



United Nations Scientific Committee
on the Effects of Atomic Radiation

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The UNSCEAR 2013 Report

*Levels and effects of radiation exposure due to
the nuclear accident after the 2011 great east-Japan
earthquake and tsunami.*

***What it tells us about exposures to
people now and into the future***

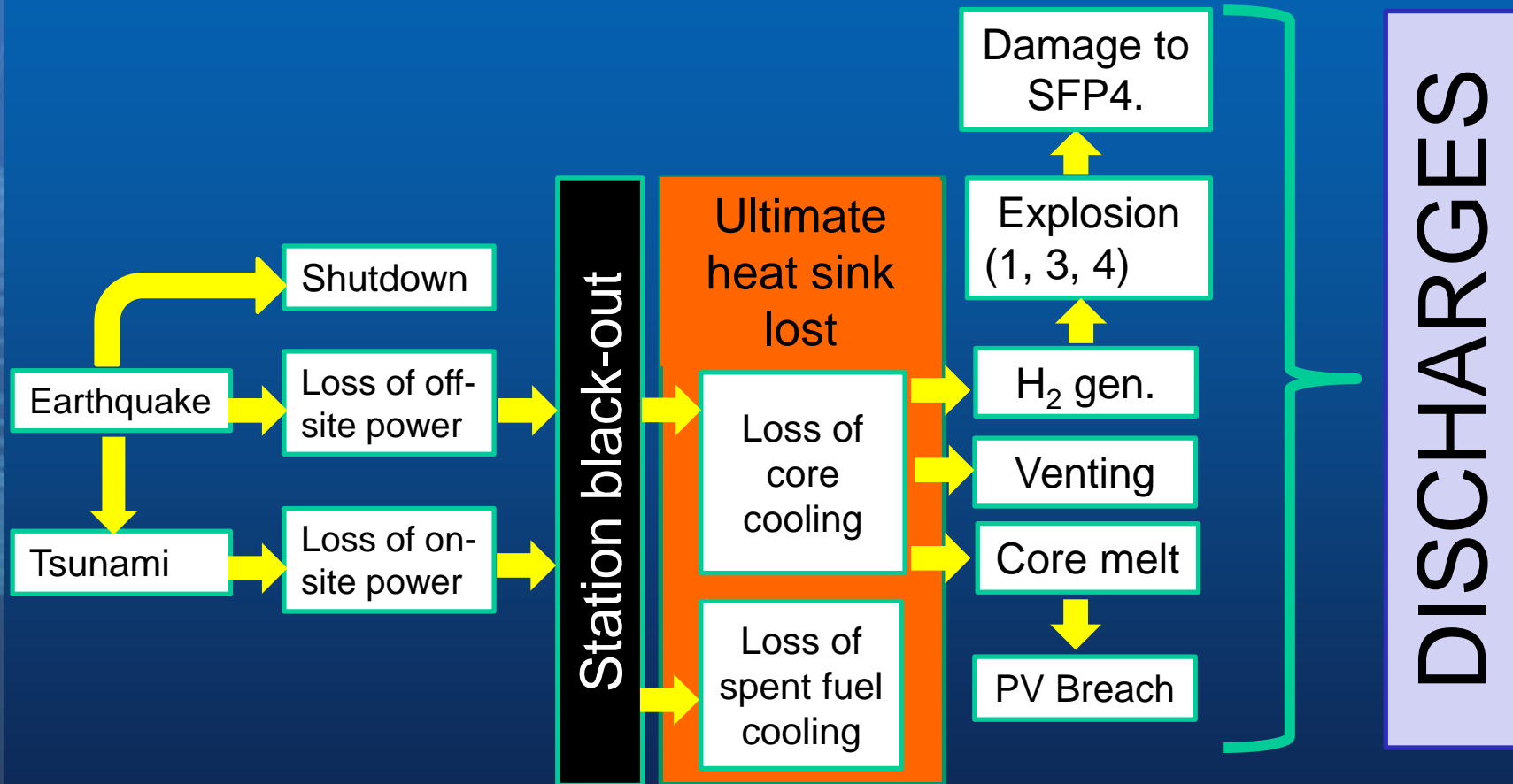
Dr Stephen Solomon (AUSTRALIA)

Leader of the public dose assessment for UNSCEAR



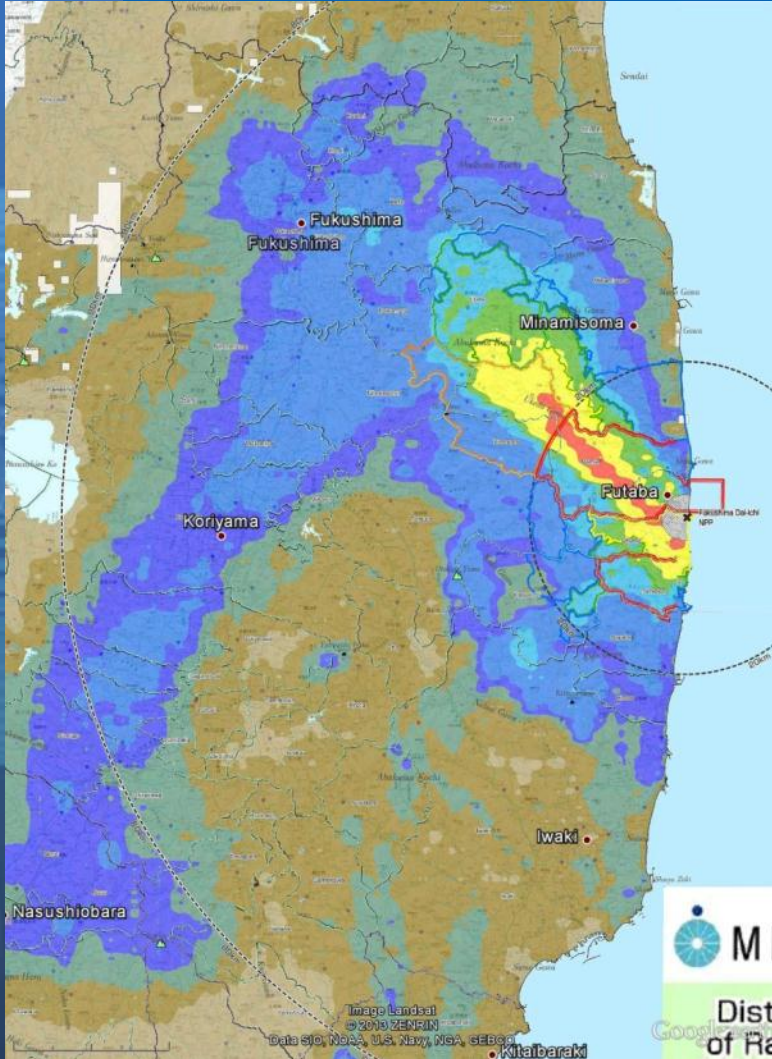
- The United Nation Scientific Committee on the Effects of Atomic radiation (UNSCEAR), at its 58th session in May 2011, initiated an assessment of the *Levels and effects of radiation exposure due to the nuclear accident after the 2011 great east-Japan earthquake and tsunami.*
- Aim was to evaluate information on levels of exposure due to the accident, and the associated risk to human health and effects on non-human biota
- More than 80 scientific experts from 18 countries
- Report to UN General Assembly comprises main text and 6 specialized appendices, with 28 electronic attachments
- Report published in English: 2 April 2014
- Advance copy of Japanese translation of main text made available: 27 May 2014





Accident progression, 11 March 2011 onwards

Estimates of release to environment of more significant radionuclides

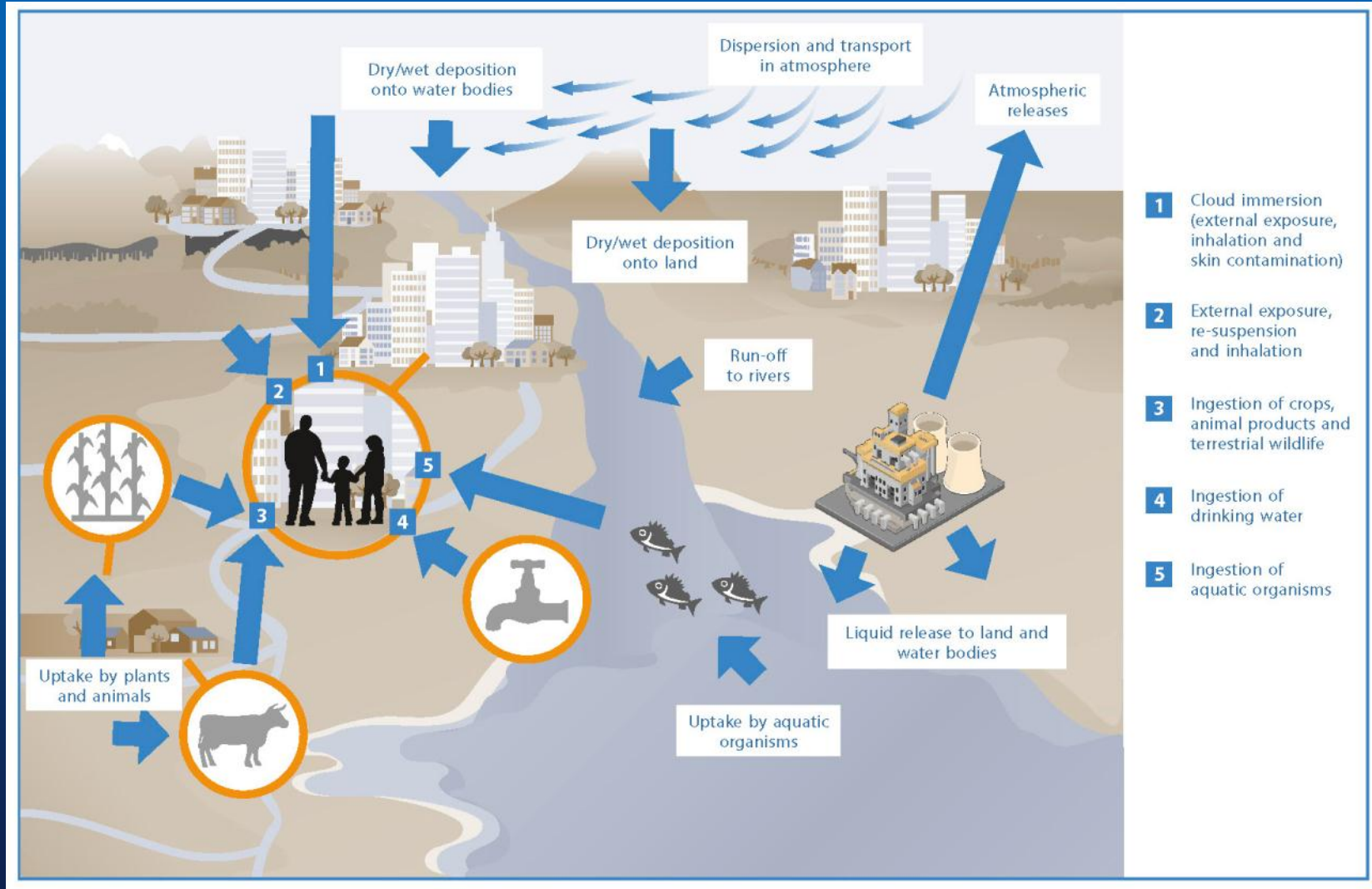


Radio nuclide	Inventory in Units 1 to 3 at reactor shutdown (PBq)	Release to the atmosphere (PBq)	Release to the ocean (PBq)	
			Direct	Indirect
^{131}I	6,000	100 to 500	10 to 20	60 to 100
^{137}Cs	700	6 to 20	3 to 6	5 to 8

