# Experiences from a high radon area in Norway

Anne Liv Rudjord, Trine Kolstad and Ingvild Finne

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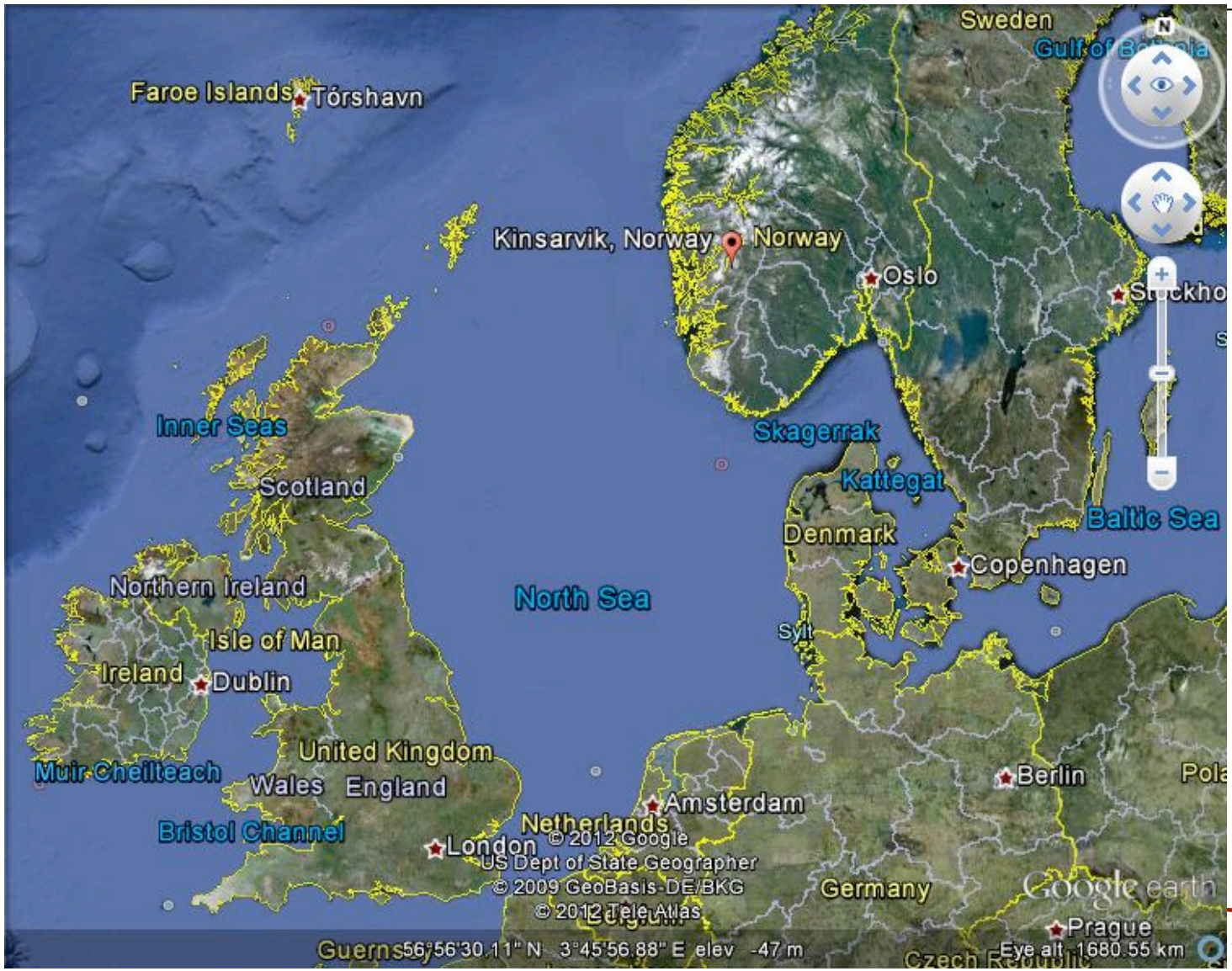
Statens strålevern
Norwegian Radiation Protection Authority

