Radiological consequences of the Fukushima nuclear power accident: myths and facts

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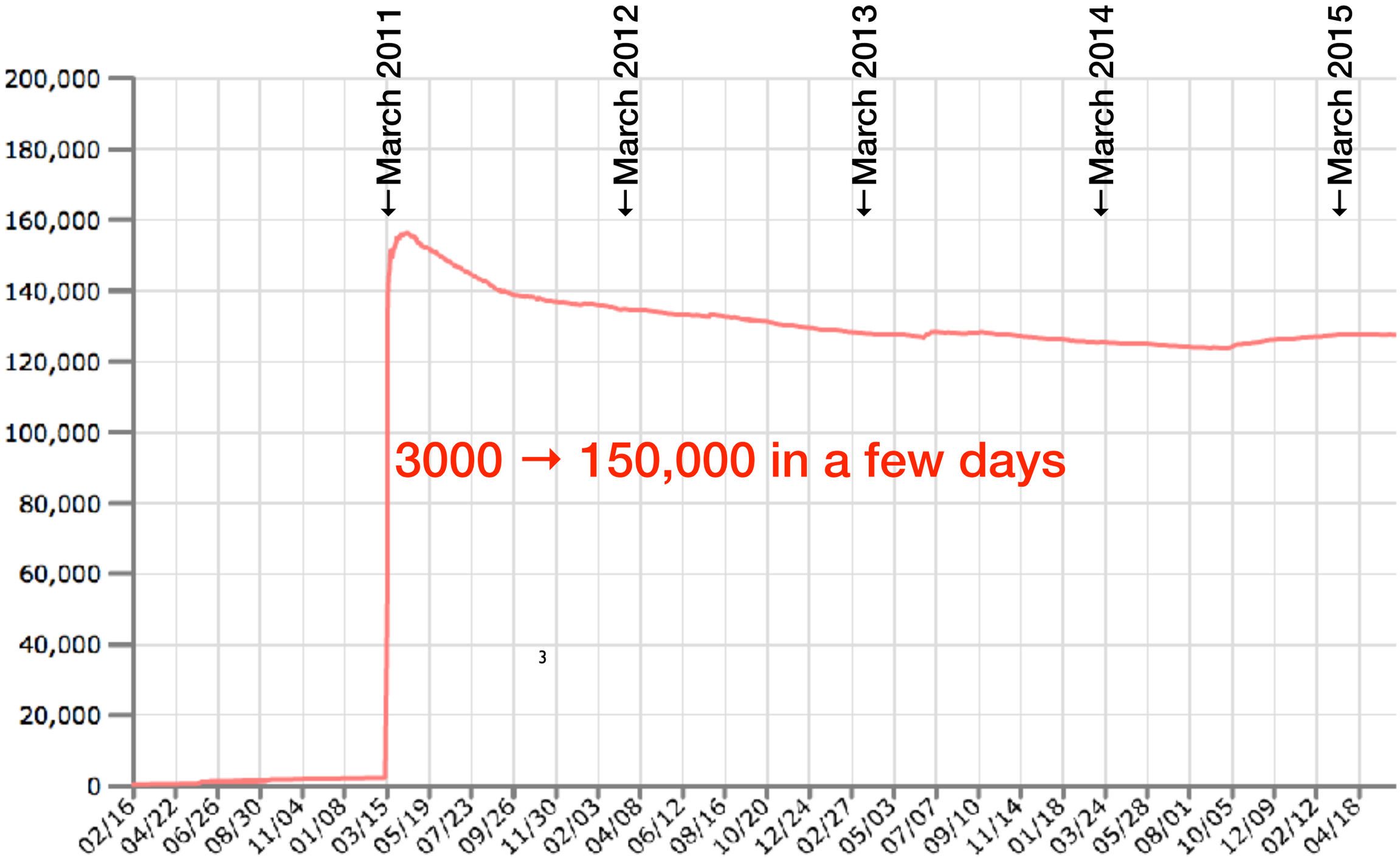
About myself

- 1997-2017: “Antimatter” team leader at CERN

- No past experience in radiation protection, nor risk communication

I am here today because of

The number of my twitter followers



Top 100 scientists on twitter

Science Magazine Blog

October 2014

■ ■ ■

20. Steven Pinker, *Cognitive scientist*

145,000 followers @sapinker (http://twitter.com/@sapinker)

Citations: 49,933 K-index: 105

Total number of tweets: 1,674

Harvard University, United States

21. Richard Wiseman, *Psychologist*

135,000 followers @RichardWiseman (http://twitter.com/@RichardWiseman)

Citations: 4,687 K-index: 209

Total number of tweets: 22,600

University of Hertfordshire, United Kingdom

22. Ryugo Hayano, *Nuclear physicist*

124,000 followers @hayano (http://twitter.com/@hayano)

Citations: 956 K-index: 319 4

Total number of tweets: 56,500

University of Tokyo, Japan

■ ■ ■

Cloud funding

My Fukushima-related work has been funded entirely by donations (which I didn't ask for) from my twitter followers

(total ~ 200,000 USD equivalent)

