Assessments by International Organizations

UNSCEAR 2020/2021 Report (1/8): Purpose of the Report

Purpose

- Summarize all of the information available and assess its implications for the findings and conclusions presented in the UNSCEAR 2013 Report.
- Validate and, where necessary, revise estimates of doses to the public, based on more detailed analyses of the available information, and update the commentary on the health implications.
- Set out an improved appraisal of the uncertainties and variabilities in the estimates of doses to the public.
- Where possible, better address issues and objectives not fully addressed in the UNSCEAR 2013 Report.

The UNSCEAR 2020/2021 Report Scientific Annex B titled "Levels and effects of radiation exposure due to the accident at the Fukushima Daiichi Nuclear Power Station: implications of information published since the UNSCEAR 2013 Report" was prepared for the purpose of compiling all scientific knowledge concerning levels and effects of radiation exposure due to the accident at Tokyo Electric Power Company (TEPCO)'s Fukushima Daiichi NPS that was available by the end of 2019, and for the purpose of assessing the influence on the content of the UNSCEAR 2013 Report. More specifically, the purpose is described as shown in the above figure.

On the other hand, the following three points are indicated as being out of the Report's intended purpose.

- The annex does not address policy issues with respect to human rights, public health protection, environmental protection, radiation protection, emergency preparedness and response, accident management, nuclear safety, radioactive waste management, prospective releases, and related issues.
- It does not intend to provide advice to local governments, the Government of Japan or to national and international bodies.
- The annex also does not address other effects (not associated with exposure to radiation) that can arise as a result of accidents, such as that at TEPCO's Fukushima Daiichi NPS, including distress and anxiety from, among other things, disruption of life, loss of homes and livelihoods, and social stigma, which can have major impacts on mental and social well-being.

The UNSCEAR 2020/2021 Report is an independent report, but is intended to be read together with the UNSCEAR 2013 Report and White Papers published thereafter. Accordingly, the Report does not contain information in full that can be obtained from these other documents.

[Relevant parts in the Report]
- UNSCEAR 2020/2021 Report (prepared based on paragraphs 7 to 8 on pages 6 to 7, ANNEX B)

Included in this reference material on March 31, 2023

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UNSCEAR 2020/2021 Report (2/8): Outline of Assessment of Public Exposure Doses

- For ease of comparison with the UNSCEAR 2013 Report, dose estimates have been made for the same age groups (20-year-old adult, 10-year-old child and 1-year-old infant) and the same dosimetric endpoints (the absorbed dose to selected organs – the thyroid, red bone marrow, colon and female breast – and the effective dose).
- Estimates have also been made of doses in the first year after the accident, over the first 10 years and until an attained age of 80 years for exposed individuals.
- In addition, estimates have been made of the average absorbed doses to the fetal thyroid over the 30-week development period of the fetus and of the average absorbed dose in utero to the red bone marrow over the 40-week term of pregnancy.

Exposure pathways

(a) External exposure to radionuclides in the air
(b) External exposure to radionuclides deposited onto the ground surface from the air by either wet or dry deposition
(c) Internal exposure from inhalation of radionuclides in the air
(d) Internal exposure from ingestion of radionuclides in food and drinking water

For ease of comparison with the UNSCEAR 2013 Report, dose estimates in the UNSCEAR 2020/2021 Report have been made for the same age groups and the same dosimetric endpoints. Concrete conditions are as shown above.

Dose assessment was conducted based on actual measurement data, while reflecting the latest scientific knowledge and progress that were published after the publication of the UNSCEAR 2013 Report up to the end of 2019 (p.194 of Vol. 1. “UNSCEAR 2020/2021 Report (3/8) Update from the UNSCEAR 2013 Report upon Assessing Public Exposure Doses”).

[Relevant parts in the Report]
- UNSCEAR 2020/2021 Report (prepared based on paragraphs A4 to A5 on page 110, ANNEX B)

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Assessments by International Organizations

UNSCEAR 2020/2021 Report (3/8): Update from the UNSCEAR 2013 Report upon Assessing Public Exposure Doses

Points updated from the UNSCEAR 2013 Report

- Measurement data on people (in particular, those using personal dosimeters and whole-body counters (WBCs) and thyroid measurements)
- New measurements of concentrations of radionuclides in the air
- New information on radionuclides in foodstuff as consumed
- New information on occupancy factors
- New information on dose reduction factors (location factors)
- Information on protective measures

It became possible to estimate doses based on enhanced measurement-based information by the use of the latest knowledge up to the end of 2019 that became available, following the publication of the UNSCEAR 2013 Report.

