# Experiences from a high radon area in Norway

Anne Liv Rudjord

3rd SFRP/IRPA workshop

Tolerability and Reasonableness

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DSA

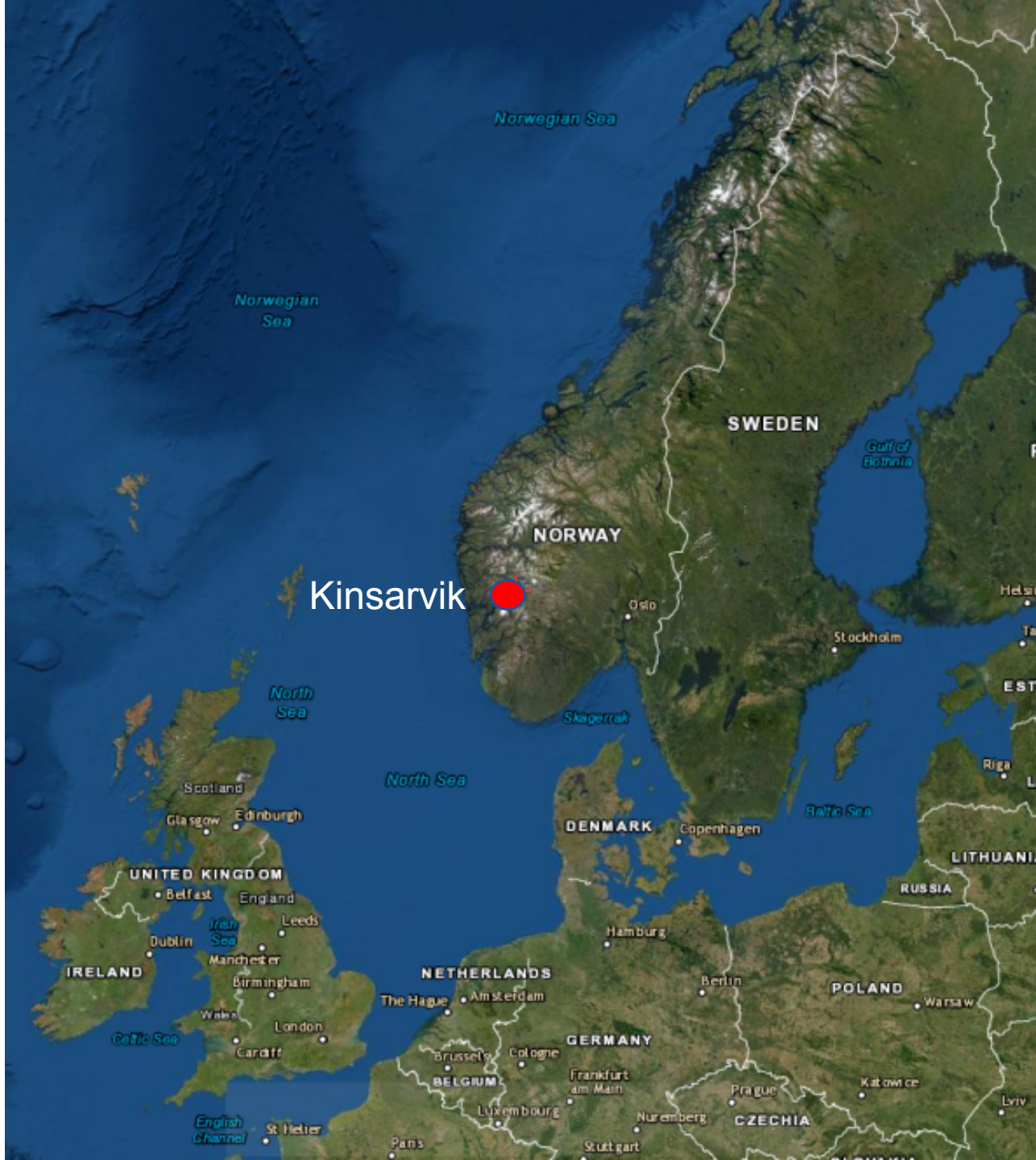
Direktoratet for strålevern og atomsikkerhet