# Kinsarvik, Norway

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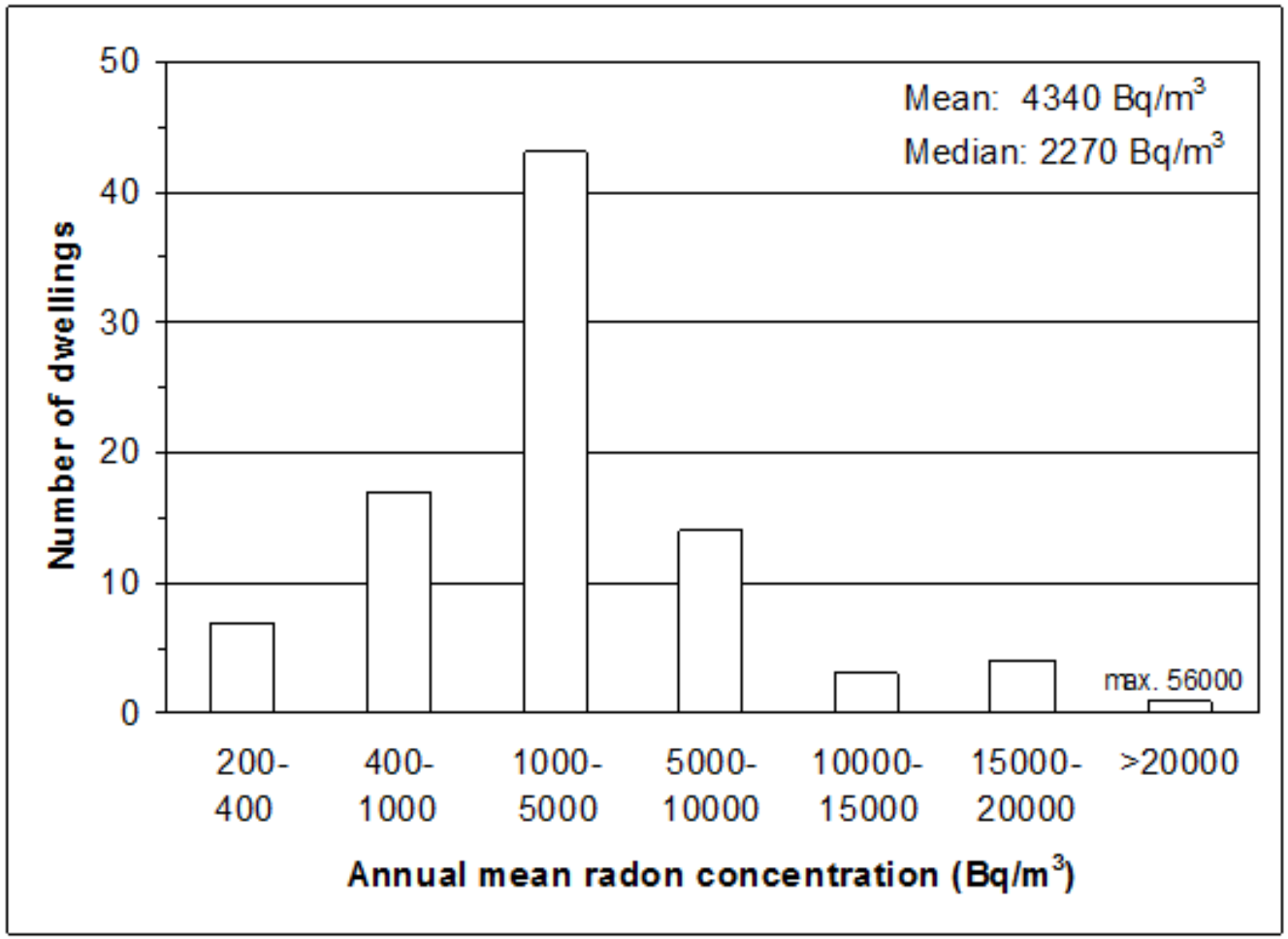
# Radon in Kinsarvik

- **Very high radon concentrations in most houses. More than 99 % above 200 Bq/m3**
- **Unusual seasonal variations**

# 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
- National Strategy and action plan 2009
- New pilot project from 2011
- Still in 2012 a severe radon problem persists

