Uranium Tailing and Their Influence on Antimicrobial Resistance to Clinical Antibiotics

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Introduction

- The emergence of Antimicrobial Resistance (AMR) continues to be a leading concern for human health and poses a huge obstacle for hospitals and other clinical facilities globally (Gao, Y et al, 2024 & Salam et al, 2023).
- The rise of AMR stems from a variety of factors, such as the misuse of antibiotics and unsanitary living environments (Alam et al, 2025).
- Uranium mining on the Navajo Nation led to many mines being abandoned in remote areas, posing a major health risk factor to the local communities, causing cancer, and other serious illnesses.

Figure 1. Antimicrobial resistance showed on MHA.

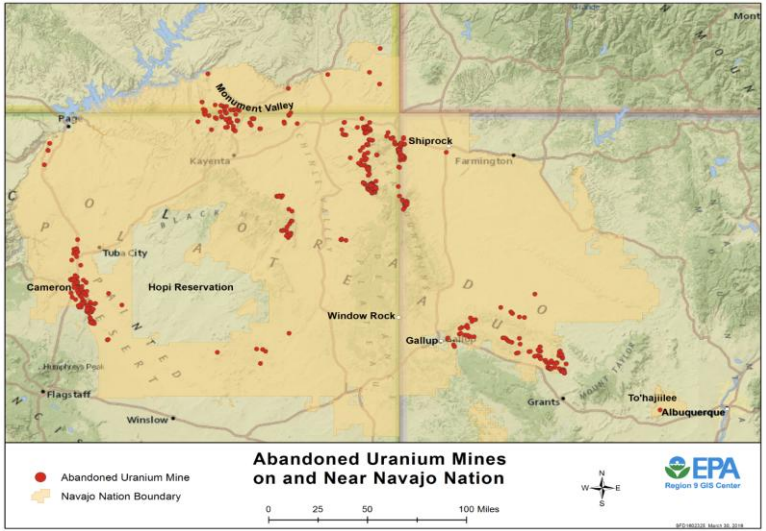

Figure 2. A map of all the Uranium mines on the Navajo Nation.

Hypothesis

- There will be more antimicrobial resistance in location where there is higher uranium concentrations.

- Minimum Inhibitory Concentration (MIC) strips will reveal more resistance in locations where the concentration of uranium high.

- Locations with high concentrations of uranium will have much higher bacterial colony forming unites (CFU).

Research Question

- What will the MIC levels and Disk diffusion be in places that have higher uranium by-products, compared to other locations with lower uranium by-products?

- What in vitro effects of Uranium tailing have on bacterial CFUs?

Objective:

- To quantify and compare the effects of MIC strips to locations with high levels of clinical antibiotics.

- To compare bacterial CFU density in uranium-contaminated soils versus nearby uncontaminated soils to quantify the impact of radioactive stress on microbial viability

