Monitoring of contaminated area in a late phase of radiation accident

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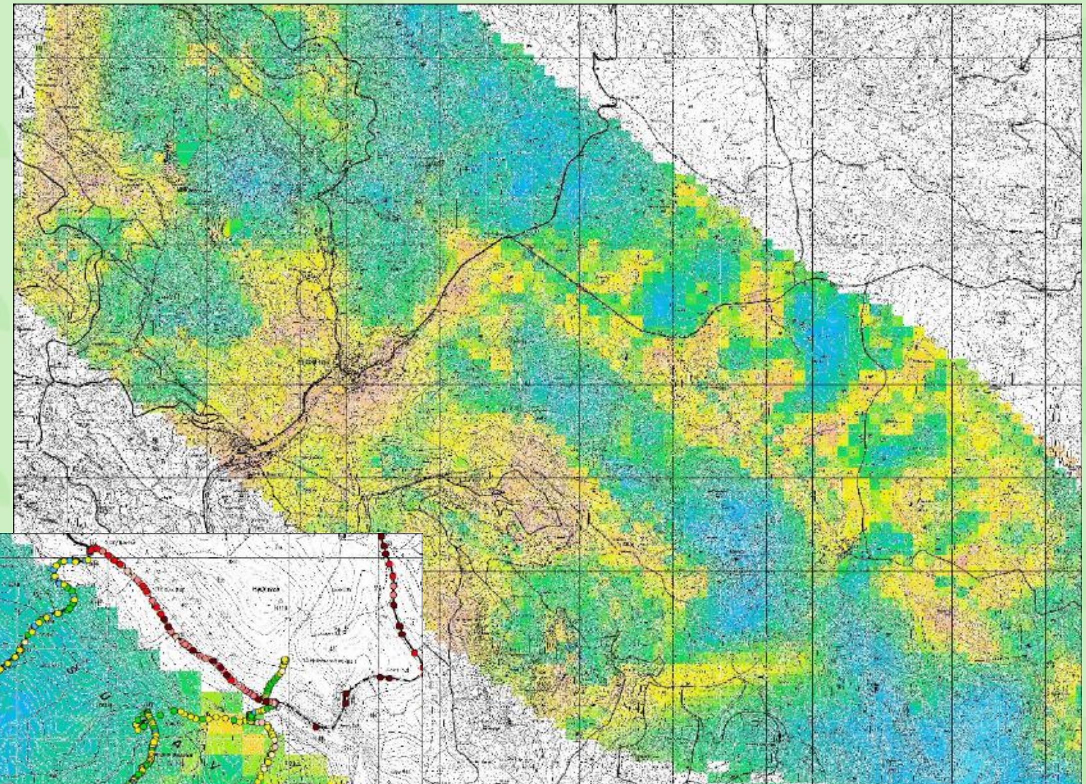
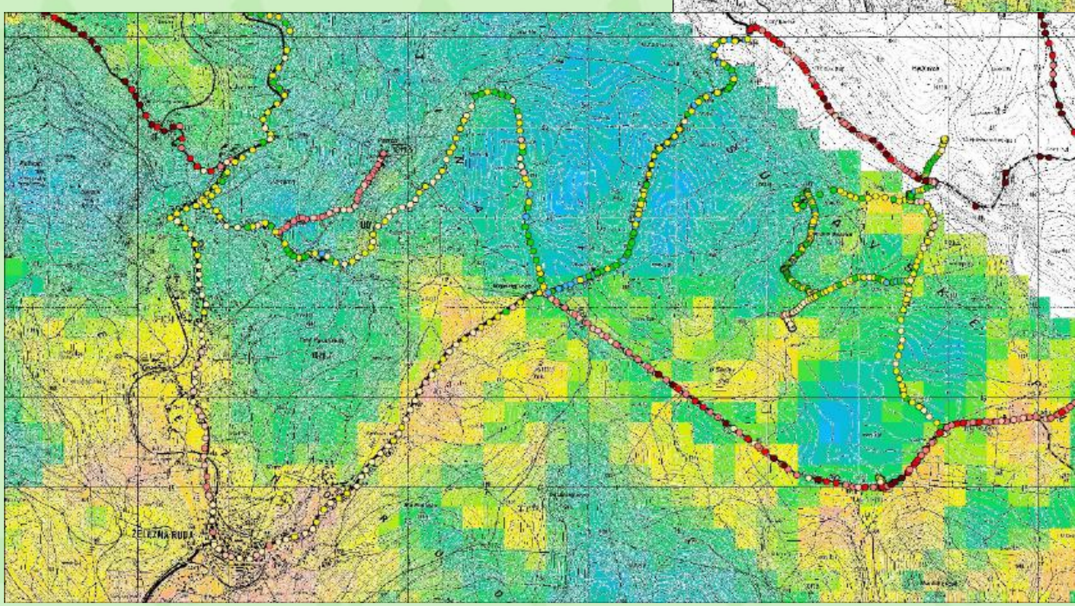
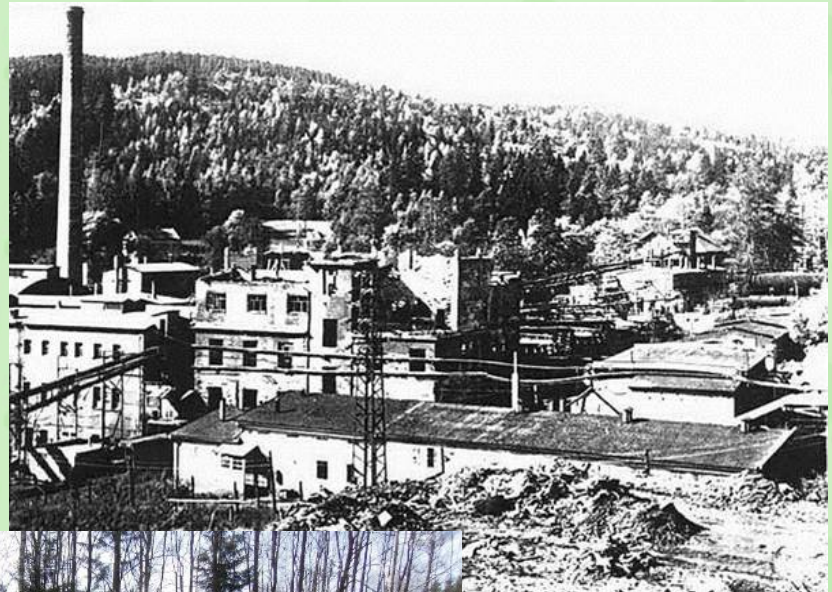
Various devices & methods

