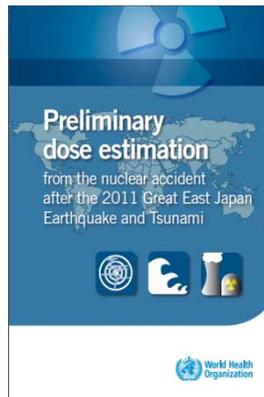


Overview of the WHO reports on dose estimation and health risk assessment from the nuclear accident after the 2011 Great East Japan Earthquake and Tsunami



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World Health Organization

- ◆ **Function:** acts as the **UN directing and coordinating authority** on international health work
- ◆ **Objective:** "the attainment by all peoples of the *highest possible level of health*"
- ◆ **Definition:** "**HEALTH** is a state of **COMPLETE** physical, mental and social well-being and not merely the **ABSENCE** of disease or infirmity" (*Constitution, 1948*)



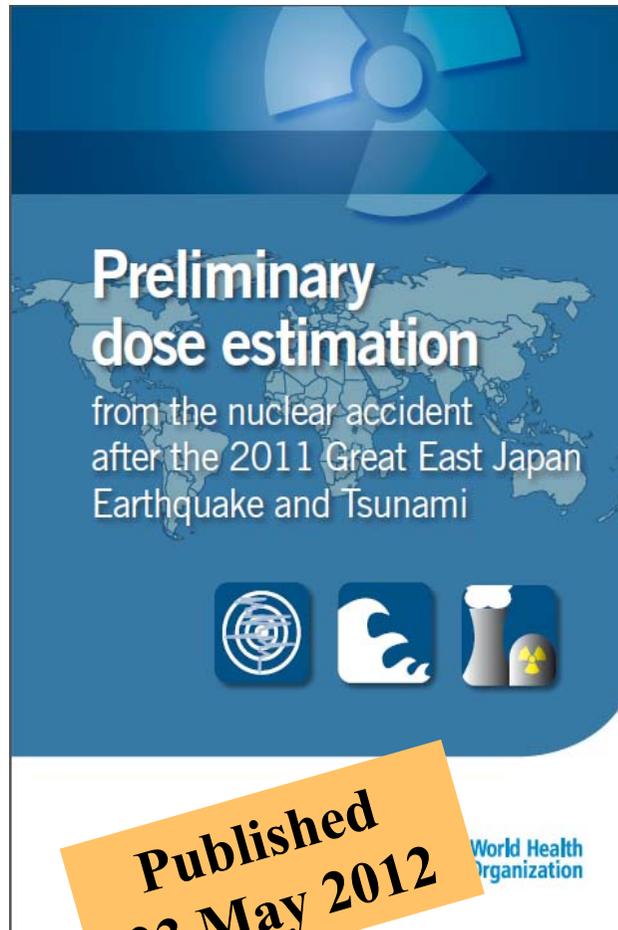
Health risk assessment

Purpose

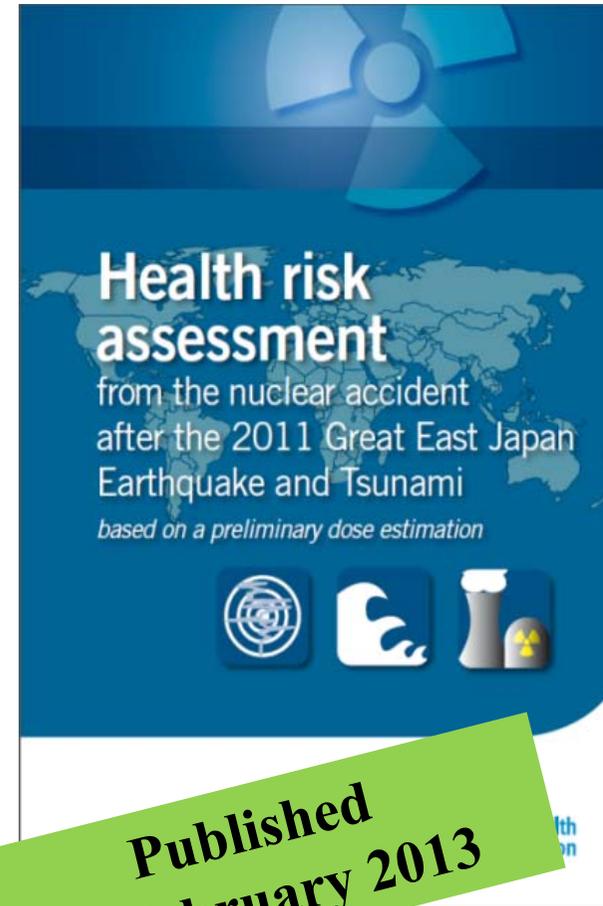
- ◆ To fulfil WHO's role and responsibilities under the *Joint Radiation Emergency Management Plan*
- ◆ To give an indication of the *radiation-related health implications* of the accident
- ◆ To Support the identification of needs and priorities for public health action
- ◆ To provide information to *policy makers* and *health professionals*, as well as *international organizations*



