Cooperation between the IAEA and Fukushima Prefecture

In the Area of Radiation Monitoring, Remediation and Waste Management following the Accident at TEPCO's Fukushima Daiichi Nuclear Power Plant

Interim Report (2013 – 2015)

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1. OBJECTIVES AND SCOPE

Following the accident at TEPCO's Fukushima Daiichi Nuclear Power Plant[1] in March 2011, the Fukushima Prefecture (hereinafter referred to as 'the Prefecture') and the IAEA concluded a Memorandum of Cooperation. Radiation monitoring, remediation, decontamination and human health were identified as propriety areas for cooperation. Concrete projects, as well as ways and means to implement them, were discussed between the IAEA and the Prefecture.

Further to the Memorandum, the Practical Arrangements were prepared and signed between the IAEA and the Prefecture. The objective of the Practical Arrangements was to set forth the framework for cooperation between the Prefecture and the IAEA, and to provide broad and extensive assistance in the Prefecture, in areas related to radiation monitoring and remediation, in order to ensure ongoing protection of people and the environment from ionizing radiation in the Prefecture after the accident.

The Practical Arrangements were signed in December 2012 and are valid for a period of five years after signature. It can be extended by the mutual consent of both sides. Implementation of the projects under the Practical Arrangements began in March 2013 and are planned to conclude in December 2017.

The main role of the IAEA in implementation of these projects is the provision of effective technical assistance and support based on international experience and best practices.

This interim report introduces activities undertaken during the implementation of individual projects during the first three years (2013 to 2015) as well as highlights and results of this cooperation.

2. TOPICS OF COOPERATION

The IAEA and the Prefecture have identified the following areas and activities in which cooperation may be pursued:

- Research and study on radiation monitoring including application of environmental mapping technology by using unmanned aerial vehicles and the IAEA's assistance in the use of radiation monitoring data to develop maps to be made available to the public;
- Research and study on off-site decontamination, including the IAEA's assistance in analyses of results of environmental monitoring and exploration of exposure pathways in order to reduce or avoid exposure;
- Research and study on the management of radioactive waste including IAEA's assistance in the study on management methods of low level radioactive waste from the above-referenced decontamination activities.

The above-referenced cooperation is designed to complement existing Japanese activities and to provide immediate assistance and support, which will be of direct benefit to those living in the Prefecture.

3. ACTIVITIES AND ACHIEVEMENTS

3.1. OFF-SITE DECONTAMINATION AND ENVIRONMENTAL MONITORING

In the freshwater bodies of the Prefecture – more than four years after the accident – dissolved radiocaesium[2] levels in water are close to or below the detection limit. This can be explained by the strong sorption of radiocaesium by sediments, in which much higher radiocaesium levels are observed.

[1] Hereinafter referred to as 'Fukushima Daiichi NPP'
[2] Hereinafter, the term radiocaesium includes ^{134}Cs and ^{137}Cs.

In addition, due to radioactive decay, there is also a clear decline of the concentration of radiocaesium in suspended sediments.

The reduction of the radiocaesium levels in the environment is mainly caused by radioactive decay, whereas the runoff of radiocaesium provides only a minor contribution to the reduction of the overall inventory in the catchment. When the radiocaesium is attached to particles, it is subject to sedimentation in ponds, lakes, and reservoirs i.e. such waters act as a sediment trap.

A key question of the work is related to the long term behavior of radiocaesium in the freshwater environment. Therefore, in addition to the measurements of radiocaesium in water and sediments by the Prefecture, mathematic models have been used to estimate the transport of radiocaesium from the upper part of a catchment area through the river system of the Prefecture to the Pacific Ocean. The results of these calculations help with the interpretation of monitoring measurements. Additionally, such models provide valuable input when planning the possible effects of countermeasures.

At some locations, river banks are used for recreation by the local population. The Prefecture initiated a number of demonstration projects to test the effectiveness of measures for reducing gamma dose rates at recreation areas near rivers. Comprehensive measurements show that the gamma dose rates could be reduced by about 50%.

Experience gained through remediation activities of freshwater bodies worldwide indicates that technical measures have only a limited potential to control the dispersion of radionuclides in water bodies. For reducing exposures to the public arising from the use of water, experience has shown that easy to implement recommendations and restrictions with regard to the use of freshwater bodies are more effective in reducing exposure.

Since 2011, under coordination of the Prefecture, intensive decontamination work has been carried out in private homes and public areas, on agricultural land and in forests. For public facilities, decontamination is the most advanced; as of 29 February 2016, 90% of the planned activities were completed. Depending on the type of area treated, gamma dose rates were reduced by a factor of 1.5 to 2. Such reduction factors are very similar to those achieved by remediation measures in areas affected by the Chernobyl accident.

