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Annals of Biological Research, 2013, 4 (1):22-28
(http://scholarsresearchlibrary.com/archive.html)

Annals of Biological Research
Scholars Research Library
ISSN 0976-1233
CODEN (USA): ABRNBW

The Role of International Environmental Laws and Regulations in Peaceful Use of Nuclear Energy

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ABSTRACT

Presence of environmental concerns, insufficient confidence regarding fossil fuels and the need for variety of resources are among important issues, which make consideration of modern technology such as nuclear energy inevitable. The overall aim of this study is to examine the peaceful use of nuclear energy based on international environmental law. Considering the ever-growing capabilities of nuclear energy, and legal and environmental problems in developing this technology, the need for this study seems obvious. This research is an applied, descriptive study based on questionnaire survey. The statistical population of the current study is authoritative researchers and students in the field of environmental and nuclear law in the doctorate level. Twenty-nine individuals were selected and studied by means of random sampling. The dependent variable of the study was peaceful use of nuclear energy. Findings showed that the current situation of international laws and regulations in peaceful usage of nuclear energy is unsuitable, therefore preventive, deterrent, and controlling laws and regulations must be considered. Factor Analysis showed that safety, responsibility, waste, environment, and cooperation among the most important considered points in international environmental laws and regulations in peaceful use of nuclear energy, in total were able to explain 79.14 % of the variance. In fact, creating obligatory legal procedures, and supporting a system of international cooperation regarding execution and planning, and accurate supervision on functions related to environmental and nuclear energy laws with sufficient supportive facilities seem essential.

Keywords: International Law, Environment, Nuclear Energy, International Responsibility,Nuclear Safety.

INTRODUCTION

Today, most of the world countries have realized the role and importance of different energy sources in supplying needs of the present and the future, and have engaged in investments and extensive research on policy making and devising strategies and infrastructural plans in this regard. At present, documenting a strategy consisting assessment of all effective parameters in energy, and determining suitable solutions for improvement and better efficiency of energy and optimal usage patterns are in the foremost position of the infrastructural programs of the majority of the world nations [1]. Among different energy carriers, nuclear energy has a special position, and today, many nuclear power plants are active in different parts of the world [2]. Considering that continuous operation of nuclear sites and protection of existing natural resources requires a series of global principles and standards, and this importance will be assured by conclusion and execution of international laws and regulation; Thus, using nuclear energy for peaceful purposes is considered as one of the most important and fundamental topics in the field of international environmental law. In this course, following the production of nuclear weapons and their usage by some governments;scientists, sociologists, and authorities, in order to control usage of this scientific breakthrough, and

finally, efforts for the "control and positive and non-military use" of nuclear energy yielded the Non Proliferation Treaty (NPT) following the United Nations General Assembly resolution in 1968. From then onwards, countries were prohibited from developing this technology for military purposes. However, based on article four of this treaty, countries may continue their efforts on using nuclear energy for peaceful purposes [3]. Thus, the problem of using nuclear energy for peaceful purposes, following scientific and applied activities in this field and its effects on the environment and uncertainty of the Environmental Protection Organization's regulation potentials, is a topic that has been discussed in public international laws and national regulations in the past few years [4].

In fact, international law is the law governing relations between governments. Rules of international law arise from the free will of governments or stated in form of treaties, or accepted habits [5]. International law in this definition implies for public international law, which sets relations between independent societies, and governments are obliged to abide the rules of this law [6]. The environment constitutes a surrounding covering the process of life and interacts with it. Therefore, it comprises nature, human societies, and human made surroundings (e.g. nuclear reactors) and covers all the earth's living space [7].

The energy obtained from nuclear reactions is known as nuclear energy, which originates from two sources: fission of heavy atomic nucleus, and fusion or melting of light atomic nucleus. Atomic energy is one of the most efficient energies in the world, which with little effect on the environment, produces the largest amount of electricity [8]. Nuclear energy is one of the largest sources of energy without pollutant emissions, and nuclear plants do not produce any of the air pollutants including sulfur and dust or greenhouse gases that break the ozone layer and therefore act as a hazard for our atmosphere. They require a relatively small space and reduce other negative effects of the environment. Utilizing this energy instead of other sources will preserve clean air, maintain continental conditions, and prevent acid rain.

