RADIATION IN OUR RIVERS: A SOCIO-LEGAL CRITIQUE OF INDIA'S WATER-BASED RADIOACTIVE WASTE DISPOSAL REGIME

Arushi Rastogi, Heeralal Yadav Law College, Lucknow

ABSTRACT

Radioactive water pollution in India is an under-reported but serious environmental hazard, with long-term implications for public health, ecological balance, and inter-generational equity. This study examines the legal, scientific, and social dimensions of radioactive discharges, particularly from nuclear facilities and geogenic sources, into India's water systems. Through doctrinal analysis and secondary data review which includes court rulings, regulatory guidelines, and groundwater quality reports, the paper identifies key regulatory gaps, challenges faced by affected communities, and the failure of current legal frameworks. It concludes with suggestions for robust legal and institutional reforms to ensure environmental justice, transparency, and the right to clean water.

Keywords: Radioactive Discharge, Public Consultation, Transparency, Right to Clean environment, Contamination, Strict liability, Victim Compensation Scheme, Polluter Pays Principle.

Introduction

Water pollution has been a serious concern for us and to mitigate the damage and further prevent it. More common water contaminants are heavy metals, dyes and organic pollutants. Although there is another aspect of water pollution which common people are not generally aware of, neither would you see it making headlines that often, it is the radioactive pollution of water. This kind of damage or contamination of water is invisible, Cumulative and irreversible. Once it reaches into an aquifer or river system, it remains for hundreds to thousands of years since radiation cannot be filtered or boiled away.

Radioactivity is the phenomenon of spontaneous emissions of particle waves from the unstable nuclei of some elements, with there being three types of radioactive emissions, namely alpha- the positively charged, beta- the negatively charged and the gamma rays which are neutral electromagnetic radiations.[1] Radioactive elements are found naturally in the earth's core. Studies have proved that although the radioactive pollution or simply mixing of radioactive material into water streams or groundwater is often credited to negligent waste disposal from nuclear power plants, it could also be of geogenic origin.

Despite the seriousness of the threat, radioactive pollution doesn't get the attention it deserves. People living near nuclear facilities, mining zones, or waste storage sites, many of whom are tribal or rural communities often face health hazards without even knowing the cause. They lack access to information, legal recourse, or provision for proper compensation. This paper explores the neglected issue by looking into the **s**ources and social impact of radioactive water pollution in India, examining the gaps in our legal and institutional frameworks, delving deep into understanding as to why affected communities remain unheard despite comprehensive rules and regulations. At last, it will address the burning question of what change can be made, in order to restore the integrity of environmental justice.

Research Objectives

This paper aims to perusal over the following questions and comprehend the insights there upon:-

[1] https://www.iaea.org/Publications/Factsheets/English/radlife

1. What are the primary sources and social impacts of radioactive water pollution in India?

2. How does India's legal framework regulate (or fail to regulate) radioactive discharges into water bodies?

3. Why are affected communities — especially tribal populations — unable to access justice or compensation?

4. What legal, institutional, and constitutional reforms are required to address this hidden crisis?

Research Methodology

The present research employs a **qualitative and doctrinal methodology**, with a focus on understanding the social, legal, and environmental implications of radioactive water pollution in India. The research primarily involves the analysis of **secondary data sources**, including academic literature, regulatory reports, judicial pronouncements, and expert commentaries. This approach was chosen due to the limited availability of direct access to radioactive sites or first-hand environmental data, and the nature of the subject which often involves restricted or classified information.

Doctrinal research forms the backbone of this study, wherein legal provisions such as the *Atomic Energy Act, 1962*, the *Environment Protection Act, 1986*, and the *Atomic Energy (Safe Disposal of Radioactive Waste) Rules, 1987* have been critically examined. Judicial interpretations—particularly the landmark case of *G. Sundarrajan v. Union of India*—have been evaluated to understand how Indian courts have dealt with questions of environmental safety, right to life under Article 21, and radioactive waste disposal mechanisms. These legal texts were analyzed to identify gaps in regulation, implementation challenges, and the balance between technological development and constitutional rights.

Additionally, the research draws extensively from **scientific and institutional sources**. Peer-reviewed journal articles such as *"Arsenic Contamination in Indian Groundwater: From Origin to Mitigation Approaches for a Sustainable Future"* by Deepali Marghade et al. were consulted to understand the underlying scientific basis of groundwater contamination, while contextual insights were derived from articles like *"Uranium in the Water of Indian States – Is*

it Alarming?" hosted on Chaitanya Products' blog. These resources provided background on geogenic and anthropogenic sources of radioactive pollution and the states most affected.

In order to understand international standards and comparative practices, official publications of the **International Atomic Energy Agency (IAEA)**, particularly its technical guide on radioactive waste management, were studied. Regulatory practices and official guidelines from the **Atomic Energy Regulatory Board (AERB)** were also examined through its online documentation, particularly its section on radioactive waste management. These sources contributed to assessing India's compliance with global nuclear safety norms and the robustness of its domestic mechanisms.