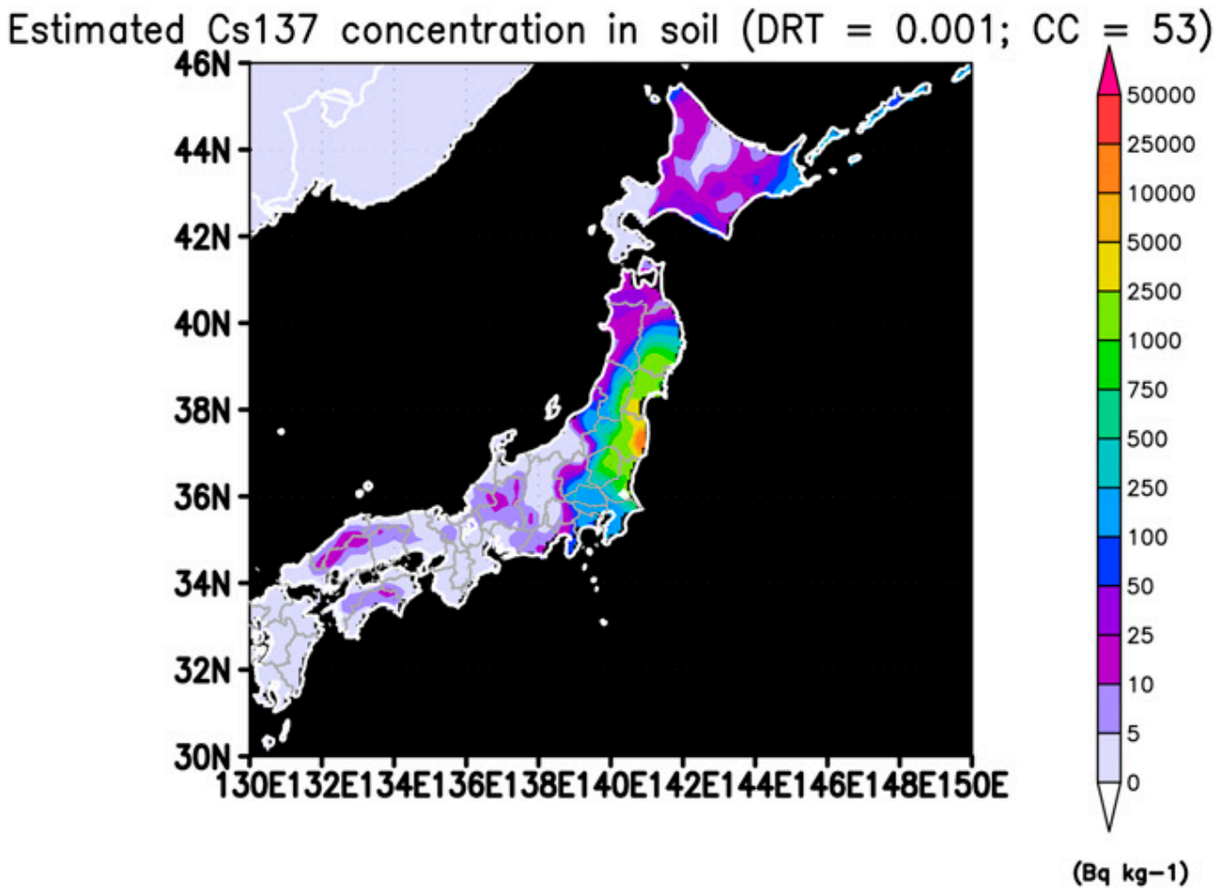
Myths vs Facts

Soil contamination

Myth	Fact
The Fukushima Dai'ichi NPP (FDNPP) accident severely contaminated entire Japan, and the contamination still prevails.	Repeated measurements have shown ← these to be untrue Evacuation area: 370 km^2 (2.7% of Fukushima Prefecture, <0.1% of Japan, as of March 2019) The average air dose rate within 80km of FDNPP dropped to ~1/4.

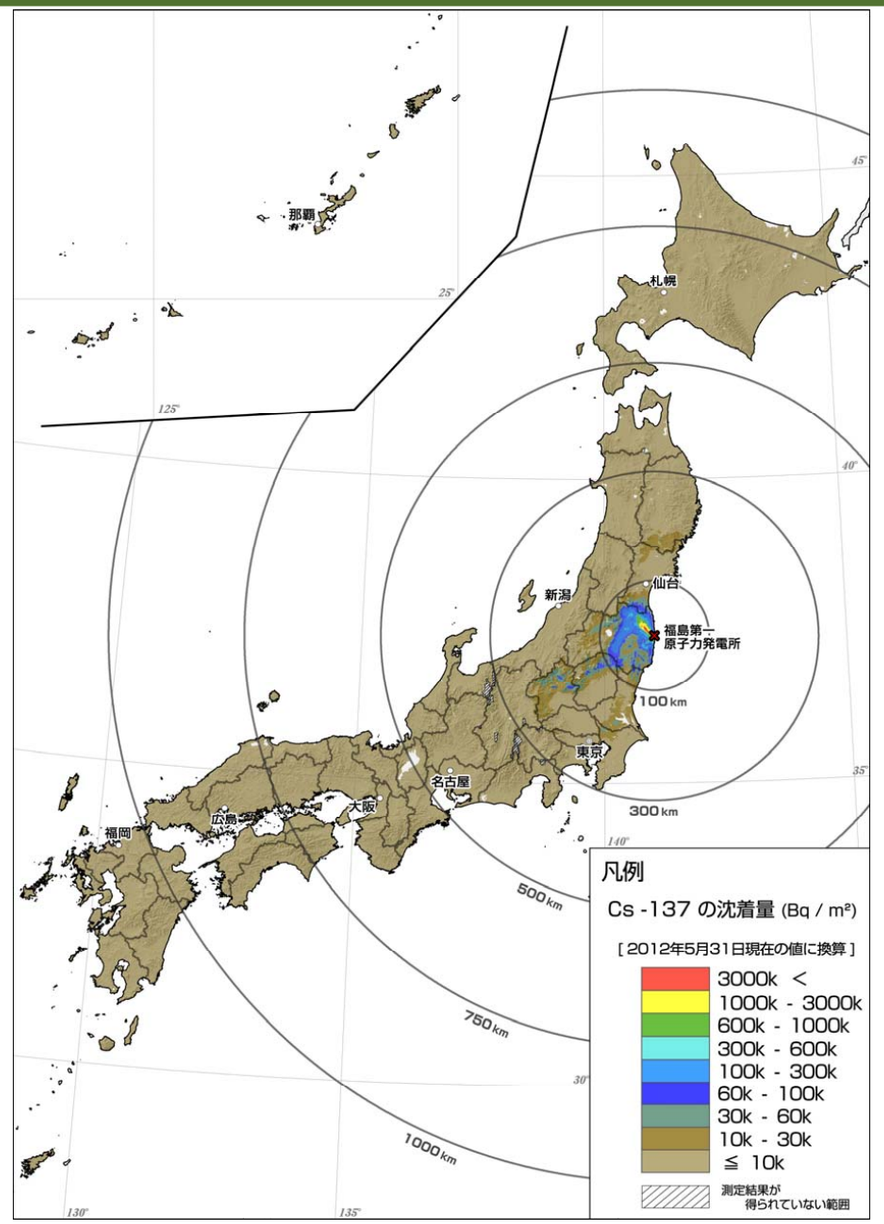
Soil contamination

Myth



Our "PNAS" paper: estimated by using a dispersion model and a preliminary "source term".

Fact



Airborne monitoring result (as of July 2012).

Food Safety

2011 Mar 17 ~

○ **Provisional regulation values for radioactive cesium[1]**

Category	Limit
Drinking water	200
Milk, dairy products	200
Vegetables	500
Grains	
Meat, eggs, fish, etc.	