# Radon concentrations 1996-97



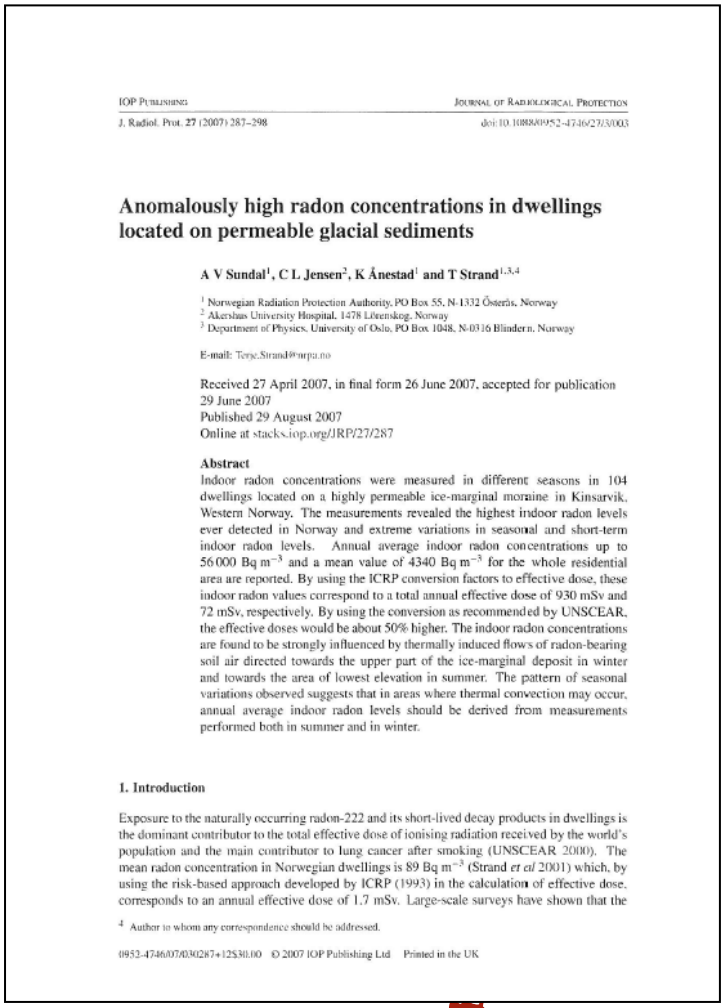
# Radiation doses Kinsarvik 1996-97

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**

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



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## 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.

