Status of Food Safety after the Fukushima Accident

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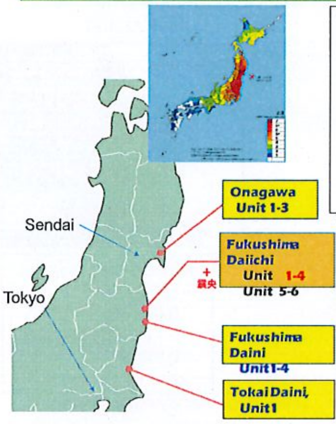
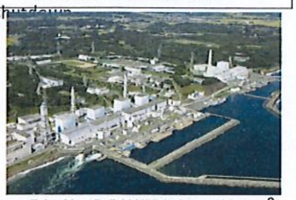
1. Fukushima Accident

March 11, 2011
- Magnitude =9.0 earthquake attacked four nuclear power plants (NPP) in north east Japan
- Huge tsunami (>15 m), damaged Fukushima-Daiichi NPP's emergency cooling system and led melt down & hydrogen explosion
- The others reached cold shutdown





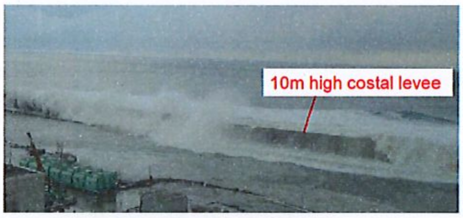
Fukushima Daiichi NPP before accident

Progression of the accident

- ＊March 11
  - 14:46 Earthquake occurred
    - Units 1-3 stopped automatically
    - Tower for external AC power collapsed,
    - → External AC power lost,

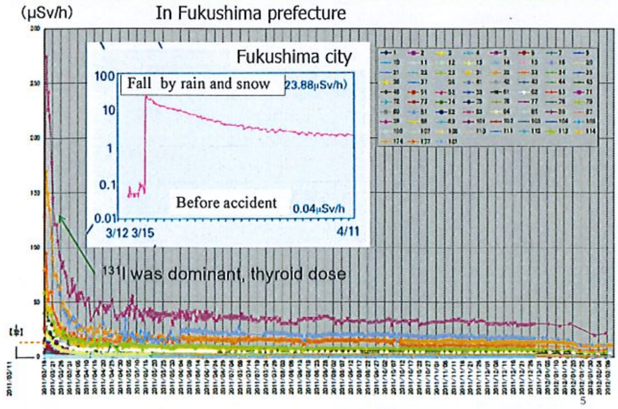
  - 15:37 Tsunami hit the site
    - Oil tank, diesel generator for emergency cooling were lost,
    - All electricity lost, no means for fuel cooling
    - *Fuels were heating→ hydrogen generation, melting of fuels*
  - 20:50 Evacuation < 2km ordered
- ＊March 12, 18:25 Evacuation < 20km ordered
- ＊March 14, 11:01 Unit-3 R/B hydrogen explosion

- ＊March 15
  - 06:10 Unit 2, R/B, hydrogen explosion: *Maximum emission*
  - 06:14 Unit-4, R/B, hydrogen explosion (hydrogen migration)
  - 11:00 Sheltering 20-30km ordered
- ＊April 1-6, Highly contaminated water flowed out to the Pacific Ocean



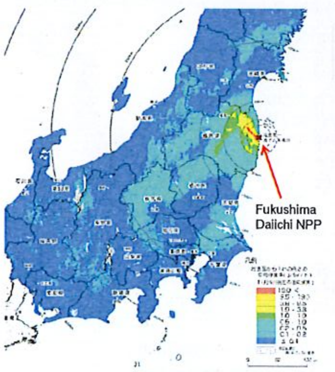
Tsunami

Spatial dose rate after the accident



Radiation dose & Evacuation

Air dose rate distribution
Ministry of Education, Dec 16, 2011



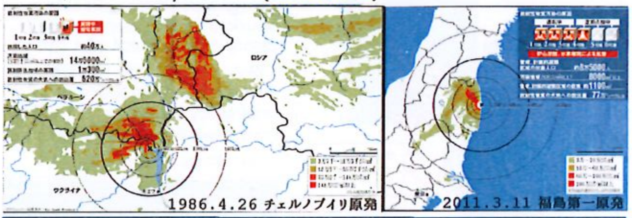
Evacuation & sheltering

- Evacuation: residents < 20km, ~ 78,000+10,000 (>20km, April)
- Sheltering: residents in 20-30km ~ 62,000

Contamination & evacuation

Fig.: Asahi Shinbun, Sept. 11, 2011

Chernobyl (same scale) Fukushima



	Chernobyl	Fukushima
Radioactivity Emiss[1]	52.0 X10^{17} Bq	7.70 x10^{17} Bq (~15 %)
Evacuee	~400,000	~160,000 [2]
Contaminated area	45,000 km^2 (>37,000Bq/m^2)	8,000 km^2 (~18%) (>30,000Bq/m^2)
Enforced Evacuation area	10, 300 km^2	1,100m^2
Loss of lives (acute)	50 in 4 months	zero up to now

1) UNACAER 2013 Report, ^{131}I equivalent, 2) Including voluntary evacuation

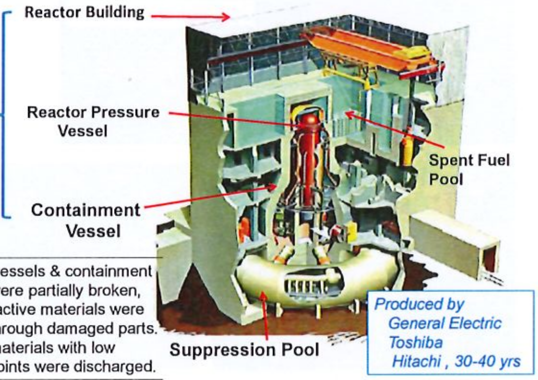
Released radio-active materials

Nuclide	Half Life	Boiling Point(℃)	Melting Point (℃)	Amount of release (PBq)		Fukushima/ Chernobyl
				Fukushima*1	Chernobyl*2	
Xe-133	5d	-108	-112	11000	6500	1.69
I-131	8d	184	114	160	~1760	0.09
Cs-134	2y	678	28	18	~47	0.38
Cs-137	30y	678	28	15	~85	0.18
Sr-90	29y	1380	769	0.14	~10	0.01
Pu-238	88y	3235	640	1.9·10^{-5}	1.5·10^{-2}	0.0012
Pu-239	24100y	3235	640	3.2·10^{-6}	1.3·10^{-2}	0.00024
Pu-240	6540y	3235	640	3.2·10^{-6}	1.8·10^{-5}	0.00018

*1: *UNSCEAR 2013 Report*, *2: *UNSCAER 2008 Report*

- Total amount of radioactive materials ~ 18 % of the Chernobyl, Level-7 in INES (IAEA)
- Sr & Pu isotopes with high biological effect were little & within the fallout due to nuclear test in '50-60 because of their high melting /boiling points.

Reactors in Fukushima-I : BWR/3,4

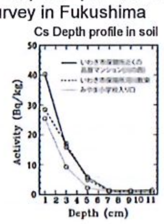


Reactor vessels & containment vessels were partially broken,
→Radio-active materials were emitted through damaged parts.
→ Only materials with low melting points were discharged.

Recovery Actions

* Works in NPP
  - Recovery of cooling system & reactor stabilization
  - Reduction of radionuclides discharge & contaminated water
* Radiation monitoring & Health management
  - Installation and operation of monitoring stations
  - Extension of radiation monitoring
    - airborne measurement
    - mobile type monitors with GPS
  - De-contamination: school, public place, house
  - Health management survey in Fukushima prefecture

Mobile dosimeter with GPS



Decontamination works

2. Food safety: monitoring & control

* March 16, radioactive I and Cs detected in tap water (Fukushima) Monitoring of foods and drinking water started
* Establish limits for radioactive materials in foods
  - Provisional regulation values (March 17)
  - Revision to the present limits (April 1, 2012-)
* Monitoring of radioactive materials in foods
  - By the local governments, 17 prefect. (March 18)
  - Guidelines on the monitoring (April 4) by Nuclear Emergency Response Headquarters (NERH)

17 prefectures for food monitoring

* Treatment of foods exceeding the limits (NERH, March 21, 2011-) .
  - All the articles in a lot above the levels are disposed
  - Restriction of
    - distribution: If contamination spreads over area
    - consumption: when concentration is high
* Requirement for "lift of restrictions" [NERH]
  - Every testing result for samples within one month & three different locations < the limits.

http://www.mhlw.go.jp/english/topics/2011eq/index_food_policies.html

Standard limit of Cs concentration in foods (Bq/kg)

	Drinking Water	Milk, Milk products	Infant Foods	Vegetables, Grain, Meat, Egg, Fish	Ratio of contaminated foods
Japan*	10	50	50	100	50 %
Taiwan Korea	370	370	370	370	TBC
CODEX Committee	1,000	1,000	1,000	1,000	10 %
USA	1,200	1,200	1,200	1,200	30 %
EU	1,000	400	1,000	Dairy 1,000 others 1,250	10 %
	200**	200**	500**	500**	

* The Japanese limits is given for Cs including contribution of Sr-90, Ru-106, Pu (12%)
- so that the sum of effective dose does not exceed 1mSv/year
- considering age-dependence of biological effect of radiation and the intake

** Applied to foods imported to EU from Japan, since April 8, 2011, equals to Japanese provisional limit.

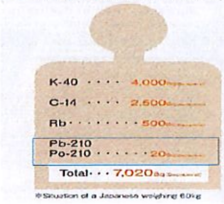
How much is "1 mSv/y" ?

Annual exposure from natural radiation (mSv/y)	Cosmic rays	Earth radiation	Foods	Radon in the air
Japan average	0.30	0.33	0.98	0.48
World average	0.39	0.48	0.29	1.28

1mSv/y is almost same with the annual exposure from foods in Japan.