The study further incorporates **data-driven reports**, such as the *2023 Annual Ground Water Quality Report* by the **Central Ground Water Board (CGWB)**, as cited by Mongabay India. This report revealed alarming statistics related to uranium, arsenic, and nitrate contamination in Indian groundwater, providing a crucial environmental context to the legal and regulatory discussion. Supplementary materials such as a YouTube documentary discussing the environmental impacts of radioactive pollution were also referenced to understand public perception and the gaps in local-level awareness and engagement.

The research is, however, subject to certain limitations. The lack of primary fieldwork, such as interviews with affected communities or environmental sampling, restricts the scope to a largely doctrinal and secondary data-based study. Moreover, the opaque nature of data shared by regulatory bodies regarding radioactive emissions and groundwater impact limits the possibility of precise quantification. Nonetheless, the study endeavors to provide a holistic overview by integrating environmental science, legal doctrine, and policy evaluation.

Mapping the Threat: sources of radioactive water pollution

Radioactive water pollution in India can be traced back to multiple origins, stemming from both industrial activities related to nuclear power plants, etc. and even the naturally occurring sources amplified by the conditions around.

In the case of **Uranium Mining and Processing**, uranium processing plant which was being operated by uranium corporation of India limited in Jadugoda which is a significant source, leaks of radioactive sludge from the plants pipelines had occurred discharging waste into local

rivulets, which were in use by the local men for fishing, irrigation and other household activities.[2] Not only that, open ponds storing leftover Radioactive material tailings, percolated and leached in the ground, contaminating the groundwater. If we look back, we will find similar uranium mining happenings in places like radium hill in South Australia which operated from 1906 to 1961, earlier by private excavators and later on by the South Australian government. The site was eventually abandoned due to the risk from open and unsecured tailing dumps of radioactive material and contamination thereby, having severe impact on the workers (including more chances of lung cancer) and those living in the area. The incident has rendered the site as a 'ghost town' with no inhabitants anymore.[3] This reiterated upon the radioactive waste management considerations.

In the case of **Nuclear Power Plants (NPPs) and Research Reactors**, one of the highlighter practice is that of how Pakistan's Liquid Radioactive Waste (LRW) is generated from NPP operations (e.g., Pressurized Water Reactors and Pressurized Heavy Water Reactors), these streams can include spent ion exchange resins, clean drains from system components, process drains from regeneration and washing, and floor drains although efforts are made to treat and monitor these effluents before discharge.[4]

Research reactors also generate very low level liquid waste, which is managed through processes like delay and decay tanks and disposal pits.

The pollution could be the result of **Accidents at Nuclear Facilities,** Accidents can lead to the release of radioactive materials into water systems. An accident in 2003 at the Kalpakkam Reprocessing Plant (KARP) in India, owing to a valve failure, involved highly radioactive waste entering a tank containing waste of reportedly lower radioactivity[5]. Another notable one in this category is the Chernobyl Disaster (1986) wherein a steam explosion at a nuclear power plant in Ukraine took place, causing a widespread release of radiation which has led to significant long-term health effects.[6] Further in the Fukushima Daiichi Nuclear Disaster in

[2] Lina Krishnan 'Jadugoda: Four decades of nuclear exposure'. http://www.indiaenvironmentportal.org.in/files/5_21.pdf
[3] BERND G. LOTTERMOSER, PAUL M. ASHLEY 'Environmental review of the Radium Hill mine site, South Australia'. https://researchonline.jcu.edu.au/8154/1/Lottermoser.pdf
[4] laraib, S. 'Current Practices and Efficacy of Improvements in Radioactive Management System of Pakistan – a Review. Environmental Contaminants Reviews'. https://doi.org/10.26480/ECR.02.2018.09.12
[5] Ministery of ATOMIC ENERGY, UNSTARRED QUESTION NO:2338 ANSWERED ON:17.12.2003. https://eparlib.sansad.in/bitstream/123456789/458365/1/70869.pdf
[6] 'Chernobyl Accident 1986' WORLD NUCLEAR ASSOCIATION, Updated Monday, 17 February 2025. https://world-nuclear.org/information-library/safety-and-security/safety-of-plants/chernobyl-accident

Japan, a series of explosions and release of radioactive material at a nuclear power plant after a major earthquake and tsunami took place[7] which registered as another alarming incident, exposing the vulnerability of any sort of protection tied around the power plant with regards to the risk of permanent contamination once hit by such calamity.

Uranium and such similar elements are **naturally occurring** which are found in varying concentrations in groundwater depending on the soil and bedrock composition of the geographical area.[8] Further, water-rock interactions, oxidation processes, and the interaction with other chemicals like bicarbonate can enhance uranium solubility in groundwater.

Human Influence also leads the path in this regard. We read that radioactive elements like uranium are naturally occurring and also that contamination is considered dangerous after a certain limit, now, when the groundwater has been witnessing decline, the radioactive contaminant level is rising in the equation rendering the groundwater unsafe. Besides the above, nitrates are also of polluting nature which comes from excessive use of certain fertilizers, their pervasive nature too intensifies the pollution.

