompanying elements, through using drilling devices and equipment to construct some trenches and subsurface wells to trace those nuclear raw materials and their accompanying elements to the depths, and construction of concrete terraces and units for processing, melting and extracting these materials and possibility of separating and exploiting them to purify geological environment from it, and then preserving the ecological balance in Abu Rusheid area located inside Wadi El-Gemal Reserve (protectorate), as requires to return of rubble left by the dissolution, separation and extraction processes to their natural places to preserve geological diversity of the area.

These activities are consistent with the nature and classification of the reserve, and it has safety and security factors against various hazards and does not expose the area to pollution or destruction, and the areas of activities and subsequent buildings in the less sensitive areas of the reserve must be consistent with the nature and topography of the reserve, and take into account the weather and water conditions and the geology of the protected area, all under the conditions, rules, and procedures for activities in natural reserve areas.

Egyptian legislature added its protection to natural reserves according to Law No. 102 of 1982 Concerning natural reserves, which defined a nature reserve in Article (1) as: “In the application of the provisions of this law, a natural reserve is defined as any area of land or

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 4, 2021, Pages. 4115 - 4133
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coastal or inland waters characterized by flora, fauna and natural features having culture, scientific, touristic or aesthetic value. These areas will be designated and delineated by decree of the Prime Minister upon the recommendation of the Egyptian Environmental Affairs Agency" [4].

So; this research relates to the extent of benefiting of processing radioactive materials that are abundant in the Abu Rusheid area located in Wadi El-Gemal Reserve to purify and maintain the reserve and maintain the environmental balance in it by preserving the terrestrial and marine animals and plants from pollutants resulting from harmful radiation. [5]

Consequently, the topic of the research seeks to identify the mechanism of action for processing radioactive materials in the Abu Rusheid area, and the conditions and controls necessary for doing this activity in a way that achieves the biological balance of organisms in the area and does not affect the geological diversity that characterizes the area.

This research aims to create a model for regulating of processing radioactive materials in the Abu Rusheid area of Wadi El-Gemal reserve, Eastern Desert, Egypt.

2. Research methods

To achieve this goal, scientific publications were analyzed on means of preserving the ecological balance in nature reserves in terms of their types and the legislation that would ensure their achievement, and two proposed models were prepared, one for the environmental management system (EMS) and the other for legislation, to be followed during the extraction and extraction of radioactive elements and their accompanying elements, and purification of the Abu Rusheid area from those elements harmful to animals and plants land and sea.

Among the methods used in preparing the two models were the complete description of activities and preparation of complete regulates to be followed during construction and management in all its stages.

3. Results of research and discussion

Egypt has been concerned with protecting the divine wealth present in natural reserves of natural resources and biodiversity, and what follows that in preserving the ecological balance that is negatively affected by human activity and the pollutants that it leaves behind, and this interest was evidenced by Egypt's accession to many international and regional agreements, and the issuance of Law No. 182/1983 concerning natural reserves, and the issuance of many decisions regulating dealing with nature reserves.

3.1. Legal protection of nature reserves in Egypt.

The legal protection of nature reserves in Egypt varied according to the different sections of public and private law, as well as the protection within the framework of public law. There are many branches of protection between international law, represented in international and regional agreements and treaties that Egypt has acceded to, and between the provisions of administrative and criminal law. At the level of international law; Egypt has acceded too many international and regional agreements that seek to preserve and protect natural life in natural reserves, and we have prepared a list of the most important of those conventions that Egypt has joined.

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 4, 2021, Pages. 4115 - 4133
Received 05 March 2021; Accepted 01 April 2021.

Table (1): *shows List of the most important international and regional agreements related to protecting nature reserves, which Egypt has joined) (prepared by the authors)*

Title of the agreement	The Aim	Into Effect	Egypt Joined
The Convention for the Preservation of Animals and Plants in their Natural Condition	Preserving animals and plants in certain parts of the world, especially Africa	8/11/1933	14/1/1936
International convention regulating whaling	Protect all kinds of whales from hunting And the preservative of major natural resources	10/11/1984	18/9/1981
International Plant Protection Convention	Control of pests and diseases of plants and plant products and preventing the introduction and spread of these pests and diseases across borders	3/4/1952	31/8/1978
Ramsar Agreement	Stopping steady wetland encroachment	21/12/1948	25/12/1986
The Convention Concerning the Protection of the World Cultural and Natural Heritage	Establishing a system to protect the cultural and natural heritage of outstanding global value	17/12/1985	17/2/1975
Convention on International Trade in Endangered Species of Animals and Plants (CITES)	Protecting certain endangered species from overexploitation	1/7/1975	4/4/1978
Convention on Biological Diversity	Developing and maintaining systems to sustain life in the biosphere	5/6/1992	00/00/1992
United Nations Convention on Law of the Sea	Establishing a comprehensive legal system for the seas and oceans	10/12/1982	10/12/1982
Regional Agreement for the Protection of the Environment of the Red Sea and the Gulf of Aden	Ensure human use of living and non-living marine and coastal resources	20/8/1985	20/8/1990
Convention for the Protection of the Mediterranean Sea from Pollution	Creating a coordinated and comprehensive system to protect and improve the marine environment	12/2/1978	23/9/1978
African Convention on the Conservation of Nature and Natural Resources	Encouraging action to conserve, use and develop soil, water, plant, and animal materials for human well-being	16/6/1969	12/5/1972

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 4, 2021, Pages. 4115 - 4133
Received 05 March 2021; Accepted 01 April 2021.

