

Environmental radiation status of the University of Tokyo after the TEPCO Fukushima Dai-ichi nuclear power plant disaster

Takeshi IIMOTO*, Norio NOGAWA, Hiroshi MITANI, Masao KAMIKO,
Natsumaro KUTSUNA, Yasuhiro WATANABE and Takahiko SUZUKI

The University of Tokyo, 7-3-1 Hongo Bunkyo-ku, Tokyo 113-8654, Japan

*iimoto.takeshi@mail.u-tokyo.ac.jp

The University of Tokyo campuses are primarily located in the metropolitan area of Tokyo, Japan. The three main university campuses are the Hongo campus and the Komaba campus, located in the mideastern part of Tokyo prefecture, and the Kashiwa campus, located in the north western part of Chiba prefecture. The distance between the Fukushima Dai-ichi nuclear power plant and these three campuses ranges from ~200 to ~250 km. Immediately after the nuclear disaster, the university organized a special correspondence team to survey the environmental radiation status for the university. The team consists of about 20 members, including mostly radiation protection specialists or technical experts of the university specialized in radiation measurements. This project is not research-oriented; rather, the purpose is to provide, in the absence of related information, the actual data on environmental radiation immediately after the accident. This information is provided both to the members of the university community and to the public.

The two primary measured quantities are (1) the ambient radiation dose (microsieverts per hour) and (2) the specific radioactivity (becquerels per kilogram) of soil around the surface of a ground, which is used to indicate the level of contamination. The ambient dose data were reported every day on the web site and the portal site magazine of the university, and soil contamination data were reported occasionally. This report provides the background status and technical information on the related activities. In addition, it documents the measured environmental radiation data.

Temporal variation of the ambient radiation dose rate had been officially surveyed since the morning of March 15, 2011, at the selected representative locations on the campus sites. In addition, maps were drawn that showed the distribution area of the ambient dose rate of three campuses. The first peak dose of $0.72 \mu\text{Sv h}^{-1}$ was observed at ~2:30 pm on May 15, 2011, in the Kashiwa campus and the second peak dose of $0.80 \mu\text{Sv h}^{-1}$ was observed at ~11:00 am on May 21, 2011, at the same location. The continuous surveillance was completed at the end of March in 2012. At that time, the representative ambient dose rates of the campuses were $\sim 0.11 \mu\text{Sv h}^{-1}$ for Hongo, $0.23 \mu\text{Sv h}^{-1}$ for Kashiwa (at the elevation of 1 m above the ground), and $0.05 \mu\text{Sv h}^{-1}$ for Komaba (at the elevation of ~15 m above the ground). These values included the natural background dose rate that was detected by the energy compensation type surveymeters. Following the plan that was determined by the Kashiwa local government, some parts on the Kashiwa campus site have been decontaminated. The net dose reduction effect of decontamination was estimated to be ~70%–80%.

For each one of the three campuses, the specific radioactivity of soil around the surface of a ground has been surveyed using a NaI(Tl) scintillation spectroscopy system or a Ge semiconductor spectroscopy system. For example, as of mid-April, 2011, 0.2 to 0.35 kBq kg^{-1} of ^{131}I and 1.0 to 1.5 kBq kg^{-1} of $^{134+137}\text{Cs}$ were measured at the Kashiwa campus site.

Key Words: ambient radiation dose, specific radioactivity, Tokyo, Chiba

1. Introduction

The University of Tokyo¹⁾ is located mainly in the metropolitan area of Tokyo, Japan. This university owns three main campuses; the Hongo campus and the Komaba campus are located in the middle eastern part of Tokyo prefecture, and Kashiwa campus is located in the north western part of Chiba prefecture. The distance between the Fukushima Dai-ichi nuclear power plant and the three campuses ranges from ~200 to ~250 km. Immediately following the nuclear disaster, the university organized a special corresponding team to survey the environmental radiation status in the university. The team consists of ~ about 20 members (see Table 1), and includes mostly radiation protection specialists or technical experts of the university specialized in radiation measurement. This project is not research-oriented; rather, the purpose is to provide, in the absence of related information, the actual data on environmental radiation immediately after the accident. This information is provided both to the university community members and to the public.

This report presents the data collected during the university's official project. Data collection was performed immediately after disaster, in the Tokyo metropolitan area. This data can be used to strengthen the existing related data.

2. Monitoring targets and methods

The two primary targets of the surveillance were (1) the ambient radiation dose (microsieverts per hour) and (2) the specific radioactivity (becquerels per kilogram) of rain water and of soil around the surface of a ground, which is used to show the level of contamination.