# Exposure situations

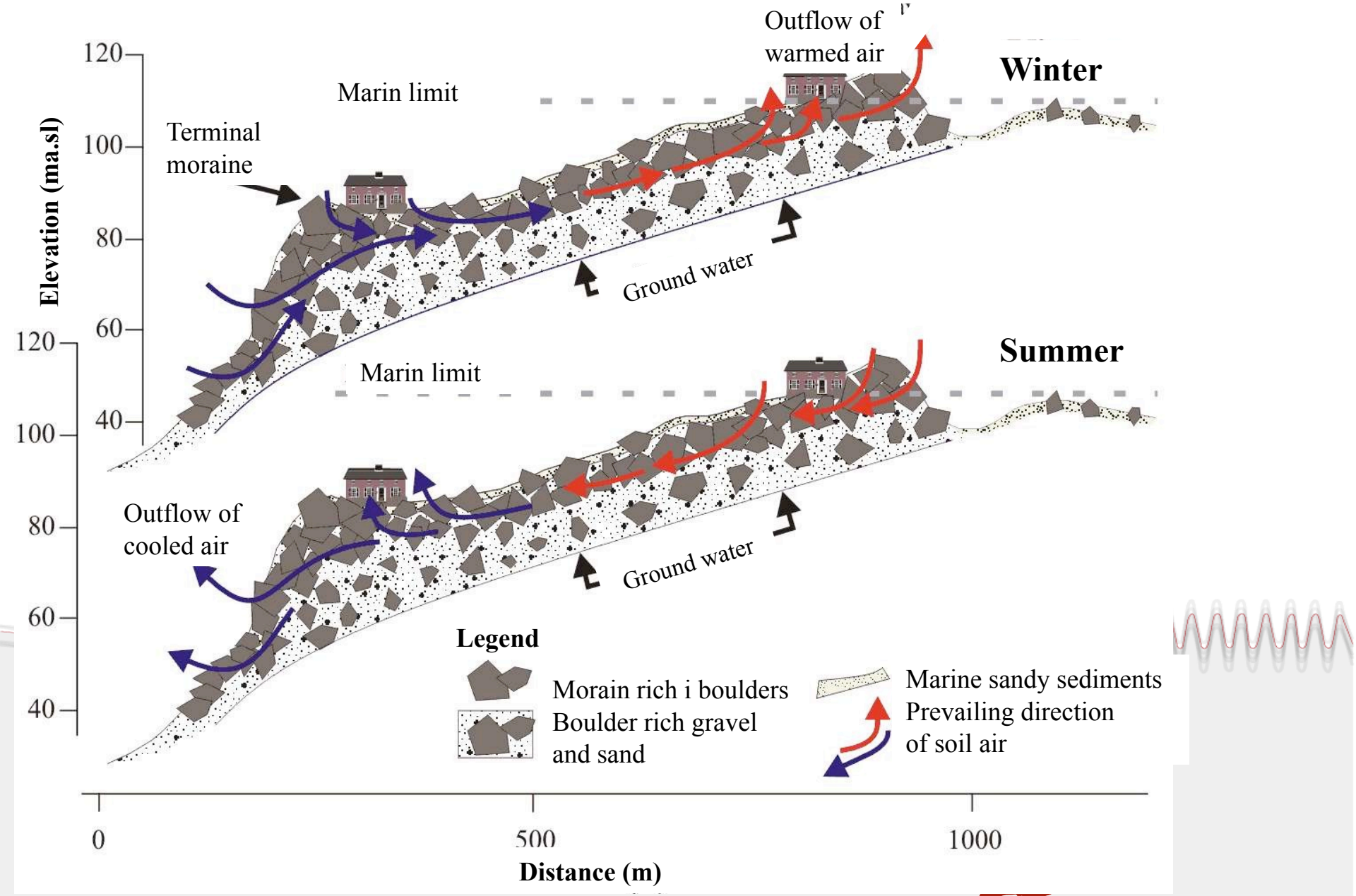
High radon concentrations in

- Dwellings
- Kindergarden
- School
- Work places
- Health care institutions
- Shops and public buildings
- Outdoor areas

➢**Radon could be seen as <u>one</u> exposure situation ?**

# 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.


Outflow of
warmed air
Winter
Marin limit
Terminal
moraine
Ground water
Summer
Marin limit
Outflow of
cooled air
Ground water
Legend
Morain rich i boulders
Boulder rich gravel
and sand
Marine sandy sediments
Prevailing direction
of soil air
Elevation (ma.sl)
120
100
80
60
40
120
100
80
60
40
0
500
1000
Distance (m)

# Seasonal variations of radon 1996-97

| | | Mean radon concentration (Bq/m3) | | |
|---|---|---|---|---|
| **Area** | | Winter | Summer | Ratio |
| Upper | (35) | 9840 | 1240 | 20.2 |
| Central | (19) | 2430 | 2900 | 2.2 |
| Lower | (35) | 960 | 5540 | 0.3 |
| **All** | **(96)** | 4660 | 3160 | 1.4 |

# Stakeholders

- National authorities
- Local administration/authority:

  political leaders

  local planning

  school and kindergardens

  health care
- Secondary informants:

  Health care workers and teachers
- Public:

  home owners, parents

- Local industry, employers

# The Kinsarvik project – 96-97

**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

# Kinsarvik – mitigation 1996-97 and 2003

- Pilot project: Testing reduction techniques in 3 houses
- Development of mitigation plans for 96 houses
- Economic compensation for mitigation available in 1999-2003

# Response of the public

- Interest and anxiety varied strongly
- Many compared their radon values with their neighbours
- Age dependent. Parents concerned with their childerens health
- Many, especially older people, did not believe in the health risks

# Radon mitigation

- Interest seemed to be suprisingly low. Only a few homeowners applied for economic compensation

