Further comments on "Individual external dose monitoring of all citizens of Date City by passive dosimeter 5 to 51 months after the Fukushima NPP accident (series): II. Prediction of lifetime additional effective dose and evaluating the effect of decontamination on individual dose."

Yoh Tanimoto
Dipartimento di Matematica, Università di Roma "Tor Vergata"
email: hoyt@mat.uniroma2.it
Yutaka Hamaoka
Faculty of Business and Commerce, Keio University
email: hamaoka@fbc.keio.ac.jp
Kyo Kageura
Graduate School of Education, University of Tokyo
email: kyo@p.u-tokyo.ac.jp
Shin-ichi Kurokawa
The High Energy Accelerator Research Organization (KEK), Tsukuba
email: shin-ichi.kurokawa@kek.jp
Jun Makino
Department of Planetology, Graduate School of Science, Kobe University
email: makino@mail.jmlab.jp
Masaki Oshikawa
Institute for Solid State Physics, University of Tokyo
email: oshikawa@issp.u-tokyo.ac.jp

Dear Sir,

In this Letter, we point out inconsistencies, obvious mistakes and inappropriate statements in [1], which were not discussed in the earlier Letter [2] by one of us (SK). Throughout this Letter, "Fig. X" refers to a figure in Ref. [1] unless otherwise specified.

(1) Section 1 gives a summary of the findings in the first paper of the series [3], yet the statement "*[T]he obtained coefficient of* 0.15 *did not change with time, across the six*

airborne surveys conducted between November 2011 (4th survey) and November 2014 (9th survey)" is not supported by either a statement or an appropriate statistical analysis of the data for each airborne survey. Specifically, the authors did not present values of the coefficient c for each airborne survey, but only an aggregated arithmetic mean over all surveys [3].

(2) Fig. 1 contains several anomalies. According to our examination, the original airborne monitoring data [4] contains 4,150 grid points in Date city[1]. We made a figure using all 4,150 points (the top panel of Fig 1 of this Letter).

- In spite of the fact that the range of the ambient dose for the 4th monitoring[2] after subtracting background of 0.04 μSv/h is $(0.39, 6.76)$ μSv/h (see the top panel of Figure 1 of this paper, where the x-coordinates of the plots range from 0.39 to 6.76), many points under 0.39 μSv/h are plotted and points over 2.7 μSv/h are missing in the Fig. 1. The same is observed for the vertical axis; for example, the range of airborne dose for the 5th monitoring is $(0.24, 3.66)$ μSv/h, but many points below 0.24 μSv/h are plotted and points larger than 2.5 μSv/h are not shown.
- In the original airborne monitoring data, the points higher than 1.0 μSv/h are discretized into steps of 0.1 μSv/h. However, such a discretisation is not present in Figure 1 of [1]. This is evident by comparing the top panel of Fig. 1 of this Letter to the original plot shown as the bottom panel.
- In Fig. 4a of [3], the bins whose ambient dose rate is smaller than 0.35 μSv/h do not have any subjects. This is inconsistent with Fig. 1 where there are points under 0.39 μSv/h.

(3) It is claimed in Section 2.2, without showing data, that $c^{\mathrm{A}} = 0.10$ and $\dot{H}^{*A}_{10}(0.65) = 2.1\,\mu\mathrm{Sv/h}$, whose product is $c^{\mathrm{A}} \cdot \dot{H}^{*A}_{10}(0.65) = 0.21\,\mu\mathrm{Sv/h}$. We strongly suspect that this is false:

- The households in Zone A are shown in Fig. 2 of this Letter. Colored points corresponds to the households in Fig. 3a of [3], and colors show the ambient dose rate at time $t = 0.65$ y. The ambient dose rates of most of these households were higher than 2.5 μSv/h, therefore, it is unlikely that the average $\dot{H}^{*A}_{10}(0.65)$ was 2.1 μSv/h, but it should be somewhere between 2.5 μSv/h and 3.5 μSv/h.

[1] The area of Date City is 265 km^2 and airborne does is estimated for each 250 m grid points or 4×4 grid per 1 km^2, thus we expect around $265 \times 16 = 4{,}240$ data points. Although, for this letter we utilized original data in Japanese[4], English version data is available at the following site. `https://emdb.jaea.go.jp/emdb/en/portals/b1010301/`

For example, "Air Dose Rate Results of the Fourth Airborne Monitoring Survey (Decay correction: November 5, 2011)" for Fukushima is obtained from the following link in the unified format. In the file, 4,150 records are listed for "Date city." `https://emdb.jaea.go.jp/emdb/assets/site_data/en/csv_utf8_unifiedformat/1010301004/1010301004_07.csv.zip`

[2] Using above mentioned file, we calculated descriptive statistics and subtracted back ground dose of 0.04 μSv/h, then obtained range of $(0.39, 6.76)$ μSv/h. For the later survey, the same analysis was conducted with the archived data.