Bq/kg

2012 Apr 1 ~

○ **New standard limits for radioactive cesium [2]**

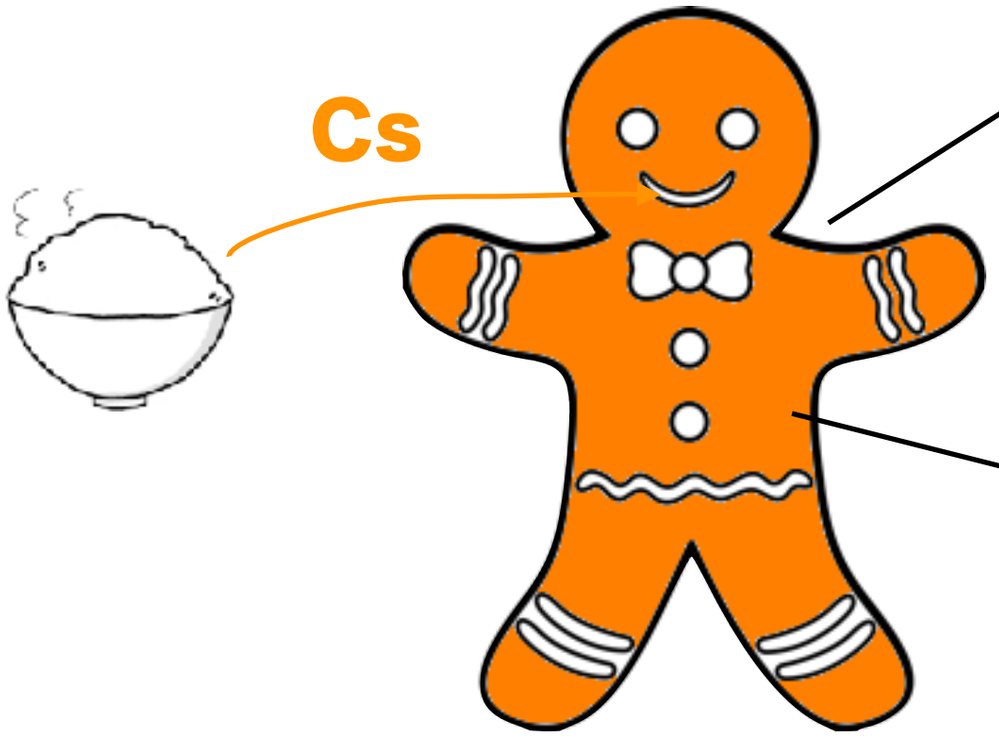
Category	Limit
Drinking water	10
Milk	50
General Foods	100
Infant Foods	50

Bq/kg

Food Safety

Myth	Fact
All Fukushima/Japanese foodstuffs are contaminated with radioactivity (at the level of 100 Bq/kg). The health of Fukushima residents is at risk.	Repeated measurements have shown ← these to be untrue Examples: 1. Whole body counter data 2. School lunch data 3. Rice data 4. Fish data

Food Safety (WBC)



whole body counter

Food Safety (WBC)

WBC measurements of some 30,000 residents in 2011-2012

The first actual data published in English

Included in the UNSCEAR report

No. 4] Proc. Jpn. Acad., Ser. B **89** (2013) 157

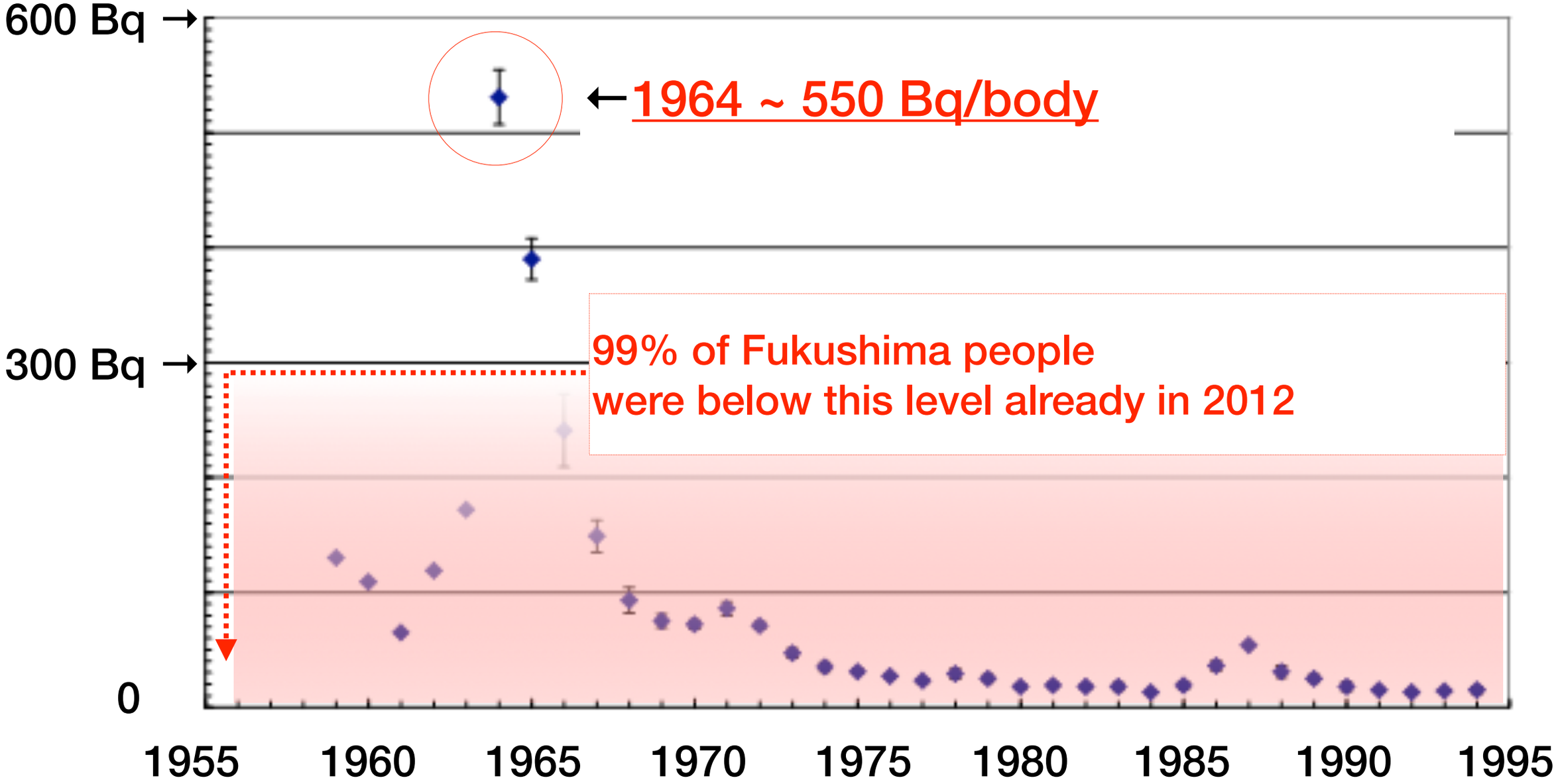
Internal radiocesium contamination of adults and children in Fukushima 7 to 20 months after the Fukushima NPP accident as measured by extensive whole-body-counter surveys