- Uncertainty on efficiency of mitigation

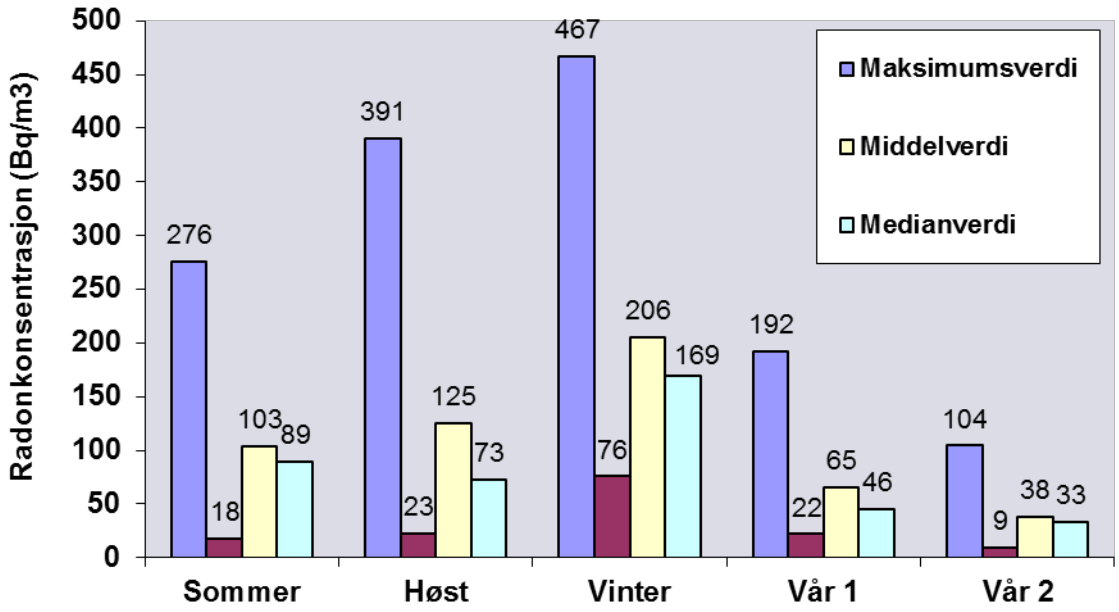
When target levels below 200 Bq/m3 were not met in the pilot study, mitigation was perceived as unsuccessful

- Focus on negative economic consequences

- Unwillingness to be associated with radon problems and cancer risk.

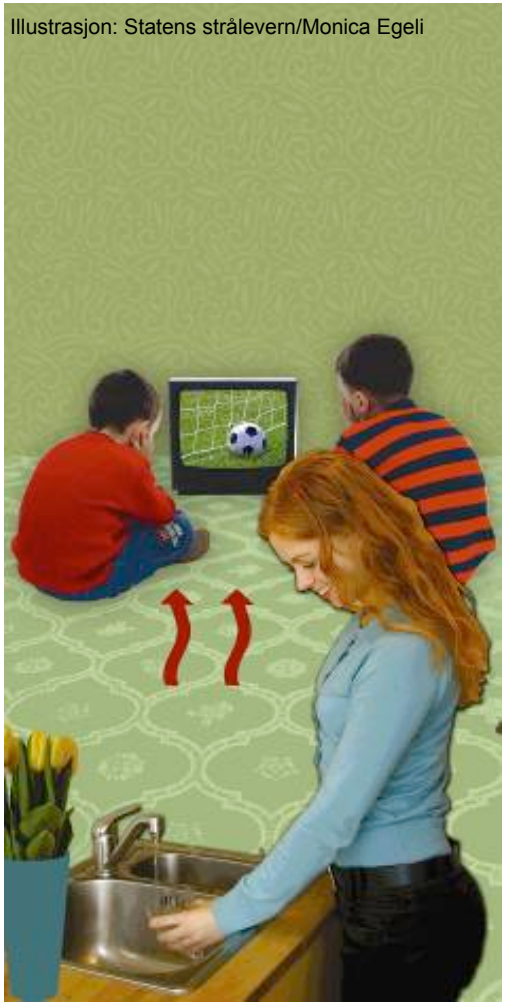
# Outdoor radon concentrations

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




# The Norwegian radon strategy

- **Strategic goal of achieving ALARA**
- **supplemented with legally binding limits where appropriate such that authorities have a basis for enforcement and compliance.**

