NKS-B MOBELRAD and GAMFAC: Nordic Field Exercises In The Belarusian Exclusion Zone.

Mark Dowdall[1], Yuri Bondar[2]
[1]*Norwegian Radiation Protection Authority, Østerås, Norway*
[2]*Polessie State Radiation-Ecology Reserve, Khoiniki, Belarus*

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Introduction

- NKS MOBELRAD - *Mobile Measurement: Field Exercise in Fallout Mapping in the Belarusian Exclusion Zone*

  NKS Activity in 2014 contract number AFT/B(14)4

  Participants – NRPA, SSM, IRSA, DEMA, PSRER

- NKS GAMFAC - *Advanced In-situ Gamma Spectrometry Field Activity – Chernobyl*

  NKS Activity in 2014 contract number AFT/B(14)4

  Participants – NRPA, FOI, IRSA, DEMA, PSRER Stirling University

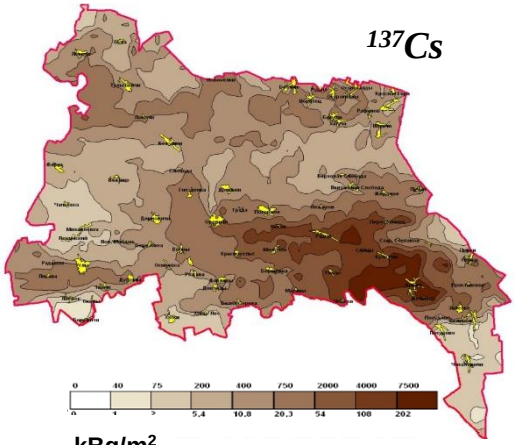
Belarus – Partners and Location

- Polessie State Radiation-Ecological Reserve (PSRER)
  Department for Liquidation of the Consequences of the Accident at the Chernobyl NPP, Ministry of Emergency Measures of Belarus

- Belarusian Exclusion Zone
  - 216.2 thousand hectares
  - ^{90}Sr: 20 kBq/m^2 to > 3 MBq/m^2
  - ^{241}Am: 0.4 kBq/m^2 to > 100 kBq/m^2
  - ^{238}Pu: 0.2 kBq/m^2 to >37 kBq/m^2
  - $^{239,240}Pu$: 0.2 kBq/m^2 to > 74 kBq/m^2
  - ^{137}Cs: up to 12 MBq/m^2

  Dose rates: up to11 µSv/hr

  92 abandoned villages/towns



General Objectives

- Exercise/development opportunity for Nordic actors in highly contaminated areas/complex post-depositional environment.
- Improve capabilities with respect to conducting typical post-accident assistance operations in other countries.
- «*Young scientist*» activity.
- Establish and maintain relations with relevant Belarusian authorities.
- Technical and expertise exchange between Belarusian partner and Nordic actors.

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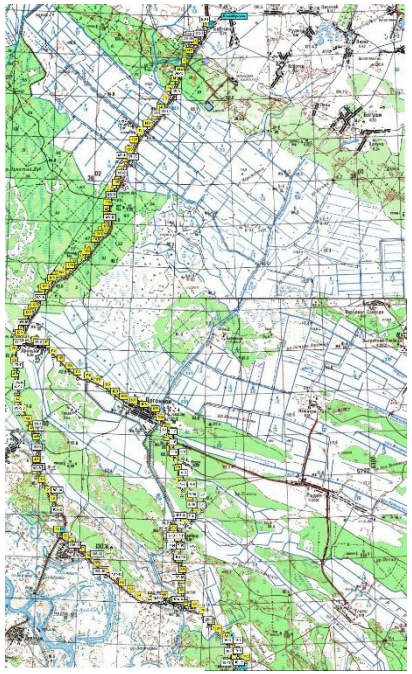
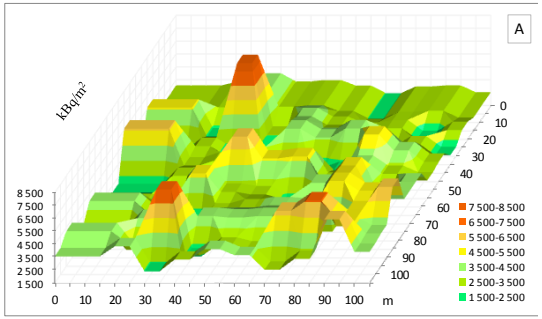
- Specific objective – exercise/practice in conducting practical mobile measurements/mapping in a highly contaminated, complex post-depositional environment.

