LATE PHASE OF NUCLEAR ACCIDENT IN AGRICULTURE – WEAKNESSES IN DECISION MAKING DUE TO LACK OF DATA, KNOWLEDGE AND SKILL AND POSSIBLE INNOVATION

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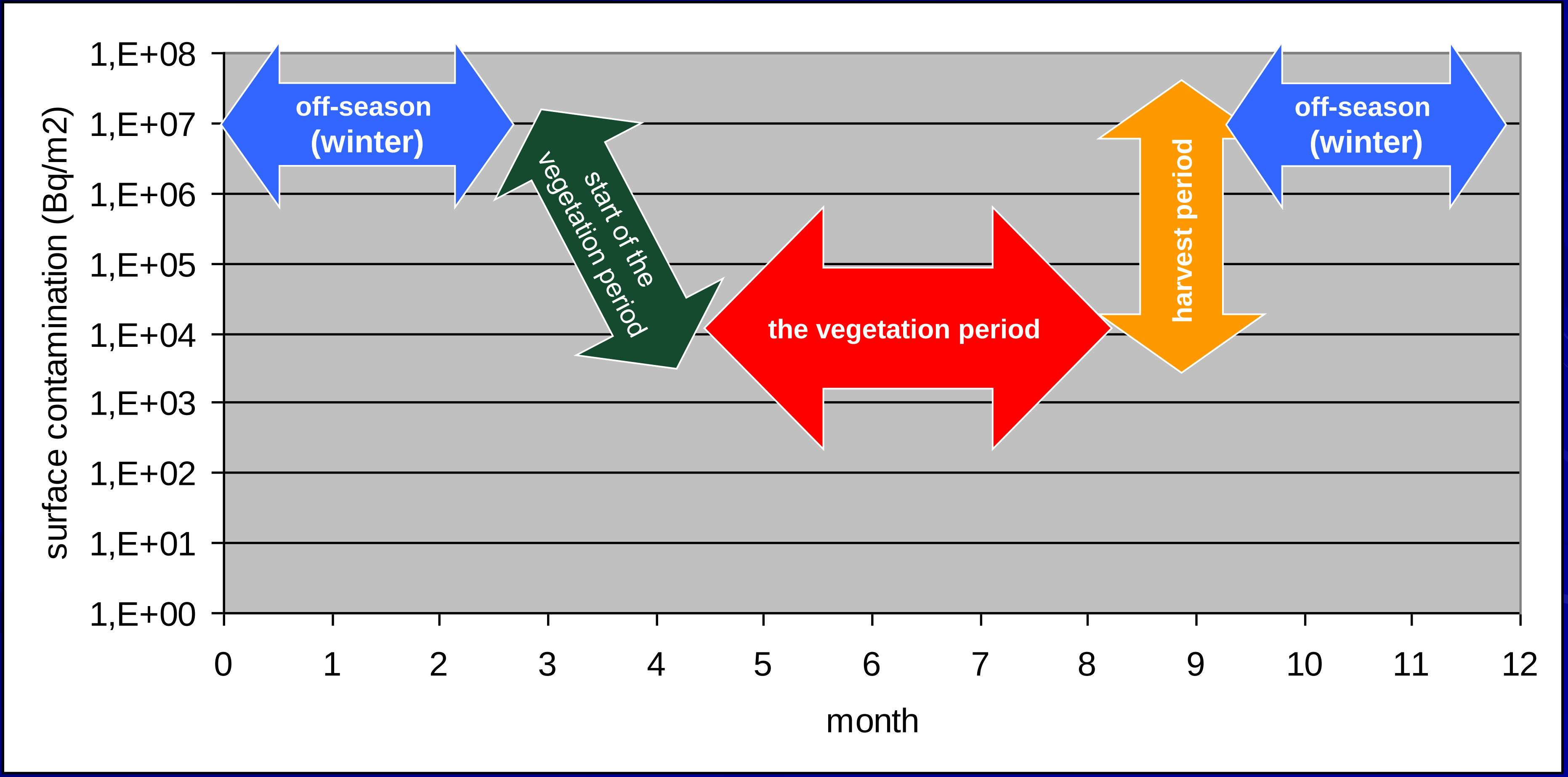
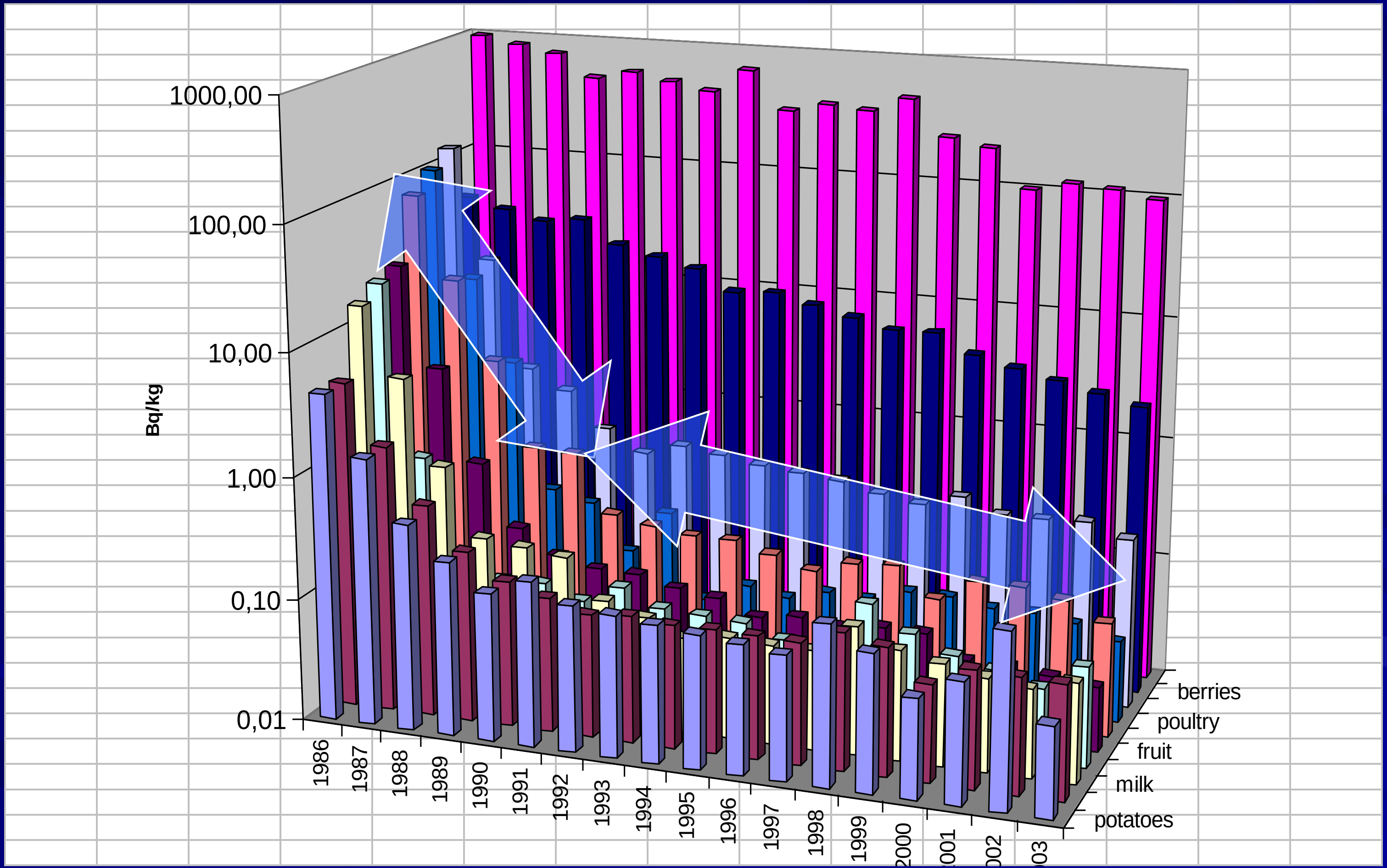
The possible key moments for decision making in agriculture.
Which questions should be answered?

