Evaluation of Radiological Impact of Abandoned Uranium Mining in Mika, Nigeria

Paper Presentation

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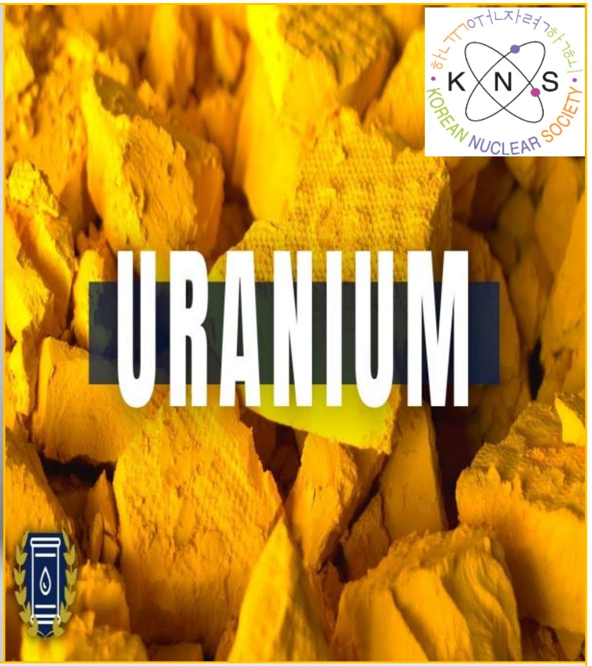
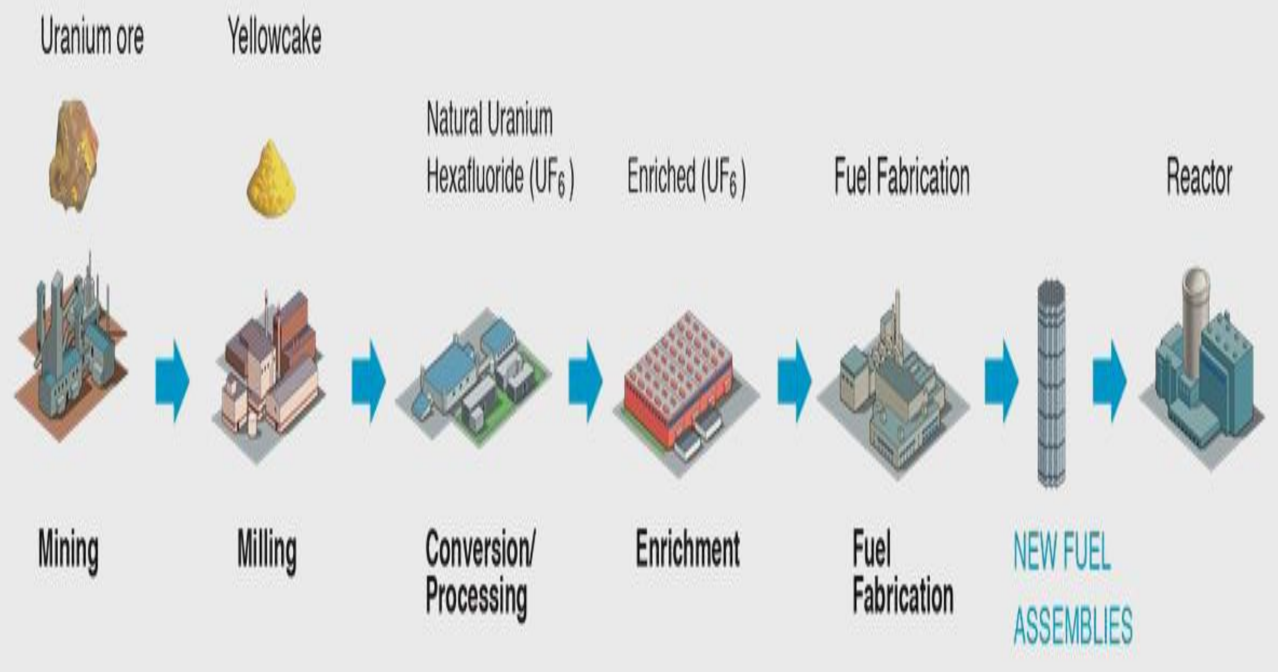
Introduction and Overview

What is Uranium?

- ❖ Uranium is a naturally occurring radioactive element that is found in rocks and soils.
- ❖ Uranium mining involves extracting uranium ore from the ground through various methods.
  - ✓ After extraction, the ore undergoes processing to produce uranium concentrate.
  - ✓ Mining is usually the first step of the nuclear fuel cycle
- ❖ Radiological and environmental assessments are crucial in uranium mining in order to;
  - ✓ protect the population/miners from health risks like lung cancer, silicosis and various respiratory diseases
  - ✓ prevent contamination of water and soil that could harm nearby communities.





