Keynote Lecture

Engaging Communities in Measuring and Assessing Individual Radiation Exposure: Insights from Post-Fukushima Daiichi Nuclear Disaster

Wataru Naito
Research Institute of Science for Safety and Sustainability (RISS)
National Institute of Advanced Industrial Science and Technology (AIST)
Tsukuba, Japan

The Fukushima Daiichi Nuclear Power Plant accident on March 11, 2011, resulted in the release of radioactive materials, contaminating land in Fukushima and surrounding prefectures. During the post-accident recovery phase, it is crucial to accurately assess or estimate realistic individual external radiation doses. This information empowers individuals to make informed decisions about returning to or living in affected areas based on their radiological protection needs. Authorities also require accurate individual dose data to understand the distribution of doses among the population and to determine whether additional protective measures are necessary, either on a large or small scale.

Between 2013 and 2019, the research team including the author have employed a semiconductor silicon personal dosimeter, known as the “D-shuttle,” in combination with GPS and GIS technologies, to measure realistic individual external doses in Fukushima (Figure 1). The D-shuttle has several key characteristics. The device uses a silicon semiconductor and can measure total doses ranging from 0.1 µSv to 99.9999 mSv. Its sensitivity is calibrated with ^{137}Cs photon source at the Oharai Research Centre of Chiyoda Technol Corporation. The D-shuttle includes features such as an erroneous detection prevention function and a shock sensor. Its response to energy at normal incidence remains within ±30% for the energy range of 80 keV to 1.25 MeV, and its dose response varies within ±10% across temperatures from 0 to 30 degrees Celsius. Additionally, the D-shuttle records cumulative dose and can provide external dose data for various time intervals, such as daily or hourly. D-shuttle in combination with GPS and GIS technologies helps correlate individual doses, ambient dose levels, and the activity patterns of residents in the affected areas. Approximately 300 residents have participated in this study. Findings indicate that the individual external doses measured by the D-shuttle are generally much lower than those predicted by models using airborne-based ambient dose data [1,2]. These results offer valuable insights into realistic individual external doses and their relationship to time-activity patterns and airborne monitoring data, which can inform estimates of future cumulative external doses as residents return to their homes in former evacuation areas.

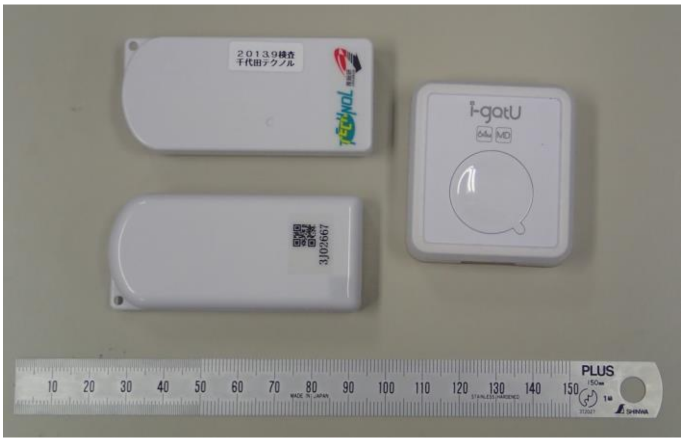

Figure 1. Personal dosimeter “D-shuttle” (left) and GPS logger (right) used in the study

Additionally, face-to-face interviews were conducted to gather feedback from participants after explaining their measured dose information [3]. The responses highlighted that many participants consider radiological conditions to be a significant factor in their decision to return home. While most agreed on the usefulness of personal dosimeters like the D-shuttle for understanding their own external dose levels, attitudes towards the measurement data varied. Personal dosimeters like the D-shuttle have a versatile role in post-accident recovery for both residents and authorities. However, the use of advanced dosimeters such as the D-shuttle by affected individuals can be a double-edged sword (Table 1). Once regulatory reference values (e.g., 20 mSv per year and 1 mSv per year) are established and communicated to the public, revising these initial criteria becomes challenging. Affected residents who measure their individual external doses typically compare their results against these reference values (e.g., 1 mSv per year). Experts also frequently use these reference values to explain radiological conditions to the residents. When measured doses fall below the reference value, residents often feel reassured. Given the significant influence of these reference values on residents' lifestyles and decision-making in affected areas, it is important to carefully consider and discuss their implications and impacts in advance. It may be necessary to prepare customized approaches to address any anxiety that arises among residents after they are informed of their measurement results. Additionally, it is crucial to clearly communicate the purpose of the measurements and develop plans for sharing and responding to both expected and unexpected results among stakeholders before conducting the measurements.

The author organized practical examples of public understanding of radiation risks in Fukushima, in addition to own experiences with individual dose measurements and communication activities [4]. The study emphasizes that contextualizing and localizing radiation risk was a key and effective part of public understanding (PU) efforts during Fukushima's recovery, as shown by practical experiences. Community-based and citizen science approaches, such as engaging residents in radioactivity measurement, have positively impacted PU of radiological conditions, though challenges like ethical issues and uncertainty remain.With the rise of information and communication technologies, stakeholders—including citizens, experts, and agencies—have leveraged social media to effectively disseminate radiation risk information. These efforts demonstrate that social media can play a crucial role in public communication about radiological risks. The insights and lessons from this study provide valuable guidance for enhancing PU of not only radiation risks but also other hazards, like toxic chemicals. They also support the development of risk communication and preparedness strategies for future disasters, especially during recovery phases.

Acknowledgements

This study was partially supported by the Study of Health Effects of Radiation organized by the Ministry of the Environment, Japan.

References

[1] Naito W et al. (2016) Relationship between individual external doses, ambient dose rates and individuals’ activity-Patterns in affected areas in Fukushima following the Fukushima Daiichi nuclear power plant accident, *PloS one* 11 e0158879

[2] Naito W et al. (2017) Measuring and assessing individual external doses during the rehabilitation phase in Iitate village after the Fukushima Daiichi nuclear power plant accident *J. Radiol. Prot.* 37 606–22

[3] Naito W and Uesaka M (2018) Role of individual dosimetry for affected residents in post-accident recovery: the Fukushima experience. *Annals of the ICRP* 47(3-4) 241–253

[4] Naito W et al. (2020) Examples of practical activities related to public understanding of radiation risk following the Fukushima nuclear accident. *Radioprotection,* 55 4 (2020) 297-307