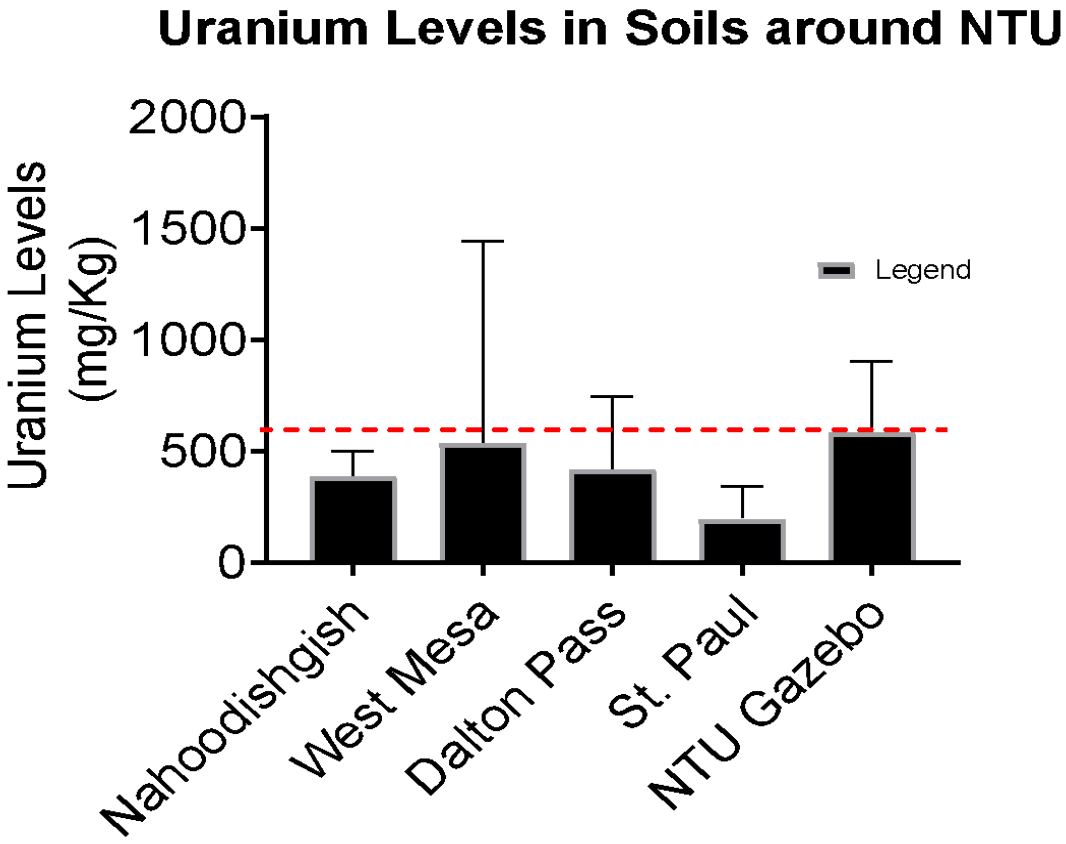

Figure 4. Shows levels of uranium levels by location (Tabaha et al, 2021).

Methods:

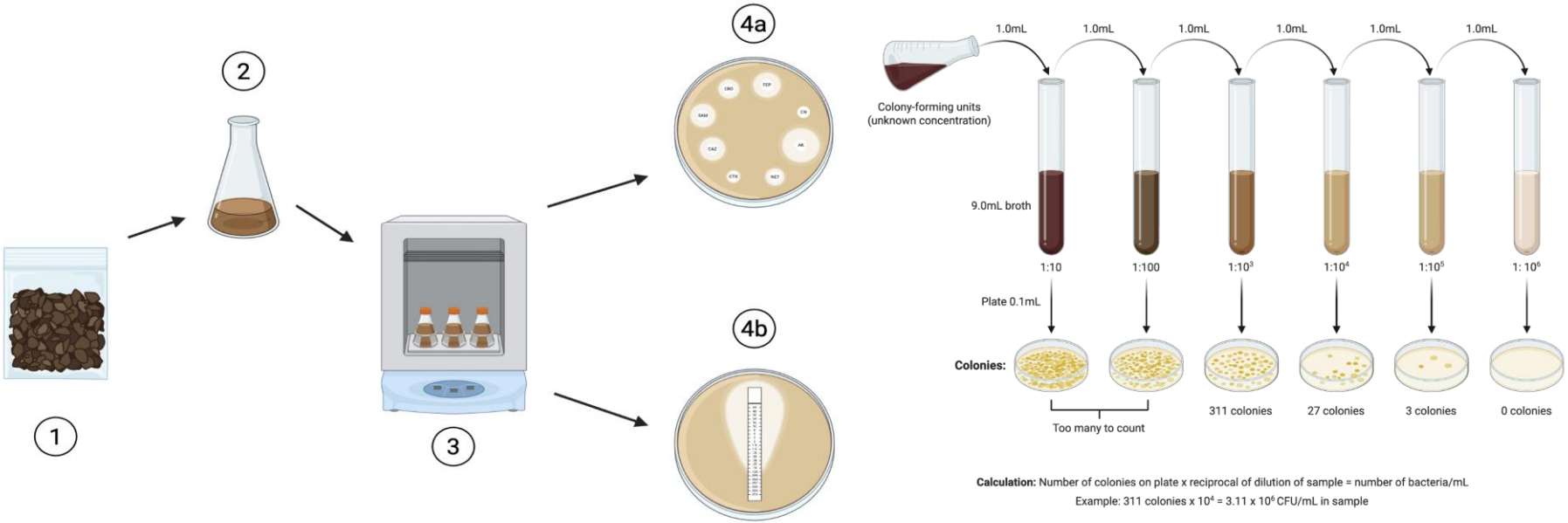

Figure 3. Left) Step 1. A total of 5 sites were collected from around the Crownpoint area. Step 2. Soil was cultured in nutrient broth and in step 3, the mixture was incubated overnight in a shaking incubator. 4a and 4b. After overnight incubation, the well diffusion and MIC was used on Mullher hilton agar (MHA). Right) is the serial dilution to count bacterial colonies.