To measure the ambient dose, TCS-171B or TCS-172 by Hitachi Aloka Medical were used. These were well calibrated NaI (TI) scintillation survey meters of energy compensation type. The time constant was set as 30 s, which was the largest value that could be used with these instruments. Some measurements were performed intermittently, while in other cases data were continuously and automatically measured and recorded. The elevations at which measurements were performed were adequately selected as one meter (for the standard height of adults in Kashiwa campus and Hongo campus), or 15 m for the airborne radioactivity survey in Komaba campus.

To measure the specific radioactivity of soil, NaI (TI) scintillation spectroscopy system of well type or Ge semiconductor spectroscopy system were used. In each case, detection efficiency was estimated using standard ⁴⁰K-Cl samples. Soil materials were sampled from the surface of a ground, from a layer between 0-1 cm depth (for surface layer target method) or from a layer between 0-5 cm depth (for standard target method). The sampled soil was weighed and measured as is (without being dried). Specific radioactivity of a sample of rain water was also measured using the NaI (TI) scintillation spectroscopy system of well type or Ge semiconductor detector system.

The ambient dose data had been reported every day on the web site. In addition, the data had been published in portal site magazine of the university. Soil contamination data were reported occasionally and periodically.

Results and discussion

(1) Ambient radiation dose

Since the morning of March 15, 2011, continuous survey of the ambient radiation dose rate had been officially performed at the selected representative locations on the campus sites. The first peak dose of 0.72 $\mu\text{Sv h}^{-1}$ was observed at around 2:30 pm on March 15, 2011, in Kashiwa campus, while the second peak dose of 0.80 $\mu\text{Sv h}^{-1}$ was observed at around 11:00 am on March 21, 2011, when the first rain fell after the Fukushima Dai-ichi NPP accident (see Fig.1). The elevation at which these measurements were performed was one meter above the ground.

The large reduction of ambient radiation dose rate was observed after 20 days following March 21, 2011,

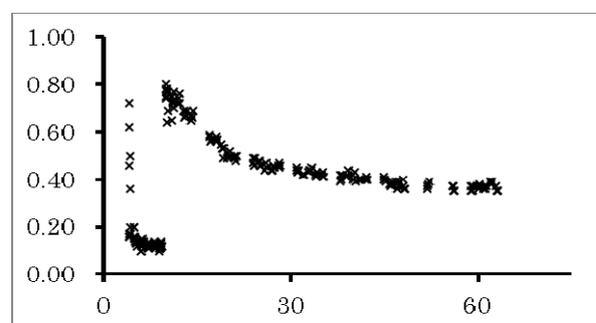


Fig.1 Ambient radiation dose rate in Kashiwa campus, plotted vs. time. Horizontal axis is days post March 11, 2011, and the vertical axis is ambient dose rate, measured in microsieverts per hour.

and afterwards, the ambient radiation dose gradually decayed until the continuous surveillance ended at the end of March, 2012. At that time, the representative ambient dose rates of the campuses were measured to be $\sim 0.23 \mu\text{Sv h}^{-1}$ for Kashiwa and $\sim 0.11 \mu\text{Sv h}^{-1}$ for Hongo (at the elevation of one meter above the ground). These measured values included the natural background dose rate that was detected by the energy compensation type survey- meters.

Fig.2 shows the spatial map of outdoor ambient radiation dose rate at Kashiwa campus, measured from October 10 to November 10, 2011. Radiation dose was measured at 1516 points that were located 6 m apart. At the elevation of 1 m above the ground, the average dose rate was $0.3 \mu\text{Sv h}^{-1}$, and more than 80% of measurements yielded values below $0.35 \mu\text{Sv h}^{-1}$. Some spots that measured more than $0.6 \mu\text{Sv h}^{-1}$ at the elevation of 1 m and more than $1.0 \mu\text{Sv h}^{-1}$ at the elevation of 5 cm have been decontaminated, following the corresponding plan determined by the Kashiwa local government. These spots were found in drainage pathways, such as the eave gutter and the underneath down spouts. The surface soil, gravel and weed were removed by shovel while the dose rate was measured. The effect of the decontamination on reducing the radiation is shown in Fig.3. This decontamination was performed on October 17 and October 19, 2011, in Kashiwa campus. After the contaminated surface soil was removed, the measured reduction rate at the elevation of 5 cm above the ground ranged from 70% to 80%.

For the reference, the highest overall surface concentration of radioactive materials ($^{131}\text{I} + ^{134+137}\text{Cs}$) was measured on the floor of a building in Kashiwa campus on March 22, 2011. This radiation dose, estimated using a gas-flow radiation counter, was $\sim 0.4 \text{ Bq cm}^{-2}$.