Operational intervention levels : Cs-137 deposition corresponding to reference levels for food (Middle Europe)



Experience from past accident long term changes in food contamination (Cs-137) for prediction



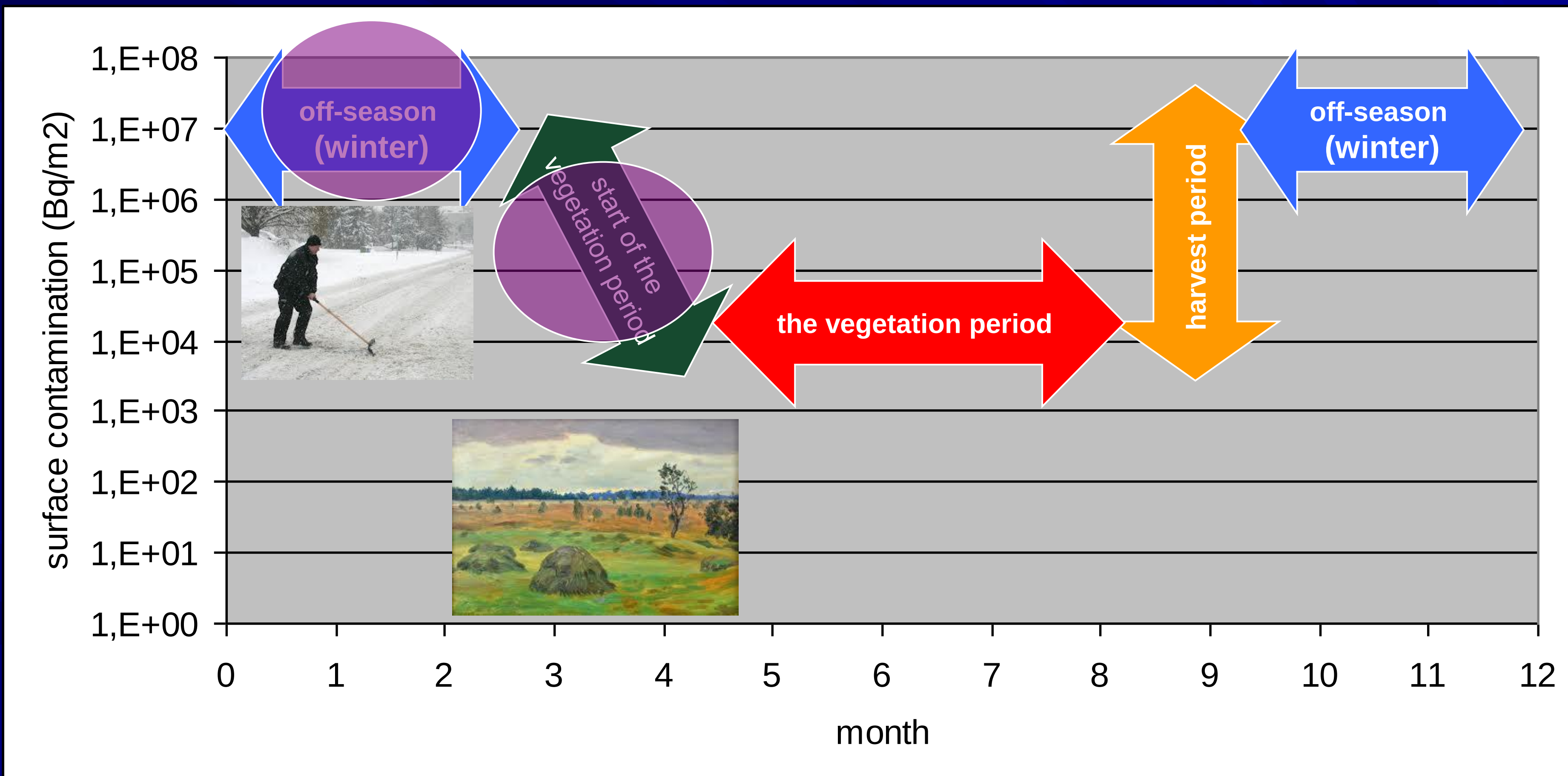
Landscape „response“ – prognosis for future

regional „transfer factors“

When timeliness can affect the remediation and amount of waste?