Concerning constitutional protection; The Egyptian constitution promulgated in 2014 required the state to protect property in all its types and forms, divided it into public property, private property, and cooperative property, and established a sanctity for the public property cannot be inviolate, and imposed its protection under the law as it is a support for the nation's strength and a source of the people's well-being, Article (33) stipulates: “The state protects the property in all of its three types, public property, private property, and cooperative property.” Article (34) stipulates: “Public property is inviolable, and it is not permissible to violate it, and its protection is a duty according to the law.”

The legislature also obligated the state to protect natural reserves, Article (45) the Egyptian constitution stipulates: “The state is obligated to protect its seas, beaches, lakes, waterways, and natural reserves. It is prohibited to encroach on them, pollute them, or use them in contradiction with their nature, and the right of every citizen to enjoy them is guaranteed, the state also guarantees protection and development of urban green space, preservation of plant, animal, and fish wealth, the protection of those exposed to extinction or danger, and animal welfare, all in the manner organized by law” [6].

In Egypt's vision 2030, the fifth goal of the vision has been defined under the title “(Environmental sustainability: an integrated and sustainable ecosystem), stipulates: “We seek to preserve development and the environment together through the rational use of resources in a manner for reserves the rights of future generations in a more secure, efficient and fulfilled future. This is done by facing the effects of climate change, enhancing the resilience of ecosystems, the ability to face natural risks and disasters, increasing reliance on renewable energy, and adopting sustainable consumption and production patterns”[7].

In terms of legal protection, Article (2) of Law No. 182 of 1983 concerning natural reserves stipulates: “It is prohibited to carry out works, actions, activities or procedures that would be ravaged, destroy or degrade the natural environment, or harm wild or marine life or It is forbidden to erect buildings or facilities ……. It is prohibited to build roads, drive vehicles, or engage in any agricultural, industrial or commercial activities in the reserve area, except with permission from the competent administrative authority under the terms, rules, and procedures specified by decree the prime minister."

Also Law No. 4 of 1994 regarding the environment established the Environmental Affairs Agency and assigned it to specific specializations specified by Article (5), which stipulated: “The Environmental Affairs Agency shall formulate the general policy and prepare the necessary plans to preserve and develop the environment and follow up its implementation in coordination with the authorities. The agency shall be the national authority responsible for supporting environmental relations between the Arab Republic of Egypt and the countries and international and regional organizations. The agency recommends taking the necessary legal measures to join international and regional agreements related to the environment and prepares draft laws and decisions necessary to implement these agreements…" [8].

