ENEP

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Long-term trends of radionuclides in foodstuffs

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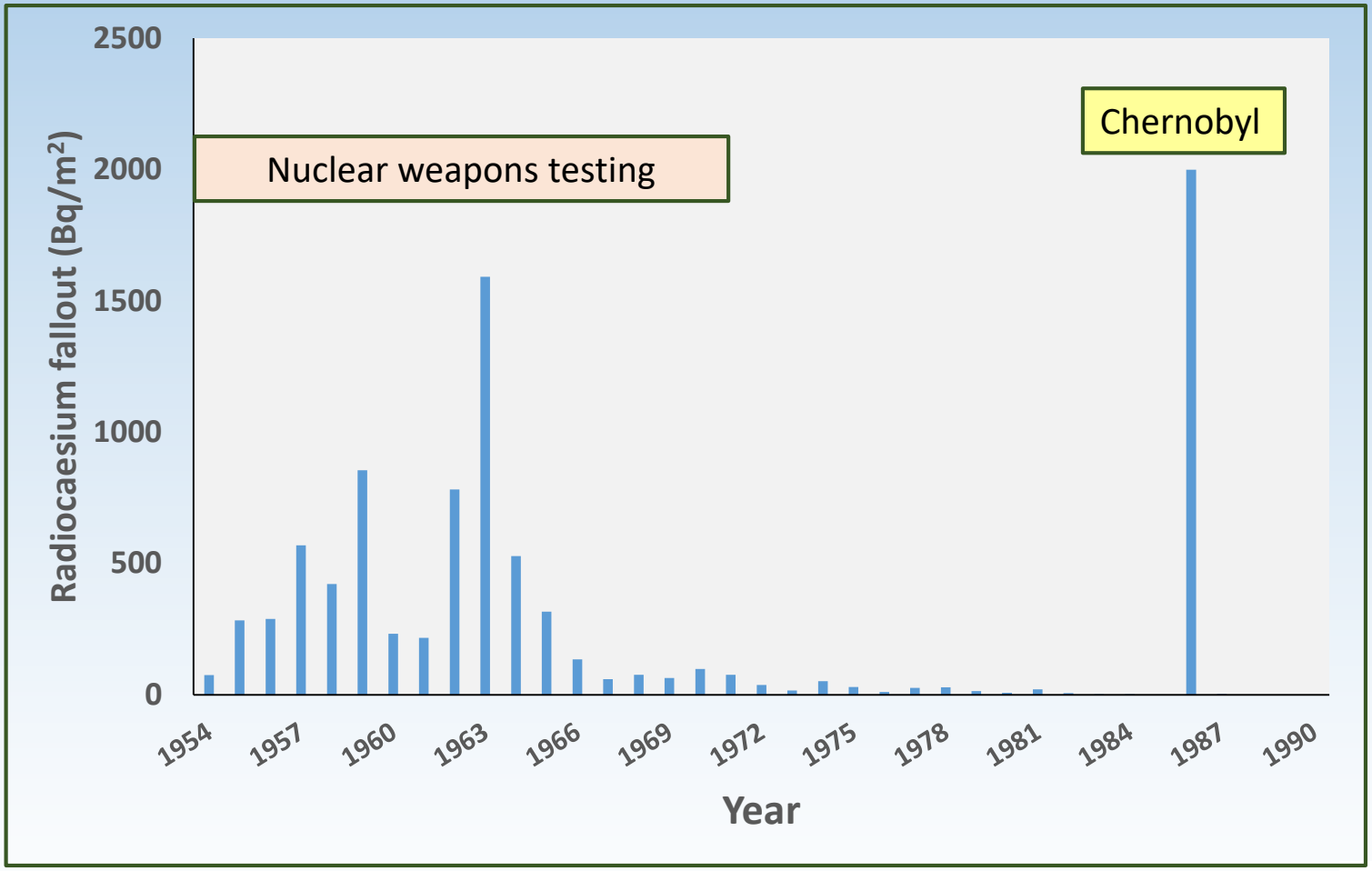
Long-term trends of Cs-137–activities in foodstuffs