Norwegian Radiation and Nuclear Safety Authority

# Kinsarvik

Norway

An area with very high radon concentrations




DSA

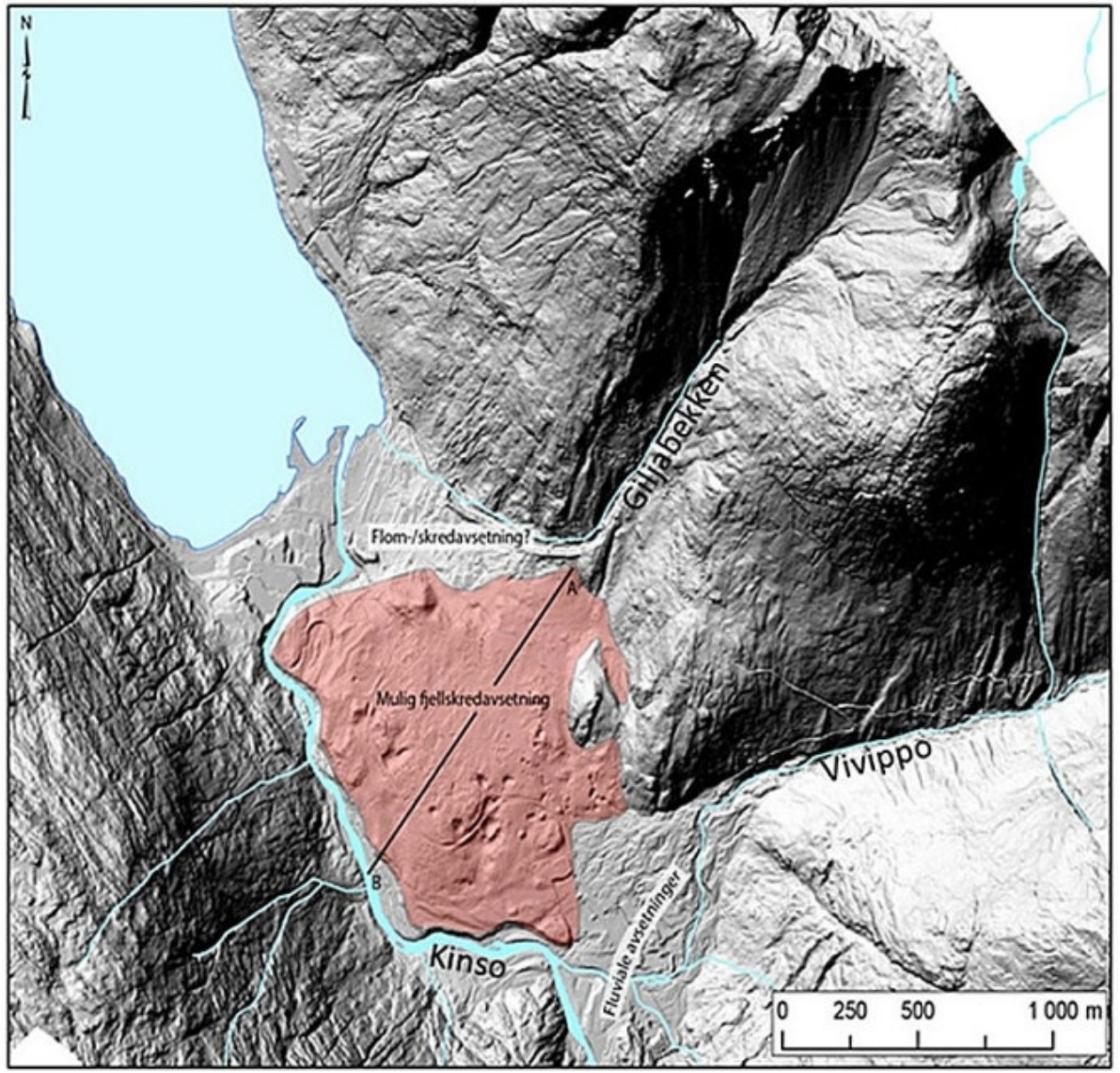
Norwegian Radiation and Nuclear Safety Authority