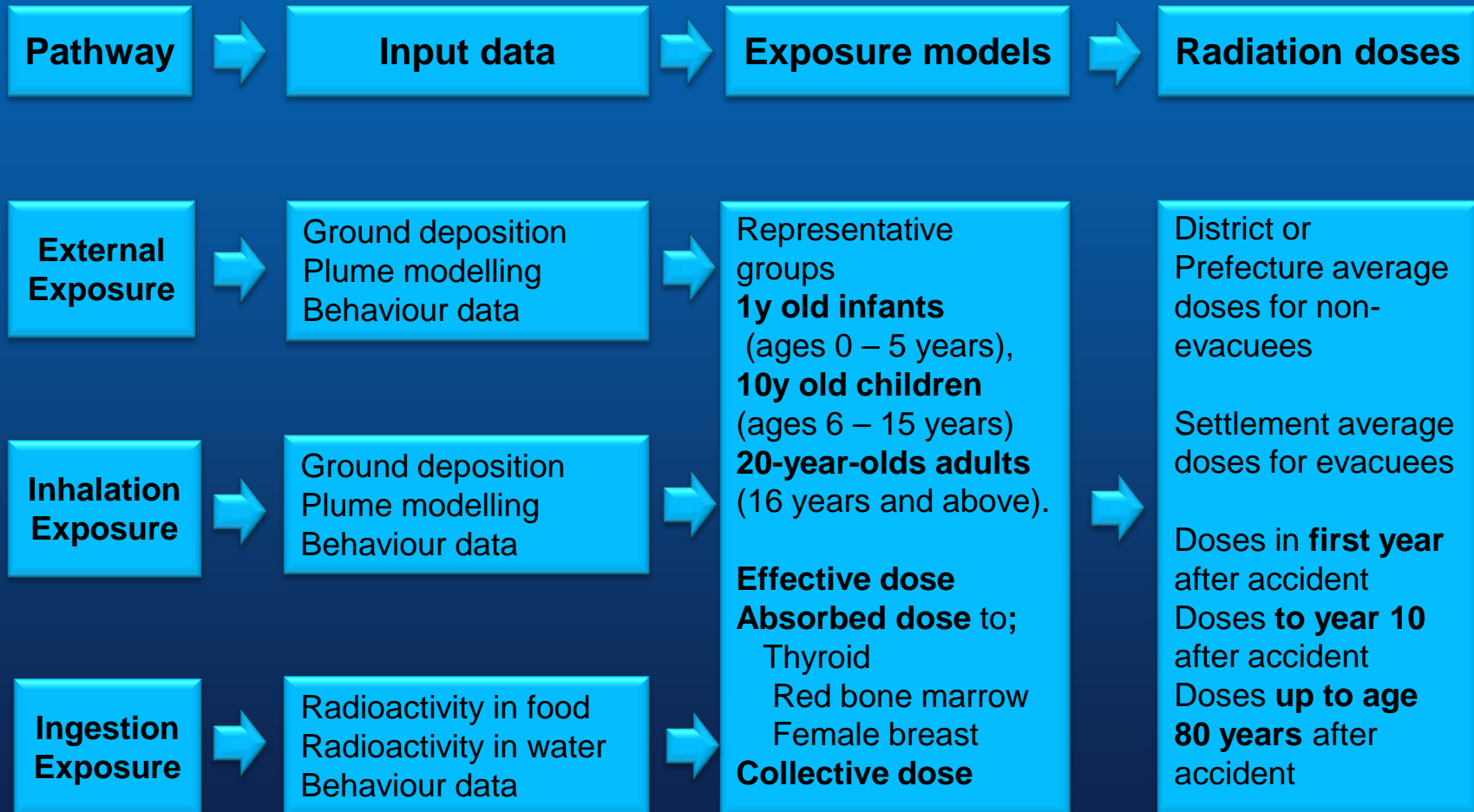
~ **2% to 10%** of ^{131}I inventory
 ~ **1% to 4%** of ^{137}Cs inventory

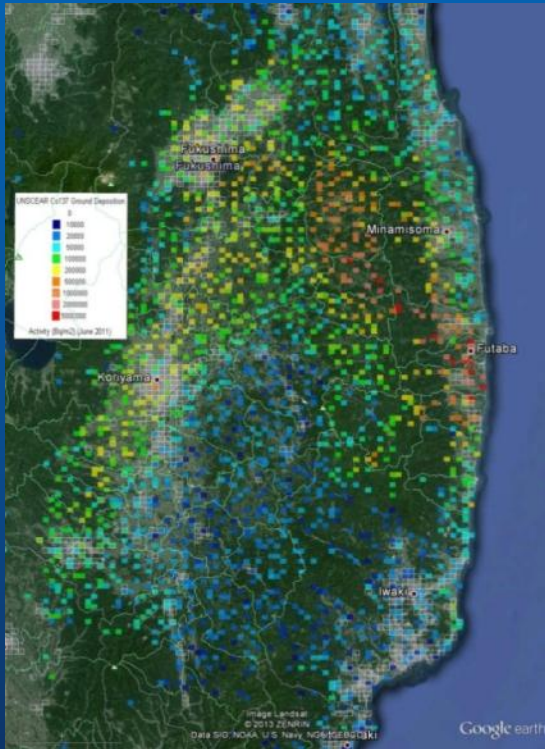
More than half of the release to atmospheric went towards sea

Exposure pathways from releases to the environment

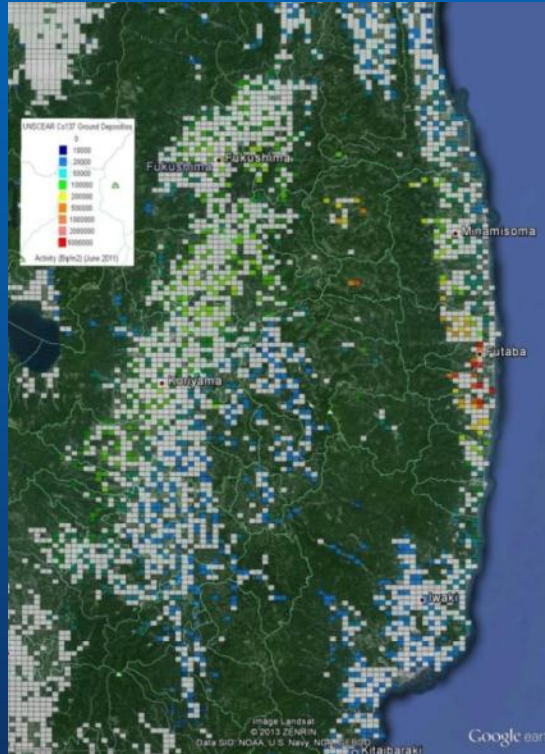


Assessment of doses to public

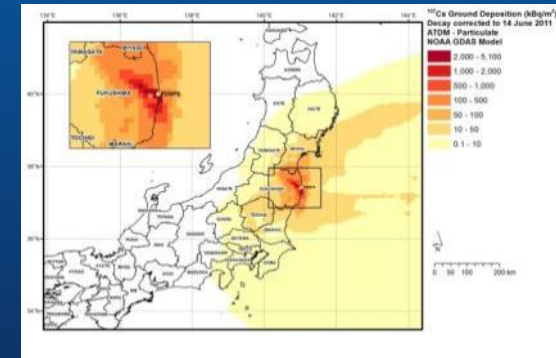
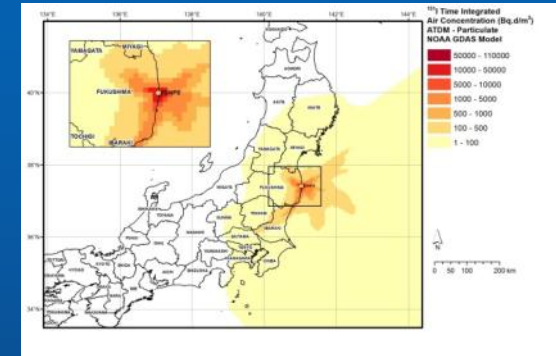




MEXT ^{137}Cs deposition survey
2km grid



MEXT ^{137}Cs on Japan census
1km grid
(Cells w/ pop. >100/km²)



