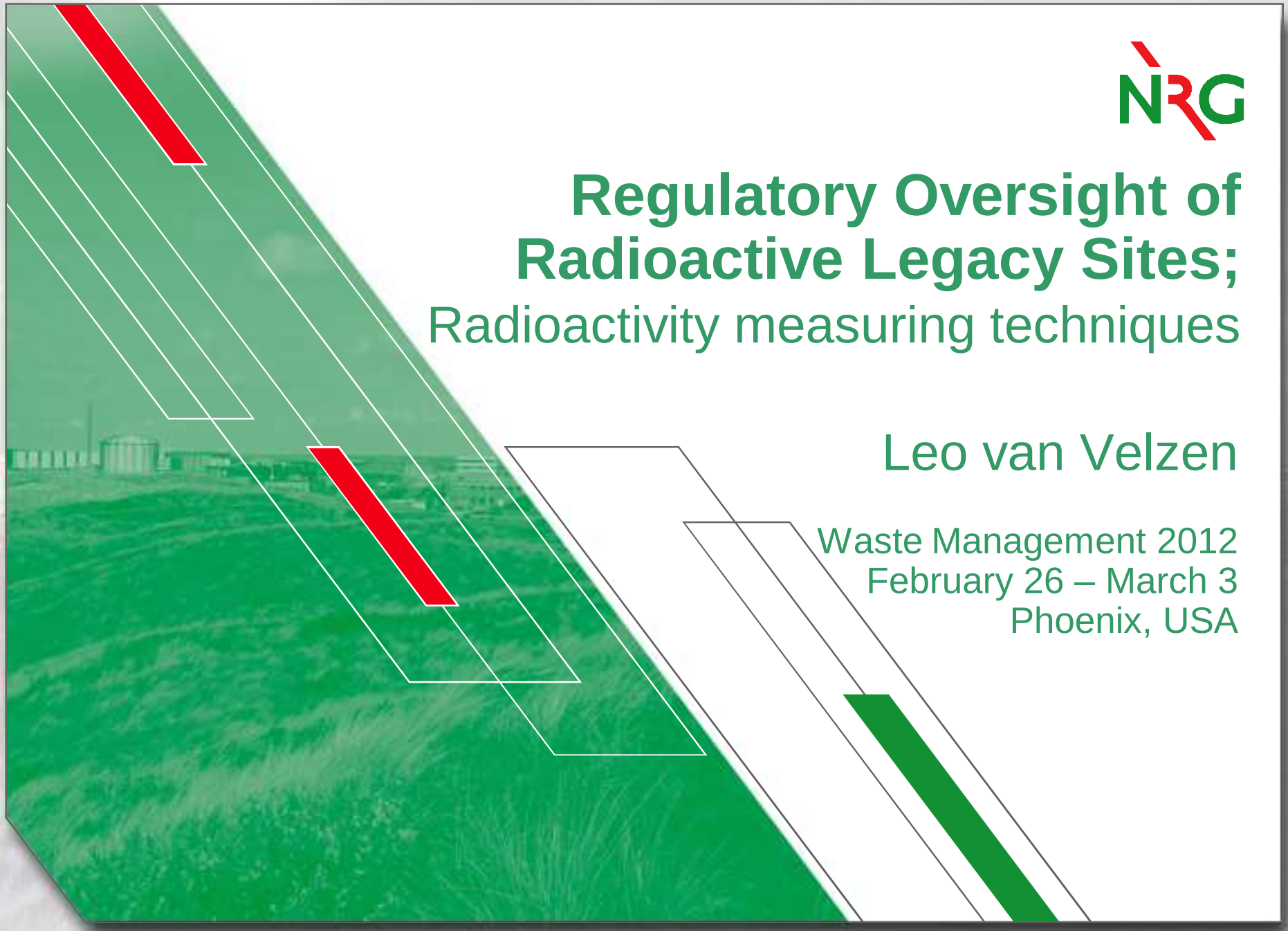

Regulatory Oversight of Radioactive Legacy Sites;

Radioactivity measuring techniques

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Introduction

How can present and future developments in radiological measuring techniques and methods for measuring the radioactivity in the environment support the finding of practical solutions to regulate situations and activities falling outside existing regulatory schemes.