After all others, comes the **Attacks and war** category which to a greater extent cannot be mitigated, although non- indulgence is always advocated between Nuclear powers. Incidents beginning from Heroshima and Nagasaki nuclear bombing which not only killed thousands of people but also resulted in permanent gene-mutation in case of exposed survivors, ultimately leading to shut down of the whole area. Then, the most recent being Israel's attack on Iran's nuclear program center[9]. Although there isn't any officially confirmed report of contamination but deadly and irreversible impact of such attacks being an act of war or otherwise cannot be denied.

[7] 'Fukushima Daiichi Accident' WORLD NUCLEAR ASSOCIATION, Updated Monday, 29 April 2024. https://world-nuclear.org/information-library/safety-and-security/safety-of-plants/fukushima-daiichi-accident

[8] Neeraj Chauhan, Stefan Krause, Jaswant Singh, Reza Dehbandi, Pavitra V. Kumar, Pankaj Kumar, Amrit Pal, Alok Srivastava 'Assessment and Mitigation of Heavy Toxic Elements with Emphasis on Uranium in the Malwa Region of Punjab, India' ACS PUBLICATIONS, February 4, 2025. https://pubs.acs.org/doi/10.1021/acsestwater.4c00900

[9] 'Radiological contamination possible inside Iran's main nuclear enrichment facility after Israeli strikes: UN top agency issues big warning' ET Online, Last Updated: Jun 16, 2025, 06:55:00 PM. https://economictimes.indiatimes.com/news/international/global-trends/nuclear-leak-in-iran-radiological-contamination-possible-inside-irans-main-nuclear-enrichment-facility-after-israeli-strikes-warns-uns-top-agency/articleshow/121886899.cms?from=mdr

Therefore, it can be said without doubt that radioactive water pollution is not confined to one cause, rather, it may stem from mining leaks, nuclear plant accidents, naturally occurring, and even by war. Incidents like Jadugoda in India, Radium Hill in Australia, and global disasters such as Chernobyl and Fukushima go on to show how radioactive contamination can leave lasting scars. Whether accidental or natural, the danger lies in its persistence and invisibility. These realities call for stronger safeguards, better waste management, and continued vigilance to protect our water sources.

Affected Communities and Social Implications

Radioactive waste disposal in open water bodies could have a direct **impact on the health** of the people. Residents using radioactive contaminated sources or exposed rivulets, ponds, etc. or groundwater which is contaminated in any other manner can be prone to kidney dysfunction, lung diseases, spontaneous abortions, and reduced life expectancy. It is also seen that excessive radiation exposure also causes congenital deformities, be it chronic lung diseases like silicosis or lung cancer, or any other neuro disorder. Exposure for a longer amount of time, eventually may lead to gene mutation.

Among **environmental and livelihood impacts** are through contamination of water, the fishing or irrigation is directly impacted, thus impacting the daily life of the communities depending upon it, at places where the radioactive contaminants are in higher amounts in the groundwater or in the river or rivulets which are supposed to irrigate the food fields. These contaminants could enter the local food chain and expose the people thereby to incurable diseases. Central Government Water Board reports 2023[10] reference to a study which showed a strong correlation between uranium concentration in drinking water and uranium in human bones, suggesting that bones are put in the gator of uranium exposure via ingestion of drinking water, etc.

If we take into account the **social and economic challenges** that are birthed by such a negligent act, we will realize that since such plants or mining companies are located at remote areas or areas not inhabited on a large scale due to its geography, most of the people who are affected are the tribal communities or simply indigenous communities which are either living there due

[10] Central Ground Water Board, 2023, 'National Compilation on DYNAMIC GROUND WATER RESOURCES OF INDIA, 2023' https://cgwb.gov.in/cgwbpnm/public/uploads/documents/17014272111704550895file.pdf

to the cultural significance or are part of the workforce mining areas. These people face occupational exposure risk, for example, plant workers taking contaminated uniforms home, casual labor handling yellow cake without protective gear, etc. Beyond health, most communities may face concerns about the impact of radioactive waste facilities on land prices, agricultural markets, and tourism. So it in turn does not just affect the communities living therein, but also the people beyond.

In the context of an Ethiopian case study, social attitudes included misconception, misunderstanding of facility goals, weak relationships between facilities and stakeholders, and lack of communication. Besides, concern about radiation, accidents, and the belief that the facility area is contaminated were noted among the residents.

At last, but not the least, when such an incident is realized by the people, with respect to a certain leak or negligent disposal or otherwise, what increases the most is **lack of trust**. As it has been observed, like in the case of Jadugoda, that there has been none or inadequate response from the authorities with respect to steps like decontamination, monitoring, etc., or even compensation or relocation. Since none of it is adequately implemented, people develop that sense of distrust.

Laws and Authorities Concerned

The disposal of radioactive waste into water bodies raises complex questions about environmental safety, legal accountability, and regulatory oversight. In India, several authorities and legal frameworks work together to manage these concerns, aiming to strike a balance between technological advancement and public health. To Understand the country's approach to radioactive water pollution, one has to perusal over the operation of the system, rules applying, the authorities for enforcement and ensuring compliance.
The following table clarifies the authorities dealing with the radioactive/ nuclear energy related projects in India, it is as follows:-

Authority	**Primary Role**
Department of Atomic Energy (DAE)	Oversees all aspects of India's nuclear program, including research, development, and deployment of nuclear power plants.
Atomic Energy Regulatory Board (AERB)	Regulates and ensures the safety of nuclear and radiation facilities and activities.
Nuclear Power Corporation of India (NPCIL)	Responsible for the generation of electricity from nuclear power.
Bhabha Atomic Research Centre (BARC)	Conducts research and development in the field of nuclear energy.

