Rapid Response Brief

April 2019

What can research evidence tell us about:

Potential impacts of a temporary radioactive storage facility on a community

Key messages

Construction of radioactive waste storage facilities causes anxiety and faces hostility from the politicians and people in the host communities anywhere in the world.

The term “radiation” is often confused to mean anything to do with nuclear power or arms.

There is a naturally occurring substantial amount of radiation that humans are exposed to daily. In most instances, the additional man-made exposure to radiation is considered very small, and its effects are rare.

Potential impacts from a low and medium level radioactive waste storage facility start from the point of selection of a site for storage, to the construction works and the radioactive waste material stored at the facility.

- These effects could either be socioeconomic, environmental or physical health. Smaller communities have significant effects of these.
    - The socioeconomic effects include; change in demographics, community character, property values speculation, employment and new road networks if planned.
    - Environment effects include change in plant, animal species and the soil composition due to radionuclide exposure.
    - Physical health effects include early or late diseases that are often inflammatory, probabilistic effects including cancer, non cancer or hereditary diseases. These effects although rare can not be discounted because of the probable DNA mutation in the mechanism.
- There is need for an open, transparent and comprehensive community engagement to share information and get the community consent.

Where did this Rapid Response come from?

This document was created in response to a specific question from a policy maker in Uganda in 2016.

It was prepared by the Uganda country node of the Regional East African Community Health (REACH) Policy Initiative.

+ Included:

- **Key findings** from research
- **Considerations about the relevance** of this research for health system decisions in Uganda

✕ Not included:

- Recommendations
- Detailed descriptions

ACRES THE CENTER FOR RAPID EVIDENCE SYNTHESIS

MAKERERE UNIVERSITY COLLEGE OF HEALTH SCIENCES

UNHRO

JUMUIYA YA AFRIKA MASHARIKI

REACH Regional East African Community Health Policy Initiative

Summary

Background:
The atomic energy council of Uganda plans to set up a centralized temporary radioactive waste storage facility in Mpoma, Kyaggwe Mukono. This radioactive waste storage facility is planned for sealed disused sources currently used in medicine, agriculture, industry and academic research institutions. However, the leadership and community of Mukono has concerns about the impact this facility will have on the health, socioeconomic status and the environment of facilities neighbouring communities.

Rapid Response Question:

To describe the potential socioeconomic, environmental and health impact of a temporary radioactive waste storage facility on the neighbouring communities.

Findings:
The impact of the radioactive waste storage facility can either be due to the selection of the site and construction of the facility or the radionuclides from the radioactive waste.
Socioeconomic effects include change in demographic status and community character as a result of new people in the community, employment levels might increase if the skills are available in the community, new road networks constructed if planned and property values will change due to speculation.
Environmental effects due to excavation will include changes in plant and animal species, land use and any leakage of radionuclides to the environment.
Health effects are often discussed in relation to any possible leakage and discharge of radionuclides. The effects of low radioactive exposure, however possible are rare since this radiation is very small compared to naturally occurring radiation. The effects can either be early or late such as inflammatory or probabilistic such as cancers, non-cancer diseases or hereditary diseases due to DNA mutation.

Conclusion:
There is need for an open, transparent and comprehensive community engagement with the politicians and community for effective communication about the effects of the radioactive waste facility.

Background

Discussions about the use or storage of “radiation” related material is often met with consternation in public debates even among professionals (1). The term “radiation” is often used in reference to the use of nuclear or atomic arms globally by armies. This is because of the dreadful events when nuclear arms were first used during World war II in Japan and also the threat of a nuclear apocalypse during the cold war between Russia and the United States of America. The fears of effects from radiation were further heightened in reports of disastrous events of massive “radiation” leaks such as Chernobyl, Ukraine and Fukushima, Japan after accidents or wilful negligence (2, 3). These events led to increased surveillance and safety regulations on storage and disposal of “radioactive” material to minimise the exposure to humans and the environment.