# The village Kinsarvik

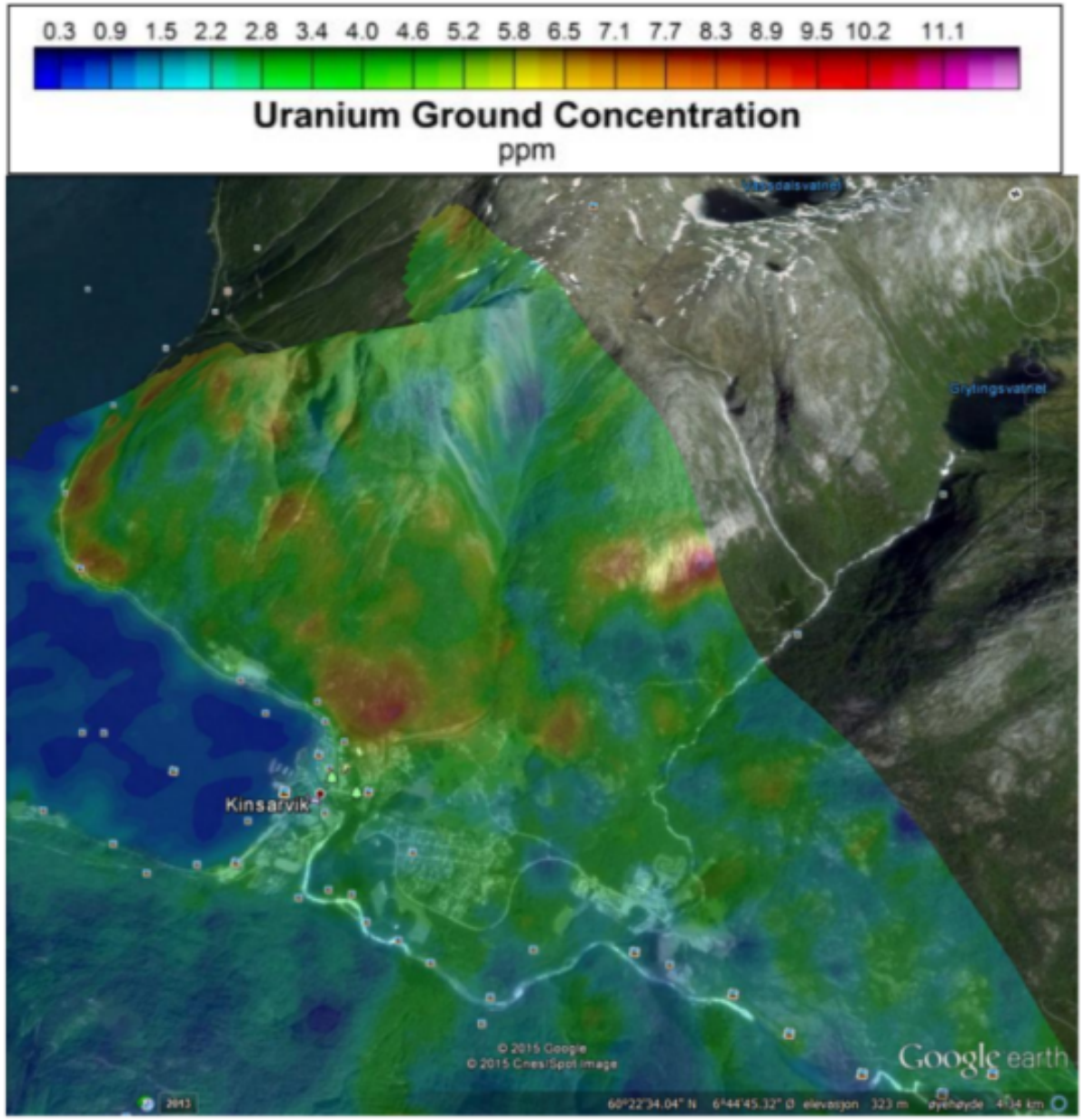
- **555 inhabitants**
- **Administrative centre in Ullensvang municipality**
- **School and kindergarden**
- **Health care centre, nursing home**
- **A variety of workplaces : local administration, shops, hotel, camping site, work shops and small production industries etc.**

# Radon in Kinsarvik

- High radon levels detected in the kindergarden 1988
- Radon measurement and mitigation project 1996-97
- 1999-2003 economic compensation for mitigation in homes
- Study of outdoor radon 2005-7
- New surveys from 2011
- High radon areas will be one of the main priorities in the new national radon strategy from 2021.



**Norwegian Geological Survey:**
Ground uranium from helicopter measurements




Figur 3.2: Uran i bakken fra helikoptermålinger drapert over Google earth-modell.