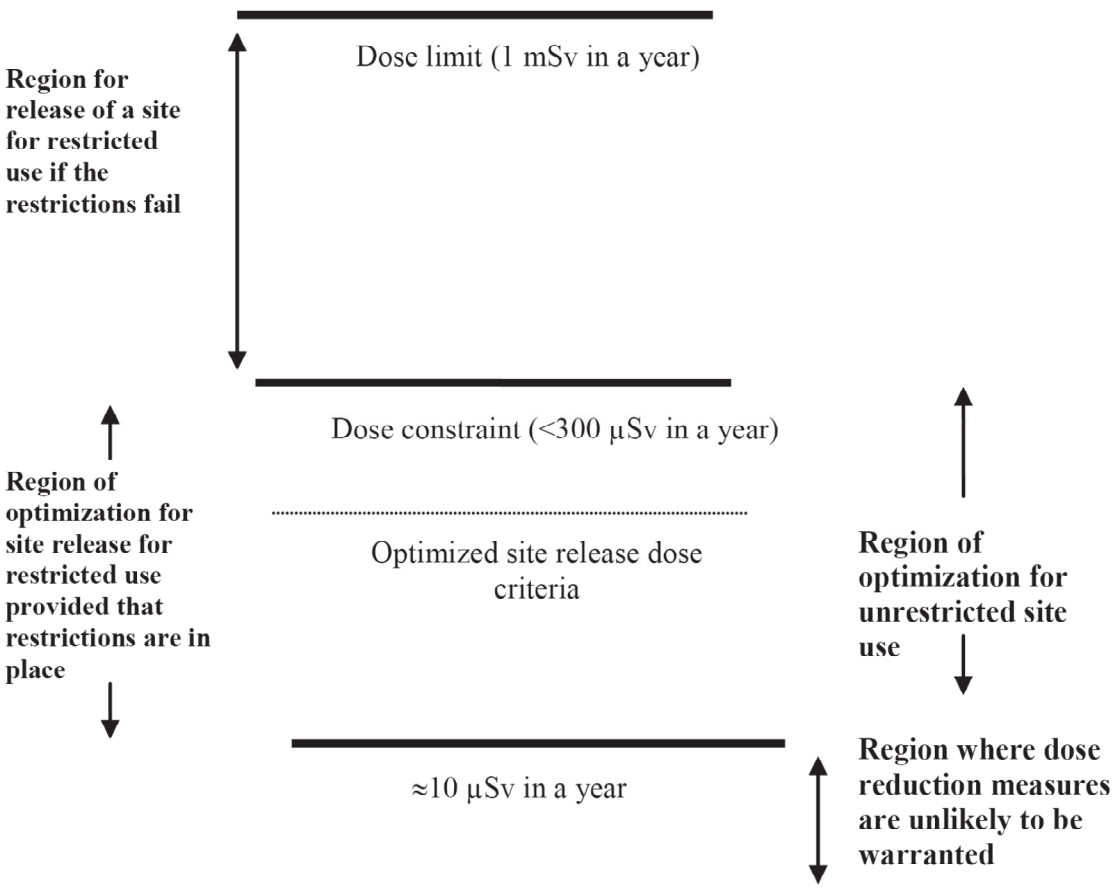
Reference Limits; IAEA-TECDOC 987

Examples of reference levels for remediation criteria

Band no.	Range of annual doses (to average member of the critical group)	Is remediation needed?	
		With constraint	Without constraint
Band 6	> 100 mSv/a	Always	Always
Band 5	10 – 100 mSv/a	Always	Almost Always
Band 4	1 – 10 mSv/a	Almost Always	Usually
Band 3	0.1 – 1 mSv/a	Usually	Sometimes
Band 2	10 – 100 μSv/a	Sometimes	Rarely
Band 1	< 10 μSv/a	Almost never	Almost never

Reference Limits; IAEA WS-G-5.1

The application of dose limitation to the unrestricted and restricted use of a site.



Constrained optimization and regions of H_{eff} for critical group

Derived Limits

- ~ Derived limits can be site specific or generic;
- ~ Site specific criteria are typically based on calculated risks to humans or the environment;
- ~ Generic criteria will usually also be based on risk consideration but are not necessarily directly related to the site under investigation;
- ~ Generic criteria are uniform for all sites in a region or country;
- ~ Generic criteria (major advantage) their greater political acceptance; easier to regulate and to enforce. Disadvantage, they could dramatically increase the costs over what would be necessary under site specific conditions.

Action Limits

- Direct: Measured radiation levels are so elevated, that direct actions are needed to protect man and/or environment;
- Investigation & Remediation: Measured radiation levels are elevated and above derived limits. More detailed investigations have to be performed to optimize remediation activities;
- Investigation: Measured radiation levels are elevated but below derived levels, however the measured levels/patterns don’t fit in the background and give therefore raise for questions.