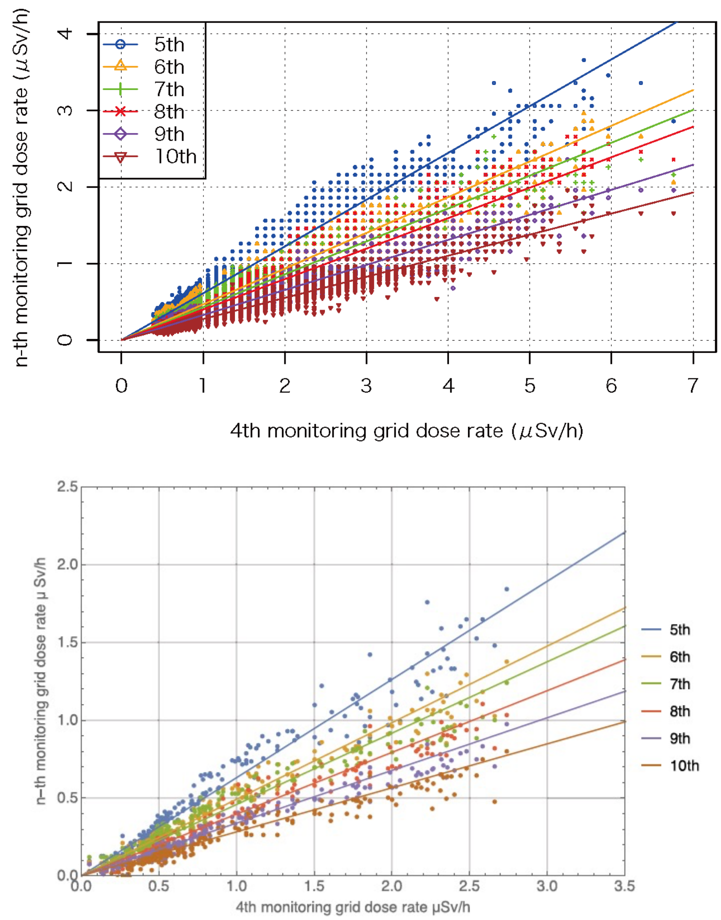

Figure 1: Comparison between Reproduced Scatter Plot with full-data and Fig.1 in [1]. The top panel was plotted using original data [4] with regression lines (n-th air monitoring dose dose was regressed on the 4th monitoring dose without intercept). The bottom panel was taken from [1] for comparison.

- If we assume the log-normal distribution of [3, Fig. 5] at each period, the mean value must be around 1.15 times higher than the median. For the curve in Fig. 6 to pass the mean value at 7-th month, the product $c^{\mathrm{A}} \cdot \dot{H}_{10}^{*A}(0.65)$ would have to be about $0.42\,\mu$Sv/h (see also [5, P.14], where a plot very similar to Fig. 6 is shown with additional orange dots. We suspect that these dots are the average dose rate in each period, and its value at 2011 Q3 (the 7th month) is about $0.95\,\mathrm{mSv/3month} = 0.43\,\mu\mathrm{Sv/h}$). This suggests that the claimed value $c^{\mathrm{A}} = 0.10$ is considerably underestimated. By looking at Fig. 4a of [3], if we pick up the part where the ambient dose rate is higher than $2.5\,\mu$Sv/h and hence should contain most of the households in Zone A, it is reasonable to assume that $c^{\mathrm{A}} \sim 0.15$.

The product $c^{\mathrm{A}} \cdot \dot{H}_{10}^{*A}(0.65)$ appears as a factor, therefore, any error in it leads to an error in the estimated lifetime doses in Zone A, which is a main result of the paper.