Uranium potential in Nigeria

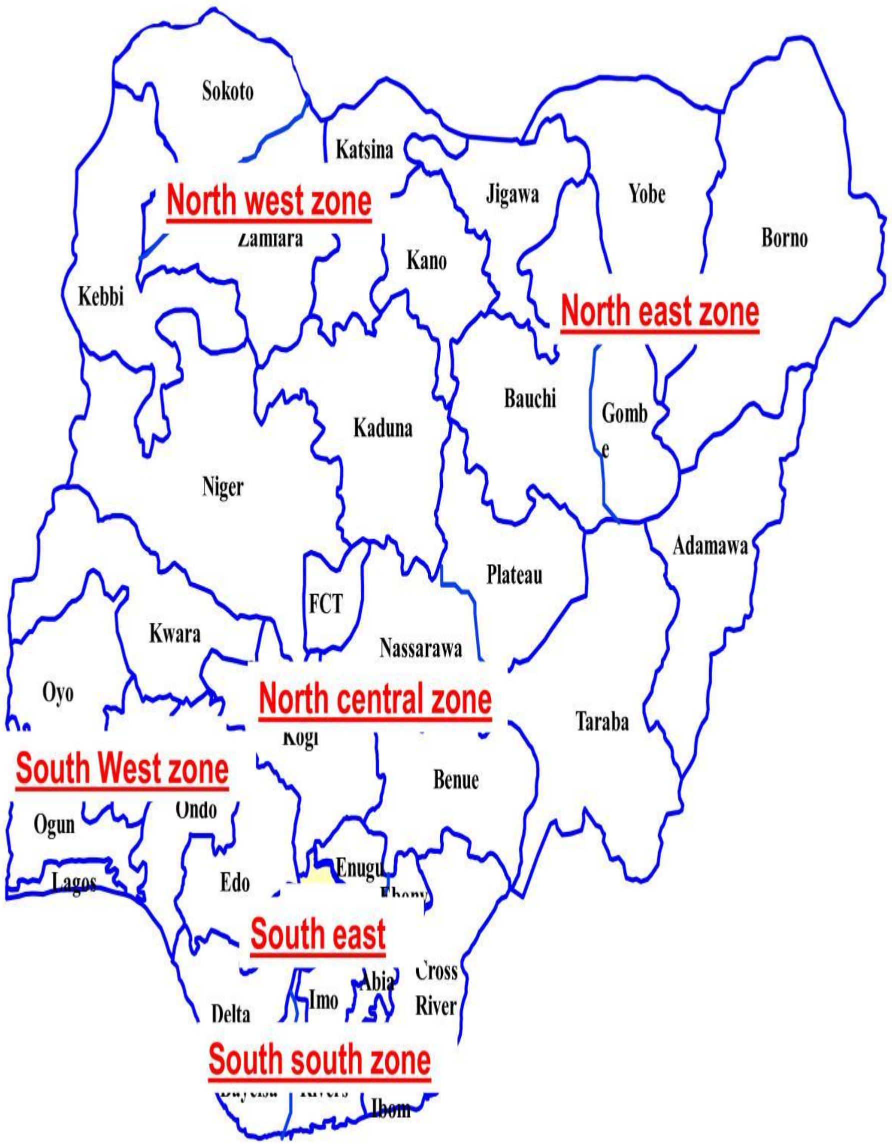
❖ Nigeria has favorable uranium potential, with known occurrences of commercial mineralization, particularly in the northeastern region.

❖ Uranium exploration in Nigeria began;

- ✓ 1970s, NUMCO (exploring & exploiting)
- ✓ Discovered in many parts along with Mika (estimated uranium reserve of 52T eU with a grade of 0.63% eU at a depth of 130m)

❖ After the uranium exploration by NUMCO in Mika;

- ✓ An open pit small scale uranium mining was carried out and the abandoned pit is a source of concern to the residents.



Objectives and Significance of the study

Objectives

❖ The study aims to assess the present and future radiological and environmental effects of the abandoned pit on the neighboring residents.

❖ To furnish data that can serve as source material for crafting an environmental impact assessment literature.

Significance

➢ To address concerns from residents by providing practical facts on the current and future effects of mining, as there are strong renewed interest by the Nigerian government to continue uranium expedition

➢ To alleviate public apprehension by some activists.

➢ The study promotes environmental conservation, regulatory compliance, and responsible mining by providing the groundwork for assessing environmental impacts and adhering to radiation protection standards.

Previous literatures

Author/Title of study	Information	Publication Year
John S. O. O, et al **Natural radionuclides in rock and radiation exposure index from uranium mine sites in parts of Northern Nigeria**	**Methodology:** Activity concentrations of natural radionuclides of ^{238}U and ^{232}Th in granitic rock samples from uranium mine sites in parts of northern Nigeria were measured using inductively coupled plasma-mass spectrometry. **Findings:** The highest concentrations were found at Mika and Riruwai communities. **Conclusion**: That terrestrial gamma radiation from granitic rock in the study area does not pose significant radiation exposure risks to workers and residents.	2020
Rweyemamu M & Kim J: **Potential environmental hazard to the public from the operation of uranium mining and milling facility in Mkuju River Project in Tanzania**	**Methodology:** MILDOS-AREA and RESRAD-OFFSITE codes were employed to estimate off-site radiological doses. **Findings:** Results indicated that estimated doses for the nearest residence were below the dose limit and dose constraint recommended by the International Atomic Energy Agency (IAEA). **Conclusion:** there were no potential radiological concerns associated with uranium mining at the Mkuju River Project.	2020
Soja J.R, et al: **Estimation of Public Radiological Dose from Mining Activities in some Selected Cities in Nigeria.**	**Methodology:** The study estimated public radiation doses around mining areas in selected Nigerian cities. **Findings/conclusion:** Results indicate that the calculated mean activity concentrations resulted in maximum doses below the International Commission on Radiological Protection (ICRP) recommended public dose limit of 1 mSv/yr.	2022