Radiological Characterization

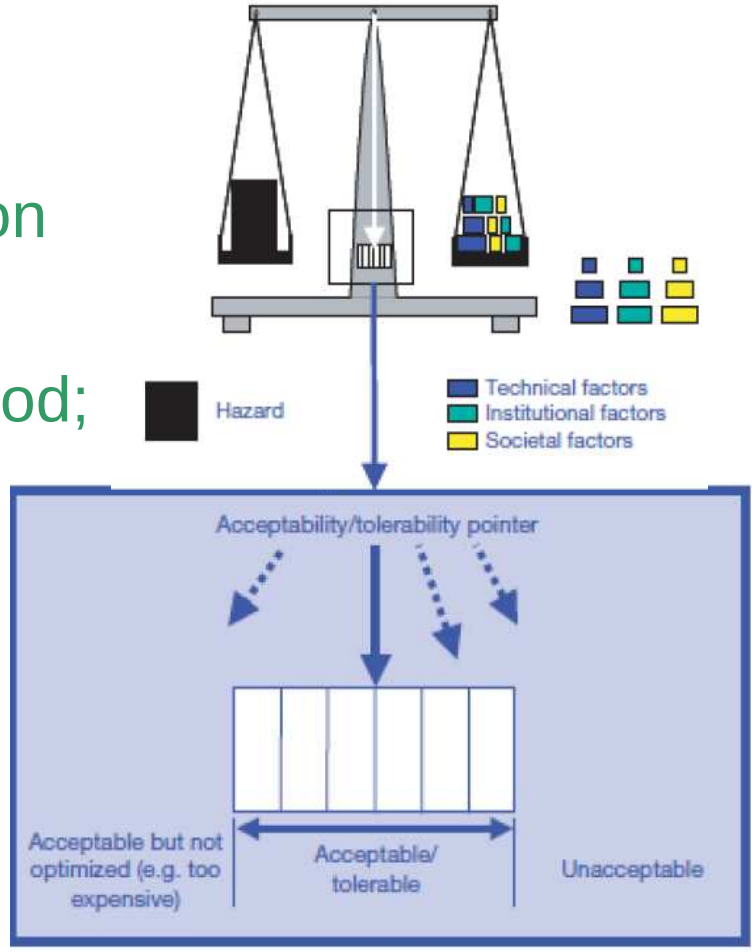
It is important to realize that a solution for a problem will consist out of multiple factors.

For radiological characterization those factors are:

~ Applied data collection method;

~ Applied instruments;

~ Applied analyze techniques.



(Reference figure: ITRC Conceptual Site Model)

Radiological Characterization

Data collection methods

- Non-intrusive
  - Fixed grid points
  - Survey scans
- Intrusive → Sampling
  - γ-analyses (laboratory)
  - α/β-analyses (laboratory)

(Reference: EURSSEM, MARSSIM)

Radiological Characterization

Selection of instrument(s)

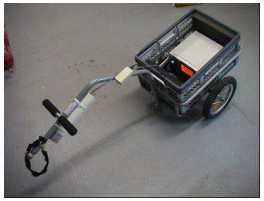
~ Fit for purpose (accuracy, *sampling frequency, recovery time*, etc.).












Radiological Characterization

Selection of instrument

~ Is the result of the analyzed collected data with the selected instrument representative for the radiation levels at a site?

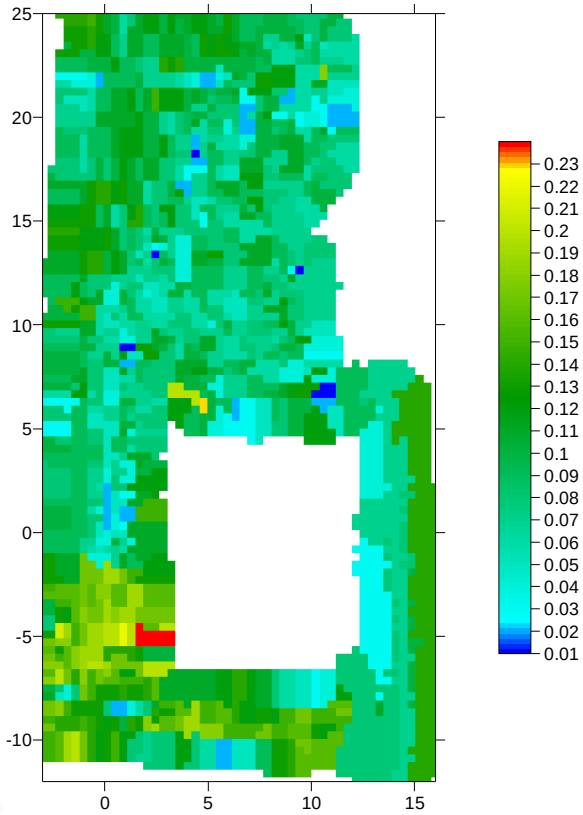
No, as most systems (at this moment) are only equipped with “one” type of sensor, meaning that only “one” property of an eventual elevated radiation level will be measured.