(e.g. soil removal, crop/plants removal….)

or help in DO NOTHING decision !



What data should be obtained in time

(for competent remediation and waste management strategy)

- Source term ?

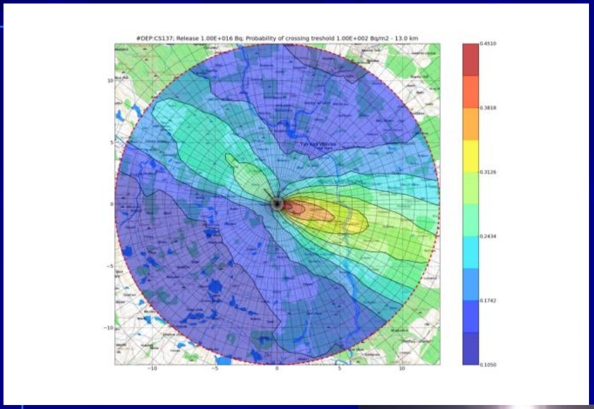
  (at least fraction of long lived radionuclides Cs-137, Sr-90… in the radionuclides mixture)

- Prognosis of deposition *(computer code)*

- The current state of crop/plants and expected progress

- True deposition in landscape

Rapid methods for estimation of landscape contamination (for timely decision making in agriculture)



Computer code prognosis of deposition
(first estimation/delineation of area)
☹ correctness ??
☹ Source term mostly unknown in time!

What is where, what is the stage of the crop/plants?
Satellite crop/plant imaging – promising technique for timely information on lanscape cover
(infrared multispectral analysis)

mass activity estimate

Rapid measurement of deposition
to verify prediction (airborne, carborne, laboratory)

Source term
mostly unknown in time !!

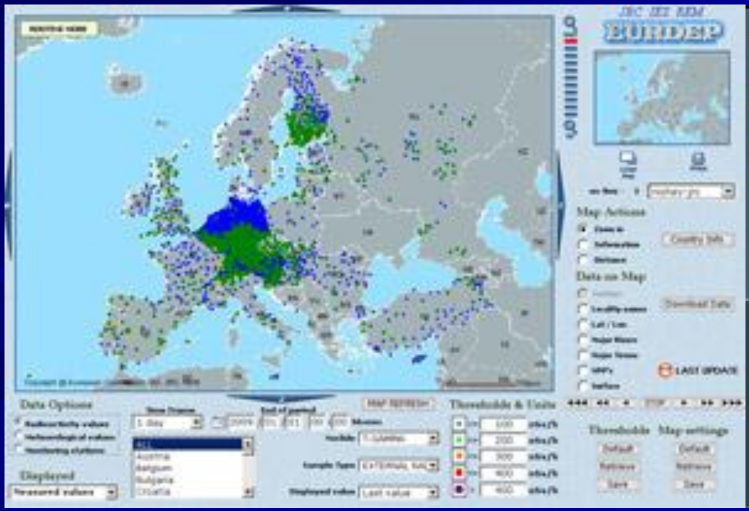
Estimate of vector of radionuclides :

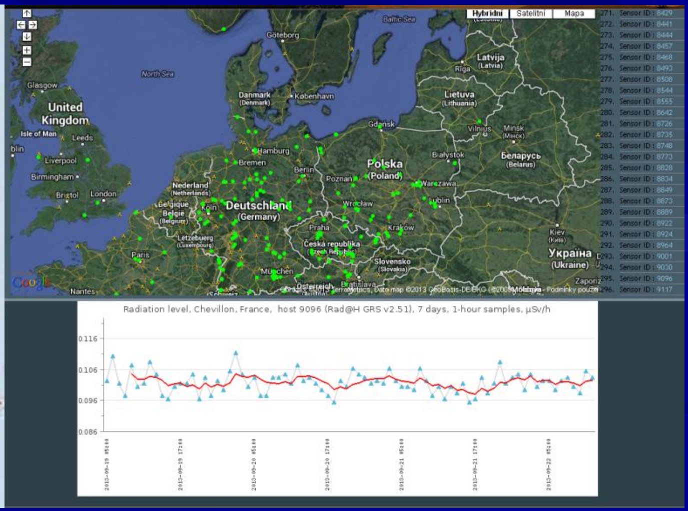
I-131; I-132; Te-132..Cs-134; Cs-137, Ru, Ba, La,.. Sr…… Pu,…..