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 4, 2021, Pages. 4115 - 4133
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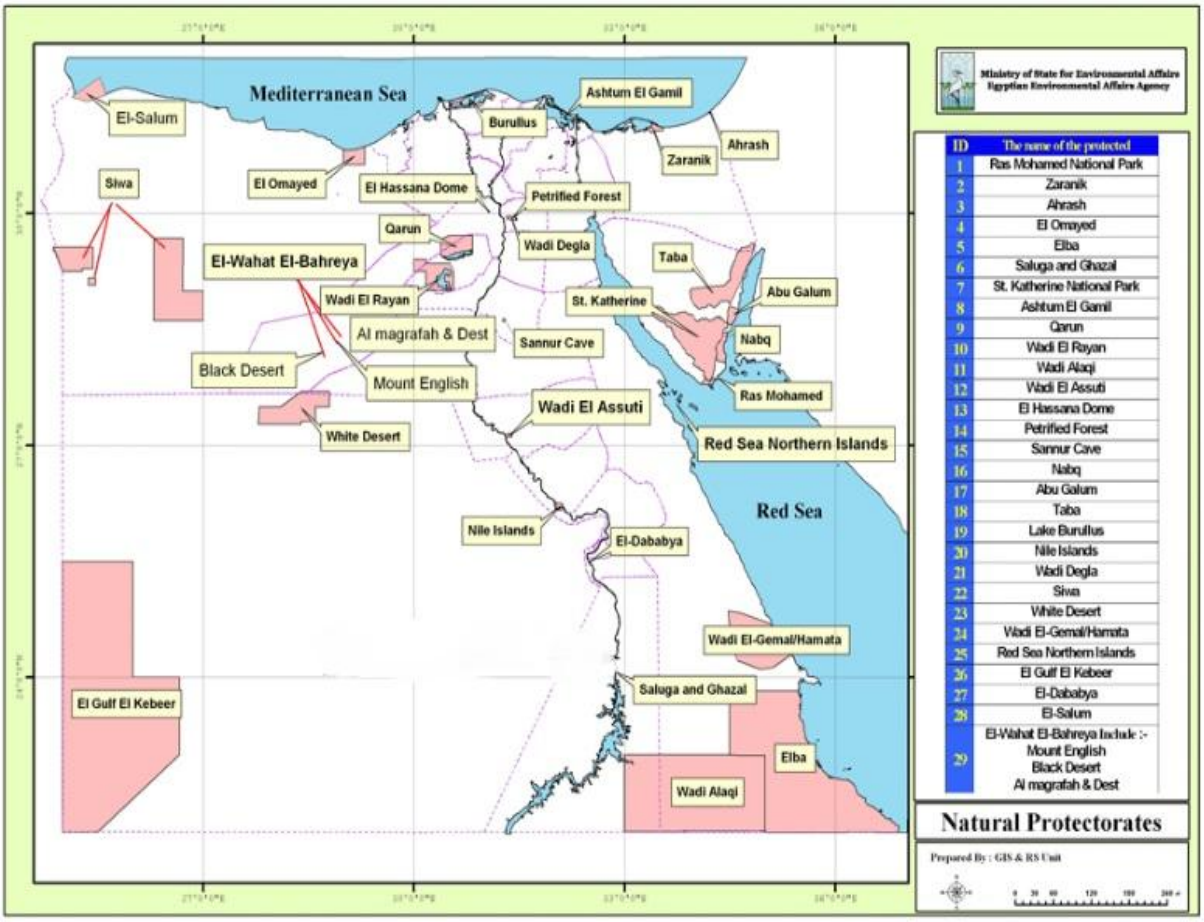

Fig. 1: *Shows Egypt's natural reserves and their locations (adapted from http://www.eeaa.gov.eg)*

3.2. The activities authorized to be carried out in the nature reserves and the conditions for their practice.

In-Law No. 182 of 1983 concerning natural reserves, the legislator assigned the prime minister the task of defining natural reserves, and in the second article, it specified the actions, works, activities, or procedures that are prohibited to carry out in the nature reserve, as well as specifying the competent administrative authority for which the authorization to conduct activities is held or carrying out actions, behaviors, or procedures that are not prohibited in the nature reserve, under the conditions, rules, and procedures that are specified by a decision issued by the Prime Minister, and the authorization to carry out any activities, actions, actions, or experiences in the surrounding areas that are specified by a decision issued by the Minister The concerned person based on the proposal of the Environmental Affairs Agency, if it would affect the protected environment or natural phenomena therein.

Article (1) of the Prime Minister's Decree No. 264 of 1994 and amended by decree No. 2728 of 2015 stipulated the conditions, rules, and procedures for practicing activities in the natural reserves areas, stating that: "It is not permissible to erect buildings or facilities, build roads, drive vehicles, or doing any Agricultural, industrial or commercial activities in the area of the natural reserve, except with a permit from the Environmental Affairs Agency, under the following terms and conditions: [9].

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 4, 2021, Pages. 4115 - 4133
Received 05 March 2021; Accepted 01 April 2021.

1- The construction of buildings or installations or the construction of roads shall be in favor of developing the reserve, and that the permitted activity shall not harm the nature of the area, the wild or marine life, or the vegetation, or the aesthetic value of the reserve.
2- The activities authorized to be practiced are consistent with the type and classification of the reserve, and that safety and security factors are available against various risks, and that they do not expose the area to pollution or destruction, in the manner determined by the Environmental Affairs Agency.
3- The areas of the authorized activities inside the reserve and the buildings and constructions that follow in the less sensitive areas of the reserve should be consistent with the nature and topography of the reserve and under its management plan and its zoning map approved by the board of directors of the Environmental Affairs Agency.
4- To take into consideration the weather, water, and geological conditions of the protected areas.
5- The movement of vehicles shall be restricted within the protected area by walking in the specified movement axes.
6- To follow the provisions of the legislation related to environmental protection.

Accordingly, the activities authorized to be practiced in the interest of developing the reserve can be carried out, provided that these activities are consistent with the nature and classification of the reserve, and that safety and security factors are available against various risks, and that they do not expose the area to pollution or destruction.

3.3. Processing of radioactive elements and their effects on (fauna) wild, marine, and (flora) plant life in the Abu Rusheid area.

