Managing the foodchain – radiation protection and societal aspects

Astrid Liland

IEM6, Vienna, 17-21 February 2014

Statens strålevern
Norwegian Radiation Protection Authority

Issues at stake

- Contamination by long-lived radionuclides is a societal problem of long duration
- Need to control the intake of radionuclides to below a safe level
  - 20-100 mSv total dose, acute or per year, in emergency phase
  - 1-20 mSv/y total in the long run (existing exposure situations)
- Food restrictions and/or countermeasures will be mandatory
- How to elaborate a viable strategy for managing the food chain in the long term?
- How to gain public acceptance and understanding?

Permissible levels (or guideline levels or regulation values) for radionuclides in food products - examples

Radionuclide	Product	Codex Guideline levels	IAEA Operational intervention levels	EC Maximum permitted levels[1)]	USA Guidance levels/ Derived intervention levels[2)]
^{131}I	Milk/dairy products	100	3000[3)]	500[4)]	170
	Other foods	100	3000	2000	170
$^{134}Cs+^{137}Cs$	Milk/dairy products	1000	^{134}Cs: 1000 ^{137}Cs: 2000	1000[4)]	1200
	Other foods	1000	^{134}Cs: 1000 ^{137}Cs: 2000	1250	1200

[1)] EC has maximum permitted levels for infant food of 150 and 400 Bq/kg for ^{131}I and $^{134}Cs+^{137}Cs$, respectively. Furthermore, EC give a list of minor foodstuffs to which the maximum permitted levels do not apply.

[2)] Applicable to foods as prepared for consumption. For dried or concentrated products such as powdered milk or concentrated juices, adjust by a factor appropriate to reconstitution, and assume the reconstitution water is not contaminated. For spices, which are consumed in very small quantities, use a dilution factor of 10.

[3)] Also for drinking water.

[4)] Also for “liquid foodstuffs”.

Comparison to national permissible levels

Radionuclide	Product	EC Maximum permitted levels[1)]	USA Guidance levels/Derived intervention levels[2)]	Russia, Ukraine, Belarus (from 2010)	Japan Provisional regulation values 2011	Japan limits from 2012
^{131}I	Milk/dairy products	500[4)]	170		300[3)]	
	Other foods	2000	170		2000[5)]	
$^{134}Cs+^{137}Cs$	Milk/dairy products	1000[4)]	1200	100	200	50
	Other foods	1250	1200	40-500[6)]	500	100

1) EC has maximum permitted levels for infant food of 150 and 400 Bq/kg for ^{131}I and $^{134}Cs+^{137}Cs$, respectively.

2) Applicable to foods as prepared for consumption.

3) Also for drinking water.

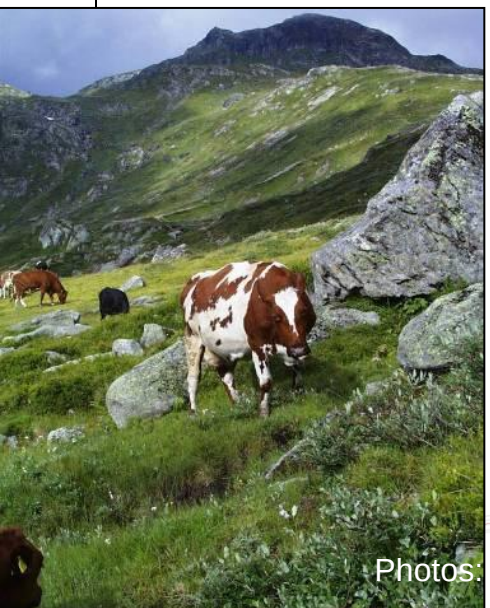
4) Also for “liquid foodstuffs”.

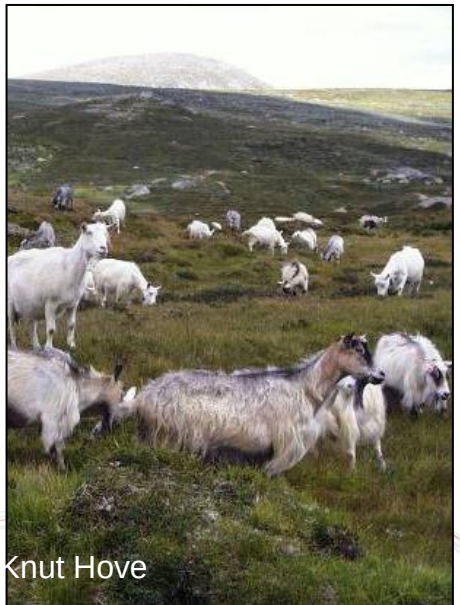
5) Following the Fukushima accident.

6) Values for different food categories ranging from 40 Bq/kg in baby food and bread, to 500 Bq/kg in mushrooms

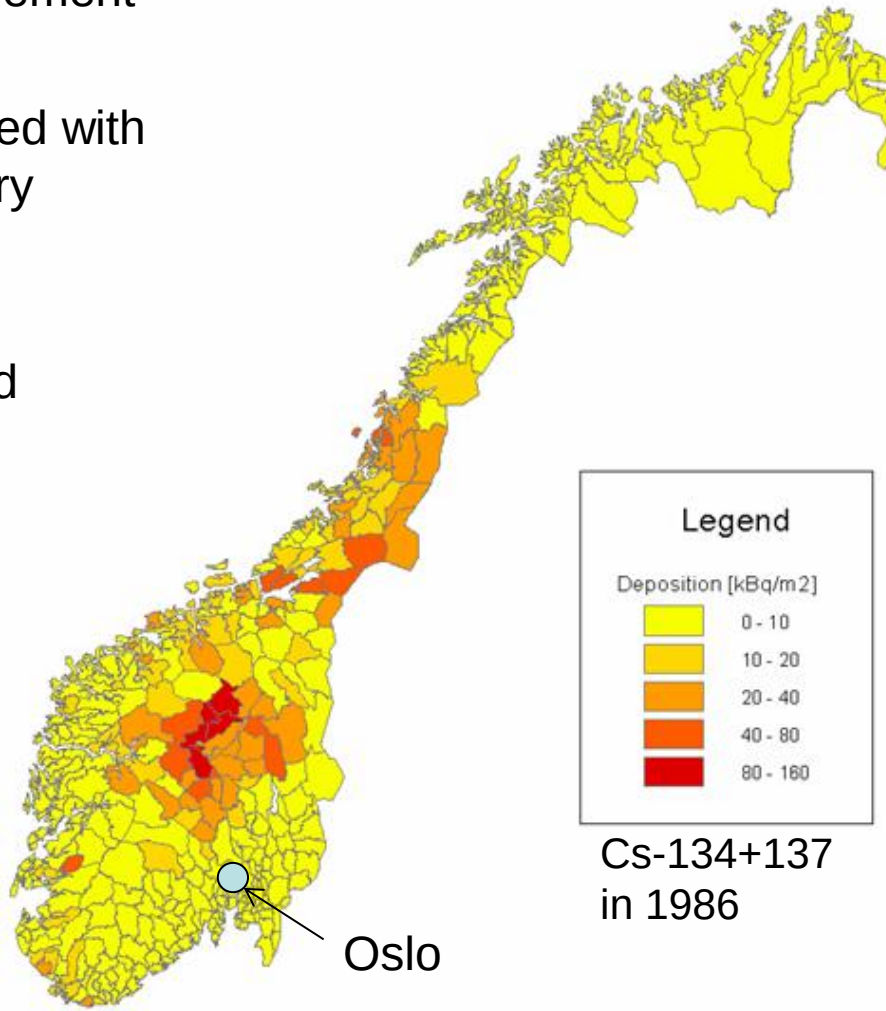
The Norwegian case after the Chernobyl accident