● Content of the radioactive material K-40 in foods of 1kg (Japan) (Unit: Bq/kg)

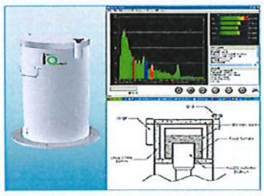
● Content of radioactive materials inside human body



"Research on Radiation data in the living environment" Atomic Energy Safety Research Society (1983, 2011)

Standard equipment for foods monitoring

Germanium (Ge) detector



NaI(Tl) detector

Shredding → Weighing → Measurement → Analysis

Lowest detection level is
- Ge: 0.5~ a few Bq/kg
- NaI(Tl):several kg/Bq

＊High precision but time consuming and destructive measurements

Development of Non-destructive equipment

Rice in-line Inspector

Smimadzu Corp. (PET manufacturer)
- BGO scintillator + Pb shielding
- Sensitivity
  - < 5 Bq/kg @225 sec
  - 10 Bq/kg @15sec
  - 20 Bq/kg @ 5sec

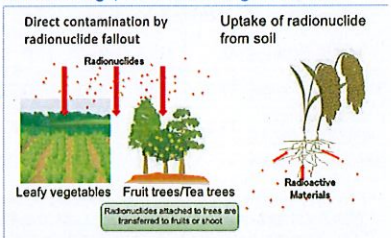
http://www.shimadzu.co.jp/news/press/miq5fd00000011p2.html

Non-destructive food inspector

For home made & home-consumed foods

Contamination pathways & countermeasures

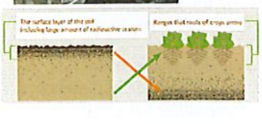
1. Agricultural products
   1) Direct contamination of leaf, trees → clean up, scrape, pruning
   2) Uptake from soil via roots
      → Decontamination of soils; reversal tillage, removal of topsoil
      → Absorption control by adding K-fertilizer onto soil: rice
   3) Uptake from mushrooms log (cultivated mushrooms)
      → Decontamination of mushroom logs, introduction of green house
2. Live stock products (cattle, pigs, chicken cultured fish);
   → management of feed
3. Sea foods
   → reduction of water contamination

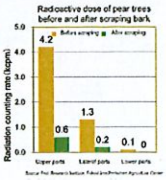


contamination path way

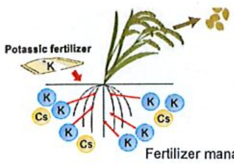
Actions to reduce food contamination

reversal tillage

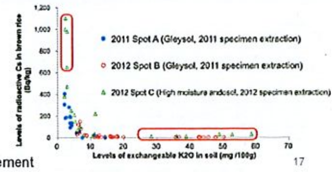




scraping bark and its effect



Fertilizer management



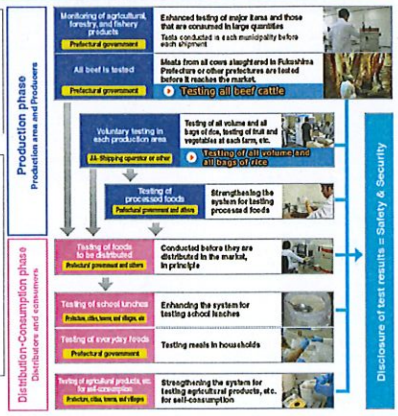
Food inspection system in Fukushima Prefecture

In Fukushima Prefecture, inspection of foods are conducted on
- *production stage,*
- *processed food and for*
- *circulation food.*

Detailed information on the inspection results are available in

http://www.new-fukushima.jp/
http://fukushima.org/ok/contents/

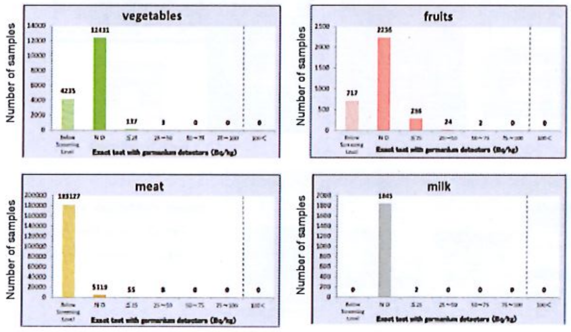
and



http://www.pref.fukushima.lg.jp/site/portal-english/en01-02.htm

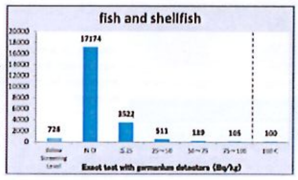
Food inspection results-1

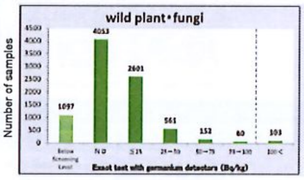
＊Number vs Cesium density (Bq/kg) for samples in FY 2013-2014
Inspection was done using germanium detector



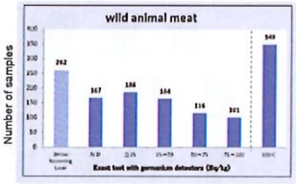
Concentration of the foods are ND or of very concentration

Food inspection results-2





For these food, in particular wild animal meat, shows higher concentration. Foods species which showed concentration above 100 Bq/kg are not distributed until the condition for lifting the restriction is fulfilled.



Results of agricultural & forestry products

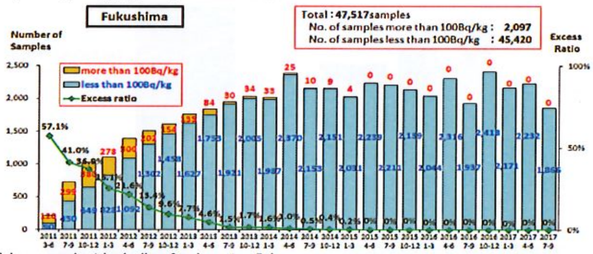
Ratio of foods with concentration exceeding the limit (%) *

Foods	2011	2012	2013	2014	2015	2016	2017
Brown Rice** (~10 million bags)	-	$7\cdot10^{-4}$	$3\cdot10^{-5}$	$1.8\cdot10^{-5}$	0	0	0
Vegetables Fruits	2.38	0.096	0	0	0	0	0
Raw milk	2.26	0	0	0	0	0	0
Meats, Eggs	0	0	0	0	0	0	0
Grass/Feed crops	17.3	2.81	0.81	0.72	0	0	0
Mountain herbs and mushrooms	11.7	7.63	5.49	1.6	0.47	0.11	0.058
Wild animal meat	-	0.719	0.693	0.533	0.70	0.484	0.163

・For *drinking water*, Cs has not been detected since May 2011.
* *http://www.maff.go.jp/j/kanbo/joho/saigai/s_chosa/index.html (in Japanese)*
***http://www.new-fukushima.jp/monitoring/en/about.php#h*

Results of fishery & marine products

http://www.jfa.maff.go.jp/e/inspection/index.html

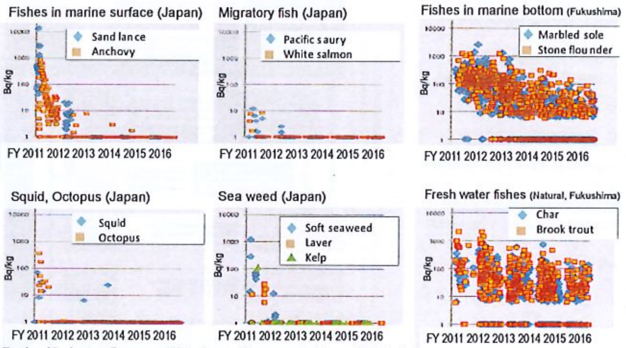


Fishery product including fresh-water fishes

FY	2011	2012	2013	2014	2015	2016	2017
Ratio	17.0	5.6	1.5	0.5	0.07	0.06	0.07

・Contamination of marine products are lower than freshwater fish due to osmotic pressure and no excess since 2015. Ten species of marine fishes are under distribution restriction.
・There are still a few excess for freshwater fishes

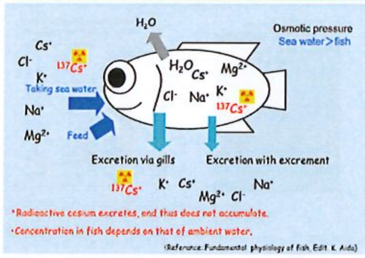
Time-dependent fishery concentration



Food and Radiation: Consumer Affairs Agency, Government of Japan 2016, in Japanese

・Marine fishes in surface region, migratory, squid, octopus, sea weed → low, faster decrease
・Marine fishes in bottom region & fresh water natural fishes → high, slow decrease

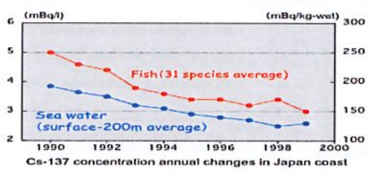
The flow of salts in marine fish body



http://www.jfa.maff.go.jp/e/q_a/pdf/qa.pdf

In **sea water**, Cs dose not accumulate because of *osmotic pressure difference between water and fish body.* But the situation is opposite for fresh water fishes.

This interprets the differences of Cs behavior in marine and fresh water fishes/shellfishes.



Marine fishes with slow decrease are long-lived fishes that absorbed highly contaminated water from NPP in April 2011.

Result of daily meals -1

* Inspection of
  - dairy meals of family
  - school lunches
  by various organizations & local authorities.

* a) Japan Coop-Union's *Kagezen* *http://jccu.coop/info/pressrelease/2012/10/2012-574.html*
  ・Inspection of meals for 2 days of families of Fukushima and other 18 prefectures,
  ・Measurements: Cs-134, Cs-137, I-131, K-40 (low limit ~1Bq/kg, 15 hours meas.)

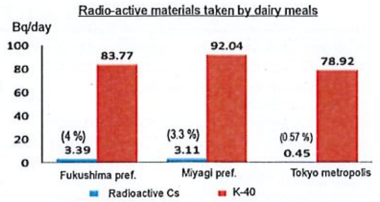
Results
・No detection since 2014年
・Detected radioactivity was
  -Less than 1/10 of natural K-40
  -Internal exposure by intake of the meal < 0.037 mSv/y
・Similar results in other studies

Year	No. of samples	Ratio of detection	Maximum Bq/kg
2011	100	10.0 %	11.7
2012	200	4.5 %	3.7
2013	200	3.0 %	3.7
2014	100	0	—

→ Radioactive materials in foods circulated in the market is negligible.

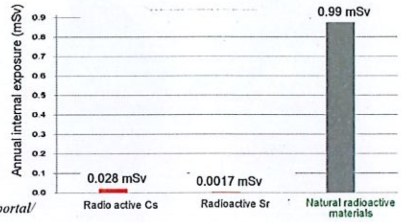
Result of daily meals -2

(b) Evaluation by
  - *National Institute for Medicine and Foods*
  - market-basket method,
  - September and November 2011
  - Natural *K-40 is dominant*
    Cs effect is negligibly small



(c)Evaluation by Fukushima Prefecture, 2012

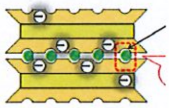
- Concentration of *strontium* is less than 1/30 of Cs



http://www.pref.fukushima.lg.jp/site/portal/nichijoshoku-moni.html

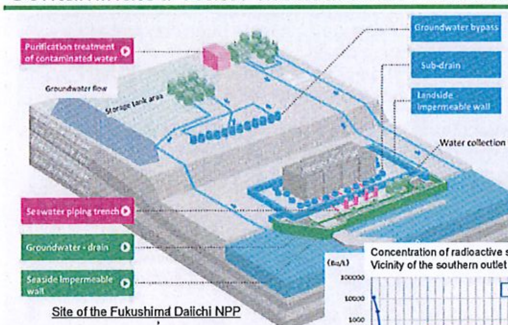
Status of foods sefety

1. Contamination of foods has become very low and is decreasing, owing to
   a) efforts for
      - reduction of Cs concentration in soil, trees and grasses
      - management of environment, water, plants, and fertilizer (potassium),
   b) clay/sticky nature of soil: Cs firmly combines with soil and then, the transfer factor of radioactive materials from soil to plants is low.
   c) decrease of contamination of sea water around NPP
2. Mechanism and feature of contamination have been studied, and applied successfully to avoid/reduce food contamination.
3. There are food species with high concentration, but they are few and not in market. They are also decreasing steadily.

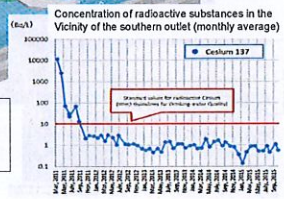


Cs just fits to the hole in clay structure and are firmly fixed by mechanical and electric force.