How this Rapid Response was prepared

After clarifying the question being asked, we searched for systematic reviews, local or national evidence from Uganda, and other relevant research. The methods used by the SURE Rapid Response Service to find, select and assess research evidence are described here: www.evipnet.org/sure/rr/methods

Technological advancements in the storage and disposal of “radiation” has since increased in the 21st century across the world and this makes it vital for countries to manage the radioactive wastes. Radioactive wastes are another source of radiation that have to be managed properly and adequately to minimise the hazards to population and the environment (4, 5). Although exposure to radiation from the radioactive wastes arises from the generation of wastes, operation, transportation, storage and or disposal, selection of sites for the storage and or disposal or radioactive wastes is a political as well as a social process (4). The identification of specific sites to be used for storage and disposal is often a source of apprehension within the communities. Local communities and the local leaders are genuinely concerned about the harmful health consequences often linked from radiations (6-8). This concern is worsened by disagreements between professionals and technical experts about the possible effects of exposure from the radioactive waste materials.

The Atomic Energy Council is the body responsible for the regulation and supervision of the peaceful application of ionizing radioactive material in Uganda (9, 10). The Atomic Energy Council plans to set up a temporary central radioactive storage facility at Mpoma, Kyagwe Mukono for temporally storage of radioactive waste materials specifically those resulting from medical, security and industrial use. As expected, this proposal has been met with stiff opposition from the neighbouring community and local leaders in Mukono. The Mukono local district leaders put a moratorium on the construction of the temporary central radioactive storage facility because of public concerns on the potential impact of the facility on both human and environment.

The aim of this rapid response brief is to, therefore, summarise the evidence of the potential socioeconomic, environmental and health impact of a temporary radioactive waste storage facility on the neighbouring communities.

Summary of findings

Facilities known to deal with radioactive materials such as wastes have always caused anxiety in the neighbouring communities mostly because of failure to distinguish between nuclear weapons and other sources of radiation (11). This could in addition also be as a result of mutual deep mistrust, misunderstanding of information, secrecy by government, exclusion of the affected communities from the discussion from the start, and poor communication between communities, politicians and technocrats (12). Furthermore, although information about the effects of radioactive materials is presented to the politicians and the community, this is often not trusted if it comes from technocrats or government officials.

Below is a summary of the terminologies related to radioactive waste storage and disposal and its safety because these are not easily comprehensible to all (3-5, 7, 12, 13).

- Radiation according to the International Atomic Energy Agency (IAEA) refers to the ionizing radiation. Ionizing radiation is which is capable of producing ion pairs in biological material(s).
- Sources of radiation can be categorised as both natural and man-made sources. All biological material (s) are radioactive material including human waste. Therefore, radioactive material is that which is designated by national law or a regulatory body subject to regulatory control because of its radioactivity. Attention is however focused on the human activity that generates radioactivity such as in medicine, agriculture, industry, education and research. some of these activities include:
    - phosphorus production; phosphoric acid production; fertilizer production;
    - primary iron and steel production; coal tar processing;
    - coke production; coal and gas fired power plant operations; the extraction of coal, peat, oil and gas; cement production;
    - the ceramics industry; mineral sand mining;
    - titanium pigment production.
    - radioactive mining and milling tailings from uranium and thorium production, mining and processing of heavy mineral sand such as ilmenite, leucoxene, rutile, zircon and in particular, and monazite.
- Waste is any material that will be or has been discarded, being of no future use for example effluents and solid materials. Waste storage is temporary retention of a waste with plans of retrieval of the material and disposal is discarding of the waste with no intention of retrieval. These two terms are often used synonymously because most countries set up temporary storage facilities but have failed to move the waste to a permanent disposal facility over the years, making the facilities more less permanent.
- Sealed radioactive sources are used extensively in agriculture, industry, medicine and various research areas in both developed and developing Member States. The total inventory for these radioactive sources is estimated to be in millions globally but only a handful are in registries within the countries.
    - Many of these sources contain high concentrations of radionuclides such as plutonium, cobalt, iridium, strontium, caesium and radium with an intense radiation emitted. These radionuclides have a short (5 years) to intermediate (100 years) half-life and that dictates the time to decay and use.
    - Countries have temporary storage facilities that might hold these wastes from these sources of radiation for a short to long time depending on the available plan for permanent disposal.
- Radioactive waste is difficult to define as almost everything is radioactive. Institutions that are mandated with the regulation of development, use and control of radioactive materials such as the Atomic energy council in Uganda, have the responsibility of specifying what radioactive waste is. Radioactive waste arises from the generation of electricity in nuclear power plants, from nuclear fuel cycle operations and from activities in which radioactive material is used. It also arises from activities and processes in which radioactive material of natural origin becomes concentrated in waste material and safety needs to be considered in its management.