- From denial to confusion to management
- Highly contaminated areas coincided with pasture areas → meat and milk very contaminated
- Wild foodstuffs highly contaminated





Photos: Knut Hove



Cs-134+137
in 1986

Some measured values, total caesium

1986

- Goat’s milk: 2890 Bq/kg
- Cow’s milk: 1160 Bq/kg
- Freshwater fish: 30 000 Bq/kg
- Lamb: 40 000 Bq/kg
- Reindeer: 150 000 Bq/kg
- Mushrooms: 1-2 MBq/kg

Changing permissible levels in Norway, Bq/kg

Food product	May 1986	June 1986 $^{134+137}$Cs	Nov. 1986 $^{134+137}$Cs	July 1987 $^{134+137}$Cs	1994 $^{134+137}$Cs	Today $^{134+137}$Cs
Basic foodstuffs	1000 for ^{131}I 300 for ^{137}Cs	600				600
Milk and infant food	-	370				370
Reindeer meat	-	-	6000		3000	3000
Game and wild freshwater fish	-	-	-	6000	3000	3000

Meat from semi-domesticated reindeer

- Free ranging animals, natural pastures only
- Difficult to implement countermeasures
- The Samis has a strong spiritual and cultural connection to the reindeer and the nature → their existence was threatened
- Low average consumption by Norwegians ~0.5 kg/y
- High consumption by Sami people > 50 kg/y

Food bans and impacts

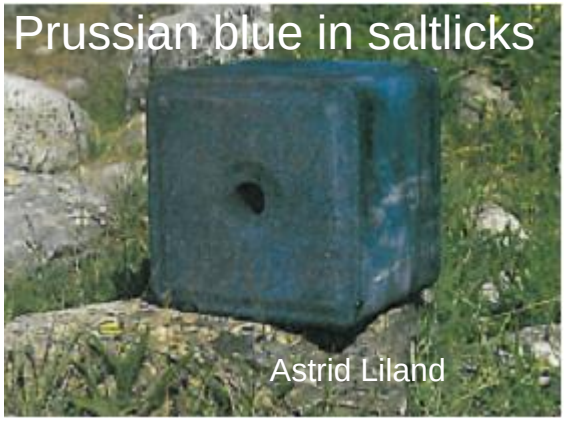
- Efficient for removing contaminated food from the market
- Will often be mandatory in the early phase
- But
  - Generates a lot of waste
  - Costly (compensation to producers, measurement campaigns, waste disposal, lost market value)
  - Stop in production changes the cultivated landscape
  - Stop in harvesting changes the ecological balance (eg. wild boar in Fukushima prefecture)
  - Loss of production knowledge
  - Import/export disturbed
  - Food shortage?
  - Malnutrition?
  - **Very unsatisfactory for the farmers, fishermen, hunters**

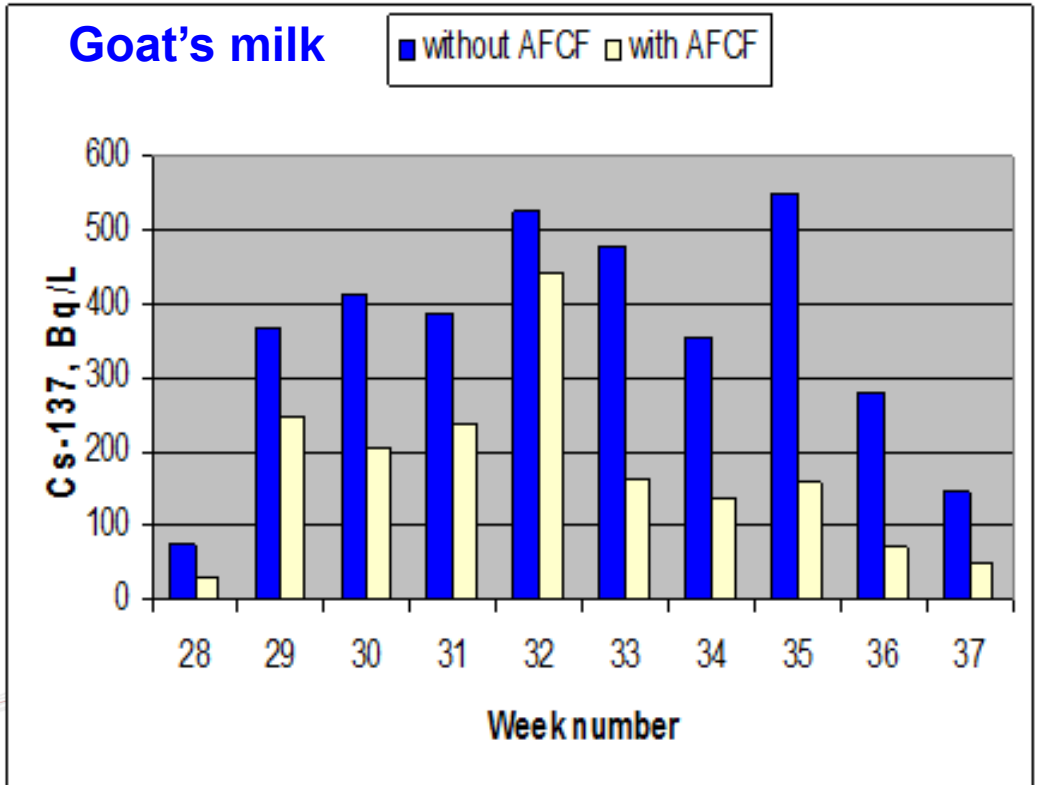
Countermeasures used in Norway

- Elevated permissible levels for reindeer, game and freshwater fish
- Monitoring of radiocaesium in animals before slaughter (“live monitoring”);
- Clean feeding of animals before slaughter;
- Caesium binder (Prussian blue) in concentrates ,salt licks and rumen boli to prevent absorption of ingested radiocaesium in the animals;
- Change of slaughter time (in reindeer husbandry); and
- Dietary advices and monitoring of internal contamination.