From March 13, members of Komaba campus had started measuring the ambient radiation dose rate using a NaI (TI) scintillation survey meter in order to investigate the variation in radioactive airborne contamination from the Fukushima Dai-ichi nuclear power plant. An automatic ambient radiation monitoring system was installed at the elevation of $\sim 15 \text{ m}$ above the ground. This system started to operate on March 18 and continued until the end of December 2011. During the measurement period, the maximal level of the ambient radiation dose rate in Komaba campus was $\sim 0.52 \mu\text{Sv h}^{-1}$ and it was

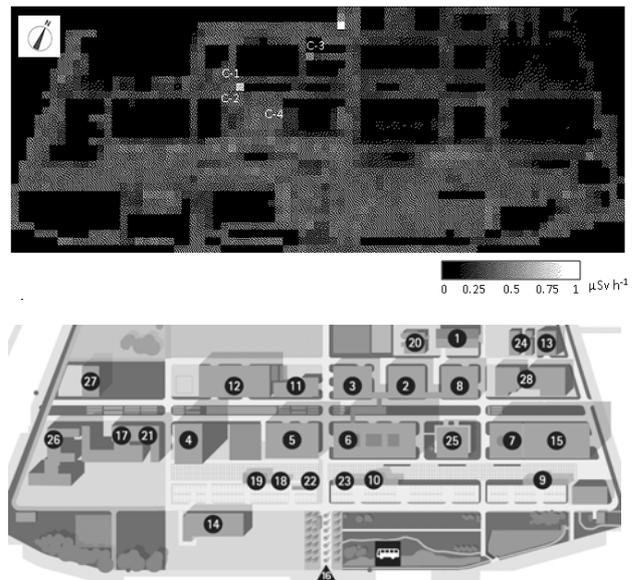


Fig.2 The spatial map of outdoor ambient radiation dose rate distribution at Kashiwa campus, measured from October 10 to November 10, 2011 (upper panel). The area map of Kashiwa campus, with several buildings shown (lower panel)

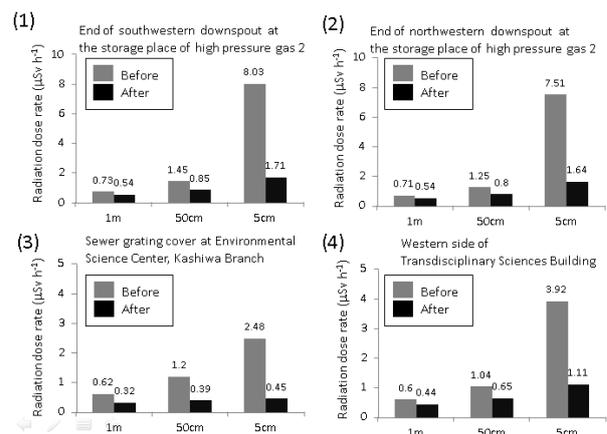


Fig.3 Effects of decontamination treatment on the reduction of ambient dose in Kashiwa campus. Decontamination was performed on October 17 and October 19, 2011. The surface soil, gravel, and weed were removed by shovel while the dose rate was measured.

observed at 7:00 pm on March 15, 2011. By the end of April 2011, the radiation dose rate at the elevation of 15 m was reduced almost to the same level as the natural background radiation ($0.05 - 0.06 \mu\text{Sv h}^{-1}$).

(2) Specific radioactivity

As of mid-April, 2011, 0.2 to 0.35 kBq kg^{-1} of ^{131}I and 1.0 to 1.5 kBq kg^{-1} of $^{134+137}\text{Cs}$ were measured in soil samples in Kashiwa campus using the standard target

method.

On March 29, 2011, 7.8 kBq kg⁻¹ of ¹³¹I and 2.7 kBq kg⁻¹ of ¹³⁴⁺¹³⁷Cs were measured in soil samples in Hongo campus using the surface layer target method.

On March 22, 2011, 3.2 kBq L⁻¹ of ¹³¹I and 0.18 kBq L⁻¹ of ¹³⁴⁺¹³⁷Cs were measured in rain water sample on Hongo campus site.

Table 1 Members of the special corresponding team appointed to survey the environmental radiation status in the university

T.Iimoto, N. Nogawa, K. Tao, S. Higaki, Y. Koike, N. Kosaka, T. Suzuki, A. Kobashi, M. Tanikawa, K. Tanoi, M. Hirota, Y. Yie, K. Nozawa, H. Mitani, N. Kutsuna, T. Watanabe, K. Kamiko, Y. Watanabe, Y. Kamimura, and Staffs of Division for Environmet, Health and Safety and Staffs of Environment, Health and Safety Department
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References

- 1) English Website of The university of Tokyo,
<http://www.u-tokyo.ac.jp/en/>