- Realisation (September 2014):
  - specific route (88 km) through the zone prepared in advance with detailed high resolution measurements of contamination status
  - route traversed a variety of road surfaces, contamination levels, environment types, etc.
  - separate well characeterised «control» points along the route.
  - calibration area for control measurements





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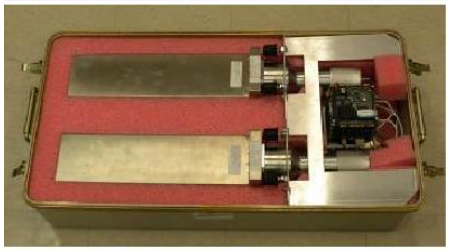
Each team travelled the route alone and with other teams.

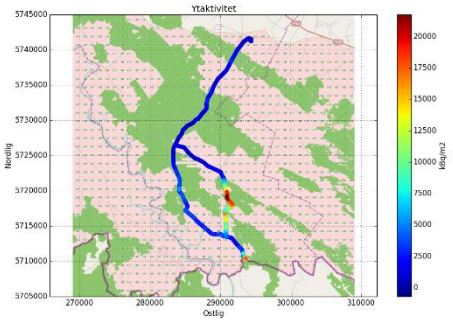
Wide variety of instrumentation employed – typical for mobile mapping/source searching.

Large volume NaI (8 l), LaBr, small volume NaI etc etc.

Wide range of typical data handling/display solutions.

Various calibration routines/systems.





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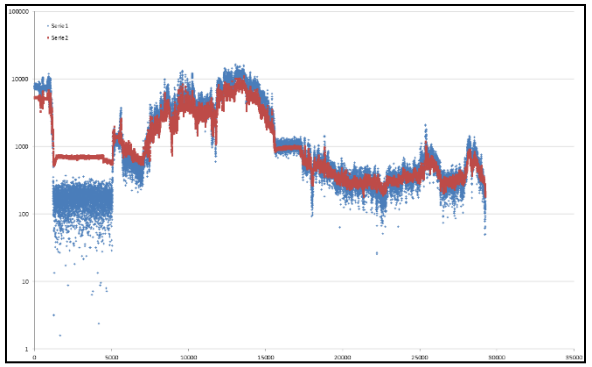
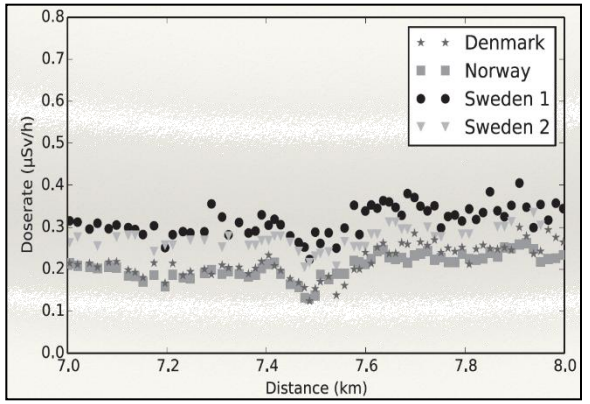
Lessons learned:

- The role of redistribution processes and their impact on measurement performance.
- The impact of rapidly varying and high contamination levels on performance.
- The difficulty in establishing realistic estimates of deposition that go beyond simple dose rate measuring.
- The role of the operator in interpreting the instrumental response in relation to the measurement environment.





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- Objective –conducting in-situ gamma spectrometric measurements in contaminated environments.

- Realisation (September 2015):
  - five sites within the exclusion zone selected based on a set of criteria relating to contamination levels, topography, soil type, etc.
  - all sites characterised by the PSRER according to depth penetration, isotope levels, dose rates etc.using laboratory and in-situ methods.
  - each team attempted to determine activity levels, depth penetration, etc. using their own in-situ systems.