The **Atomic Energy Act 1962**[11] is the central core act relating to the control and regulation of all activities that involve radioactive substances. In this act, the key provisions relevant to the waste disposal causing water pollution of radioactive kind are:-

- Section 3, which gives power to the central government, it authorizes the central government to make rules for the disposal of radioactive waste, ensuring prevention of radiation hazards to the environment and the human health as well. This section also calls for establishment of radiation safety frameworks for discharging into air, water, and soil.

- Section 17 further deals with offenses and penalties. It includes imposition of criminal liability for unauthorized handling or disposal of radioactive substances, including illegal discharge into water bodies. The next section concerning radioactive disposal in water bodies is the power to inspect. This Act gives power to inspect such regulatory authorities with respect to any facility and to enforce compliance with waste disposal

[11] 'THE ATOMIC ENERGY ACT, 1962' NO. 33 OF 1962, 15th September, 1962. https://www.aerb.gov.in/images/PDF/Atomic-Energy-Act-1962.pdf

> norms, whatever framework the government makes or the authority makes for that time.

The implication of this Act inter alias involved that no individual or company can lawfully dispose of radioactive waste into a water body without prior government authorization. Also, the AERB functioning under the DAE issues discharge consents and monitors compliance with these legal duties.

The body for Atomic Energy Regulation in India, the central body is known as the **Atomic Energy Regulation Board**, which was established by the President of India in 1983 in November using powers granted to him by the Atomic Energy Act 1962. Specifically, the establishment was based on the Section 27 of the Act. The powers of this board have been derived from the rules under the Atomic Energy Act and the Environment Protection Act 1986.

The Atomic Energy Regulatory Board has issued **safety guidelines**, the latest being in **2021**.[12] Under these guidelines, the provisions related to radioactive waste discharge into water bodies are as follows:-

> Section 4.1 puts forth that all facilities discharging radioactive waste to the environment must obtain authorization from the Board, unless exempted, which is a dosage under 10 μSy/year. It applies to all solid, liquid, and gaseous discharges, including those into water bodies.
>
> Section 4.2 of the Act deals with assessment of need for authorizations. It is based upon the justification of a facility approved by the government or DAE. Public exposure under 10μSy/year is exempted, but any exposure which is greater than equal to 10μSy/year requires authorization.
>
> Section 3.2 to 3.5 of the Act deals with the dose constraints for discharge into water bodies. For aquatic release, the dose constraint typically ranges greater than or equal to 300 μSy/year per facility, then the regional dose reserve being 50 μSy/year, further

[12] 'REGULATORY CONTROL OF RADIOACTIVE DISCHARGES TO THE ENVIRONMENT AND DISPOSAL OF SOLID WASTE' AERB SAFETY GUIDE, GUIDE NO. AERB/NRF/SG/RW-10 https://www.aerb.gov.in/storage/uploads/documents/regdocnU2OE.pdf

the site total dose must not exceed 1000 μSy/year, these are calculated using environment impact models and pathways.

Section 4.9 puts forth the authorized limits for discharges. The formula implied here is AL = AD/CD, wherein AL is the activity authorized per radionuclide, AD is assigned dosage constraint, and CD is dose per unit discharged for the site.

The sewage system discharges, e.g. hospitals, the criteria for such discharges are given under section 4.7, the dose to public must be less than 100 μSY per year, the effluent concentration must meet WHO drinking water standards, and the radiation survey and flushing out of sewage pipelines is required. Further, no activity or volume limits, but authorization of clearance is mandatory.

Section 4.8 enlists or puts forth the formal authorization process which includes, involves dose, constraint setting, application submission, AERB review, inspection, and then the grant of authorization finally. Thereafter, it also specifies radionuclide types, discharge limits, monitoring duties, and also reporting.

Section 4.10 puts forth conditions of authorization, its validity being 1 to 5 years. It puts forth the requirement of quarterly, half-yearly, and yearly reporting. Any violation or increased discharge further than the limit set has to be reported within 5 days.

Section 5.3 and 5.4 put forth the Enforcement and Compliance pointers wherein deviations must be reported within five days. AERB must take enforcement actions ranging from warning to revocation.

As per the **Radiation Protection Rules of 2004**[13], which deals with radioactive water disposal as well in order to prevent water pollution, Rule 10 of the Rules deals with Disposal of Radioactive Waste, which basically is the central provision dealing with the waste management. It puts forth that no person shall discharge or cause to be discharged any radioactive waste into the environment except in accordance with the provision of the license granted by the competent authority, the competent authority in this regard being the AERB. The prerequisites of the disposal also include treatment and dilution of effluents, also including

[13] https://www.barc.gov.in/about/07.pdf

the mandate for radioactive liquids to be stored in decay tanks until they reach the permissible activity level.