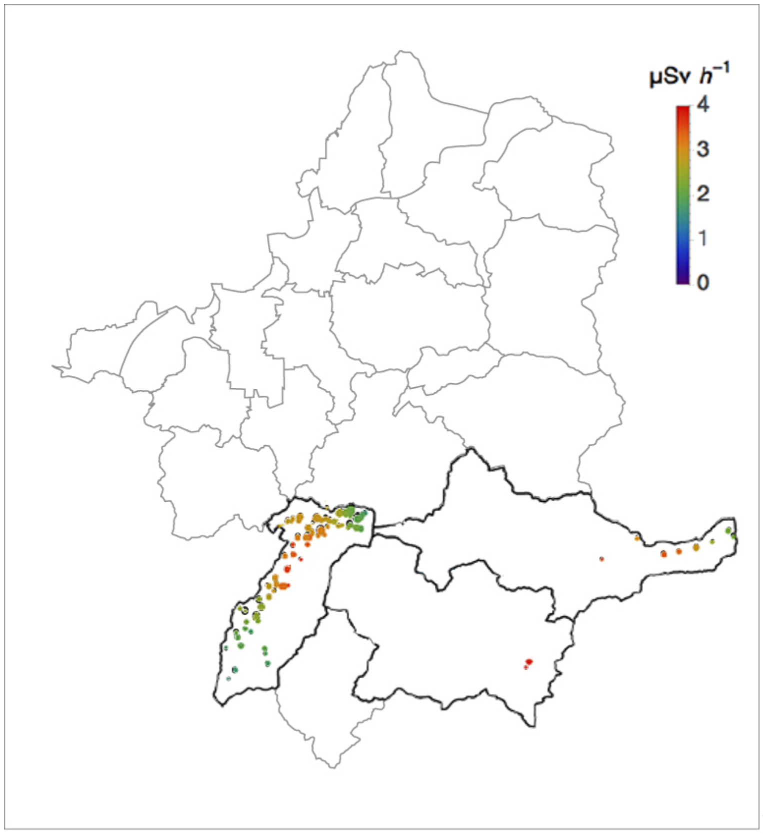

Figure 2: The points corresponding to the households in Fig. 3 are overlaid by the colored points in Fig. 3a of [3], where "the area of each circle is drawn proportionally to the number of participants within each the grid cell". At least half of them are in the grid cells with 2.5 Sv/h or higher.

(4) All three panels of Figs. 5 have box-and-whisker plots for the 5-th month (August 2011). These plots should not be included in the figures, since it is written in the paper "*we selected the subjects who held the glass badges continuously from 2011Q3 to 2015Q1 (from September 2011 to June 2015)*" (in Section 2.2).

Moreover, the statement in Section 4 "*Date City, which began measuring personal doses for schoolchildren and residents living in relatively high-dose areas from August 2011*" is imprecise: children in the survey in August 2011 were those aged 15 or younger, and there were about 100 pregnant women as well, but most of the adult residents of the area started to participate in September 2011, see [3, Table 1].

(5) In Fig. 5c, the lower whisker decreases between 14-th and 17-th months, 23-rd and 26-th months, and 44-th and 47-th months. This must be impossible because the figure is supposed to show the cumulative doses of those "*who continuously held glass badges during the study period*", i.e. of the same participants. This suggests a serious error in handling the data, or an unusual way of plotting.

(6) The authors conclude, by picking only two periods among 10 (before and after the decontamination) and assuming a single reduction function throughout the whole period,

that "*effects of decontamination on the reduction of individual doses were not evident*". This conclusion is unreasonable: the authors should have compared the dose rates before and after the decontamination and fitted each period by an *a priori* different function. Indeed, one of the authors (R. Hayano) reported in a symposium on September 13, 2015 that there were effects of decontamination in Zone A by showing the same graph [6, 13:00∼] and they also wrote that the effect of the decontamination in Zone A was ∼ 60% in [5, P.14].

(7) In Figs. 5 and 6, a majority of the participants in Zone A remained evacuated in 2014 [7, P.97, Table]. This means that the ambient dose rates associated with their addresses are not correlated with the actual dose rates they receive, and it makes little sense to claim based on such data that effects of decontamination were not evident. Furthermore, most participants in Zones B and C are children younger than or equal to 15 years old (see [3, Table 1]), and their parents often tend not to let them stay outside for a long time. Analyses without considering these factors distort the estimated lifetime doses.

(8) In Fig. 7, the number of participants is 425, while there are more than or nearly 10 outliers above each upper whisker. This is impossible if the upper whisker represents the 99-th percentile. Rather, the upper whiskers are suspected to correspond to the 90-th percentile by comparison with [3, Fig. 5] where the 90-th percentile is about 2.1 times of the median. This affects the claimed 99-th percentile of the estimated lifetime doses. This argument applies also to Fig. 5, Zone A with 476 participants.

