Connection between dispersion modelling and remote sensing:

Methodology to support environmental monitoring

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Remote Sensing and dispersion modelling:

- Remote Sensing is state-of-the art geoinformation technique in the domain of mapping the agriculture crops
- Obtaining information using satellite data **without direct** contact with the studied areas
- Advantage in case of severe nuclear or radiological accident is in possibility of getting **quickly updated** information about crop distribution

Connection between

Remote Sensing and dispersion modelling

for:

1. environmental impact assessment studies for NPP siting
2. evaluation of impacts of routine releases to the environment
3. evaluation of concentration of radionuclides in crops after accident
4. management of monitoring and management of protective measures in the field of agriculture and food industry

Process:

- from the calibration and satellite imagery classification

through

- **the source term or routine effluents and dispersion model**

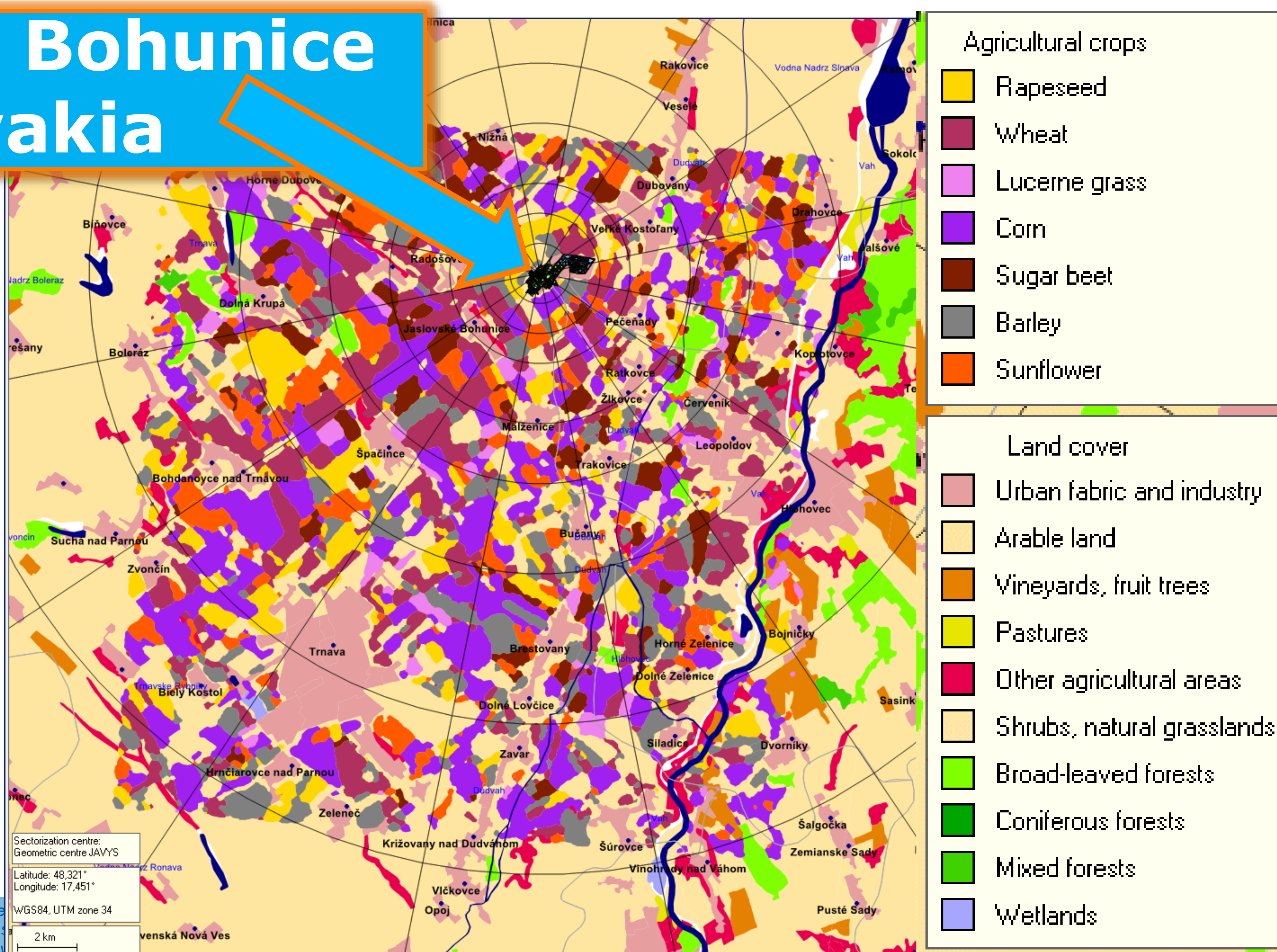
up to

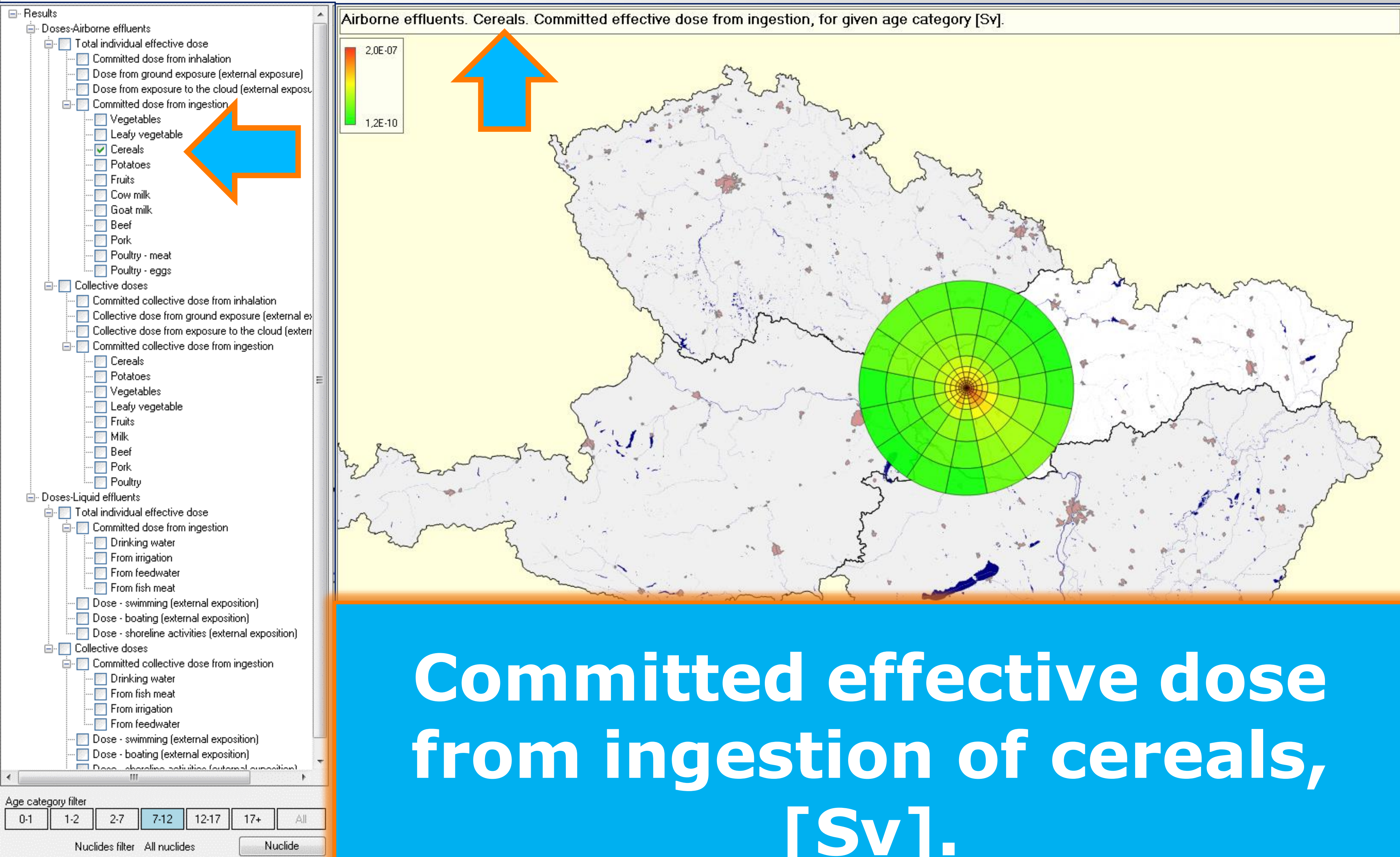
- the calculations of concentration of radionuclides in crops

Example of implementation – impacts of ROUTINE effluents:

ESTE Annual Impacts

NPP Bohunice Slovakia





Committed effective dose from ingestion of cereals, [Sv].

