

FIELD RESEARCH INSIDE THE FUKUSHIMA RESTRICTED AREA

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On March 16, 2012, Ohkuma town, where the Fukushima Daiichi nuclear power plant is located, stood quietly and peacefully, except for workers in tyvex uniforms conducting remediation work and abandoned cows migrating along unused roads. The town appeared the same as usual, except for the absence of residents, some earthquake damage, and high beeping sounds from our survey dosimeter indicating maximum radiation readings greater than 30 $\mu\text{Sv/h}$, even inside our vehicle. I was there with colleagues for a collaborative field study with Japan Atomic Energy Agency and Fukushima University.

Ohkuma town and vicinity are located in the restricted area, that is, within a perimeter of 20 km from the nuclear power plant (FIG. 1). By law, no one is allowed to enter the area without governmental permission. Security checkpoints have been set up on all roads into the area. A total of 78,200 residents were evacuated from the restricted area. Outside the restricted area, a “deliberate evacuation area” was designated, covering mainly Iitate village and Namie town, based on the area of contaminant distribution elongated toward the northwest; 10,550 residents were evacuated. The deliberate evacuation area was established by the government for those areas where the accumulated dose rate was estimated to be >20 mSv/year (FIGS. 1, 2). People are not allowed to live in this area or to enter the area except for a quick return home, vehicle transit, or a short-term visit for public services or for business purposes. Although the extent of these areas was revised in April 2012 (FIG. 1), most remain deserted.

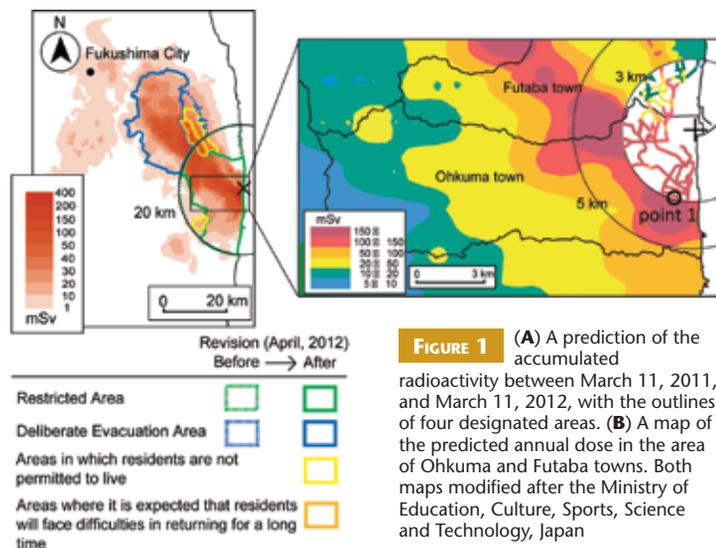


FIGURE 1 (A) A prediction of the accumulated radioactivity between March 11, 2011, and March 11, 2012, with the outlines of four designated areas. (B) A map of the predicted annual dose in the area of Ohkuma and Futaba towns. Both maps modified after the Ministry of Education, Culture, Sports, Science and Technology, Japan

Within the restricted area, especially within 3 km of the power plant, the radiation dose increases dramatically. After a few hours of field work in Ohkuma (FIG. 3), the dosimeters on our chests read >90 μSv , which is about one-tenth of the *annual* dose limit for public exposure, 1 mSv/y, recommended by the International Commission on Radiological Protection. During our field work, the dose rate about 3 km south of the plant was as high as 60 $\mu\text{Sv/h}$ at 1 m above the ground. The highest dose rate measured was 630 $\mu\text{Sv/h}$ beneath a rainwater pipe at point 1 in FIGURE 1. Such spotty occurrences of high radioactivity have been recognized at many contaminated sites, but they do not appear on the large-scale maps of contamination.

¹ Satoshi Utsunomiya has been an associate professor in the Department of Chemistry, Kyushu University, since 2007. He received a PhD from the University of Tokyo in 2000 and worked for the University of Michigan prior to his current position. As a mineralogist and geochemist, he has been studying the migration of radionuclides in the subsurface and other geochemical problems using various nanocharacterization techniques.



FIGURE 2 A dosimeter stands in the playground of the Tsushima elementary school in Namie town within the deliberate evacuation area. The few parked cars are the property of refugees. People were first evacuated to this elementary school located outside the restricted area; however, they were forced to evacuate again, after the town was included in the deliberate evacuation area.



FIGURE 3 Satoshi Utsunomiya sampling soil in a rice field in Iitate village within the deliberate evacuation area. The snow covering the field decreased the dose to some extent.

The scientific challenges at Fukushima include the very low concentrations of radionuclides that must be detected (e.g. even 160,000 Bq/kg of ¹³⁷Cs is only equivalent to ~50 parts per trillion), the characterization of the phases associated with each radionuclide, the heterogeneous size distribution of these phases in soils, the large area of contaminated land, and the wide variety of vegetation.

It is sometimes difficult to see how scientific studies can contribute to the mitigation of disastrous and tragic events. Mounting problems sometimes overwhelm us and obscure the scientific goals, but basic science will definitely be important to the strategies developed for restoration at Fukushima. Our group is contributing to the effort by carrying out Cs and Pu analyses in the contaminated area.



FIGURE 4 FROM LEFT TO RIGHT: Professors Nanba (Fukushima University), Kaneko (Kyushu University), and Utsunomiya (Kyushu University), Mr. Suenaga (Ohkuma municipal government), Mr. Saito (Ohkuma municipal government), and Mr. Iwata (Kyushu University). The photo was taken by Professor Kawatsu in front of the main building of the Ohkuma municipal government, located within the restricted area.

Finally, I express my greatest appreciation to Professors Nanba and Kawatsu of Fukushima University and to Messrs. Saito and Suenaga of the Ohkuma municipal government for transporting us to the area near the Fukushima power plant, as they exposed themselves to the same radiation dose as we did (FIG. 4).

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