- **Ecological half-lives**
  - **Decrease of activity in an environmental medium due to *natural* processes**
    - Fixation by soil particles and reduction of bioavailability
    - Migration into deeper soil laters
    - Loss of activity from soil due to erosion

- **Radioactive decay causes an *additional* reduction**
  - **The decline of activities in foodstuffs is faster than the radioactive decay**

- **Ecological half-lives derived from the analysis of monitoring data in Europe**
  - Weapons' fallout
  - Post-Chernobyl

Cs-137-deposition from nuclear weapons testing and from Chernobyl accident



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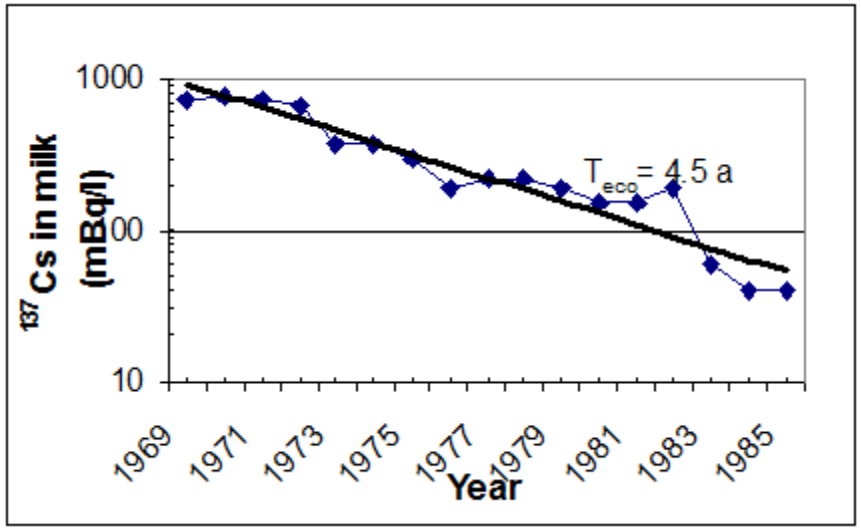
^{137}Cs-activity in milk (South Germany)

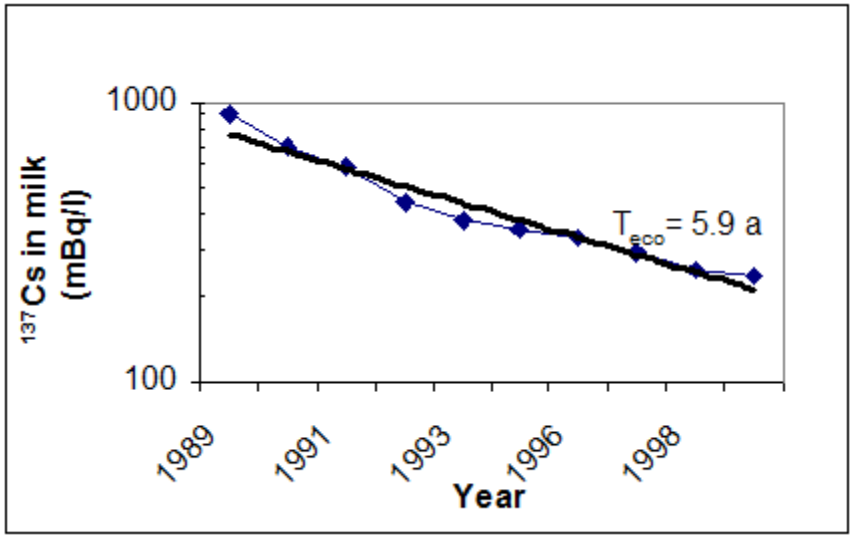
1965-1985



Ecological half-life: 4.5 years

Effective half-life (including decay): 3.9 years

1989-1999



Ecological half-life: 5.9 years

Effective half-life (including decay): 4.9 years

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Mean ecological half-lives (Belarus, Russia, Ukraine)