NGU report 2020.020
J.S. Rønning, J. Høst, M. Böhme, O. Fredin, L. Hansen, R. Hermanns, F. Ofstad og A. Solli : Årsak til radonproblemer i Kinsarvik. Oppfølgende geologiske og geofysiske undersøkelser i 2015, 2016 og 2017 (in Norwegian).
https://www.ngu.no/upload/Publikasjoner/Rapporter/2020/2020_022.pdf

# The Kinsarvik project – 1996-97

**Steering group**

(local political leaders and representatives of the public)

**Working group**

(local administration and health personell, radon experts)

**Phases**

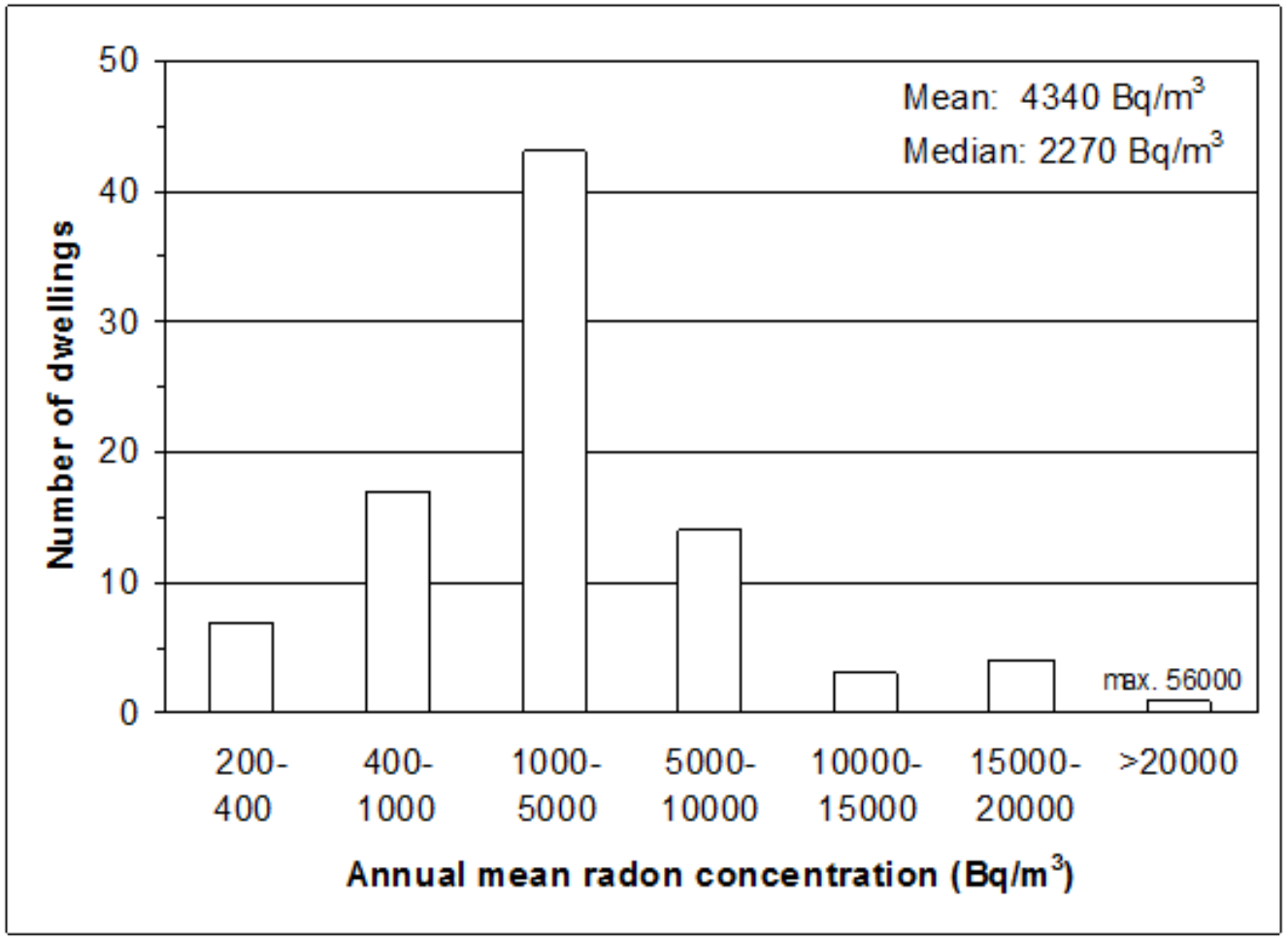
Mapping

Mitigation

Economic compensation

Extended mapping

# Indoor radon concentrations 1996-97 (annual mean)



# Radiation doses Kinsarvik 1996 -97

Pubished values based ***on old ICRP dose conversion factor*** for dwellings (risk based approach)