Radioactive waste management often involves containment and isolation from humans and the environment of the radionuclides using special packaging and disposal or storage facilities (2, 4, 12). Although all care is done for proper and adequate, using the best "reasonably" available technology, storage, these strategies might at times not preclude the discharge and leakage of residual amounts of radionuclides (12).

- Therefore, the regulatory body should ensure the operator has not only a plan to minimise any chances of discharge or leakage but also a contingency plan in case of an accident or intentional discharge or leakage that might increase exposure to the neighbouring communities and workers (2, 4, 12).

This, therefore, is a summary of the impact of a radioactive waste storage facility might have on a neighbouring communities. We use the word "might" because in radioactivity, certainty is often measured with the dose of exposure as every effort is done to minimize harm to humans and the environment.

The effects on humans and the environment from a radioactive waste storage facility can occur during site selection and the construction of the facilities or from exposure to the radionuclides from the radioactive wastes (2, 7, 13-16).

The effects from site selection and construction of the facilities will affect socioeconomic status and environment of the community while those from the radionuclides will affect the health of the people. The magnitude and distribution of the effects due to construction will depend on the characteristics of the project; the characteristics of the site area and population (16, 17). Some of these effects will not be apparent until the construction process actually ends, thereby implying that some means of monitoring and responding to effects at site are needed (16).

The effects summarised are as according to the summaries of research and epidemiologic observations made by UNSCEAR, ICRP, IAEA, WHO but are in no way exhaustive of all potential effects that might arise as a result of continued and above background exposure from radioactive wastes (1, 2, 5, 13, 14, 17-20).

Socioeconomic effects

1. Demographic change; there is a change in the demographic composition with new people in the community as workers (16, 17). The demographic change is often gradual and it's at the peak during the construction phase and then reduces to slightly above the community demography before the construction started. The effect of an increase in the number of people within a community increases in smaller rural communities.

   Assumption

   The neighbouring community of Mpoma, Kyaggwe has a small homogenous population.

   The contractor will hire most of the individuals from outside this community.
2. Change in the community character: the character of the community will be expected to change in any major construction. This changes in relation to crime, conflict within the community and relations in the community such as support networks within the community (16, 17).

   Assumption

   There is little or no crime in the community of Mpoma, Kyaggwe

   The wrong characters will be attracted towards the area as a result of increased flow of people.
3. Employment: it is said that employment within the community goes up as the new project offers new and a change in opportunities to the local community especially during the construction phase (16, 17). These opportunities however reduce back to almost the pre-construction phase. However, these opportunities are also dependent in available skill within the community as the project might require importation of labour into the community to meet the demand for specific skills.

   Assumption

   There will be the necessary skills required for the construction and running of the facility in the community.
4. Quality of public services might improve or deteriorate depending on the pressure exerted by the new entrants in the community. Services such as schools and health centres might be built or the existing ones might be overstretched and, therefore, deteriorate(16, 17).

   Assumption

The quality of public services within the community is good- these could be provided by the government or private sector.

5. Some people in the community might reject the facility and would not be willing to stay within the community once the construction starts (16). These would incur costs during the transfer and suffer economic as well as psychological effects during the process of searching and moving.

   Assumption

   There will be people willing to leave their land because of the facility

   The government has in plans to compensate people who would want to move.