Numerous measurement campaigns have been carried out to assess individual doses from external exposure through surveys of daily activity patterns of residents, measurements of ambient dose rates and individual measurements using personal dosimeters. The UNSCEAR has made use of some of these data and other scientific results published in peer-reviewed journals to validate its estimates of doses from external exposure and in the development of a revised model to apply to the wider population. Furthermore, the UNSCEAR has validated its estimates of thyroid doses from internal exposure based on the results of the thyroid measurements covering more than 1,500 persons in total that were conducted in 2011.[1] Whole-body monitoring campaigns have also been carried out by national institutes, such as the Japan Atomic Energy Agency (JAEA) and the National Institute of Radiological Sciences (NIRS), and by universities, hospitals and municipalities, and the measured levels of radioactive cesium in the body were used to estimate doses from its intake by inhalation and ingestion.

Regarding environment monitoring data, part of the results of the monitoring conducted in Japan from March 2011 to March 2018 (data on dose rate in air, radionuclide ground deposition density, and radionuclide concentrations in air and in food and drinking water) was used to estimate doses. For example, measurement data regarding radionuclide concentrations in air while radionuclides were being discharged from Tokyo Electric Power Company's (TEPCO's)'s Fukushima Daiichi NPS were limited for the initial stage of the accident and for the areas damaged by the tsunami, in particular, but data on radionuclide concentrations in suspended particles in air at seven locations in Japan from March to May 2011, which had not been available, were newly made available.

Regarding food and drinking water, in addition to their monitoring data, information on measurements of the radioactive cesium content in the whole daily diet sampled by the duplicate-diet or market-basket methods was updated.

1. The data for around 1,300 persons that are reported in papers etc., while omitting such data as those under conditions with high background levels, were analyzed.

[Relevant parts in the Report]

- UNSCEAR 2020/2021 Report (prepared based on paragraphs A11 and A13, A16, A17, A19, A20, A23, A29, and A31 on pages 112 to 122, ANNEX B)

Included in this reference material on March 31, 2023

Assessments by International Organizations

UNSCEAR 2020/2021 Report(4/8): Estimation of Public Exposure Doses for Each of the Four Groups

Area classification for dose assessment

Group	Geographical area	Spatial resolution
1	Locations where people were evacuated in the days to months after the accident	Representative areas used for each location identified in 40 evacuation scenarios
2	Municipalities and parts of municipalities of Fukushima Prefecture not evacuated	Municipality level for external and inhalation pathways, based on the estimates for each of the 1-km grid points, averaged over the municipality Prefecture level for ingestion pathway
3	Selected prefectures (Miyagi, Tochigi, Ibaraki and Yamagata) in eastern Japan that are neighboring to Fukushima Prefecture	Municipality level for external and inhalation pathways, based on the estimates for each of the 1-km grid points, averaged over the municipality Average for the four prefectures (Miyagi, Tochigi, Ibaraki and Yamagata) for ingestion pathway
4	All remaining prefectures of Japan	Prefecture level for external and inhalation pathways Average of the rest of Japan (i.e., the 42 prefectures, excluding Fukushima, Miyagi, Tochigi, Ibaraki and Yamagata) for ingestion pathway

Public exposure radiation due to the accident differs by location, and evacuees changed their locations over time. Therefore, in the UNSCEAR 2020/2021 Report, areas were classified into four groups for assessing public exposure doses, and the targets were further narrowed down depending on the exposure pathways.

For ease of comparison with the UNSCEAR 2013 Report, the classification is basically the same. However, the neighboring prefectures in Group 3 were changed from six (Iwate, Miyagi, Ibaraki, Tochigi, Gunma, and Chiba Prefectures) for the UNSCEAR 2013 Report to four (Miyagi, Yamagata, Ibaraki, and Tochigi Prefectures). This is due to differences in the spatial coverage of the most recent radionuclide deposition density information used in the dose assessment.

