Extractive Industry Toxicology: Study of Reproductive Health Protection based on the Fatwa of the Indonesian Women's Ulama Congress (KUPI)

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Abstract
The mining industry poses risks to the reproductive health of workers and their descendants. Exposure to toxins in mining areas causes reproductive health problems in male workers, which also affects women's reproductive health and leads to the birth of children with various disabilities. However, the Minerba Law and occupational safety regulations do not regulate protection against these risks. This study examines the framework of the Indonesian Women Ulema Congress (KUPI) to provide recommendations for protecting workers' reproductive health issues related to the extractive industry. The concepts used are adillah (arguments) and istidlal (analysis), which give rise to fiqhiyyah rules to emphasize the prohibition of all forms of destruction of fellow human beings and the natural environment. This approach has led to KUPI's recommendation (tazkiyah) to the state to prioritize workers' protection, especially for vulnerable groups such as women and children, and to ensure their protection from the toxic effects of the extractive industry through sustainable policy instruments and targeted programs.

Keywords: *KUPI, Extractive Industries, Reproductive Health, Toxicology, Women*

1. Introduction

In the extractive industry, particularly in the mineral and coal mining sectors, the release of hazardous materials into the environment is difficult to avoid. In some locations, mining activities have been shown to increase exposure to heavy metals, such as mercury, lead, arsenic, and cadmium, in the air, soil, and water surrounding mining sites (Singh, 2011, p. 102), which are known to cause serious problems for human reproductive health. Some of the impacts that can be caused include a decline in sperm quality, hormonal disorders, an increased risk of difficulty conceiving and miscarriage, and congenital disabilities in children (Giudice, 2016, p. 908). 908). These impacts are not only felt by miners who are directly exposed, but also by their partners and children through biological transfer or ongoing environmental pollution.

Several incidents in Indonesia highlight the severity of this issue. For example, in the Lebak and Sukabumi areas, small-scale gold mining has led to high levels of mercury in rivers and soil, resulting in negative impacts on the reproductive health of women and children in surrounding villages (Ismawati, 2020, p. 14). In Buyat, North Sulawesi, heavy metal pollution, particularly arsenic from gold mining activities, has led to an increase in reproductive problems, skin diseases, and the birth of children with health complications (Edrus, 2006, p. 77). A similar situation has occurred in East Kalimantan, where waste from coal mines has been shown to increase heavy metal levels in surface water used by the community for daily needs (Walhi, 2018, p. 32).

This phenomenon is not unique to Indonesia. The Minamata case in Japan is a classic example in which mercury waste from industry has caused neurological disorders and congenital abnormalities in hundreds of babies, including deformities and motor function impairment (Harada, 1995, p. 112). Similarly, in California, United States, research has shown that women living near arsenic mining areas

have a higher risk of experiencing problems during pregnancy (Shirley, 2019, p. 203). Similarly, in California, United States, research shows that women living near arsenic mining areas have a higher risk of experiencing problems during pregnancy (Shirley, 2019, p. 203).

Thus, although research on toxicology and health has long revealed the dangers of heavy metals to reproductive health, national regulations, such as Law No. 3 of 2020 concerning Mineral and Coal Mining, still focus primarily on technical aspects and physical work safety. Attention to long-term risks related to reproduction remains inadequate (Indonesia, 2020), creating an imbalance between health threats and applicable legal regulations. This situation is even more apparent when compared with advances in toxicology research over the past two decades.

Over the last 20 years, research in the field of industrial toxicology has made significant progress in understanding the impact of heavy metals and industrial chemicals on the reproductive system (Lafuente, 2009, p. 224). However, these studies still focus primarily on biomedical aspects without much consideration of social, ecological, gender, or ethical-spiritual perspectives. On the other hand, there are groups of women and children who are proven to be more vulnerable to various hazardous substances due to biological factors, social status, and the reproductive responsibilities they bear (WHO, 2016).

In contrast, studies linking industrial toxicology issues with religious ethical perspectives are limited. At this point, the thoughts of the Indonesian Women Ulema Congress (KUPI) are important. Using the Adillah, Istidlal, and fiqhiyyah principles in religious fatwa issuance, KUPI emphasizes that any action that causes harm to humans or the environment is considered mafsadah, which is contrary to the basic principles of Islam, especially the protection of life (hifz al-nafs), the protection of children/descendants (hifz al-nasl), and the protection of the environment (hifz al-bi'ah) (KUPI 2022). Although KUPI has issued several fatwas related to the protection of women and environmental justice, there has been no research that explicitly links these fatwas to toxicology issues in the extractive industry, which is currently experiencing rapid growth.