In addition, if we subtract the initial dose of 1.4 mSv, three curves in each figure of Figs. 5, high, middle, and low curves, have a special relation to each other; the ratio between high/middle is about 2, and also the ratio between middle/low is about 2. From [3, Fig. 5], we know that the 90-th percentile is about twice as large as the median (50-th percentile) and 10-th percentile is about half of the median. We suspect that the high curve corresponds to 90-th percentile, the middle to the median and the low to the 10-th percentile. The fact that high curves pass close to the upper end of the whiskers and low curves do not pass the lower end of the whiskers and go higher corroborates our suspicion that the upper end of whiskers are not 99-th percentile but 90-th percentile and that low curve corresponds to 10-th percentile, and not to 1-st percentile as described in the caption of Fig. 5.

(9) The accumulated doses in Fig.7 should be obtained directly summing the doses of three months shown as mSv in the database, or by summing the dose rate shown μSv/h in Fig. 6 multiplied by 24(hour) × 91(day); however, as we pointed out in [2], the doses in Fig. 7 do not coincide with the doses calculated as described above and amount to only 46% [8]. Furthermore, there is a discrepancy between the integrated curve of $\dot{H}^{*A}_{10}$ in Fig. 6 (note that the curve in Fig. 6 is drawn using the value $c^{\mathrm{A}} \cdot \dot{H}^{*A}_{10}(0.65) = 0.33\,\mu\mathrm{Sv/h}$, instead of the claimed values $\dot{H}^{*A}_{10}(0.65) = 2.1\,\mu\,\mathrm{Sv/h}$ and $c^{\mathrm{A}} = 0.1$) and the cumulative doses H^{*A}_{10} in Fig. 7: more precisely, the discrepancy is a factor of 0.58. These two shrinkage factors, 0.46 and 0.58, cannot be explained by a single mistake (e.g. we pointed out that the factor of 0.46 could be due to mistaken unit μSv/h instead of mSv/3months [8], but this could not explain the factor of 0.58). Moreover, the glass-badge data are discretized

into steps of 0.1 mSv/3month while the minimum step in Fig. 7 is 0.1mSv/3month × 0.46 (see Fig. 3 of this letter), therefore, the plots of Fig. 7 must be wrong.