[Relevant parts in the Report]

- UNSCEAR 2020/2021 Report (prepared based on Table 7 in paragraph 129 on pages 49 to 50, ANNEX B)

Included in this reference material on March 31, 2023

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UNSCEAR 2020/2021 Report(5/8): Results of the Assessment of Public Exposure Doses

Table 1. Average effective doses by area for the first one year and for the first ten years following the accident (mSv)*1

Group		For the first one year following the accident		For the first ten years following the accident	
		20 years old (adults)*2	1 year old (infants)	20 years old (adults)*2	1 year old (infants)
1[a]	Fukushima Prefecture (evacuated municipalities)	0.046-5.5	0.15-7.8		
2	Fukushima Prefecture (other than evacuated municipalities)	0.079-3.8	0.12-5.3	0.16-11	0.22-14
3	Prefectures neighboring Fukushima Prefecture [b]	0.10-0.92	0.15-1.3	0.25-2.5	0.34-3.4
4	The rest of Japan	0.004-0.36	0.005-0.51	0.009-1.0	0.007-1.3

Table 2. Estimated absorbed doses to the thyroid for the first one year following the accident (mGy)*1

Group		For the first one year following the accident	
		20 years old (adults)*2	1 year old (infants)
1[a]	Fukushima Prefecture (evacuated municipalities)	0.79-15	2.2-30
2	Fukushima Prefecture (other than evacuated municipalities)	0.48-11	1.2-21
3	Prefectures neighboring Fukushima Prefecture [b]	0.31-3.3	0.62-6.3
4	The rest of Japan	0.034-0.48	0.087-0.74

mSv: millisievert
mGy: milligray

a. Estimate evacuees' doses using 40 evacuation scenarios
b. Miyagi, Yamagata, Ibaraki, and Tochigi Prefectures

*1: Ranges of the average values by evacuation scenario for Group 1, by municipality for Groups 2 and 3, and by prefecture for Group 4
*2: Estimated doses for 10-year-old children are omitted here.

Table 1 shows the effective doses of residents in evacuated municipalities and residents in Fukushima Prefecture other than evacuated municipalities or in other prefectures, for both the first one year and the first ten years following the accident. Table 2 shows estimated absorbed doses to the thyroid of the same targeted residents for the first one year following the accident. For all these four groups, the average regional effective doses were lower than the estimated doses in the foregoing UNSCEAR 2013 Report (p.191 of Vol. 1, “Comparison of Reports (Assessment Results)”).

Doses in the tables show those added to background doses due to natural sources of radiation, that is, estimated exposure doses from the radionuclides released into the environment due to the accident at Tokyo Electric Power Company (TEPCO)’s Fukushima Daiichi NPS.

Ranges of doses show those of the average values among targeted groups by prefecture or by municipality in the targeted areas, or by evacuation scenario.

[Relevant parts in the Report]
- UNSCEAR 2020/2021 Report (prepared based on paragraph 158 on page 58 and paragraphs 166 to 169 on pages 64 to 66, ANNEX B)

Included in this reference material on March 31, 2023

Assessments by International Organizations

UNSCEAR 2020/2021 Report (6/8): Comparison with Direct Measurements

1. When comparing the UNSCEAR's estimate of municipality-average absorbed doses to the thyroid from internal exposure and the corresponding values derived from direct monitoring of the same targeted groups, the ratio varies from about 0.4 to 1.3. Thus, the comparison shows very good agreement between the two sets of data.

Table. Comparison between estimated absorbed doses to the thyroid (median values) and measured doses (mGv)

Area	20 years old (adults) *1		1 year old (infants)	
	Estimated doses	Measured doses	Estimated doses	Measured doses
Iwaki City	1.2		2.6	4.6(55) *2
Kawamata Town	0.95		2.1	4.5(286) *2
Iitate Village	1.4		2.8	7.1(79) *2
Namie Town[a]	22	21(6) *2	41	
Minamisoma City[a]	5.8	6.5(15) *2	12	10(1) *2
Tamura City	0.50	1.2(1) *2	1.2	

a: Excluding evacuees immediately after the accident
*1: Estimated doses for 10-year-old children are omitted here.
*2: Figures in the parentheses are the numbers of the subjects for the measurements.

2. The sums of the doses from inhalation and ingestion intakes of Cs-134 and Cs-137 estimated by the UNSCEAR are broadly in agreement with the committed effective doses obtained through the WBC measurements targeting residents in Fukushima Prefecture.

A comparison has been made between estimated doses in the UNSCEAR 2020/2021 Report and measured doses through thyroid measurements conducted in Fukushima Prefecture immediately after the accident at Tokyo Electric Power Company (TEPCO)'s Fukushima Daiichi NPS. Additionally, a comparison with the results of the WBC measurements of Cs-134 and Cs-137 has also been made.

As shown in the Table above, these measured data and estimates by the UNSCEAR are almost the same.