6. Speculation of property prices such as value of land and rental costs might increase during the construction as the community receives more people within it due to competition(16). However, this spike reduces with time and might dampen to below the prices before construction as people might not regard the place as suitable for human habitation. The impact on the economic value of land is not exactly linear, with some places having lost no value the closer they are to the facility, yet others have in relation to those far from the facility(21).

   Assumption

   The interested entrants to the community will be concerned about the facility.

   The facility will be constructed on a place central to the community.

7. Accidents might increase in the community during the construction of the facility as more traffic is directed to within the community. This might also be due to an increase in road networks in the area that might will increase traffic within the area (16).

   Assumption

   New road networks will be constructed.

8. Some people in the community might not like the changes of how the community will look with the storage facility in place.

Environment effects

1. Land use: the excavations and clearing of the land will affect the land as the plant and animal species in the area will be destroyed or moved (16, 17).

2. Noise and Air pollution increases during construction and transportation of radioactive wastes to the facility. This might make it inhabitable for some as the quality of air changes within the community (16, 17).

3. The soil and water in the area might also be affected during the construction and with the radioactive wastes (16, 17). The water system including piped water and sewage channels in the area is often changed to ensure a reasonable isolation from the storage facility and this will affect the community's access to water and the kind of crops they will be able to grow thereafter.

Health effects

Accidents of a lesser frequency, but with significant radiological consequences (i.e. possible accidents that could give rise to radiation doses over the short term in excess of annual dose limits), have to be considered with regard to both their likelihood of occurrence and the magnitude of possible radiation doses (2, 13, 15, 19).

Effects on health are often referred to as those that are more likely to occur above a certain degree of exposure to cumulative radiation per day- this is set at 5 per 10000 mSv by the IAEA or 100mGy (2, 13, 19). Below this threshold, the chance of any health effects to occur is quite negligible but still possible to occur. These effects have been summarised as either early or late and the Stochastic (probabilistic) effects.

1. Early effects occur within hours to weeks and these often occur after the set limit of exposure has been surpassed. This often means that we are able to see the effects after an appreciable amount of cells have been destroyed for any clinically apparent sign to occur. These effects are often inflammatory and include erythema,
2. Late effects occur within months to years; such as scars or

3. Stochastic effects- random effects on health due to radiation exposure as a result of damage to DNA or gene or chromosomal mutation- include cancers, non-cancer diseases, heritable diseases.

    Assumption:

    - Radioactive waste material in Uganda is of very low level waste including medical, industrial and security applications of radiation. An individual is exposed at less than 0.5mSv
    - The background radiation in Kaggwe Mukono and in Uganda is unknown- this could play a part.
    - Distance is associated with health outcomes; the closer to the facility, the higher the likelihood of adverse health outcomes(21).

Other considerations for a radioactive waste storage facility

Radioactive waste storage and disposal facilities have often been met with hostile reception in the communities proposed to host them. The IAEA emphasizes the need for community approval to the facility wherever they have to be set up. In places where this hostility has been volatile, the operators have either to have a comprehensive community engagement plan at all stages of the temporary storage facility and where this has failed, they have had to find another location. This has obviously increased the costs and time in setting up these facilities.

When selecting a site, the aim is to provide a storage/ disposal system which complies with established safety and environmental requirements. The stages involved are; a) conceptual and planning stage, b) area survey stage c) site characterization stage d) site confirmation stage. At each stage, societal, ecological and legislative issues should be evaluated and addressed according to the national policies, and the regulatory body should be kept informed and involved in the decisions (22).

It is important that technology used and the construction of site includes a buffer zone significant enough to isolate the waste from the environment for a duration consistent with its decay to insignificant levels(23).

The operations for radioactive waste management and regulations by the necessary regulatory bodies need to be clear to those concerned at the district leadership and the community (24). It is important to have a clear plan of how the waste managers are solicited and the roles of the regulator to ensure adherence to minimum required standards.

There needs to be a contingency plan well detailed to the district leadership about what happens in case a leakage happens(5, 25). This is no way to anticipate that a leakage will occur but most of these leakages and discharges across the world have happened due to accidents or willful negligence of the staff. This also has to be reflected in the required law especially about who is responsible for cleaning up, communication and compensation in case the people are directly affected.