Based on the international law dictionary, responsibility in international law is defined as follows:"Responsibility in international law is the duty imposed on a government by virtue of international law, to compensate for damagesinflected on another government as a result of violating international law". Certain effects result from international responsibility;when international responsibility is realized, the liable country or international organization is obliged to repair and compensate for the inflicted damages. Thus, the fundamental result of responsibility is commitment to complete compensation of damages [9]. Moreover, according to article IIof the statute of the International Atomic Energy Agency (IAEA), "The Agency shall seek to accelerate and enlarge the contribution of atomic energy to peace, health and prosperity throughout the world";or according to article III, "The Agency is authorized to encourage and assist research on, and development and practical application of, atomic energy for peaceful uses throughout the world"; however, attention to principle issues for assurance of nuclear safety cannot be disregarded. In fact, the general goal of nuclear safety is to protect people, the society, and the environment by devising supportive and supervisory measures against nuclear hazards, or in a simpler sense, all actions must be in the course of preventing nuclear accidents [10].

Here, we will mention some of the studies carried out in this regard:

Castiglione et al. (2012) in a study titled "Rule of law and the environmental Kuznets curve: evidence for carbon emissions" show that there exists a negative relation between status of laws and pollution. They argue that when there is a strong governing law, therefore, we observe improvement in environmental preservation[11]. Kueny (2011) in a study titled "Environmental radiological protection and nuclear law: from the protection of humans to the protection of the environment per se?" addresses the problem of international laws and regulations with regard to effects of ionizing radiation on the environment and on nature; and that nuclear laws not only cover human societies, but non-human species are also protected from hazardous effects of ionizing radiations[12]. Ferro (2008) in a research titled "The future of the regulation of nuclear safety in the EU" considers prevention of harm to workers, people, and the environment among the fundamental issues discussed in nuclear safety laws and regulations. Although, he stresses that regulations must not limit themselves to nuclear power plants, but should cover all effective factors within the nuclear fuel cycle including radioactive waste management[13].

Qiang (2002) in a study titled "Nuclear energy and the environment" attempts to compare environmental effects of generating electricity through nuclear technology and coal. This comparison shows that the nuclear electricity generation process, effect on the environment, human health, and emission of greenhouse gases, are far less than generating electricity using coal. In this course, accelerating development of nuclear energy is considered one of the main solutions for solving environmental pollution problems[14]. Riley (2006) in his research titled "Justification of the continued development of the peaceful use of nuclear energy" in order to justify development of peaceful nuclear energy applications, explains the scientific application of nuclear energy in different fields, the economic advantage of this technology compared to many other current options, its positive effects on health, safety, security,

and finally environmental protection[15]. Gharib (2007) in his evaluation titled "Nuclear energy and non-proliferation", while explainingthe legal issues around peaceful applications of nuclear energy, accounts it as a new, effective, and efficient source of energy, and realizes that the prerequisite of a world transition of movement toward peaceful nuclear energy usage, apart from utilizing related technical and scientific equipment, requires governments and international organizations' adherence to international laws[16]. Moreover, Van der Zwann (2008) in a study titled "Prospects for nuclear energy in Europe" discusses the role of nuclear energy in sustainable development by presenting a general display of the current situation and outlook of nuclear technology in Europe. This study states somewhat unlikely significant change in Europe's nuclear capacities during the next few years due to the benefits of applying this technology. However, in a deeper analysis, it reaches problems such as waste management, condition of nuclear weapons, and operational safety. However, it states alongside these problems, benefits of utilizing nuclear energy such as reducing dependence on energy, economic advantage, and reduction in air pollution[17]. In another study by Atieh and Workman (2006) titled "Thirty-five years of successful international cooperation in nuclear knowledge preservation: the International Nuclear Information System (INIS)", in course of international mechanisms for information exchange in the fields of peaceful use of nuclear science and technology, attempt to explain the main operations and activities of the international nuclear information system. Among the highlights of this system are related technical and scientific cooperation in accordance to international obligations, with the aim that on this account, in addition to promoting scientific and technical capabilities, legal tools be provided in the framework of international regulations[18].