Effective doses

**Range 3.6 - 930 mSv/year**
**Mean 72 mSv/year**

**Current ICRP dose conversion factor gives effective doses twice these values**

IOP Publishing Journal of Radiological Protection
J. Radiol. Prot. 27 (2007) 287–298 doi:10.1088/0952-4746/27/3/003

## Anomalously high radon concentrations in dwellings located on permeable glacial sediments

A V Sundal[1], C L Jensen[2], K Ånestad[1] and T Strand[1,3,4]

[1] Norwegian Radiation Protection Authority, PO Box 55, N-1332 Østerås, Norway
[2] Akershus University Hospital, 1478 Lørenskog, Norway
[3] Department of Physics, University of Oslo, PO Box 1048, N-0316 Blindern, Norway

E-mail: Terje.Strand@nrpa.no

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**Abstract**
Indoor radon concentrations were measured in different seasons in 104 dwellings located on a highly permeable ice-marginal moraine in Kinsarvik, Western Norway. The measurements revealed the highest indoor radon levels ever detected in Norway and extreme variations in seasonal and short-term indoor radon levels. Annual average indoor radon concentrations up to 56 000 Bq $m^{-3}$ and a mean value of 4340 Bq $m^{-3}$ for the whole residential area are reported. By using the ICRP conversion factors to effective dose, these indoor radon values correspond to a total annual effective dose of 930 mSv and 72 mSv, respectively. By using the conversion as recommended by UNSCEAR, the effective doses would be about 50% higher. The indoor radon concentrations are found to be strongly influenced by thermally induced flows of radon-bearing soil air directed towards the upper part of the ice-marginal deposit in winter and towards the area of lowest elevation in summer. The pattern of seasonal variations observed suggests that in areas where thermal convection may occur, annual average indoor radon levels should be derived from measurements performed both in summer and in winter.

### 1. Introduction

Exposure to the naturally occurring radon-222 and its short-lived decay products in dwellings is the dominant contributor to the total effective dose of ionising radiation received by the world's population and the main contributor to lung cancer after smoking (UNSCEAR 2000). The mean radon concentration in Norwegian dwellings is 89 Bq $m^{-3}$ (Strand *et al* 2001) which, by using the risk-based approach developed by ICRP (1993) in the calculation of effective dose, corresponds to an annual effective dose of 1.7 mSv. Large-scale surveys have shown that the