Contaminated Water Measures at Fukushima NPP

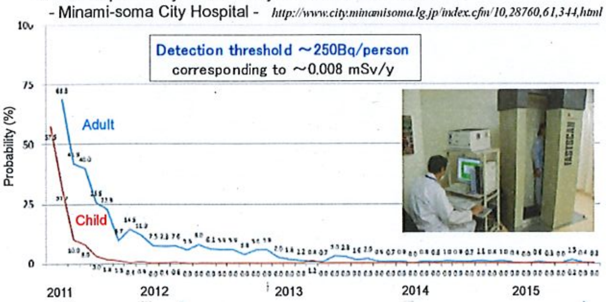


3 basic policies against contaminated water
・Isolating ground water from contaminating source
・Preventing leakage of contaminated water
・Removing the contaminating source



3.Present Status and Risk communication

Internal exposure by Whole–Body Counter Measurement
- Minami-soma City Hospital - *http://www.city.minamisoma.lg.jp/index.cfm/10,28760,61,344,html*

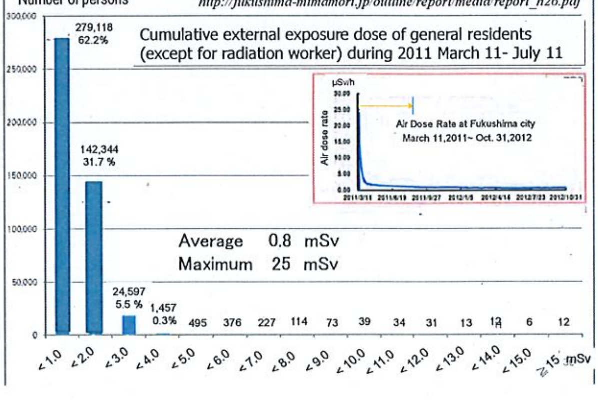


・Probability of cesium detection is decreasing and now almost zero,
・Decreasing rate is faster for child
・Internal exposure is much less than 1 mSv/y, consistent with other data.

External exposure

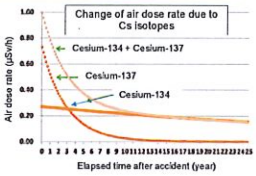
June 12, 2015: Fukushima Medical Univ. Home Page
http://fukushima-mimamori.jp/outline/report/media/report_h26.pdf

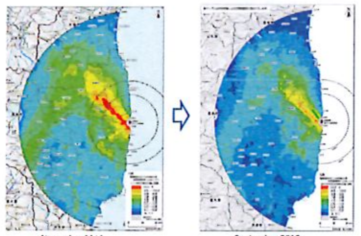
Cumulative external exposure dose of general residents (except for radiation worker) during 2011 March 11- July 11



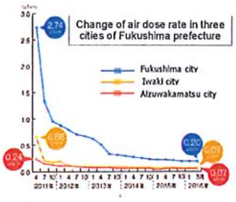
Air dose rates in Fukushima

- Average air dose rate at 1 m height decreased by about 70 % since November, 2011, owing to
  - *natural decay of radioactivity* and
  - *decontamination.*
- This is consistent with estimation based on the decay of major isotopes, Cs-134 and Cs-137.
- Evacuation orders were cancelled except for very near area to NPP





November 2011 September 2015



Source: Created by the Reconstruction Agency based on Fukushima Prefecture "Steps for Revitalization in Fukushima (March 11, 2016)"

Risk communication on food safety

* The radioactivity concentration in circulated foods and internal exposure proved to be similar with those before the accident owing to extensive works and soil nature in Fukushima.

* Nevertheless, negative reputational impact still exist about foods from Fukushima & Tohoku area:
- Price is still low & market is limited,
- Import of foods in the area is prohibited or restricted in many countries.

* Fundamental problem seems fear/concern for negative effect of radiation such as, cancer, genetic effect.

* More information is needed to solve the situation on foods and the mechanism biological effect of radiation.

Ratio of persons who fear the foods from Fukushima	
Taiwan	81.0 %
Korea	69.3
China	66.3
Russia	56.0
Germany	55.7
Singapore	52.7
France	39.7
U.S.A	35.7
Japan	30.3
UK	29.3

Questionnaire by Univ. Tokyo & Fukushima Univ.

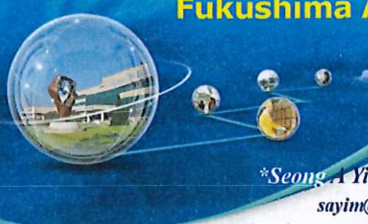
4. Summary

1. Extensive works and investigations have been conducted for
   - recovery and monitoring of environment,
   - inspection and reduction of contamination in foods, and
   - suppression of contaminated water in NPP.
2. Owing to the efforts, the environment in Fukushima and NPP was improved greatly, and return home is in progress.
3. Contamination of foods decreased markedly and those in market are equivalent to that before the accident. Foods in the market are now free from radioactive materials due to the accident. In addition, valuable information on the mechanism and countermeasures on food contamination has been obtained.
4. Exposure dose due to the accident proved to a few to several mSv, and returning to natural radiation level.

We highly appreciate for your understanding on the current status of the environment and foods in Fukushima.

2017 International Conference on Food Safety and Health Risk on Human Populations Post Nuclear Accident
December 16, 2017 / School of Medicine, National Taiwan University, Taipei

Radiological Impact on Korean Environment and Food Following Fukushima Accident



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I. Introduction

Korea Institute of Nuclear Safety

Nuclear Safety Regulation
- Review and inspection of nuclear installations including commercial nuclear power plants, nuclear fuel cycle facilities and research reactors

Radiation Safety Regulation
- Review and inspection of the industrial uses of radioactive materials;
- Review and inspection of transport, storage, and disposal of radioactive materials and wastes;
- Safety assessment of environmental radiation exposure

Emergency Preparedness and Response
- Response to nuclear accident and terrorism
- Environmental radiation monitoring throughout the country
- Nuclear tests monitoring in neighboring countries

I. Introduction

Korea Institute of Nuclear Safety

Safety R&D
- Development of regulatory standards and requirements
- Development of nuclear safety policy and culture
- Education and training for regulatory capacity building

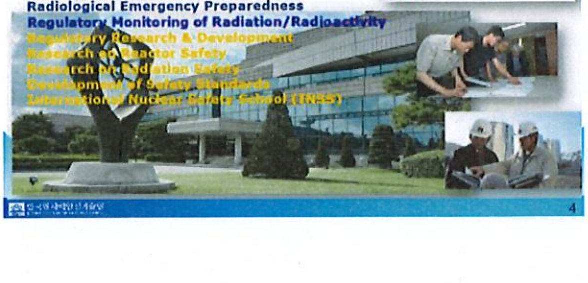
International Cooperation and Public Communication
- Multilateral and bilateral cooperation for information exchange
- Promotion of safety culture and public confidence

Beautiful  Dream

I. Introduction

Korea Institute of Nuclear Safety

Reactor Safety Regulations
Safety Reviews
Safety Inspections
Radiation Safety Regulations
Safety Management of Radiation Sources
Safety Management of Radiation in the Natural Environment
Emergency Preparedness & Response
Radiological Emergency Preparedness
Regulatory Monitoring of Radiation/Radioactivity
Regulatory Research & Development
Research on Reactor Safety
Research on Radiation Safety
Development of Safety Standards
International Nuclear Safety School (INSS)

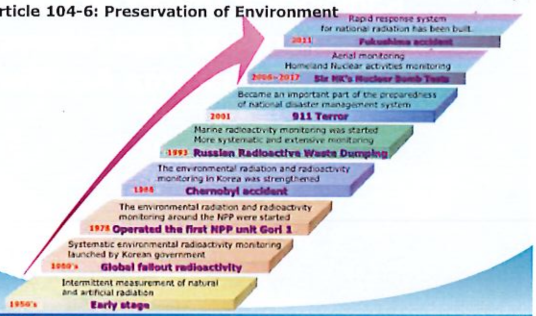


I. Introduction

Regulatory Monitoring of Radiation/Radioactivity

I. Introduction

- **The Atomic Energy Act**
  Article 104-7: Monitoring of National Environmental Radioactivity
  Article 104-6: Preservation of Environment



I. Introduction

Drastic changes in the circumstances surrounding the Korean Peninsula
- Nuclear activity and menaces of North Korea
- Rapid increase of nuclear facility constructions in China
- Fukushima accident and active spent fuel reprocessing in Japan

- The Atomic Energy Act
  Article 104-7: Monitoring of National Environmental Radioactivity
  Article 104-6: Preservation of Environment

I. Introduction

In Korea, investigations regarding imported food following the Fukushima accident are mainly conducted. Because there is little effect on food produced domestically after the Fukushima accident. However, the imported food is different from domestic food. So the investigation on imported food products is strictly carried out.

Upon initial accident, the analysis of all imported foods was performed by KINS alone. However, the role of each agency was reorganized.

Now imported food products are analyzed at the Ministry of Food and Drug Safety and the analysis results are reported by them.

I. Introduction

In the past (1997~2010), KINS conducted radioactivity survey of food products over 10 years in normal situation to get the base-line data.

Korea has developed a long-term survey program to investigate radioactive content in living environment samples including food products. We are using this data to assess the internal radiation exposure effects by ingesting food.

II. Environment and Food Monitoring in Korea (Normal situation)

II. Environment and Food Monitoring in Korea

Nationwide Territory Monitoring

Objective of Nationwide Monitoring

- To early detect radioactive contamination all across Korea resulting from atmospheric weapon testing and nuclear or radiological accidents in Korea and neighboring countries
- To ensure base-line data for evaluation of environmental impact due to radioactive materials when nuclear accident occur

II. Environment and Food Monitoring in Korea

Nationwide Territory Monitoring

- **Samples**
  - Ambient dose
  - Atmospheric samples (airborne dust, dry and wet deposition)
  - Milk, soil, surface water, drinking water, indicate plant, food stuff
- **Monitoring Targets**
  - Dose-rate & Accumulated dose
  - Gamma radionuclides (natural & artificial)
  - ^{3}H, ^{90}Sr, gross Beta
- **Analysis Period**
  - Continuous, Daily, Weakly, Monthly, Quarterly, Biannually

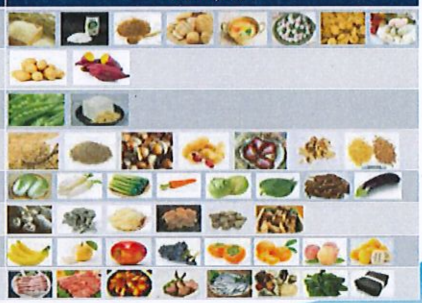
II. Environment and Food Monitoring in Korea

Statistics on food intake

*KHIDI: Korea Health Industry Development Institute

II. Environment and Food Monitoring in Korea

Food Group	Food Species
Grain /Processed Food	
Potato /Starch Products	
Pulse Crops /Processed Food	
Seeds and nuts /nut products	
Vegetables	
mushroom	
Fruits	
Meats/Fish	



II. Environment and Food Monitoring in Korea

Nationwide Territory Monitoring

Year	Food Species	Isotope
1997	Rice, Chinese cabbage, stock farm milk, fish	^{137}Cs
1998-1999	Grain, pulse crops, vegetables, meats, eggs, milk, fish and shellfish, seaweeds, stock farm milk	
2000-2001	potato and starch, vegetables, fruits, fish and shellfish, stock farm milk	
2002-2003	Nut products and nut seeds(acorn, chestnut, pine nut), mushroom, tea, rice, cabbage, stock farm milk	
2004-2005	Vegetables, fruits, fish and meat processed food, rice, cabbage, stock farm milk	
2006	Processed food(vegetables, pulse crops, grain, oil), condiment, rice, cabbage, stock farm milk, standard menu, local specialty	
2007	Processed food(vegetables, pulse crops, grain, oil), condiment, rice, cabbage, stock farm milk, local specialty	
2008	Imported food, rice, cabbage, stock farm milk	
2009-2010	Rice, cabbage, stock farm milk	