Prussian blue efficiency

- Prussian blue (a caesium binder) added to concentrates, salt licks and boli
- Reduces the uptake of Cs from the animals' gut
- Efficiency between 50 and 80 %





Live monitoring

3” NaI

Inspector 1000 with special software

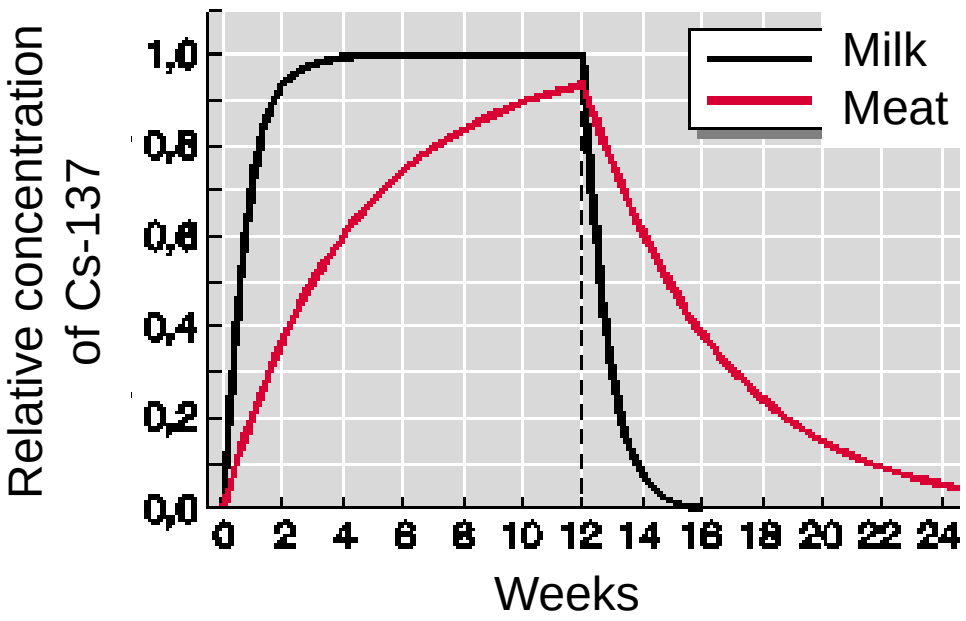
Astrid Liland

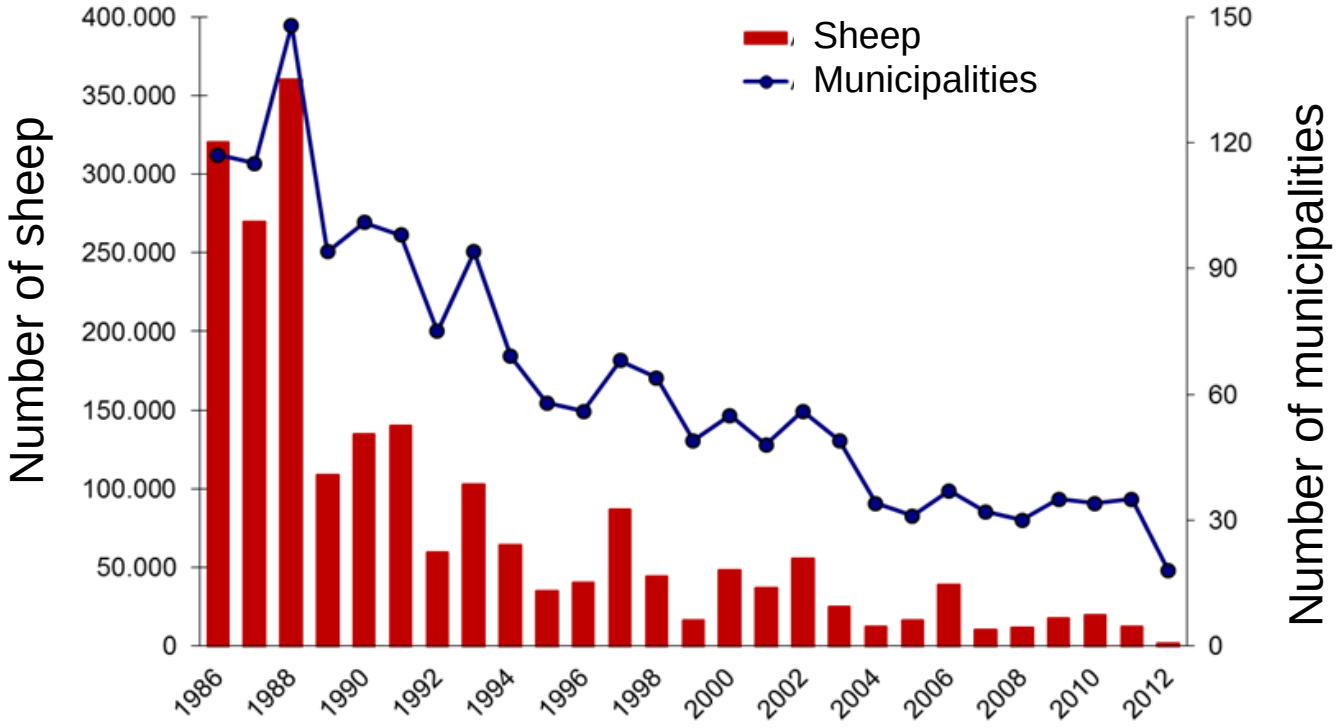
- Measures directly the contamination of meat in Bq/kg of Cs-134+137
- Basis for decision on slaughter or clean feeding

Astrid Liland, 2012

Clean feeding

- Natural decrease in contamination levels due to the biological half-life of caesium