Antibiotic Name	Initial	Treatment
Amoxicillin-clavulanic acid	AMC	Sinusitis, pneumonia, ear infections, bronchitis, urinary tract infections (UTIs), and skin infections.
Trimethoprim-sulamethoxazole	SXT	Urinary tract infections, middle ear infections (otitis media), bronchitis, traveler's diarrhea, and shigellosis (bacillary dysentery).
Levofloxacin	LEV	osocomial pneumonia, community-acquired pneumonia, acute bacterial rhinosinusitis, acute bacterial exacerbation of chronic bronchitis, acute bacterial prostatitis, acute pyelonephritis, urinary tract infection, skin or skin structure infections, and prophylaxis.
Penicillin G	P	Syphilis, gonorrhea, meningitis, pneumonia, and various streptococcal and staphylococcal infections.
Vancomycin	VA	Resistant bacterial infections. Intravenous (IV) vancomycin treats systemic infections like MRSA, sepsis, endocarditis, and bone/skin infections. Oral vancomycin is used specifically for Clostridioides difficile (C. diff) and enterocolitis
Ceftriaxone	CRO	Given before certain types of surgery to prevent infections.
Erythromycin	E	Respiratory tract infections, skin infections, and STIs—often acting as a substitute for penicillin-allergic patients. It also prevents eye infections, fever, and aids in treating gastro infections
Tetracycline	TE	Pneumonia and other respiratory tract infections; certain infections of skin, eye, lymphatic, intestinal, genital and urinary systems; and certain other infections that are spread by ticks, lice, mites, and infected animals
Nitrofurantoin	N	Is used to kill bacteria causing acute, uncomplicated lower uninary tract infections.

Ciprofloxacin	CIR	Uncomplicated uninary tract infections, chest infections, skin and bone infections, sexually transmitted infections, eye infections, and ear infections.
Meropenem	MRP	is a powerful intravenous antibiotic used to treat severe bacterial infections, including those of the skin, abdomen, lungs (pneumonia), and brain.
Polymyxin B	PB	For its potential for serious side effects like kidney toxicity, it is often considered a "last-line" treatment when other antibiotics are ineffective. Polymyxin B can be used to treat infections in the urinary tract, brain, and blood. Polymyxin B (PB) is an antibiotic primarily used to treat serious infections caused by multi-drug resistant (MDR) or extensively-drug-resistant (XDR) Gram-negative bacteria.

Results: CFU/mL

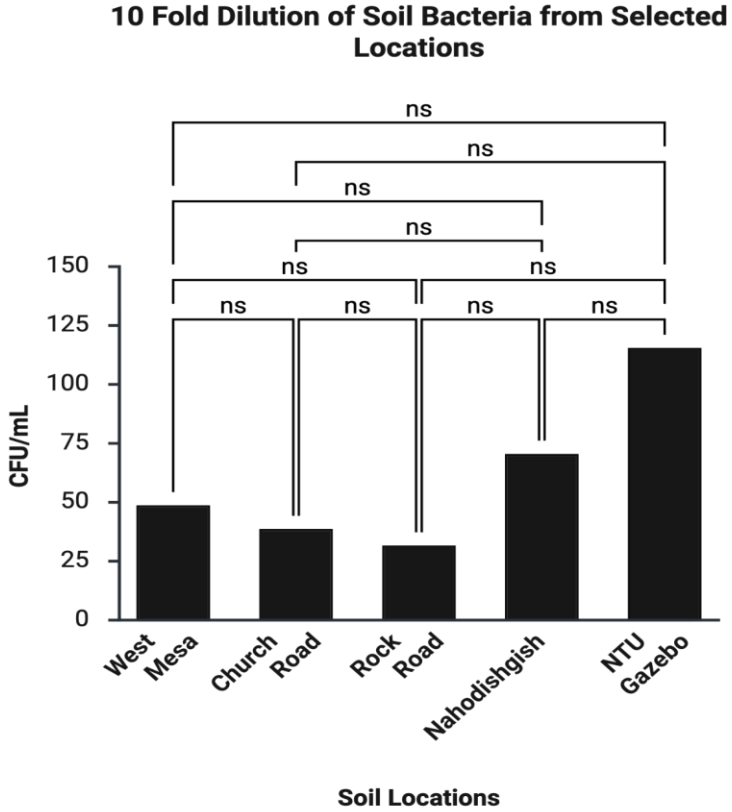

Figure 5. Bacterial CFU/mL by location.