Direct consequence: By detecting an elevated level new radiological characterization efforts have to be performed to establish the cause of this elevated level.

Radiological Characterization

Example: Advantage of multiple sensor technique (e.g. dose rate and γ-spectroscopy) in combination with fast sampling frequencies.

Dose Rate; Net values [µSv/h]



Radiological Characterization

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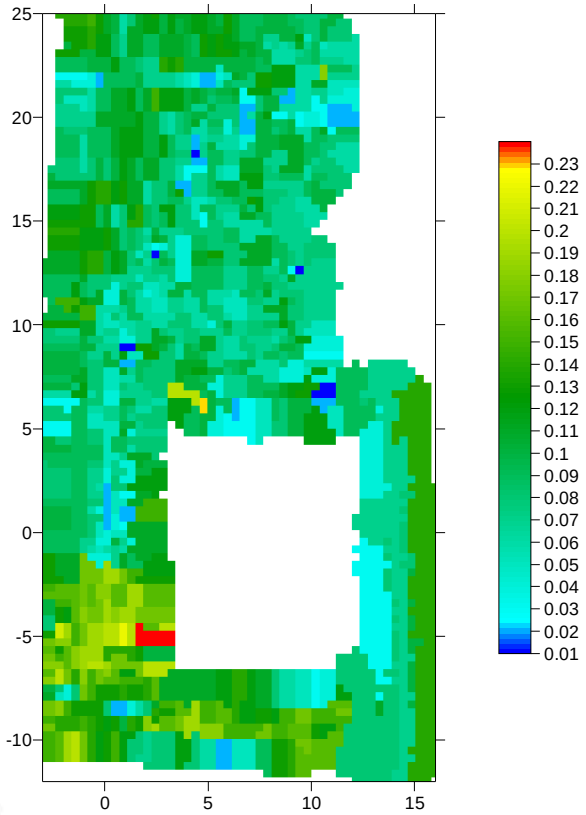
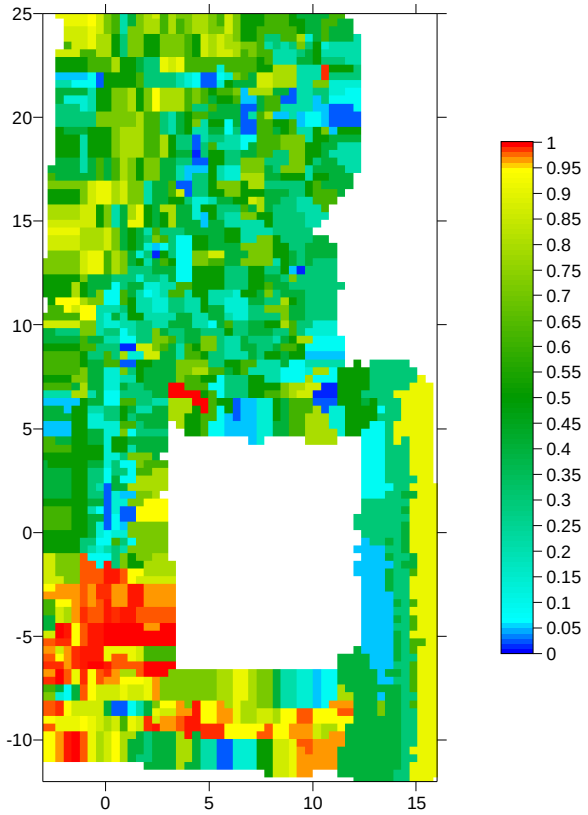