Nuclear Materials Authority, Egypt was established as a scientific research Authority by Presidential Decree No. 196/1977 with the aim of the research, detection, and exploration of nuclear raw materials, their exploitation, manufacture, and regulation of their circulation, and the activity of the authority extends to all regions rich in nuclear raw materials in all parts of Egypt. [10]

Studies have shown that the nuclear raw materials naturally present on Earth contain radioactive isotopes that have a long half-life that remain stable for long periods, and upon their decomposition, they form so-called radionuclides, such as the decay of isotopes of thorium-232, uranium-238, and uranium. -235, to produce secondary radionuclides of radium and polonium, all of which are highly radioactive elements. [11]

Studies have also shown that radioactive elements have harmful effects on wild, marine, and plant life. They may affect the genetic mutations of the animal, which leads to damage to the DNA strands, which leads to the genetic division over time. The degree of the genetic mutation that leads to changes in the composition of the DNA varies due to the level of radiation they were exposed to and the type of exposure, if the animal exposed to it a lot of radiation from the atmosphere or the water used at that time, it is possible that their body has already absorbed the radiation, once it enters the body it remains active because the energy cannot be destroyed. [12]

Radiation may sterilize the soil; As long as the radiation is present in the atmosphere, this means that it is present in the soil, as the radioactive materials in the soil interact with the various nutrients, which leads to the destruction of those nutrients, making the soil sterile and of high toxicity for consumption by humans and animals.

Radiation may destroy cells; radioactive contamination has a variety of effects on changing cells, so Radiation distorts existing cells, which leads to permanent damage to various organ systems.

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 4, 2021, Pages. 4115 - 4133
Received 05 March 2021; Accepted 01 April 2021.

Radiation affects wildlife; Herbivores such as cattle when grazing contaminated land accumulate large amounts of radiation on the tissues of animals, so these radionuclides enter their metabolic cycles and affect their DNA, and this ends up having a mutated animal generation with a higher risk of health problems through a small number of radionuclides.

Radiation may affect plants, as their exposure to radiation leads to damage mostly due to increased ultraviolet waves, as different plants are affected differently, as the stomata stop evaporating during the increase in radiation and when the radiation hits the chromosomes, reproduction is hindered as it results in changing shapes, sizes and health in plants, as well as Exposure in large quantities, destroys the affected plants and when we eat these plants we eat nuclides.

Radiation may affect marine life as these radionuclides can be detected in the soft tissues or on the bones of fish, and the seaweed used in bread contains radioactive isotopes of ruthenium, and the shells of all peeled fish and fish tissues are contaminated with radionuclides.

Hence the importance of processing radioactive elements present in the Abu Rusheid area to rid the nature reserve of its harmful effects, and to benefit from the extraction and extraction of products from the nuclear elements in the Egyptian nuclear program, and the accompanying elements in many industries.

3.4. Environmental management system (EMS) model for processing radioactive materials

Processing radioactive materials requires carrying out many arrangements and procedures inside the Abu Rusheid area, such as the entry of equipment, excavators, crushers, transport, and transmission cars, the entry of individuals, geologists, engineers, technicians, and workers to carry out mineral extraction operations from rocks, and the extraction of radioactive materials through melting ponds that are constructed for this purpose.[13]

3.4.1. Means of maintaining the ecological balance during processing radioactive materials

- **The processes of extracting radioactive materials are as follows:**

- Drilling operations are carried out using a small driller (Baby Loader) in places where it is required.
- Rock crushing operations are carried out using a small crusher (Baby Crusher) to disengage and release minerals and separate them from rotten minerals and sterile rock components.
- Rock grinding operations are carried out with simple grinding tools to reach the granular size of the minerals so that the treatment and purification of radioactive minerals can be carried out.
- Rock sifting operations are carried out after grinding through simple screening tools.

- **The processes of releasing radioactive materials are as follows:**

- Putting raw materials, after crushing them to certain sizes, inside ore melting basins.
- Dissolving Minerals in the ores using sulfuric acid after dilution with water to certain concentrations.
- Receiving the solutions carrying radioactive materials in special tanks and pumped to the extraction unit.
- Releasing radioactive materials from impurities using ion exchange resins inside the separation columns.

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 4, 2021, Pages. 4115 - 4133
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- Removing radioactive materials from the resins using table salt.
- The settling process takes place and then pressure inside the filter to obtain the yellow-cake, the final product.
  - **<u>Processing radioactive materials take place in basins that are constructed as follows:</u>**
- Construction of Processing's basins on the fringes of the area and far from plants and animals.
- Construction of Processing's basins from impermeable materials that do not allow permeability and prevent the materials from leaking into the groundwater.
- Air filters are installed on Processing's basins to absorb any fumes that may mix with the air.
- Waste resulting from Processing was obtained and managed in preparation for its safe disposal [14] (Fig. 2).