Accordingly, this study aims to fill this gap by analyzing the extent to which KUPI's ethical framework can be used as a basis for designing reproductive health protection for workers in the extractive sector. This study will explore how Adillah, Istidlal, and fiqhiyyah rules, which form the basis of the KUPI fatwa, can be applied in policy recommendations that are more gender-sensitive and in line with the development of toxicological risks that not only sacrifice the environment but also target women's reproductive health rights. Thus, this research makes three main contributions: first, it enriches the perspective of religious ethics in industrial toxicology studies; second, it strengthens the normative basis for reproductive health protection policies; and third, it broadens KUPI's discourse on environmental, health, and gender justice issues.

2. Method

This study employs a qualitative descriptive approach, specifically phenomenology with an interpretive paradigm, as it is well suited for interpreting data from diverse sources. The method used was evidence-based policy (EBP), an approach that formulates policies based on data, facts, and research results as a basis for decision-making (Firma Aditya et al., 2020). According to Guéguen and Marissen (2002), EBP involves input from policymakers or community leaders, scientific evidence, and data on phenomena in narrative or statistical forms (Monger, 2022) to develop evidence-based policies (Lentari, 2024).

The steps taken in this study are as follows: first, collecting data from literature reviews in the form of empirical research results, laws and regulations, academic papers, and media reports. Second, collecting data from interviews with religious leaders. The primary informants were female scholars who were members of KUPI, as key stakeholders who could provide relevant fatwas related to the findings of toxicological evidence of weak reproductive health protection for workers in the extractive industry. The analysis technique began with data reduction, followed by data presentation, and then drawing conclusions and verifying the data.

3. Discussion

Pollution from the extractive industry, especially small-scale mining, has become a serious threat to public health and the future of the next generation. Toxic waste, such as mercury, lead, and arsenic, dumped into rivers or contaminating the soil, enters the food chain and drinking water of the surrounding community (Mukti, 2023). Chronic exposure to these hazardous chemicals not only causes a decline in general health, such as respiratory disorders and skin diseases, but also has the potential to cause genetic mutations (Ajeng, 2024). The prevalence of illegal mining in Indonesia indicates the use of chemicals that do not meet health and safety standards (WALHI, 2023).

This can impact the reproductive health of workers and their families. This phenomenon is referred to as environmental toxicology, which focuses on the harmful effects of toxins (chemicals) on the ecosystem (Sembel, 2015). According to Soedjajadi (2020), toxicology has developed into three main branches: forensic toxicology, which relates to medical aspects; economic toxicology, which relates to harmful effects for specific purposes such as the use of pesticides in food; and environmental toxicology, which relates to the harmful effects of substances in the environment to which humans are exposed, namely environmental factors, food and beverages, as well as the workplace (Keman, 2020).

The influence of the extractive industry in the form of mining has created environmental toxicology that causes disorders in infants due to parental exposure to toxins that cause new congenital abnormalities, such as physical defects, cognitive disorders, and stunting (Sinaga, 2020). This demonstrates that these environmental crimes not only harm nature but also impact the health and safety of future generations. For example, children born with internal organ abnormalities (Sinaga, 2020), mental health problems (Guswahyuni, 2018), and respiratory disorders (Nashra, R. et al., 2025). Thus, chemical exposure has fatal consequences for the reproductive health of workers in the extractive industry.

Most mining workers do not receive reproductive health protection at work (Sinaga, 2020). Continuous exposure to toxins, such as mercury and lead, can cause reproductive disorders, ranging from infertility and miscarriage (Indrayanti et al., 2025) to genetic damage to sperm and eggs, which are then passed on to offspring (Daulay & Putri, 2024). In other words, not only is the environment contaminated, but the workers' own bodies have become carriers of toxins to their offspring, resulting in various congenital diseases in newborns.

3.1 The Phenomenon of Environmental Toxicology in the Extractive Industry

Environmental toxicology in the extractive industry has become a concern for many parties since the discovery of health issues affecting communities living in industrial areas. Previous studies have shown that 60% of workers (24 out of 40 people) experienced mercury poisoning in Cisarua Village (Sumantri et al., 2014). Additionally, 70.8% of miners were exposed to mercury in the Behe River (Grishela &

Tamba, 2017). In addition, infants were found to be born with organ abnormalities due to mercury from the mining industry in Mandailing, North Sumatra (Andriansyah, 2019; Sinaga, 2020). This evidence demonstrates that the health threats posed by the extractive industry are a pressing issue that urgently needs to be addressed.