[Relevant parts in the Report]

- UNSCEAR 2020/2021 Report (prepared based on paragraph A136 on pages 180 to 181 and paragraph A140 on page 183, ANNEX B)

Included in this reference material on March 31, 2023

Assessments by International Organizations

UNSCEAR 2020/2021 Report (7/8): Assessment of Health Effects on the General Public

- In the years since the publication of the UNSCEAR 2013 Report, no adverse health effects among Fukushima Prefecture residents have been documented that are directly attributable to radiation exposure from the accident at Tokyo Electric Power Company (TEPCO)'s Fukushima Daiichi NPS.
- No acute health effects that could have been attributed to radiation exposure had been reported.
- Currently available methods would most likely not be able to demonstrate an increased incidence in the future disease statistics due to irradiation.
- The UNSCEAR's updated statistical power analyses suggest that excess thyroid cancer risk that could be inferred from radiation exposure was most likely not discernible in any of the age groups considered.
- These observations suggest that the increased incidence rates may be due to over-diagnosis (i.e., detection of thyroid cancer that would not have been detected without the screening and would not have caused symptoms or death during a person's lifespan).

The UNSCEAR assessed public health effects as indicated above based on its exposure dose assessment.

A substantial number of thyroid cancers have been detected among exposed children. However, the excess does not appear to be associated with radiation exposure, but rather a result of the application of highly sensitive ultrasound screening procedures. The reasons are as follows:

(a) no excess of thyroid cancer has been observed in those exposed before age 5 in Fukushima Prefecture, in contrast to the large excess observed in the same age group exposed as a result of the Chornobyl accident; and

(b) thyroid cancers were observed within 1 to 3 years after exposure following the accident in Fukushima Prefecture rather than beginning 4 to 5 years after exposure as in Chornobyl and other radiation studies.

There has been no credible evidence of excess congenital anomalies, stillbirths, preterm deliveries or low birthweights related to radiation exposure. Increases in the incidence of cardiovascular and metabolic conditions have been observed among those evacuated following the accident but are probably associated with concomitant social and lifestyle changes and are not attributable to radiation exposure.

[Relevant parts in the Report]

- UNSCEAR 2020/2021 Report (prepared based on paragraphs 213, 215, and 225 on pages 84 to 88 and paragraphs 244 to 248 on pages 96 to 97, ANNEX B)

Included in this reference material on March 31, 2023

Assessments by International Organizations

UNSCEAR 2020/2021 Report (8/8): Comparison between Various Attributes and Consequences of the Accidents at Chornobyl and Fukushima Daiichi NPSs

	Chornobyl NPS Accident	Fukushima Daiichi NPS Accident
Thyroid doses of evacuees for the first one year following the accident	Around 500 mSv	Around 0.8 – 15 mSv (adults)
Effective doses of evacuees for the first one year following the accident	Around 50 mSv	Around 0.05-6 mSv (adults)
Thyroid cancers	Substantial fraction of the 19,000 thyroid cancers observed (up to 2016) among people who were children or adolescents at the time of the accident is attributable to radiation exposure.	• Greater incidence of thyroid cancer and abnormalities was observed in those screened than were expected based on national statistics. • It is most likely the result of using high resolution ultrasound in the screening. • There is an increasing body of evidence that the observed thyroid cancers are not attributable to radiation exposure.
Other effects (e.g., other cancers, birth defects, fetal deaths, non-cancer diseases, etc.)	There is no persuasive evidence of any other health effect attributable to radiation exposure at Chornobyl NPS or Fukushima Daiichi NPS.	

The UNSCEAR 2020/2021 Report compiles major characteristics and features of the accidents at Fukushima Daiichi NPS and Chornobyl NPS, as well as estimated exposure doses and health effects due to these accidents regarding radiation workers and the general public. Results of the comparison concerning some items are shown in the table above.

The Report states that the consequences of the accident at Fukushima Daiichi NPS were much milder than those at Chornobyl NPS. As one of the reasons, it points out that the reactors at Fukushima Daiichi NPS had specifically designed containments within which most of the radionuclides released from the molten fuel were retained; by contrast, the reactor at Chornobyl NPS did not have a containment and the core was directly exposed to the atmosphere as a result of the explosion that occurred at the beginning of the accident. Additionally, cited major reasons include the rates of dispersed radionuclides deposited over the ocean and those deposited over the land mass, the transfer of radionuclides to agricultural products, the binding or fixation of radioactive cesium in soil, protective measures in respect of people and foodstuffs after the accidents, and differences in the regulations.

[Relevant parts in the Report]

- UNSCEAR 2020/2021 Report (prepared based on paragraph B1 on pages 189 to 198, ANNEX B)

Included in this reference material on March 31, 2023