Materials and methods

- ❖Description of the study area
- ❖Methodology
- ❖Meteorological data and Dispersion
- ❖MILDOS Input parameters
- ❖Source types and receptors information
- ❖Population and Ingestion parameters

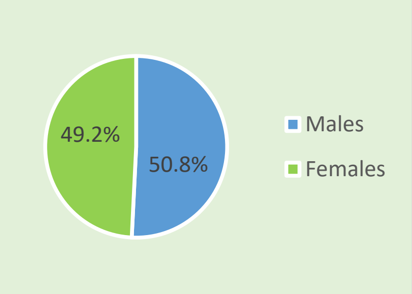
Description of the study area

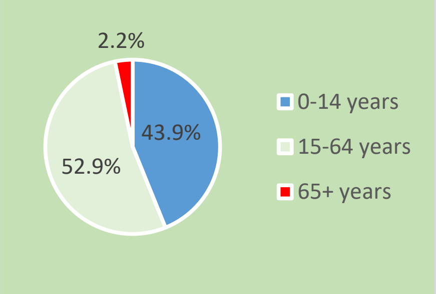
(Mika → Yorro LGA → Taraba State → Northeast → Nigeria)

Meteorology: 2 seasons(Dry and wet)

- 7 months dry (Coldest month-January)
- 5 months rain (Wettest month-August)

1275km^2





located on latitude 8˚58′34.5″N and longitude 11˚37′34.81″E in Yorro LGA, Northeast-Nigeria

Methodology

MILDOS

- Used for estimating the radiological impacts arising from airborne emissions at the uranium mining site

TEDE

- Annual total effective dose equivalent to selected receptors (FB,GA,NR,NV)

ANALYSIS

- Impact analysis to public health and environment

Meteorological Data and Dispersion

- MILDOS-Area uses the Gaussian plume equation for modeling of meteorological parameters as shown below;

$$C_a(i,x,y,z,t) = \frac{Q_{x_i}}{(2\pi)^{3/2}\sigma_y^2\sigma_z} exp\left(\frac{-r^2}{2\sigma_y^2}\right)\left[exp\left(\frac{-(z-H)^2}{2\sigma_z^2}\right) + exp\left(\frac{-(z+H)^2}{2\sigma_z^2}\right)\right]$$

Where,

C_a (i, x, y, z, t) = air concentration of radionuclide i at (x, y, z) from a release at (0, 0, H) at time t after release (Ci/m^3),

Q_{xi} = depleted source strength of nuclide i at a distance x (Ci)

Ϭy= horizontal dispersion coefficient (m)

Ϭz = vertical dispersion coefficient (m)

$r^2 = (x - u_H t)^2 + y^2$ is the square of the distance from the receptor to the plume center (m^2) [assumes Gaussian symmetry, that is σx = σy],

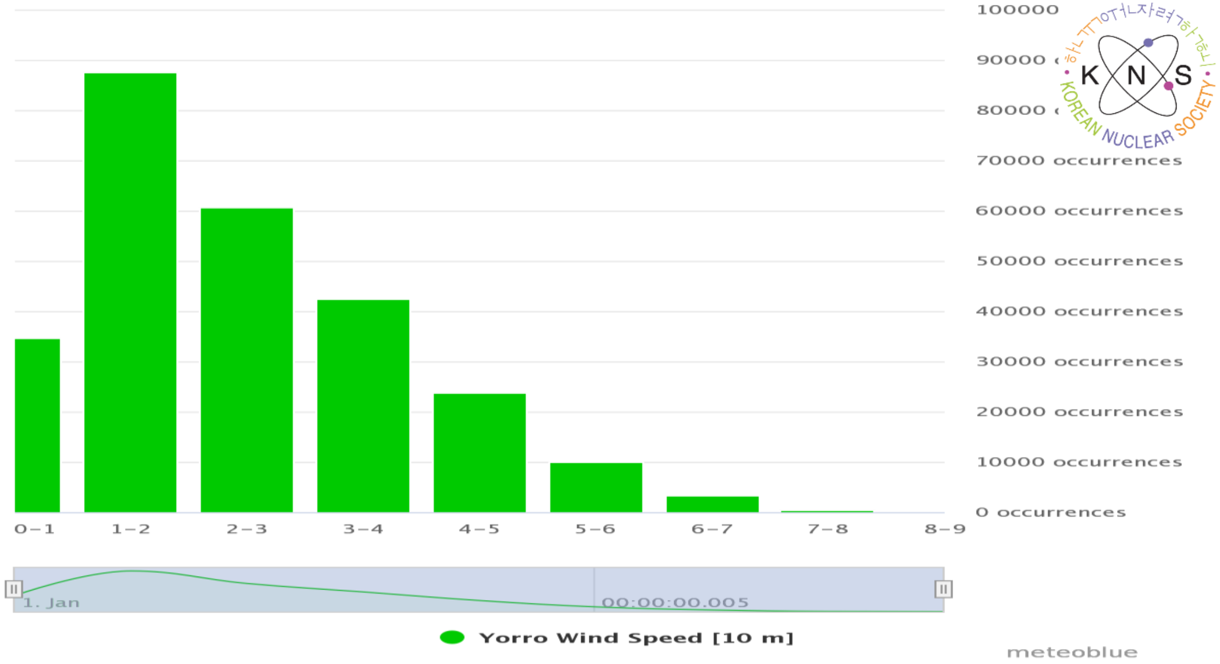
x = downwind receptor distance from the release point (m),