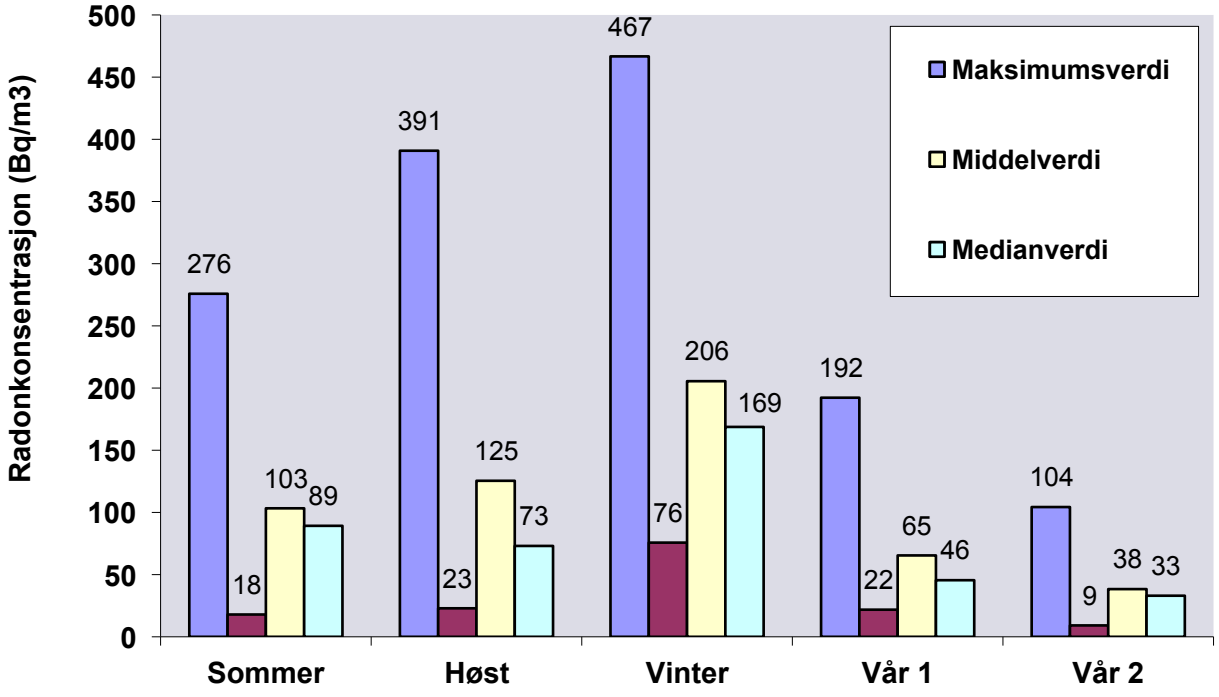
[4] Author to whom any correspondence should be addressed.

# Kinsarvik – radon mitigation efforts

- 1997:  Pilot project: Testing reduction techniques in 3 houses
- Difficult to achieve sufficient reduction of radon (below 2-400 Bq/m3 )
- Development of mitigation plans for 96 houses
- Economic compensation for mitigation available in 1999-2003
- Interest seemed to be suprisingly low. Only a few homeowners applied for economic compensation
- Uncertainty on efficiency of mitigation

# Outdoor radon concentrations

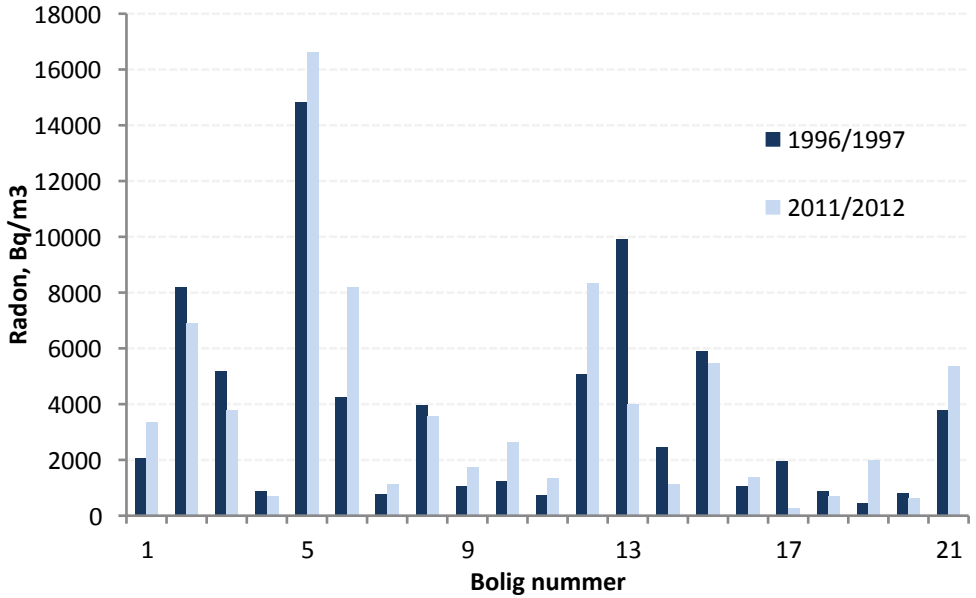
- Explains why it was difficult to achieve radon levels below national recommendations in dwellings




# Annual mean radon 1996-97 and 2011-12

- No improvement from1996-1997 when same dwelling is measured again

- However, indications that <u>new</u> dwellings have lower radon concentrations. Values still too high