Countries whose only source of regulated radioactive material including sealed and unsealed sources in medicine, agriculture, industry and academic research applications often have a temporary storage facility for these sources (4, 5, 25). Many of the facilities that use these sources have a room for storage at the site of use but might be ineffective especially with poor handling of packages and location often increasing the exposure to the workers. Though proper storage can be at the facility of use such as in hospitals, it is often necessary to set up a centralized storage facility to reduce the exposure in the country (5, 12, 25). However, challenges might stem from:

- It is estimated that over one million sources are in the world but only a handful are known to the regulators posing a challenge on the waste management of these sources (25).
- The need to have a temporary solution should have a plan of when and where the final disposal will take place. This is because temporary storage has been reported to often end up as the final disposal as this might take more than 100 years (25). It will be good for the regulatory body and operators to share any plans for a permanent radioactive waste disposal facility in Uganda and where it will be located.

- One of the options is to transfer these sources back to the manufacturer but this often requires that there is a certification of disposal available with each equipment. Knowing that these sources such as x-rays often change hands in use from one user to another, it becomes difficult to trace that certification as it is between the initial user and the manufacturer. Countries therefore have been advised by the IAEA to have a plan for final disposal if this is not possible (25).

Conclusion

Radioactive waste storage facilities have often met with hostility from the communities where they are planned because of the potential health, socioeconomic and environmental effects. This is often a sensitive topic that is filled with a lot of suspicion, mistrust, misunderstanding and miscommunication between the technocrats, regulators, politicians and the communities.
One of the sources of misunderstanding is the confusion between nuclear power, arms and other sources of radioactivity. Communities have a lot of radioactive materials around us that we do not pay attention to often. The possibility of the health effects is very low but it is not possible to assuage the public of it not happening because of the incidents such as Chernobyl, fukushima that have occurred in the past. It is, therefore, important to have a comprehensive community engagement if attitudes and perception are to be changed. Lastly, according to IAEA community approval is vital for the construction of the site and without it other locations might need to be considered.

References

1. UNSCEAR. Report of the United Nations Scientific Committee on the Effects of Atomic Radiation 2010. New York: United Nations, 2011.
2. ICRP. Annals of the ICRP: The 2007 recommendations of the International Commission on Radiological Protection Exeter, United Kingdom: ICRP, 2007.
3. IAEA. IAEA safety glossary terminology used in nuclear safety and radiation protecion; 2016 revision. Vienna: International Atomic Energy Agency, 2016.
4. IAEA. IAEA Safety standards for protecting people: The management system for the disposal of a radioactive waste. Vienna, Austria: International Atomic Energy Agency, 2008.
5. IAEA. IAEA Safety standards for protecting and the environment: Disposal of Radioactive waste Specific safety requirements. Vienna: International Atomic Energy Agency, 2011 ISBN 978–92–0–103010–8.
6. Porta D, Milani S, Lazzarino AI, Perucci CA, Forastiere F. Systematic review of epidemiological studies on health effects associated with management of solid waste. Environmental health : a global access science source. 2009;8:60.
7. Giusti L. A review of waste management practices and their impact on human health. Waste management (New York, NY). 2009;29(8):2227-39.
8. Fonteyn ME. A second look: update on safe handling of hazardous drugs. ONS news. 2006;21(8 Suppl):27-8.
9. Government of Uganda. The Atomic Energy Act, 2008. In: Parliament, editor. Kampala2008.
10. Government of Uganda. Statutory instruments 2012 No. 4. The atomic energy regulations, 2012 arrangement of regulation. Entebbe, Uganda: UPPC; 2012. p. 41-258.

What is a Rapid Response?

Rapid Responses address the needs of policymakers and managers for research evidence that has been appraised and contextualised in a matter of hours or days, if it is going to be of value to them. The Responses address questions about arrangements for organising, financing and governing health systems, and strategies for implementing changes.

What is ACRES?

