
A review of Masuda's re-investigation of 'black rain' after the Hiroshima A-bomb

Yoshinobu Masuda

Present affiliation: Izumihoncho 2-18-13, Komae, Tokyo 201-0003, Japan

5

Abstract

Uda et al. (1953) investigated the so-called 'black rain' 1–4 months after the Hiroshima A-bomb in August 1945. In their report, they described two rainfall areas: a 'heavy rain area' and a 'light rain area.' The heavy rain area was oval shaped, with a long axis of 19 km and a minor axis of 11 km; the 'light rain area' was also oval shaped, with a long axis of 29 km and a minor axis of 15 km. The map of the heavy rain area has been used in a support system for A-bomb survivors by the government of Japan. Uda et al.'s sample size of rainfall reports from survivors was only 170, so it was possible that their maps might not include the entire rainfall area. Masuda (1989) therefore re-investigated the black rain area using a much larger data set and reported revised results. In addition to the data used by Uda et al., Masuda used new questionnaires, hearing results, reports of survivors, and other sources to make a revised rainfall area map. The width of the rainfall area was 4 times or more that reported by Uda et al., and the shape was more complex. The start times, duration, and estimated amount of precipitation of black rain were also reported. This paper is a review of Masuda's paper, which was written in Japanese for the journal *Tenki* in 1989.

1. Investigation of black rain by Uda et al.

On 6 August 1945, a U.S. bomber dropped an A-bomb over Hiroshima City. The city was almost entirely destroyed. Many survivors were subjected to large doses of radiation and suffered from leukemia and other types of cancer long after the bombing.

Survivors reported that the rain that fell soon after the bombing was black or gray. These 'black rains' were observed in a wide area around the western part of Hiroshima City and its northwestern suburbs. This rain water was later found to be contaminated by high levels of radiation, and many people exposed to it suffered from alopecia, diarrhea, and other diseases. Many fish exposed to the rain died and floated on water surface.

Uda et al. (1953) investigated the black rain mainly by hearing 1–4 months after the bombing. Two rainfall areas were identified: a 'heavy rain area' and a 'light rain area.' The heavy rain area was oval shaped, with a long axis of 19 km and a minor axis of 11 km; the light rain area was also oval shaped, with a long axis of 29 km and a minor axis of 15 km.

ISBN 978-4-9905935-0-6

Revisit the Hiroshima A-bomb with Database: 125-130

© Yoshinobu Masuda

In 1976, the government of Japan decided that people who had been living in the heavy rain area at the time of the bombing should receive subsidized medical treatment. However, the sample size used in Uda et al.'s study was only 170 hearings, so they may not have been able to correctly identify the entire area affected by heavy rains. Many residents of areas outside the identified heavy rain area complained about the government's decision to use the results of Uda et al.'s investigation.

2. Tentative black rain area reported by Masuda (1987)

Masuda attended the '1985 World Conference Against A&H Bombs' held in Hiroshima on 2–6 August 1985. During this conference, A-bomb survivor Tsuneyuki Murakami told him that black rain was observed in a wider area than that shown in Uda et al.'s map, which prompted him to re-investigate the black rain area. Unfortunately, 40 years had passed since the explosion, making this investigation quite difficult. Masuda used official reports about the Hiroshima A-bomb from the Hiroshima Prefecture and Hiroshima City, as well as written accounts by survivors to extract black rain data.

Uda et al. (1953) used the all data they collected in 1945 in order to draw Uda et al.'s map. However, only extracted data were reported in their paper. In this re-investigation, it was therefore very important to find their original total data and use the same classification methods for light, moderate, and heavy rain to reproduce the rain area map. After a lengthy search, the originally data were found at Makoto Ishino's laboratory at Tokyo Fisheries University. Uda et al. extracted only 107 hearing data in their paper, but 170 original hearing data were found.

Masuda combined all 170 original data with the new data and used Uda's classification methods to classify rainfall areas as light, moderate, and heavy. The tentative revised black rain area map was announced at the annual meeting of the Japan Meteorological Society on 26 May 1987.