3.2. EVALUATION OF THE LONG TERM BEHAVIOUR AND IMPACT OF RADIONUCLIDES IN FORESTS

The importance of forests in the economy of the Prefecture and in the life of its inhabitants underlines the need to understand the mechanisms of movement and cycling of radiocaesium within these ecosystems. One of the main sources of knowledge on the behaviour of radionuclides in forests is research carried out in Europe in the years following the Chernobyl accident in 1986. However, forests in Europe differ from those in Japan and the results of previous studies may not be directly applicable. For that reason, an extensive forest monitoring program has been established by the Prefecture.

The research undertaken by the Prefecture suggests that clay minerals present in the forest soils in the Prefecture are helping to immobilize radiocaesium, resulting in a low transfer to understory vegetation and to trees. Given the importance of the forests as an economic resource, the relatively low concentrations of radiocaesium measured by the Prefecture in harvested wood allows the unrestricted use of timber. The IAEA has underlined the importance of assessing if this trend continues in future years.

Initial indications from work undertaken by the Prefecture are that the future planting of trees does not need to be restricted as the levels of radiocaesium will be significantly reduced when these trees reach maturity and are harvested in 50 to 80 years' time. The Prefecture also recognizes that the reduction in dose rate due to natural decay will gradually allow harvesting of wood from wider areas of forest, and

this, however, in turn may bring need for monitoring of large volume of harvested timber, as well as managing radiation exposure of forest workers.

Another important observation to emerge from the Prefecture's monitoring programme is that the bulk of the radiocaesium initially deposited on the forests of the Prefecture has now been transferred to the soil and litter layer, where it continues to contribute to the gamma dose rate. Most of the radiocaesium initially deposited is retained within the forest and the amount of radiocaesium lost from the system to date seems to be low. This suggests that the contamination of nearby agricultural land is unlikely, except in the case of a major landslide or other similar event. On the other hand, the half-life of 30 years of ^{137}Cs is a dominating factor in the reduction of gamma dose rate within the forest. Several countermeasures, involving the addition of uncontaminated soil or wood chips, are currently being evaluated by the Prefecture in terms of long term effectiveness and applicability.

The life cycle of forest trees from planting to harvesting is normally a number of decades. At the time of the Fukushima Daiichi NPP accident, the forests that received fallout were at various stages of development, from newly-planted saplings to fully mature trees ready for harvesting. The IAEA has advised that the uptake of radiocaesium by forest vegetation and trees, and the redistribution between the different components of trees, will need to be monitored for several years to ensure that the long term cycling mechanisms are fully understood. Now that appropriate monitoring programmes have been established by the Prefecture, the IAEA has also advised that consideration can be given to reducing the frequency of monitoring in future years. The knowledge gained will allow the forests to be managed in an effective manner and to maintain them as both an economic and a leisure resource.

3.3. MANAGEMENT OF RADIOACTIVE WASTE FROM DECONTAMINATION ACTIVITIES

The safety assessment was carried out by the Prefecture using the IAEA methodology for assessing the safety for predisposal radioactive waste management facilities and activities. The results of the safety assessment have indicated that IAEA methodology is appropriate for the specific conditions and storage facilities for radioactive waste in the Prefecture. The implementation process was supported by applying the IAEA methodology – the SAFRAN software developed by the IAEA – for assisting in development of the safety assessment for predisposal facilities and/or activities. It is standalone software, which allow user to change/adopt the preinstalled parameters, enabling the iterative process of development of the safety assessment. It allows reviewing of the key steps relevant for safety, and their consequent refinements. This approach also assists in optimizing the main parameters responsible for radiation safety in a consistent and traceable manner.

The results gained from application of the IAEA methodology by the Prefecture to the storage facilities in the Prefecture clearly indicate that all radiation doses (calculated using a conservative approach) are under normal operating conditions well below the prescribed dose limits. A systematic analysis of all relevant hazards by the Japanese experts would provide a sound justification for further examination and potential application of measures which might be necessary in future to avoid any type of undue consequences to the human population and/or environment under the accidental situations.

The development of the safety assessment for the temporary storage facility at the Prefecture is an important step in finding a safe and reliable solution for storage of the large amounts of radioactive waste accumulated from remediation activities after the Fukushima Daiichi NPP accident.

3.4. THE USE OF RADIATION MONITORING DATA TO DEVELOP MAPS TO BE MADE AVAILABLE TO THE PUBLIC

The Prefecture website is extensively used by the local population as an authoritative source of information. The Prefecture sought the views of those who use the website in order to identify the type of information they require and how the website can be improved to better meet their needs. The need for the Prefecture to supplement the information available through the website with a broader outreach

to the public was highlighted. In this regard, the Prefecture has identified the information needs of returning evacuees are particularly important.

Best international practice and experience in providing radiation data to the public was reviewed among radiation protection, public information and IT experts. A wide range of options regarding data presentation, including the use of interactive maps, were considered. Technical issues such as how to present representative data, how to indicate long term trends in dose rate and how to merge data from fixed monitoring stations and different types of measurement surveys, as well as different approaches and practical solutions, were discussed.

Based on the discussions with IAEA experts, the Prefecture prepared a tender document to update its website. The new website went live in 2016. Therefore, this project has now been successfully concluded.