Crop	Soil Group	Half-lives, years
Cereal	Sand	7-11.8
	Loam	5.1-22.0
	Clay	14.4-40.4
	Peat	9.2-14.4
Potato, Beetroot	Sand	7.0-9.2
	Loam	10
	Clay	13.3
	Peat	10
Perennial Grasses	Sand	6.4
	Loam	4.0
	Clay	9.8
	Peat	17.3
Natural Grasses	Sand	5.8
	Loam	18.0
	Clay	13.3
	Peat	17.3

IAEA Chernobyl Forum Report, 2006; in IAEA TECDOC 1616

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Ecological half-lives in plants after the Chernobyl accident

Soil Group	The first period, 1987-1989			The second period, 1989-1999		
	$T_{1/2}^{eco}$	$F^*_v(0)$	R^2	$T_{1/2}^{eco}$	$F^*_v(0)$	R^2
			Barley			
Sand	1.3	4.3×10^{-1}	9.9×10^{-1}	6.2	1.4×10^{-1}	6.5×10^{-1}
Loam	1.9	2.1×10^{-1}	9.8×10^{-1}	6.7	9×10^{-2}	7.1×10^{-1}
Clay	1.4	1.7×10^{-1}	9.8×10^{-1}	3.8	7×10^{-2}	8.7×10^{-1}
			Potato			
Sand	1.2	5.7×10^{-1}	8.8×10^{-1}	7.5	1.2×10^{-1}	9.9×10^{-1}
Loam	2.4	1.4×10^{-1}	9.8×10^{-1}	8.5	1×10^{-1}	(2.0×10^{-1})*
Clay	2.9	7×10^{-2}	9.5×10^{-1}	5.0	4×10^{-2}	6.4×10^{-1}
			Beetroot			
Sand	2.9	3.2×10^{-1}	9.2×10^{-1}	5.2	2.9×10^{-1}	8.3×10^{-1}
Loam	2.6	2.5×10^{-1}	8.2×10^{-1}	5.9	1.2×10^{-1}	9.8×10^{-1}
Clay	2.9	1.8×10^{-1}	7.2×10^{-1}	7.2	1.5×10^{-1}	9.6×10^{-1}
			Natural Grasses			
Sand	1.6	2.9×10^{1}	9.9×10^{-1}	1.5×10^{1}	1.8×10^{1}	8.7×10^{-1}
Loam	1.3	7.0	9.9×10^{-1}	4.7	2.3	(3.7×10^{-1})*
Clay	1.3	3.6	9.9×10^{-1}	4.9	1.4	5.6×10^{-1}
Organic	1.8	8.3×10^{1}	8.4×10^{-1}	1.1×10^{1}	3.0×10^{1}	7.2×10^{-1}
			Perennial Grasses			
Sand	2.3	1.2×10^{1}	9.9×10^{-1}	4.8	3.5	9.1×10^{-1}
Loam	2.5	1.2×10^{1}	9.5×10^{-1}	4.6	6×10^{-1}	6.0×10^{-1}
Clay	2.5	1.9	9.5×10^{-1}	1.0×10^{1}	6.5×10^{-1}	6.6×10^{-1}
Organic	2.6	2.3×10^{1}	9.9×10^{-1}	2.1×10^{1}	9.9	(2.1×10^{-1})*

*–insufficient data for adequate estimation.

Fesenko et al., Rad.Prot.Dosim. 69 (1997), p. 289, in IAEA TECDOC-1616 (2009)