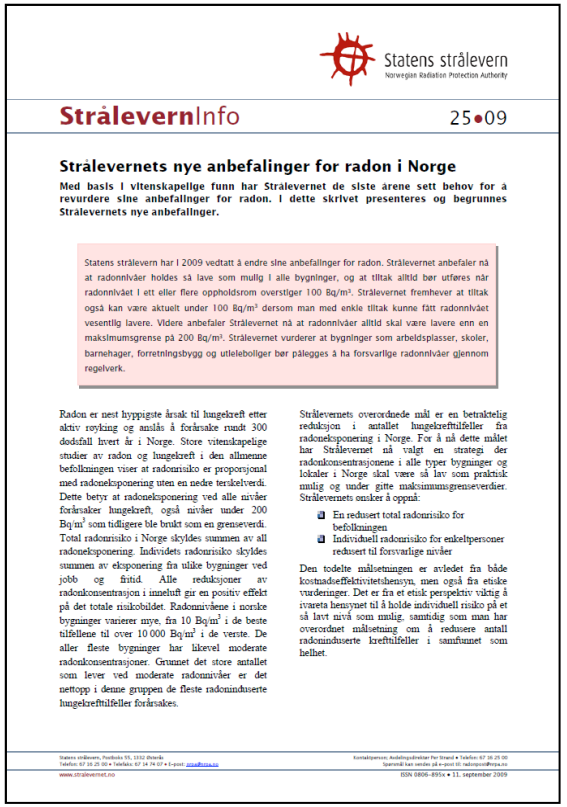



**Sub-strategies all have separate goals and suggested initiatives:**

- **Radon in land planning**
- **Radon with regard to new-build**
- **Radon in existing homes**
- **Local communities in Norway with extreme radon problems**
- **Radon in buildings and localities where the public have access**
- **Radon in the workplace**

# NRPA recommendations for radon - 2009

- All buildings should have radon levels as low as reasonably achievable and within recommended limits:
  - 100 Bq/m$^3$ – Action Limit
  - 200 Bq/m$^3$ – Maximum Limit
- All buildings should be measured for radon regularly and always following modifications
- Radon measurements should be performed long-term during winter months using track-etch detectors
- Radon mitigation measures in existing buildings should be source-specific
- Radon measurements should be repeated after mitigation measures have been carried out



Statens strålevern
Norwegian Radiation Protection Authority

StrålevernInfo 25•09

**Strålevernets nye anbefalinger for radon i Norge**

**Med basis i vitenskapelige funn har Strålevernet de siste årene sett behov for å revurdere sine anbefalinger for radon. I dette skrivet presenteres og begrunnes Strålevernets nye anbefalinger.**

Statens strålevern har i 2009 vedtatt å endre sine anbefalinger for radon. Strålevernet anbefaler nå at radonnivåer holdes så lave som mulig i alle bygninger, og at tiltak alltid bør utføres når radonnivået i ett eller flere oppholdsrom overstiger 100 Bq/m³. Strålevernet fremhever at tiltak også kan være aktuelt under 100 Bq/m³ dersom man med enkle tiltak kunne fått radonnivået vesentlig lavere. Videre anbefaler Strålevernet nå at radonnivåer alltid skal være lavere enn en maksimumsgrense på 200 Bq/m³. Strålevernet vurderer at bygninger som arbeidsplasser, skoler, barnehager, forretningsbygg og utleieboliger bør pålegges å ha forsvarlige radonnivåer gjennom regelverk.