Dose estimation & health risk assessment

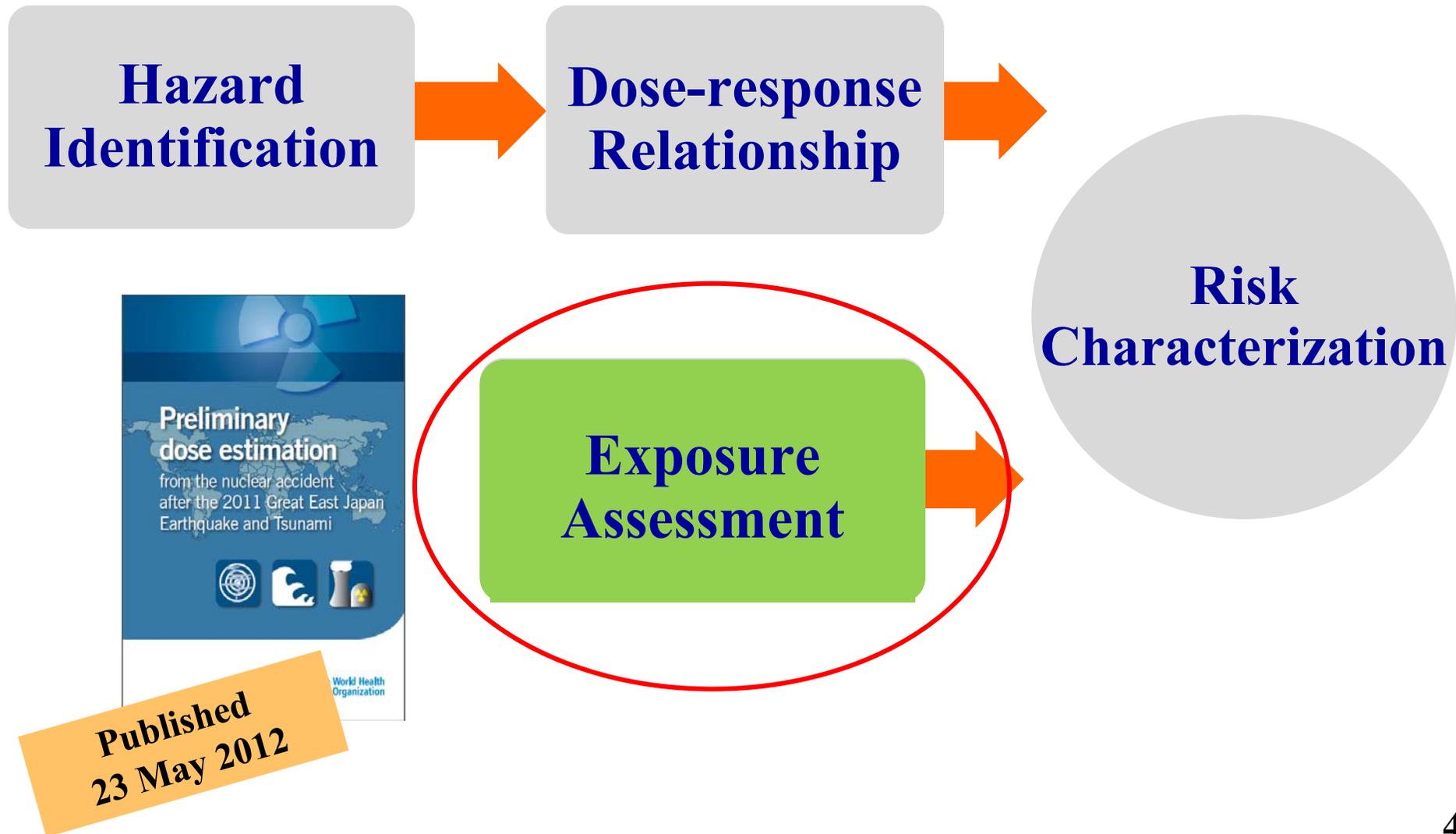


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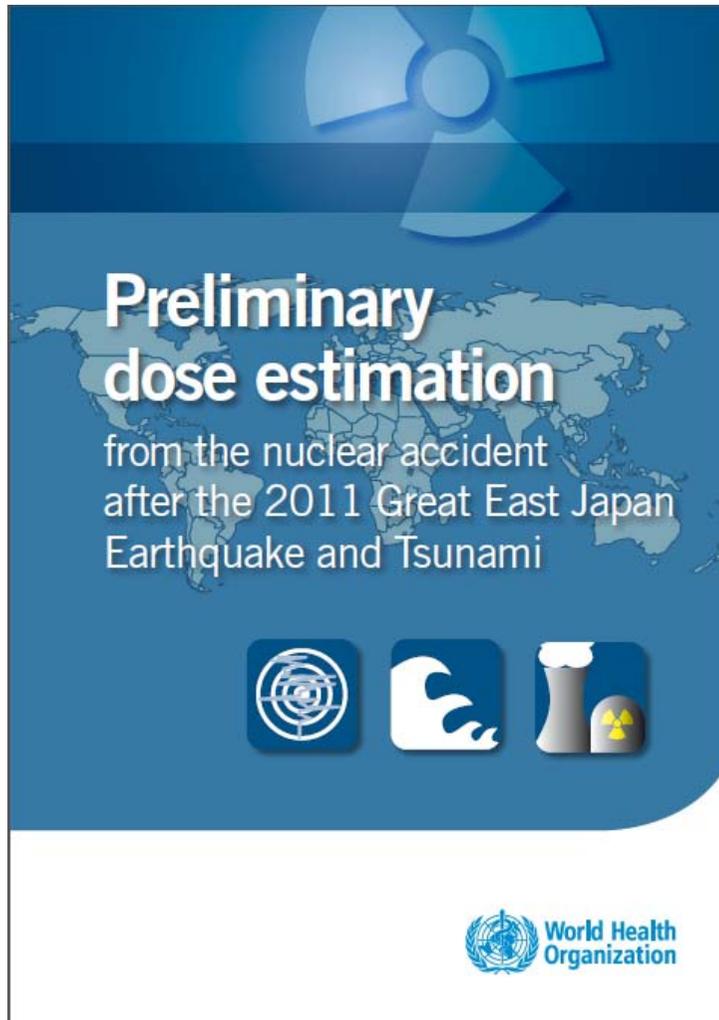