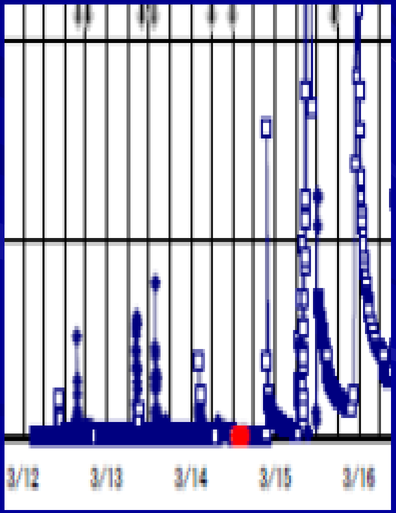
aerosol sampling (*sparse)* ***and soil sampling (for estimate of deposition)***

Dose rate monitoring networks
- governmental (not too dense) and new - civil

Kr-85; Kr-85m; Kr-87; Kr-88; ..Xe-133; Xe-135; Xe-135m;







Satellite crop/plant monitoring

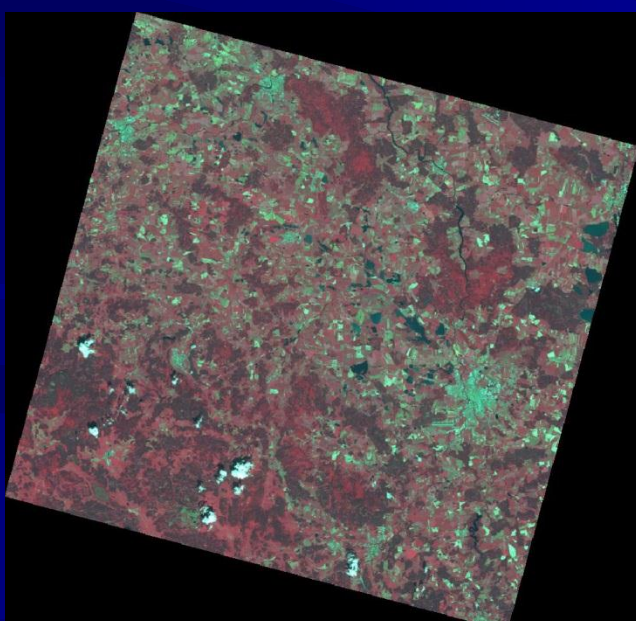
What is where and in what stage

(the prognosis of the future waste volume)

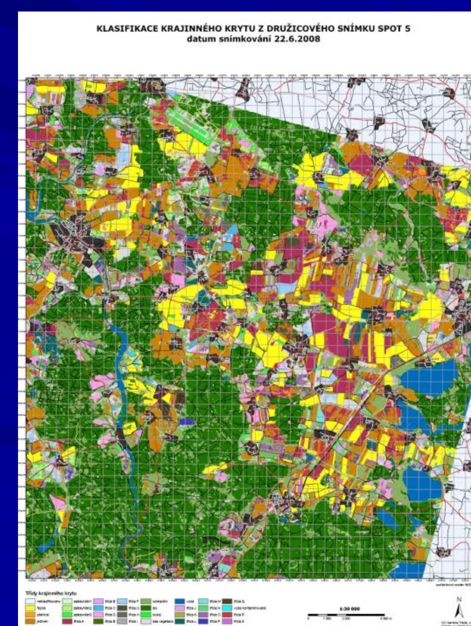
Satellite crop monitoring : real-time crop vegetation monitoring via (infrared) spectral analysis, high resolution satellite images for different fields and crops