National Marine Monitoring

Year	Food Species	Isotope
2005-2010	Fish, shellfish, seaweeds	^{137}Cs, ^{90}Sr, $^{239+240}Pu$

II. Environment and Food Monitoring in Korea

	Food Species	Survey period	No. of samples	^{137}Cs(mBq/kg-fresh)		
				Min.	Max.	Ave.
1	rice	1997~1999,2002~2010	176	<0.91*	149	17.3
2	Kimchi	2006~2007	24	<22.1		
3	milk	1997~1999	20	11.7	44.6	24.6
4	beer	No survey				
5	soju	No survey				
6	green tea	2002~2003	22	68.3	372	194
7	pork	1998~1999	53	<10.3	1,380	90.8
8	apple	2000~2001,2006	22	<4.44		
9	beef (foot)	No survey				
10	pepper	2000~2001,2006~2007	22	<8.34		
11	onion	2000~2001	20	<5.57		
12	egg	1998~1999	40	<5.83	24.1	20.3
13	pear	2000~2001,2006~2007	23	<6.46		
14	mandarin	2000~2001	20	7.4	57.2	19.6
15	Been curd	2006~2007	24	<11.3		

* < : MDA, minimum detectable activity   출처: Report, 전국환경방사능조사보고서

II. Environment and Food Monitoring in Korea

	Food Species	Survey period	No. of samples	^{137}Cs(mBq/kg-fresh)		
				Min.	Max.	Ave.
16	potato	2000~2001,2007	22	<13.6	33.1	19.9
17	tomato	2007	2	<17.3		
18	watermelon	2006	1	<7.24		
19	beef	1998~2001	51	<10.6	606	75.8
20	grape	2000~2001,2006~2007	21	<4.38		
21	coke	No survey				
22	Bean sprouts	2000~2001	20	<6.54	63.6	29.2
23	cucumber	2004~2005	25	<5.77	9.67	10.4
24	laver	1998~1999,2005~2010	35	<15.6		
25	ramen	2006~2007	24	<15.2		
26	chicken	1998~1999	43	8.46	54.7	25.8
27	persimmon	2000~2001	20	<7.24	11.4	12.1
28	Rice cake	2006~2007	24	<7.38	40.9	18
29	Chinese cabbage	1997~1999,2002~2010	195	<5.67	1,210	31
30	bread	2006~2007	24	<10.8	25.7	18.3

II. Environment and Food Monitoring in Korea

Dose assessment of foods

- Radioactivity (Bq/kg)
  x dosage converting factor (Sv/Bq)
  x amount of intake (kg)
- Public dose limit per year: 1 mSv (ICRP)

※ dosage converting factor (Sv/Bq)
: IAEA Safety Series 115

^{137}Cs: 1.3×10^{-6}
^{90}Sr: 2.8×10^{-6}
$^{239+240}Pu$: 2.5×10^{-7}

II. Environment and Food Monitoring in Korea

	Food Species	Intake/year (kg)	Dose/year (mSv)
1	rice	66.87	1.50E-05
2	Kimchi	28.98	-
3	milk	26.75	8.56E-06
4	beer	16.46	NA
5	soju	14.13	NA
6	green tea	13.07	3.30E-05
7	pork	12.99	1.53E-05
8	apple	10.80	-
9	beef (foot)	10.33	NA
10	pepper	8.69	-
11	onion	8.54	-
12	egg	8.21	2.17E-06
13	pear	8.21	-
14	mandarin	7.92	2.02E-06
15	Been curd	7.92	-

	Food Species	Intake/year (kg)	Dose/year (mSv)
16	potato	7.52	1.95E-06
17	tomato	7.19	-
18	watermelon	7.04	-
19	beef	5.26	5.18E-06
20	grape	5.26	-
21	coke	5.11	NA
22	Bean sprouts	5.07	1.93E-06
23	cucumber	5.00	6.76E-07
24	laver	4.82	-
25	ramen	4.67	-
26	chicken	4.56	1.53E-06
27	persimmon	4.49	7.06E-07
28	Rice cake	4.49	1.05E-06
29	Chinese cabbage	4.12	1.66E-06
30	bread	3.91	9.29E-07

[D.J. Kim, 2017 Radiation Protection Workshop]

III. Environment and Food Monitoring in Korea (Fukushima accident)

III. Environment and Food Monitoring in Korea

FDNPP Accident (March 11, 2011)

- 2011-03-11,
  - 14:46, Earthquake & Tsunami
  - 15:37, loss of electricity, except DC on Unit 3.
- 2011-03-12
  - 02:45, strong likehood of reactor pressure vessel failure in Unit 1
  - 04:50, ambient doserate near main gate of FDNPS increased
  - 15:36, reactor building of unit 1 damaged by hydrogen explosion

III. Environment and Food Monitoring in Korea

FDNPP Accident (March 11, 2011)

- Release amount to the atmosphere

	UNSCEAR estimation (PBq)	Chernobyl (PBq)
I-131	100 - 500	1,800
Cs-137	6 – 20	85

- Korea activity
  - After the accident, the monitoring environmental radioactivity was immediately reinforced.
  - In Apr. 28, 2011, ^{131}I was detected in air samples.

Ref. : UNSCEAR 2013 Report, Levels and effects of radiation exposure due to the nuclear accident after the 2011 great east-Japan earthquake and tsunami

III. Environment and Food Monitoring in Korea

- **To assess radiological impact** in Korea following the FDNPP accident on March 11, 2011, **deposition amount of ^{134}Cs were estimated**, on the basis of rainfall amounts, areas, and environmental radiation monitoring results at the 12 regional monitoring stations (RMS).
  - **As a consequence of land deposition, ^{134}Cs and ^{137}Cs were detected in some fish samples**

※ The 12 regional monitoring station (green dot) were located in densely populated major city areas.

III. Environment and Food Monitoring in Korea

Estimation Method of deposition amount

- ^{134}Cs activity in rain water (Bq/L) sampled at the 12 regional monitoring stations (A_{Cs134})
- Amount of regional precipitation
- Areas of Administrative district

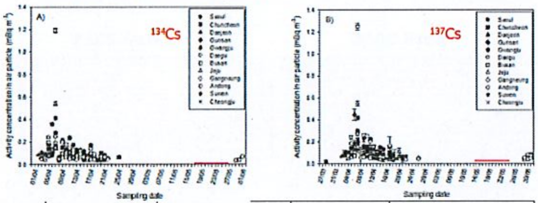
Combine

$$Wet\ depostionamount(Bq/m^2) = \frac{A_{Cs134}(Bq/L) \times precipitate(L)}{area(m^2)}$$

III. Environment and Food Monitoring in Korea

Monitoring results

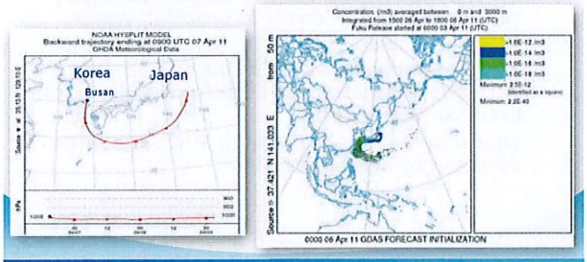
- Monitoring results in **air suspension** samples in 12 regional monitoring stations (RMS)



Radionuclides	Maximum activity (mBq/m³)	Station	Sampling date
^{134}Cs	1.19 ± 0.02	Busan	7th April,l 2011
^{137}Cs	1.25 ± 0.03	Busan	7th April, 2011

III. Environment and Food Monitoring in Korea

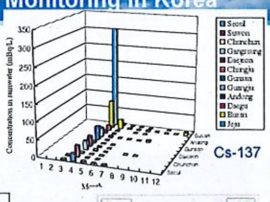
- **Plume route in 6th – 7th April, 2011**
  - NOAA HYSPLIT mode and GDAS meteorological data
  - The plume arrived at southern part of Korea from south.
  - ^{134}Cs and ^{137}Cs transferred to the southern part of Korea, Busan, and detected.

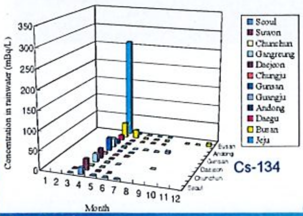


III. Environment and Food Monitoring in Korea

Monitoring results

- Monthly monitoring results in **rainwater** samples in 12 RMS

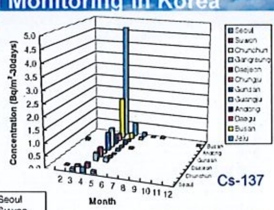


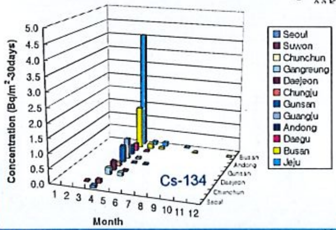


III. Environment and Food Monitoring in Korea

Monitoring results

- Monthly monitoring results in **dry deposition** samples in 12 RMS





III. Environment and Food Monitoring in Korea

Comparison with soil analysis

- ^{134}Cs analysis in soil samples

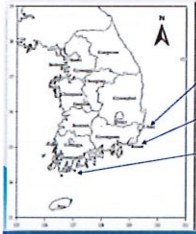
Sampling locations	Sampling date	^{134}Cs concentrations (Bq/kg-dry)	^{137}Cs concentrations (Bq/kg-dry)	^{134}Cs deposition (Bq/m²)
A	Jun. 22, 2012	0.47 ± 0.04	16.8 ± 0.3	2.4 ± 0.2
B	Jun. 28, 2012	0.75 ± 0.05	22.6 ± 0.4	2.0 ± 0.3
C	Jun. 22, 2012	0.48 ± 0.05	6.3 ± 0.1	4.4 ± 0.4
I	Jun. 28, 2012	0.75 ± 0.05	22.6 ± 0.4	2.9 ± 0.2
F	Jun. 22, 2012	0.66 ± 0.05	17.2 ± 0.3	2.7 ± 0.2
H	Jun. 28, 2012	0.84 ± 0.06	26.0 ± 0.3	2.7 ± 0.2
O	Jun. 28, 2012	0.57 ± 0.04	9.0 ± 0.1	2.2 ± 0.2
N	Jun. 28, 2012	0.47 ± 0.04	4.3 ± 0.1	4.7 ± 0.4
P	Jun. 28, 2012	1.14 ± 0.06	6.3 ± 0.1	10.1 ± 0.5
Jeju	Oct. 12, 2011	7.78 ± 0.14	81.5 ± 0.6	13.5 ± 0.2

* Cs-134 in other soil samples were not detected.

III. Environment and Food Monitoring in Korea

Impact on fish

- As a result of land deposition, ^{134}Cs and ^{137}Cs were detected much higher than normal level in only mullet samples taken in coastal sea of the southern part of Korea.
  - However, in other fish samples, ^{134}Cs was not detected.