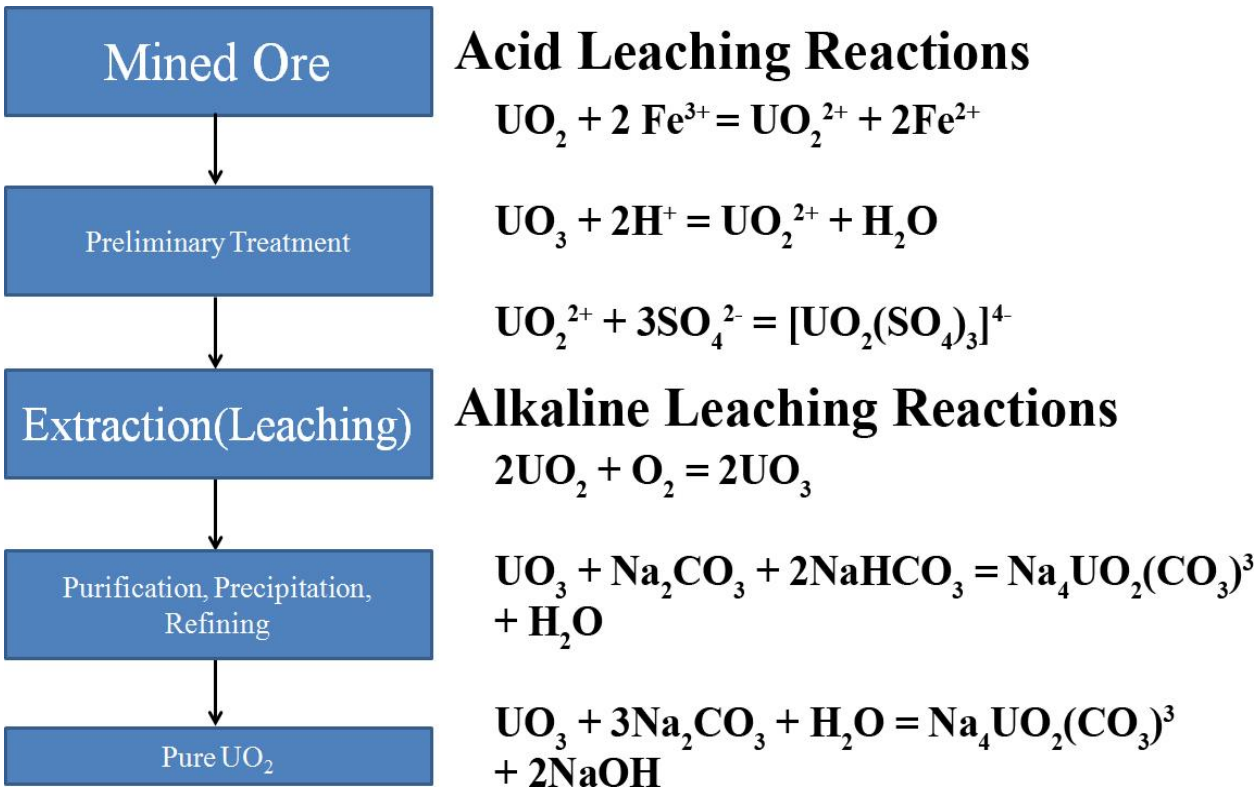

Fig. 2: *Process scheme for uranium mining and processing to produce useable uranium product, including chemical equations for acid and alkaline leaching process.* *(adapted from [14])*

3.4.2. Means of maintaining ecological balance during construction and operation phases using Environmental Management Systems (EMS) [15]

- **<u>Logistics Management.</u>**
- Reducing excessive loads on the road network, traffic, and problems resulting from the operation.

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 4, 2021, Pages. 4115 - 4133
Received 05 March 2021; Accepted 01 April 2021.

- Adopting a tight traffic plan to cover all traffic logistics and arrangements during the operational phase.
- Implementing safe driving procedures that require compliance with local traffic laws, in addition to determining vehicle speeds, ways to confront traffic hazards, available trip times, using mobile phones or communication devices while driving, etc.
- Collisions and traffic accidents of vehicles are reduced.
- Conducting training courses for drivers in topics of safe driving and developing driver's capabilities.
- Putting appropriate traffic signs to alert drivers and other road users on all roads and paths leading to the project site, which indicates the risks that road users may be exposed to.
- Availability of first aid and safety equipment for vehicles.
- Immediate cleaning and disinfection of areas where road spills or leaks may occur.

- **Air monitoring.**

- Minimizing the environmental impacts expected during project operation on the air quality in the area.
- Ensuring that the percentage of environmental impacts do not exceed the gases and dust emitted from vehicle exhausts used by visitors.
- Ensuring that the impact on air quality in the project area is very slight.