☹ calibration fields necessary, timeliness/robustness of method should be tested

satellite image



Conversion to crop



System of measurements :
capacity of laboratories and in situ measurements

- complex mixture of radionuclides (radioisotopes of iodine, tellurium, cesium, ruthenium, etc) - HpGe spectrometry preferred, however laboratory capacity on national level are limited *(CZ some 1000 samples /day)*

- Mobile group

  (dose rate, in situ measurements, sampling)

- Airborne measurements (plane, helicopter or unmanned aerial vehicles) are effective but with some restrictions

- no risk for crew,
- cheap enough (in case of contamination)
- Multi-UAV system with advanced cooperative control algorithms has advantages over single UAV system,

☹

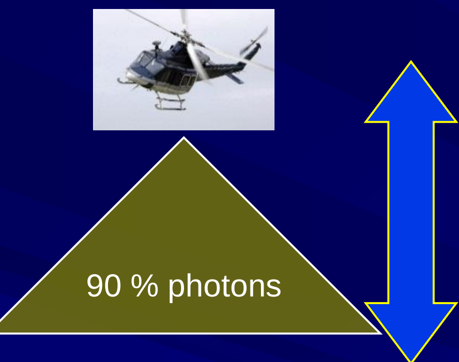
Limitation/weakness of airborne measurements

It detects from some 500 m (95% photons]

high risk of contamination in radioactive cloud

(thought-out strategy when to use a plane)

Advantage of airborne measurements (MDA and strategy)



optimum flight height = compromise MDA vs. area

☺ rapid sampling (~1 s)

NaI(Tl) high volume detectors,

speed 100 -200 km/h distance of flight lines 100m

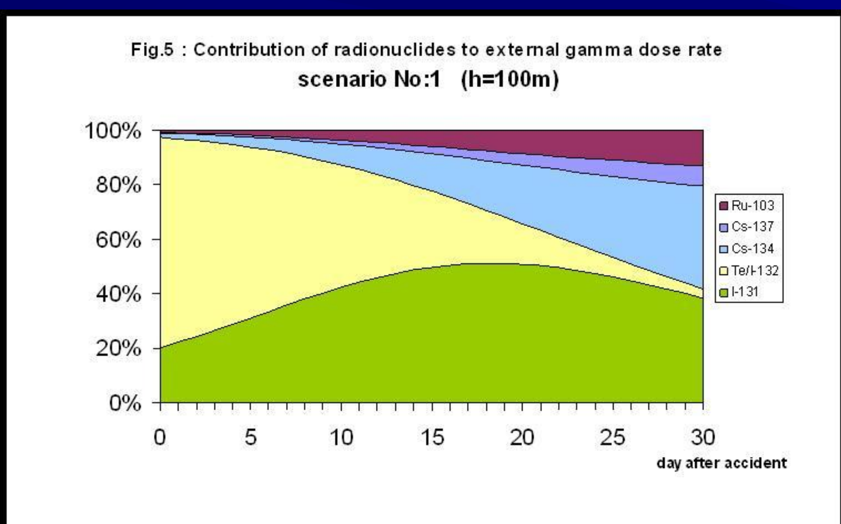
Monitoring

~ 10–100 km²/h

(more effective than car-borne measurements)

MDA some 5-10 kBq/m2 (Cs-137)