By Ryugo S. Hayano,[*1,†] Masaharu Tsubokura,[*2] Makoto Miyazaki,[*3] Hideo Satou,[*4] Katsumi Sato,[*4] Shin Masaki[*4] and Yu Sakuma[*4]

- Internal exposure of Fukushima people surprisingly low
  - children 100% (adult 99%) below detection limit already in 2012

Food Safety (WBC)

^{137}Cs in Japanese adult male in 1964
was much higher than in Fukushima



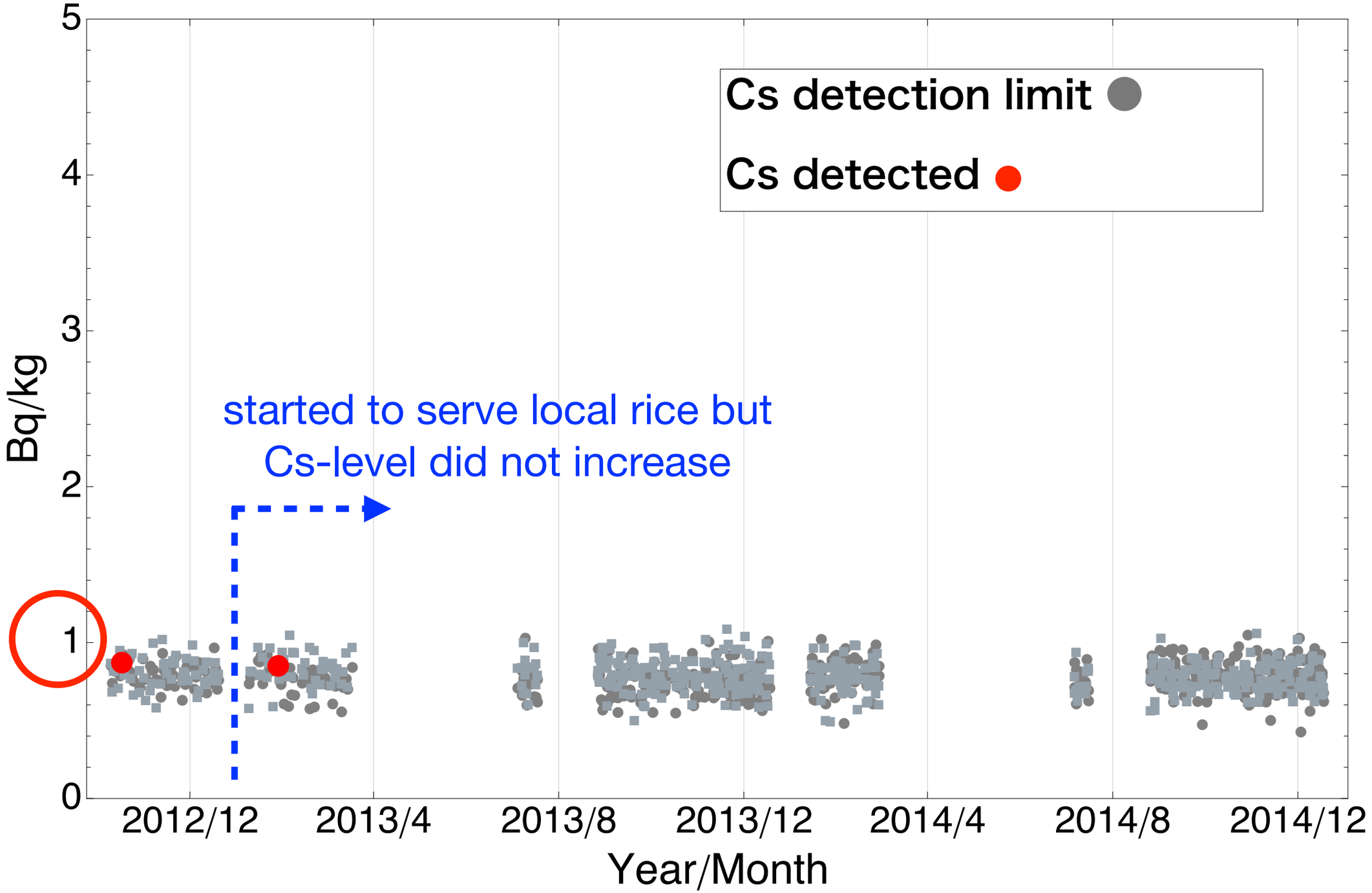
Food Safety (School Lunch)

I proposed to measure school lunch
the government funded the project from 2012

Food Safety (School Lunch)

Fukushima-city school lunch: free of radiocaesium

(results of other municipalities are similar)



Source: Fukushima Prefecture School Board

Food Safety (School Lunch)

School lunch measurements - summary

	# of samples	# of samples > 1 Bq/kg	Maximum Bq/kg
2012	1962	14	2.53
2013	2480	6	1.28
2014	2859	0	-
2015	2669	2	1.14
2016	3488	0	-

Source: Fukushima Prefecture School Board

Food Safety (Rice)

Every rice bag harvested in Fukushima, more than 10,000,000 (30 kg each), measured every year