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Dose estimation

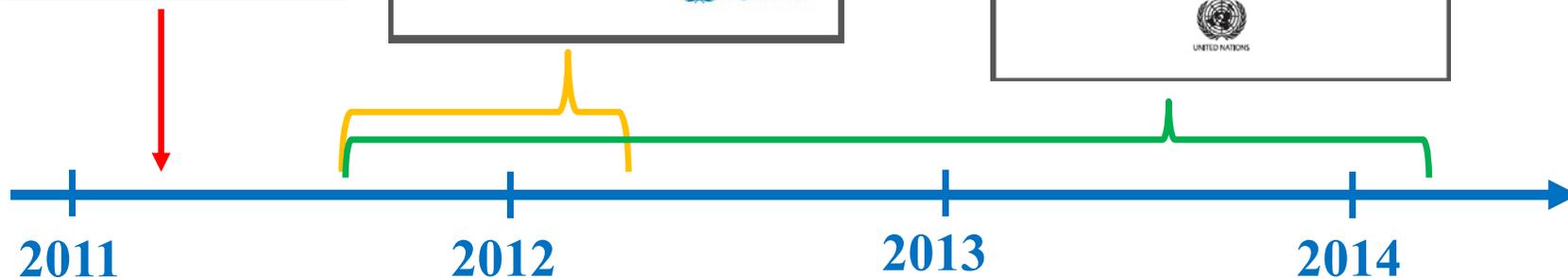
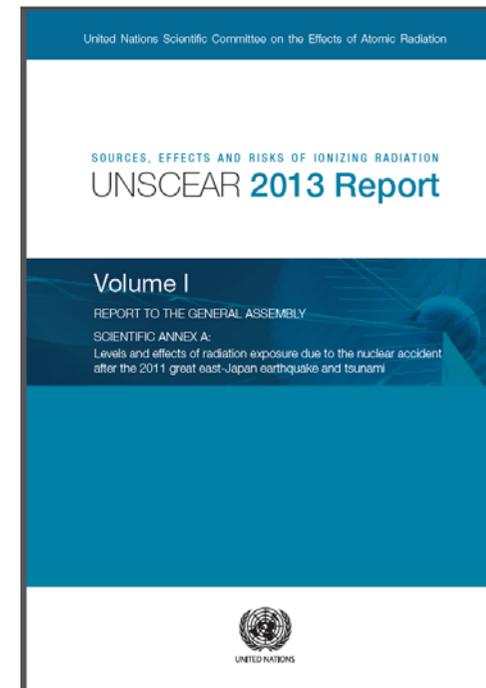
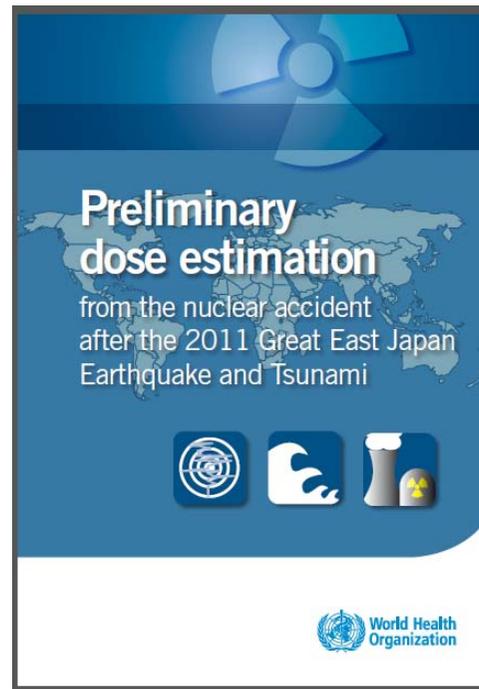


Dose estimation



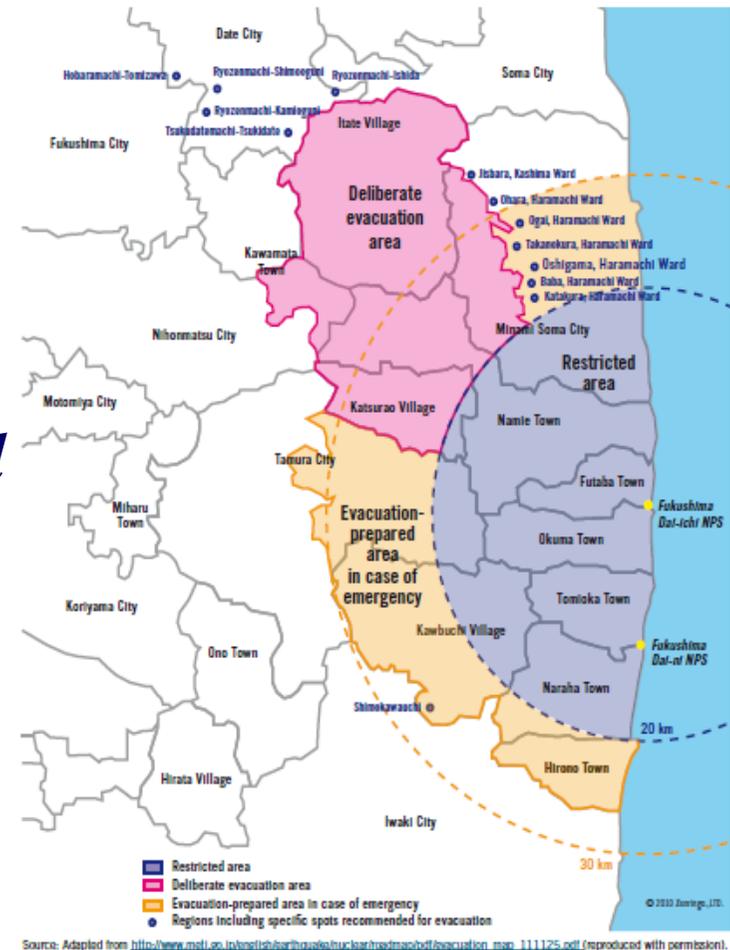
- ◆ This report was primarily intended for use by the **WHO Health Risk Assessment Group** to inform an *initial assessment of health risks* incurred as a consequence of the **FDNPS** accident