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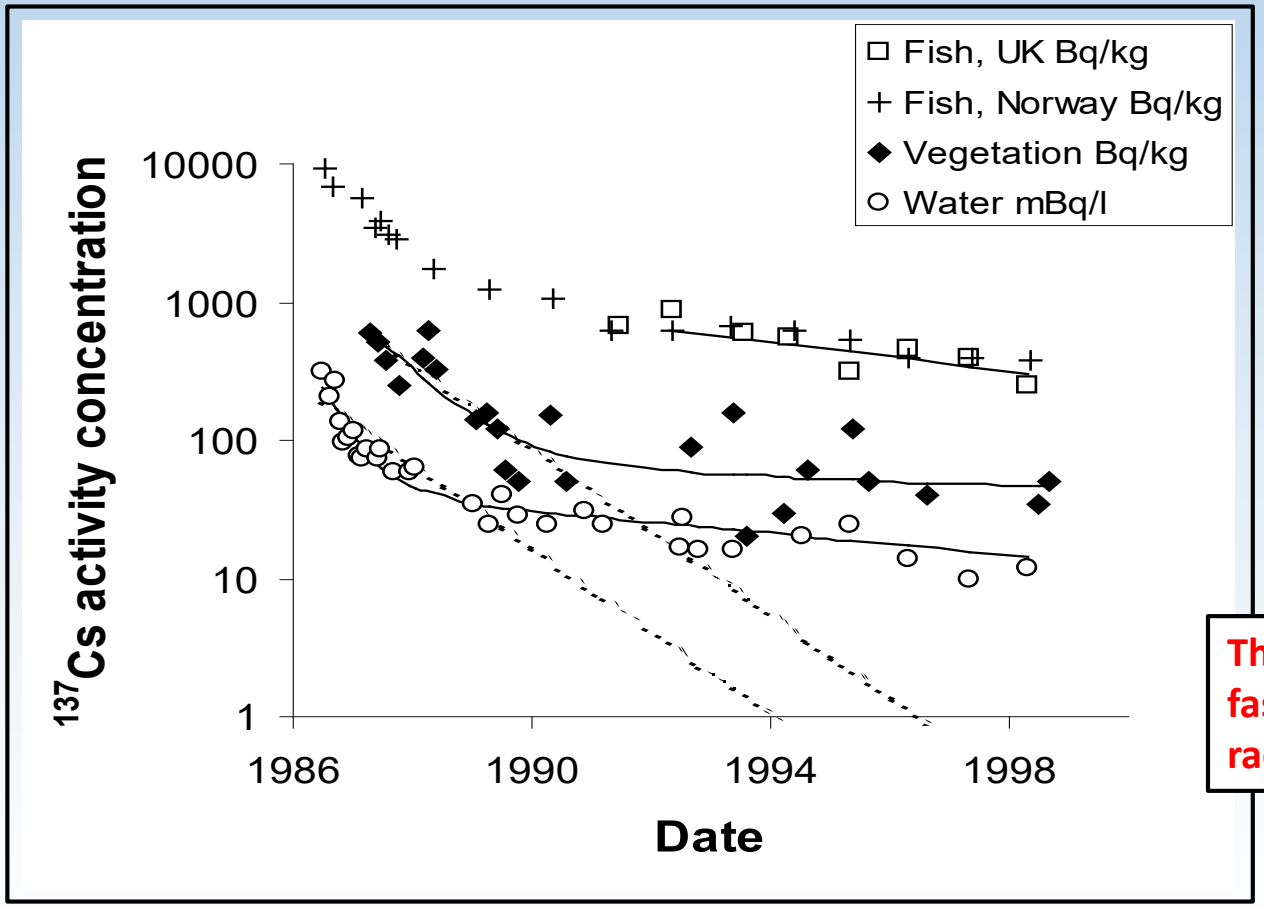
Decline of ^{137}Cs-levels in food and water

First few weeks
Fast processes of sorption, vertical migration, biological uptake

Up to 4-7 years
"Fixation"

More than 4-7 years
Slow desorption, vertical migration, erosion



The decline is much faster than due to the radioactive decay only

Smith, J.T. et al. (2000) Chernobyl's legacy in food and water. *Nature*, 405.