Bhattacharjee (2012) in his study showed that by expanding diverse applications of nuclear technology in various fields including industrial, medical, and agricultural fields, governments have realized the fact that in order to respond to technical and managerial requirements of environmental protection, and safety and human health, creating a well-organized legal framework, especially in the fields of governmentliability in lieu of nuclear harm, is essential[19]. In an article by Rizwan-uddin (2010), benefits and problems of nuclear energy have been pointed out, and finally, due to increase in energy costs, and climate apprehensions, introduce nuclear energy as an important source of energy for different countries. Moreover, he carries on by stating that the growing trend of peaceful nuclear energy usage requires respect for every country's right for using nuclear energy for peaceful purposes. However, provided transparency in activities, he believes that such relations require documentation and development of proportionate national and international laws and regulations[20]. Considering the above explanations about the legal and environmental conditions of nuclear energy application, this study aims to examine the role of international environmental laws and regulations in using nuclear energy for peaceful purposes. Therefore, obtaining the following specific objectives is evident:

1. Study in usage of nuclear energy from international law sources perspectives, especially treaties, general principles and judicial procedures.
2. Study in environmental requirements and responsibilities of governments in the peaceful use of nuclear energy.
3. Study in criteria and standards of safety observing control and reduction of nuclear energy usage effects.

MATERIALS AND METHODS

Considering that the overall aim of this study is to examine the role of international environmental laws and regulations in the peaceful usage of nuclear energy, the aim of the study is applied and the used method of study is descriptive. Our information collection is by questionnaire. In order to document the questionnaire, theoretical fundamentals of the subject were initially examined within related sources and references. Then, considering study results, the primary questionnaire was prepared, and after ensuring validity and reliability, the final questionnaire was designed. In order to assess validity of the research tool, the designed questionnaire was given to a number of related professionals and experts, and after making correction and changing some questions; the credibility of the questionnaire was confirmed. Cronbakh's Alpha was used in order to calculate reliability. Questions were multiple-choice or multiple-level. In this course, Cronbach's Alpha was obtained 0.89. In order to maintain reliability, Cronbach's Alpha must not be less than 0.7;therefore, we can say that the questionnaire possesses the required reliability.

Independent variables include **international law sources, especially treaties, general principles, and judicial procedures**: (lack of a comprehensive nuclear energy convention, non-adherence of governments to nuclear law principles, weak influence of international law on country domestic laws, cautious international judicial resolutions, and insufficientwarrantiesin international nuclear laws etc.), **governments environmental requirements and responsibilities**: (non-determination of amounts of environmental responsibilities, non-proportional methods of compensating damages related to nuclear disasters, lack of government obligations for observing environmental assessment results, lack of environmental standards for waste discharge, lack of consideration of environmental measures in nuclear tests etc.), and **criteria and standards of safety observing control and reduction of effects**:

(lack of regular control and inspection of nuclear sites, shortage of specialized training resources and facilities, non-separation of supervising body and responsible body in nuclear installations, insufficient nuclear safety regulations in the fields of trans boundary transport, not publishing complete details of accidents etc.). The individual and professional specifications of respondents included sex, age, degree and field of study, academic ranking etc.

The dependent variable of the study was peaceful use of nuclear energy. The statistical population of the present study included expert researchers on the considered field with doctorate degrees, and current doctorate degree student. The number of researchers and students are 29. Statistical analysis was carried out after data extraction using SPSS 16 software. Frequency, percentage, collective percentage, mean, median, and standard deviation were used in descriptive statistics, and Exploratory Factor Analysis (EFA) was used in inferential statistics.