WHO and UN Reports on radiation exposure from accident

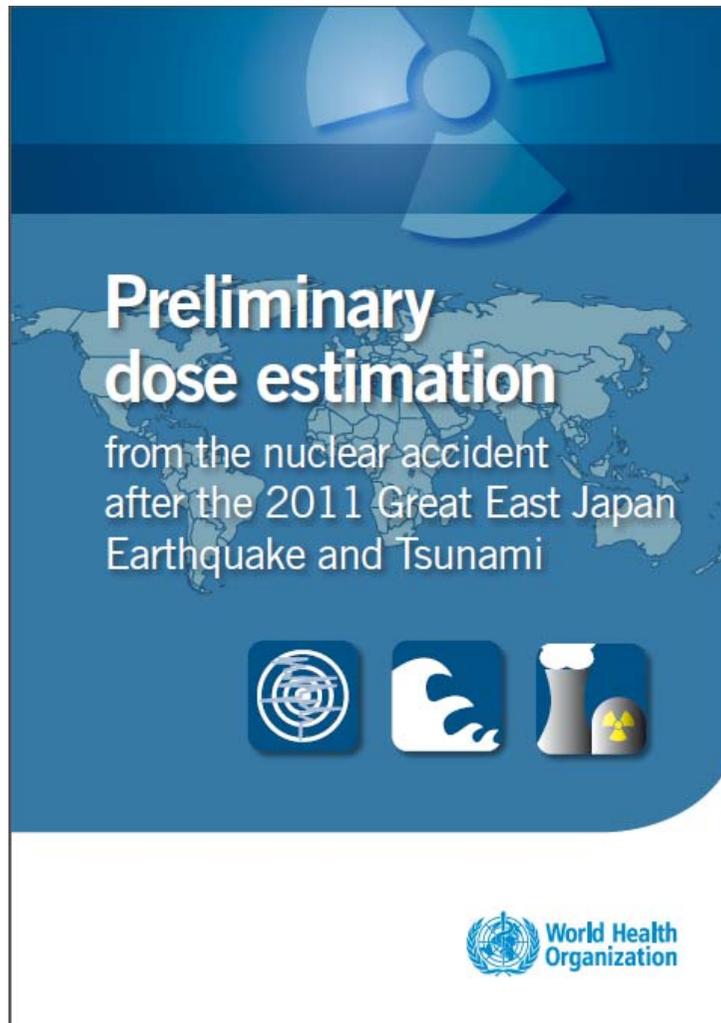


Preliminary dose estimation

- ◆ Radiation doses to the public **for the first year following the accident**
- ◆ Doses characteristic of the average doses, assessed for *different age groups in locations around the world*
- ◆ Excludes
 - Doses within 20 km of the NPP
 - Doses to workers
 - Health risks and public health actions



Dose estimation



- ◆ Giving the limited information available to the panel during the time frame of its work, the assessment contains *a number of assumptions*
- ◆ In particular, some assumptions regarding the *implementation of protective measures* are *conservative*
- ◆ Some possible dose *overestimation* may have occurred

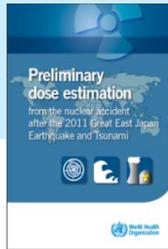
Assumptions (1)

- ◆ All people in Fukushima prefecture *consumed only food produced in Fukushima prefecture* (possible dose overestimation)
- ◆ *Losses due to radioactive decay* between the point of food ‘marketing’ and the time of consumption *not included*, neither are losses due to food preparation and losses during cooking

Food sourcing and normal food distribution practices likely to have been significantly **altered** by the impact of the tsunami, the earthquake, and public protection measures

Assumptions (2)

- ◆ **Movement of people**
 - < 20 km radius: *not considered* (people evacuated)
 - 20-30 km: *not specific considerations for sheltering*
 - "Deliberate evacuation zone": the assessment assumed relocation at 4 months
- ◆ **Stable iodine: it was assumed that KI tablets were not taken in Japan nor elsewhere**
- ◆ **Food and water restrictions: *the assessment does not explicitly model the effect of the imposition of food and water restrictions*, it is implicit since the assessment is based on monitoring results reported by the GoJ**



Dosimetric endpoints

- ◆ **Effective doses and equivalent doses to the **thyroid** for the first year after the accident in:**
 - *1 year old infants, 10 year old children and adults*
 - **Exposure through drinking tap water used in the preparation of infant formula was considered for 6 month old infants**
 - **Foetus and breast-fed infants not separately calculated but considered in the text**