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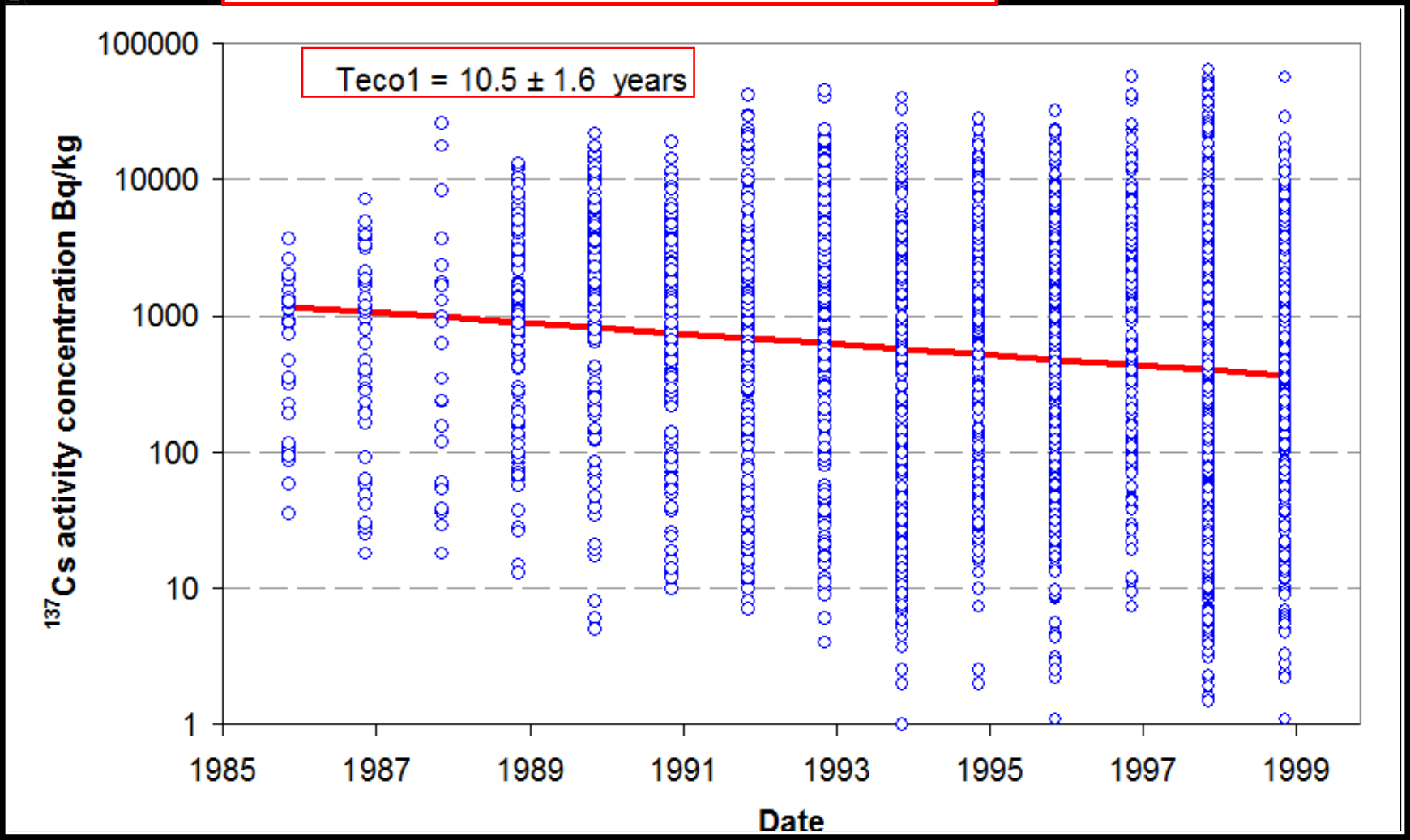
Ecological half-life: 10.5 years
Effective half-life (including decay): 7.8 years



^{137}Cs in wild boar collected in South Germany (1986 to 1999)