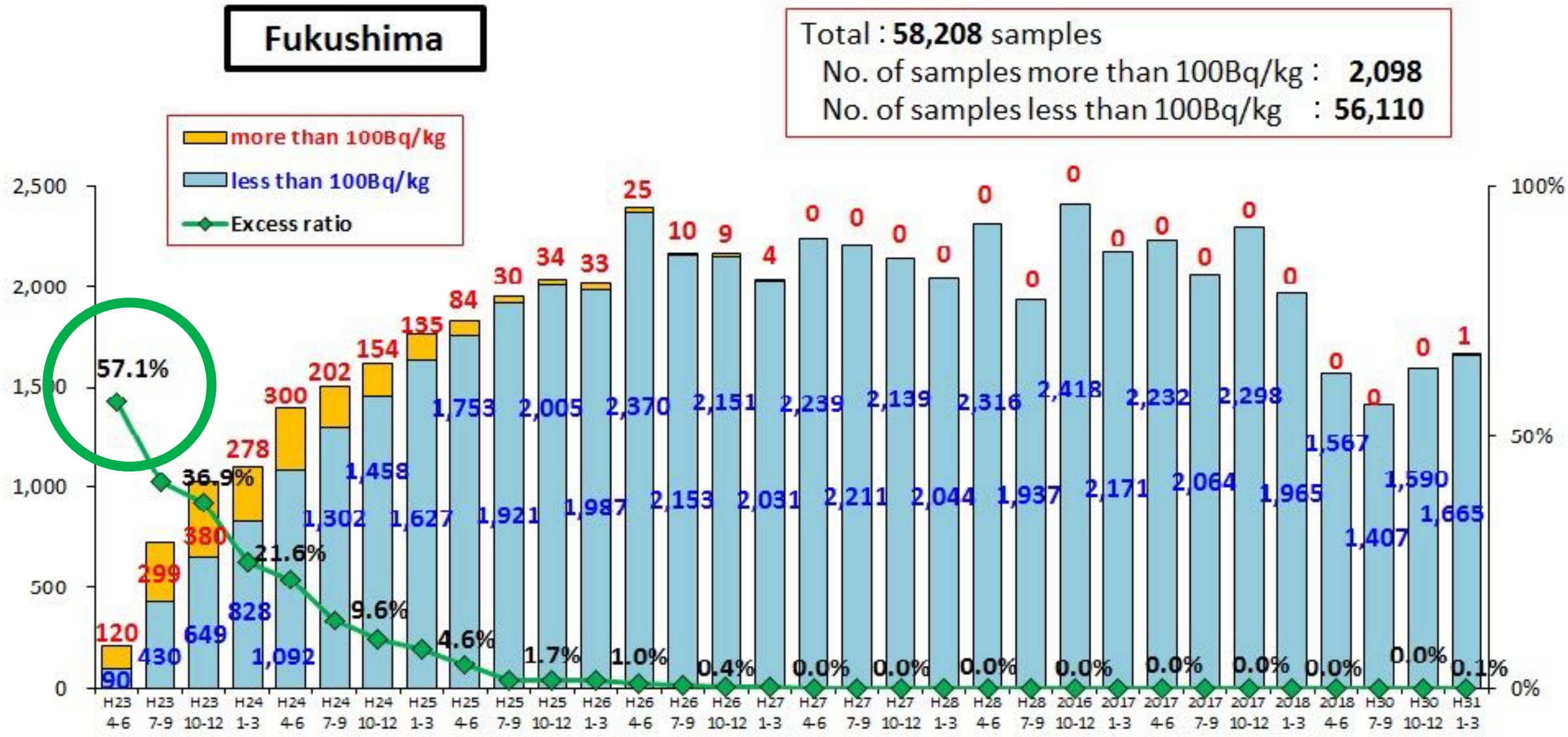
The number of bags which exceeded the 100 Bq/kg limit

71	in 2012
28	in 2013
2	in 2014
0	in 2015
0	in 2016
0	in 2017
0	in 2018

source: Fukushima Prefecture - https://fukumegu.org/ok/contentsV2/kome_summary_2.html

Food Safety (Fish)

Fishery products monitoring results (Apr 2011 - Mar 2019)



Source: Fishery agency - http://www.jfa.maff.go.jp/e/inspection/index.html

External exposures

Myth	Fact
The radiation level (air dose rate) is high in Fukushima. - It is dangerous to visit Fukushima. - It is out of question to live in Fukushima.	Except for the areas under the evacuation order, the external doses received by Fukushima residents are similar to those in other parts of the world. Examples: 1. High school data 2. School children data 3. Seoul/Tokyo data

External exposures (high school data)

co-authored by 233 high school students, teachers, and experts from Japan, France, Poland and Belarus

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IOP Publishing | Society for Radiological Protection Journal of Radiological Protection
J. Radiol. Prot. **36** (2016) 49–66 doi:10.1088/0952-4746/36/1/49

Measurement and comparison of individual external doses of high-school students living in Japan, France, Poland and Belarus—the 'D-shuttle' project—

N Adachi[1], V Adamovitch[2], Y Adjovi[3], K Aida[4], H Akamatsu[5], S Akiyama[6], A Akli[7], A Ando[8], T Andrault[9], H Antonietti[3], S Anzai[10], G Arkoun[3], C Avenoso[11], D Ayrault[9], M Banasiewicz[12], M Banaśkiewicz[13], L Bernardini[11], E Bernard[7], E Berthet[11], M Blanchard[3], D Boreyko[14], K Boros[15], S Charron[16], P Cornette[9], K Czerkas[15], M Dameron[11], I Date[17], M De Pontbriand[3], F Demangeau[9], ł Dobaczewski[18], L Dobrzyński[19], A Ducouret[3], M Dziedzic[20], A Ecalle[9], V Edon[9], K Endo[21], T Endo[21], Y Endo[21], D Etryk[12], M Fabiszewska[18], S Fang[4], D Fauchier[9], F Felici[7], Y Fujiwara[10], C Gardais[9], W Gaul[20], L Gurin[9], R Hakoda[22], I Hamamatsu[6], K Handa[10], H Haneda[10], T Hara[10], M Hashimoto[1], T Hashimoto[8], K Hashimoto[21], D Hata[1], M Hattori[10], R Hayano[23], R Hayashi[22], H Higasi[5], M Hiruta[6], A Honda[6], Y Horikawa[8], H Horiuchi[24], Y Hozumi[17], M Ide[25], S Ihara[8], T Ikoma[24], Y Inohara[22], M Itazu[24], A Ito[8], J Janvrin[9], I Jout[11], H Kanda[5], G Kanemori[5], M Kanno[10], N Kanomata[10], T Kato[24], S Kato[24], J Katsu[5], Y Kawasaki[21], K Kikuchi[4], P Kilian[26], N Kimura[25], M Kiya[10], M Klepuszewski[15], E Kluchnikov[14], Y Kodama[5], R Kokubun[10], F Konishi[22], A Konno[6], V Kontsevoy[2], A Koori[6], A Koutaka[6], A Kowol[27], Y Koyama[4], M Kozioł[13], M Kozue[1], O Kravtchenko[14], W Kruczała[12], M Kudła[28], H Kudo[29], R Kumagai[24], K Kurogome[25], A Kurosu[29], M Kuse[25], A Lacombe[3], E Lefaillet[3], M Magara[17], J Malinowska[26], M Malinowski[18], V Maroselli[7], Y Masui[29], K Matsukawa[29], K Matsuya[17], B Matusik[20], M Maulny[9], P Mazur[27], C Miyake[29], Y Miyamoto[4], K Miyata[1], K Miyata[5], M Miyazaki[30], M Molęda[20], T Morioka[1], E Morita[24], K Muto[1], H Nadamoto[5], M Nadzikiewicz[28], K Nagashima[29], M Nakade[22], C Nakayama[25], H Nakazawa[17],