Time-integrated

- ^{131}I in air
- ^{137}Cs deposition from WMO ATDM

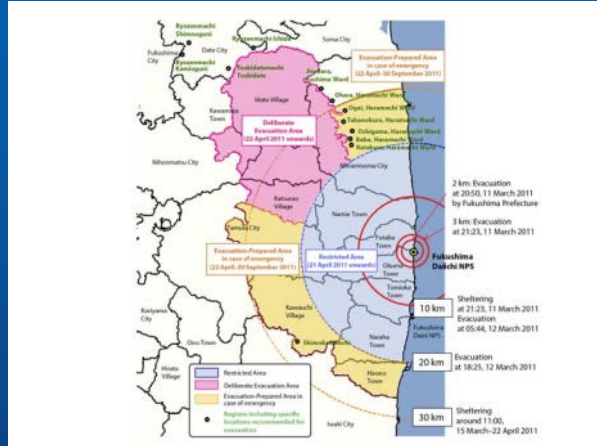
Effective dose by pathway

Residential area	Effective dose by pathway (mSv)					
	Adults			1-year old		
	External + Inhalation	Ingestion	Total	External + inhalation	Ingestion	Total
Fukushima Prefecture						
Settlements not evacuated	0.0 – 3.3	0.9	1.0 – 4.3	0.1 – 5.6	1.9	2.0 – 7.5
Near by prefectures						
Chiba Prefecture	0.1 – 0.8	0.2	0.3 – 1.1	0.1 – 1.1	0.5	0.6 – 1.7
Gunma Prefecture	0.1 – 0.6	0.2	0.3 – 0.8	0.1 – 0.9	0.5	0.6 – 1.5
Ibaraki Prefecture	0.1 – 0.6	0.2	0.3 – 0.8	0.1 – 1.0	0.5	0.6 – 1.5
Miyagi Prefecture	0.1 – 0.3	0.2	0.3 – 0.5	0.1 – 1.0	0.5	0.6 – 1.6
Tochigi Prefecture	0.1 – 1.2	0.2	0.3 – 1.4	0.2 – 2.0	0.5	0.7 – 2.5
Iwate Prefecture	0.1 – 0.3	0.1	0.2 – 0.5	0.1 – 0.6	0.2	0.3 – 0.8
Rest of Japan						
40 remaining prefectures	0.0 – 0.2	0.1	0.1 – 0.3	0.0 – 0.3	0.2	0.2 – 0.5

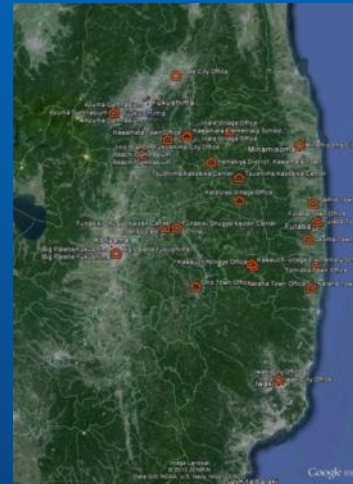
Absorbed dose to thyroid by pathway

Residential area	Absorbed dose to thyroid (mGy)					
	Adults			1-year old		
	External + inhalation	Ingestion	Total	External + inhalation	Ingestion	Total
Fukushima Prefecture						
Settlements not evacuated	0.1 – 9.6	7.8	7.8 – 17	0.2 – 19	33	33 – 52
Nearby prefectures						
Chiba Prefecture	0.2 – 2.1	2.1	2.3 – 4.2	0.3 – 4.0	9.4	9.7 – 13
Gunma Prefecture	0.2 – 1.4	2.1	2.3 – 3.5	0.3 – 2.6	9.4	9.7 – 12
Ibaraki Prefecture	0.2 – 1.5	2.1	2.3 – 3.6	0.3 – 2.9	9.4	9.7 – 12
Miyagi Prefecture	0.1 – 1.5	2.1	2.2 – 3.6	0.2 – 3.0	9.4	9.6 – 12
Tochigi Prefecture	0.2 – 3.0	2.1	2.3 – 5.1	0.4 – 5.8	9.4	9.7 – 15
Iwate Prefecture ^b	0.1 – 0.9	0.5	0.6 – 1.4	0.2 – 1.7	2.6	2.7 – 4.2
Rest of Japan						
40 remaining prefectures	0 – 0.4	0.5	0.5 – 0.9	0 – 0.8	2.6	2.6 – 3.3

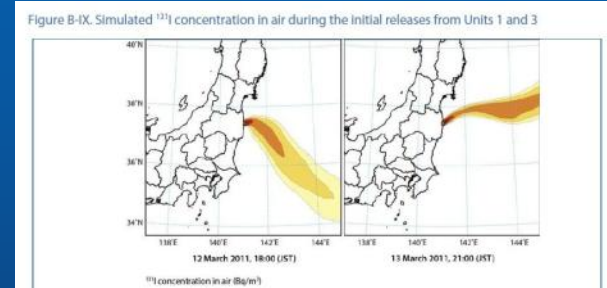
Evacuee dose assessment



Areas subject to measures to protect the public (3 Aug 2011)



NIRS 18 evacuation scenarios



WMO ATDM (NOAA-GDAS) 3h intervals for ¹³¹I and ¹³⁷Cs concentrations in air and deposition

Settlement-average effective doses and absorbed doses to the thyroid for evacuees for first year after accident

Age group	EFFECTIVE DOSE (mSv)					
	Precautionary evacuated settlements			Deliberately evacuated settlements		
	Before and during evacuation	At the evacuation destination	First year total	Before and during evacuation	At the evacuation destination	First year total
Adults	0 – 2.2	0.2 – 4.3	1.1 – 5.7	2.7 – 8.5	0.8 – 3.3	4.8 – 9.3
Infant, 1-year-old	0 – 3.3	0.3 – 7.5	1.6 – 9.3	4.2 – 12	1.1 – 5.6	7.1 – 13
Age group	ABSORBED DOSE TO THE THYROID (mGy)					
	Precautionary evacuated settlements ^a			Deliberately evacuated settlements		
	Before and during evacuation	At the evacuation destination	First year total	Before and during evacuation	At the evacuation destination	First year total
Adults	0 – 23	0.8 – 16	7.2 – 34	15 – 28	1 – 8	16 – 35
Infant, 1-year-old	0 – 46	3 – 49	15 – 82	45 – 63	2 – 27	47 – 83

Average effective doses for non-evacuated areas, in first year, to year 10 and to age 80y

Age group as of 2011	District- or prefecture-average effective dose (mSv)		
	Geographical area of Japan		
	Group 2 Fukushima Prefecture	Group 3 prefectures	Group 4 Rest of Japan
FIRST YEAR EXPOSURE			
Adult	1.0 – 4.3	0.1 – 1.4	0.1 – 0.3
Infant, 1-year-old	2.0 – 7.5	0.3 – 2.5	0.2 – 0.5
10 YEAR EXPOSURE			
Adult	1.1 – 8.3	0.2 – 2.8	0.1 – 0.5
Infant, 1-year-old	2.1 – 14	0.3 – 6.4	0.2 – 0.9
EXPOSURE UP TO AGE 80 YEARS			
Adult	1.1 – 11	0.2 – 4.0	0.1 – 0.6
Infant, 1-year-old	2.1 – 18	0.4 – 6.4	0.2 – 0.9

- Detailed information about remediation was not available to UNSCEAR and there is no allowance for these measures in assessment of doses
- For context, 80-year cumulative doses from background exposure to natural sources of radiation in Japan are on the average about 170 mSv.

External exposure from deposition

Effective dose External exposure First Year

- ~ 20% in first week
- ~ 30% in first month
- ~ 50% in first 4 months

Future years

- ~ 30% in first year
- ~ 50% in first 3 years
- ~ 70% in first 10 years

Figure C-VIII. Percentage contribution of different radionuclides to the dose rate in air at 1 m above the ground in the first months after the accident

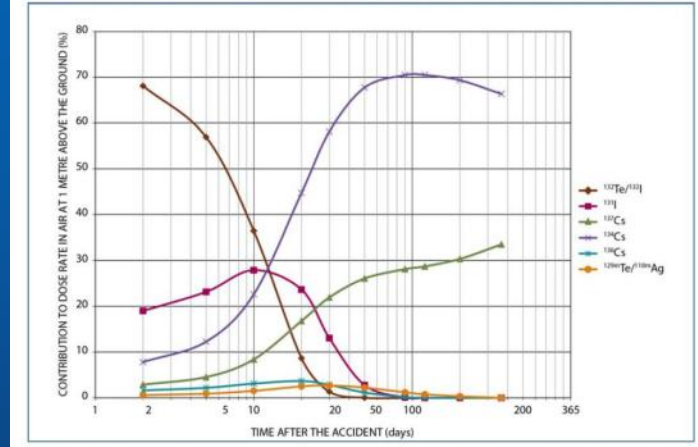
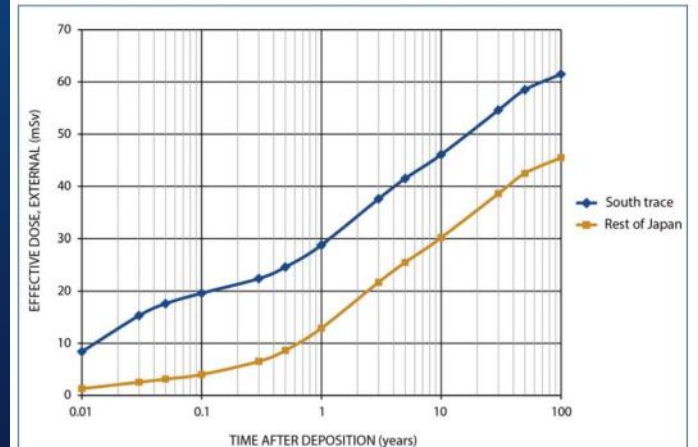
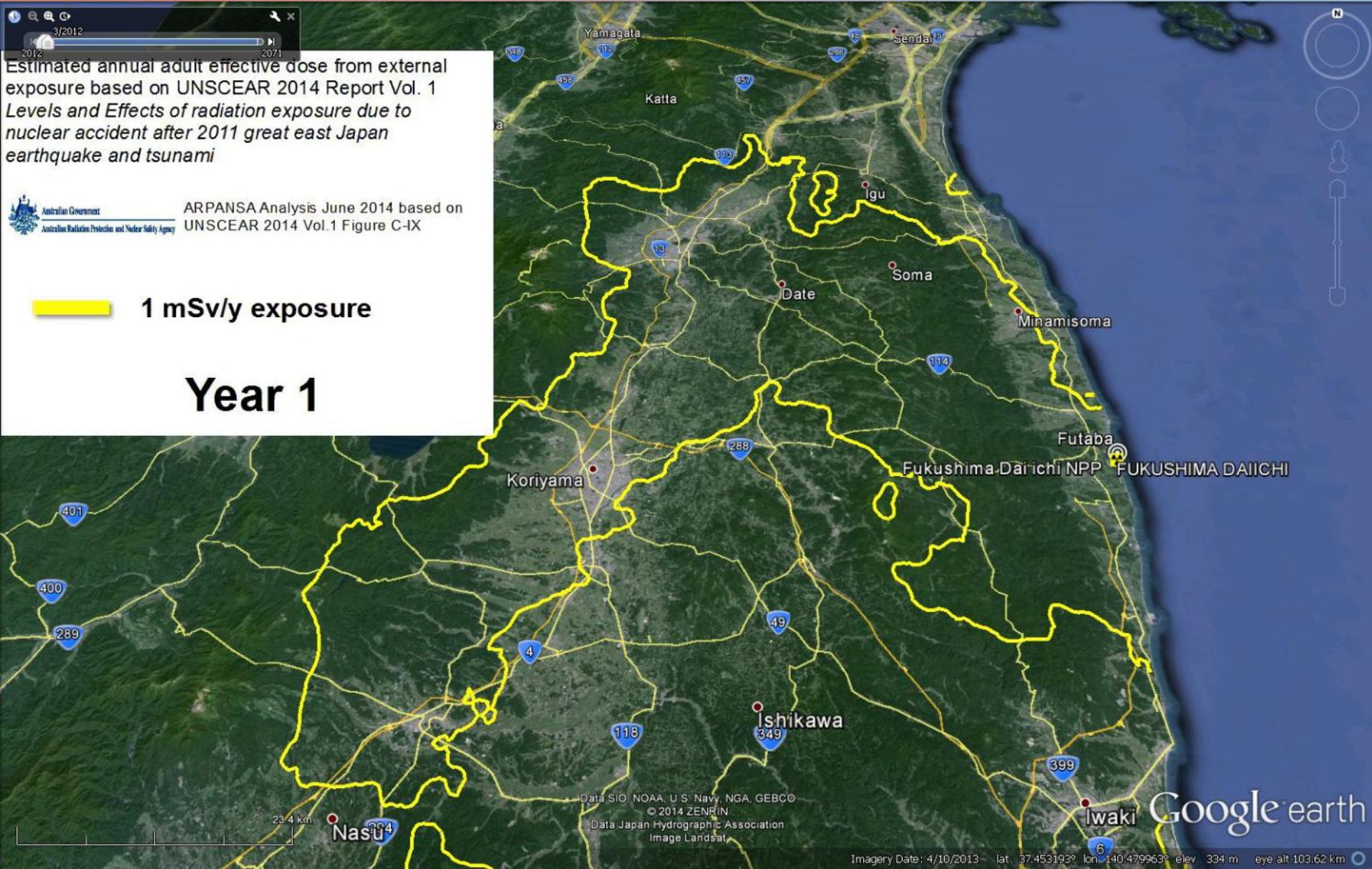


