

## Basic Survey: External dose estimation

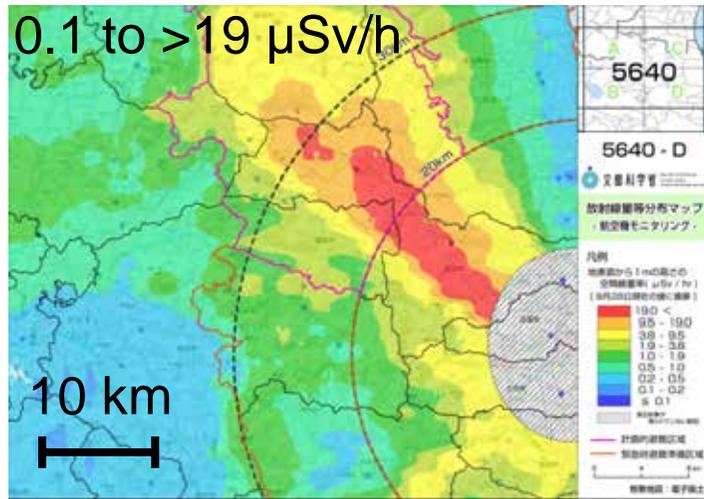
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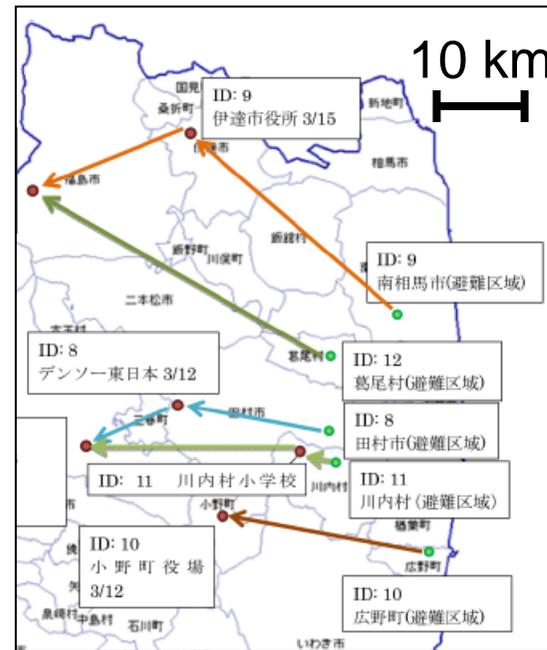
# Background

- Gamma ray dose rate is considerably different from place to place
  - Evacuees moved from their original places
  - Various evacuation patterns
- “Record of movement” for each resident is necessary to estimate realistic external dose



Example of gamma ray dose rate map after the accident (MEXT website)

MEXT: Ministry of Education, Culture, Sports, Science and Technology



Eastern part of Fukushima Pref.



Five examples of evacuation patterns

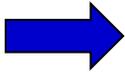
# Background

Many dose estimation studies have been done after the accident

In some cases, dose estimation is based on conservative assumptions to avoid underestimation



Ex. People stay outdoor all day long  
a kind of “projected dose” (see below)

More realistic dose based on actual situations  Basic Survey

Projected dose:

The dose that would be received if no countermeasures were to be taken

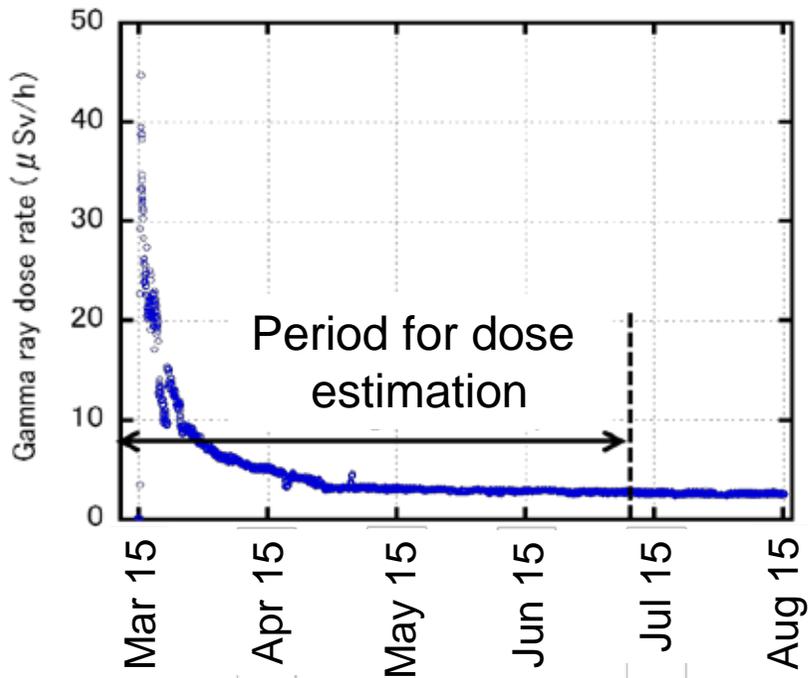
(IAEA Basic Safety Standard, 1996)

Similar definition in ICRP Publication 63.