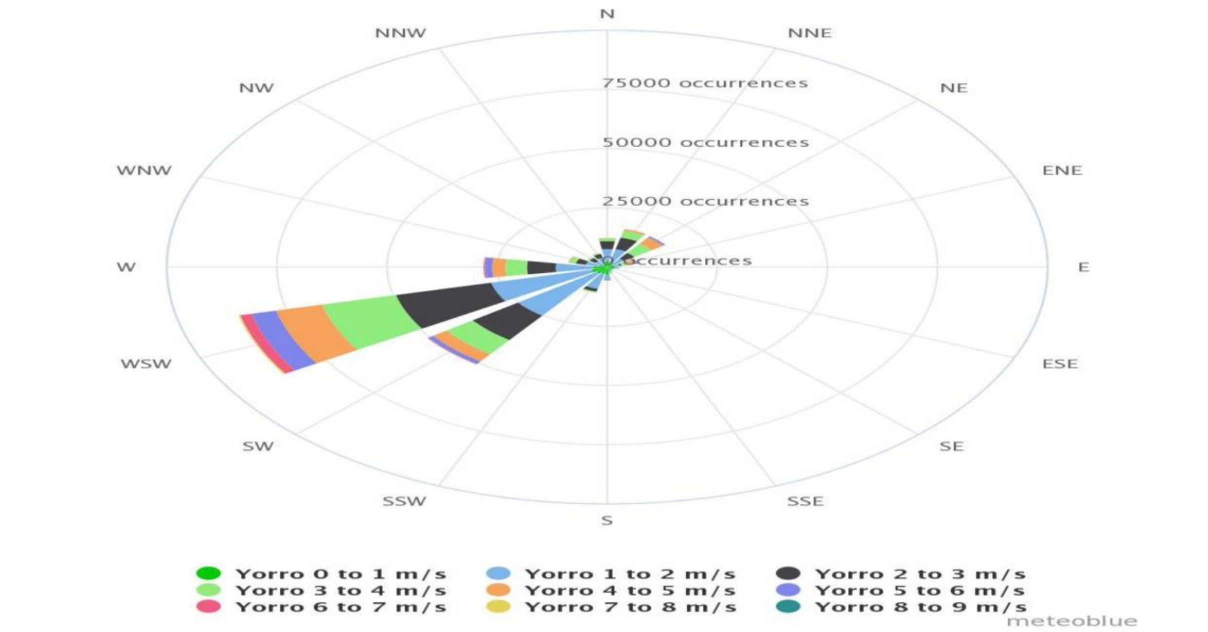
y = crosswind distance from the plume centerline (m),

u_H = average wind speed at the effective release height (m/s)

t = time following release (s), and

H = effective release height (m)