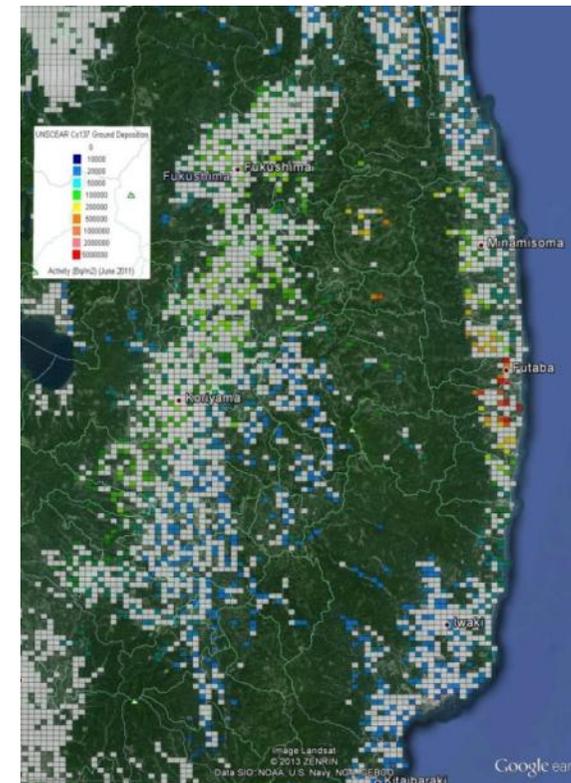
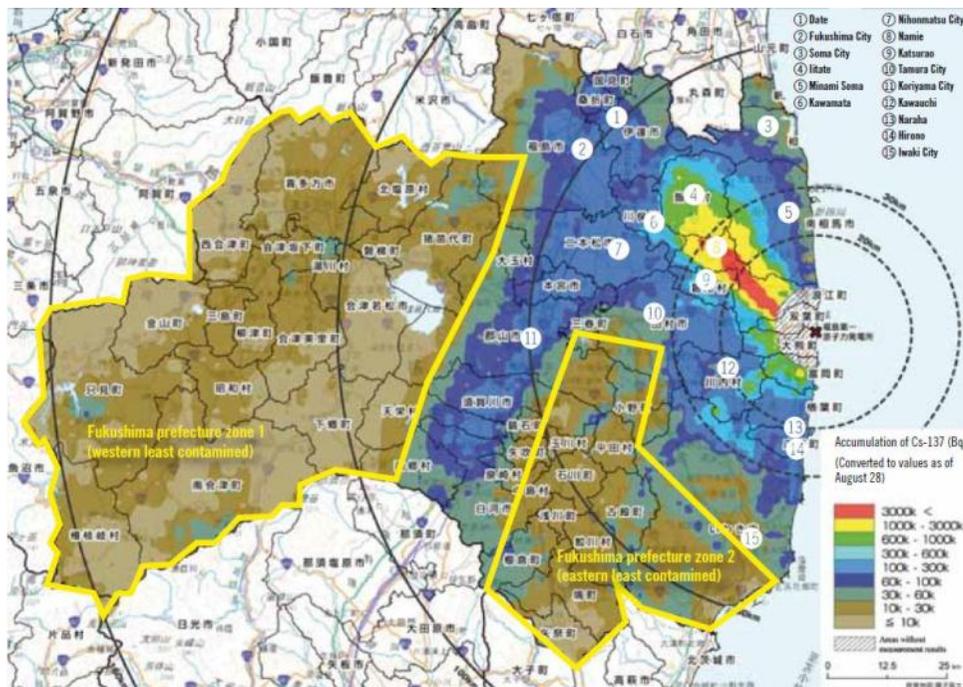
Data for estimates of doses from external and inhalation exposure for non-evacuated areas

WHO

- Measured ground deposition data from Japan Government
- bulk deposition velocity

UNSCEAR

- 1 km Population density grid
- 2 km MEXT deposition grid
- 5 km WMO ATDM grid



Geographical coverage

- ◆ **Group 1**: Two locations within Fukushima prefecture (Namie Town, Iitate Village)
- ◆ **Group 2**: Katsurao Village, Minami Soma City, Naraha Town, Kawauchi Village, Date City, Fukushima City, Nihonmatsu City, Kawamata Town, Hirono Town, Koriyama City, Tamura City, Soma City
- ◆ **Group 3**: The rest of Fukushima prefecture (less affected) and other prefectures in Japan
- ◆ **Group 4**: Countries neighbouring Japan and other regions of the world

Figure 4. Neighbouring prefectures considered in the assessment



Comparison of WHO and UNSCEAR assessment - Members of the public -

Location	WHO assessment	UNSCEAR assessment
	First year	First year
	EFFECTIVE DOSE TO ADULTS (mSv)	
Evacuated Areas		
Namie Town	10-50	5.0 ^a
Naraha Town	1-10	3.7 ^a
Iitate Village	10-50	8.0 ^b
Katsurao Village	1-10	6.0 ^b
Minamisoma City	1-10	5.7
Non-evacuated areas		
Iwaki City	1-10	2.2
Rest of Fukushima Prefecture	1-10	1.0-4.3
Neighbouring prefectures	0.1-10	0.2-1.4
	ABSORBED DOSE TO THYROID OF 1-YEAR-OLD (mGy)	
Evacuated Areas		
Namie Town	100-200	81 ^c
Naraha Town	10-100	82 ^c
Iitate Village	10-100	56 ^c
Katsurao Village	10-100	73
Minamisoma City	10-100	53 ^c
Iwaki City	10-100	52
Non-evacuated areas		
Rest of Fukushima Prefecture	10-100	33-52
Neighbouring prefectures	1-10	3-15

Health risk assessment



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**Independent
experts
+
Observers**



Risk assessment

Includes

- **General population in Fukushima Prefecture***
- **General population in the rest of Japan**
- **General population around the world**
- **FDNPS emergency workers****

Not includes

- **First responders (e.g. police, fire fighters, Japan self-defence forces)**

Risk assessment

*Definition of the general population in Fukushima Prefecture

- Geographic location

4 distinct geographic areas

- Age group

1-year-old infant / 10-year-old children / 20-year-old adults

(Health risks from exposure *in utero* was considered but not quantitatively)