Figure C-IX. Accumulated effective doses per unit deposition density from external exposure of typical adults living on the south trace and in the rest of Japan. The doses are normalized to the deposition density on the ground of 1 MBq/m² of ¹³⁷Cs. A typical adult is defined as an adult living in a wooden house and working indoors in a concrete multi-storey building







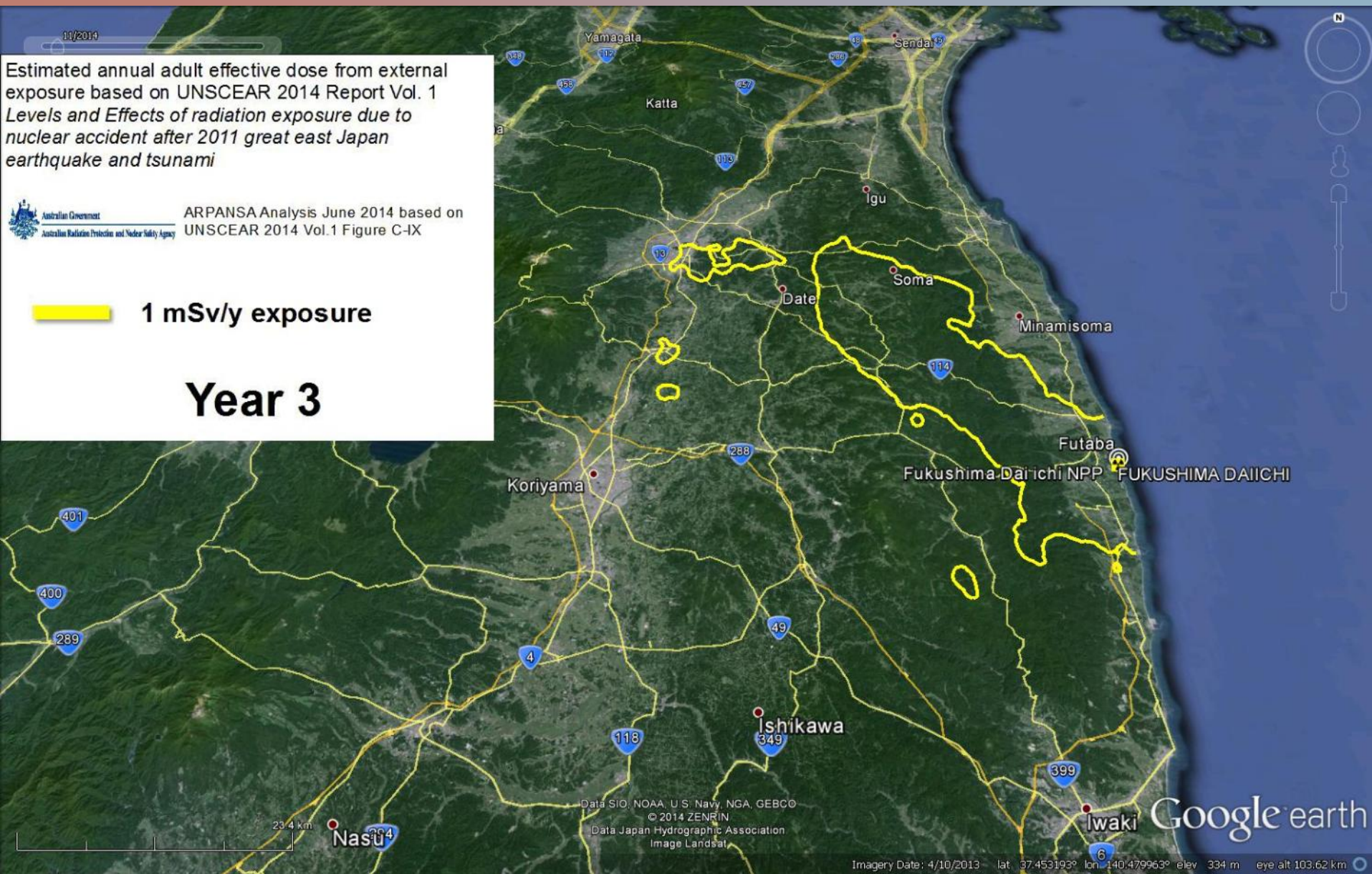
11/2014

Estimated annual adult effective dose from external exposure based on UNSCEAR 2014 Report Vol. 1 *Levels and Effects of radiation exposure due to nuclear accident after 2011 great east Japan earthquake and tsunami*

Australian Government
ARPANSA Analysis June 2014 based on
UNSCEAR 2014 Vol.1 Figure C-IX