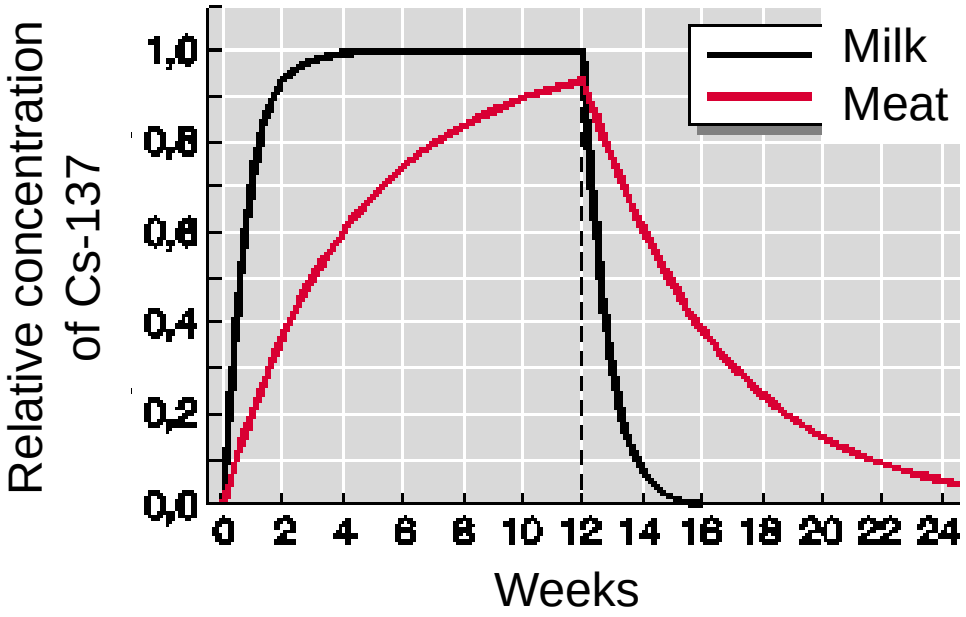


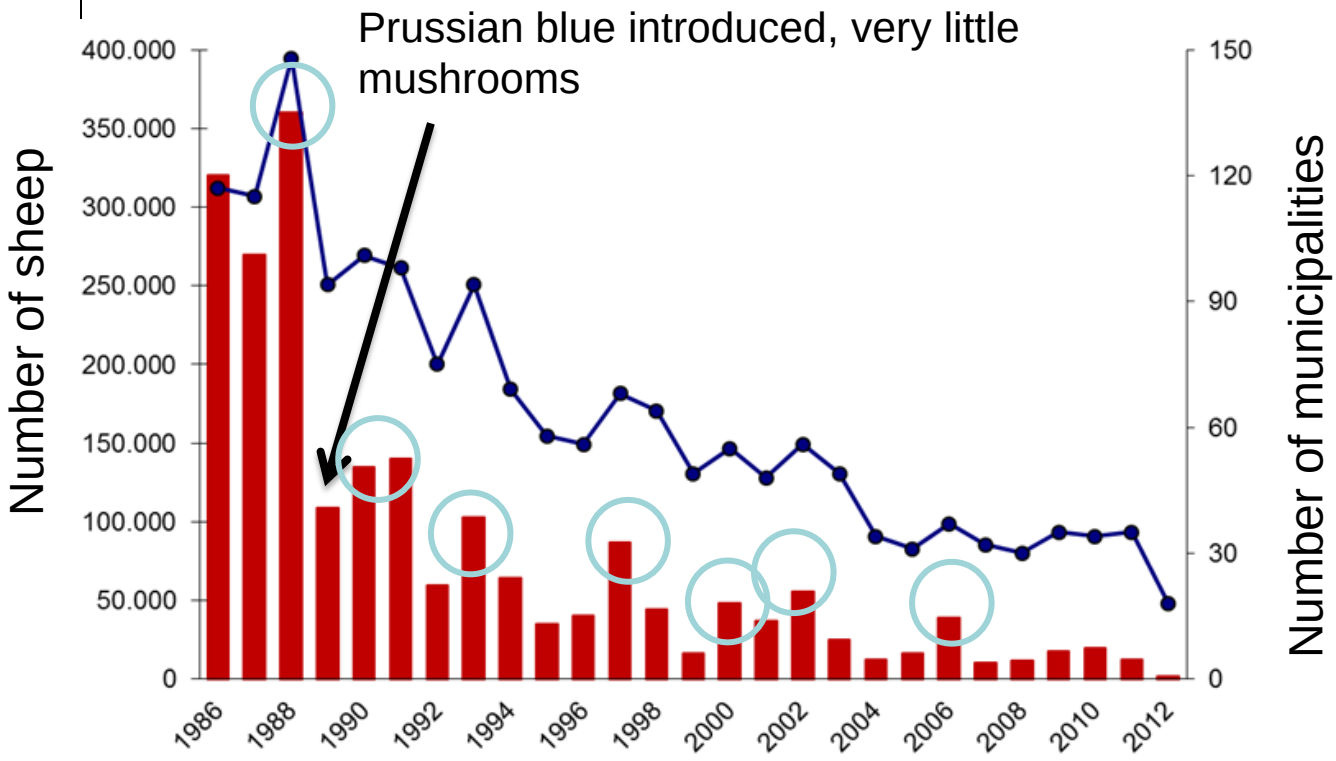


Statens strålevern
Norwegian Radiation Protection Authority

Clean feeding

- Natural decrease in contamination levels due to the biological half-life of caesium



