

# From environmental contamination to policy reform: Radiological impact of unregulated tin-tailing in support of Malaysia's Nuclear Safety Framework

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The tin-tailing processing industry in Malaysia has long operated with minimal regulatory oversight, particularly regarding radiological safety and environmental management. This has resulted in significant exposure risks to workers and surrounding ecosystems due to elevated level of Naturally Occurring Radioactive Materials (NORM) and heavy metals. Radiological Impact Assessment (RIA) conducted on environmental sample revealed concentrations of radionuclides such as  $^{226}\text{Ra}$ ,  $^{232}\text{Th}$  and  $^{40}\text{K}$  ranging between 0.1-10.0, 0.0-25.7, and 0.1-5.8 Bq/g, respectively. These levels contributed to annual effective doses (AEDs) exceeding the 1 mSv/y limit recommended by UNSCEAR and enforced by AELB. Correspondingly, the calculated radium equivalent activity (Raeq) indicates potential gamma-ray hazards to human health. Heavy metal pollution indices also demonstrated substantial contamination, particularly arsenic (As) and iron (Fe), with average exposure through soil ingestion and dermal contact exceeding tolerable thresholds, raising both non-carcinogenic and carcinogenic health concerns for industry workers. Statistical correlations between NORM and trace elements further highlight the compounded environmental burden. The current situation is exacerbated by the 1994 exemption order, which excluded this industry from compliance with the Atomic Energy Licensing Act 1984. Despite clear evidence of radiological of radiological harm, regulatory response and industry accountability remain limited. Lessons from other countries show that strict enforcement, comprehensive regulations, and punitive measures are effective in mitigating such risks. This study underscores the urgent need for Malaysia to reform its nuclear safety framework to safeguard public health and environmental sustainability in the face of ongoing tin-tailing activities.

## Technical Track

Nuclear Applications and Radiation Processing

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