- **Groundwater monitoring.**

- Regular maintenance and checking the places where sewage and water are stored within the project.
- Establishing a schedule for the regular withdrawal of the disbursement and the periodic maintenance.
- Determining the quantities of water in toilets by introducing water consumption regulators in all health facilities, which reduces water consumption.
- Using water use sensors and water tank discs contribute to reducing water consumption to at least 40%.
- The natural and biological variables of water quality for human use, accommodation, and drinking are monitored periodically.
- The water that is transported to the site is tested in every shipment (during the construction phase) or daily (during the operation phase).
- Salinity, pH, dissolved oxygen, and turbidity are detected using a portable water quality measuring instrument.
- Monthly or quarterly basis, samples of water are collected and sent to an independent laboratory for analyzing minerals and bacteria.
- The water quality standards for human use and drinking water specified by the Egyptian Ministry of Health and the World Health Organization are applied.
- A regular biological quality test is performed.
- Chlorine is measured in drinking water tanks to ensure the correct percentage. After a holding period of at least 30 minutes, the reading rates using the test instrument should reach 0.2-0.5 mg of chlorine per liter of water at a faucet installed in the tank. If the ratio reaches less than 0.2 mg / l, this means a failure in the purification process.
- All records and documents are kept in the environmental register of the project.

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 4, 2021, Pages. 4115 - 4133
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- **Soil monitoring.**

- Management and control methods are weighted to reduce negative impacts on soils.
- Hazardous materials causing pollution are stored and managed according to best environmental practices to avoid spills or leaks.
- A spill response plan will be activated at the project site.
- Issuing an integrated waste management plan that emphasizes safe storage and periodic processing of waste, or good handling for safe disposal of waste. Waste should be managed and safely disposed of according to the waste management plan.
- Follow a policy of recycling all solid waste whenever possible. [16]

- **Noise Monitoring.**

- Employees are required to stop any disturbing activities for long periods.
- Putting up indicative panels to show the impact of noise.
- Not carrying out any maintenance or repair during the night.
- Switch off equipment when not in use.
- Providing appropriate personal protection tasks that reduce the impact of noise for workers who require their presence in the workplace with a loud noise.

- **Waste management.**

- The waste generated from the project is dealt with according to a waste management plan, in which a list of solid waste generated by the activities is listed, with an explanation of the management procedure and the places for their disposal.
- The solid waste generated from operations is classified as non-hazardous, and hazardous.
- The amount of waste is reduced.
- Prioritize long-term materials; avoid using bottles that cannot be reused. Avoid canned drinks and choose low-packaging products.
- All waste is collected in a special area of the site, and then it will be transferred to the sanitary landfill.
- All employees are encouraged to adopt a policy of separating waste from the source and collecting recyclable waste.
- Reducing the use of disposable items such as paper napkins, paper cups, and plastic tools. [17]

- **Solid waste management**

- Waste is dealt with according to a waste management plan.
- All wastes are classified according to whether or not they are hazardous.
- A sufficient number of containers are placed in all places that generate waste.
- All the waste stored at the site, except for the inert material waste, is placed in sealed containers in good condition and suitable for the type of waste they contain.
- All waste containers are classified in a way that contributes to the safe and appropriate handling of each type of waste.
- Waste classification requirements are chosen to be consistent with the agreed project procedures.
- Maintaining that the waste containers are always closed, except in the case of adding or removing waste from them.

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 4, 2021, Pages. 4115 - 4133
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- Avoid mixing different types of waste by placing them in the same container if mixing leads to complicating disposal/recycling or if the waste is incompatible together.
- Open containers are used from the top with a lid or ring to seal in the case of solid wastes that do not contain any liquids.
- Hazardous waste is kept in its original packaging, if possible, or a container specially designed for this purpose.
- Hazardous waste is stored in closed places or buildings designated for this purpose. Access to these places is controlled or stored inside the site in a gated storage space or through any properly secured building or any suitable device.
- Waste containers are protected from weather conditions (rain and wind) as much as possible to maintain the integrity of the waste containers as well as reduce the chance of spills.
- Documents that document the fate of the waste that will be disposed of outside the site are kept.

- **<u>Waste management policies and principles</u>**

- Avoid or minimize waste generation.
- Dispose of any waste that cannot be avoided or disposed of in an environmentally responsible manner.
- Avoid generating waste whenever possible.
- Trying to reduce waste to a minimum if it is generated.
- Reuse of waste generated, recycled, or recovered to the maximum extent possible.
- Processing should not be considered until after the options for recovery and recycling have been exhausted.
- Waste disposal, as a final option, should be restricted to a specific and well-managed area.[18]

