Topics Fukushima 7 February 2013 No. 14

Topics Fukushima introduces JAEA's activities related to Fukushima.

How does radiocesium migrate?

Investigation of cesium migration in mountain forests

"Radioactive cesium released by the accident at the Tokyo Electric Power Company's (TEPCO's) Fukushima Daiichi Nuclear Power Station has been tightly adsorbed on clay particles of the soil, and would not migrate easily. There is however the possibility of radioactive cesium migrating along with movement of particles in the soil caused by typhoons, heavy rainfall and melting of snow. The residents have expressed concern for radioactive cesium migrating from surrounding areas to places that have already been decontaminated. What is the impact of forces of nature such as rain and wind on radioactive cesium in forests? How does radioactive cesium migrate? The objective of this program is to estimate future distribution of radioactive materials over the long term and assess the exposure dose, coupled with studying the process by which it migrates to predict the trend of future movement and exploring ways to suppress migration to the living environment. It is our hope that the results of these efforts can help provide the residents with a sense of security."

On December 3, 2012 at an opening in a mountain gorge in Kawamata Town, Fukushima Prefecture, Shinichi Nakayama, the leader of Fukushima-TRACE Project (long-term assessment of Transport of RAdioactive Contaminant in the Environment of Fukushima), talked to 11 workers in boots in the face of occasional gusts of wind (see photo on left).

The Japan Atomic Energy Agency (JAEA) has conducted research on the impacts of radioactive materials contained in radioactive waste disposed in geological layers about how they migrate in the layers and the biosphere, and have effect on human beings. This project was planned because researchers in charge of the decontamination model verification project conducted from November 2011 to May 2012 remarked that change in radiation dose at decontaminated sites should be monitored.

The research on radioactive cesium spreading widely in the environment with the focus on the locations it settles, factors causing it to move again and how it moves is limited to few cases such as those conducted after the Chernobyl accident, and in addition, Fukushima has its own environment. In such situation, this project, which was named the "Fukushima Long-term Environment Dynamics Research Project," began from scratch, by deciding the objects and methods of investigation. The investigation initiated on this day in the approximately 8000 m^2 of mountain forest of Kawamata

Town is the first serious field research of the project.

Simultaneous measurement of meteorological phenomena and air dose rate

A device equipped with a solar panel and camera has been set up on the side of a small road to the mountains with a gentle slope. Standing in front of the device, Makoto Terauchi, an expert in measurement of radioactivity, described how it works.

"This device is equipped with a camera on the top that records the visual image of what goes on in the front. It is also equipped with instruments such as a precipitation gauge and wind velocity indicator to collect meteorological data. It is furthermore equipped with a radioactivity sensor that measures air dose rate. It can therefore simultaneously measure variation in meteorological conditions and variation in air dose rate."

The height of the device is about 2 meters. The base is fastened in place by a tripod, on which a radiation sensor, camera, precipitation gauge, wind velocity/direction indicator, data transmission unit and solar panel that serves as the power supply are mounted. The small gently sloping road (forest road) to the mountains and its surrounding area are within the range of the camera. The camera is able to monitor water containing dirt and sand flowing in bleeding channels (depressions that act as water conduits) that have already been formed in the road.

The device automatically transmits the meteorological and air dose rate data with the image data to a computer at 10-minute intervals. Collecting this data enables us to get an accurate understanding of the relationship between meteorological conditions and air dose rate. The all-in-one meteorological conditions / radiation monitor was jointly developed by the JAEA and Yamada-Giken, Co., Ltd., in Fukui City.

A gamma plotter (see photo on right) has also been introduced to plot a planer expanse of air dose rate distribution. The gamma plotter is a stick-shaped device equipped with GPS and a pair

of plastic scintillators that can measure radiation. If you walk while holding the device, real-time mapping of the radiation dose on an electronic map is available. By measuring with this device after a typhoon passes or snow melts, besides measurements at regular intervals, migration of radioactive cesium according to the meteorological conditions can be checked.

Study of vegetation and terrain

In order to predict how radioactive cesium migrates with particles in soil in the forest by the flow of water, a detailed study of the mineral composition and vegetation and terrain of forests that will influence the movement of cesium is required, as well as the surface soil layers of the target area and the concentration distribution of cesium in the layers. The JAEA is therefore conducting a thorough investigation of types and distribution of undergrowth, vegetation and terrain in the area, as well as cesium concentration distribution in the surface layer soil, soil layers and mineral composition using the soil sampler mentioned below. In terms of the trees in the forest, their positioning, height, trunk thickness and types are examined, and regarding the undergrowth, its distribution, and thickness/distribution of leaf mulch called "litter" (see photo above) are investigated.

3D scanners used for the topography study (see photo on right) enable accurate 3-dimensional measurement of the ground surface including irregularities. "This device was used to measure the state of mineshafts. The measurements let us know where water tends to flow and collect," confidently explained Tadafumi Niizato, an expert on geological radiowaste disposal.

The results of these studies should provide a more accurate understanding of the movement of the water that flows over the surface layer in the forest, and will be used to select locations where automatic monitoring instruments

such as turbidity meters and water-level gauges are to be set up, in order to study in further detail.

Study of lichens

Lichens are symbiotic organism of fungi and algae. The majority of these organisms grow on the surface of wood and rocks. Because lichens resemble moss in appearance, the two are often confused, but lichens are in fact fungi. Unlike moss, lichens do not have roots.