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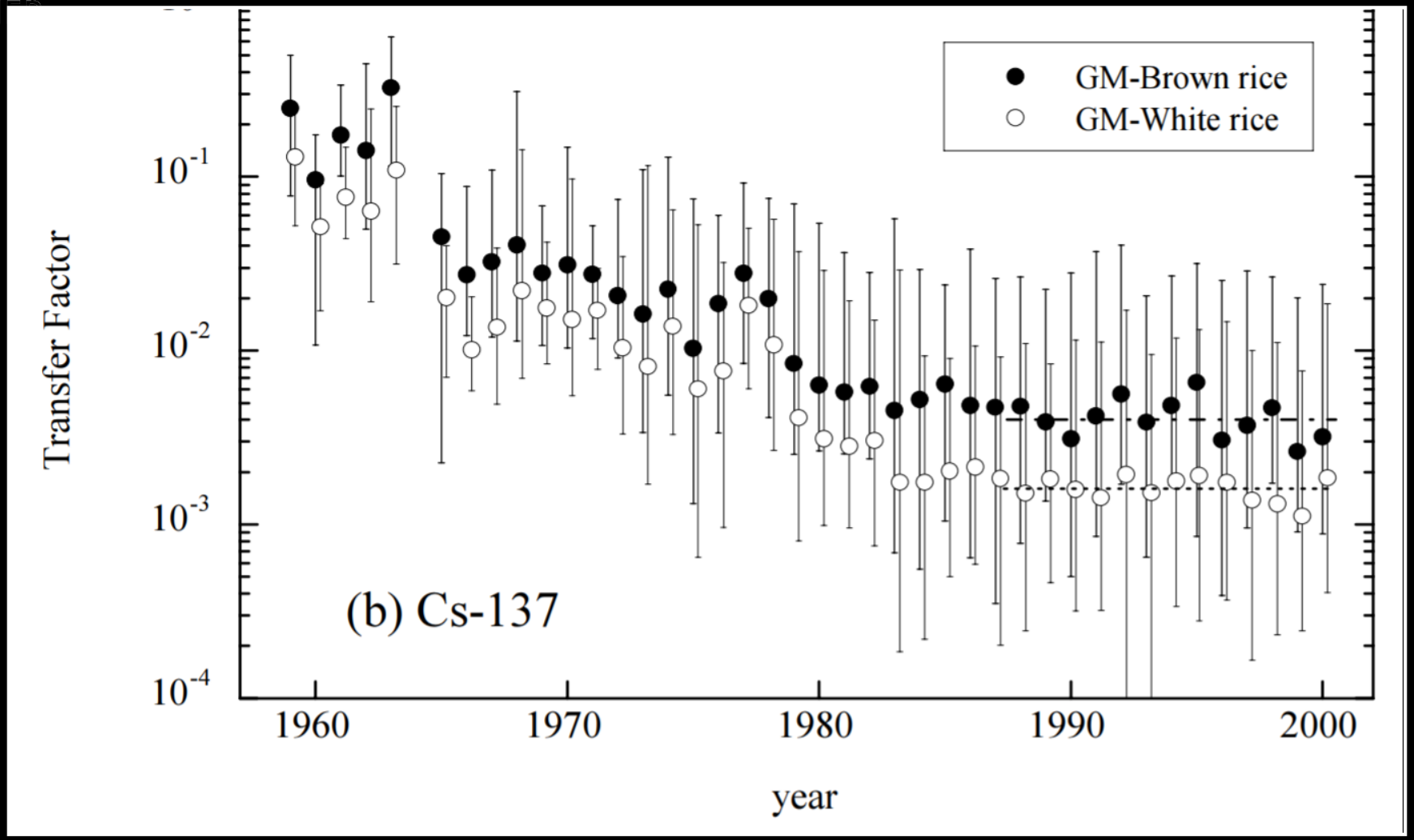

Time-dependence of ^{137}Cs-TFs for brown and white rice in Japan

S. Fesenko, N. Sanzharova, K. Tagami: Evolution of plant contamination with time (IAEA-TECDOC 1616), 2009)

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Summary of ecological half-lives for Cs

Plants and animal food products on agricultural land

- **4 to 6 years**

Pasture

- In the first 5-6 a after deposition: **1 - 4 years**
- Afterwards: **5 - 15 years**
- Slower decline for vegetation on *peat* and mineral soils *low in clay* minerals.

Forest products (Roe deer, deer, wild boar, forest plants, berries, fungi (Middle Europe))

- Average: **12 years**
- In some areas much longer