The Rule 11 of the Rules includes records in reporting provisions stating that facilities must maintain detailed logs of radioactive discharges, including the date, volume, radionuclide content, treatment method, and so on. It also provides for annual reports to be submitted to the AERB and when required to the Pollution Control Boards as well. Further, in case of unauthorized or accident discharge, immediate reporting to the AERB is mandatory.

Case Study of Jaduguda and Uranium Corporation of India Ltd.
The conflict of nuclear progress at human cost

The first uranium mine in India began in 1967 in Jharkhand's Singbham district. Nearly almost 50,000 residents predominantly of tribal communities who were living within a 5 km area of such ponds which were later found to be exposed to both radiations and toxic chemicals were put at risk or rather were put through congenital deformities, cancer, especially in minor families, kidney dysfunction, lung disease, spontaneous abortions, low life expectancy, and so on.Many independent studies have found radiation levels near tailings 20 times higher than surrounding areas, and multiple health outcomes strongly correlated with the proximity.

Reports on Jadugoda's condition were being published for a long time, but it wasn't until 2013 when Hindustan Times published an article titled 'Jadugoda the Nuclear Graveyard'[14] when Jharkhand's High Court took suo moto cognizance, issuing notice to the Union of India Department of Atomic Energy, the UCIL, which was the company which ran the mining, and the Jharkhand State Pollution Control Board, along with others. The court demanded detailed responses on safety measures of the workers and communities, their disposal of radioactive waste and tailings, the healthcare facilities, public awareness initiatives, monitoring and control mechanisms, etc.

In January 2016, based on court directions, an expert committee was constituted, selected by DAE, Department of Atomic Energy, under the government. It was asked to conduct a fresh ground-level survey. Its members included formal AERB officials, a UCIL mining manager, a cancer genetic expert, and a retired coal company executive. A court-appointed Amicus Curiae

[14] https://www.hindustantimes.com/static/groundglass/jadugoda-the-nuclear-graveyard.html

reviewed the report and assured that the situation was by and large satisfactory. The findings of the said report were local radiation levels being within the acceptable limits, the tailings, ponds, etc. were generally sound, reporting maintenance and monitoring gaps. The report also put forth that there were no unequivocal incidents of radiation-linked diseases, such as cancer or congenital disabilities directly traceable to the mining activity.

In the court's final order in 2016, it was noted that the court approved eight member committee recommendations, including fortifying fencing around tailings, improving maintenance of mill-to-pond pipelines, routine quarterly health awareness scans, etc. and thereby closing the petition.[15]

But post this order,Activists remain sceptical. A leader from Jharkhand Organisation Against Radiation commented, everything is false. The same people go to the court, conduct their own inquiry and then deliver justice themselves. Later on, NHRC issued Suo Moto notices in December of 2015 demanding reports from DAE, UCIL and Jharkhand authorities based on media exposure and persistent community concerns. Further, independent studies continue to document high radiation levels, health anomalies and inadequate remediation even after UCIL assertions of safety. Recent media on-site report by a credible journalist, YouTuber KKCreate[16], which any prudent person would find quite contrary to the committee's findings, said, In fact, there was a clear, unequivocal radiation impact on the communities living there. The women were facing abortion one after the other. The people born were being born with deformities, were being born without mental development. They were constantly facing skin diseases. Some of them had cancer from the very beginning of their childhood. Her report on site coverage, the video also went to the extent of showing that the radioactive element was being transported on an open rickshaw, when it was supposed to be put in a closed space, when it was not supposed to be exposed to the surroundings; and the worker without gear.

It clearly shows a lack of understanding on the part of the people there, a lack of understanding of severity, even though they face the consequences. And the greater consequence, the greater liability, or the greater dent lies on the side of the government and the company which had claimed to enforce the court's decision in 2016. The company fails to take action, the government fails to sensitize people of the severity of the things that they were being exposed

[15] Court On Its Own Motion vs Union Of India And Ors 2016 (2) AJR 544
[16] https://www.youtube.com/watch?v=-xsc_m10YX8&t=55s

to. These people in no way are compensated. These people are left alone in helpless, vulnerable states in the area that is exposed to such dangerous levels of radioactive contamination. To the extent that these people still wash their utensils in the exposed rivulets which have the waste disposal pipeline opened into it. These people wash their utensils there, their children bathe there, they drink that water, etc. Therefore, this goes on to show not just disobedience on the part of the authorities there, but also sheer negligence. Rather than that, they are deliberately putting these people's lives at risk. It is uranium extracting versus the human cost that India is paying. Did anyone take consent of these people? Did these people really want to go through what they are being made to go through? Does Article 21 fail when it reaches Jadugoda? Remains a question!

The Case of G. Sundarrajan v. Union of India

A judicial reflection on the tension between technological progress and environmental constitutionalism

In the case of G. Sundararajan v. Union of India[17] 2013, a petition was filed wherein the commissioning of Unit 1 or 2 of the kudankulam Nuclear Power Plant (KKNPP) in Tamil Nadu was challenged.In the petition, concerns were raised over the safety of local population, disposal of radioactive waste, risk of accidents similar to that of Fukushima and Chernobyl, and violation of Article 21's right to life due to potential health hazards.