"We learned from the accident at Chernobyl that lichens tend to absorb radioactive cesium, and that the cesium absorbed hardly migrates at all. This project, therefore, collects lichen samples from the surface of trees and rocks. The samples are then studied to see how much radioactive cesium they contain and how they differ according to where they grow. We think we can determine how much the amount of radioactive materials has reduced since the accident occurred in March, 2011 by comparing with the amounts of radioactive materials contained in the surrounding area," explained Terumi Dohi while continuing to scrape off lichen samples with a spatula (see photo below).

Lichens are not plants, but are rather symbiotic organism of fungi and algae.

Study of soil

How much radioactive cesium has seeped into the soil? How does the amount vary as time passes? A soil sampler is used to study the vertical distribution of radioactive cesium.

A soil sampler is a device that obtains cylindrical samples without disturbing the layer configuration. Samples are obtained by inserting a cylinder into the ground and drawing it back out (see photo on right). The rate at which radioactive cesium seeps into the ground can be determined by studying the distribution of the substance in the cylindrical shaped samples. Also the process by which cesium migrates can be learned by studying concentration distribution, soil composition, and mineral composition of those composing soils.

I witnessed the actual sampling. The sampler cylinder was pushed gradually into the ground while making a shrill sound. JAEA staff members were controlling it by supporting with their hands.

Because it took time to take out the soil from the cylindrical sampler, I was shown the sample taken at the same place for a test the previous day, and I found several different types of soil at different depths. To remove the part where the surface soils were mixed when the cylinder was pushed in, a JAEA staff member exfoliated the surface portion of the soil sample (see photo on right). It's extremely mundane work. Answering to my question, why they take soil samples from that place, Tadafumi Niizato, an expert on the subject explained: "If we look at the front and right/left sides of the topography with the downstream portion in the back, we can tell that rainwater flows here. If you place your face close to the ground, you can sense the gradient." I actually did this, and could see that what I thought was flat land was actually a slope.

The preliminary study shows that radioactive cesium is more concentrated within the depth of 10 cm from the surface. They plan to conduct a detailed study of this place.

Kawamata Town

Kawamata Town is located in Date County, Fukushima Prefecture. The population is approximately 14,000. Because of the sericultural and silk industries that began there in the Heian Period, it is known as "Kinu-no-Sato", or "home of silk." In recent years, the industrial structure has undergone a change; the silk industry is being replaced by factories that manufacture automobile parts and electronic components and so on.

Study of rivers

The JAEA has also studied migration of radioactive cesium in rivers in addition to mountain forests. On that afternoon, a study of rivers has begun in the Odakakawa River of Minamisōma, which is one of the areas to be studied. The study was conducted about a kilometer upstream from the mouth of the river.

The study includes measuring the width and depth of the river, and the velocity and turbidity of the water. By conducting periodic studies of the river water, sediment at the bottom of the river, and sediment and soil of its banks, the state of the sediment and migration of soil particles that have adsorbed cesium can be identified, as well as how it varies according to the change in the current velocity and increase in salinity by seawater in case of the soil near the mouth of the river, and what happens when water increases by heavy rainfall or melting winter snow. By taking soil samples in centimeter units with a scraper plate (see photo above), the characteristics of the soil and concentration of radioactive cesium in the soil can be determined. Tadahiko Tsuruta, who was in charge of the operation, responded: " Through this research, we can find out whether the amount of cesium increases by the swelled river water bringing cesium to the place or oppositely the amount of cesium is reduced by the water scraping away soil containing cesium. The dose rate measurement of the riverbed conducted today tells us that the dose rate rises as we move away from the river and declines as we move toward the river. We expect the amount of cesium to change by the movement of earth and sand when the amount of water in the river increases." Tadahiko never stopped working as he spoke.

In addition to the Odakakawa River, the Ukedogawa River, Kumagawa River, and Tomiokakawa River are included in the study.

Minamisōma

Minamisōma City is located in the northern part of Hamatori region of Fukushima Prefecture and faces the Pacific Ocean. The population is approximately 65,000. The city is known for "Soma Nomaoi", which is designated as a significant intangible folk cultural asset of Japan. The origin of this event goes back more than a thousand years. For the occasion a group of about 500 knights in armor called "Kachu" gather, and ancient armored horse racing and "god flag" fights take place. The event was significantly downsized in 2011 when the Great East Japan Earthquake and accident at the TEPCO‘s Fukushima Daiichi Nuclear Power Station occurred, but was fully restored from July 28 to 30 last year, and was attended by large crowds of visitors.

Study/research of migration of radioactive in the environment of Fukushima Prefecture
Fukushima Long-term Environmental Dynamics Research Project

Aim of project

The aim of the project is to bring to light the migratory behavior of radioactive cesium in the biosphere, etc., and to estimate/assess exposure dose in conjunction with migration, as well as develop a migration prediction model. The project also includes coming up with ways to suppress migration that take exposure dose and migratory behavior into account and establish an assessment system that comprehensively includes long-term study data, migration forecast, dose assessment and measures to suppress migration.

Overview of forest study

The forest study includes a study of distribution of vegetation, terrain and soil to learn the migratory behavior of radioactive materials in forests, steady monitoring of amount of precipitation and water flowing over the ground surface, degree of turbidity of water and analysis of soil and water samples.

Overview of river study

The river study includes measurement of river shape along with basic information such as state of terrain, topsoil, vegetation and land use, plus monitoring of river flow rate / turbidity and meteorological data such as amount of precipitation, in order to learn the migratory behavior of radioactive materials in rivers. It also includes analysis of soil and water samples taken from rivers and dry/wet riverbeds.