Sampling date	^{134}Cs (Bq/kg-fresh)	^{137}Cs (Bq/kg-fresh)	Ratio ($^{134}Cs/^{137}Cs$)
5/24/2012	4.99 ± 0.05	7.08 ± 0.06	0.70
5/31/2013	1.38 ± 0.03	2.72 ± 0.05	0.51
4/13/2012	0.17 ± 0.01	0.27 ± 0.01	0.64
4/26/2013	3.56 ± 0.04	6.38 ± 0.06	0.52
4/26/2013	1.14 ± 0.02	2.16 ± 0.03	0.53
5/12/2012	0.20 ± 0.01	0.29 ± 0.01	0.67

- ^{137}Cs Range in fish before FDNPP accident : <0.015 ~ 0.184 Bq/kg-fresh
- ^{134}Cs Range in fish before FDNPP accident : N.D

Y.J.Kim, S.A.YIM et. Al., 2014, NRE9

III. Environment and Food Monitoring in Korea

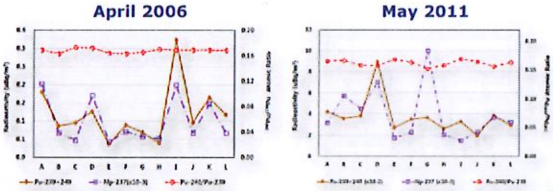
Impact on fish

- It was inferred that ^{134}Cs and ^{137}Cs deposited in land inflow into surface water system by run-off and settle down in brackish water zone.
- The Mullets have a feed habit on non-living particulate organic material from sediment in brackish water zone.
- That may be a cause of high ^{134}Cs and ^{137}Cs detected in mullet samples

III. Environment and Food Monitoring in Korea

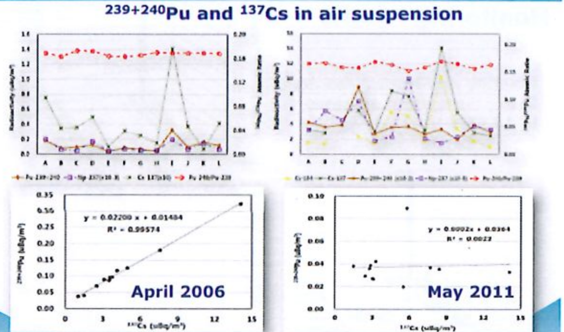
Regional distribution of $^{239+240}Pu$, $^{240}Pu/^{239}Pu$ atomic ratio, ^{237}Np in air suspension

April 2006 May 2011



III. Environment and Food Monitoring in Korea

$^{239+240}Pu$ and ^{137}Cs in air suspension



* $^{239+240}Pu/^{137}Cs$ activity ratio in surface soils (27): 0.013~0.032, AVE. 0.024±0.004 *(C.S.Kim et.al., J. Environ. Radioactivity, Vol. 40, No. 1, pp. 75 - 88, 1998)*

IV. Conclusion

IV. Conclusion

- Southern part of Korea was affected by FDNPP accident.
- Estimated deposition amount (max.) was several ten Bq/m^2.
- ^{134}Cs in some soil samples taken in southern part of Korea were detected with several Bq/kg with ^{137}Cs.
- As a result of radiocesium deposition in land environment, ^{134}Cs and ^{137}Cs were detected in some fish (mullet).
- The U.N. Commission on Radiological Science and Technology (UNSCEAR) collected and published radioactive concentration levels of enviroenmental materials from all countries around the world.

IV. Conclusion

- Korea has developed a long-term survey program to investigate radioactive content in living environment samples.
- We use this data to assess the internal radiation exposure effects by ingesting food.
- Foods produced domestically such as rice, cabbage, and milk were not affected by the accident.
- However, ^{134}Cs was found and ^{137}Cs increased in the index organisms (mugwort, pine neeedles) that directly affected from the soil.
- The environmental radioactivity monitoring including foods is being conducted regularly in Korea and the public interest is still high.

Food Safety Monitoring in Hong Kong After Japan Fukushima Nuclear Accident

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Background

On 11 March 2011, an earthquake registering 9.0 on the Richter scale struck off the northeast coast of Japan. The earthquake and subsequent tsunami have damaged the cooling system of the four reactors at the Fukushima Daiichi Nuclear Power Plant resulting in a release of radioactive substances into the atmosphere and surrounding environment. This article, summarizes responses in Hong Kong (related to food safety monitoring) to this particular nuclear incident.

Background

Earthquake at Japan on 11 March 2011
The earthquake triggered powerful tsunami
Fukushima Daiichi Nuclear Power Plant was damaged by the tsunami
Radioactive substances have been released in the environment
Certain foods in a number of prefectures
had been contaminated at levels hazardous to human health

Probable Routes of Exposure in Hong Kong

From the experience of the Chernobyl nuclear power plant accident in 1986, agricultural products, animals and water bodies were contaminated mainly by surface deposits of radionuclides, primarily radioidine, in the initial release of radioactive materials. After the early phase of direct deposit, the accumulation of relatively persistent radionuclides in food became increasingly important.

Probable Routes of Exposure in Hong Kong

Foods collected from the wild, such as mushrooms, berries and game meat continued to be a radiological problem and high levels of radioactivity have persisted for more than two decades. In the long term, Cs-137 in milk and meat and, to a lesser extent, in plant foods and crops remain the most important contributors to human internal dose.

Probable Routes of Exposure in Hong Kong

Hong Kong may be exposed to radioactive materials released from the damaged Japanese nuclear plant through the ingestion of contaminated foodstuffs. Due to the long distance from Japan (more than 3,000 km), the released radioactive substances in the plume will be much diluted when it reaches Hong Kong, produce grown locally is not likely to be significantly contaminated by deposits of the radioactive fallout.

Probable Routes of Exposure in Hong Kong

However, depending on the concentration of radioactive materials in the atmosphere and amount of deposition, minute amount of radioactive caesium and iodine might be found in produce grown in neighbouring areas of Japan. Moreover, the accumulation of some persistent radionuclides in food produced in areas near the affected nuclear plant is of concern.

Unsatisfactory samples

Iodine-131 level in 3 samples exceeding the Guideline Levels

- 1 White Radish 260 Bq/kg
- 1 Turnip 800 Bq/kg
- 1 Spinach 1,000 Bq/kg

Expert Involvement

On 6 April 2011, the Expert Committee on Food Safety held a special meeting to discuss food safety issues related to the nuclear incident in Japan.

The Expert Committee on Food Safety considered that the CFS's risk management approach and the prompt issuance of a prohibition order were appropriate and in line with the international consensus.

The CFS will continue to strengthen food surveillance at both import and retail levels for food imported from Japan and will closely monitor the situation.

Public Awareness

On 6 April 2011, the Expert Committee on Food Safety held a special meeting to discuss food safety issues related to the nuclear incident in Japan.

The Expert Committee on Food Safety considered that the CFS's risk management approach and the prompt issuance of a prohibition order were appropriate and in line with the international consensus.

The CFS will continue to strengthen food surveillance at both import and retail levels for food imported from Japan and will closely monitor the situation.

Advice to Public and Trade

- Possible residual surface radioactive contamination on food may be reduced by suitable food preparation, such as washing, brushing, scrubbing, or peeling.
- Concerned consumers may consult their suppliers if they have doubt about the origin of food imported from Japan.
- Traders may source ingredients from alternative sources outside the affected areas in Japan.

Stepped-up Surveillance

In view of the incident of radiation leak at the Fukushima nuclear plant, the Centre for Food Safety (CFS) has stepped up surveillance at import level on fresh produce imported from Japan such as vegetables, fruits, milk, meat, and aquatic products, for radiological testing since 12 March 2011.

Stepped-up Surveillance

Samples of Japanese food were also taken at retail level for testing of radiation level.

The CFS adopts the guideline levels, which are international standards, laid down by the Codex Alimentarius Commission's Guideline Levels for Radionuclides in Foods Contaminated following a Nuclear or Radiological Emergency in testing the radiation levels of food.

Stepped-up Surveillance

General Standard for Contaminants and Toxins in Food and Feed [CODEX STAN 193-1995, Amended 2010] (GSCTFF)", which are internationally accepted standards for protection of public health and facilitation of global trade, following a nuclear or radiological emergency. The Codex Guideline Levels for I-131 is 100 Bq/kg while that for Cs-134 and Cs-137 in food is 1000 Bq/kg.

Stepped-up Surveillance

Standard for Radiation Testing Level

CFS currently adopts the standards laid down by the Codex Alimentarius Commission in the Guidelines Levels for Radionuclides in Foods Contaminated following a Nuclear or Radiological Emergency (Guideline Levels)

Radionuclides Codex Guideline Level

- Iodine-131 100 Bq/kg
- Caesium-134 1,000 Bq/kg
- Caesium-137 1,000 Bq/kg

Stepped-up Surveillance

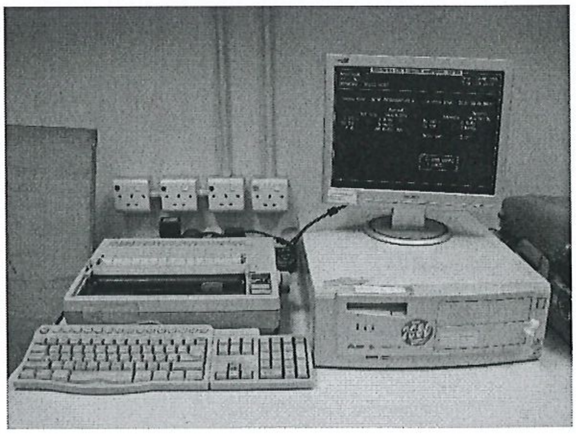
According to Codex, when radionuclide levels in food do not exceed the corresponding guideline levels, the food should be considered as safe for human consumption.

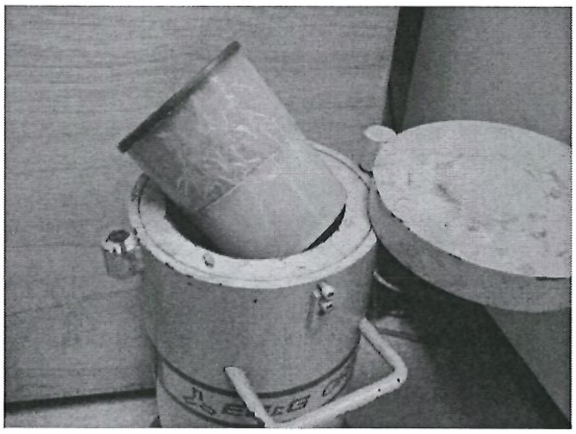
If a consignment of food is tested to have exceeded the guideline levels, the CFS will immediately mark and seal that consignment and arrange for disposal.

Food Surveillance
Import, Wholesale and Retail Level

Take food samples.

Use Contamination Monitoring System (CMS) for examination.



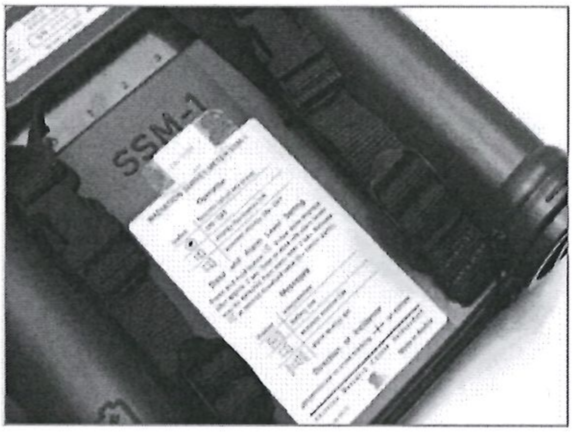


Food Surveillance at Import Level

Inspect imported food by hand-held survey meter for surface contamination

Food consignment failing hand-held survey meter or CMS screening will be held

Samples will be sent to Government Laboratory for further quantitative analysis



Stepped-up Surveillance

- As of 20 April 2011, a total of 2 666 samples have been tested. All have satisfactory results except the two consignments mentioned above. The surveillance results were uploaded onto the CFS website for public information.