Results: Disk Diffusion

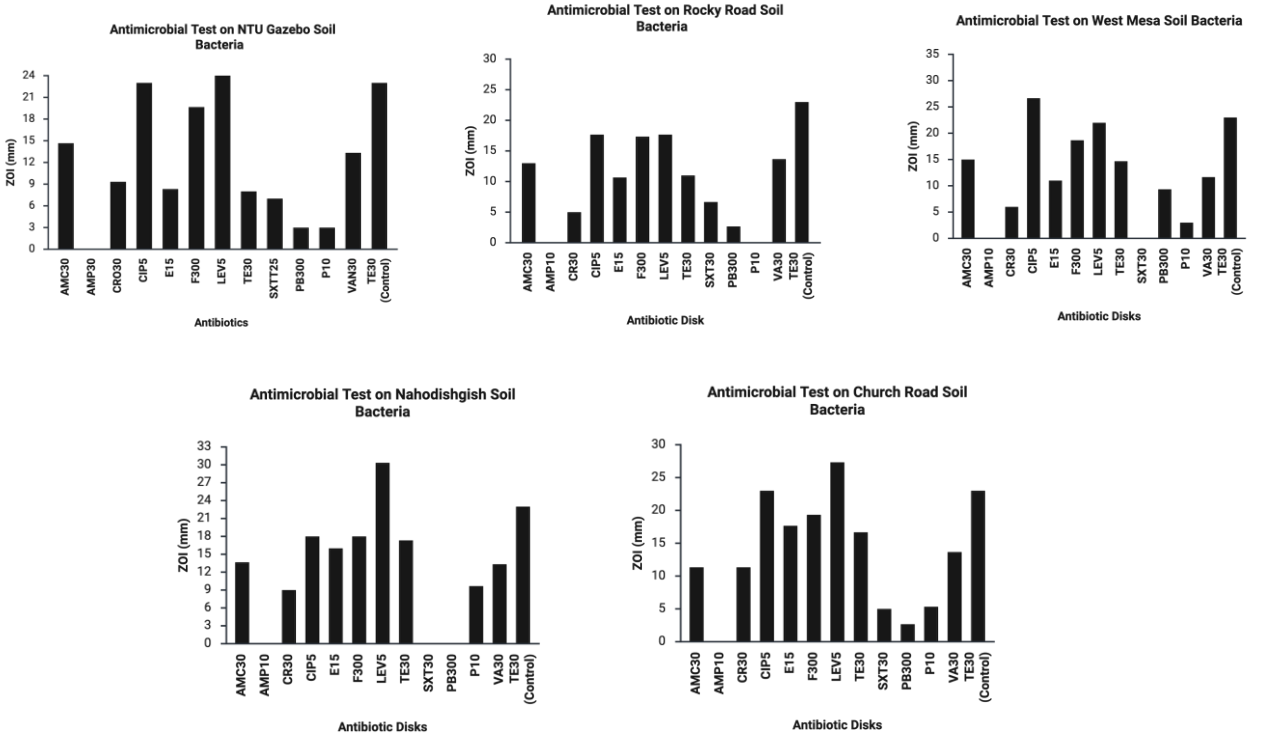

Figure 6. Shows a comparison of disk diffusion effects on soil by location. Top Left to Right NTU gazebo, Rocky Road, and West Mesa. Left ot right) Nahodishdish and Church Road.

