Report on "Radiation Disaster Recovery Studies"

Course : Radioactivity Environmental Protection
Name : Sharifah Nabihah Binti Syed Othman

Radiation Disaster Recovery Studies

On 11 March 2011, Japan's triple disaster that was triggered by earthquake and tsunami has led to Fukushima Daiichi Nuclear Power Plant (FDNPP) explosion. The accident has released a huge amount of radioactive material to the surrounding due to the overheating of reactors in FDNPP that lead to the explosion (Hasegawa 2012). Consequently to the impact of the accident, numerous studies were conducted to provide sufficient information in order to plan for radiation recovery in Fukushima. One of the crucial information to understand is the severity of exposure by monitoring the release of radioactivity to the environment and one of the most concerning elements was radiocesium-137 with a half-life of 30.1 years, which increase the risk of exposure to over decades. (Yasunari *et al.* 2011). Therefore, there has been extensive research regarding radiocesium-137 deposition to assess the risk and determine the contamination level in Fukushima after the accident (MEXT, 2011).

Ecoanalytic has become the fast growing development in determining and detecting the trace amount of pollutant in the natural environment. It has become an interdisciplinary technique, which combined the use of biological material with analytical techniques to facilitate and providing the monitoring information requires in the study (Gadzała et al. 2004). Biomonitoring can be defined as a process that used,

plant and animal organisms or their fragments as “analytical tools” to provide a continuous and/or real time analytical information (Namieśnik & Wardencki 2000). Besides, due to the high diversity of living organisms, biomonitoring can offer many possible ways to collect information.

The capability of providing broad and complete information by the plant has increased some interest among researchers to investigate the potential of small species from bryophyte group. Extensive research was conducted on bryophyte as monitors and accumulators of mineralization since 1948 and the effort to utilize the potential of bryophyte in heavy metal tolerance was started since 1987. There were various studies conducted to highlight the potential of bryophyte for biogeochemical prospecting and pollution monitoring (Giribala & Tewari 1998).

Mosses have been frequently used as biomonitors in environmental pollution studies, owing to their unique morphological and physiological characteristics (Zeichmeister *et al*., 2003). Such characteristics include a wide distribution in Japan (Suzuki, 2016), a large surface-to-plant mass ratio with absence of root system, allowing greater interaction with the atmosphere and improved adsorption (Angelovska *et al*., 2014), the ability to survive a series of highly toxic substances (Yang *et al*., 2011) including radionuclides and pollutant accumulation throughout their lifespan (Čučulović *et al*., 2016). However, the capability of a specific species in the group in accumulating the radioactive fallout has not yet been discovered.

Hence, our study emphasized on investigating the potential of a specific moss, *Hyophila propagulifera* as biomonitoring tools in determining the contamination level in Fukushima after the FDNPP accident, which may help to facilitate in the recovery process after the radiation disaster.

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Title of Doctoral Thesis

Spatial distribution of radiocesium contamination using a specific moss, *Hyophila propagulifera* (Pottiaceae. Bryophyta) after Fukushima Daiichi Nuclear Power Plant accident

Summary of Doctoral Thesis

Extensive studies were conducted on plants and soils to understand the mechanism of radionuclides uptake from the environment after the Fukushima Daiichi Nuclear Power Plant (FDNPP) accident. It is essential to measure and monitor the magnitude of radiation contamination on the environment to effectively and efficiently plan for radiation recovery. Bryophyte can be very precise and sensitive bio-indicators for heavy metal contaminations, while it can be a long-term monitoring tool if they are tolerant to the contamination. Therefore, it is important to investigate and understand the natural potential of bryophyte to control this radiation disruption. In my research, I studied the trend of radiocesium

accumulation in a bryophyte, *Hyophila Propagulifera* Musci, as a bio-measuring tool focusing the area of northeastern region of Fukushima Prefecture. *Hyophila propagulifera* was selected because of their high availability to be found in targeted area, their ability to accumulate the radiocesium, their tendency to grow around all seasons of year and their ability to survive in dry weather or highly polluted area. Since they are commonly found on the surface of rock and roadside wall, we can minimize the influence of the soil factor, which enhance the variation of radiocesium contamination. The study may help in the monitoring field and decontamination practice effort as it can provide quick estimation of contamination by considering its relationship between the accumulation and environmental factors. Such data can extensively help in determining the level of contamination of restricted area and understand other environmental factors that involve in radiocesium accumulation in the plant bodies.

This study will also investigate on how radiocesium contamination level detected by *H. propagulifera* compared to air-dose rate measured by the expert group such as research group by JAEA (Japan Atomic Energy Agency). The methodology was included comparing and analyzing the spatial distribution between air-dose rate and radiocesium contamination in the *H. propagulifera*, while considering the different environmental factors. The expected result of this study has shown the difference in spatial distribution and identified the significant influence of environmental factors between two different measurement approaches. A soil removal study (removal of soil from plant body) was conducted to determine the accuracy of the radiocesium accumulation in the plant bodies and to ensure the efficiency of washing procedure in producing consistent and reliable in the study. All the results have presented the promising potential of *Hyophila propagulifera*, Musci as a monitoring tool to represent the contamination level in the environment.

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