 1 mSv/y exposure

Year 3



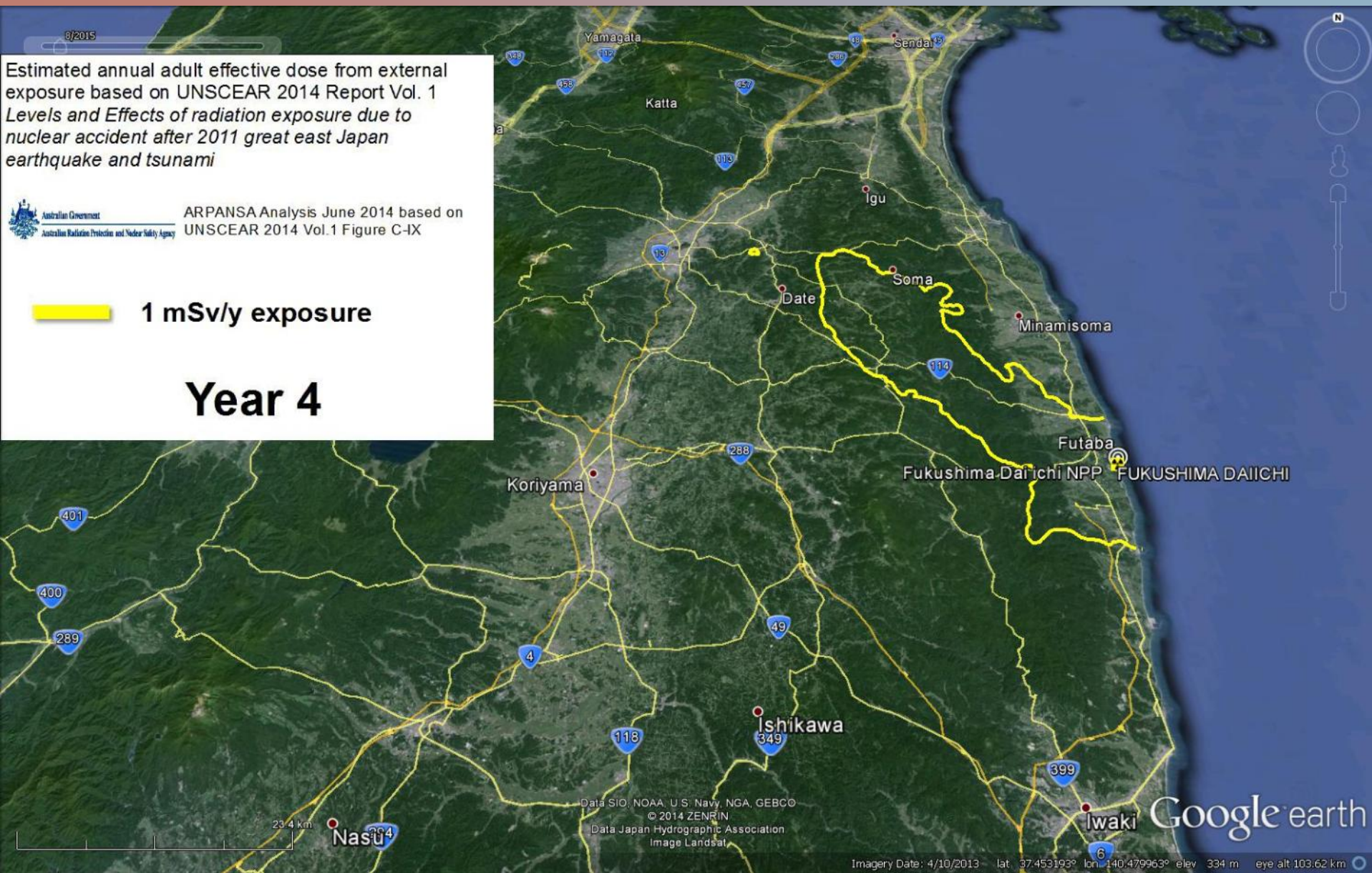
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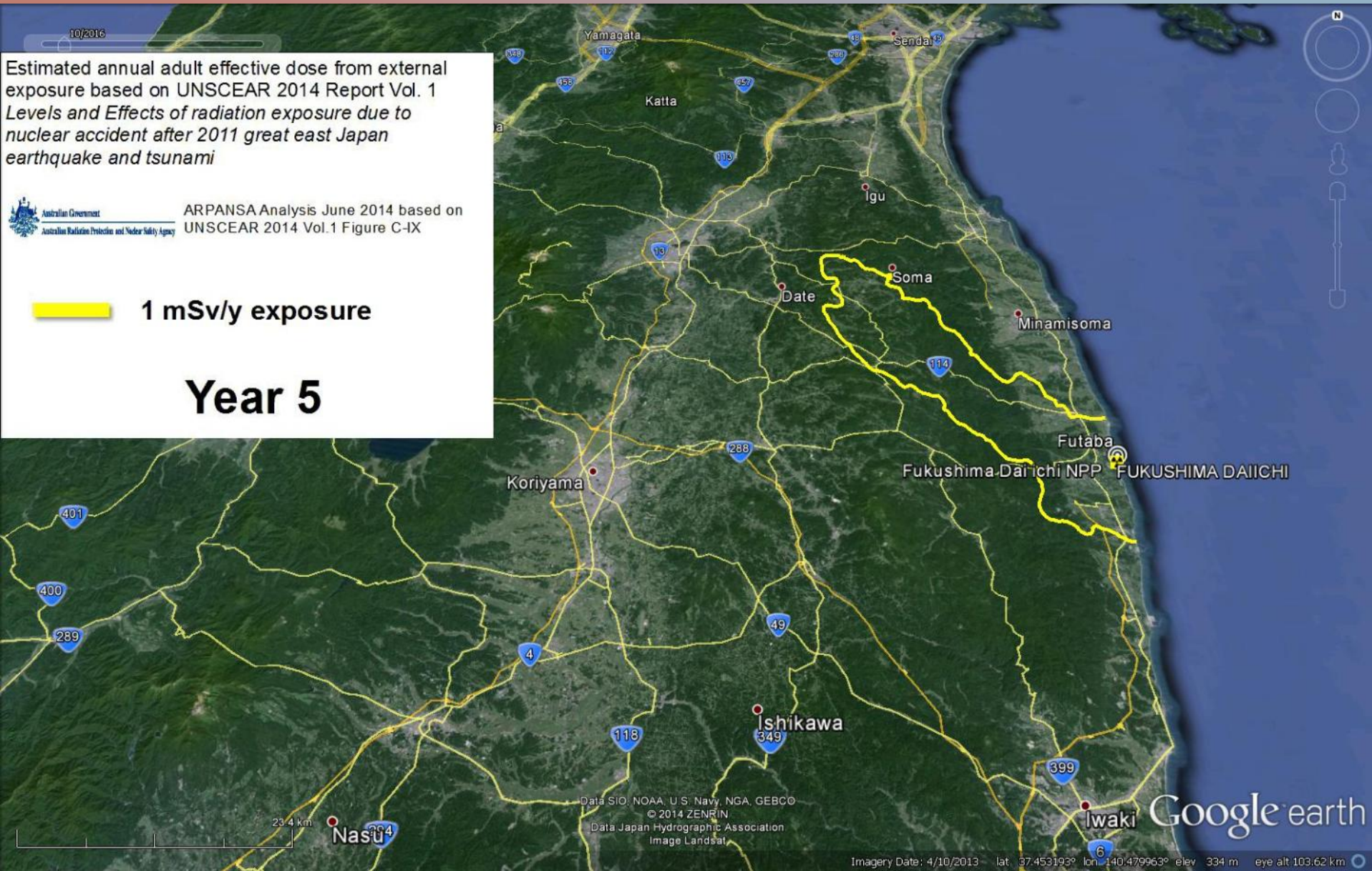
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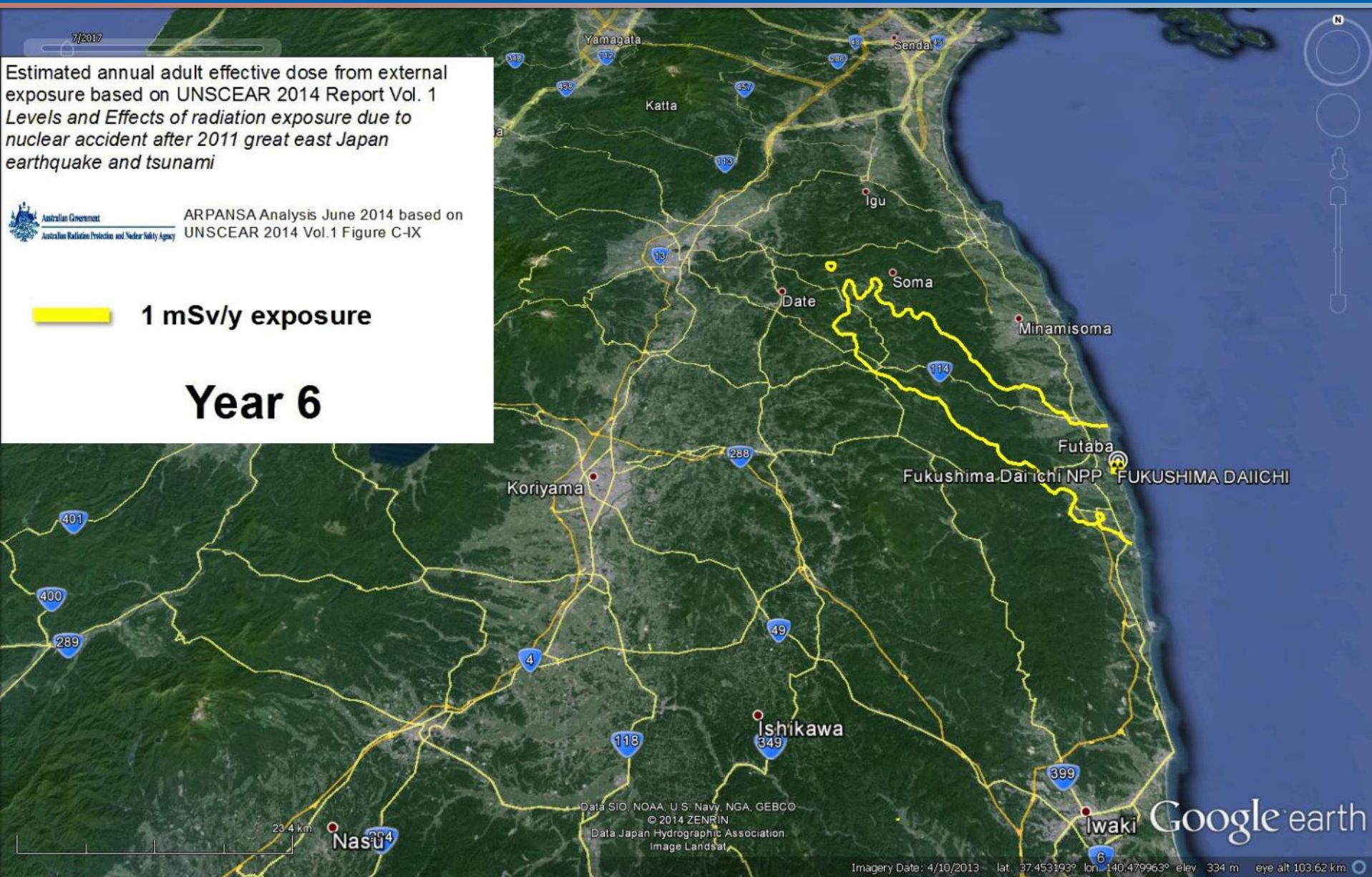
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 1 mSv/y exposure