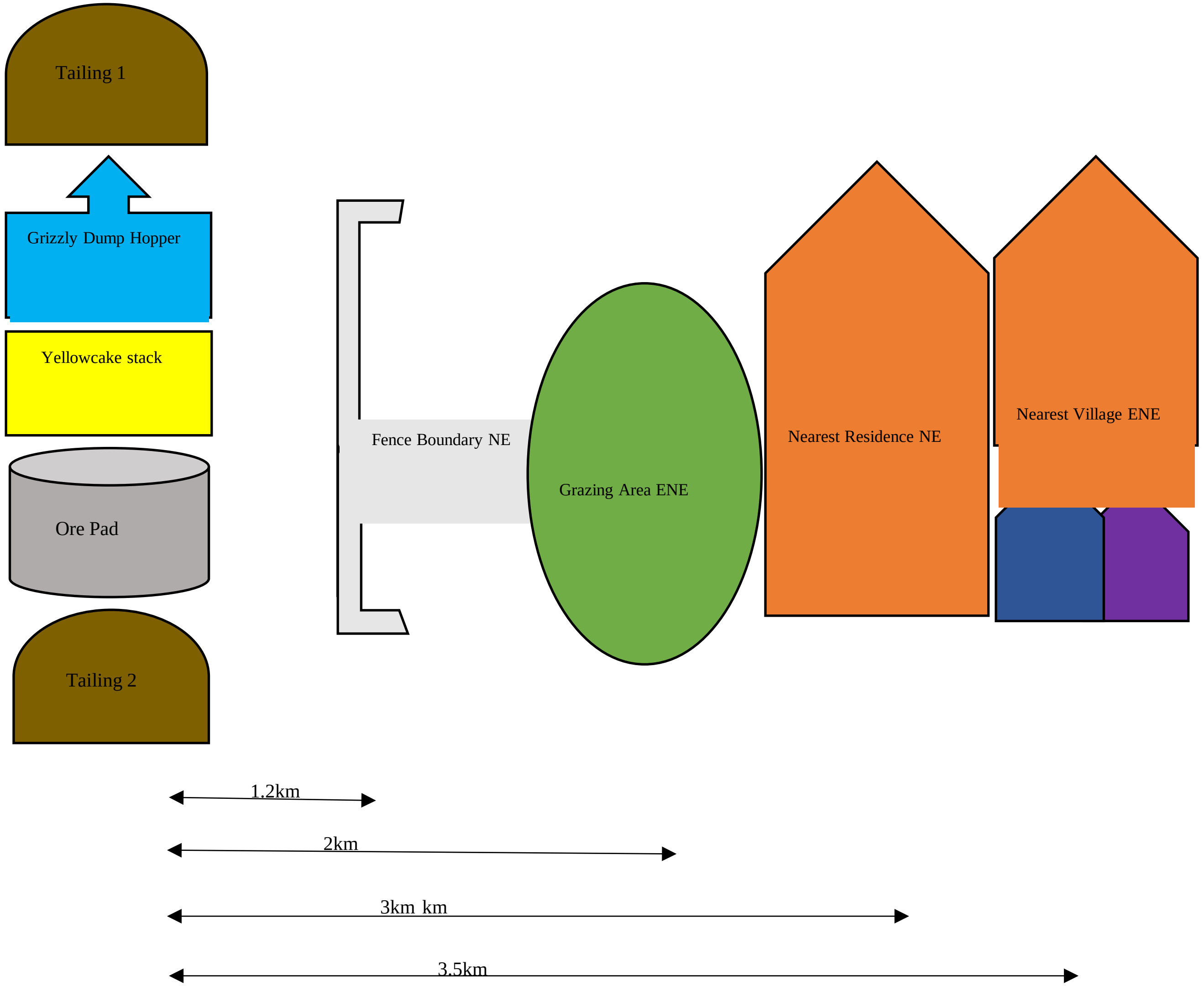


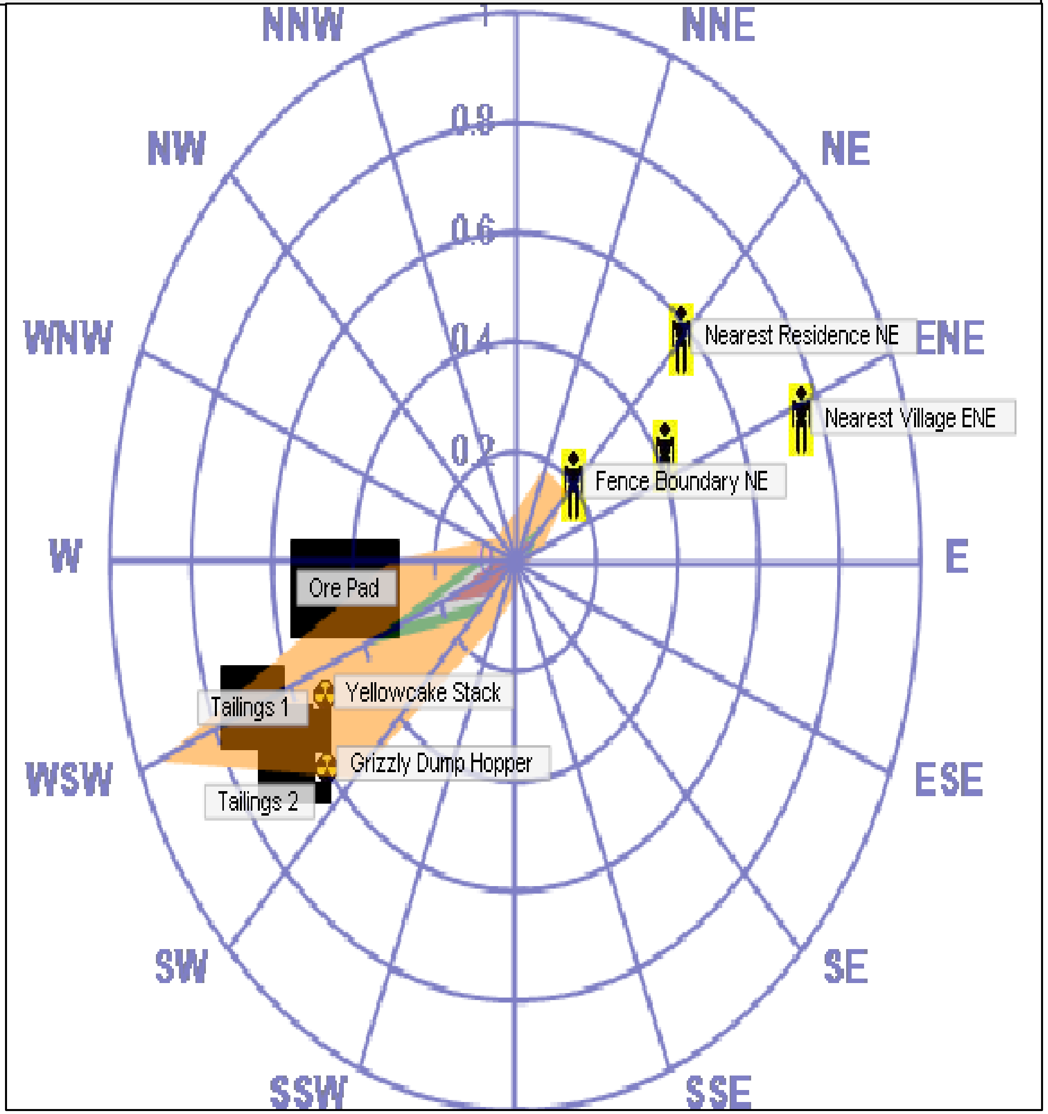


MILDOS Input Parameters

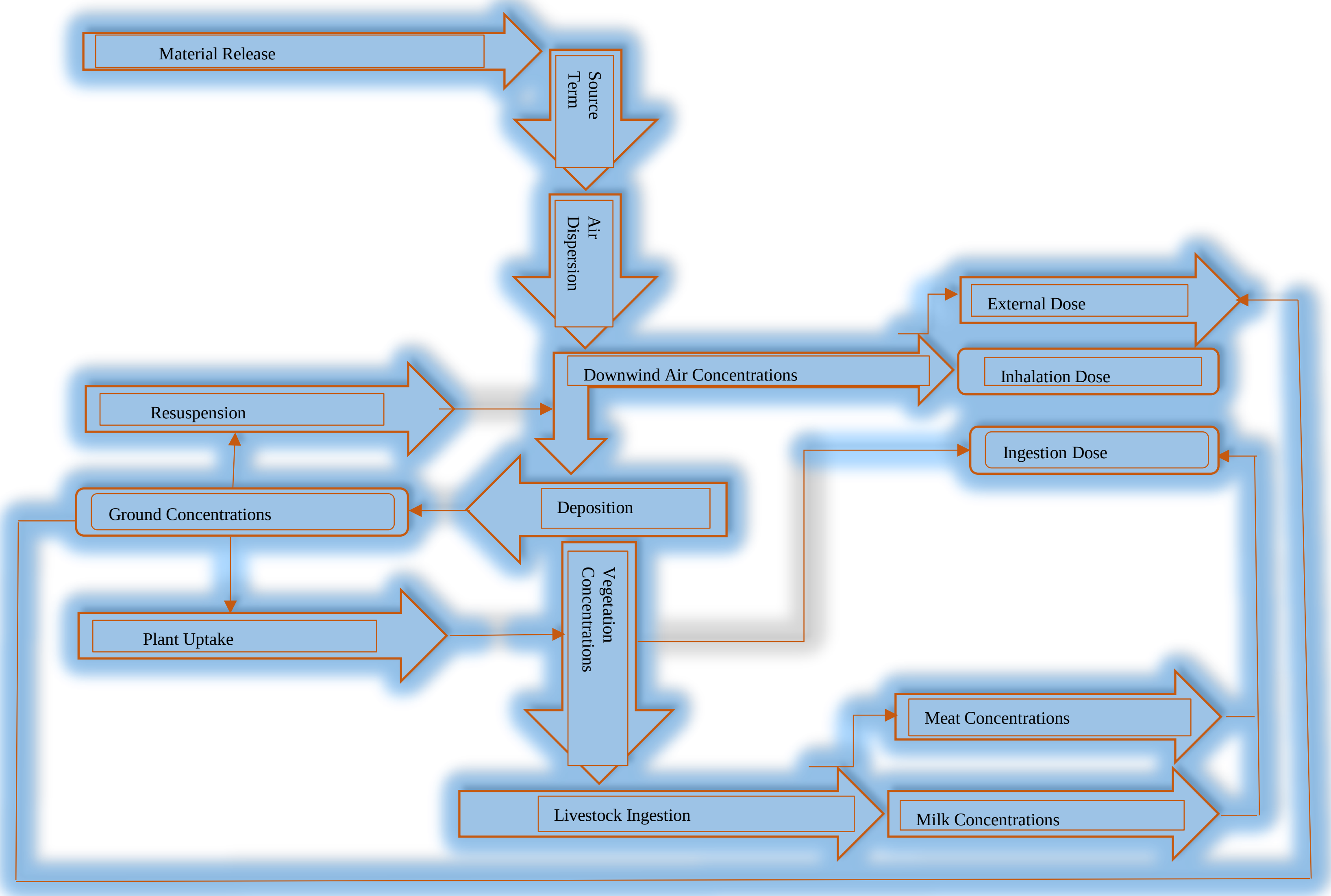
Items	Description
Receptors Considered	Fence boundary NE Grazing area ENE Nearest residence NE Nearest village ENE
Source types	Yellowcake stack Ore pad Grizzly dump hopper Tailings 1 Tailings 2
Radionuclide & activity concentrations: ^{238}U, ^{234}Th, ^{234}U, ^{230}Th, ^{226}Ra, ^{210}Pb, ^{210}Po (secular equilibrium) ^{232}Th, ^{228}Ra, ^{228}Th, ^{224}Ra (secular equilibrium)	^{238}U: 84.447 pCi/g ^{232}Th: 53.669 pCi/g
Metrological parameters: Seasons Rainfall Rate (mm/yr) Ambient Temperature (K)	 2 (Wet and Dry) 100 283
Others	Population and ingestion parameters (vegetables, meat and milk)

