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A Study on Health Effects of Uranium Mining Waste in Tanzania

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1. Introduction

The radioactive waste generated from uranium and thorium mining and milling activities contains only radioactive materials in low concentration. However, these waste are generated in large volume compared with waste from other facilities. Due to long lived radionuclides content in the waste, proper management of these waste is one of great concerns [1]. Many residue from bulk Naturally Occurring Radioactive Materials (NORMs) contain elevated levels of natural radionuclides. In uranium mining, residue are coming from waste rock, tailings, treatment sludge and clean waste. Potential exposure is from waste rock since it contain elevated level of radioactivity (radon, elevated gamma fields and uranium/radium leachates) [2]. This study was conducted to assess the health effects of uranium mining waste and from there to be able to suggest the possible recommendation(s) for the purpose of radiation protection.

2. Method and Materials

A. Study Area

The study area is Mkuju River uranium mine which is located in Namtumbo district in Ruvuma region, southern of Tanzania between 9° 59'50" to 10° 07' 15" S and longitudes 36° 30' 00" to 36° 37'55" E. This area hosts a viable uranium deposit in sandstone of about 25,200 tU. The annual production is estimated to be 1,600 tU yr^{-1} at maximum capacity over a minimum period of 13 years. The weather pattern that most likely influences pollution of the atmosphere in this area is characterized by two major seasons. The first is a rainy season, which commences in January and ends in April with an average rainfall of 70 mm and temperatures ranging from 11 to 29°C. The second is a dry season, which commences in May and ends in December with temperatures ranging from 14 to 37°C[3]. The closest village (most exposed population) to the site was identified to be Likuyu-Sekamaganga which is situated 53 km from the site.

Figure 1. Location of Mkuju river project [4].

B. Model Description

In this study, the MILDOS-AREA 4 computer code was used to calculate the off-site radiation dose within 80 km radius. This computer code was developed by Argonne National Laboratories for U.S. Nuclear Regulatory Commission (U.S NRC). This code is used to estimate the radiological impacts of airborne emissions from uranium mining and milling facilities. The license applicants and U.S NRC has been using this code routinely in different uranium recovery operations for radiological impact and compliance evaluation purposes. This computer code consider a Gaussian plume dispersion model to calculate radiological release and transport root from point sources and different area sources. The transport model included mechanisms such as radioactive decay, plume depletion by deposition, ingrowth of daughter radionuclides, and re-suspension of deposited radionuclides. The considered pathways are: inhalation; external exposure from ground shine; cloud immersion; and ingestion of vegetables, meat, and milk [5]. Available to the code include the individual dose commitments, total individual dose commitments and annual population dose commitments. The conversion factors for calculations of the committed dose are derived from recommendations of the International Commission on Radiological Protection (ICRP) and it considers age-specific [6]. This computer code is capable of estimating dose received by various receptors with the largest source of emissions being stockpiles, tailings impoundments, and uranium dryer stack [7].

C. Input Parameters

The input parameters used in this code includes the source term for with their decay progenies. Meteorological information is another input parameter needed to be defined because re-suspension and dispersion of radionuclides from point and area sources are significantly influenced by meteorological conditions [8]. These meteorological information include wind speed, wind direction, stability class, and ambient temperature. The input for the nuclide specific activity in the waste was obtained from the environmental impact assessment (EIA) report (2012), and considered all the waste generated in by the tailings, waste rock etc.

Table I. Specific activity concentration (EIA Report).

Nuclide	Concentration (Bq/kg)
U-238	28.4
Th-230	30.3
Ra-226	30.3
Pb-210	30.3

3. Results and Discussion

The results of this study are presented in table II and table III for the individual dose and population dose respectively. From these results it shows that the dose from the waste (tailings and waste rock) seem to be small compared to the recommended dose of 1mSv/year. Therefore, there is no potential radiological concern about these radioactive waste. However, since the waste are in bulk materials that is a large volume of tailings, the waste materials may represent the potential exposure especially for long period of exposure. On the other hand, the radionuclide contained in the tailings are long lived radionuclides, therefore their existence in these tailing will be the challenging for the public and/or environment.

Table II. Individual doses by pathways.

Exposure Pathway	Effective Dose (mSv)
Groundshine	5.73E-06
Cloudshine	2.19E-05
Inhalation	9.55E-03
Plant Ingestion	2.18E-05
Meat Ingestion	3.87E-06
Milk Ingestion	2.11E-06
Total	9.61E-03

Table III. Population doses by pathways.

Pathway	Dose (Person-mSv)
Groundshine	1.61E-04
Cloudshine	1.14E-02
Inhalation	4.77E-01
Total	4.89E-01

4. Conclusion

The objective of this study was to assess the health effects of uranium mining at Mkuju River Project in Tanzania. The results of this study shows that there is no potential radiological concern about these waste since the dose calculated is very low. However, since these radionuclide waste are in bulk volumes (large amount of tailing), they can represent significant exposure considering the fact that the radionuclide contained in these materials are long lived radionuclides. Therefore, proper management of these radioactive waste should be adhered.

Acknowledgement

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