Year 4







7/2017

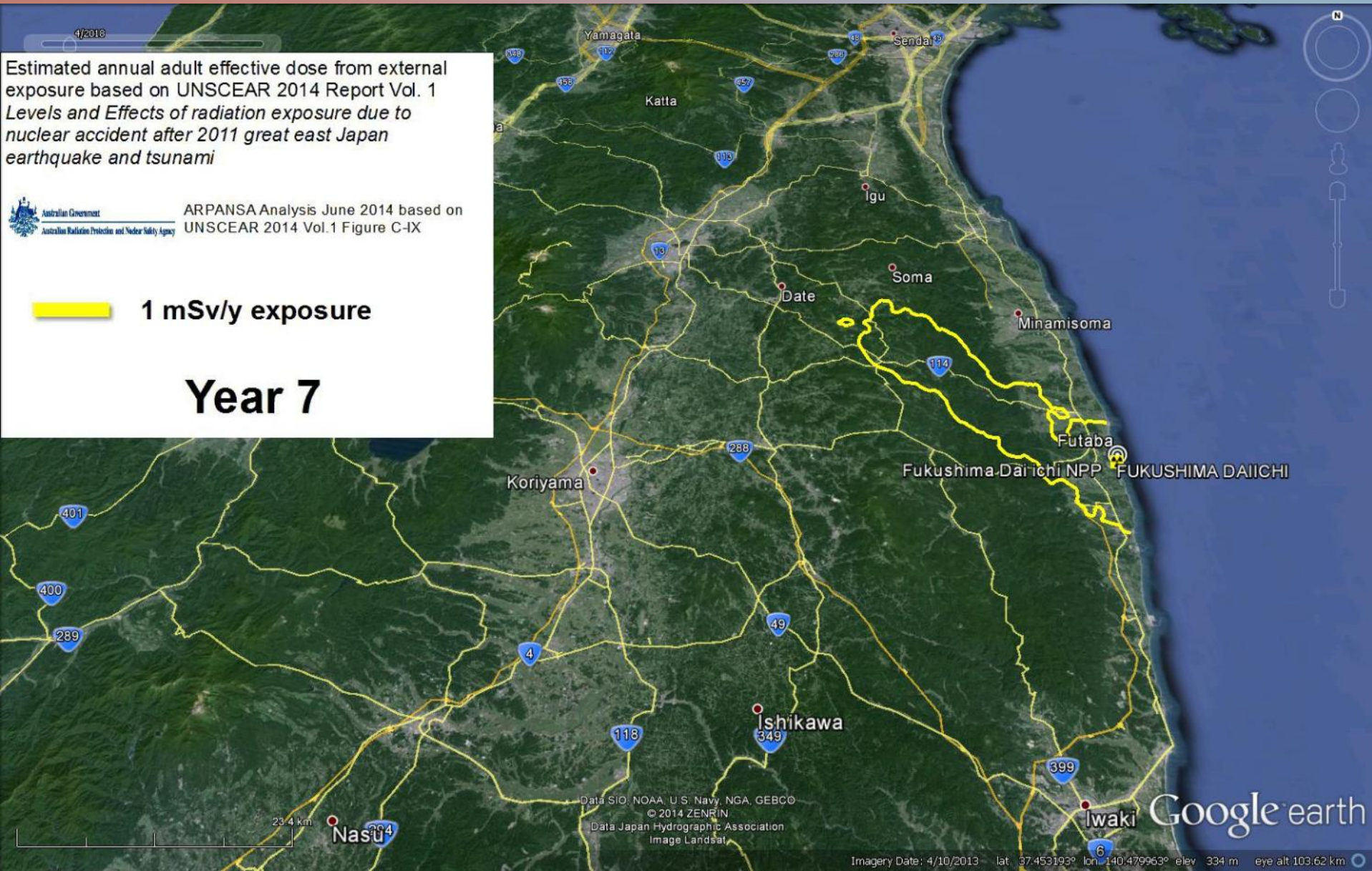
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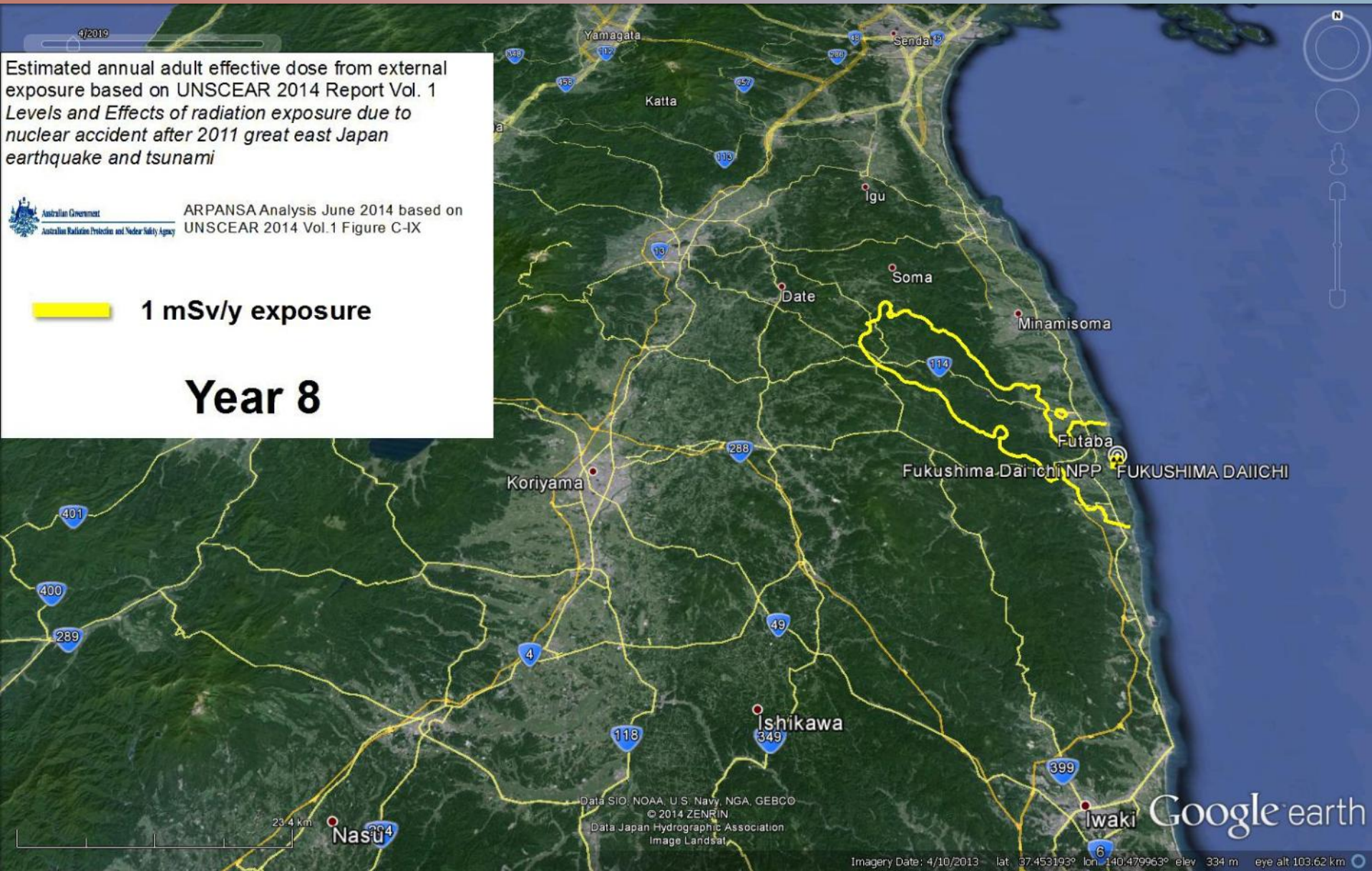
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Australian Radiation Protection and Nuclear Safety Agency

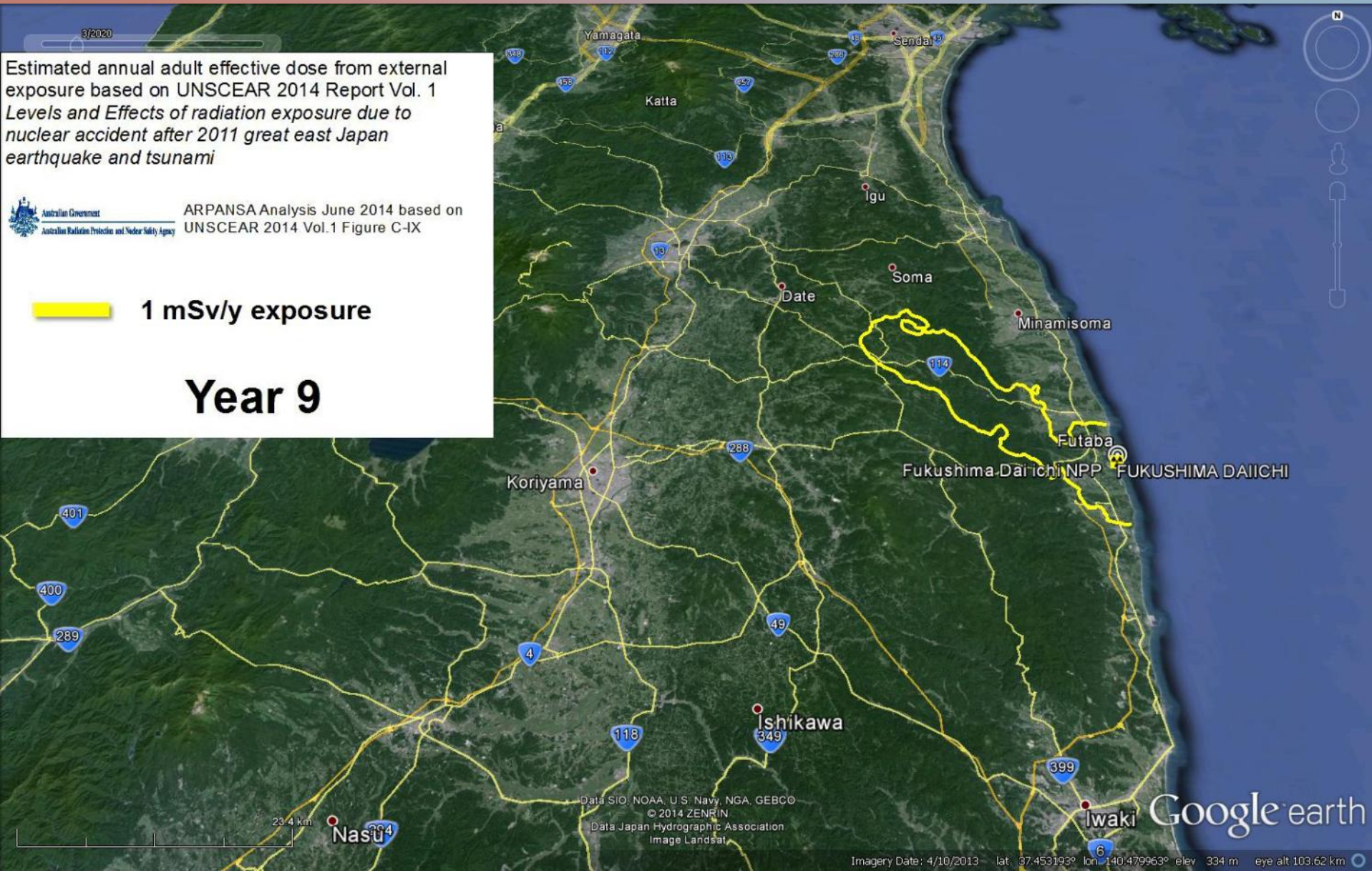
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1 mSv/y exposure