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		Koordinater	Doserate (1 m) µSv/h	^{137}Cs kBq/m^2 ^{90}Sr kBq/m^2
Site 1	sod-podzol	N 51º33'07,9" E 029º55'26,1"	2.21 – 2.50	2414 356
Site 2	sandy soil	N 51º33'17,1" E 029º55'12,1"	0.29 – 0.35	215 0.38
Site 3	peat soil	N 51º32'54,7" E 029º55'52,2"	1.55 – 1.73	1672 319
Site 4	partly flooded	N 51º31'45,2" E 029º56'07,5"	0.52 -0.89	1178 194
Site 5	agricultural land	N 51º47'11,8" E 030º01'16,8"	0.25 – 0.39	644
Site 6	control (football stadium in Khoiniki)	N 51º54'46.5" E 029º58'57.1"	<0,1	13 22

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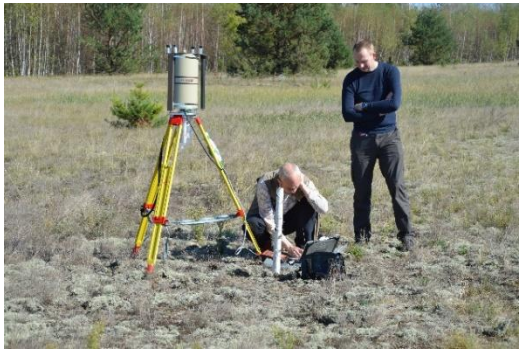
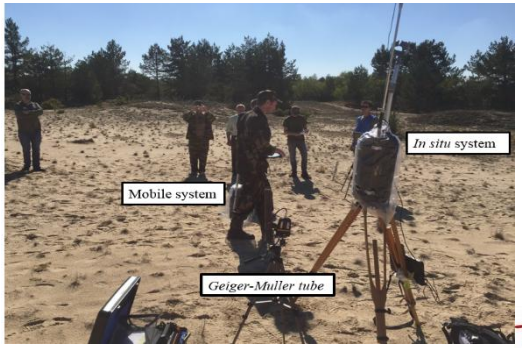
- Wide variety of instrumentation employed:
  - HPGe
  - NaI and LaBr
  - CdZnTe
- Wide range of methods and routines:
  - mathematical calibration
  - empirical calibrations
  - depth penetration routines
  - realtime mapping
- Wide variety of experience levels.





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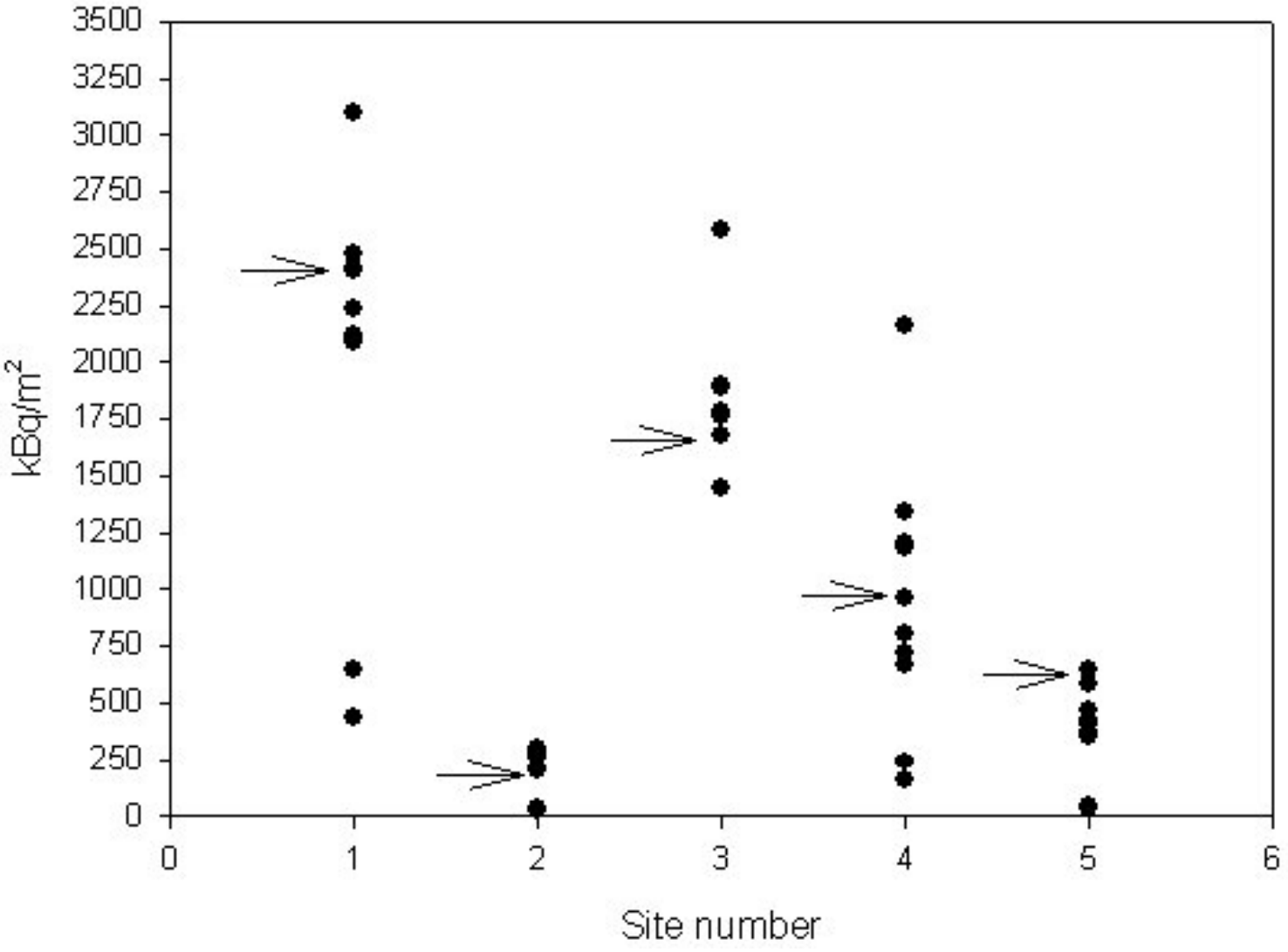
3500
3250
3000
2750
2500
2250
2000
1750
1500
1250
1000
750
500
250
0
kBq/m2
0
1
2
3
4
5
6
Site number