3. Data used in the re-investigation

After the tentative map was distributed by television and newspaper, many A-bomb survivors called or wrote to inform Masuda that this revised map was still incorrect, and it became clear that a more detailed investigation was needed. The investigation was expanded so that the final map was created using the following sources (total number of data points was 2125):

- (1) The Hiroshima Meteorological Observatory and 5 local meteorological stations (6);
- (2) Uda et al.'s original data (170);
- (3) Questionnaires about black rain and health condition at Yuki village made by Hiroshima Prefecture in October 1978 (123);
- (4) Statements organized by Mr. Hyozo Hamamoto, the leader of "group of black rain" (83);
- (5) Hearing results about black rain made by Mr. Tsuneyuki Murakami (25);
- (6) Hearing results about black rain made by Masuda (111);
- (7) Questionnaires about black rain made by Masuda (1188);
- (8) Newspaper and television reports (61);
- (9) Written accounts of survivors published in books or elsewhere (358).

4. The revised black rain area map made by Masuda (1989)

The data were arranged in notebooks so as to group all data belonging to a given geographic area (e.g., a community in Hiroshima or village in the prefecture) on the same page. This data arrangement was very useful because the accuracy of the data varied.

After arranging the data, the duration of continuous rainfall was determined for each community or village. Uda et al. (1953) classified the periods as follows: less than 30 minutes was light rain, between 30 minutes and 1 hour was moderate, and more than 1 hour was heavy. The same method was used to plot the data on the revised map, which was published in Masuda (1989). Hereafter, we call this rain area map ‘Masuda’s black rain area map,’ or more simply ‘Masuda’s map’

Figure 1 shows Masuda’s map overlaid on the old Hiroshima City map. Masuda’s map differs greatly from Uda et al.’s map. In Uda et al.’s map, the area with no rain spreads across the southern part of the hypocenter of the A-bomb, and the shape of rain area is very simple. However, in Masuda’s map, light rain areas are scattered in the southern part of the hypocenter of the A-bomb, and the shape of the rain area is very complex.

A narrow no rain area penetrates from south to north just at the east of hypocenter. And around the hypocenter, the light rain area is surrounded by the moderate and heavy rain area like horseshoe.

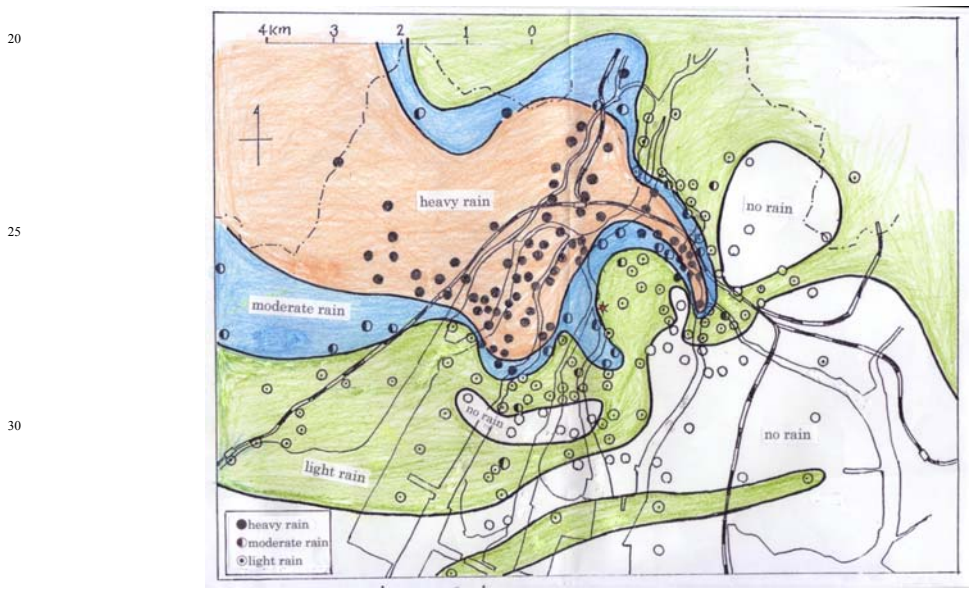


Figure 1 Masuda’s black rain area map of Old Hiroshima City (Figure 1 in Masuda, 1989)