Results: MIC

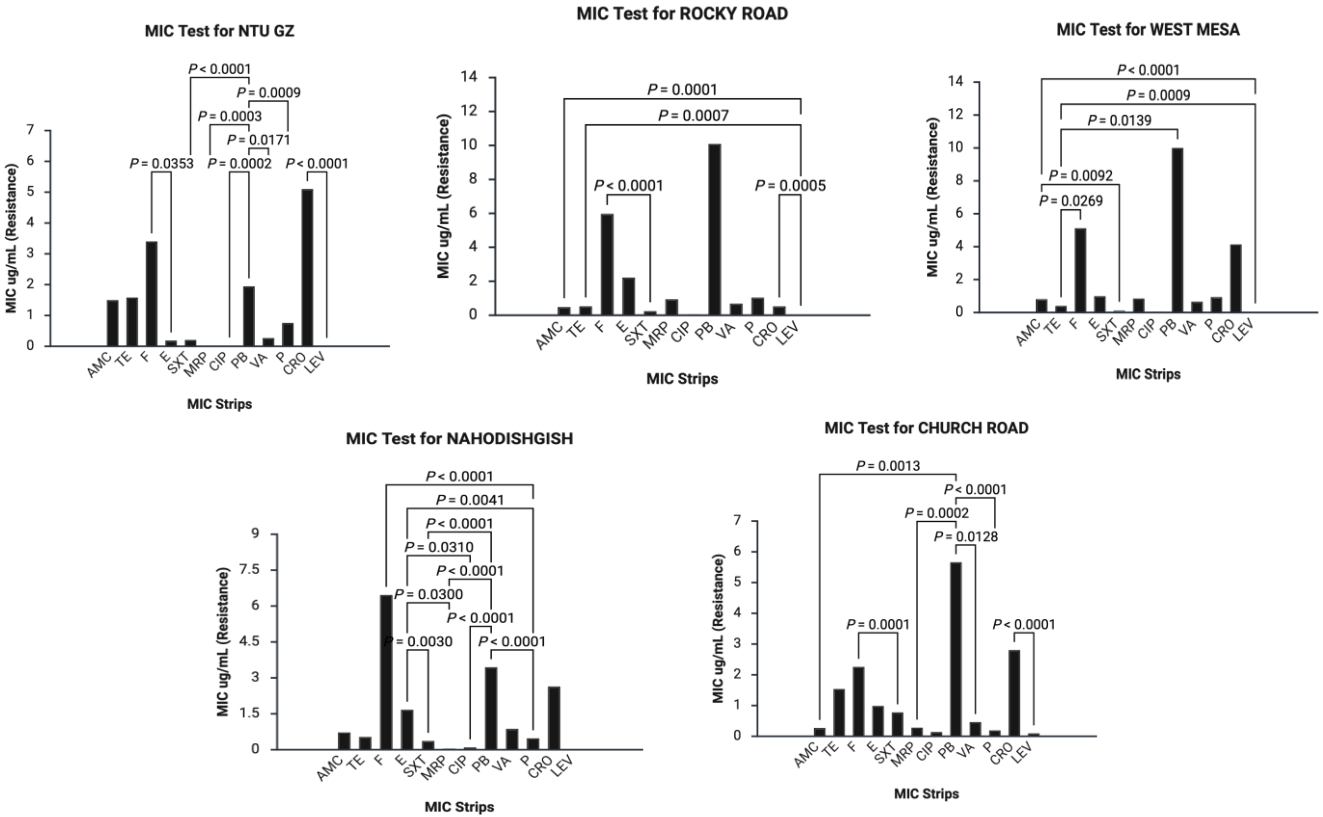

Figure 7. Shows a comparison of MICK by Location. Top Left to right are NTU Gz, Rocky Road, and West Mesa. Bottom left to right, is Nahodishgish and Church Road.

Conclusion

- These sites were selected due to past studies that indicated high uranium by-products and we sought out to investigate the uranium's possible interference with antibiotic efficacy.
- Polymyxin B is a last resort antibiotic when other available antibiotics are rendered ineffective in treating bacterial infections.
- Our results showed that even Polymyxin B is also rendered ineffective in producing ZOI in the soil of West Mesa and NTU Gazedo.
- This study may shed some light on the link between uranium radiation and their influence on AMR, causing possible mutation in bacteria leading to AMR.
- This study also proves the crucial need of antimicrobial research to find new and more effective antimicrobial compounds to fight AMR emergence.

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References

- Alem, K., Dagnew, M., Gizachew, M., Gelaw, B., & Moges, F. (2025). Environmental Antimicrobial Resistance: Key Drivers, Hotspots, Innovative Strategies, and Challenges in the Fight Against Superbugs. MicrobiologyOpen, 14(5), e70067. https://doi.org/10.1002/mbo3.70067
- Gao, Y., Zhou, S., Yang, Z., Tang, Z., Su, Y., Duan, Y., ... & Wang, Y. (2024). Unveiling the role of uranium in enhancing the transformation of antibiotic resistance genes. Journal of Hazardous Materials, 479, 135624.
- Zhou, S., Xiong, C., Su, Y., Wang, Y., Gao, Y., Tang, Z., ... & Duan, Y. (2022). Antibiotic-resistant bacteria and antibiotic resistance genes in uranium mine: Distribution and influencing factors. *Environmental Pollution*, *304*, 119158.
- Zhou, S., Yang, F., Wang, W., Yang, Z., Song, J., Jiang, T., ... & Wang, Y. (2024). Impact of uranium on antibiotic resistance in activated sludge. *Science of The Total Environment*, *917*, 170369.