Year 6







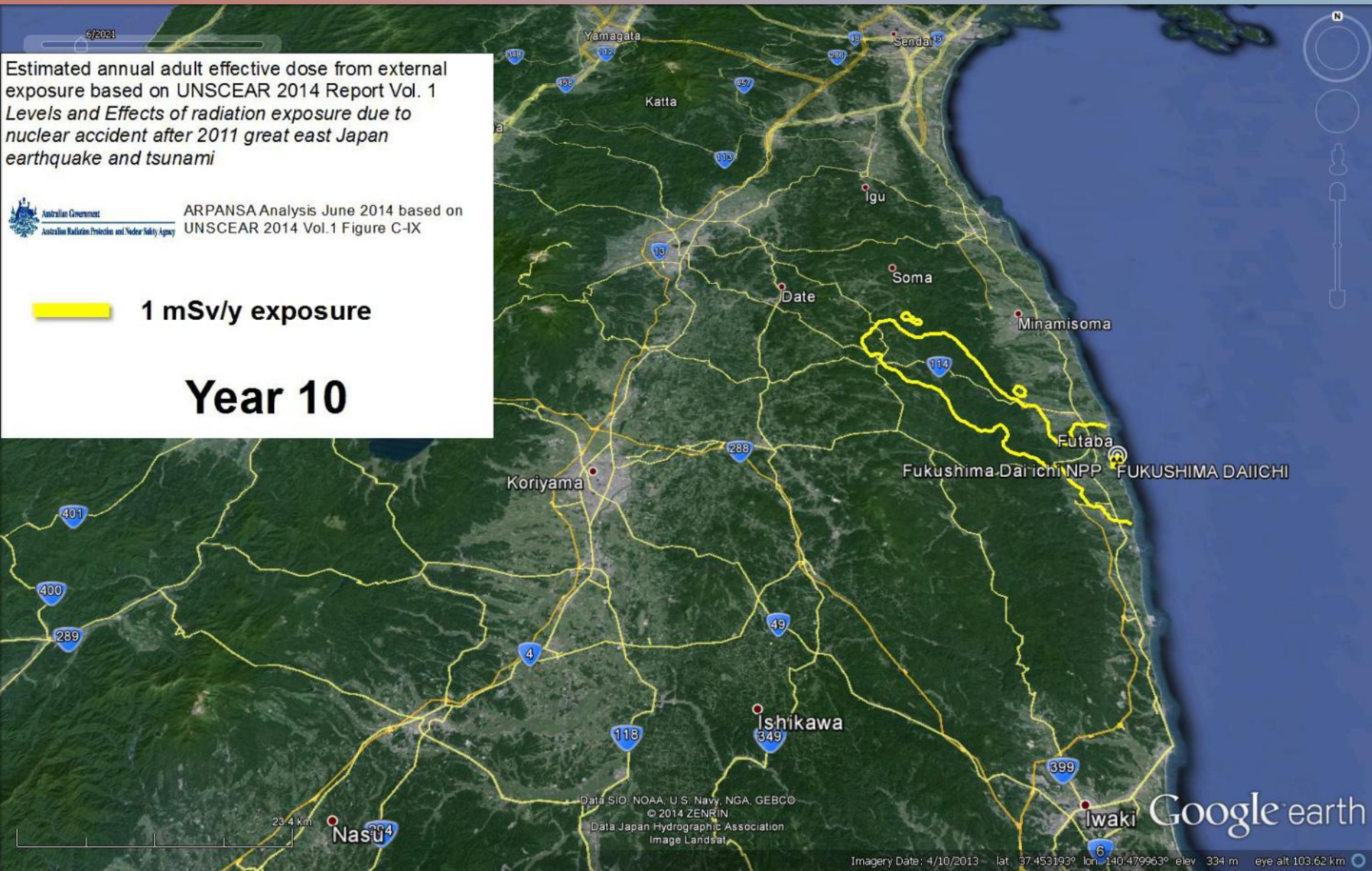
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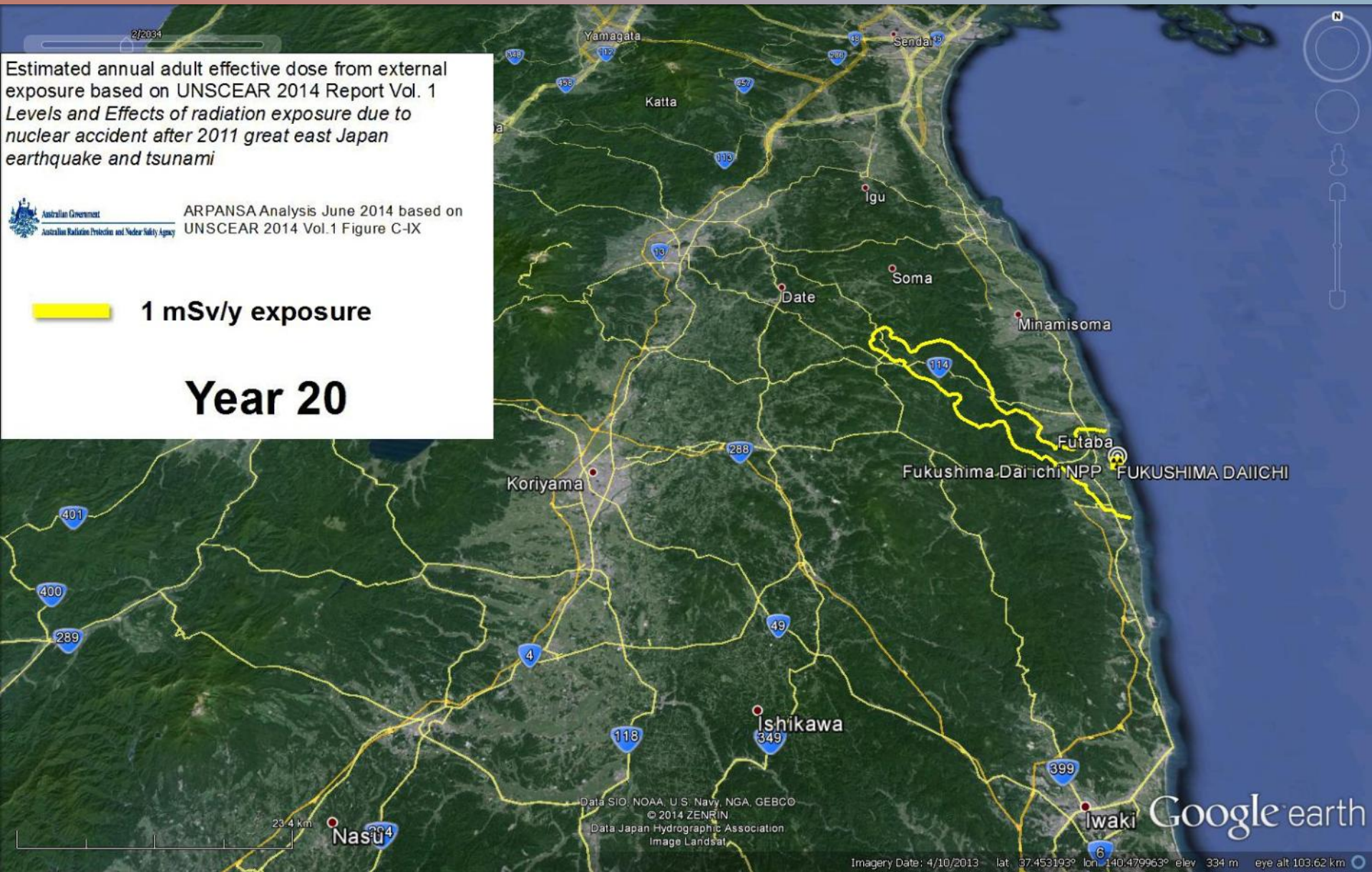
Estimated annual adult effective dose from external exposure based on UNSCEAR 2014 Report Vol. 1 *Levels and Effects of radiation exposure due to nuclear accident after 2011 great east Japan earthquake and tsunami*

Australian Government
ARPANSA Analysis June 2014 based on
Australian Radiation Protection and Nuclear Safety Agency UNSCEAR 2014 Vol.1 Figure C-IX

 1 mSv/y exposure

Year 10



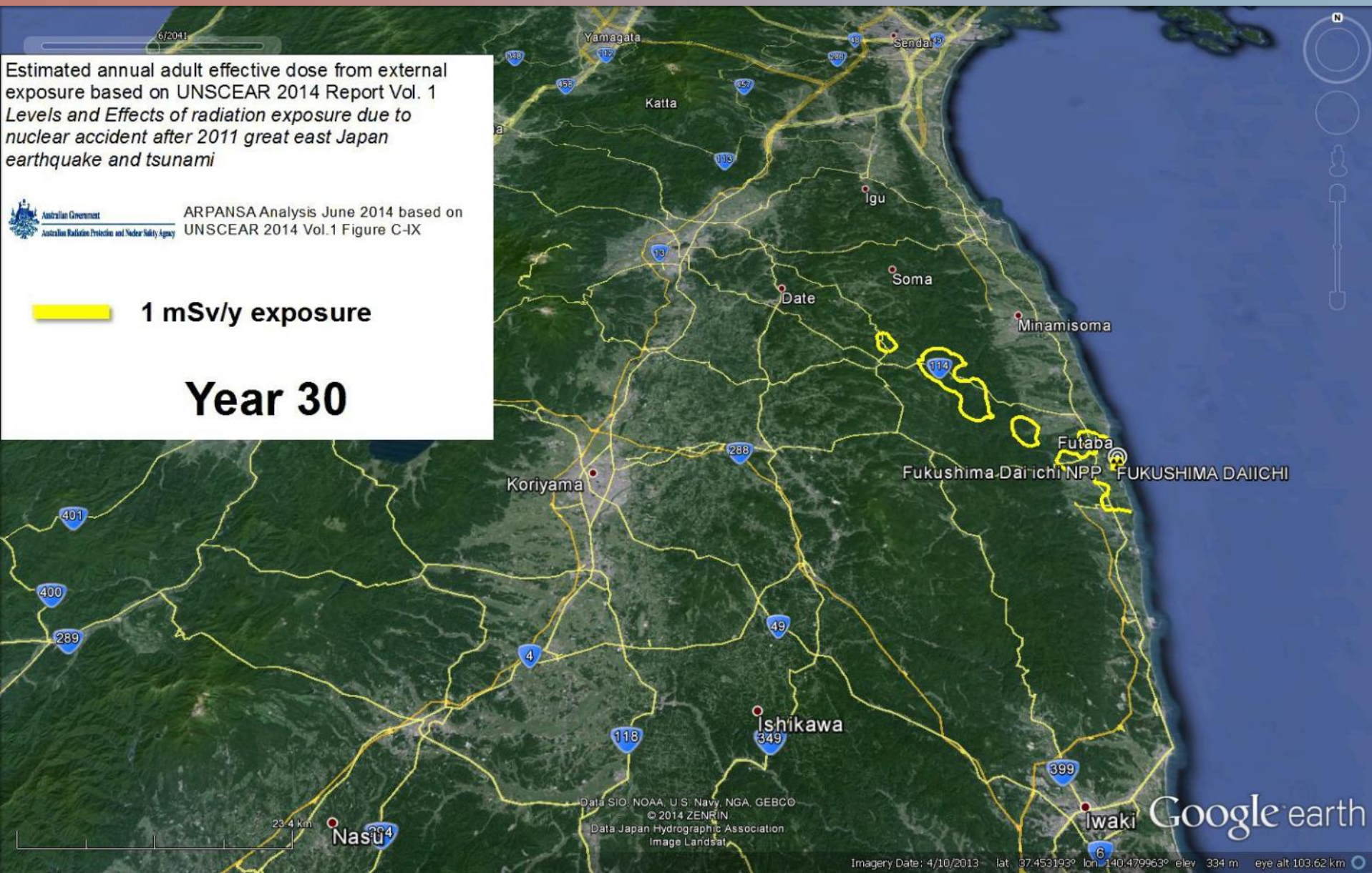


Estimated annual adult effective dose from external exposure based on UNSCEAR 2014 Report Vol. 1 *Levels and Effects of radiation exposure due to nuclear accident after 2011 great east Japan earthquake and tsunami*