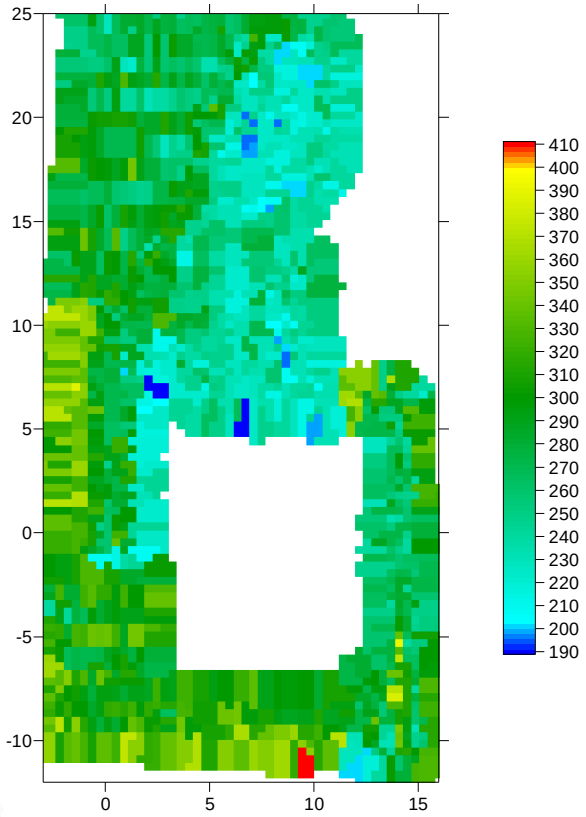
Dose Rate; Data Significance Calc. [ ]



Radiological Characterization

Gammaspectroscopy: Total spectrum

Net values
[cps]



DSC
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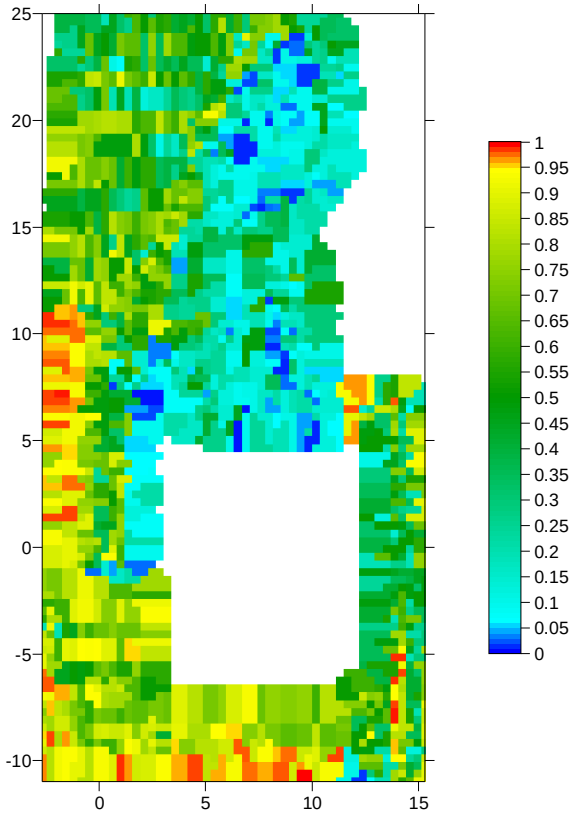
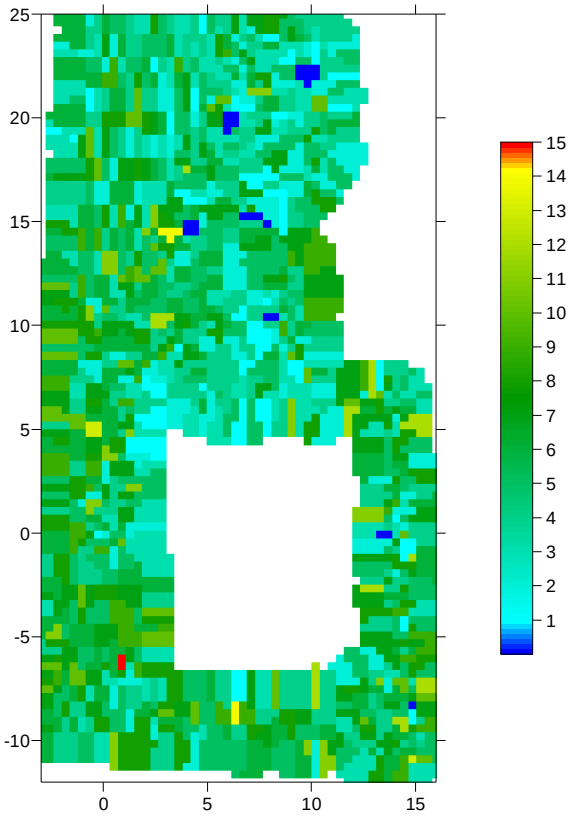


