Atmospheric releases of FD-NPP have lead to heavy **ground deposition** (well documented)

Marine releases have contaminated the **sea sediment** (data are available)

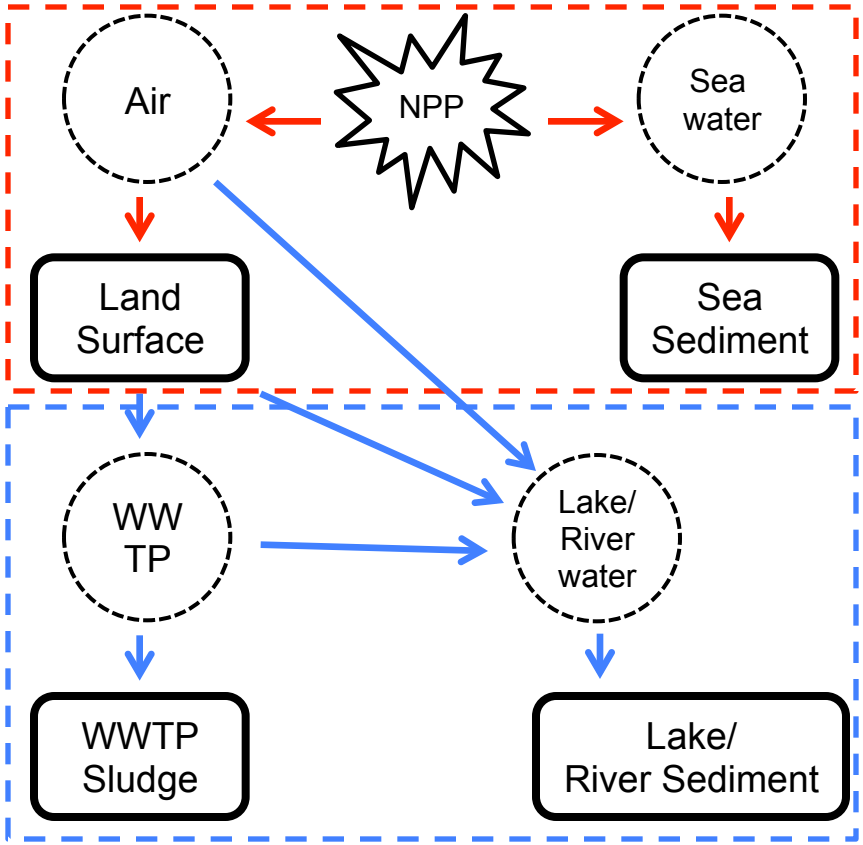
Several processes on land lead to contamination of additional **sinks**:

The sewer system can receive contaminated rain water and surface runoff

Wastewater treatment plants (WWTP) produce sludge and effluents (to rivers and lakes)

Rivers and lakes receive radioisotopes also from air and via washoff/erosion

Sludge and river/lake sediment are important additional (delayed!) sinks



Historical data can be an information source for:

- time constants/transport rates
- concentration ratios
- unexpected effects

A wealth of records is available, e.g. in Europe

Common problems involve

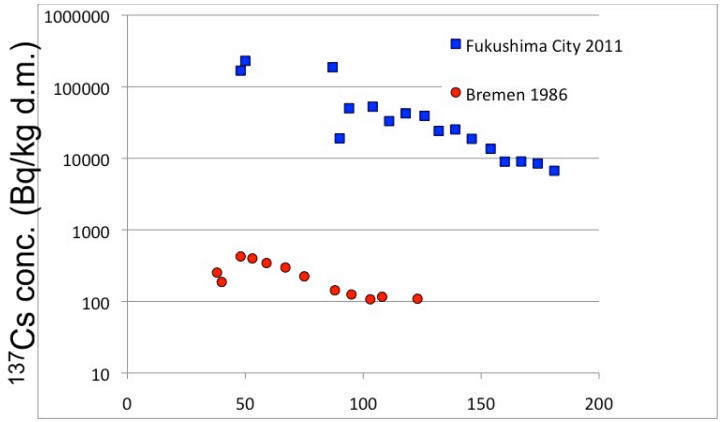
-„non-scientific“ sampling for monitoring and surveillance

-intercomparability of data

Nevertheless, useful information can be retrieved from comparison between different countries, events and times.

See the following examples!

Example: slow decrease of ^{137}Cs in WWTP sludge



Location/year	Deposition density (kBq/m²)
Fukushima city, 2011	400
Bremen 1986	3

Comparison of monitoring and research data from Japan and Germany

Data come from a variety of sources

Data were obtained for different purposes

Translation from Japanese difficult

^{131}I data quite unreliable due to short half life and varying sampling dates

Bremen 2009 data: continuous input (medical ^{131}I)

	Bremen, Germany 1986		Fukushima City, 2011		Bremen, Germany 2009	
	^{131}I	^{137}Cs	^{131}I	^{137}Cs	^{131}I	^{137}Cs
Deposition (kBq/m^2)	12	3	3000	400	n.a.	1
WWTP inflow (Bq/l)	150	20			0.4	
WWTP effluent (Bq/l)					0.2	
WWTP dig. sludge (Bq/kg w.m.)	40	200	6000 (May 2011)	200000 (May 2011)	80	3
River water (Bq/l)	0.4	0.1		1 (July 2011)	0.002	0.003
River sediment (Bq/kg d.m.)	100	1000	65 (May 2011)	12000 (May 2011)	0.5	6

(references available on request)