# Outline of Basic Survey

## Fukushima Health Management Survey

- Basic Survey  Questionnaire targeting roughly 2,050,000 people who were living, or were present, in Fukushima Prefecture as of March 11, 2011.
- Four detailed Surveys



Items:

Whereabouts for each day in the period (locations and Indoor, outdoor, or moving)

Period: March 11, 2011 – July 11, 2011

Changes in gamma ray dose rate in Iitate Village:  
After four months, gamma ray dose rate seems to be plateau

# Questionnaire of Basic Survey

## Sample of response sheet

※Please write for each day from March 11 to March 25

	Whereabouts	Time								Place / Facility
		0	3	6	9	12	15	18	21	
March 11 (Fri)	Indoors	←		←		←		←		① Home ② Place of employment ③ Evacuation center ( District community center) (C)
	Moving									
	Outdoors									

※From March 26 onwards, please fill out the basic details of your area of residence (places where you spent time).

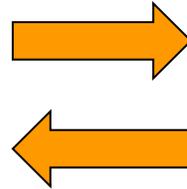
Children under 20y: signatures by their parents are necessary

# Dose calculation (check of response sheets)

Checking response sheets returned from the residents



The response sheet is sufficient?  
(any blank items?)



Contact each respondent to completely fill in the response sheet (by telephone or mail, more than 70,000 respondents)



Records of the movement of respondents are digitized



Sending the records to NIRS

NIRS: National Institute of Radiological Sciences,  
Chiba, Japan



# NIRS dose calculation program

Monitoring data obtained  
by MEXT



- Subtracting dose due to natural radiation
- Conversion to effective dose



Construction of daily  
dose rate maps



Calculation of effective dose for adult



Body size (age) correction



Effective dose for each respondent

Records of the movement  
(digitized questionnaire)

- Moving, outdoor, indoor
- Hours spent in the region
- Hours of moving
- Location of the region
- Dose reduction factor for each type of dwellings



Akahane et al: *Scientific Report*  
3: 1670 (2013)

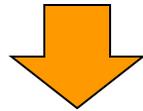


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# How to report the results

Individual estimates of external dose

The individual doses are statistically processed at FMU



The results are discussed at Fukushima Prefectural Oversight Committee Meeting (once in about three months) <http://www.fmu.ac.jp/radiationhealth/>

FMU reports the individual external dose to each respondent by mail

Doses have been estimated for 470,234 / 515,212 respondents (91.3 %) as of 31 December 2013.



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# Results (whole prefecture)

Effective dose (mSv)	Number of respondents (excluding radiation workers)	Ratio
< 1	305,286	66.3 %
1 - 2	131,606	28.6 %
2 - 3	20,403	4.4 %
3 - 4	1,457	0.3 %
4 - 5	578	0.1 %
> 5	1078	0.2 %
Total	460,408	100 %

Maximum: 25 mSv

Average: 0.8 mSv (As of December 31, 2013)