Y Nihei[4], R Nikul[2], S Niwa[8], O Niwa[30], M Nogi[6], K Nomura[29], D Ogata[8], H Ohguchi[31], J Ohno[24], M Okabe[17], M Okada[22], Y Okada[6], N Omi[25], H Onodera[10], K Onodera[25], S Ooki[21], K Oonishi[29], H Oonuma[10], H Ooshima[8], H Oouchi[1], M Orsucci[11], M Paoli[11], M Penaud[9], C Perdrisot[9], M Petit[9], A Piskowski[15], A Płocharski[15], A Polis[13], L Polti[3], T Potsepnia[14], D Przybylski[12], M Pytel[28], W Quillet[9], A Remy[3], C Robert[9], M Sadowski[19], M Saito[10], D Sakuma[1], K Sano[5], Y Sasaki[24], N Sato[4], T Schneider[32], C Schneider[3], K Schwartzman[2], E Selivanov[14], M Sezaki[25], K Shiroishi[21], I Shustava[14], A Śniecińska[28], E Stalchenko[14], A Staroń[27], M Stromboni[7], W Studzińska[26], H Sugisaki[17], T Sukegawa[21], M Sumida[22], Y Suzuki[17], K Suzuki[10], R Suzuki[10], H Suzuki[10], K Suzuki[6], W Świderski[18], M Szudejko[33], M Szymaszek[27], J Tada[34], H Taguchi[22], K Takahashi[4], D Tanaka[5], G Tanaka[29], S Tanaka[24], K Tanino[4], K Tazbir[13], N Tcesnokova[14], N Tgawa[5], N Toda[6], H Tsuchiya[17], H Tsukamoto[8], T Tsushima[1], K Tsutsumi[25], H Umemura[8], M Uno[24], A Usui[25], H Utsumi[29], M Vaucelle[9], Y Wada[17], K Watanabe[4], S Watanabe[22], K Watase[29], M Witkowski[26], T Yamaki[21], J Yamamoto[4], T Yamamoto[17], M Yamashita[22], M Yanai[21], K Yasuda[22], Y Yoshida[1], A Yoshida[21], K Yoshimura[25], M Żmijewska[15] and E Zuclarelli[7]