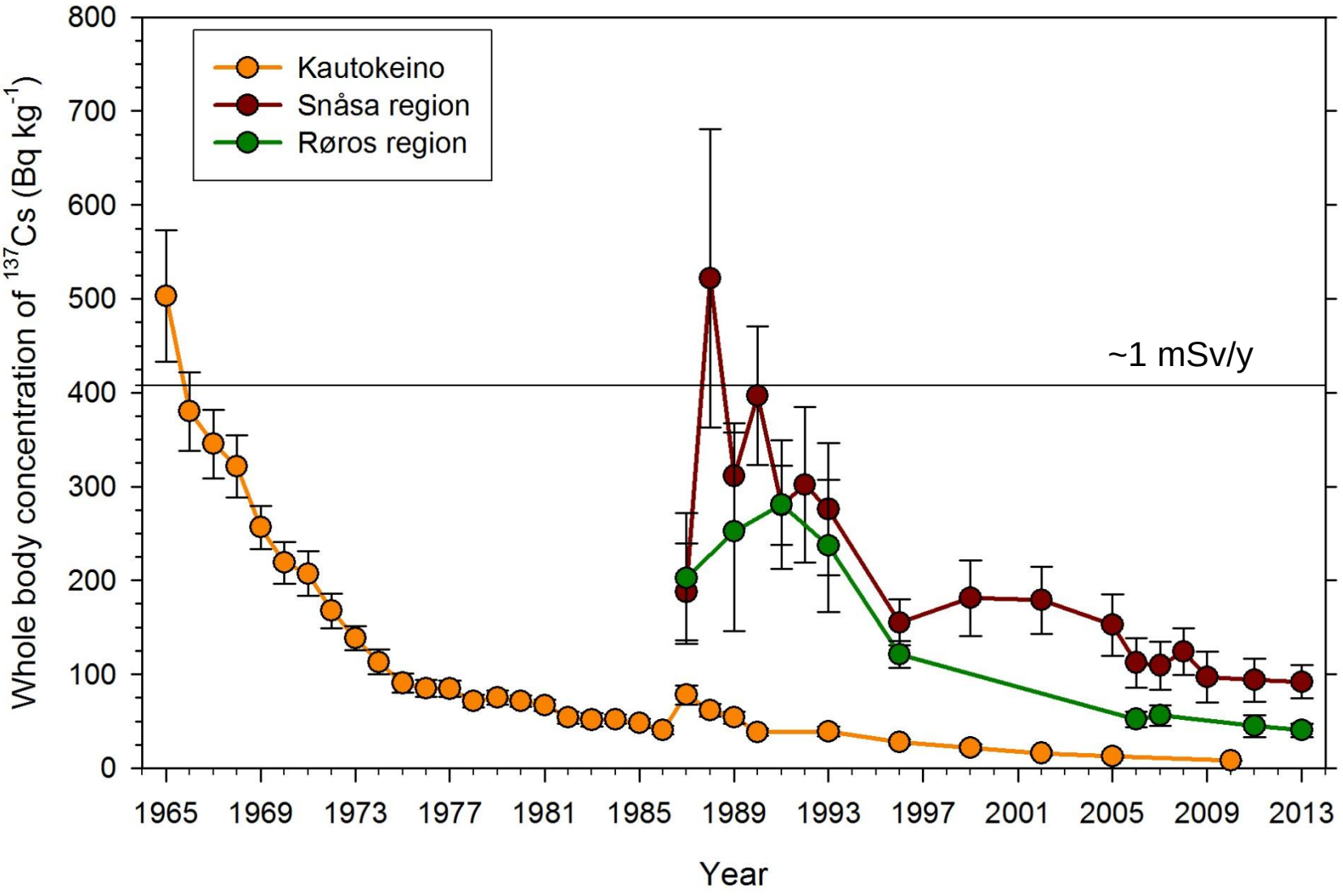


Statens strålevern
Norwegian Radiation Protection Authority

Dietary advice and WBC of Samis

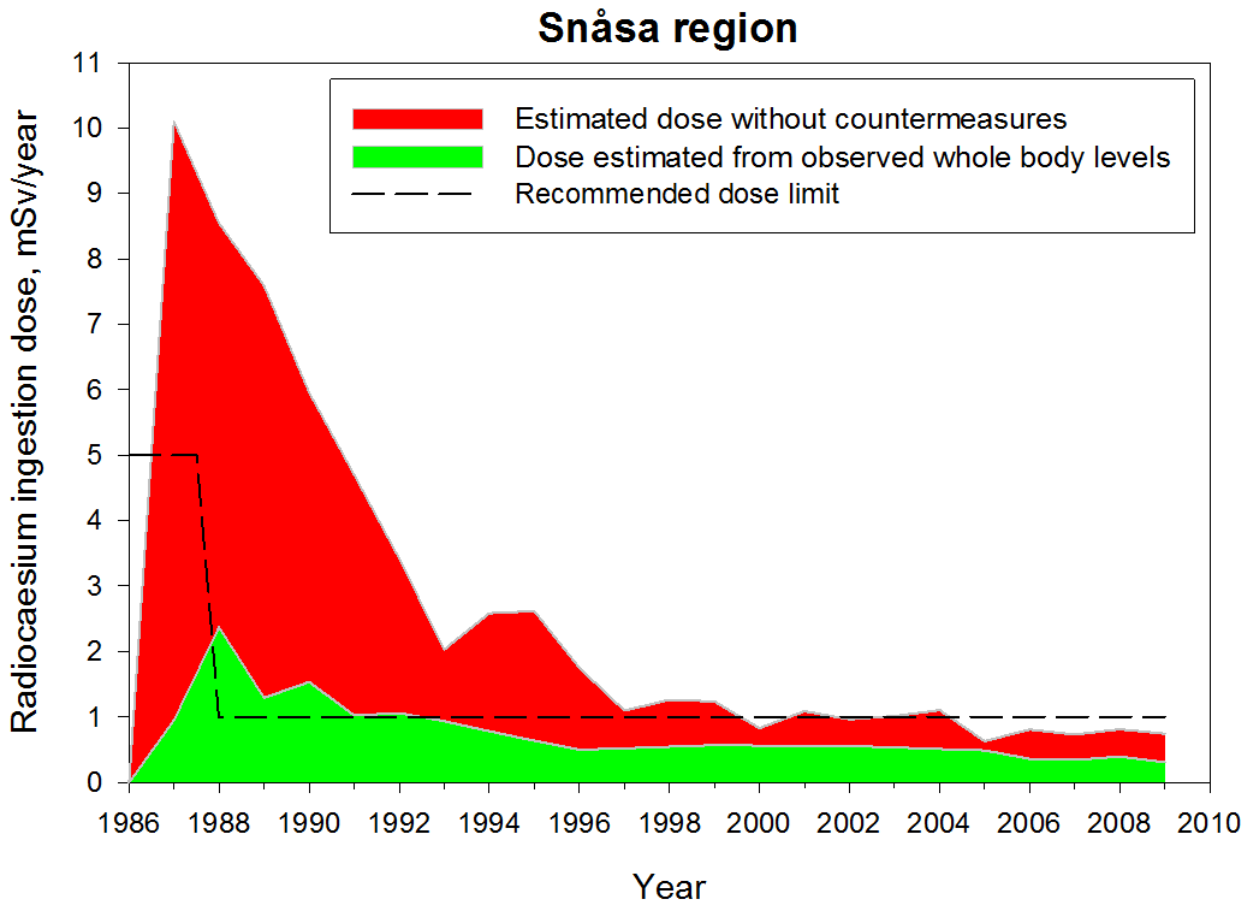
- Advice to reduce levels to below 600 Bq/kg of Cs-134+137 for reindeer consumed in the Sami household
- Compensation payed to Sami huseholds to buy food from less contaminated areas or to clean feed their animals
- Invited to wholde body counting at regular intervals
  - Both measurement and dialogue