Radiological Characterization

Gammaspectroscopy: Potassium-40

Net values

[cps]

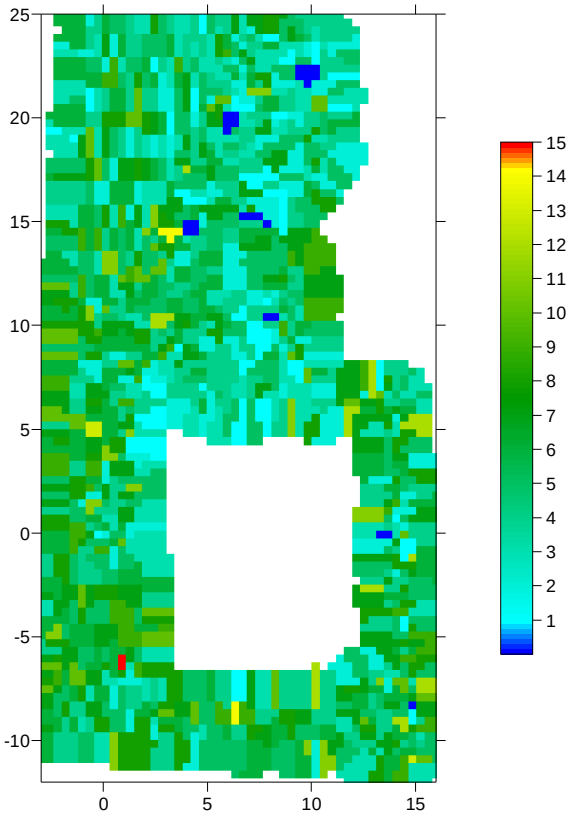


Radiological Characterization

Gammaspectroscopy: Potassium-40

Net values

[cps]



DSC

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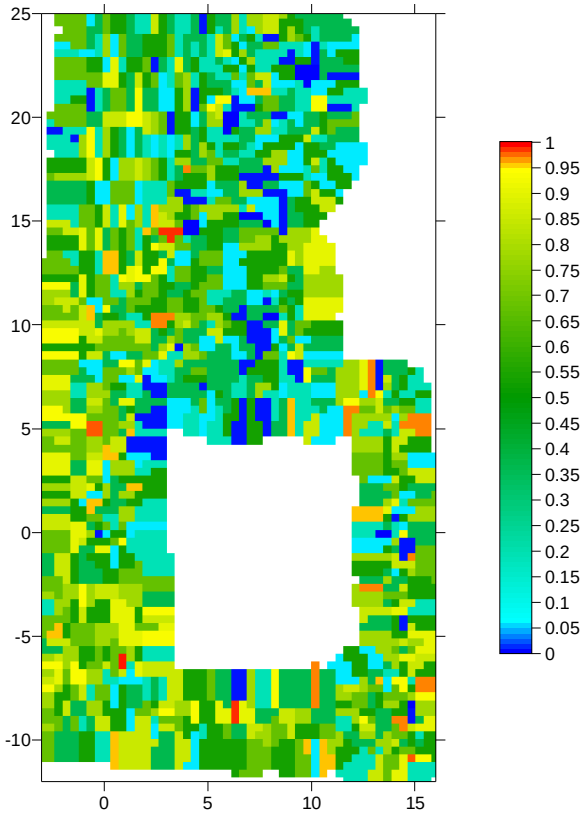

Analyzes and reporting

Depending on the collected radiological data, the data can be reported in tables, figures, etc.

Important is also to report the “false decision error”. In general an accepted value of the probability of such an error is <3% (preferable) but rarely >5%.

The false decision error is based on the number of collected data at a site, but gives no information about the chance that a part of the surface of the area under investigation has not been measured.

Analyzes and reporting

Example: Assessment of the 10% risk (P_{10}) that an elevated area with a circular surface "s [m^2]" will not be detected with an applied rectangular sample grid.

Site area surface [m^2]	Number of measurements [ ]	P_{10} elevated area [m^2]
1000	1000	1.1
10000	1000	11
100000	1000	110
1000000	1000	1100

Conclusion

The largest potential for improvement of the accuracy of a radiological site characterization in combination with decreasing characterization costs lies in the development of survey scans with multiple sensors, high sampling frequencies with leading analyze and reporting techniques followed by a (limited) judged expert sampling.

Such developments might take care that in the future less situations and activities will fall outside existing regulatory schemes.


Thank for your attention
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Spare

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