- Both sexes

**Definition of the emergency workers

- Male workers in age groups of 20-, 40- and 60-year-old

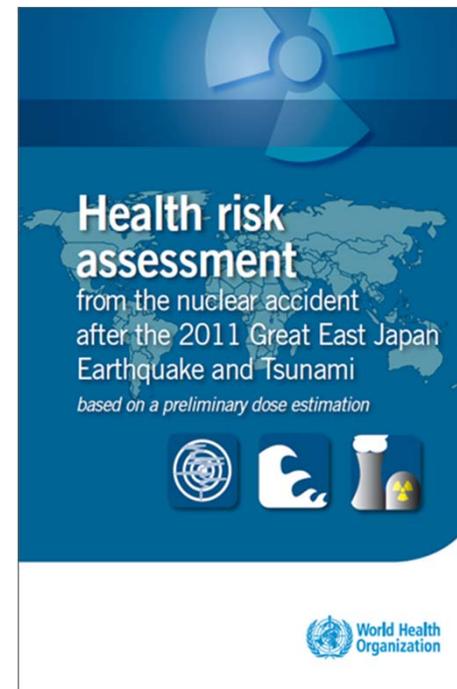
Risk assessment

Four distinct geographical areas were identified based on estimated doses

- ◆ ***Group 1: the two locations*** within Fukushima prefecture with effective doses of 12– 25 mSv;
- ◆ ***Group 2: locations in Fukushima prefecture*** where effective doses are between 3 and 5 mSv;
- ◆ ***Group 3: the less-affected locations of Fukushima prefecture and the rest of Japan,*** where effective dose values are around 1 mSv;
- ◆ ***Group 4 – the neighbouring countries and the rest of the world,*** where effective doses are well below 1 mSv;

Health endpoints considered

- ◆ **Cancer risks were estimated by using risk models for**
 - all-solid cancers incidence
 - leukaemia incidence
 - thyroid cancer incidence
 - female breast cancer incidence
- ◆ **Non-cancer risks were considered but not modeled**
 - thyroid nodules, thyroid dysfunction, visual impairment, circulatory diseases, reproductive dysfunctions, risk to embryo and fetus



Cumulative cancer risk over 15 years after exposure

Figure 17. Leukaemia: cumulative cancer risk over 15 years after exposure (AR_{15}) (a) for both genders and 3 age groups (infants, children and adults) in locations ① and ⑧; and (b) with cumulative baseline risk (BR_{15}) in location ①

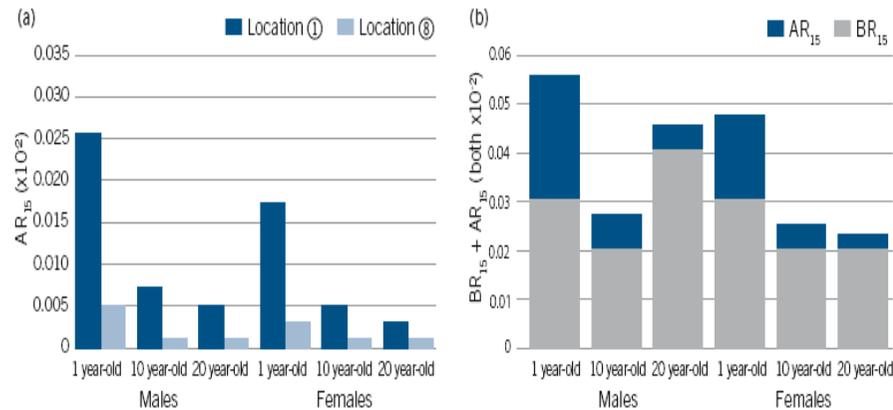


Figure 19. Thyroid cancer: cumulative attributable cancer risk over 15 years after exposure (AR_{15}) (a) for both genders and 3 age groups (infants, children and adults) in locations ① and ⑧; and (b) with cumulative baseline risk (BR_{15}) in location ①

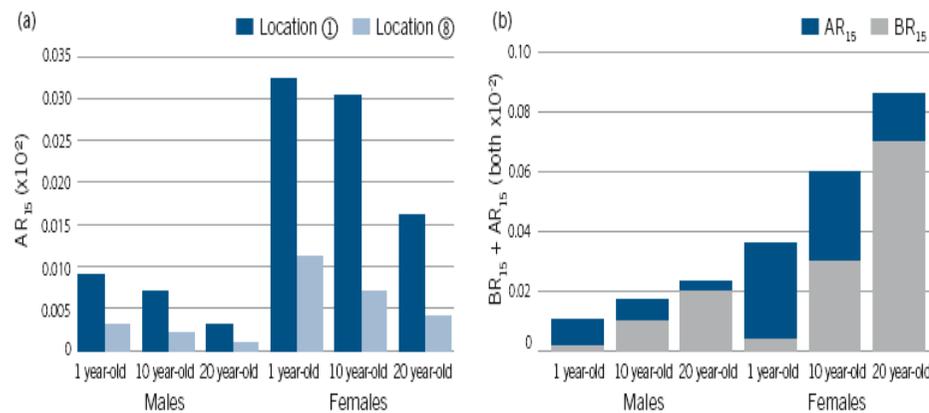


Figure 18. All solid cancer: cumulative cancer risk over 15 years after exposure (AR_{15}) (a) for both genders and 3 age groups (infants, children and adults) in locations ① and ⑧; and (b) with cumulative baseline risk (BR_{15}) in location ①