Figure 2 shows Masuda’s map for the northern part of Hiroshima Prefecture. This map also differs very much from Uda et al.’s, which is shown by the dotted lines in the Figure. The shapes of the heavy and light rain areas in Uda et al.’s map are simple ovals, whereas those of Masuda’s map are more complex. The northernmost light rain area is 45 km from the hypocenter of the A-bomb in Masuda’s map, and the light rain area reaches 36 km in width. Masuda’s light rain area is about 4 times larger than that reported by Uda et al. (1953).

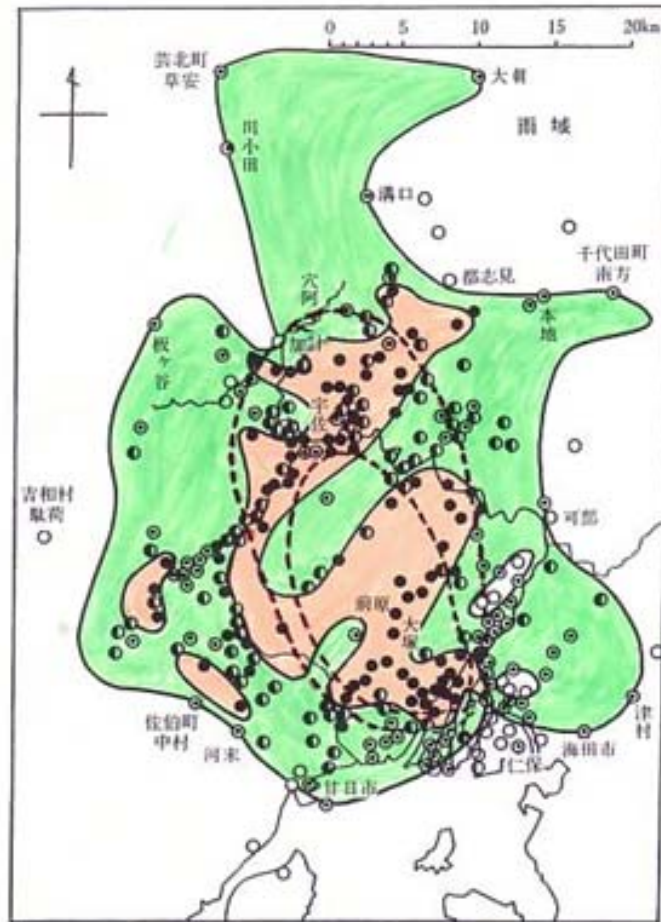


Figure 2 Masuda’s black rain area map for the northern part of Hiroshima Prefecture (Figure 2 in Masuda, 1989). The dotted lines represent the boundaries of Uda et al.’s (1953) original map.

5

5. Starting time ,continuation time and precipitation amount of black rain

Masuda also reported when the rain began in each area, as well as how long it fell and estimated the amount of precipitation for this area.

The length of the periods of continuous black rain are directly related to the light, moderate, and heavy classifications, but these results are not shown here for the sake of brevity. Heavy rains continued for more than 4 hours around the western part of Hiroshima City and the northwestern mountain side of the suburbs.

The figure of the starting time of black rain is also not shown here. However, from this figure, the starting time data did reveal a very important finding. Two types of black rain were observed, one precipitated from the mushroom cloud of the A-bomb itself and the other from the cumulonimbus cloud created by the fires that occurred after the explosion

The Figure 3 shows the estimated precipitation amount of black rain. In this Figure, an estimated more than 100 mm of rain fell in the central part of the heavy rain area and levels of more than 20 mm were observed in several areas.