Site 1 - Šumava (Chernobyl fallout)





Site 2 - Nejdek (former uranium ore processing facility)



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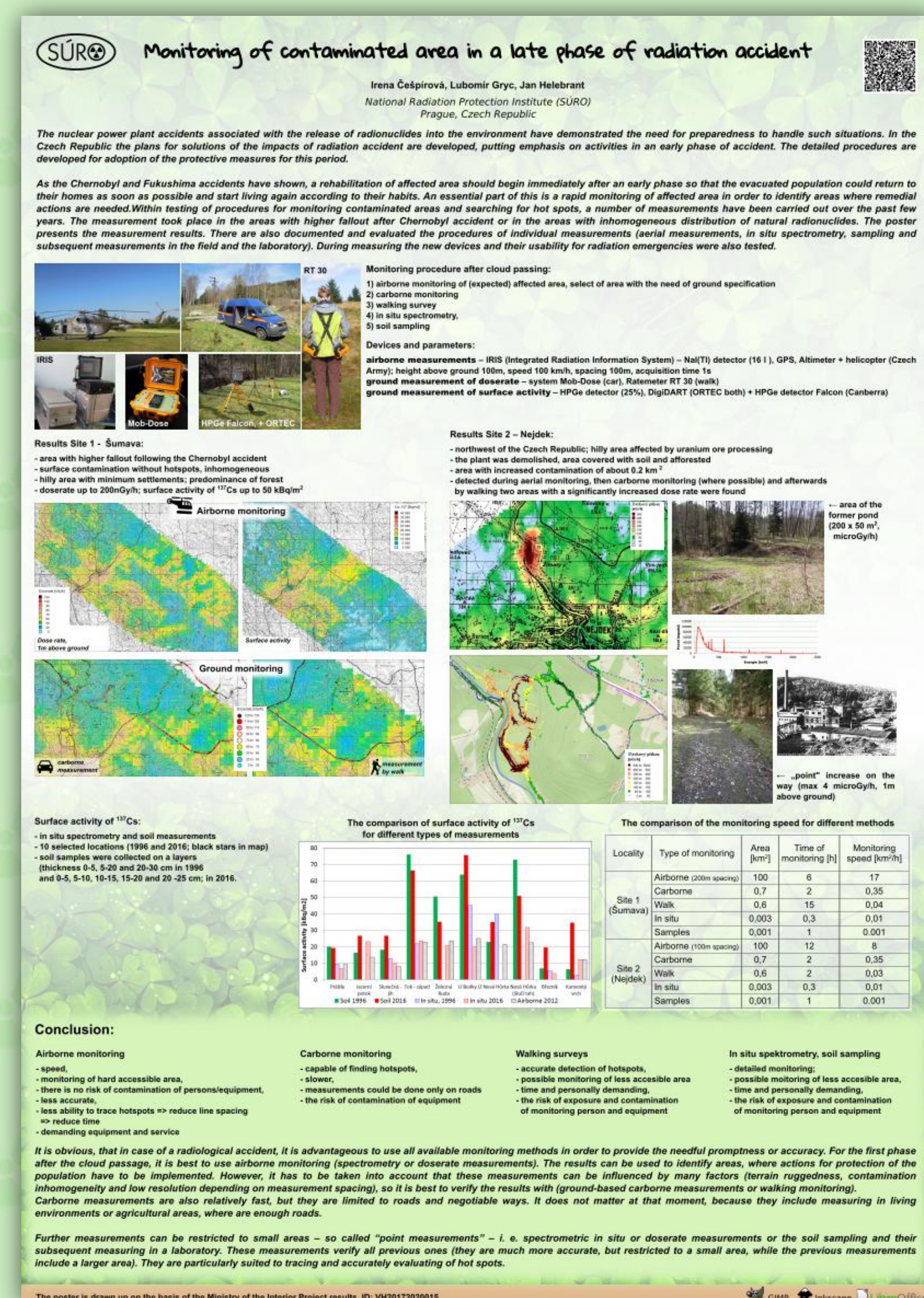

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The nuclear power plant accidents associated with the release of radionuclides into the environment have demonstrated the need for preparedness to handle such situations. In the Czech Republic the plans for solutions of the impacts of radiation accident are developed, putting emphasis on activities in an early phase of accident. The detailed procedures are developed for adoption of the protective measures for this period.

As the Chernobyl and Fukushima accidents have shown, a rehabilitation of affected area should begin immediately after an early phase so that the evacuated population could return to their homes as soon as possible and start living again according to their habits. An essential part of this is a rapid monitoring of affected area in order to identify areas where remedial actions are needed.Within testing of procedures for monitoring contaminated areas and searching for hot spots, a number of measurements have been carried out over the past few years. The measurement took place in the areas with higher fallout after Chernobyl accident or in the areas with inhomogeneous distribution of natural radionuclides. The poster presents the measurement results. There are also documented and evaluated the procedures of individual measurements (aerial measurements, in situ spectrometry, sampling and subsequent measurements in the field and the laboratory). During measuring the new devices and their usability for radiation emergencies were also tested.