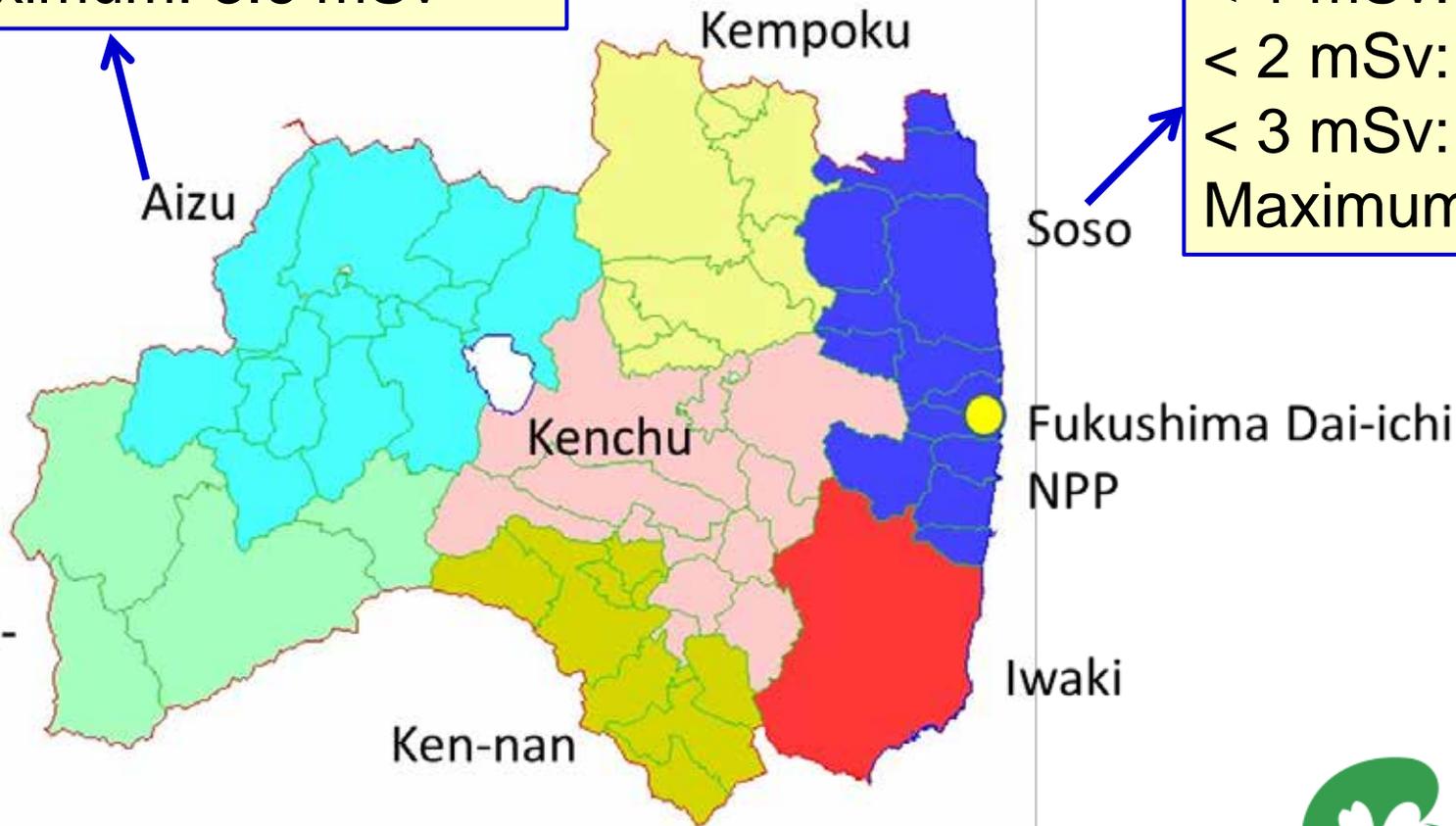


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# Results (dose distribution by regions)