WBC results from ongoing programme



Averted doses due to countermeasures

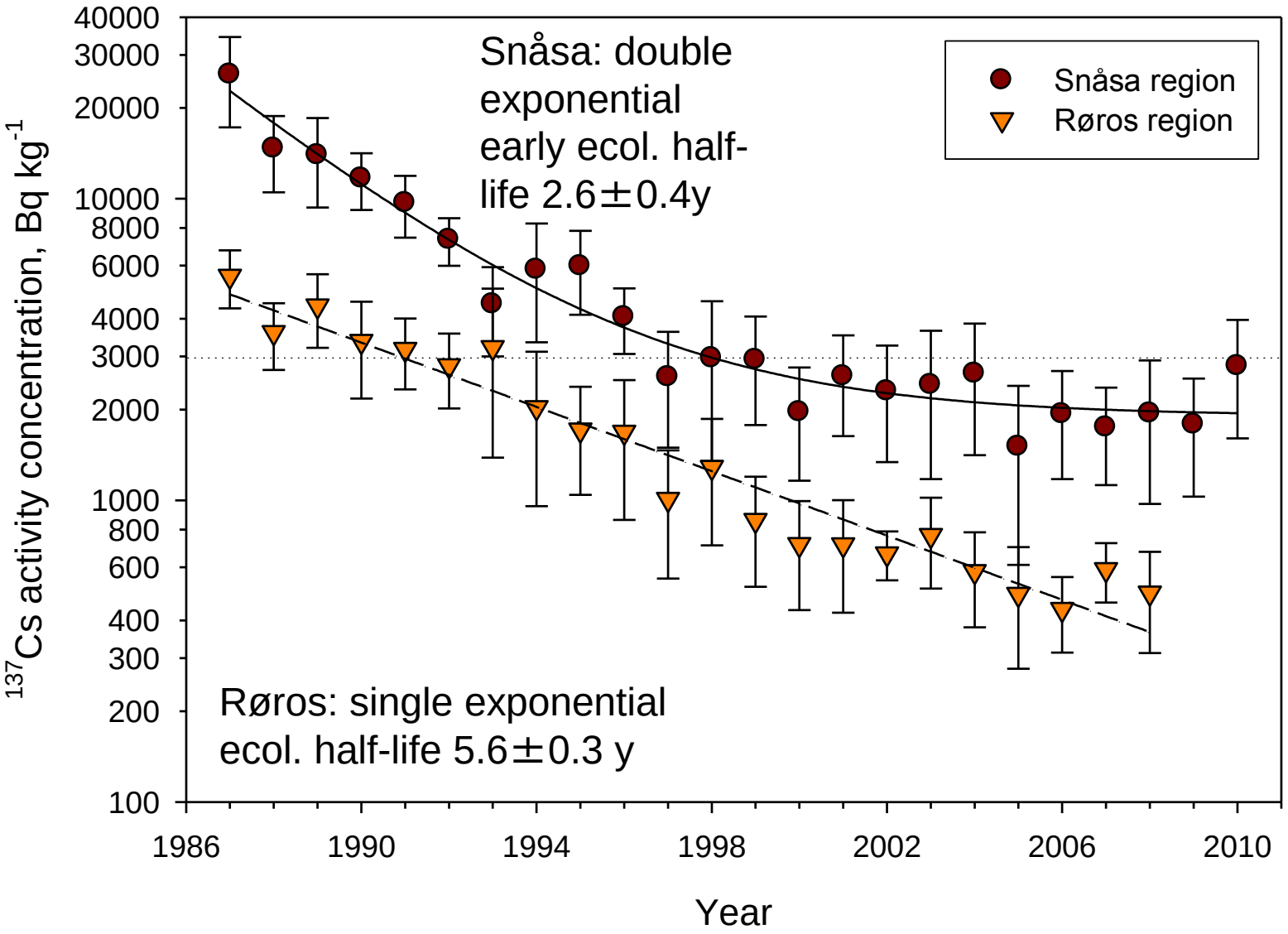
- Change in slaughter time
- Clean feeding
- Dietary vigilance



Costs of countermeasures in Norway

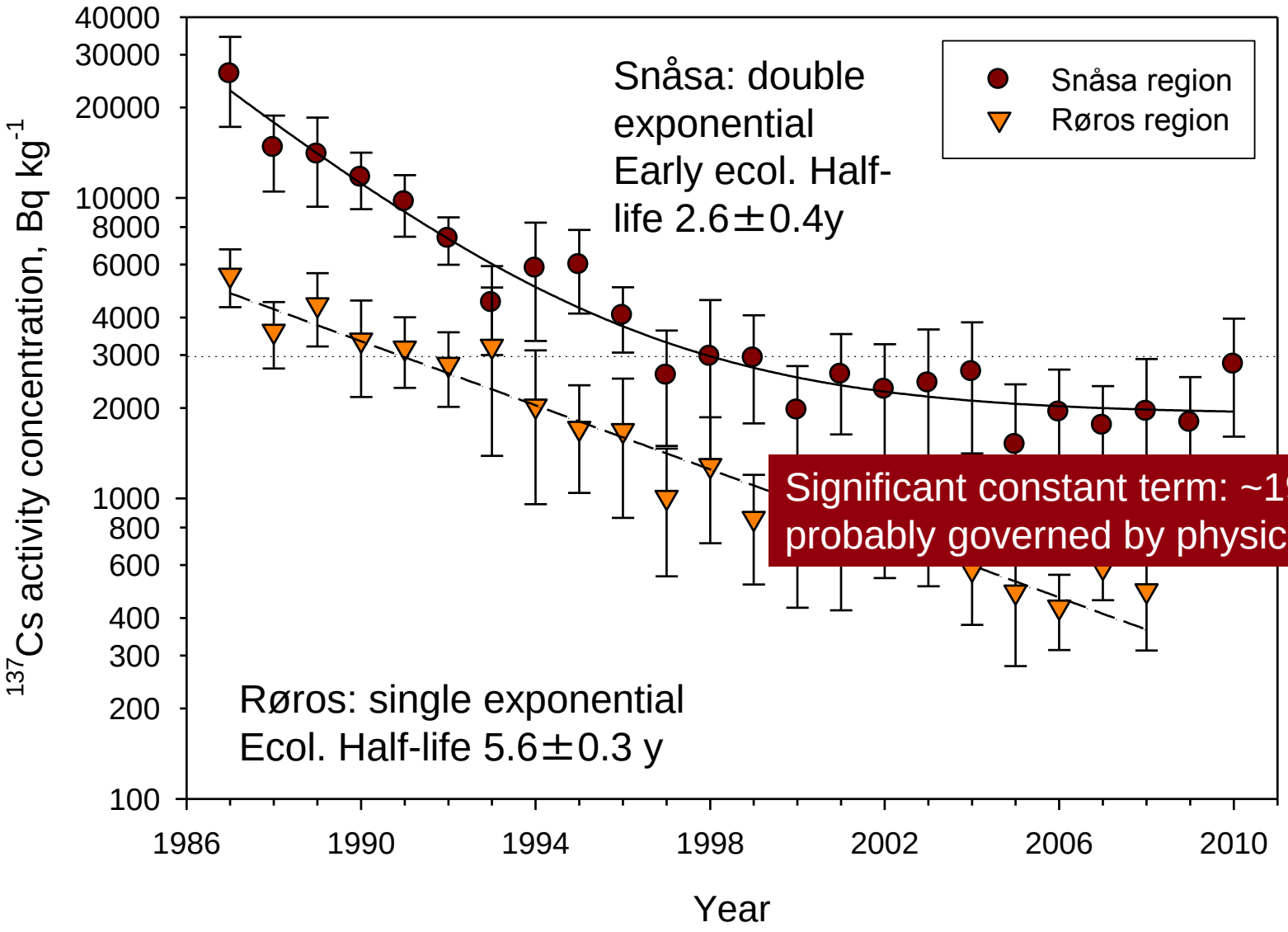
- Total costs ~90 million € since 1986 (measurements, mangement, countermeasures, compensation, research)
- ~1.8 million € still spent annually
  - 1.25 million € for sheep, goats, cows, foodstuffs
  - 0.55 million € for reindeer, reindeer herders, WBC
- Sheep on clean feeding 1986-2010
  - ~2,2 millions animals
  - Total costs: 28,5 million €
  - Value of the saved meat 350 million €