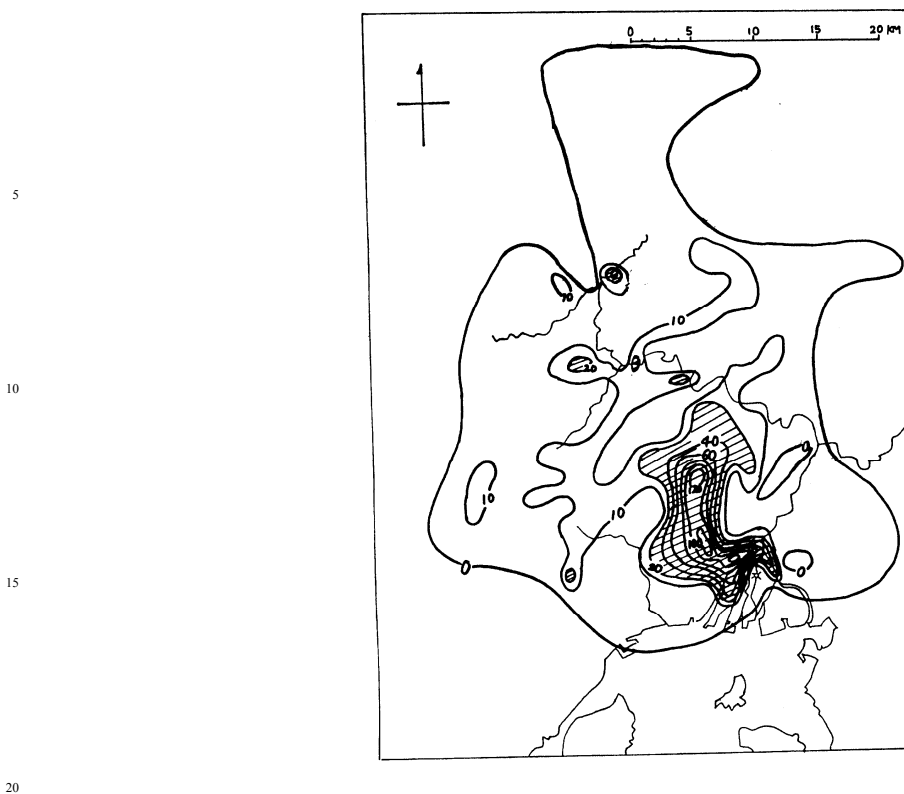


Figure 3 Masuda's map of the precipitation amount of black rain for the northern part of Hiroshima Prefecture (Figure 8 in Masuda, 1989)

6. Conclusion

1. The Masuda rain area spread to 45 km from the hypocenter to northwest, and the maximum width is 36 km from west to east. And the area width is 4 times wider than the Uda's area.
2. Rains were identified at Niho, Kaitaichi, Mukaigawa in Etajima, Kure and Kurahashijima in this study while rains were not reported for these locations in Uda et al.
3. The Masuda's heavy rain area is almost equal to the Uda's light rain area.
4. Shapes of rain area, especially of heavy rain area are very irregular and complex.
5. From values of estimated precipitation amounts, it seems that a big downpour of more than 100 mm occurred. And several sites with precipitation amounts of more than 20 mm were observed.
6. There is no rain region just east of hypocenter, and this region is surrounded by the horseshoe shape region of heavy rain.
7. There are two types of black rain, one was coming from the mushroom cloud of A-bomb itself, the other was coming from cumulonimbus clouds developed by the big fire after A-bomb explosion.

Recently, the accuracy of the rain map near the hypocenter was confirmed by Sizuma et al. (1996) and that for the entire area of the northern part of Hiroshima by Ohtaki (2010).

References

- Masuda, Y., A re-investigation of 'black rain' after Hiroshima A-bomb. Tenki. 1989
- Ohtaki, M., Partial-time distribution of black rain based on questionnaire study. Current status of studies on radioactive fallout with "black rain" due to the Hiroshima atomic bomb. 2010
- 5 Shizuma, K., Iwatani, K., Hasai, H., Hoshi, M., Oka, T., Okano, M., ¹³⁷CS Concentration in Soil Samples from an Early Survey of Hiroshima Atomic Bomb and Cumulative Dose Estimation from the Fallout. Health Phys. 1996
- Uda, M., Sugawara, Y., Kita, I., Meteorological conditions related to the atomic bomb explosion in Hiroshima. Collection reports on investigation of the atomic bomb casualties. Science Council of
10 Japan. 1953.