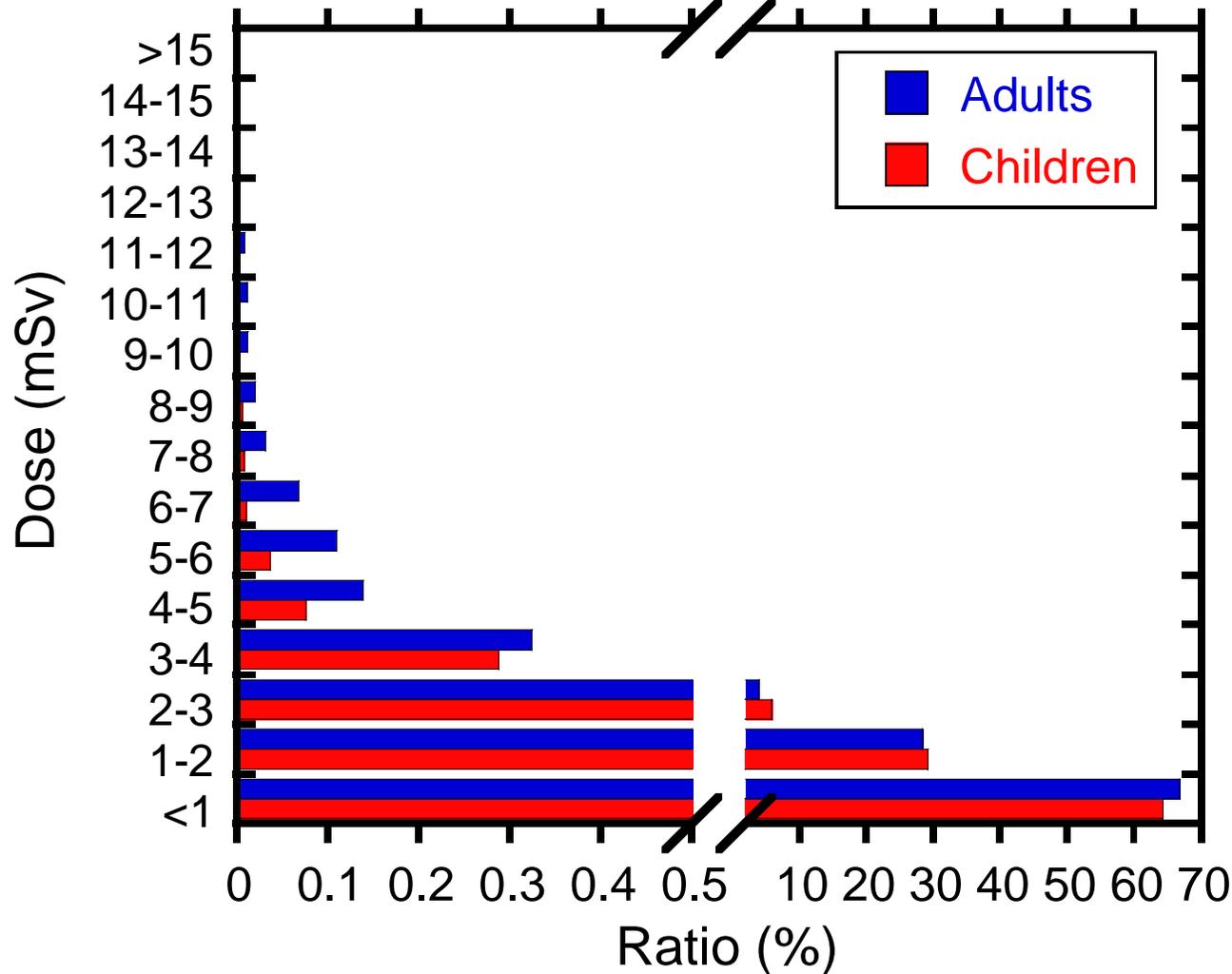
< 1 mSv: 99.38 %  
< 2 mSv: 99.98 %  
Maximum: 3.6 mSv

Most of residents evacuated  
< 1 mSv: 78.0 %  
< 2 mSv: 94.7 %  
< 3 mSv: 97.2 %  
Maximum: 25 mSv



# Results (dose distribution: adults vs. children)

Dose distribution (adults versus children)

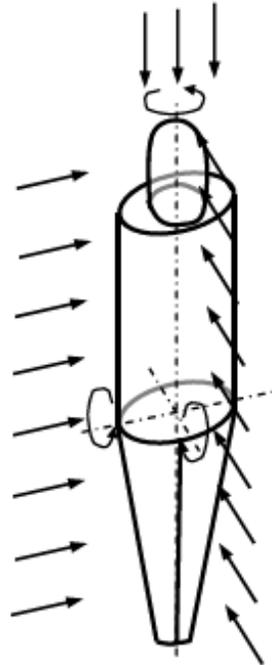


Dose distribution was almost similar between adults ( < 20y) and children (< 20y).

The number ratio of doses of > 3 mSv was higher for adults.

# Thyroid equivalent dose and effective dose

ISO irradiation geometry  
(adopted in the NIRS dose calculation system)



Thyroid equivalent dose                      1.1  
Effective dose

(for gamma rays of 100-800 keV)  
ICRP 74

Effective doses estimated by the Basic survey

➔ Thyroid equivalent doses due to external radiation during the corresponding period

# Summary

- I External doses (for the first four months after the accident) have been estimated for more than 470,000 respondents by the Basic Survey.
- I The effective dose distribution (excluding radiation workers):  
< 1 mSv, 66.3 %; <2 mSv, 94.9 %; <3 mSv, 99.3 %
- I According to ICRP 74, the ratio of thyroid equivalent dose to effective dose is around 1.1 in the case of isotropic irradiation geometry.
- I The effective dose values estimated in the Basic Survey could be similar to the thyroid equivalent doses due to external radiation during the first four months after the accident.