Mercury exposure among workers, as recorded in Cisarua Village and on the Behe River, is directly correlated with the incidence of congenital disabilities in the Mandailing population. The mechanism is toxicological and direct: inorganic mercury vapor inhaled by parents at mining locations is converted in the body into organic methylmercury, a highly neurotoxic form (Ms et al., 2021). This compound then easily crosses the placental barrier, attacks the rapidly developing central nervous system of the fetus, and causes permanent damage that manifests as organ abnormalities (Grishela & Tamba, 2017).

The urgency of addressing this issue becomes even more critical when considering the vulnerability of female workers. In the context of male-dominated extractive industries, women's reproductive health is often neglected. Women who work or live near mines face the same risk of poisoning, as well as a double burden as prospective mothers. Mercury exposure in women increases the risk of miscarriage, stillbirth, and premature birth. This demonstrates that the impact of environmental toxicology not only harms individuals but has also become a matter of gender justice and the children's right to a healthy life. Therefore, efforts between the parties are needed to overcome the health crisis caused by the extractive industry.

Table. 1

Category	Number (Millions of People)	Percentage
Total Workforce	130,6	100%
Formal Mining Workers	1,67	1,28%
Illegal Mine Workers (Est.)	1.35 (Average)*	~1.03%

Based on recorded data, it can be concluded that the formal mining and quarrying sector in Indonesia employs approximately 1.67 million workers, accounting for 1.28% of the total national workforce of 130.60 million people. However, the real picture of labor absorption in this extractive industry is incomplete without considering the informal sector, where the Ministry of Energy and Mineral Resources estimates that between 1.2 and 1.5 million workers are involved in illegal small-scale gold mining (PESK). If these illegal workers are combined with formal workers, the overall contribution of the mining sector to the national workforce could reach approximately 2.2%–2.4%. This data reveals the extent of the community's dependence on the mining sector, while highlighting the vulnerability of more than one million informal workers who are generally unregistered and do not receive occupational safety and health protection, including from toxicological hazards such as mercury exposure, which threatens their reproductive health.

3.2 The Maqāṣid KUPI Framework and Its Relationship with Toxicology and Reproductive Justice

In the KUPI tradition, maqāṣid al-sharī'ah is viewed not merely as legal objectives but also as a moral perspective that helps understand social realities more fairly and humanely. Therefore, the protection of life (hifz al-nafs), the protection of the next generation (hifz al-nasl), and the protection of the environment (hifz al-bi'ah) are important aspects in assessing various types of damage, including chemical and ecological damage resulting from extractive industrial activities (Rofiah, 2017). KUPI updates the interpretation of these maqāṣids by integrating classical arguments (Adillah), contextual analysis (Istidlal), and scientific findings that have a direct impact on the lives of women and vulnerable

groups (Mahfud, 2019). Within this framework, industrial toxicology is viewed as a moral and religious issue that requires serious attention.

1. Hifz al-Nafs and the Dangers of Industrial Toxicity to Life Safety

From the perspective of hifz al-nafs, protection of life means the obligation to avoid all forms of threats that can endanger human survival. These threats are evident in cases of heavy metal pollution in Indonesia. For example, in Buyat, North Sulawesi, coastal communities have been found to suffer from neurological disorders, skin cancer, and congenital abnormalities linked to mercury and arsenic contamination from mining activities (Edrus, 2006). A similar case occurred in Poboya, Palu, where traditional gold processing practices resulted in high exposure to methylmercury among women and children, causing memory impairment, tremors, and decreased motor function (ATSDR, 2020).

The KUPI perspective interprets such conditions as a form of ecological injustice because they involve the loss of the fundamental human right to live healthily. In other words, damage caused by industrial toxins violates the principle of protecting human safety. This damage is certainly not merely a side effect of industry but also a moral violation that requires government intervention to prevent the spread of wider harm. At this point, the toxicological approach, which highlights the dangers of heavy metals, intersects directly with Islamic ethics, which emphasizes the responsibility to protect life.

2. Hifz al-Nasl and Women's Reproductive Vulnerability in Contaminated Environments

The principle of hifz al-nasl places a strong focus on reproductive health and the continuity of generations. In various toxicological studies, women are more vulnerable to hormonal disorders and reproductive problems due to exposure to heavy metals, such as cadmium, arsenic, and nickel. This vulnerability is evident in nickel-producing areas, such as Weda Bay in North Maluku. Women living near processing plants have reported menstrual problems, chronic anemia, premature births, and other pregnancy risks associated with air pollution and heavy metal contamination. From a hifz al-nasl perspective, these conditions constitute severe damage because they directly endanger reproductive functions that are essential for human survival.