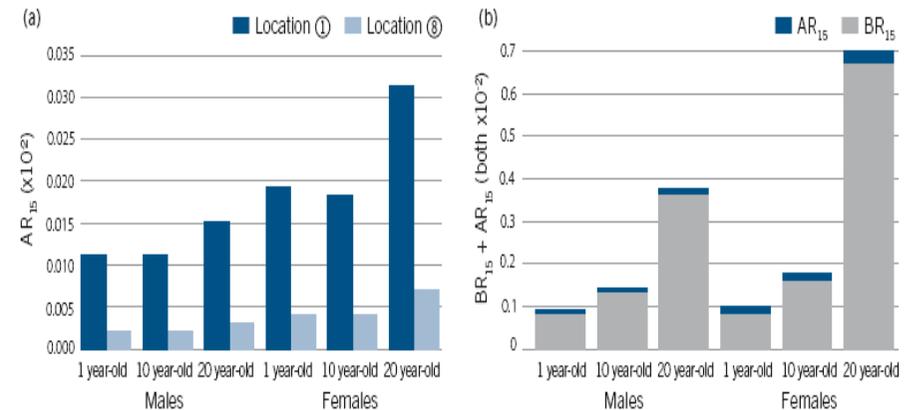
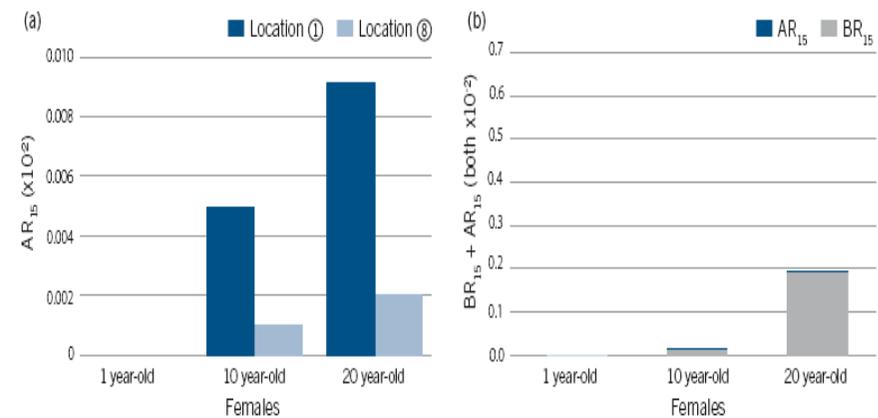


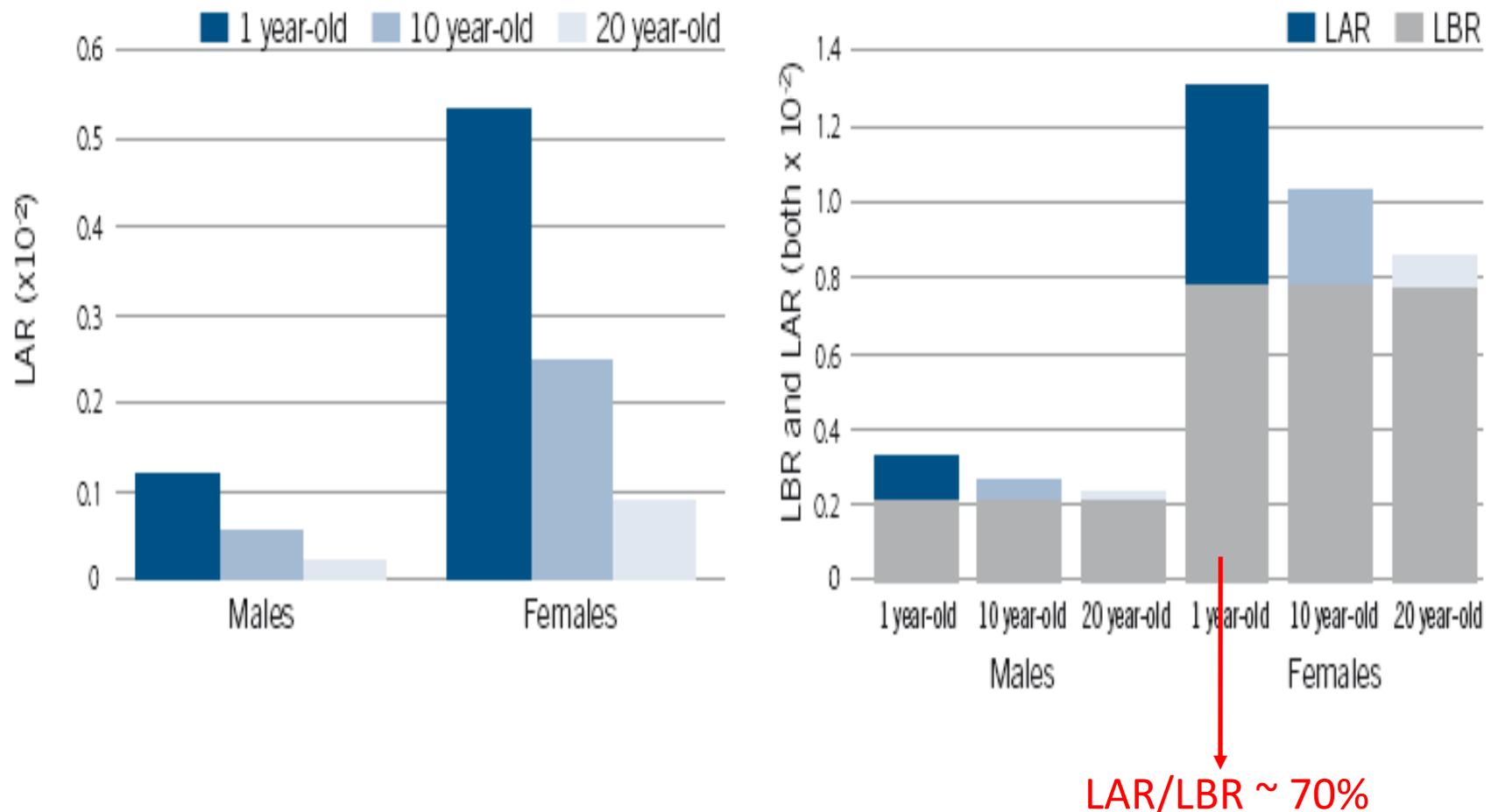
Figure 20. Breast cancer: cumulative attributable cancer risk over 15 years after exposure (AR_{15}) (a) and 3 age groups (infants, children and adults) in locations ① and ⑧; and (b) with cumulative baseline risk (BR_{15}) in location ①