The legal questions that arose before the court were Whether the establishment of KKNPP violates the constitutional right to life and right to safe environment of the people? Have environment and nuclear safety regulations been complied with? Is radioactive waste disposal mechanism safe, transparent, and adequate?

The arguments raised on the petitioner's side were inadequate environment impact assessment, lack of public consultation and transparency, no final policy on disposal of spent fuel, dangers from radioactive pollution to the marine life due to the seawater use, and lastly, the risk of earthquake, tsunamis not properly addressed.

Court's key observations on the above concerns were, as for the Radioactive Waste Disposal, it cited the AERB Safety Guidelines and Atomic Energy Disposal of Radioactive Waste Rules

[17] 2013 AIR SCW 4019

1987 and recognized the existence of near-surface disposal for low-intermediate-level waste, spent fuel storage pools or dry storage, commitment to building deep geological depositories, and held that spent fuel will be recycled, reprocessed, and not permanently stored at the site, and proper radiation containment will be ensured, thereby ensuring the safety of the people concerned. As for the compliance with the regulations, the court found no violations of the atomic energy, 1962, environment protection act, 1986 and the disaster management act, 2005. Affirmed that necessary permits and clearances have been granted. Further to ensure continued compliance, The court directed AERB, the Ministry, the Tamil Nadu Pollution Control Board, and the District Administration for Oversight. In regards to the issue raised with respect to the violation of fundamental rights, the court justified the establishment saying that no right to life, which includes the right to clean environment, is being violated since precautions, international standards and expert oversight were in place.

The final verdict of the Supreme Court allowed the commissioning of KKNPP but issued 15 detailed directions to ensure safety of radioactive disposal, emergency preparedness, regular monitoring, environmental sustainability, and continued regulatory audits and transparency.

Legal principles that form the base for environmental justice

Legal principles that apply in case of a dispute between such entity being alleged to have caused radioactive pollution into water sources and the probable human lives at stake, are shown in the following table:-

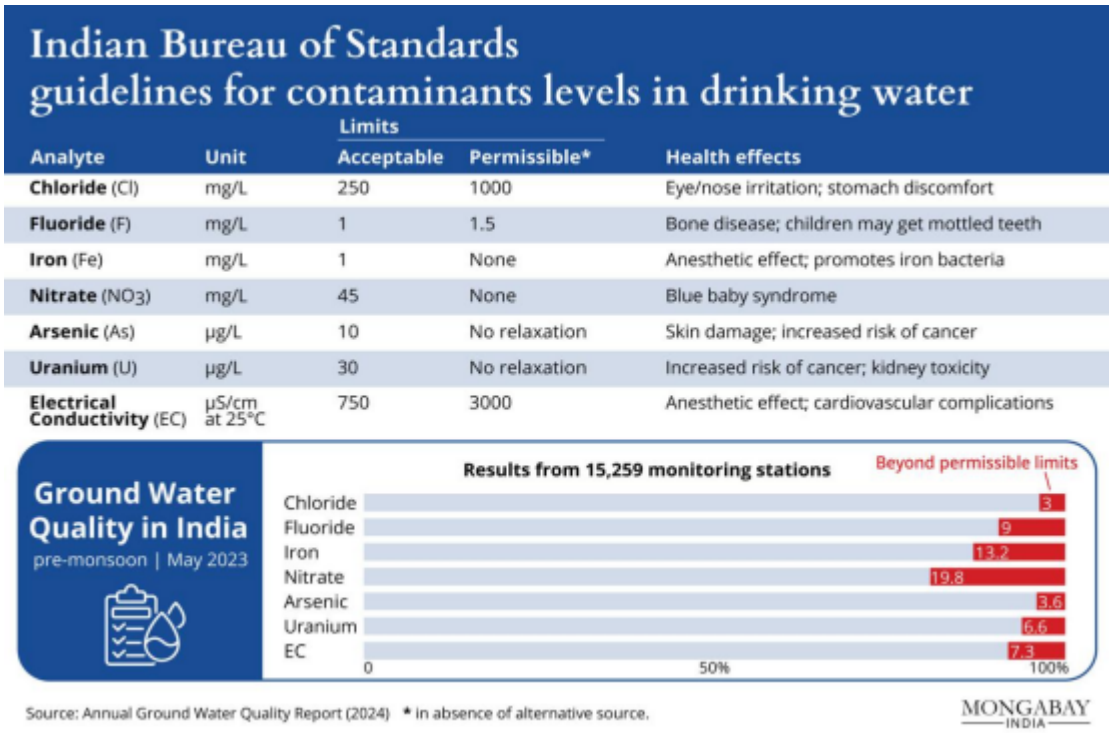
Principle	**Explanation**	**Application to Radioactive Water Pollution**
Precautionary Principle	When an activity raises threats of harm to the environment or human health, precautionary measures should be taken even if some cause-and-effect relationships are not fully established scientifically.	Nuclear facilities must conduct stringent safety reviews and **prevent discharge of radioactive waste into water bodies**, even if risks are uncertain or long-term. Design features (e.g., multiple containment layers, dry cask storage) reflect this.