Persistence of the contamination, reindeer



Statens strålevern
Norwegian Radiation Protection Authority

Persistence of the contamination, reindeer

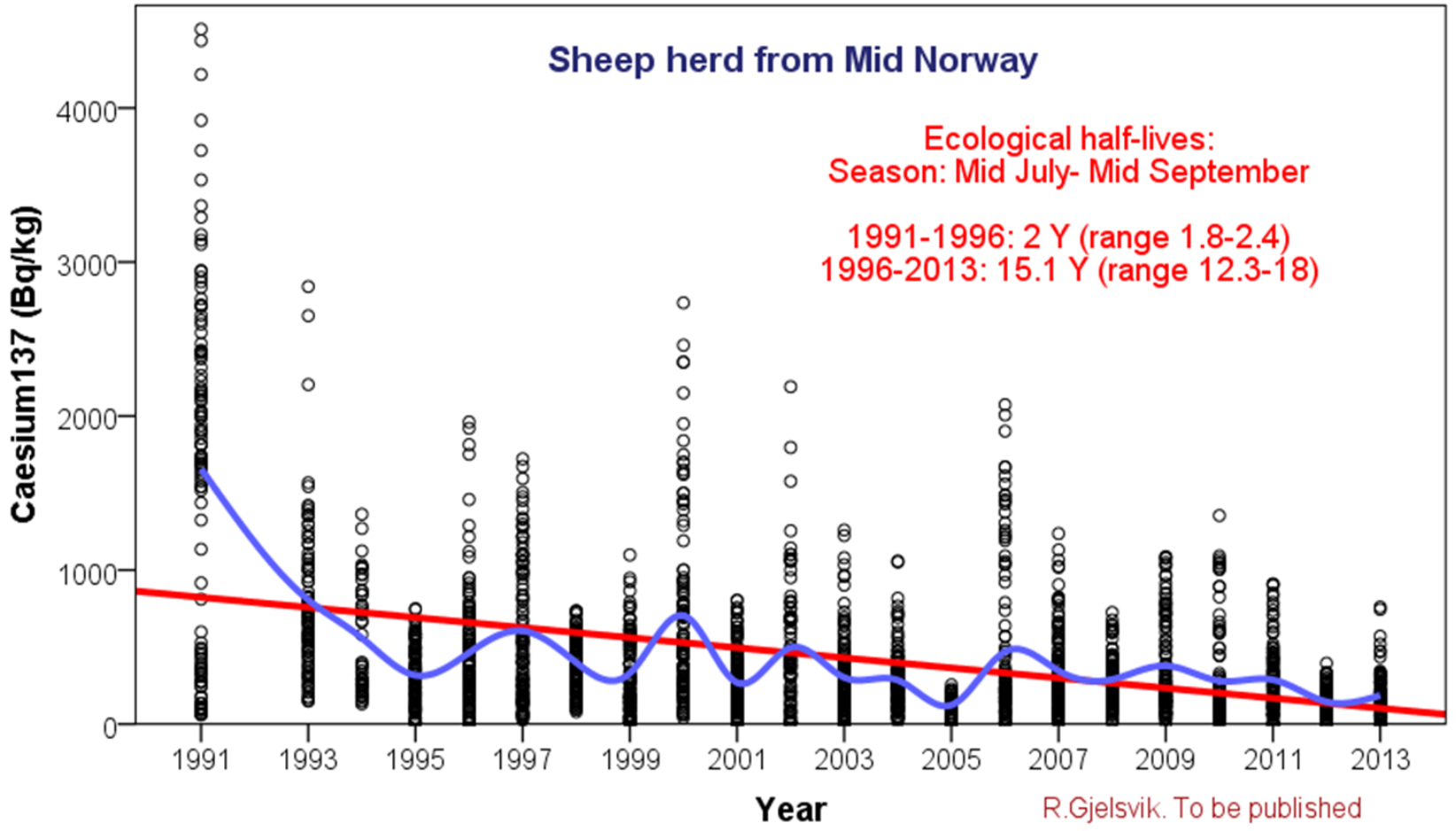


Significant constant term: ~1900 Bq/kg, i.e. probably governed by physical decay (30 y)