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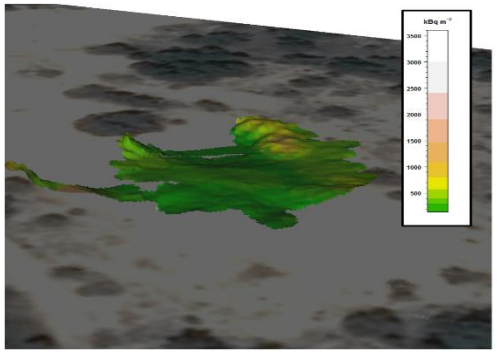
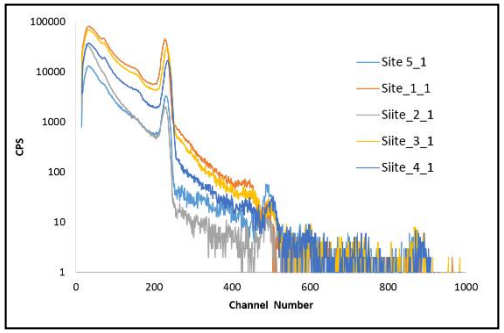
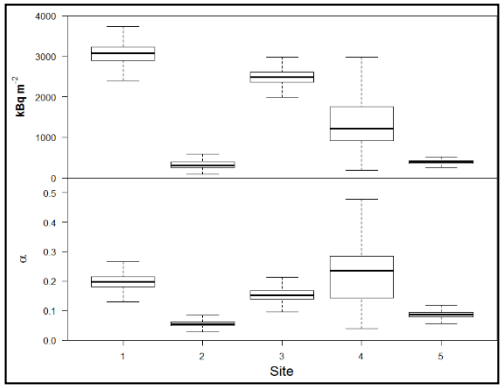
- More advanced methods indicate uses beyond simple determination of activity levels.
- Realtime mapping and advanced analysis procedures expand the use of traditional in-situ measurement methods.
- Vertical distribution analysis – of obvious interest but requires work.







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Some observations:

Mobile measurements

- High sensitivity systems/procedures for source searching/low level mapping will fail in a fresh fallout/high contamination situation.
- Procedures for such operations must be flexible enough to account for post-depositional processes (contamination in/on trees/buildings).
- Operator experience is and will continue to be more important than technical solutions.

In-situ measurements

- Larger detectors are not optimal for higher contamination levels.
- Newer detector types offer significant advantages.
- The impact of higher contamination levels on various automatic analysis routines.
- Certain weaknesses in performance for non-trivial cases.

Acknowledgements

- The NKS – willing to take a risk in funding such activities.
- The staff of the PSRER for facilitating and participating such activities.
- All the willing participants.

Report links:

NKS-GAMFAC (NKS Report 352)
http://www.nks.org/scripts/getdocument.php?file=111010213245375

NKS-MOBELRAD (NKS Report 320)
http://www.nks.org/scripts/getdocument.php?file=111010212617378