Polluter Pays Principle	The party responsible for producing pollution should bear the cost of managing it to prevent damage to human health or the environment.	Nuclear operators must **pay for treatment, containment, monitoring, and remediation** of radioactive effluents released into water sources. They are liable for any contamination or health damage to nearby populations or ecosystems.
Intergenerational Equity	The present generation holds the environment in trust for future generations and must use natural resources sustainably.	Disposing radioactive waste into water bodies **endangers marine ecosystems for centuries** due to the long half-life of isotopes. Ensuring **long-term safe storage** and minimal environmental discharge upholds this duty.
Right to Environment	Recognized under Article 21 of the Indian Constitution as a part of the right to life; it guarantees a pollution-free environment.	Uncontrolled radioactive water pollution would **violate the public's fundamental right to clean water and health**. Regulatory oversight, waste management norms, and transparency in nuclear policy help protect this right.

Insights from Annual Ground Water Quality Report was released by the Central Ground Water Board (CGWB)

The annual groundwater quality report was released by the Central Groundwater Board in 2023. According to this report, almost a fifth of the samples collected had exceeded permissible limits of pollutants in it with significant quantities of radioactive uranium present. The report also cites urbanization and climate change as additional contributing factors than the industrial activities and the agricultural practices. The report is prepared based on 15,259 groundwater samples which were collected in May of 2023 for a comprehensive groundwater quality assessment. Among the samples, 19.8% of the samples exceeded the permissible limit for nitrates, 9.04% for fluoride, and 3.55% for arsenic. A significant portion for the sample was

found to have more than the permissible limit of iodine, 13.20%, chloride, 3.07%, electrical conductivity, 7.25%, and uranium, 6.60%.



Indian Bureau of Standards guidelines for contaminants levels in drinking water

Analyte	Unit	Limits: Acceptable	Limits: Permissible*	Health effects
Chloride (Cl)	mg/L	250	1000	Eye/nose irritation; stomach discomfort
Fluoride (F)	mg/L	1	1.5	Bone disease; children may get mottled teeth
Iron (Fe)	mg/L	1	None	Anesthetic effect; promotes iron bacteria
Nitrate (NO_3)	mg/L	45	None	Blue baby syndrome
Arsenic (As)	µg/L	10	No relaxation	Skin damage; increased risk of cancer
Uranium (U)	µg/L	30	No relaxation	Increased risk of cancer; kidney toxicity
Electrical Conductivity (EC)	µS/cm at 25°C	750	3000	Anesthetic effect; cardiovascular complications

Source: Annual Ground Water Quality Report (2024) * in absence of alternative source.

MONGABAY INDIA

The CGWB report[18] reveals a correlation between areas with high uranium concentration in groundwater and regions facing significant groundwater stress. This overlap points to the exacerbating effect of over-exploitation and deepening water levels on uranium contamination in these areas. This implies groundwater is being over-exploited beyond what rainfall or other irrigation sources could replenish, forming yet another contributory factor for the radioactive growth in water, thus extending as a danger.

Criticism and challenges to the Radioactive waste management mechanism and authorities in India

Through the above case studies, legal implication we can understand the challenges that radioactive waste management in India faces today are enlisted below:-

1.Weak monitoring of groundwater spread: While reports such as the 2023 CGWB assessment acknowledge the problem, routine radiation surveillance is limited. Furthermore, access to

[18] Central Ground Water Board, 2023, 'National Compilation on DYNAMIC GROUND WATER RESOURCES OF INDIA, 2023' https://cgwb.gov.in/cgwbpnm/public/uploads/documents/17014272111704550895file.pdf

accurate, real-time data on radioactive emissions is restricted, undermining transparency and public trust.

2. Violation of dilution and decay protocols: The Atomic Energy (Safe Disposal of Radioactive Wastes) Rules, 1987[19], and the AERB's Safety Code prescribe dilution and storage standards, yet India lacks deep geological repositories for high-level waste. According to an IAEA 2022 review, India relies on "provisional engineered near-surface disposal", which may not effectively contain long-lived radionuclides.

3. Lack of transparency with respect to the locals: As supported by the Centre for Science and Environment (CSE) reported in 2020 that nuclear EIA reports are not publicly disclosed in local languages, violating procedural transparency[20].

3. Minimal deterrence or penal action, there is no strong framework for victim compensation : Victims of radiation exposure are left to struggle for justice due to legal ambiguities and the burden of proof. There is no victim-centric compensation framework for those affected by radioactive water pollution, leaving marginalised populations vulnerable.

4. There is poor access to data for the public on radioactive emissions: Agencies such as the AERB and NPCIL rarely publish site-specific radiation discharge data in the public domain. In contrast, the US Nuclear Regulatory Commission (NRC) provides real-time updates on emissions and leakages.In India, RTI (Right to Information) requests have often been denied citing national security, leaving citizens and local researchers without essential environmental data.[21]

5. Almost no role for public participation or consultation in the radioactive sphere: The Principle 10 of the 1992 Rio Declaration[22] affirms that environmental issues are best handled with the participation of all concerned citizens, at the relevant level. The Radioactive waste management in India is largely technocratic and closed-door, leaving the most vulnerable

[19] https://www.barc.gov.in/about/05.pdf
[20]https://www.downtoearth.org.in/environment/eia-2020-public-consultation-without-informing-the-public--72919
[21] Chetan Chauhan '83% increase in rejection of RTI applications on national security grounds: Data' Hindustan times, Mar 05, 2022. https://www.hindustantimes.com/india-news/83-increase-in-rejection-of-rti-applications-on-national-security-grounds-data-101646469748249.html
[22] https://www.unep.org/civil-society-engagement/partnerships/principle-10

populations voiceless.