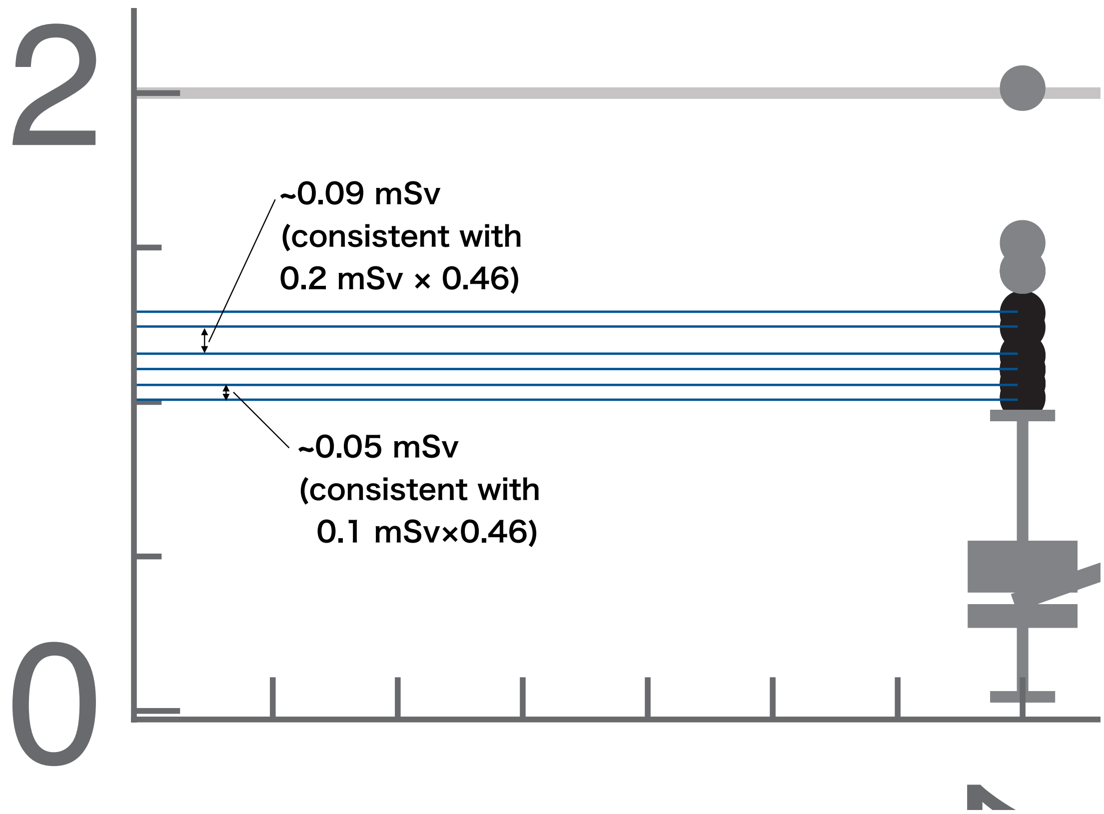

Figure 3: The minimal steps in Fig. 7 are 0.1 mSv × 0.46, while the minimal increase of the doses registered with a glass-badge should be 0.1 mSv.

(10) Note also that the participants of Fig. 5a are the residents in Zone A who held the glass-badge continuously in the period 2011Q3 to 2015Q1, while those of Fig. 7 held the glass-badge in the period 2011Q3 to 2014Q1 and their houses were subject of decontamination in 2012 Q3. It is natural to expect that most participants are common in these figures. If so, Fig. 5 has the same problem: compared with Fig. 6, individual doses are smaller by a factor of 0.55 and the integrated curve is smaller by a factor of 0.70 [8].

(11) Let us assume that the glass-badge data of Fig. 5 are shrunken by a factor of 0.55, as we argued above. On the other hand, the outliers are discretized into steps of about 0.1 mSv (see Fig. 4 of this Letter). This means that the original data would have to be discretized into steps of about 0.2 mSv, which is very unlikely because the minimal increase of a glass-badge is 0.1 mSv. This suggests an error in plotting in Fig. 5.

(12) As Fig. 7 shows the cumulative doses, the first period contains the doses received during the 3 months, hence this must coincide (after converting the units) with the first period

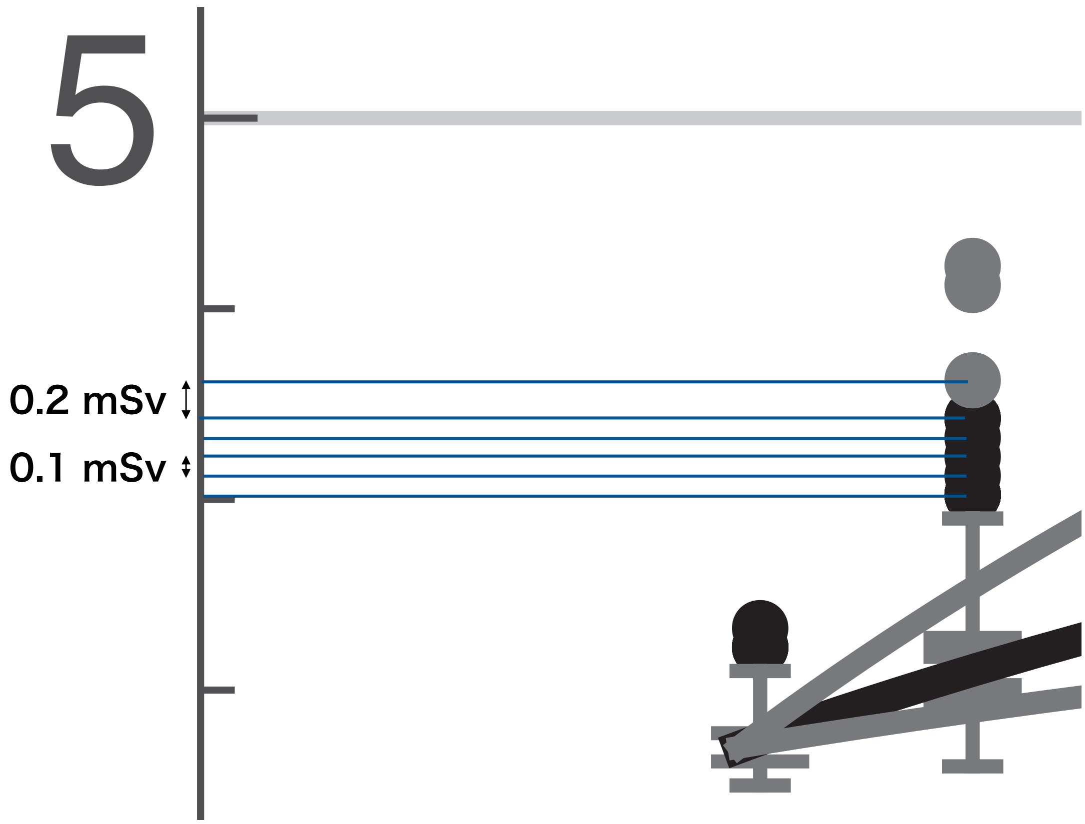

Figure 4: A part of Fig. 5a, enlarged. The minimal distance between outliers is about 0.1 mSv. (The scale on the vertical axis is 1 mSv)