☹ Scintillation spectrometry is not appropriate in case of complex spectra,



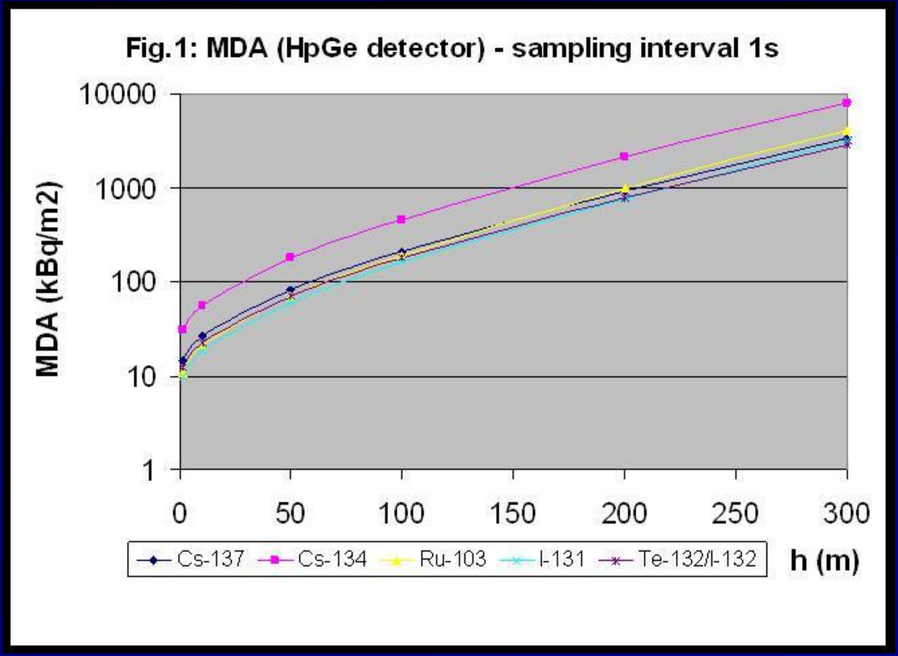
Alternative dose-rate measurements

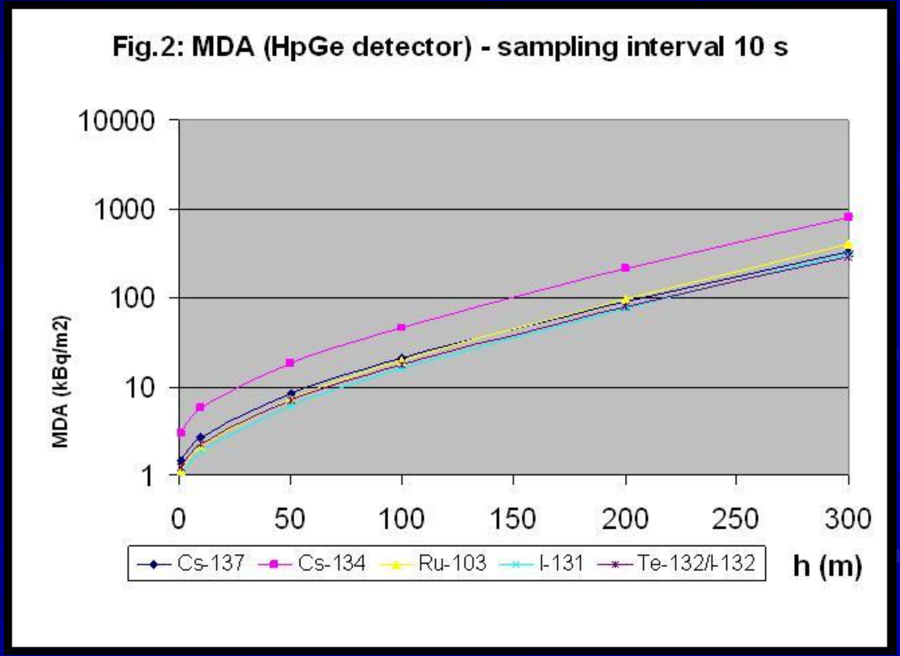
difficult to interpret due to changes of radionuclide vector in time

Airborne HpGe spectrometry monitoring

Minimum detectable activities (MDA) :