Stepped-up Surveillance

Three food samples belonging to two consignments of food (including a spinach, a white radish and a turnip sample) imported from Chiba prefecture, Japan were found to have radioactivity exceeded the Codex guideline level on 23 March 2011.

Although consumption of the food will not impose immediate health risk, the CFS made the decision to safeguard public health and food safety through imposing restriction.

The consignments had been disposed of and did not enter the Hong Kong market.

Stepped-up Surveillance

- As of 20 April 2011, a total of 2 666 samples have been tested. All have satisfactory results except the two consignments mentioned above. The surveillance results were uploaded onto the CFS website for public information.

Stepped-up Surveillance

On 23 March 2011, three food samples belonging to two consignments of food (including a spinach, a white radish and a turnip sample) imported from Chiba prefecture, Japan were found to have radioactivity exceeded the Codex guideline level. Although consumption of the food will not impose immediate health risk, the CFS made the decision to safeguard public health and food safety through imposing restriction. The consignments had been disposed of and did not enter the Hong Kong market.

Case Study on Individual Food Items : Milk Powder

"Radiation Fears, Hong Kong Shoppers Stock up on Japanese Milk Powder" Mar 16, 2011

"No radiation in milk powder found"
Dec 7,2011

https://www.youtube.com/watch?v=FoZsC1DGnNk

https://www.youtube.com/watch?v=2d8f6JqMp_E

Prohibit Import and Supply of Food from Five Prefectures in Japan

From the beginning of the incident, the CFS has kept close communication with the food traders, Japan authorities and International Food Safety Authorities Network (INFOSAN) for the most updated information.

Subsequent to the detection of excessive radiation in two consignments of food mentioned earlier, the Director of Food and Environmental Hygiene issued an Order, with effect from noon on 24 March 2011, to prohibit import and supply of a variety of Japanese food, including all fruits and vegetables, milk, milk beverages and dried milk, harvested, manufactured, processed or packed on or after 11 March 2011 from five prefectures in Japan.

Section 78B Order

Director of Food and Environmental Hygiene make an order under Section 78B of Public Health and Municipal Services Ordinance, Cap 132

Prohibits import and supply of the following food harvested, manufactured, processed or packed on or after 11 March 2011 from the five affected prefectures in Japan, namely Fukushima, Ibaraki, Tochigi, Gunma and Chiba

All fruits, vegetables, milk milk beverage and dried milk

All chilled or frozen game, meat, poultry, poultry eggs, live, chilled or frozen aquatic products, unless accompanied by a certificate issued by the competent authority of Japan certifying the radiation levels do not exceed the standards laid down by the Guideline Level

Section 78B Order


香港特別行政區政府
憲報號外

The Government of the Hong Kong Special Administrative Region Gazette Extraordinary

Published by Authority

Section 78B Order

To prohibit the import of all fruits and vegetables, milk, milk beverages and dried milk from the five most affected prefectures of Japan, namely Fukushima, Ibaraki, Tochigi, Chiba and Gunma, with effect from 24 March 2011. Under the order, all chilled or frozen game, meat and poultry, poultry eggs and live, chilled or frozen aquatic products from these five prefectures may be imported into Hong Kong only if accompanied by a certificate issued by competent authority of Japan certifying that the radiation levels do not exceed the guideline levels laid down by the Codex Alimentarius Commission (Codex)

Prohibit Import and Supply of Food from Five Prefectures in Japan

The order also prohibits import and supply of chilled or frozen game, meat and poultry, poultry eggs, and live, chilled or frozen aquatic products, unless they are accompanied by a certificate issued by the competent authority of Japan stating that the radiation levels do not exceed the guideline levels laid down by Codex.

Prohibit Import and Supply of Food from Five Prefectures in Japan

The prefectures affected include the four prefectures (Fukushima, Ibaraki, Tochigi, Gunma) which Japan government has prohibited export of raw milk, spinach and kakina (a kind of Japanese vegetable), and the Chiba prefecture from which the three food samples were found by the CFS to have unsatisfactory radioactivity results.

Prohibit Import and Supply of Food from Five Prefectures in Japan

CFS agreed to accept certificate on radiation levels issued by the competent authority of Japan for importation of

- aquatic products with effect from 8 November 2011
- meat, poultry and poultry eggs with effect from 21 March 2012

Thereafter, importation of such food with valid certificate from the five affected prefectures is allowed.

Section 78B Order

The Order has taken effect on 24 March 2011 and is still in force. Contravene a term of the Order commits an offence and is liable on conviction to a fine of HK$100,000 and to imprisonment for 12 months

LATEST SITIATION

Number of samples tested for radiation levels for food imported from Japan

Accumulative no. of samples examined (from 12 March 2011 to 8 December 2017)

Vegetables 25,465 Fruits 30,007 Milk and milk beverage 2,908 Milk powder 1,131 Frozen confections 934

Aquatic products 71,174 Meat & products 12,439

Drinks 41,752 Others (eg. Cereal products, snacks) 270,317

RESULTS : (All satisfactory) 456,127 (3 unsatisfactory) (The 3 unsatisfactory samples were announced on 23 March 2011).

The Way Forward

- Taking into account the overall surveillance results, the latest expert opinions of IAEA and the established mechanism to monitor and assess import control measures imposed by other countries/places upon food products imported from Japan, CFS considers the existing control measures adequate for the protection of public health.

The Way Forward

CFS will remain vigilant and continue with its current risk-based strategy for surveillance of food products imported from Japan, and will also keep track of the situation of the Fukushima nuclear power plant in Japan and the development in related regions, as well as the latest measures taken by other countries/places against food products imported from Japan.

The Way Forward

In the meantime, CFS will keep in view the recommendations made by international agencies including WHO and IAEA on the issue. Based on such recommendations, CFS will develop strategies for testing relevant food products, make timely adjustment to the strategies accordingly in consultation with experts, and take necessary surveillance measures to ensure food safety and protect public health.

Conclusion

The risk of Fukushima nuclear plant event has not been cleared

Radioactive isotope Caesium-137 has a half-life of several decades

The order on prohibition of importation of food from the affected 5 prefectures in Japan is required to be maintained

To ensure the safety of imported food from Japan, CFS continues to monitor closely the situation in Japan and the radiation testing results of food samples in order to formulate surveillance programme according to risk assessment

Risk Assessment, Risk Management and Risk Communication of Imported Food from Japan after the Fukushima Nuclear Accident

Dr. Tsu-Mu Kao
Institute of Nuclear Energy Research (INER)

International Conference on Food Safety and Health Risk on Human Populations Post Nuclear Accident

Taipei, Taiwan
December 16, 2017

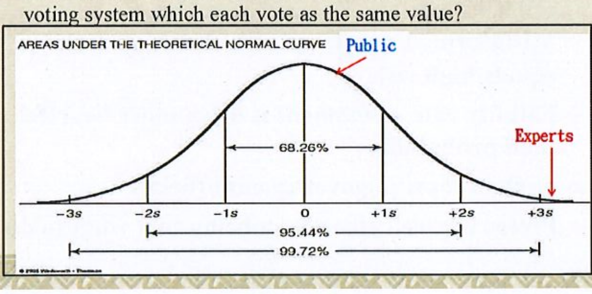
Outline

1. Introduction

- Globalization has resulted in the spread of infectious diseases, food safety and environmental issues, commodity hazmat and radiation proliferation and other public issues
- Risk Analysis, the fundamental methodology of food safety standards enables modern citizens to enjoy the benefits of technological developments while ensuring autonomy
  - **Risk Assessment: To find the sources of potential hazard, occurrence probability, and its consequence**
  - **Risk Management: The process of weighing policy alternatives according to the results of risk assessment**
  - **Risk Communication: An interactive process of exchange of information and opinion on risk among risk assessors, risk managers, and other stakeholders**
- Risk analysis uses strict scientific methods and procedures, excluding all other non-scientific factors (i.e., politics, ideology) to ensure the greatest credibility, presenting itself as the basis for decision-making in modern countries

1. Introduction (Cont.1)

- In US and Europe, professional questions are handled by experts, yet in Taiwan, everyone wants to participate
- Public opinion has roughly the same capacity as Normal Distribution, so naïve opinions take up the majority
- How can we change the basis of decision-making under the voting system which each vote as the same value?



1. Introduction (Cont.2)

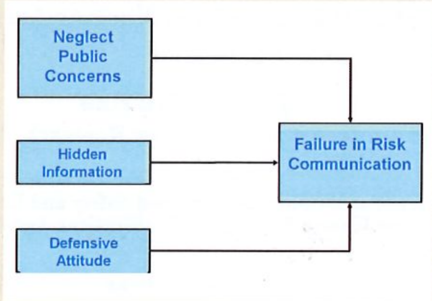
- Since lack of trust is a major issue in Taiwan, effective communication is essential. Especially, informal pre-policy public interaction is key
- How to enable the people with foresight and expert opinions to help the public make the right choices will be of great help to the quality of democratic decision-making

2. Risk Analysis

- **Objective expert assessment of the scientific risk**
  - Technical rational measurement
  - Based on statistical hard facts
  - Risk = probability x consequence
- **Subjective public perception towards risk**
  - Impact of risk on family and related communities
  - Is it a risk of voluntary choice?
  - The level of trust in government officials
  - Emotional reaction towards the decision making process

2. Risk Communication with the Public

2. Effective Risk Communication



2. Public Understanding of Risk

- **Risk is not only probability x consequence**
- **Inseparable from cultural and psychological aspects**
- **Misinformed public opinion that high-tech equals high risk**
- **Fatality rate assessment is often more heartfelt than probability**
- **Lack of trust in government officials**
- **Prefer advice rather than being told what to do**

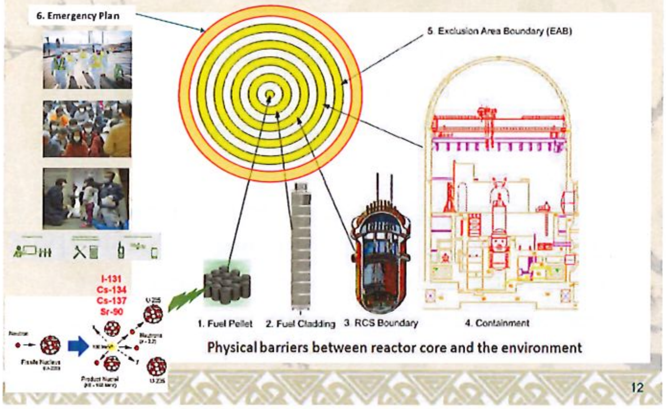
2. Relationship of Risk and Safety

- German Philosopher Ulrich Beck introduced the "Risk Society" doctrine in 1986, pointing out that despite increased human welfare due to globalization and capitalism, the corresponding risk has also heightened. That is, mankind has entered a new era that requires co-existence with risk and potential disasters
- Risk and safety appear to be polar opposites, yet they are in fact interconnected and dependent. In reality, there is nothing that guarantees 100% security, the best we do is reduce the risk
- "Security" indicates comprehensive and effective pre-risk management, and the use of resources according to the risk proportions to decrease risk