of Fig. 6. In correspondence to the outliers for the first period of Fig. 7, there must be many outliers above 1.0 μSv/h for the same period in Fig. 6. A reconstruction of these outliers, taking the error of the factor 0.46 between Figs. 6 and 7 (see item (10)) into account, is given in Figure 5 of this Letter. Evidently, these significant data were truncated from Fig. 6, without any comment or explanation.

(13) Section 5 claims that "*[R]egardless of the magnitude of the ambient dose rates, the difference in decontamination method, or whether or not decontamination was carried out, the reduction function was the same throughout Date City*". The authors did not show it. Rather, they just assumed the same reduction function in different zones.

(14) The authors' conflicts of interest are not properly declared. Date City has asked the authors to carry out the research and write scientific papers, and one of the authors (M. Miyazaki) is a policy adviser of Date City (see Ethics statement of Ref. [3]).

As we have shown, the paper [1] contains many serious errors, and/or inappropriate handling of data. They inevitably affect the main conclusions of the paper, which must be regarded invalid in the light of the issues pointed out in this Letter.

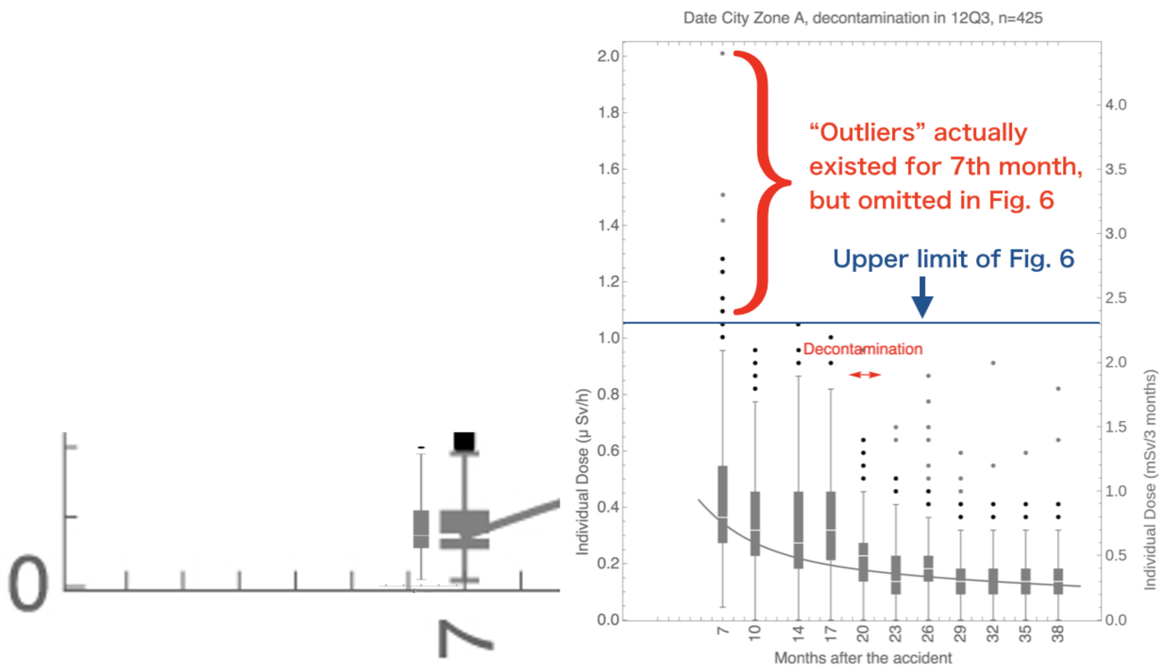

Figure 5: Left: we compare the first box-and-whisker plot of Fig. 7 (enlarged) and that of Fig. 6 (vertically shrunken and overlaid alongside) of [1]. Right: we reconstructed outliers above the first box-and-whisker plot of Fig. 6, based on the outliers for the same period in Fig. 7. The error of the factor 0.46 (see item (10)) between the two figures was taken into account.

Acknowledgements

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Conflicts of interest

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