Statens strålevern
Norwegian Radiation Protection Authority

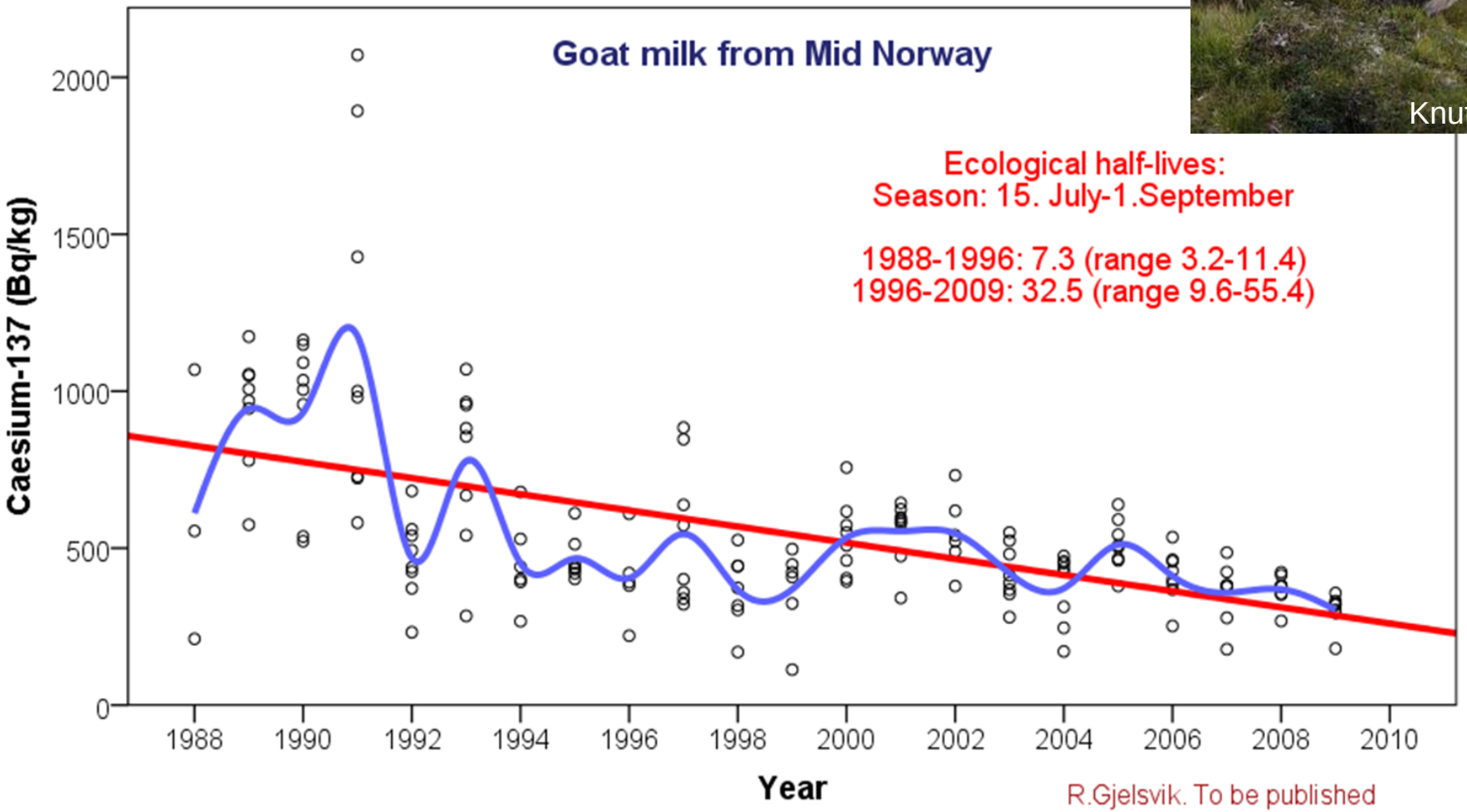
Sheep


Astrid Liland


Sheep herd from Mid Norway
Ecological half-lives:
Season: Mid July- Mid September
1991-1996: 2 Y (range 1.8-2.4)
1996-2013: 15.1 Y (range 12.3-18)
Caesium137 (Bq/kg)
0
1000
2000
3000
4000
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
Year
R.Gjelsvik. To be published

Goat's milk


Knut Hove


Goat milk from Mid Norway
Ecological half-lives:
Season: 15. July-1.September
1988-1996: 7.3 (range 3.2-11.4)
1996-2009: 32.5 (range 9.6-55.4)
Caesium-137 (Bq/kg)
2000
1500
1000
500
0
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
R.Gjelsvik. To be published

Socio-ethical aspects

- Cultural heritage
  - Traditional land use
  - Personal value of farming, hunting and fishing
  - Value of regional food

Syndicat Interprofessionnel de Défense du Camembert de Normandie

Statens strålevern
Norwegian Radiation Protection Authority

Societal aspects

- Food bans / destruction of foodstuffs
  - Very unrewarding for the farmers
- Quality of food
  - Local monitoring stations valuable
- Consumers trust
  - Information, understanding and independent measurements

Empowering the producers

- Depending on contamination, land use, environmental factors etc. the producers could be facing decades of problems
- Food bans and production prohibition is not viable in the long term
- A countermeasure strategy should be elaborated with the producers
- Experts needed to assist local communities in developing strategies and local monitoring stations
- Active participation in mitigating actions and access to local monitoring stations empowers the producers → less psycho-social stress
- Compensation only to cover the costs associated with implementation of countermeasures

Challenges

- Public perception
- The differing values
- Harmonisation across borders
- Persistence of the contamination
- Elaboration of strategy with the stakeholders
- Need to change strategy with time
- Continued information and communication

References

- Liland, A. & Skuterud, L. (2013). Lessons Learned from the Chernobyl Accident in Norway. In D. Oughton & S. O. Hansson (Eds.), *Social and Ethical Aspects of Radiation Risk Management*. Elsevier Science, 157-176. ISBN: 978-0-08-045015-5, ISSN: 1569-4860.

- Skuterud L, Thørring H. Averted doses to Norwegian Sámi reindeer herders after the Chernobyl accident. Health Physic 2012; 102(2): 208-216

- Liland, A., Lochard, J., Skuterud, L. How long is long term? reflections based on over 20 years of post-Chernobyl management in Norway. Journal of Environmental Radioactivity 100 (2009) 581-584. doi:10.1016/j.jenvrad.2009.04.006

- Gjelsvik R. Radioactivity in sheep meat, cow and goat milk, 1988-2004. StrålevernRapport 2005:10. Østerås: Norwegian Radiation Protection Authority, 2005. Language: Norwegian. (*Soon to be updated with data until 2013 included*).

astrid.liland@nrpa.no