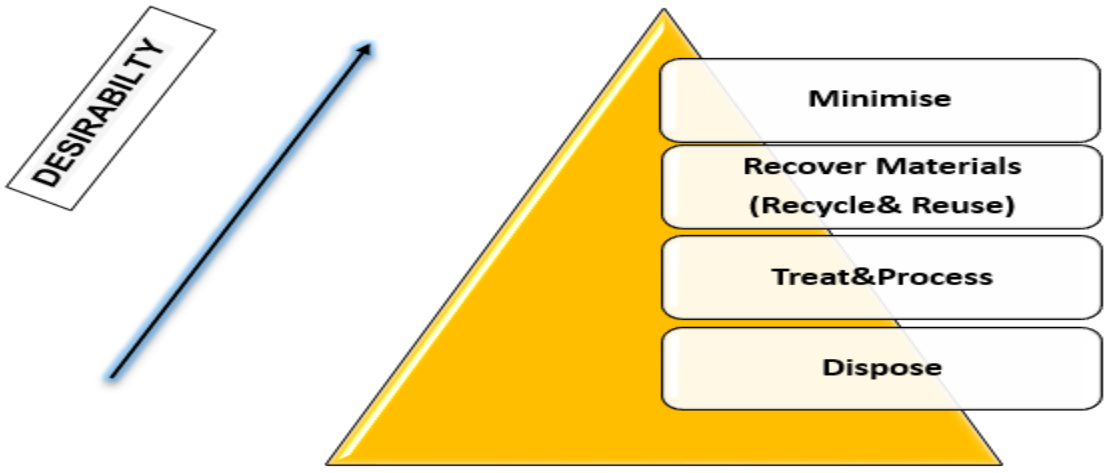

Fig. 3: *shows Waste management in the reserve (prepared by the authors)*

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 4, 2021, Pages. 4115 - 4133
Received 05 March 2021; Accepted 01 April 2021.

- **Requirements for the waste management system**

- The individuals and project management are responsible for the generated waste.
- Implement waste minimization practices to the minimum whenever possible (source reduction, reuse, recycling, recovery).
- Evacuating garbage from trucks, and placing all garbage in metal or plastic containers for storage before transporting and disposal.
- Primary separation of waste (such as sorting metals, chemicals, kitchen waste, and paper) helps in its recovery and proper disposal.
- Dispose of only waste that is not suitable for recycling in a licensed sanitary landfill.
- If the hazardous waste is not removed, the waste is kept safely and monitored to ensure that it does not destroy the environment now or in the future.

- **Waste handling**

- Personal protective equipment and tools are provided to individuals handling waste, whether hazardous or non-hazardous, and include clothing, goggles/masks, gloves, dust masks, long shoes with steel toes, and hard hats (helmets).
- The use of safety gloves, rubber gloves, and masks of organic materials when handling hazardous waste.

3.4.3. Measures to mitigate non-periodic accidents during operation.

- **Preparing the emergency response plan.**

- The following general management methods and control procedures are weighted to reduce the effects of accidents and non-periodic symptoms during the various phases of the project.
- The emergency response plan is monitored and updated from all occasional or non-periodic events (such as fires, explosions, and leaks), making sure that it is present and available to everyone on the site.
- Staff are trained on the emergency response plan and know how to deal with related emergencies during the occurrence of those emergencies or accidents.
- Contact and coordinate with the relevant authorities and neighboring companies in cases of fires and explosions.
- The operational systems are provided with two levels of stop and shutdown systems, depending on the incoming emergency: Process Stop System (PSD) and Emergency stop system (ESD). [19]
- The necessity of sounding the emergency warning sirens to inform workers of the occurrence of an emergency, to allow them to take the necessary precautions. The alarm system includes Fire, Emissions, and Leaks.

- **The air**

- Alarm sirens are triggered at the time of fires and explosions, as well as the presence of an emergency response plan at the project site.
- Procedures that include continuous inspection and follow-up, as well as periodic maintenance, are implemented to avoid accidental emissions.

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 4, 2021, Pages. 4115 - 4133
Received 05 March 2021; Accepted 01 April 2021.

- **The groundwater**

- Measures introduced during these phases are adopted to reduce the effects of leaks and spills.
- A waste management plan is in place that emphasizes safe storage, timely handling, and/or waste removal.
- Waste is well managed and the waste should be disposed of according to the safe disposal methods used in the waste management plan.
- Liquid wastes resulting from the project's operations are handled under the best available procedures.
- Liquid wastes, which are confined to the sewage, are directed to the sewage plant and the liquid wastes (the solutions produced after the uranium absorption process on the resins), and these solutions are reused again in the processes of dissolving uranium from raw materials after adding sulfuric acid to them.
- Methods are followed to reduce and mitigate these effects on groundwater.
- Carry out appropriate maintenance and integrated site management during the operational phase to ensure that spillage and leakage risks are minimal.
- Preparing and implementing a system for reviewing and reporting the status of structures and valves and their being sound on-site, and immediate reporting of their condition while allowing rapid visualization in case of necessity.
- Issuing an integrated waste management plan that emphasizes safe storage and periodic handling of waste or good handling for safe disposal of waste; where good management and safe disposal of waste must take place.
- Activating the spill response plan, as well as making the necessary equipment available to cope with spills at the project site. [20]

- **The soil**

- All areas that will be used to store any polluting materials shall be provided with secondary spaces to collect accidental spills.
- Vehicles are maintained to avoid spills and leaks of fuel, oils, and grease.
- Preparing several methods and procedures for controlling operations, maintenance, and response plan to spills.
- Filtration is being controlled with BPAs should they occur.
- Developing spill contingency plans and spill response plans.
- Availability of emergency response equipment and the constant presence of trained personnel on-site.
- Preparing a waste management plan that emphasizes safe storage, timely treatment, or the safe removal and disposal of waste

3.4.4. Means of maintaining the ecological balance after processing using Environmental Management Systems (EMS) [21]

Things are returned to their original pre-treatment procedures, as much effort as possible, so that it appears as if nothing of the treatment has been done, to preserve the geological diversity of the area.