Adachi et al
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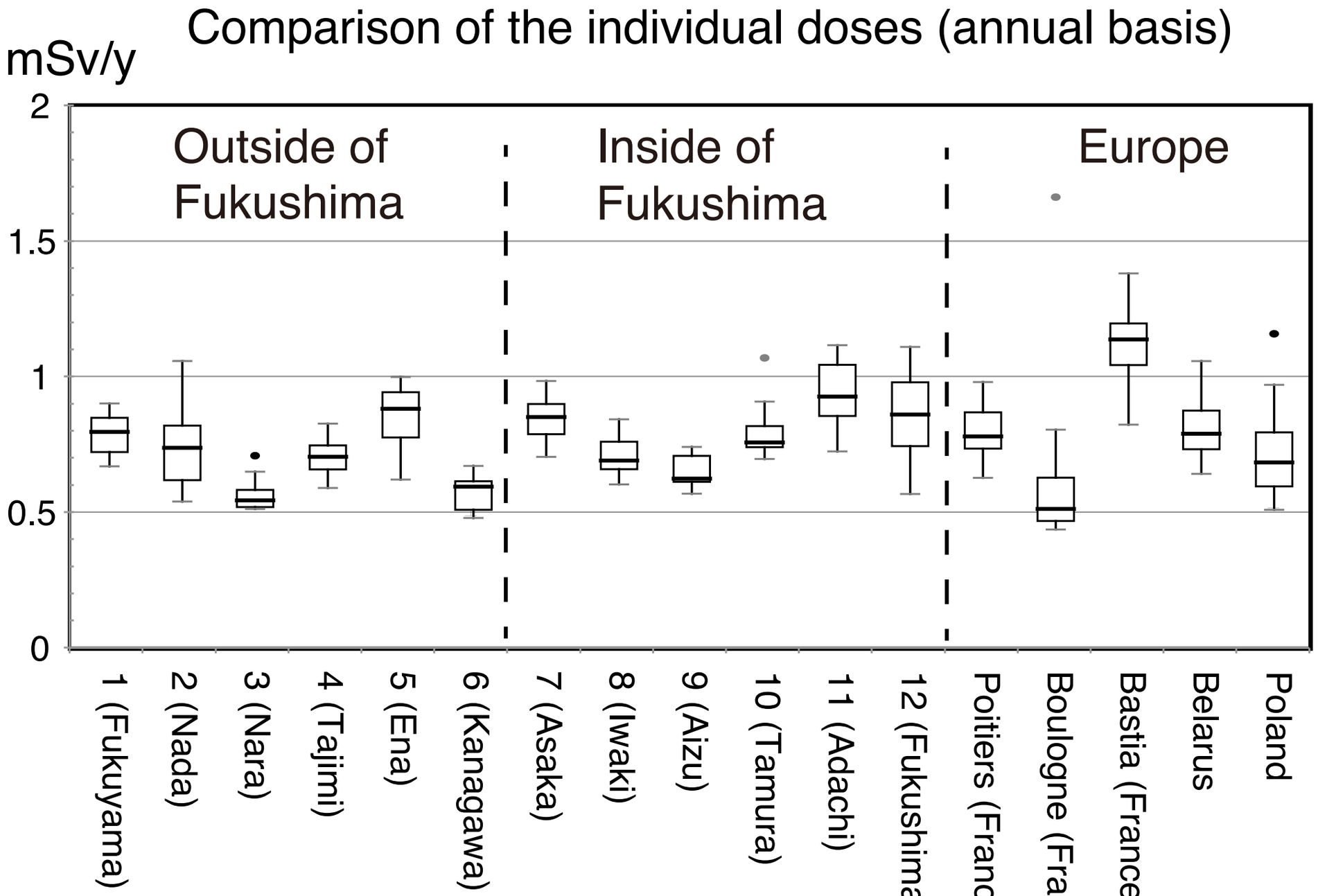
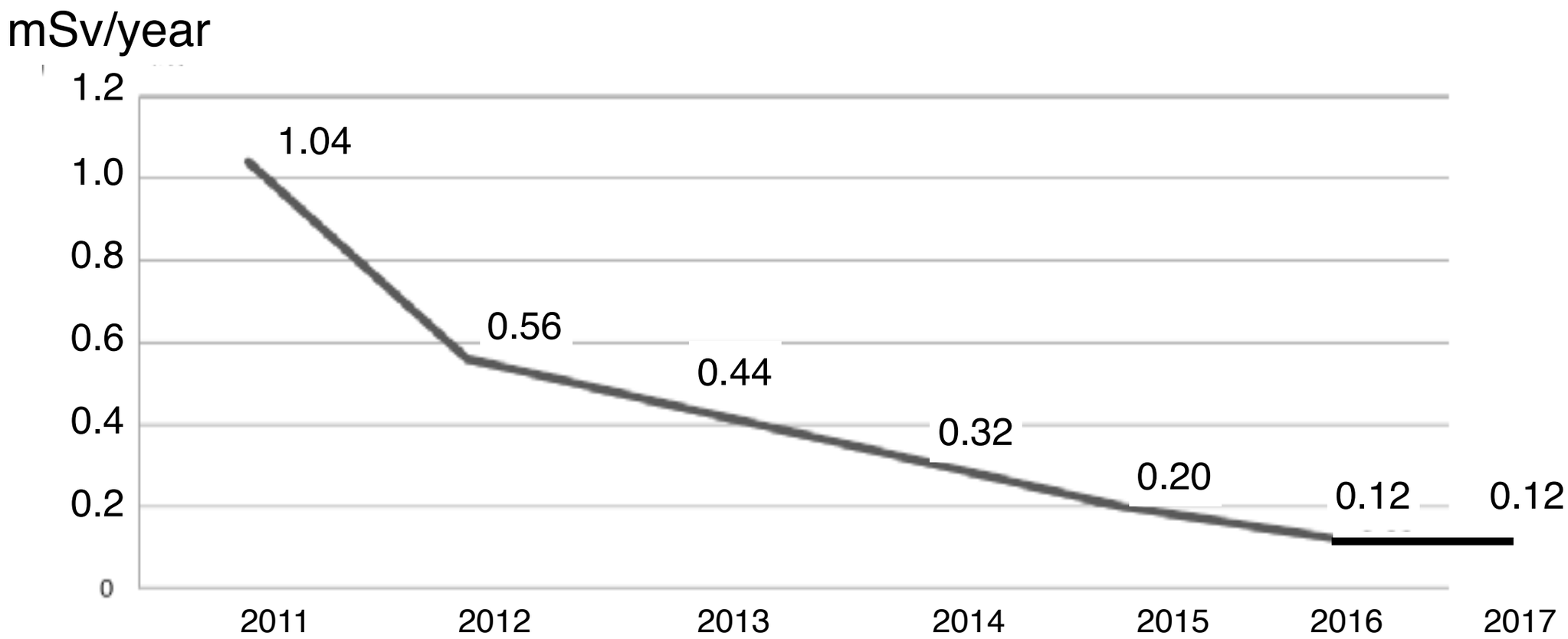
External exposures (high school data)



Adachi et al., J. Radiol. Prot. 36 (2016) 49

External exposures (school children data)

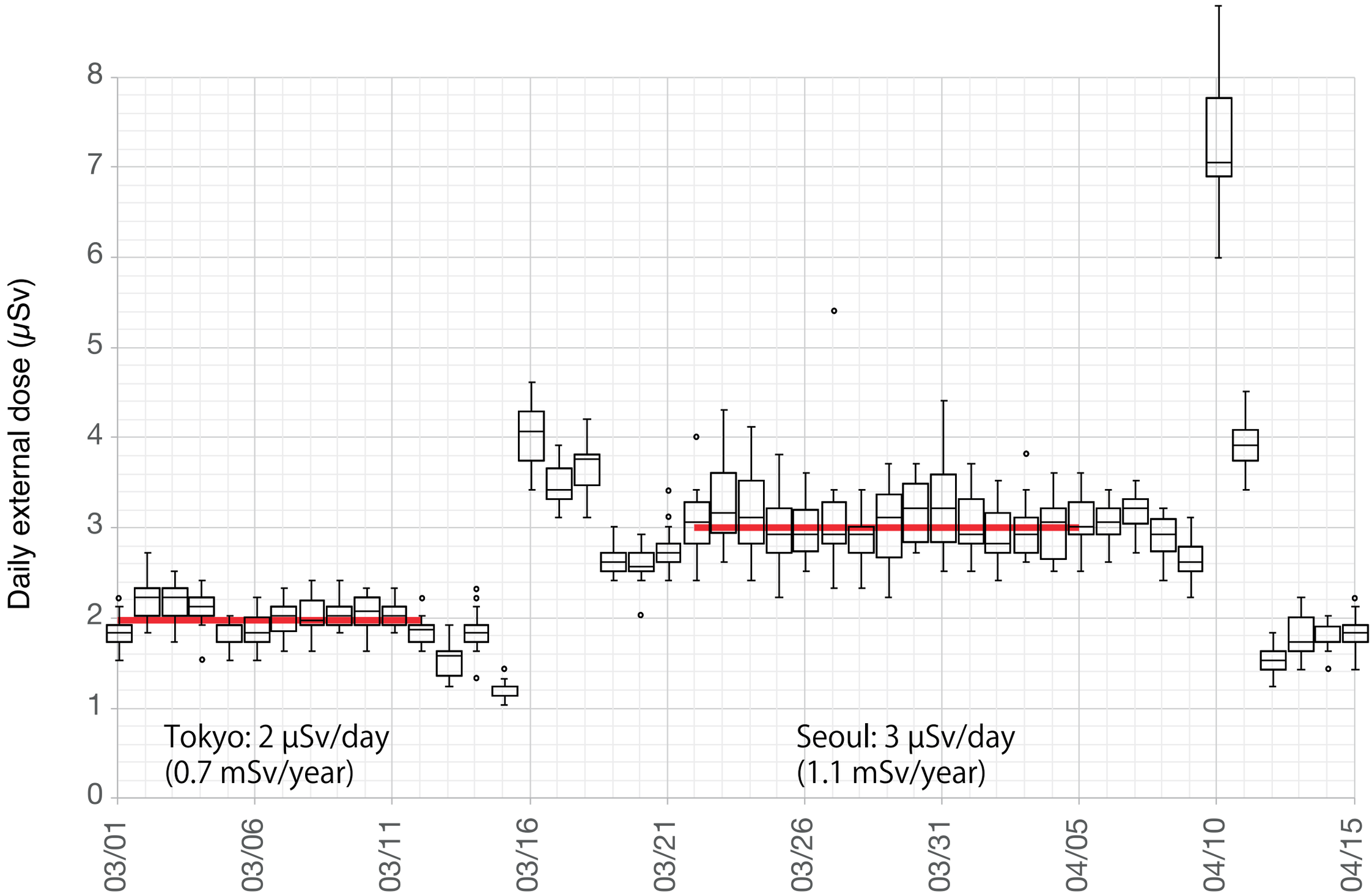
Fukushima-city school children (below 15 yo)
mean <u>“additional”</u> annual exposures - 7-year trend