Similar phenomena have been observed in various nickel mining locations in Southeast Sulawesi, including Baubau and its surroundings, where women report high incidents of prolonged coughing, abnormal menstrual cycles, and decreased fertility due to exposure to industrial dust containing hazardous particles (Sukmawati, 2023). KUPI views this reproductive disorder not only as a health issue but also as a violation of the Sharia principle that women's bodies are the first to feel the effects of environmental damage. Therefore, reproductive damage caused by exposure to toxic substances falls under the category of mafsadah, which the state and all existing social structures must avoid.

3. Hifz al-Bi'ah as an Ethical Foundation for Environmental Protection

For KUPI, hifz al-bi'ah is not merely a call to preserve nature but a fundamental principle that the environment is the means of life itself. Damage to nature threatens all maqāṣid. In KUPI Fatwa II (2022), it is explicitly stated that environmental damage caused by modern industry creates long-term risks that impact water quality, soil, air, the food chain, and the health of future generations. The case in Buyat demonstrates that heavy metal pollution has been proven to create a bioaccumulation chain in marine organisms, ultimately endangering humans when they consume the fish caught (Edrus, 2006).

In Poboya, pollution not only threatens humans but also damages water and soil ecosystems, demonstrating that industrial damage is a multidimensional environmental problem. KUPI believes that

actions that can cause damage as described above are contrary to Sharia principles because they have a significant effect on the destruction of the basis of community life. The environment is not merely a space for industrial activities but an integral part of human life that must be preserved in its dignity (Anshori, 2019).

Thus, it can be emphasized that the three maqāṣid principles demonstrate the method of fatwa in KUPI, which provides a solid ethical framework for analyzing toxicological issues in today's industry. By combining normative arguments, scientific research, and women's experiences, KUPI aims to expand existing religious understanding further, enabling it to address contemporary issues that have not been explicitly discussed in classical fiqh literature.

In the context of this study, this framework provides a clear theoretical basis that exposure to hazardous substances in industry is not merely an environmental issue but also a moral issue, a matter of reproductive justice, and a matter of protecting life. This approach ultimately resulted in recommendations (tazkiyah) from KUPI encouraging the government to take serious action to protect workers and communities living near extractive industries. This is because the damage caused by toxic substances is a form of oppression that contradicts maqāṣid al-sharī'ah and destroys human dignity and the future of generations (KUPI, 2022).

3.3 Ethics of Generational Stewardship (Hifz al-Nasl) and the Threat of Heavy Metals from the Perspective of Indonesian Female Scholars

In the view of the Indonesian Women Scholars Congress (KUPI), the issue of heavy metal pollution caused by extractive industries cannot be viewed solely as an environmental or health problem, but as a serious threat to ḥifẓ al-nasl, which places the protection and sustainability of future generations as an important element of maqāṣid al-sharī'ah. As a movement that accommodates scholars who develop a fatwa approach based on women's experiences, scientific data, and social analysis, KUPI argues that damage to the reproductive system due to exposure to mercury, lead, arsenic, or cadmium is a manifestation of injustice that destroys the potential for future life, both for nature and for humans (KUPI, 2022). From the perspective of generational care ethics, any industrial activity that endangers the health of infants, children, or fetuses not only contradicts the principles of humanity but also undermines the religious responsibility to preserve the continuity of offspring (Rahman, 2019).

Several toxicological studies have indicated that heavy metals can have long-term detrimental effects on child development, ranging from neurological issues, reduced IQ, hormonal disorders, and congenital disabilities (ATSDR, 2020). The Minamata case in Japan is a clear example of how mercury waste disposal has caused neurological disorders and abnormalities in hundreds of babies over a period of more than 20 years (Harada, 1995). In Hunan, China, cadmium accumulation from zinc mining activities has led to an increase in cases of infertility and developmental disorders in children among communities living near industrial areas (Zhang, 2012).

In contrast, research conducted in California revealed that exposure to arsenic in pregnant women in mining areas increases the risk of preeclampsia, low birth weight babies, and various other pregnancy complications (Shirley, 2019). This series of cases clearly demonstrates that the threat of heavy metals is a global phenomenon, indicating a clear pattern: when the environment is damaged, future generations will also be threatened.