ACRES – The Center for Rapid Evidence Synthesis (ACRES) is a center of excellence at Makerere University- in delivering timely evidence, building capacity and improving the understanding the effective, efficient and sustainable use of the rapid evidence syntheses for policy making in Africa. ACRES builds on and supports the Evidence-Informed Policy Network **(EVIPNet) in** Africa and the Regional East African Community Health **(REACH)** Policy Initiative (see back page). ACRES is funded by the Hewlett and Flora foundation.
http://bit.do/eNQG6

SURE
Supporting the Use of Research Evidence

REACH
Regional East African Community Health Policy Initiative

Reagional East African Community Health Policy Initiative
www.eac.int/health

EVIPNet

EVIPnet
www.evipnet.org

Glossary

of terms used in this report:
www.evipnet.org/sure/rr/glossary

11. Covello VT. Communicating information about the health risks of radioactive waste: a review of obstacles to public understanding. Bulletin of the New York Academy of Medicine. 1989;65(4):467-82.
12. IAEA. Issues and trends on radioactive waste management. Vienna: International Atomic Energy Agency, 2003.
13. UNSCEAR. Sources, effects and risks of ionizing radiation UNSCEAR 2016 Report: Report to the General Assembly Scientific Annexes A and B. Newyork: United Nations, 2017.
14. WHO. Health effects of the Chernobyl disaster: an overview Geneva: World Health Organization; 2006 [cited 2006 April 2006]. Available from: http://www.who.int/ionizing_radiation/chernobyl/backgrounder/en/.
15. Fry RJM. Deterministic effects. Health physics. 2001;80(4):338-43.
16. National Research Council. Social and Economic Aspects of Radioactive Waste Disposal: Considerations for Institutional Management. Washington, DC: The National Academic Press, 1984.
17. IAEA. Socioeconomic and other non-radiological impacts of the near surface disposal of radioactive waste. Vienna, Austria: International Atomic Energy Agency, 2002 ISBN 92–0–115302–3.
18. ICRP. The Evaluation of risks from radiation: A report prepared for committee I of the international commission of radiological protection Belfast, Northern Ireland: ICRP, 1966.
19. UNSCEAR. Sources, effects and risks of ionizing radiation UNSCEAR 2017 Report: Report to the General Assembly Scientific Annexes A and B. Newyork: United Nations, 2018.
20. Kautsky U, Saetre P, Berglund S, Jaeschke B, Norden S, Brandefelt J, et al. The impact of low and intermediate-level radioactive waste on humans and the environment over the next one hundred thousand years. Journal of environmental radioactivity. 2016;151 Pt 2:395-403.
21. National Research Council. Social and Economic Aspects of Radioactivite Waste Disposal: Considerations for Institutional Management. . Wasgington, DC: National Accademies Press; 1984.
22. International Atomic Energy Agency. Siting of Geographical Disposal Facilities; A safety guide. Vienna: International Atomic Energy Agency; 1994.
23. Nuclear Energy Agency. Low-level radioactive waste repositories: An analysis of costs. France: Organisation for economic co-operation and development; 1999.
24. Defra, DTI, Devolved Admistrations. Policy for the long term management of solid low level radioactive waste in the Unitesd Kingdom. In: Department of Environment FaRA, editor. London: Department of Environment, Food and Rural Affairs; 2007. p. 1-44.
25. IAEA. IAEA Nuclear series; Management of Disused sealed Radioactive Sources. Vienna, Austria: International Atomic Energy Agency, 2014.

This summary was prepared by

The Center for Rapid Evidence Synthesis (ACRES), REACH PI Uganda node, College of Health Sciences, Makerere University, New Mulago Hospital Complex, Administration Building, 2nd Floor, P.O Box 7072, Kampala, Uganda

Conflicts of interest

None known.

Acknowledgements

The following people provided comments on a draft of this Response: [Name, Affiliation; Name, Affiliation].

This Rapid Response should be cited as

Ismael Kawooya, Edward Kayongo Rhona Mijumbi-Deve, Potential impact of temporary radioactive waste temporary storage facility on a community, April 2019: A Rapid Response Brief.

For more information contact

Ismael Kawooya, kismae@gmail.com