- **People, materials, and supplies**

- Go out individuals and all their belongings from the site in a safe manner.
- Take out all materials and supplies that were used from the site in a safe manner

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 4, 2021, Pages. 4115 - 4133
Received 05 March 2021; Accepted 01 April 2021.

- **Vehicles, equipment, and machines**

- Moving all vehicles, equipment, and machines through safe traffic routes.
- No noise during movement is avoided.

- **Constructions**

- Safely remove all constructed facilities. Safely move all demolished or dismantled facilities.
- Avoid any noise during demolition, disassembly, or transport

- **Rocky aggregates**

- Collecting rock aggregates resulting from treatment processes
- Rock aggregate classification
- Return the rocky aggregate to the places from which it is obtained.
- Arranging the rubble as it was before it was obtained.

3.5. Model legislative rules for processing radioactive materials

- Obligation the terms and conditions stipulated in Law No. 4 of 1994 and amended by Law No. 9 of 2009 regarding protecting the environment, Law No. 102 of 1983 regarding natural reserves, and the Prime Minister's Decree No. 264 of 1994 amended by Decision No. 2728 of 2015 concerning conditions And the rules and procedures for practicing activities in natural protected areas.
- Obligation the above-mentioned coordinates and not to carry out other new work outside the specified range.
- Obligation the instructions of the representatives of the Environmental Affairs Agency regarding the exploitation of the licensed area and in the licensed activity, and the implementation of their instructions.
- Obligation to carry out the licensed activity only, not to amend it, and not to assign or delegate others to that permit or part of it in any way.
- Obligation not to use firecrackers inside the reserve, and the work is to use equipment only.
- Obligation to dispose of solid and liquid wastes resulting from activity far from the protected area by safe methods and under laws and regulations.
- Obligation not to drain harmful liquids, chemicals, oils, or wastes into the protected area.
- C Obligation to preserving plants, wildlife, and creatures in the area and not to disturb, hunt, or trade-in them.
- Obligation to the maximum limits for air pollutants and noise under Law No. 4/1994 regarding the protection of the environment.
- Obligation to collect and transport the treatment wastes to safe and specific storage sites and backfill them with sediments from the same site and not dispose of them within the scope of the nature reserve.
- Obligation to settle the site to the nearest situation it was in before treatment, after the completion of the treatment.
- Obligation to maintaining the geological balance of the reserve.

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 4, 2021, Pages. 4115 - 4133
Received 05 March 2021; Accepted 01 April 2021.

- Obligation to the approval of the Ministry of Water Resources and Irrigation to drill the necessary underground well, to use groundwater as a source of water in the project, and to the safe withdrawal rate from it.
- Obligation to prepare the environmental register and make it available upon environmental inspection. [22]

4. Discuss the research results

Countries have been concerned with the ecological balance of natural reserves, by setting up legislation to protect them and criminalizing attacks on them or not following the rules related to dealing with them. [23]

Consistent with what is prevalent between countries; Egypt has issued many legislations that regulate dealing with natural reserves, and it has prohibited all activities that affect the marine and terrestrial environment of plants, animals, and wildlife in natural reserves. However, these legislations have permitted the conduct of scientific research and activities that preserve those natural reserves and work to maintain, develop and develop them.

To protect the Abu Rashid area located in Wadi El-Gemal Reserve, Egypt from the harmful effects of the radioactive sources, even the high radiation present in them, we have prepared a model through which the radioactive materials can be processed in the Abu Rusheid area and purified from harmful radioactive materials to maintain the biological balance in it, and obtain those Important and necessary radioactive materials for use in the Egyptian nuclear program, as well as the accompanying economic materials and their use in many industries and their development, without prejudice to the geological diversity of the region.[24]

5. Conclusions

- Radioactive sources greatly affect the biological balance in the Abu Rusheid area, as they may lead to harmful effects on wild, marine, and plant life.[25]
- It is possible to maintain the Abu Rusheid area and purify it from radioactive sources by processing those sources, extracting and releasing strategic nuclear elements, and extracting and releasing elements associated with them that are used in several industries.
- The activities related to processing radioactive sources can be practiced through strict rules that prevent harm to the Abu Rusheid area or the plants or animals or the terrestrial and marine environment of the area, as they are consistent with the nature and classification of the reserve, and have safety and security factors against various hazards. The area is not polluted or destroyed, and it also reserves the geological diversity of the region by returning the rubble left by the dissolution, separation, and extraction processes to their natural places. [26]
- Processing radioactive materials in the Abu Rusheid area is under Egyptian legislation, as it aims to preserve the area, raise its efficiency, and preserve its biological diversity.

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.

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