The maqāṣid framework, as applied by KUPI, provides a crucial foundation for analyzing this scientific information. KUPI not only examines normative arguments regarding the prohibition of environmental damage but also considers evidence from the field of toxicology as a reason ('illat) that the damage caused by modern industry has gone beyond ecological hazards and continues to destroy future generations (Anshori, 2019) biologically. Thus, industrial activities that cause heavy metal pollution are considered a fasād that violates three maqāṣid at once, namely, the protection of life (ḥifẓ al-nafs), protection of offspring (ḥifẓ al-nasl), and protection of the environment (ḥifẓ al-bi'ah).

This assessment is consistent with medical and environmental ethics, which emphasize that future generations are the most vulnerable to heavy metal toxins because their biological processes are not yet fully developed (Giudice, 2016). The KUPI fatwa on "Protecting Women from the Impact of Ecological Crises" provides a concrete illustration of the application of the maqāṣid approach. In the fatwa, KUPI asserts that environmental damage that endangers women's reproductive health is a form of ecological injustice that the government must prevent.

This fatwa emphasizes that women, as bearers, caregivers, and protectors of the sustainability of future generations, bear a greater burden of biological and social risks when faced with environmental pollution (KUPI, 2022). Therefore, the government has a responsibility to regulate industries so that they do not produce pollution that adversely affects the health of pregnant women, fetal development, and child health. This fatwa serves as a normative basis, indicating that efforts to protect the environment are part of caring for future generations.

In the Indonesian context, KUPI's recommendations are significant because the regulatory framework governing occupational safety and health (OSH) outlined in Law No. 1 of 1970 and Law No. 3 of 2020 concerning Minerba does not explicitly include women's reproductive safety as an important element in risk analysis. These regulations focus more on technical aspects, worker safety in the workplace, and production efficiency. However, research shows that the impact of the extractive industry can affect the health of women who do not work in mines but live near industrial areas (Firma Aditya et al., 2020). This is where KUPI positions itself to offer a different perspective, that the protection of future generations cannot be separated from the protection of women's bodies, which function as reproductive organs.

Through this concept of tazkiyah, KUPI aims to encourage the government to immediately improve and adjust existing policies to align with maqāṣid. This recommendation emphasizes the importance of incorporating reproductive health indicators into the environmental impact assessment (EIA), occupational safety and health (OSH) certification, and routine environmental audits. KUPI also considers it important to ensure the participation of women, especially those who are survivors or live in affected areas, in the policy-making process, in accordance with the mandate of gender justice in maqāṣid (Hidayat, 2020). This approach encourages the government to not only reduce industrial risks to male workers but also to extend protection to the entire community by paying special attention to the most vulnerable groups, namely, pregnant women, women of childbearing age, and children.

Thus, through the combination of ḥifẓ al-nasl, toxicology, and socio-ethical fatwas, KUPI creates a religious framework that can connect the need to protect the environment and future generations. This approach is not merely a critique of development methods that rely on extraction but also offers a perspective that preserving the quality of future generations is a spiritual obligation and a national

responsibility. As a female cleric, KUPI emphasizes that protecting women from exposure to hazardous substances is the first step in safeguarding the future of humanity as a whole.

4. Conclusion

The extractive sector in Indonesia has created an environmental health emergency that directly impacts the reproductive health of workers and surrounding communities, particularly women and children. Although the impact is alarming, national legal frameworks, such as the Minerba Law and OHS standards, still do not provide adequate protection against reproductive risks, with a focus on technical aspects and physical safety in the workplace. The Indonesian Women Ulema Congress (KUPI) provides a strong religious ethical framework through maqāṣid al-sharī'ah in its three forms, namely hifz al-nafs, hifz al-nasl, and hifz al-bi'ah, to evaluate and address toxicological issues in industry.

KUPI emphasizes that industrial pollution is a form of damage (mafsadah) that simultaneously violates all three basic principles, as it damages life, offspring, and the environment. The Adillah and Istidlal approaches used by KUPI incorporate scientific evidence, women's experiences, and moral judgments, resulting in recommendations (tazkiyah) for the government to take more serious and systematic action. Thus, this study demonstrates that reproductive health protection in the extractive sector is no longer solely relevant as a technical medical issue but must be viewed as a matter of ecological justice, gender justice, and the government's moral responsibility.

The KUPI approach makes a significant contribution to broadening the discussion on the relationship between religion, the environment, and reproductive health. It provides a normative basis for the government to formulate policies that are more gender-sensitive and evidence-based. The implementation of this framework is expected to result in policies that protect mine workers and ensure the safety of future generations from the toxicological risks associated with the extractive industry.

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