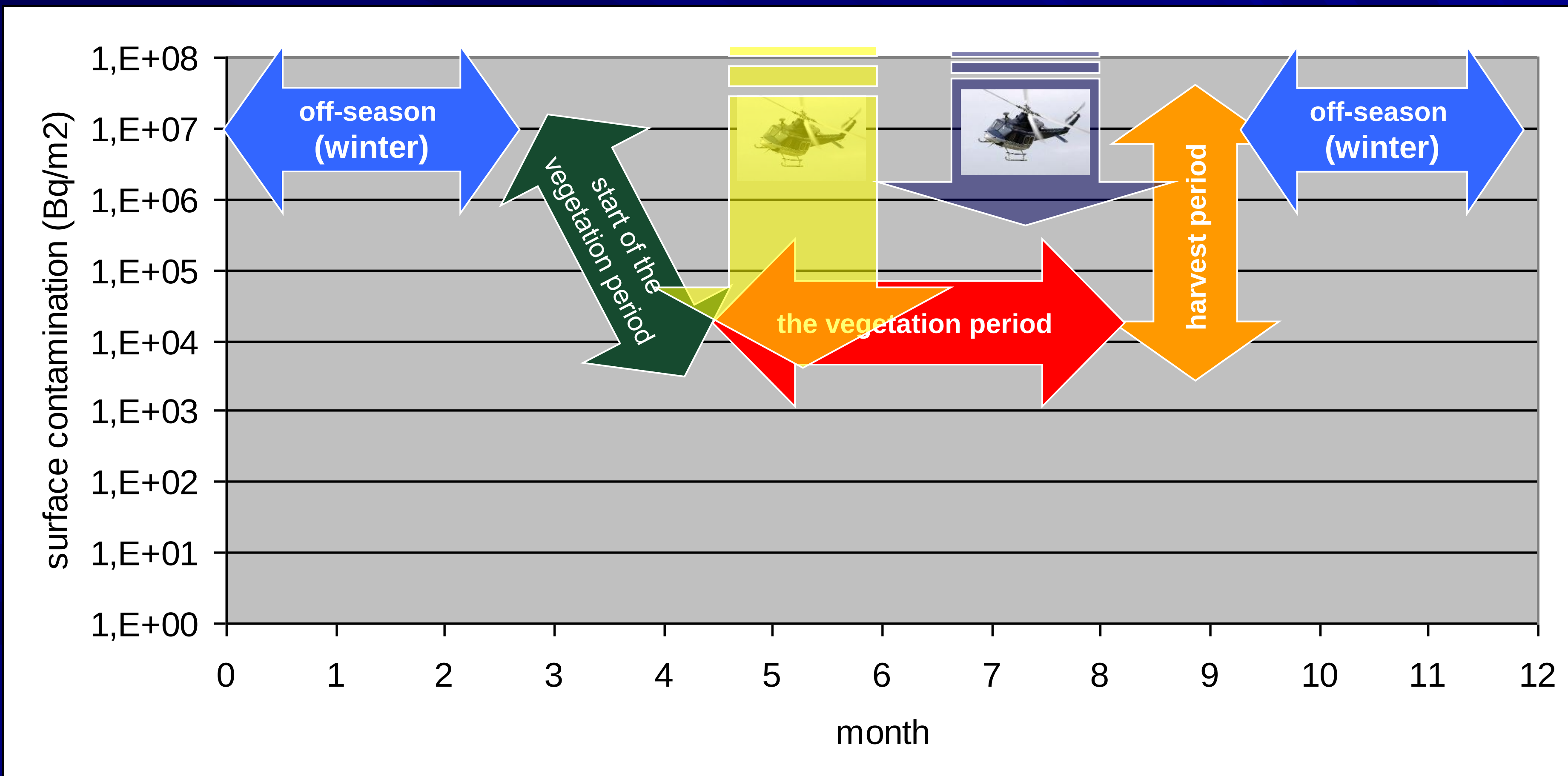
- high (10-300m),
- time of measurement 1-10 s
- radionuclides (131I, 132Te, 137Cs, 134Cs, 103Ru..).





H = 100m, T (1s -10 s) , MDA some (300-30) kBq/m2

Airborne measurements and estimation of exceeding of the operational intervention levels (Cs-137 deposition)



Summary

The key moment and important factor in planning of remediation and reduction of amount of waste after accident could be :

timely knowledge of

- long live radionuclides (Cs 137..) fraction in mix of radionuclide released in environment and their deposition in landscape
- crop/plants state and their evolution.

Innovation in

- satelite/airborne imaging technologies
- airborne measurement (including unmanned aerial vehicles)

seems to be promising - if carefully thought out and ready to be used.

- New civil dose-rate monitoring networks (stationary or car-borne) could help in dose-rate mapping and should be taken into account, too.

Thank you