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 1 mSv/y exposure

Year 30

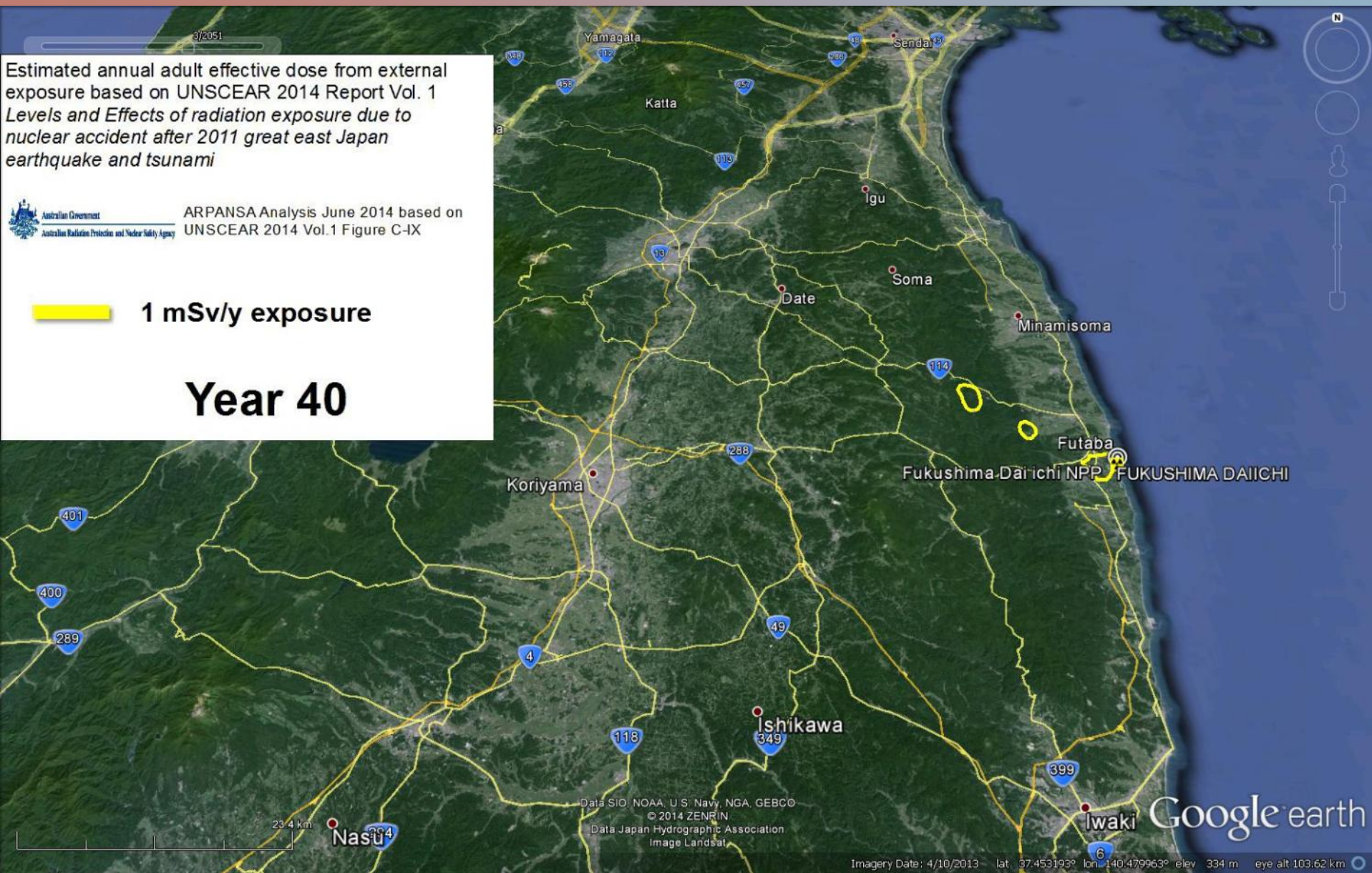


Estimated annual adult effective dose from external exposure based on UNSCEAR 2014 Report Vol. 1 *Levels and Effects of radiation exposure due to nuclear accident after 2011 great east Japan earthquake and tsunami*

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 1 mSv/y exposure

Year 40



Estimated annual adult effective dose from external exposure based on UNSCEAR 2014 Report Vol. 1 *Levels and Effects of radiation exposure due to nuclear accident after 2011 great east Japan earthquake and tsunami*

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 1 mSv/y exposure

Year 50



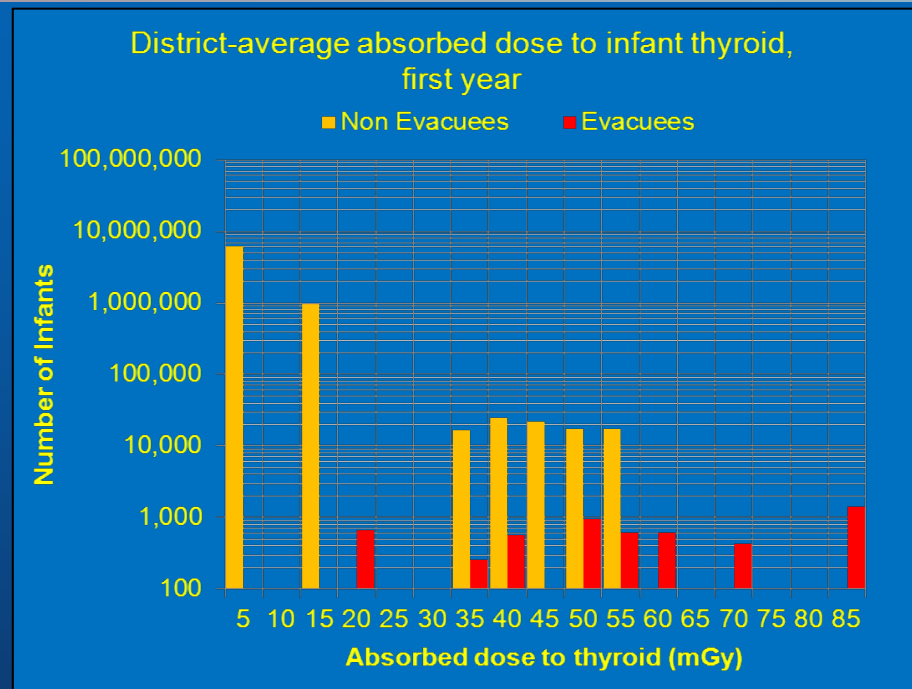
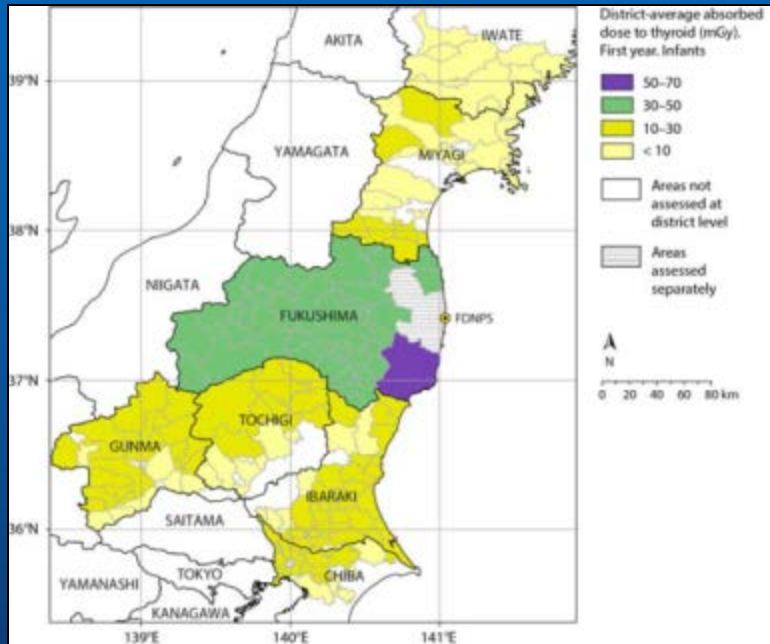
From the UNSCEAR report:

- ...the Committee has used the phrase “**no discernible increase**” to express the idea that currently available methods will not be able to demonstrate an increased incidence in the future disease statistics due to irradiation.
- This does not equate to absence of risk....; nor does it disregard the suffering associated with any such cases.

Exposed population (disease)	Baseline risk	Dose	Attributable risk	Impact on health statistics	Main determinant of impact level	
					Relative risk	Absolute N° cases
20 000 infants ≤ 5y (leukaemia)	0.06% childhood 0.5% lifetime	~5 mGy (RBM)*	~0.004%	Not discernible		Very few
20 000 girls 6-15y (breast cancer)	5.5% (lifetime)	~15 mGy	~0.1%	Not discernible		Few

*RBM = Absorbed dose to the red bone marrow

Absorbed dose to thyroid for infants in the first year



NOTES

- Districts averages dose based on data average of 1 km grid
- Absorbed dose thyroid for 1yo for ingestion 1st year ~33 mGy
- 95%tile for data ~ factor 2 – 3

THYROID DOSE RANGES

- ~ 6 million infants < 5 mGy
- ~ 1 million infants 5 mGy to 15 mGy
- ~ 35,000 infants 45 mGy to 55 mGy
- ~ 2,500 infants 55 mGy to 85 mGy
- ~ 500 infants 100 mGy to 150 mGy
- < 10 infants ~ 150 mGy

Exposed population	Baseline risk (lifetime)	Dose	Attributable risk	Impact on health statistics	Main determinant of impact level	
					Relative risk	Notional cases
~ 35 000 children 0-5y	0.5%	45-55 mGy	~0.15%	Indeterminate	Medium	Several tens

“Information on dose distribution and uncertainties was not sufficient for the Committee to draw firm conclusions as to whether any potential increased incidence of thyroid cancer would be discernible among those exposed to higher thyroid doses during infancy and childhood.”



Three years on

- **Deterministic effects:** not observed, unlikely in future
- **Cancer rates:** discernible increases not expected generally, risks may have increased
- **Thyroid cancer:** Uncertainties in dose distribution mean no firm conclusions on potential discernible increase
- **Heritable effects:** not discernible
- **Birth defects:** No impact
- **Workers:** no discernible increase expected, though risks increased
- **Wildlife:** Transient impact

Conclusions apply to radiation effects only

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