RESULTS

The average age of the individuals studied was 31. From overall participants, 67.4 % were male, and 32.6 % were female. 12 % possessed university faculty positions, and 4.7 % were assistant professors. 73.8 % of the studied individuals (largest amplitude) were doctorate students. Moreover, 26.2 % of participants possessed doctorate education. Studentsand researchers studied environmental law, environmental management, energy, international law, and environmental sciences disciplines, where 34.8 % of individuals (with the largest amplitude) studies in the field of environmental law, 31.4 %international law, 26.5 %energy and environmental management, and 7.3 % studied environmental sciences.

In this study, 50 variables were entered into SPSS 16 software in order to examine the role of international environmental laws and regulations in the peaceful usage of nuclear energy. Factor analysis is used to summarize data. In order to explore the main role related to international environmental laws and regulations in the peaceful usage of nuclear energy, all variables and possible itemswere entered into the factor analysis. This means that research variables are converted into factors to show if data are suitable for factor analysis or not? In order to do this, Bartlett and KMO tests were carried out, where in this study KMO was obtained equal to 0.768, and the Bartlett test value was equal to 1654, which are significant in the 0.000 level, and notion suitability of the collective correlation of the entered variables for factor analysis (table 1).

Table 1: Bartlett and KMO test results for evaluating suitability of data for factor analysis

KMO test	
Kaiser-Meyer-Olkin Measure	0.768
Bartlett test	
Amount	1654
Sig.	0.000

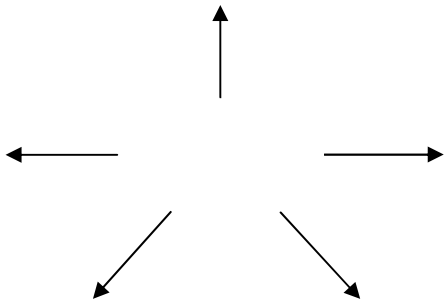

Figure 1: Classification of factors using ordinal factor analysis

The number of factors in this research was selected based on factors that explained more than 50 % of the variance. In order to determine the number of factors, eigenvalue and variance percentage were used. On this basis, in this study five factors including safety, international responsibility, waste, environment, and international cooperation were identified, which collectively, 79.14 % of the total variance was covered with these five factors. After factor rotation using the Verimax method, and based on table results, items related to each factor were named (fig. 1).

Table 2a: Classification of effective international environmental law and regulation factors in peaceful use of nuclear energy using ordinal factor analysis

Factor	Variables	Variance Percentage
Safety	lack of preventive criteria and standards, lack of continuous control of nuclear sites, absence of a supervising professional body, failure to update employee and people's information, lack of a single and knowledgeable management, insufficient allotted financial resources,shortage of specialized training resources and facilities, insufficient nuclear safety regulations in the fields of trans boundary transport, not publishing complete details of accidents	27.83
International Responsibility	limitation of incumbent responsibility, non-proportionality between damage and liability, unspecific actually responsible, non-proportional insurance coverage, insufficient complementary indemnification from governmental reserves, inquiry by non-technical courts, the pail role of domestic rules and regulations in international responsibility, non-desirable relation between laws and their administration, scarce knowledge or unfamiliarity of domestic judicial courts about international responsibilities and related discussions	23.41
Waste	waste discharge with low safety factor, lack of long-term supervision and inspection on wastelands, non-principle transportation of wastes, import and export of radioactive material without international supervision, insufficient assignment and distribution of credit and funds for ensuring wasteland safety, non-separation of nuclear waste producing supervisors and authorities, insufficient processing and preparation stages of wastes prior to their discharge	11.39
Environment	lack of nuclear authorities' environmental knowledge, non-adherence to environmental assessments, incapability to calculate environmental damages, non-determination of environmental responsibilities, non-proportionality between redress and nuclear accidents, lack of environmental standards for waste discharge, non-adherence of environmental measures in nuclear tests	9.17
International Cooperation	unspecific government duties in international cooperation, weak relations between countries' nuclear experts and professionals, incomplete broadcast of nuclear information form accidents and tests, costly actions, weak warranties for achieving international cooperation, lack of a comprehensive nuclear energy convention, non-adherence of governments to nuclear law principles	7.34