Individual receptors and source types

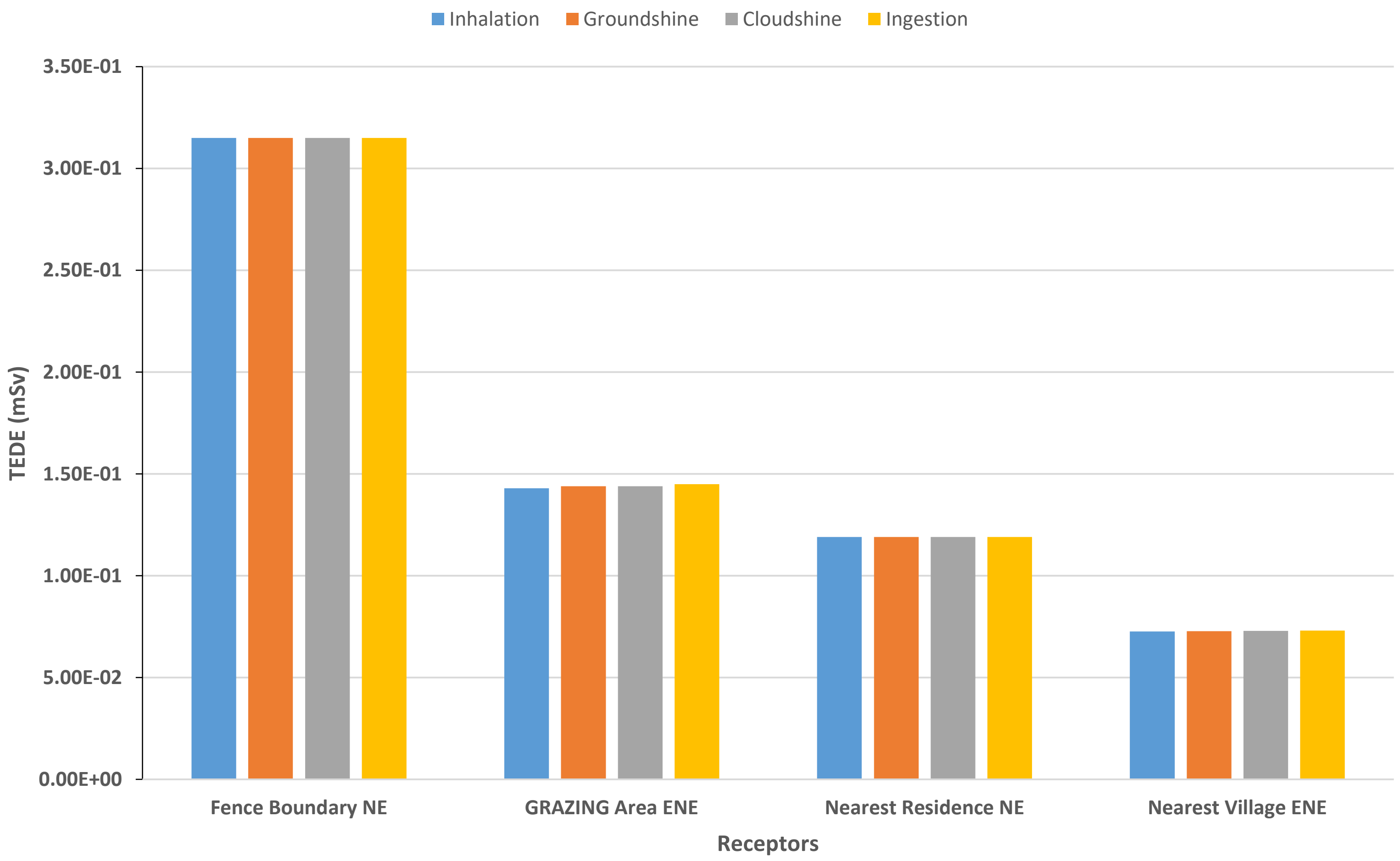




Structure of exposure pathways in MILDOS-AREA



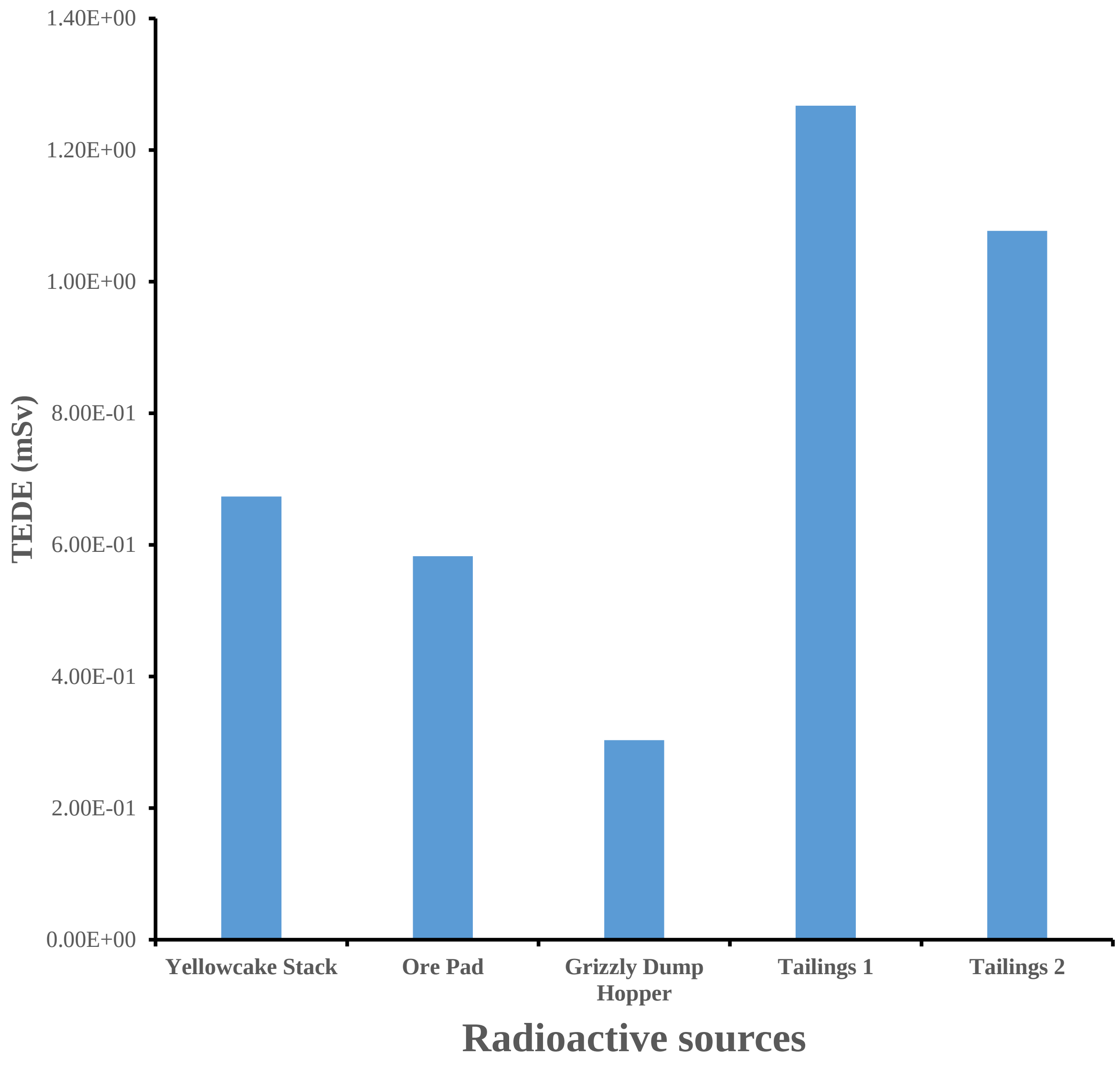
TEDE across receptors

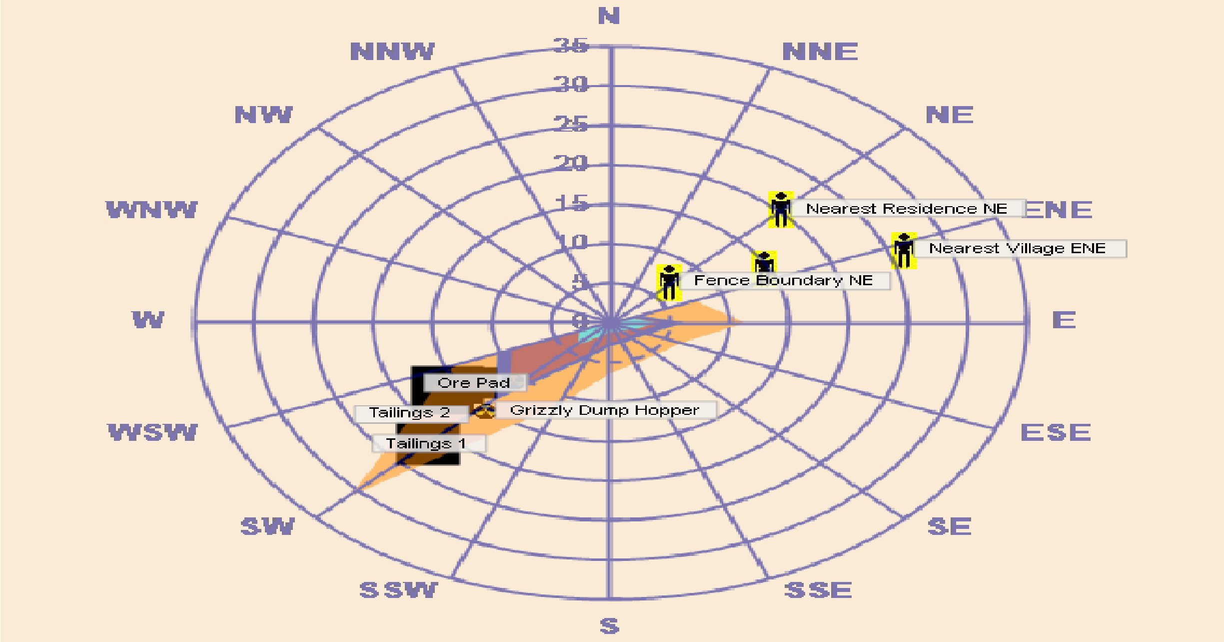


- Fence Boundary NE = 3.15 * 10^{-1} mSv/yr
- Grazing Area ENE = 1.43 * 10^{-1} – 1.45m 10^{-1} Sv/yr
- Nearest Residence NE = 1.19 * 10^{-1} mSv/yr
- Nearest Village ENE = 7.26 * 10^{-2} – 7.30 * 10^{-2} mSv/yr

- Decrease in TEDE with distance
- TEDE generally below 1 mSv/yr for public exposure

TEDE across major sources





- ❖ The study identified tailings, a byproduct of surface mining operations, as the primary radiation source of concern due to its concentrated radioactive elements. Proper waste management methods are crucial to mitigate radiological risks associated with waste rock.

Summary and Conclusion

❖ **Study Focus**:

Evaluating the radiological impacts of uranium mining in Nigeria's Mika region

❖ **Data Used**:

- ✓ 30 years of historical meteorological data
- ✓ Previous geological data

❖ **Modeling Technique**:

- ✓ MILDOS code used to analyze radiological impacts, TEDE

❖ **Safety Standard**:

- ✓ TEDE Generally met ICRP/IAEA's 1 mSv/yr threshold

❖ **Key Research Findings**:

- ✓ The study identified tailings, a byproduct of surface mining posing radiological risks, source of increased radon gas and dust to the public

❖ **Recommendation**:

- ✓ Effective waste management is vital to reduce associated radiological risks.
- ✓ The study suggests that adopting the In-situ Recovery mining method is an effective approach to mitigate the risk of excessive tailings exposure, which could lead to increased radiation exposure for nearby populations and potential public health impacts.
- ✓ The study's findings have broad implications, guiding uranium mining methods, supporting environmental management, and urban planning.

Thank You

Questions?