6. There is also conflict of interest wherein the Department of Atomic Energy is both the promoter and regulator of atomic energy: such dual control weakens accountability and compromises objective safety audits.

Conclusion & Suggestions satisfying the set objectives

The radioactive pollution, though quite overshadowed by other kinds of pollution, given its invisible kind, but it possesses severe and long-lasting threats to both human health and ecological stability. The above research paper has set out investigations into the sources, legal gaps, justice deficits, and reforms related to this issue. The findings align with the objectives thus they are met. Let's understand each issue that we set out earlier separately. As for the first issue, ***its primary sources and social impact***, we understood that primary contributors to radioactive water contamination, especially in India, is or are uranium mining, spent fuel mismanagement, discharges from nuclear facilities, such as Jadugoda. These activities have had devastating consequences, particularly for rural or tribal communities, culminating into serious health disorders, polluted groundwater which further worsens both human health and other ecology. Recent data as given out by the Central Groundwater Board in its annual report has further revealed increasing uranium presence in groundwater, worsened by lack of safeguards on the ground.

The next issue was with respect to ***the regulatory framework of Radioactive Waste Management in India and whether it is adequate.*** Through our understanding now, we can infer that while laws such as Atomic Energy Act 1962 and Environment Protection Act 1986 remain enforced, their impact on the ground seems, to some extent, weak and opaque. And as for the Atomic Energy Regulation Board, though established for oversight, it operates under the Department of Atomic Energy, which is also a body to promote nuclear power. This leads to conflict of interest and further lack of trust of people who seek to rely on such authorities for safeguard and protection. This also leads to lack of just reporting as well, as observed in case of Jadugoda, thus, often leading to technical clearances without adequate engagement with affected communities and lack of transparency in Radioactive Waste Management.

With respect to our third issue, which was ***communities being affected***, especially the tribal communities, we have understood that these communities face disproportionate harm and lack

of access of meaningful redressal, there is lack of sensitization, public consultation, or informed consent, along with lack of environmental data transparency, which goes on to reflect, leading to isolation of these communities from justice and from right to life and right to safe environment that comes with it.

Lastly, we were to understand the ***path forward or legal or constitutional reforms***. Through this paper, we are able to conclude that this crisis could be addressed only by some comprehensive reforms, especially ones that could institutionalize strict liability and ensure victim compensation schemes along with periodic impact assessment and real-time emission disclosures. Then, some structural reforms are also needed to separate the regulatory and promotional functions of the authorities responsible in the nuclear sector to guarantee the independence and accountability and to reinstate the trust of people in these authorities. Moving forward, the constitutional commitments to right to life and clean environment under Article 21 should be translated into actual applicability on the ground when it comes to nuclear and environmental law and legal governance. Moreover, a greater role must be played by integrating community consultation, public access to environmental information and civil society monitoring into the process, so that these communities stay informed and they, merely due to their economic standards, are not left helpless or made to suffer.

REFERENCES

1. Deepali Marghade, Girish Mehta, Sagar Shelare, Ganesh Jadhav and Keval Chandrakant Nikam 'Arsenic Contamination in Indian Groundwater: From Origin to Mitigation Approaches for a Sustainable Future'. https://www.mdpi.com/2073-4441/15/23/4125

2. Uranium in the Water of Indian States – Is it Alarming?Posted on 12th July 2018 https://www.chaitanyaproducts.com/blog,

3. https://www-pub.iaea.org/MTCD/Publications/PDF/PUB2077_web.pdf

4. https://www.youtube.com/watch?v=-xsc_m10YX8&t=55s

5. https://www.aerb.gov.in/english/regulatory-facilities/radioactive-waste-management

6. https://india.mongabay.com/2025/01/government-report-highlights-groundwater-contamination-across-india/

7. 'About Health Effects of Radiation' CDC(gov.) February 19, 2024 https://www.cdc.gov/radiation-IMPACT OF URANIUM MINE ON HEALTH OF TRIBAL

8. 'About Health Effects of Radiation' CDS (gov.), February 19, 2024. https://www.cdc.gov/radiation-health/about/health-effects-of-radiation.html

9. 'G.Sundarrajan vs Union Of India & Ors on 6 May, 2013' CASEMINE. https://www.casemine.com/judgement/in/5c066ec7b338d127125a7529#:~:text=In%20the%20judgment%20dated%206.5,not%20violated%201991%20CRZ%20Notification.

10. Adrian Levy 'India's nuclear industry pours its wastes into a river of death and disease' publicintegrity.org, December 14, 2015. https://publicintegrity.org/national-security/indias-nuclear-industry-pours-its-wastes-into-a-river-of-death-and-disease/