RT 30
IRIS
Mob-Dose
HPGe Falcon, + ORTEC

Monitoring procedure after cloud passing:

1) airborne monitoring of (expected) affected area, select of area with the need of ground specification
2) carborne monitoring
3) walking survey
4) in situ spectrometry,
5) soil sampling

Devices and parameters:

airborne measurements – IRIS (Integrated Radiation Information System) – NaI(Tl) detector (16 l), GPS, Altimeter + helicopter (Czech Army); height above ground 100m, speed 100 km/h, spacing 100m, acquisition time 1s
ground measurement of doserate – system Mob-Dose (car), Ratemeter RT 30 (walk)
ground measurement of surface activity – HPGe detector (25%), DigiDART (ORTEC both) + HPGe detector Falcon (Canberra)

Results Site 1 - Šumava:

- area with higher fallout following the Chernobyl accident
- surface contamination without hotspots, inhomogeneous
- hilly area with minimum settlements; predominance of forest
- doserate up to 200nGy/h; surface activity of ^{137}Cs up to 50 kBq/m^2

Airborne monitoring
Dose rate, 1m above ground
Surface activity
Ground monitoring
carborne measurement
measurement by walk

Results Site 2 – Nejdek:

- northwest of the Czech Republic; hilly area affected by uranium ore processing
- the plant was demolished, area covered with soil and afforested
- area with increased contamination of about 0.2 km ^{2}
- detected during aerial monitoring, then carborne monitoring (where possible) and afterwards by walking two areas with a significantly increased dose rate were found

← area of the former pond (200 x 50 m^2, microGy/h)

← „point" increase on the way (max 4 microGy/h, 1m above ground)

Surface activity of ^{137}Cs:

- in situ spectrometry and soil measurements
- 10 selected locations (1996 and 2016; black stars in map)
- soil samples were collected on a layers (thickness 0-5, 5-20 and 20-30 cm in 1996 and 0-5, 5-10, 10-15, 15-20 and 20 -25 cm; in 2016.

The comparison of surface activity of ^{137}Cs for different types of measurements

Surface activity [kBq/m2]
Soil 1996
Soil 2016
In situ, 1996
In situ 2016
Airborne 2012

The comparison of the monitoring speed for different methods

Locality	Type of monitoring	Area [km^2]	Time of monitoring [h]	Monitoring speed [km^2/h]
Site 1 (Šumava)	Airborne (200m spacing)	100	6	17
	Carborne	0,7	2	0,35
	Walk	0,6	15	0,04
	In situ	0,003	0,3	0,01
	Samples	0,001	1	0.001
Site 2 (Nejdek)	Airborne (100m spacing)	100	12	8
	Carborne	0,7	2	0,35
	Walk	0,6	2	0,03
	In situ	0,003	0,3	0,01
	Samples	0,001	1	0.001

Conclusion:

Airborne monitoring

- speed,
- monitoring of hard accessible area,
- there is no risk of contamination of persons/equipment,
- less accurate,
- less ability to trace hotspots => reduce line spacing => reduce time
- demanding equipment and service

Carborne monitoring

- capable of finding hotspots,
- slower,
- measurements could be done only on roads
- the risk of contamination of equipment

Walking surveys

- accurate detection of hotspots,
- possible monitoring of less accesible area
- time and personally demanding,
- the risk of exposure and contamination of monitoring person and equipment

In situ spektrometry, soil sampling

- detailed monitoring;
- possible moitoring of less accesible area,
- time and personally demanding,
- the risk of exposure and contamination of monitoring person and equipment

It is obvious, that in case of a radiological accident, it is advantageous to use all available monitoring methods in order to provide the needful promptness or accuracy. For the first phase after the cloud passage, it is best to use airborne monitoring (spectrometry or doserate measurements). The results can be used to identify areas, where actions for protection of the population have to be implemented. However, it has to be taken into account that these measurements can be influenced by many factors (terrain ruggedness, contamination inhomogeneity and low resolution depending on measurement spacing), so it is best to verify the results with (ground-based carborne measurements or walking monitoring).
Carborne measurements are also relatively fast, but they are limited to roads and negotiable ways. It does not matter at that moment, because they include measuring in living environments or agricultural areas, where are enough roads.

Further measurements can be restricted to small areas – so called "point measurements" – i. e. spectrometric in situ or doserate measurements or the soil sampling and their subsequent measuring in a laboratory. These measurements verify all previous ones (they are much more accurate, but restricted to a small area, while the previous measurements include a larger area). They are particularly suited to tracing and accurately evaluating of hot spots.

The poster is drawn up on the basis of the Ministry of the Interior Project results, ID: VH20172020015.

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