Source: Fukushima City

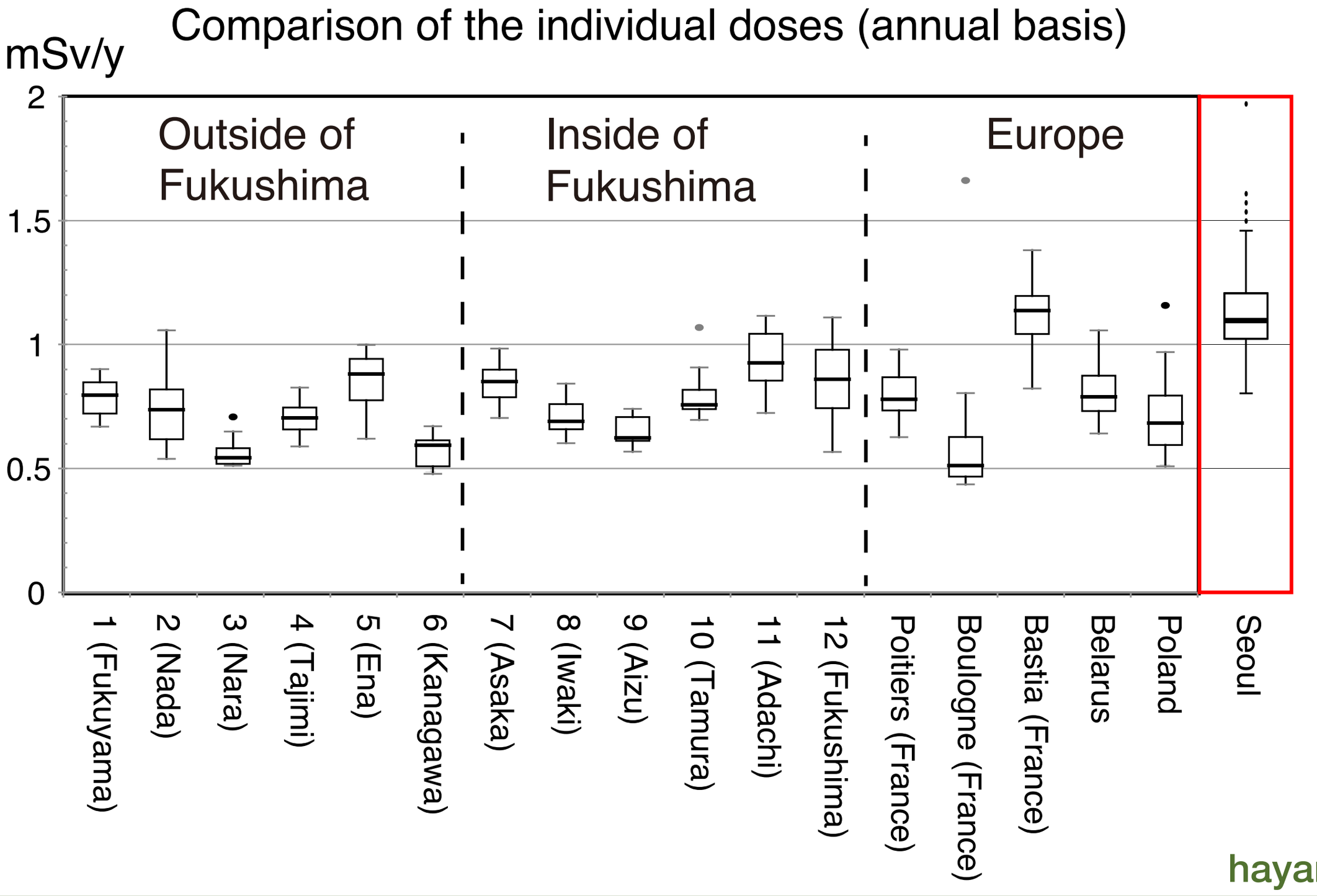
External exposures (Seoul/Tokyo data)

20 "d-shuttles" in Seoul, in collaboration with Dongbuk high school



External exposures (Seoul/Tokyo data)

The median external dose in Seoul is higher than in Fukushima
(But this does NOT mean living in Seoul is dangerous)



Death toll - earthquake, Tsunami, FDNPP

as of March 2019, 8 years after the earthquake

	Earthquake & Tsunami Death (+missing)	Disaster-related Death	Death due to radiation
Iwate	5788	467	0
Miyagi	10761	928	0
Fukushima	**1810**	**2268**	**0**

Conclusions

- In 8 years, lots of data have been accumulated, e.g., soil contamination, food contamination, external as well as internal exposure doses of residents.

- Please DO use the data, NOT the estimates (such as in our PNAS paper), when discussing radiological consequences of the FDNPP accident.

Conclusions

- Fukushima food: safe to eat,
  Fukushima is safe to live in.

- Normal life is returning to ~2 M Fukushima residents
  (although there are still ~42 k evacuees).

- The risks due to internal/external exposures have
  been found to be small.

- However, psychosocial and economical problems
  still remain.