2. Relationship of Risk and Safety (Cont. 1)

- WHO indicates food safety is to prevent food from harming the health of consumers, including all chronic and acute hazards
- Consumers often demand "zero risk" for food safety. This is even more so due to improvement in food safety testing technology. As a result, more and more accurate testing equipment is constantly available, and laboratories can test relevant chemicals from food products. However, once consumers realize there is some amount of harm, regardless of the level, will feel uneasy
- The cost and practical feasibility of maintaining "zero risk" should be taken into account. How safe is safe enough?
- The myth of half-life and biological half-life (pharmacokinetic half-life) (Cesium 137 has a half-life in the environment of about 30 years, but in the human body it reduces radiation intensity as soon as 70 days)

3. Defense in Depth in Nuclear Power Plants Design



3. PRA: Probabilistic Risk Assessment

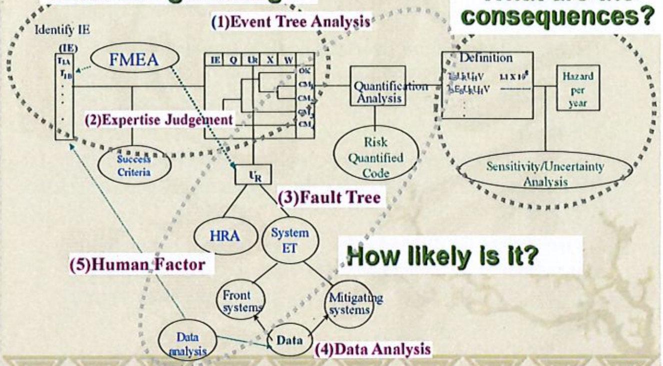
- PRA: Probabilistic Risk Assessment, Quantified Risk Assessment (QRA), Probabilistic Safety Assessment (PSA)
- PRA is a scientific methodology through inquiring, assessing and resolving 3 following issues：

(1)What can go wrong

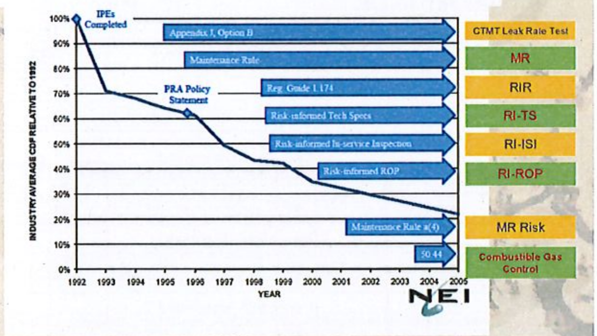
(2)How likely is it?

(3)What are the consequences?

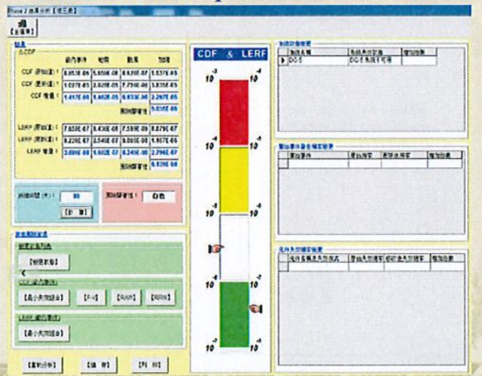
3. PRA Methodology



3. Reducing Nuclear Risk through Risk Management of Nuclear Regulation



3、Development of the Risk-Informed Regulatory Tools for Site Resident Inspectors of Taiwan's NPPs



3. Risk Perception

- **Risk Perception is not equal to Risk Assessment**
- **The general public vs experts have different perceptions towards risk**
  - **Subjective factors in assessing risk**
  - **"Voluntary risk" is more tolerable than " Non-Voluntary risk"**
  - **General public expect a zero-risk society**

3、Ordering of Perceived Risk

(Paul Slovic, "The Perception of Risk", *Science* 236: 280-285, 1988)

Activities	League of Women Voters	Colleague students	Expert
Nuclear Power	1	1	20
Motor Vehicles	2	5	1
Handguns	3	2	4
Smoking	4	3	2
Motorcycles	5	6	7
Alcoholic beverages	6	7	3
Private aviation	7	15	12
Police work	8	8	17
Pesticides	9	4	8
Surgery	10	11	5
Fire Fighting	11	10	18
Bicycles	16	24	14
Swimming	19	30	10
Skiing	21	26	30
Vaccinations	30	29	25

1. There are significant gaps between general versus expert opinions

2. It is important to present communicate this gap with the intent to help the general public realize the mismatch

3. Only through constant communication and public education can the gap be closed.

4. Risk Communication of Imported Food from Japan after the Fukushima Nuclear Accident

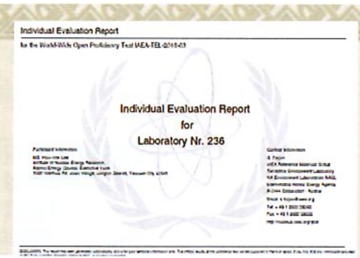
- The EU introduced the General Food Law Regulation No. 178/2002 in 2002 to established a set of risk analysis-centered food safety control mechanisms and scientifically based "risk assessment"
- The United States established a similar mechanism on January 4, 2011, President Obama signed off the Food Safety Modernization Act (FSMA)
- On December 10, 2014, Taiwan's Food Safety and Sanitation Management Law amendment "Food Safety Risk Management" Article 4 state that food safety management measures should be based on risk assessment

4. Radiation Detection Approach for Imported Food from Japan

- INER and RMC's radiation detection methods are all certified by the Taiwan Accreditation Foundation (TAF), which are the same as those used in EU and Japan
- Radionuclide species with half-life of more than 1 year (such as: cesium-134, cesium-137, strontium-90, ruthenium-106 and the like) has been revised into account. The Japanese limits is given for Cs including contribution of Sr-90, Ru-106, Pu (they contribution is only 12% of the sum of effective dose and the sum of effective dose does not exceed 1mSv/year) , so that only the detection of gamma (γ) nuclear species (such as cesium-134 and cesium-137) is necessary
- According to the EU Regulation, the amount released to the environment by strontium, sodium and potassium is very limited according to the accident status of the Japanese power plant, Therefore, it is not necessary to control or carry out special tests on Japanese food such as strontium and Pu , and only the detection of gamma (γ) nuclear species (such as cesium-134 and cesium-137)

4. TAF Certification of INER Lab.

4. IAEA Evaluation Results for INER Lab. in Year of 2016



Evaluation Tables for Labcode 236.

Evaluation Result Table for Sample 1

Sample Code	Analyte	Target Value	Target Unc.	MARB	Rep. Value	Rep. Unc.	Rel. Bias	Robust SD	Z-Score	U-Test	Accuracy	P	Precision	Final Score
1	Cs-134	19.9	0.6	15 %	21.6	1.9	8.54 %	1	1.70	0.85	A	1.30	A	A
1	Cs-137	39.5	1	15 %	41.8	3.8	5.56 %	1.5	1.47	0.56	A	1.44	A	A
1	Na-22	53.2	1.5	15 %	53.7	4.6	0.94 %	2.5	0.14	0.10	A	1.02	A	A
1	Sr-90	14.7	0.5	15 %	14.1	1.5	-4.08 %	1.6	-0.38	-0.83	A	1.61	A	A

Evaluation Result Table for Sample 2

Sample Code	Analyte	Target Value	Target Unc.	MARB	Rep. Value	Rep. Unc.	Rel. Bias	Robust SD	Z-Score	U-Test	Accuracy	P	Precision	Final Score
2	Am-241	26.7	0.7	15 %	27.8	2.7	4.12 %	1.9	0.58	0.39	A	3.08	A	A
2	Co-60	370	15	30 %	369	33.9	-0.17 %	72	-0.02	-0.03	A	3.50	A	A
2	Sr-90	20.5	0.5	20 %	20.2	1.8	-1.46 %	3.1	-0.10	-0.16	A	1.24	A	A

Evaluation Result Table for Sample 4

Sample Code	Analyte	Target Value	Target Unc.	MARB	Rep. Value	Rep. Unc.	Rel. Bias	Robust SD	Z-Score	U-Test	Accuracy	P	Precision	Final Score
4	Cs-137	209	11	20 %	208	20.4	-0.48 %	17	-0.06	-0.04	A	1.13	A	A
4	Sr-90	17	2	30 %	18.4	2.2	8.24 %	4.2	0.33	0.47	A	4.77	A	A

4. Food Inspection Equipment of EMRAL

Pure germanium gamma spectroscopy system—HPGe

Food Inspection

INER's EMRAL participated " Environmental samples irradiative nuclide analysis and their comparison" in 2015. EMRAL obtained the same measured data as those of JCAC and RMC.

EMRAL (Environmental Media Radioanalytical Lab., INER, Taiwan)
JCAC (Japan Chemical Analysis Center)
RMC (Radiation Monitoring Center, AEC, Taiwan)

4. Food Inspection Procedure of Gamma Radioactive Nuclide

Phase I Screening Procedure (10 Bq/kg)



1. Put sample in a bag → 2. Weighting it → 3. Put it into Detector for 1000sec counting

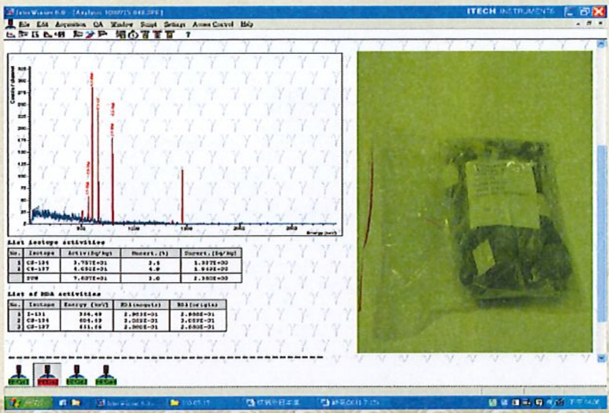
Once Finding I-131、Cs-134 and Cs-137 Radioactive Nuclide, Performing Phase II works

Phase II Quantification Analysis (10 Bq/kg)

4. Open the bag of Sample and Smash it, put it into Marin Cup and weighting it

5. Put it into Detector for 6000sec. counting

4. Sampling Results of Green Tea in July 2011



4、Case Study of Risk Communication

- (**The myth of Zero detection**) To control the risk of concerns should be reasonable to reduce detection value, but also take into account the practical aspects. For example, the instrument needs to measure the time is too long, it will affect the freshness of imported dairy products, seafood and other food. Required detection time of 100Bq/kg needs around 300sec, 10Bq/kg needs 1,000sec, and 1Bq/kg needs 6,000sec. Considering background radiation factors, the measurement uncertainties below 0.1Bq/kg will become larger and reliability of the measured data will be reduced
- Without overdemanding low detection value can relocate regulatory resources to inspect items and scopes of general food safety and to better ensure overall food safety
- If our country still has to adopt more stringent standards, we must put forward relevant scientific evidence for proof of necessity, otherwise exposes us to potential hidden dangers that countries under regulation may complain to the WTO at any time

4. Limitation Value of Radioactive Nuclei for different Countries

Nuclei	Food	Taiwan	CODEX	Canada	EU	USA	Singapore/ Hong Kong	Japan
I-131	Milk	55	–	100	500	–	–	–
	Infant Food	55	100	–	–	–	100	–
	Other Food	100	100	1000	2000	170	100	–
Cs-134 +Cs-137	Milk	50	–	300	370	–	–	50
	Infant Food	50	1000	–	–	–	1000	50
	Other Food	100	1000	1000	600	1200	1000	100