Radon er nest hyppigste årsak til lungekreft etter aktiv røyking og anslås å forårsake rundt 300 dødsfall hvert år i Norge. Store vitenskapelige studier av radon og lungekreft i den allmenne befolkningen viser at radonrisiko er proporsjonal med radoneksponering uten en nedre terskelverdi. Dette betyr at radoneksponering ved alle nivåer forårsaker lungekreft, også nivåer under 200 Bq/m³ som tidligere ble brukt som en grenseverdi. Total radonrisiko i Norge skyldes summen av all radoneksponering. Individets radonrisiko skyldes summen av eksponering fra ulike bygninger ved jobb og fritid. Alle reduksjoner av radonkonsentrasjon i inneluft gir en positiv effekt på det totale risikobildet. Radonnivåene i norske bygninger varierer mye, fra 10 Bq/m³ i de beste tilfellene til over 10 000 Bq/m³ i de verste. De aller fleste bygninger har likevel moderate radonkonsentrasjoner. Grunnet det store antallet som lever ved moderate radonnivåer er det nettopp i denne gruppen de fleste radoninduserte lungekreftilfeller forårsakes.

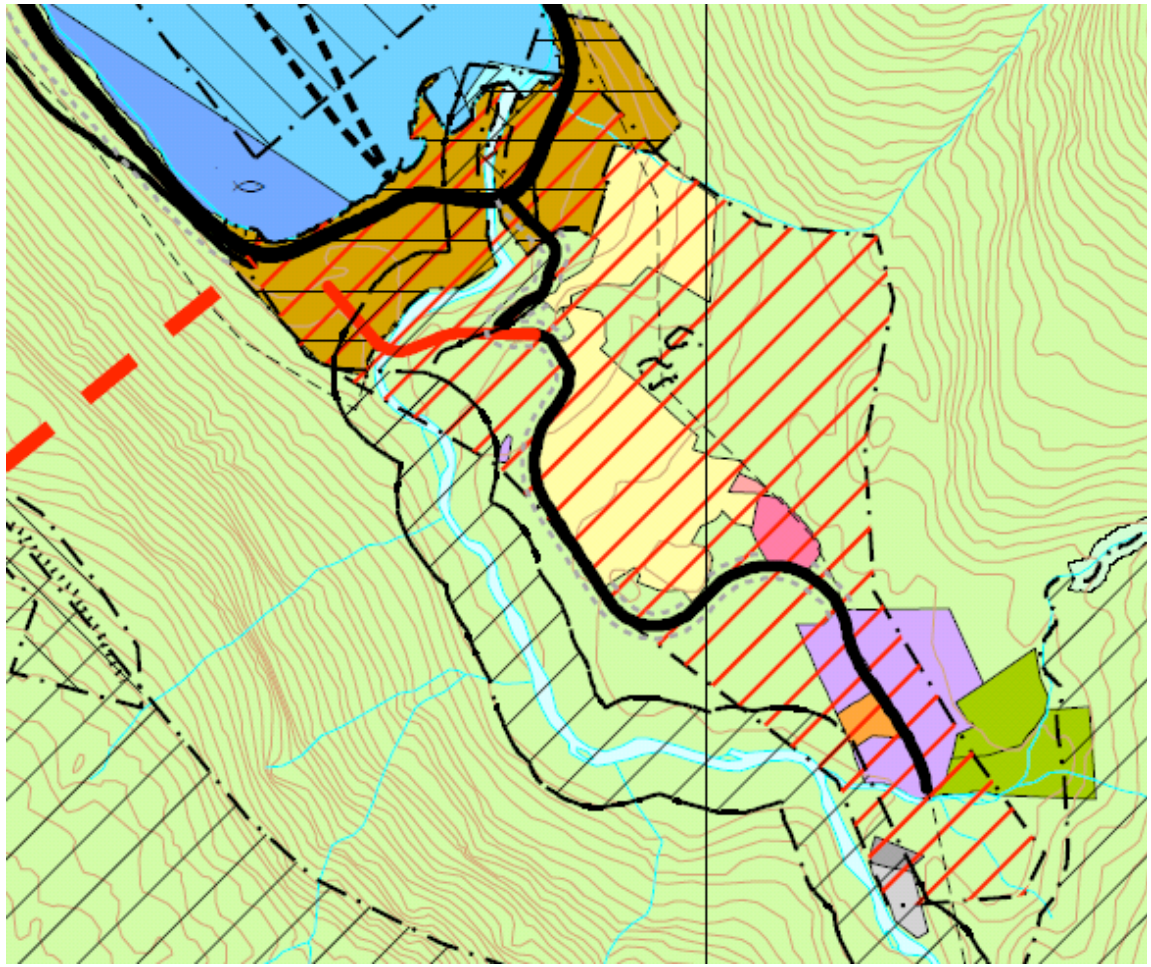
Strålevernets overordnede mål er en betraktelig reduksjon i antallet lungekreftilfeller fra radoneksponering i Norge. For å nå dette målet har Strålevernet nå valgt en strategi der radonkonsentrasjonene i alle typer bygninger og lokaler i Norge skal være så lav som praktisk mulig og under gitte maksimumsgrenseverdier. Strålevernets ønsker å oppnå:

- En redusert total radonrisiko for befolkningen
- Individuell radonrisiko for enkeltpersoner redusert til forsvarlige nivåer

Den todelte målsetningen er avledet fra både kostnadseffektivitetshensyn, men også fra etiske vurderinger. Det er fra et etisk perspektiv viktig å ivareta hensynet til å holde individuell risiko på et så lavt nivå som mulig, samtidig som man har overordnet målsetning om å redusere antall radoninduserte kreftilfeller i samfunnet som helhet.

# Radon in new buildings

- Population is increasing, and new homes are being built.
- Most of Kinsarvik is now categorized as a natural hazard area with specific local regulations on new building.



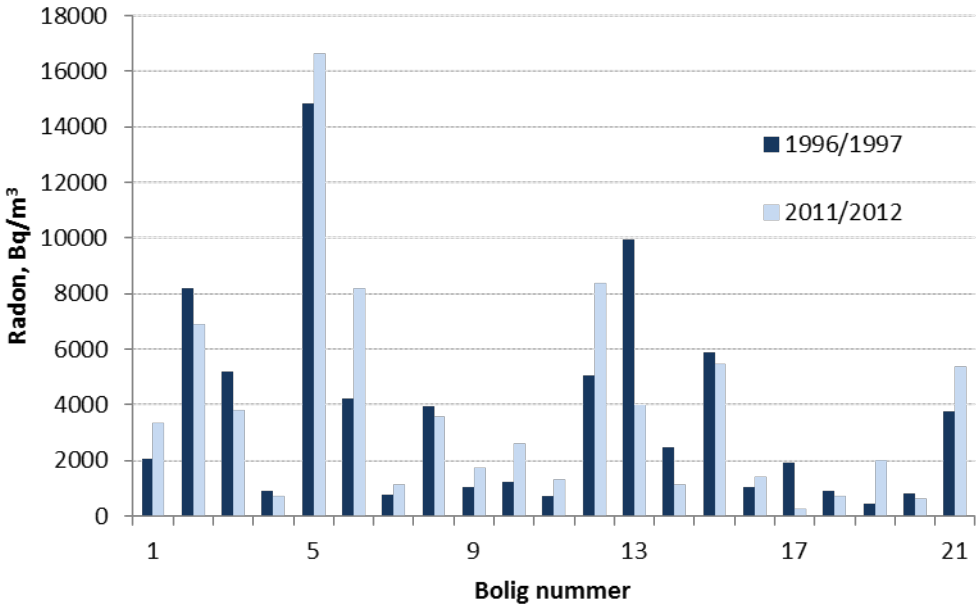
# New pilot project

- Project leader from local public administration
- New measurements to obtain updated status on radon
- Offering advice and support about radon mitigation to members of the public
- Advice on radon to local politicians and administrators
- Seminar for municipal administrators and health sector
- Excursion to a radon prone area in Finland i planned

# Annual mean radon 1996-97 and 2011-12

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

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



# Seminar on radon april 2012


Audience from local and regional public administrations including health sector

# Some lessons learned

- The local authorities and the public must be involved in the planning and implementation of radon reduction projects
- Information about the health hazards and measurement campaigns needs to be followed up immediately with efficient mitigation.
- Local health workers and public health specialists need sufficient knowlegde on radon risks and synergy with smoking.

# lessons learned

- Competence and experience of radon remediation companies is essential
- The message on efficiency of radon reduction must not be unrealistic. It should be emphasized that any reductions of radon are beneficial.
- The ability of the public and local authorities to cope with the problems may be strengthened for instance by more focus on succes stories and positive side effects.


Xpelair