Comparison of monitoring and research data from Japan and Germany

^{137}Cs, deposition and sludge:

concentration ratios similar

	Bremen, Germany 1986		Fukushima City, 2011		Bremen, Germany 2009	
	^{131}I	^{137}Cs	^{131}I	^{137}Cs	^{131}I	^{137}Cs
Deposition (kBq/m^2)	12	**3**	3000	**400**	n.a.	1
WWTP inflow (Bq/l)	150	20			0.4	
WWTP effluent (Bq/l)					0.2	
WWTP dig. sludge (Bq/kg w.m.)	40	**200**	6000 (May 2011)	**200000** (May 2011)	80	3
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River sediment (Bq/kg d.m.)	100	1000	65 (May 2011)	12000 (May 2011)	0.5	6

Comparison of monitoring and research data from Japan and Germany

^{131}I and ^{137}Cs retention in WWTP:

higher for Cs, I is retained less efficiently

	Bremen, Germany 1986		Fukushima City, 2011		Bremen, Germany 2009	
	^{131}I	^{137}Cs	^{131}I	^{137}Cs	^{131}I	^{137}Cs
Deposition (kBq/m^2)	12	3	3000	400	n.a.	1
WWTP inflow (Bq/l)	**150**	**20**			**0.4**	
WWTP effluent (Bq/l)					**0.2**	
WWTP dig. sludge (Bq/kg w.m.)	**40**	**200**	6000 (May 2011)	200000 (May 2011)	80	3
River water (Bq/l)	0.4	0.1		1 (July 2011)	0.002	0.003
River sediment (Bq/kg d.m.)	100	1000	65 (May 2011)	12000 (May 2011)	0.5	6

Comparison of monitoring and research data from Japan and Germany

Concentration ratios water and sediment:

similar for all data sets; somewhat higher for Cs

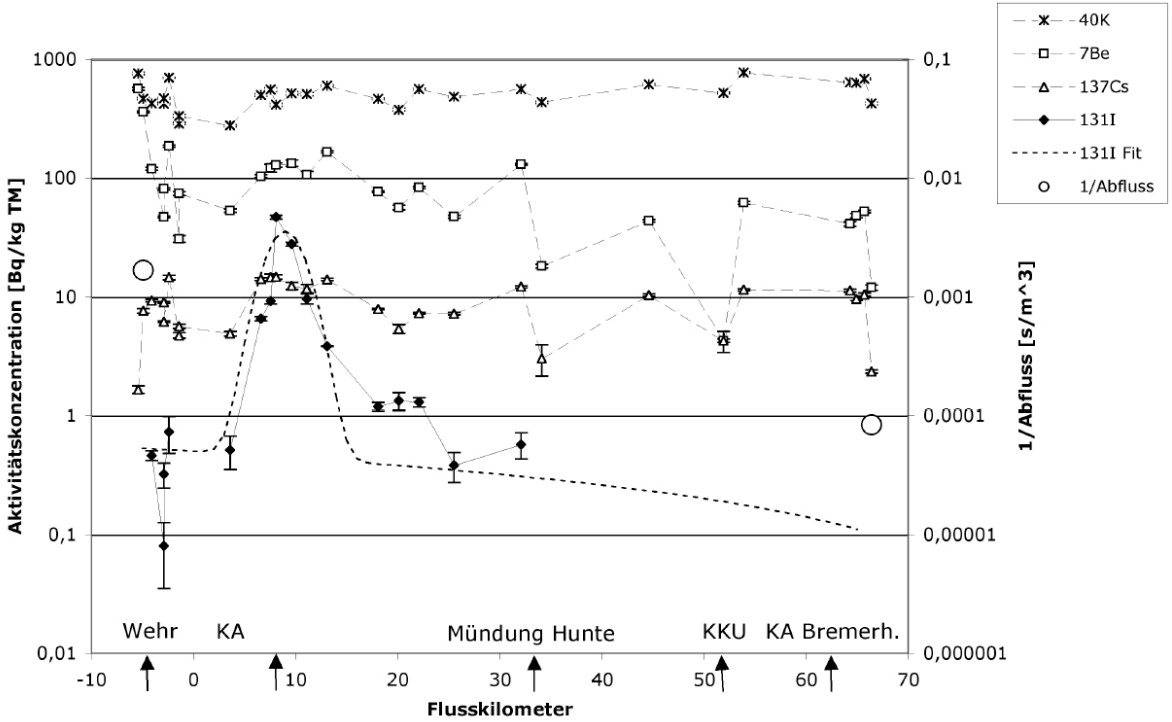
	Bremen, Germany 1986		Fukushima City, 2011		Bremen, Germany 2009	
	^{131}I	^{137}Cs	^{131}I	^{137}Cs	^{131}I	^{137}Cs
Deposition (kBq/m^2)	12	3	3000	400	n.a.	1
WWTP inflow (Bq/l)	150	20			0.4	
WWTP effluent (Bq/l)					0.2	
WWTP dig. sludge (Bq/kg w.m.)	40	200	6000 (May 2011)	200000 (May 2011)	80	3
River water (Bq/l)	**0.4**	**0.1**		**1** (July 2011)	**0.002**	**0.003**
River sediment (Bq/kg d.m.)	**100**	**1000**	**65** (May 2011)	**12000** (May 2011)	**0.5**	**6**

Tidal river sediment research data from Germany, 2009

Sediment isotope concentration vs. river length

^{131}I (medical origin, continuous emission from WWTP): characteristic profile, indicating a resuspension process

^{137}Cs: homogeneously distributed (probably long-term erosion from land)



Conclusions, outlook

Sediments and sludges are important (late) sinks for NPP accident emissions (^{137}Cs concentration in WWTP sludge is far higher than in soil of the same region).

Comparison of recent and old data shows similarities and might allow for predictions.

Current research on WWTP and river system processes will aid in further understanding monitoring data.