At present, only the detection of Cs-134, Cs-137 and I-131, and detection of Sr-90 are not allowed in food radiation tests. Cs limit set at 100 Bq / kg has taken into account the factors affecting human health, thus it does not need parallel analysis of other nuclear species

4. Case Study 2: In Sept. 2017, the United States controls only over 119 out of more than 7,000 items of Japanese food

4、Associated Website for Risk Communication

- 勿慌！林杰樑醫師告訴你：微量鈷60 銫137可排出
  https://www.youtube.com/watch?v=InWc7VKyDA8
- 全國唯一！輻射食品檢驗室探祕
  http://m.ftv.com.tw/newscontent.aspx?sno=2015401N06M1
- 2016.11.14 晚上8點【政經看民視】播出「日本輻射食品專題報導」(相關部份為正式播出總長度1.5小時的前20分鐘)
  https://www.youtube.com/watch?v=YQspORjEy4o
- 風險管理與黑天鵝效應《科學發展》月刊，2016年9月，525期，56～60頁
  https://scitechvista.nat.gov.tw/zh-tw/Articles/C/0/1/10/1/2572.htm

5. Conclusions

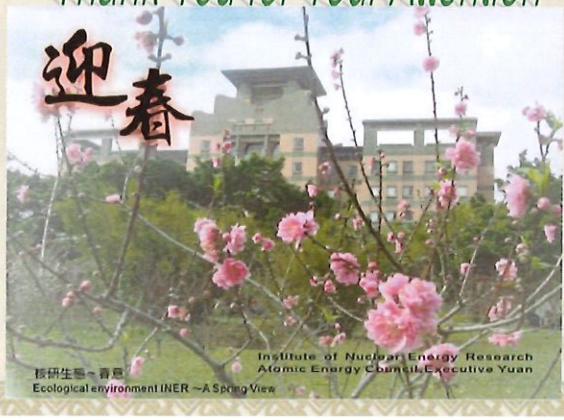
- Risk decision-making should not be passive, nor should it just be relief after the fact of a disaster. If we can analyze the possible causes and trajectory of risk, we can find ways to prevent them beforehand.
- In the long term, risk analysis can promote the overall public awareness towards risk
- Risk analysis can construct a mechanism which meets both scientific standards and communication of risk control

5. Conclusions (Cont.)

- The general public often has unnecessary fear towards unidentified affairs, yet scientific methods provides a means to deal with this problem. Risk Analysis is an important and accurate tool for the formation of public policies in modernized countries

- We strive for food safety policy to be in keeping with scientific methods while balancing the interests of all parties. However, the final choice is still in the hands of the people

Thank You for Your Attention



How Do Japanese NGOs Establish Radiation Monitoring Instruments?

Homemakers United Foundation
Research Fellow
Lin Hsiang Tang

Outline

- Why do we care about the Japanese NGOs radiation monitoring?
- Why do Japanese NGOs conduct radiation monitoring?
- How do Japanese NGOs conduct radiation monitoring?
- Conclusion

2

Why do we care about the Japanese NGOs radiation monitoring?

3

Food Safety

Anti-Nuclear

4

For Food Safety & Anti-Nuclear movement

- For 30 years, we have been participating in the anti-nuclear movement, and we are concerned about the effect of radiation on human health.
- Taiwan imports 250,000 metric tons of Japanese food each year, accounting for 5% of imported food in Taiwan.
- After the nuclear disaster, we are very worried about the radioactive contamination in imported food from Japan.

5

Protest against adjustment of the permissible levels of radioactivity in food (2012)

台灣食品輻射污染容許量管制標準

銫134、銫137	修改前	修改後
乳品	370	200
嬰兒食品	370	200
其他食品	370	600

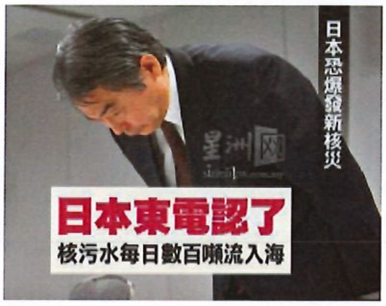
資料來源：原能會

Japan adjusted the standard from 500 Bq/kg to 100 Bq/kg in the same year.

6

Petition For no radioactive contamination food in 2012

TEPCO admitted that there are hundred tons of radioactive water leaked into sea everyday. (2013)



Press conference on radioactivity in seafood in 2013

2014 Taiwan-Japan Conference On Radiation Monitoring Instruments

Fake label incident led to the requirement of Certificate of Origin (2015)

DPP administration planned to adjust the criteria on imported Japanese food from "by prefecture" to "by item" (2016)

- Our demand:
  - Ban on food from Fukushima should remain unchanged. High-risked foods from other 4 prefectures (e.g. tea, infant food, drinking water, wild aquatic products) should be banned.
  - Permissible levels of radioactivity in food should remain N.D. (Non Detected) in practice.
  - Reveal and communicate with the public on risk assessments.

Our concern

- 6 years after the nuclear disaster, what is the risk of radioactivity in Japanese food? Does it get better? We do not have credible first-hand information and investigation.
- How do Japanese consumers deal with radioactivity in food?
- Do control measures in Taiwan effectively reduce the risk of radioactivity in Japanese food?

Research concept framework

Why do Japanese NGOs conduct radiation monitoring?

Why do Japanese NGOs conduct radiation monitoring?

- People do not trust the information from their government
- The government provided few reliefs or supports on radiation issues
- As time goes by, the government gradually put less efforts on the radioactivity in food.

How do Japanese NGOs conduct radiation monitoring?

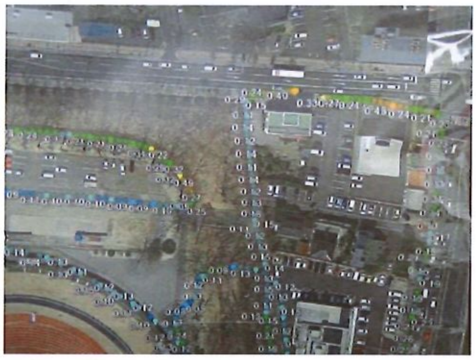
Radiation monitoring instruments from government and civil society

- There are many radiation tests conducted by radiation monitoring organizations, supermarkets and agricultural cooperatives. They have different kinds of acceptable levels of radioactivity in food.

Parents measured radiation at surrounding school or park

19

20



21

資料:「有機之里東和」創辦人菅野正壽

22

There are still high level of radiation in soil

23

24

Retail store with radiation measuring device

Retail store with radiation measuring device

The device which measures Strontium-90

Measuring radiation in soil of the farmland

Measuring radiation in soil of the farmland

Farmers do additional tests to gain confidence

Radiation-measuring devices in Consumers' co-operative

1号機：戸田DC　3号機：戸田DC
2号機：戸田DC　4号機：戸田DC　5号機：飯能DC　6号機：検査室

機器番号	機種概要	測定容器	標準測定時間	Cs合計検出下限
1号機 2号機	2inch NaIシンチレーション	1リットルマリネリ	4時間 12時間	約6 Bq/kg 約4 Bq/kg
3号機 4号機	3inch NaIシンチレーション	1リットル (V11) 3リットル マリネリ	4時間 10時間	約6 Bq/kg 約1.5 Bq/kg
5号機	1.5inch×4 CsIシンチレーション	100ml(U8)	2時間	約6 Bq/kg
6号機	3inch Ge半導体検出器	2リットルマリネリ 1リットル (V11)	1時間 1. 5時間	約1 Bq/kg 約2.5 Bq/kg

2011年3月～第0階段　放射能汚染食品測定室へ委託
- 每日3個樣本：鮮乳2個樣本、畜產品1個樣本
- 災前基準370貝克/公斤；9月將基準從370調成500。

2011年9月～第1階段　買了NaI檢測裝置2台做所有流通品項檢查
- 每週600樣本
- 1個樣本測5分鐘，檢出下限值100貝克

2011年11月～第2階段 調整檢出下限為50貝克、檢測時間延長，加買2台NaI檢測裝置
- 檢出下限目標調整為50貝克，一年約檢測17000件樣本。

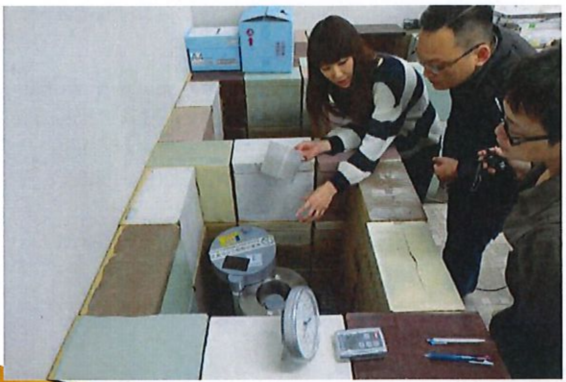
2012年4月～第3階段　調整自主基準從500貝克到100貝克
- 檢出下限目標調整為20貝克，一年約檢測23000件樣本。

2013年4月～第4階段 訂定新的自主基準
- 購買測加工食品的5號機，1天可以測40個樣本。
- 檢出下限目標調整為10貝克，一年約檢測20000件樣本。

2014年4月～第5階段
- 根據產地選出不用檢測以及需要加強檢測的品項。
- 自主基準的1/10以下為檢出下限，一年約檢測20000件樣本。

2015年4月～第6階段
- 預定購買純鍺偵檢器但延期，先委託外部檢測。
- 自主基準的1/10以下為檢出下限，一年約檢測12000件樣本。

2016年4月～第7階段
- 調整自主基準值，買進純鍺偵檢器
- 自主基準的1/10以下為檢出下限，一年約檢測9000件樣本。



The device which measures radioactivity in human body

There are many different acceptable levels of radioactivity in food

Type	Name	Acceptable levels of radioactivity
Radiation-monitoring organizations	磐城放射能市民檢測室 TARACHINE	Nearly 0Bq
Cooperative	日本消費者聯盟在福島的消費合作社會員	4Bq/kg
Retailer	「安全、安心的柏產柏消」圓桌會議	20Bq/kg

There are many different acceptable levels of radioactivity in food

Type	Name	Acceptable levels
Cooperative	生活俱樂部消費合作社	Infant food：N.D.(MDA below 1Bq) Drinking water、milk、rice：5Bq/kg Egg、Chicken、pork、beef、dairy：10Bq/kg Fruit、vegetable、Aquatic products、Processed food：25Bq/kg Mushroom：50Bq/kq
Retailer	通販生活	Drinking water、Tea：2Bq/kg Infant food：2Bq/kg Rice：10Bq/kg General food：20Bq/kg

Permissible levels of radioactivity doesn't mean safe or unsafe

- There is no "safe level" in radiation protection, but "acceptable level".
- National permissible levels of radioactivity can only guarantee the largest extent on human health.
- Private sector can adopt stricter level and monitoring instruments to gain more protection.

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Safety based on scientific evidence / safety based on subjective perception

- No interviewee agree with the "National permissible levels of radioactivity" most of them think it is unsafe.
- If people feel unsafe with the national permissible levels of radioactivity, does it make any difference?
- People adopt stricter levels and monitoring instruments to gain additional protection is the key factor of the subjective perception of safety.

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Conclusion

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Conclusion

- Risk is not black-or-white, it's a probability.
- The lesser risk we are willing to take, the more additional cost we have to pay.
- Additional cost could be paid by individual, or by collective. But collective actions cost more resource with little effect.
- With limited resources, government could only guarantee safety to some extend. Additional protections may depend on private sectors based on one's risk acceptance.

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主婦聯盟

Thank you for your listening

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