# Exposure situations

High radon concentrations in

- → Homes (200-56000 Bq/m3)
- → Kindergarden (281-988 Bq/m3)
- → School (127-6500 Bq/m3)
- → Work places (96-2000 Bq/m3)
- → Health care institutions (90-3800 Bq/m3)
- → Shops and public buildings (200-1700 Bq/m3)
- → Outdoor area (~100-400 Bq/m3)

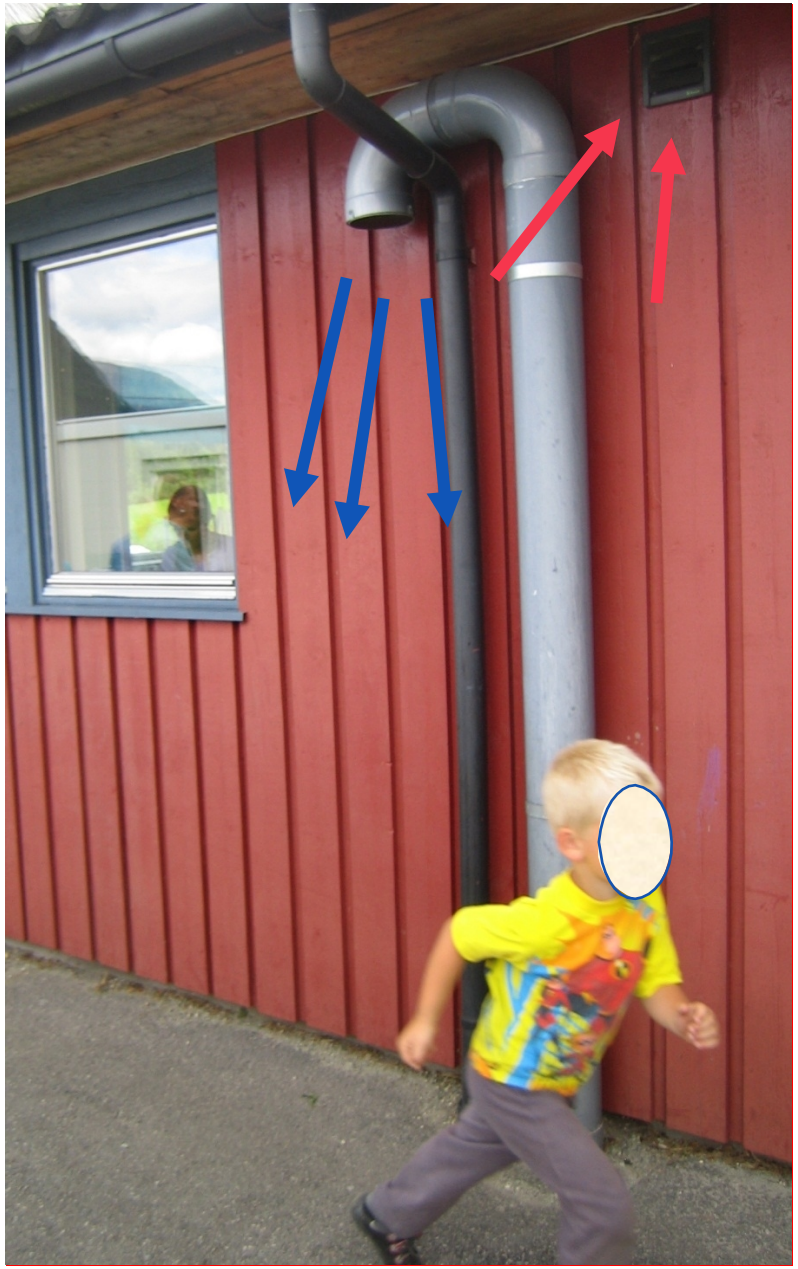


Photo Bård Olsen

# Radon in Kinsarvik - priorities

→ Highest radon exposure in dwellings

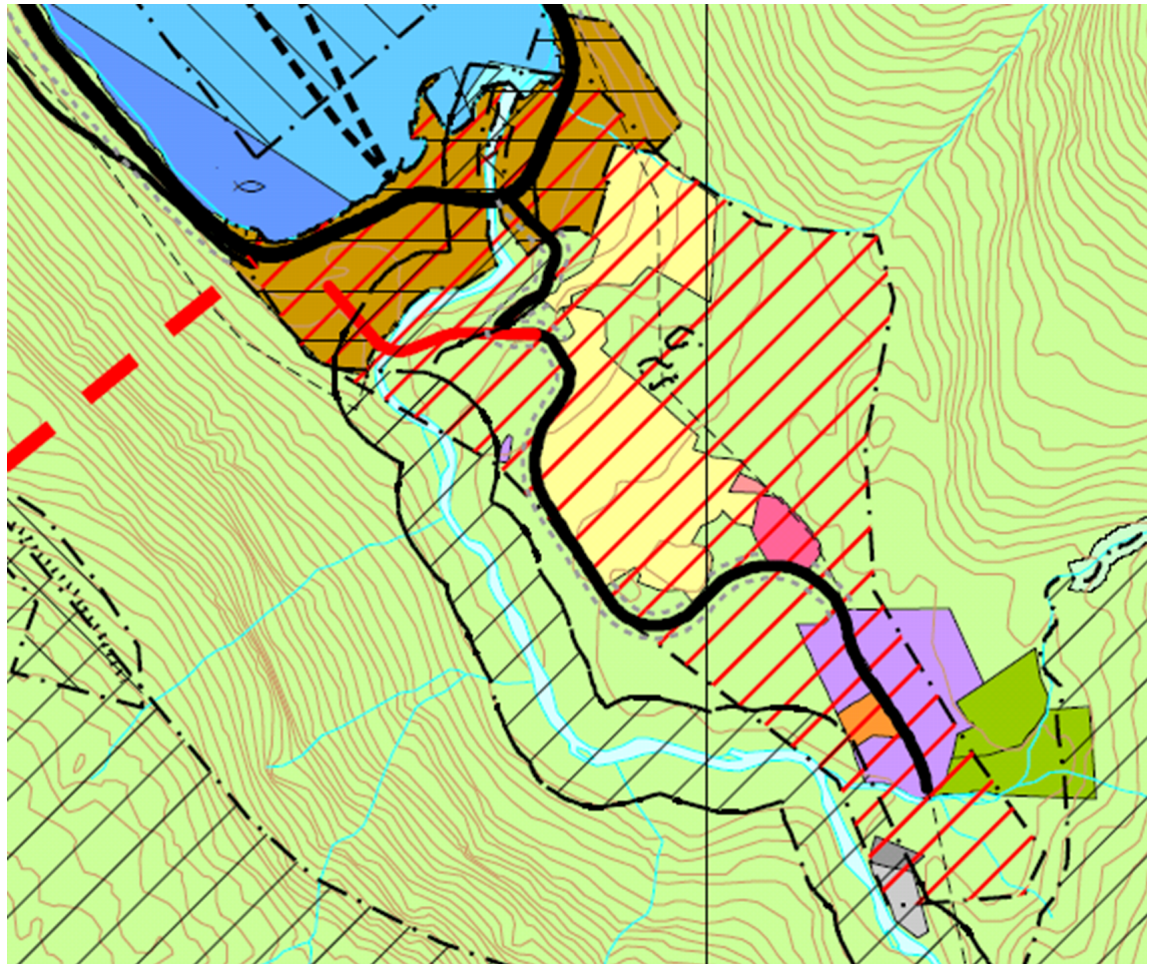
→ Regulations on radon apply to radon in new construction, workplaces, kindergardens, schools etc, but not in most existing dwellings

→ Since the local administration has responsibilities for schools, kindergardens, some workplaces etc, radon reduction in these situations tend to be prioritized.

# Land planning : Radon in new buildings

→ National building regulations require radon concentrations below 200 Bq/m3 in new build.

→ Most of Kinsarvik is now categorized as a natural hazard area with specific local regulations on new building.



# Summary

→ Very high indoor radon concentrations indoors in homes, but also kindergarden, school, workplaces.

→ Mean estimated effective dose 72 mSv/year, max 930 mSv/year (using old ICRP dose conversion factor)

→ The radon problem is largely due to very permeable building ground – probably originating from a landslide. Unusual seasonal variations are seen.

→ Substantial reductions in radon exposures can be achieved through mitigation. However, it proved difficult to achieve levels below action limits and «reference» value (200 Bq/m3).

→ Outdoor levels of radon are unusually high, up to 467 Bq/m3 in winter

→ Areas with very high radon concentrations will be a priority in the new national radon strategy

# Thank you for your attention !