Table 2b: Extracted variables related to each one of the factors along with their factor C after rotation

Factor	Variables	Factor C
Safety	lack of preventive criteria and standards	0.917
	lack of continuous control of nuclear sites	0.879
	absence of a supervising professional body	0.872
	shortage of specialized training resources and facilities	0.863
	lack of a single and knowledgeable management	0.794
	insufficient allotted financial resources	0.783
	failure to update employee and people's information	0.755
	insufficient nuclear safety regulations in the fields of trans boundary transport	0.605
	not publishing complete details of accidents	0.591
International Responsibility	non-proportionality between damage and liability	0.916
	inquiry by non-technical courts	0.864
	unspecific actually responsible	0.799
	non-proportional insurance coverage	0.785
	limitation of incumbent responsibility	0.774
	insufficient complementary indemnification from governmental reserves	0.728
	scarce knowledge or unfamiliarity of domestic judicial courts about international responsibilities and	0.642
	related discussions	0.613
	non-desirable relation between laws and their administration	0.597
	pail role of domestic rules and regulations in international responsibility	
Waste	lack of long-term supervision and inspection on wastelands	0.758
	non-separation of nuclear waste producing supervisors and authorities	0.727
	waste discharge with low safety factor	0.655
	non-principle transportation of wastes	0.607
	import and export of radioactive material without international supervision	0.594
	insufficient assignment and distribution of credit and funds for ensuring wasteland safety	0.574
	insufficient processing and preparation stages of wastes prior to their discharge	0.526
Environment	lack of nuclear authorities' environmental knowledge	0.694
	non-adherence of environmental measures in nuclear tests	0.670
	non-adherence to environmental assessments	0.645
	incapability to calculate environmental damages	0.563
	non-proportionality between redress and nuclear accidents	0.507
	non-determination of environmental responsibilities	0.471
	lack of environmental standards for waste discharge	0.412
International Cooperation	unspecific government duties in international cooperation	0.639
	weak relations between countries' nuclear experts and professionals	0.605
	non-adherence of governments to nuclear law principles	0.589
	weak warranties for achieving international cooperation	0.518
	incomplete broadcast of nuclear information form accidents and tests	0.487
	costly actions	0.461
	lack of a comprehensive nuclear energy convention	0.402

Safety factor (lack of preventive criteria and standards, lack of continuous control of nuclear sites, absence of a supervising professional body, failure to update employee and people's information, lack of a single and knowledgeable management, insufficient allotted financial resources, presenting incorrect repots for nuclear accidents etc.), in sum explained 27.83 % of the variance. The international responsibility factor (limitation of incumbent responsibilities, non-proportionality between damage and liability, unspecific actually responsible, non-proportional insurance coverage, insufficient complementary indemnification from governmental reserves, inquiry by non-technical courts, the pail role of domestic rules and regulations in international responsibility etc.) in sum, explained 23.41 % of the variance. Waste factor (waste discharge with low safety factor, lack of long-term supervision and inspection on wastelands, non-principle transportation of wastes, import and export of radioactive material without international supervision, insufficient assignment and distribution of credit and funds for ensuring wasteland safety, non-separation of nuclear waste producing supervisors and authoritiesetc.) in sum, explained 11.39 % of the variance. Environment factor (inappropriate environmental regulations, lack of nuclear authorities' environmental knowledge, non-adherence to environmental assessments, incapability to calculate environmental damages etc.) in sum, explained 9.17% of the variance. International cooperation factor (unspecific government duties in international cooperation, weak relations between countries' nuclear experts and professionals, incomplete broadcast of nuclear information form accidents and tests, costly actions, weak warranties for achieving international cooperation etc.) in sum, explained 7.34 % of the variance (table 2).