Note that LAR_{15} is not calculated for a 1 year-old (age-at-exposure) because existing evidence shows no breast cancer before an attained age of 20 years (section 2.2.1).

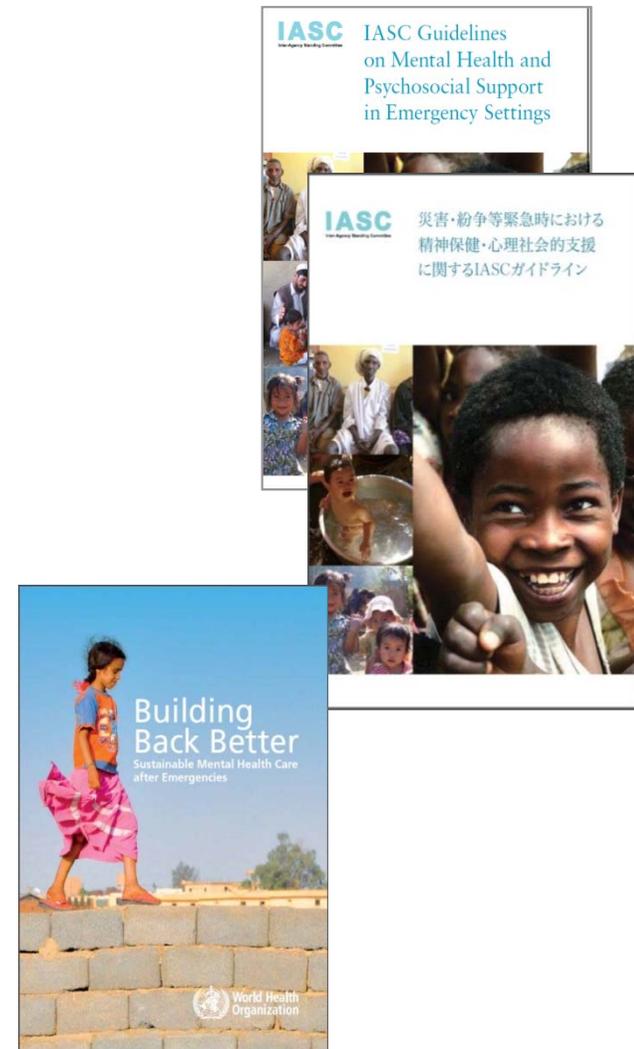
Thyroid cancer

Figure 12. Lifetime attributable risk (LAR) and lifetime baseline risk (LBR) for thyroid cancer in Group 1 Location ① for males and females exposed at 1, 10, 20 year-old.



Psychological impact

- ◆ The **psychological impact** can outweigh direct radiological consequences (lesson from Chernobyl)
- ◆ Soon after the accident, WHO recommended improving availability and access to community mental health services in the affected areas of Japan
- ◆ This remains a challenge today, and may require special considerations



Conclusion (1)

- Radiation doses from the damaged nuclear power plants in Fukushima are *not expected to cause an increase* in the incidence of *miscarriages, stillbirths and other physical and mental conditions that can affect babies born* after the accident
- The report notes that the *psychosocial impact* may have a consequence on health and well-being

Conclusion (2)

- In terms of specific cancers, for people living in the most contaminated locations, the *estimated increased risks* over what would normally be expected are:
 - ◆ *All solid cancers* - around **4 %** in females exposed as infants;
 - ◆ *Breast cancer* - around **6%** in females exposed as infants;
 - ◆ *Leukaemia* - around **7%** in males exposed as infants;
 - ◆ *Thyroid cancer* - up to **70%** in females exposed as infants (the normally expected risk of thyroid cancer in *females over lifetime is 0.75%* and the additional lifetime risk assessed for females exposed as infants in the most affected location is **0.50%**)

Conclusion (3)

- For people living in the second most contaminated locations of Fukushima Prefecture, the estimated risks are *approximately one-half of those* in the location with the highest doses.
- For 2/3 of the *emergency workers (< 10 mSv)*, all calculated risks were of similar magnitude as the normal fluctuations in the baseline cancer risks

Conclusion (4)

- For 1/3 of the *emergency workers* (10 - 100 mSv), **the relative increase over background for thyroid cancer** is estimated to be up to 20% for the youngest workers
- For less than 1% of the *emergency workers* ($> 100 \text{ mSv}^1$), **the relative increase over background for leukaemia and thyroid cancer** is as high as 28% in the youngest workers
- For those few *emergency workers* who received very high doses to the thyroid ($> 100 \text{ mSv}^2$), **a notable risk of thyroid cancer** is estimated, especially for young workers

¹external effective doses

²internal effective doses

Thank you for your attention