DISCUSSION AND CONCLUSION

In our first specific objective, in order to examine peaceful use of nuclear energy from an international law perspective, we found fundamental issues such as non-adherence of governments to nuclear law principles, and lack of a comprehensive nuclear energy convention. Likewise, Stoiber et al. (2003) in their study titled "Nuclear Law" concluded that today, the main goal of nuclear laws and regulation must be to present a legal framework for carrying out activities related to nuclear energy and ionization, whilst ensuring adherence to international nuclear law principals such as security and sustainable development[10]. In addition, Ferro (2008) in a study titled "The future of the regulation of nuclear safety in the EU" stated attempts for documenting a comprehensive convention as one of the fundamental issues in the nuclear system; although while noting that these conventions must not limit themselves to nuclear plants, all effective factors in the nuclear fuel cycle including radioactive waste must be included[13].

In order to utilize nuclear energy in course of the second goal, we proceeded with the topic that governments are obliged to abide a series of environmental requirement while using these energies, and non-adherence will have the outcome of environmental responsibilities for offender governments. Emmerechts (2008) in a study titled "Environmental law and nuclear law" concluded that nuclear law has traditionally emphasized on protecting individuals and assets; however, the Chernobyl disaster and the increase in public knowledge of the hazardous effects of nuclear activities, resulted in the tendency of environmental law to cover nuclear issues. In this course, environmental and nuclear laws, were directly – by defining activities – and indirectly – by introducing protection concepts – related to each other[21]; and or Bhattacharjee (2012) in a study titled "Looking through the prism of international environment and human rights law - International civil nuclear liability law" showed that by extending diverse applications of nuclear technology in different industrial, medical, and agricultural fields, governments have realized the fact that in order to respond to technical and managerial requirements of environmental protection, safety, and human health, creating a versatile legal framework , especially in the fields of government liabilities towards nuclear damages in essential[19].

Based on the third goal, we examined the criteria and standards supervising control and reduction of effects, and found that ensuring safety is amongst the most important issues in the peaceful usage of nuclear technologies. Berger (2008) in a research titled "Environmental law developments in nuclear energy", stated that from the one hand, climate change, oil price fluctuations, and increase in energy dependency, has fueled interest in nuclear energy; however, on the other hand, by mentioning disasters such as Three Mile Island and Chernobyl, introduced environmental protection and safety assurance as requirements for developing this technology[22].

In terms of the role of international law sources: non-adherence of governments to nuclear law principles, lack of a comprehensive nuclear convention, weak international warranties, and non-proportional international responsibilities of governments for peaceful use of nuclear energy are considered amongst the most important issues in this regard. On the international level, while allowing usage and expansion of nuclear energy sources for peaceful purposes (fulfilling human needs and fighting against existing environmental problems), world powers must commit and be obliged to general and comprehensive nuclear disarmament, and start to close-down all military nuclear sites. In addition, governments must solve their international conflicts through agreements and current and future

conventions. The International Court of Justice, International Court of Arbitration and regional mechanisms must work to peacefully facilitate resolution of nuclear conflicts.

From environmental perspective: inability to calculate environmental damages, non-adherence to environmental assessment results, and lack of environmental standards for application of nuclear technologies are among the most important problems in this regard. Existing facts regarding fossil fuel limitations, and worries about increase in greenhouse gas emissions and global warming, shows that in the current century, using the nuclear energy solution for supplying part of the fundamental needs of different countries is inevitable. In this course, considering recent developments in nuclear plant technologies, utilization of this approach for countries who have obtained this technology provides many environmental advantages compared to other energy options. While sustainable development of nuclear energy necessitates that activities do not pollute and harm the environment, therefore promoting environmental knowledge of nuclear authorities, and devising comprehensive trans boundary environmental programs are amongst the most important requirements in this regard.

In terms of safety: lack of preventive criteria and standards, lack of continuous control of nuclear sites, and insufficiency of technical training resources and facilities are amongst the most important problems in this area. Although, one of the most important necessities in development of sciences and technologies (mentioned for nuclear technologies), is existence of an international responsibility system, which covers explaining important issues such as proportion of damage and liability, insurance coverage, and complementary indemnifications, however, in the field of international law, in order to ensure nuclear safety, instead of indemnifications and other such actions, the course of direction must move towards devising preventive solutions, laws, and regulations.

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