Example of implementation – impacts of ACCIDENTAL releases:

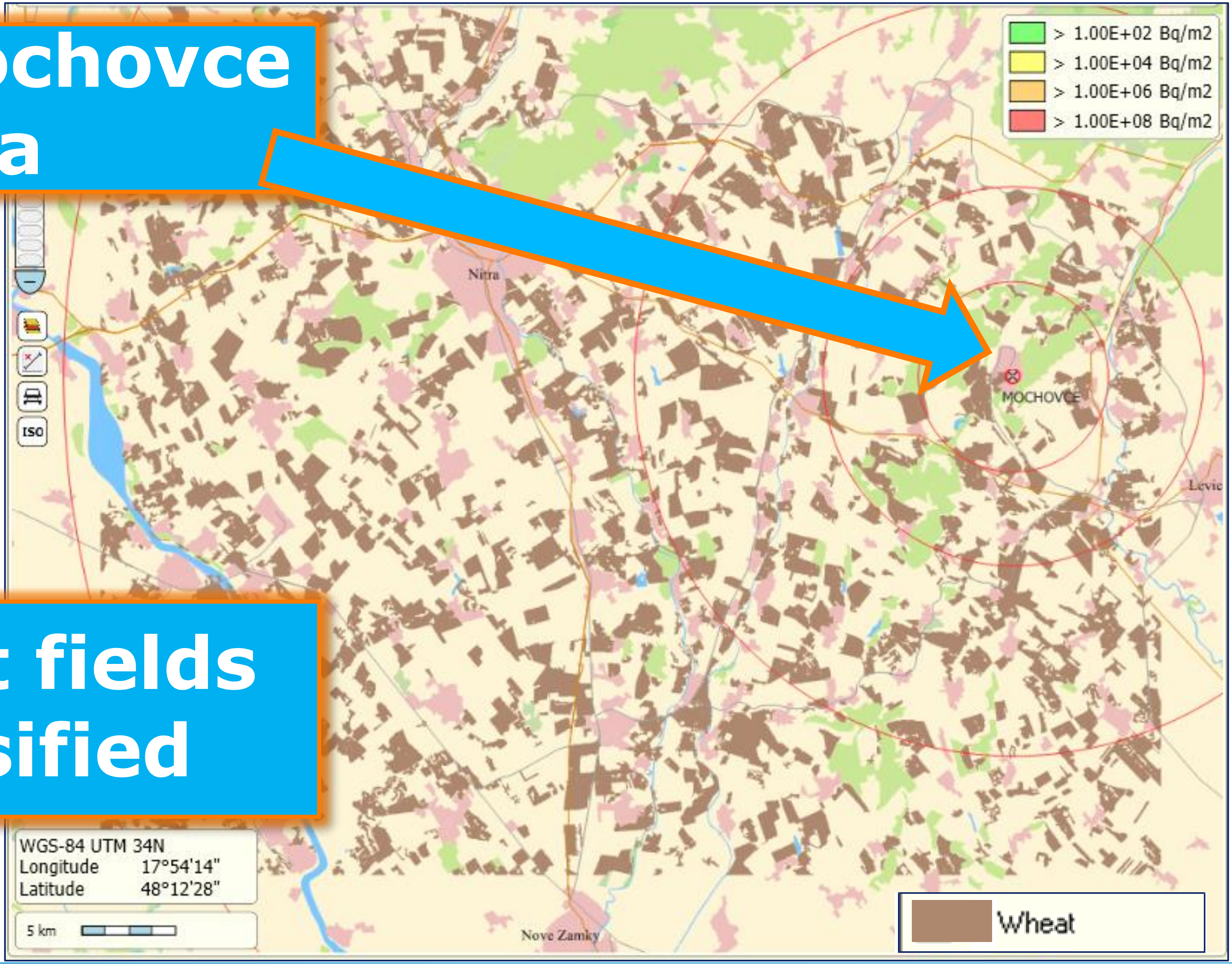
DSS ESTE

Example - our case study

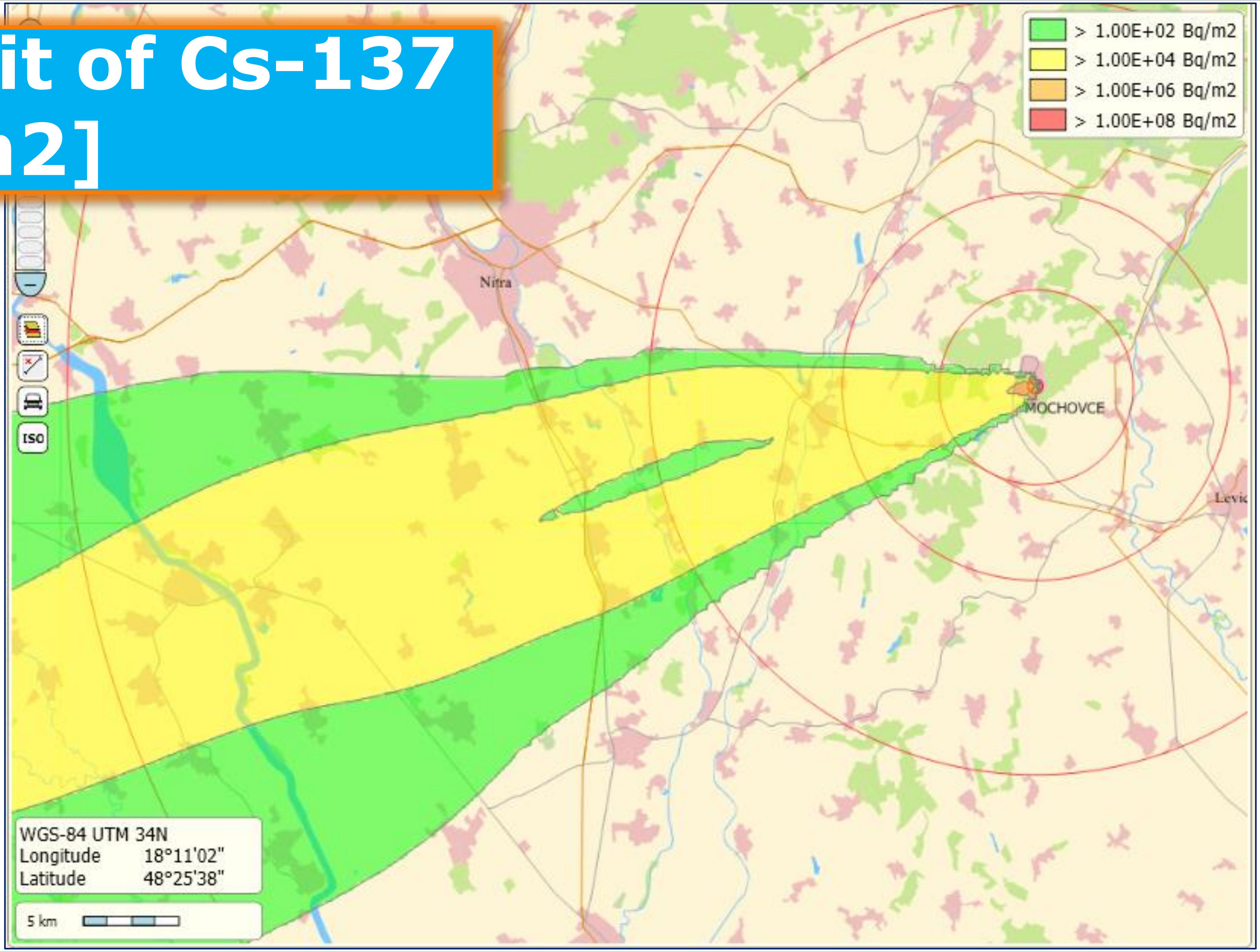
- based on hypothetical accidental release due to hypothetical severe accident at Mochovce NPP (Slovakia)
- release of about 1E+15 Bq of Cs-137 (and release of Cs-134, I-131, Sr-90) was assumed.
- Applied dispersion model of ESTE was Puff Trajectory Model.
- Hypothetical release was realized at the beginning of July
- meteorological conditions during the release were without any rain
- wheat was harvested at the beginning of August and 10% of the mass of wheat is really utilized in food chain and in feed chain.

NPP Mochovce Slovakia

Wheat fields classified

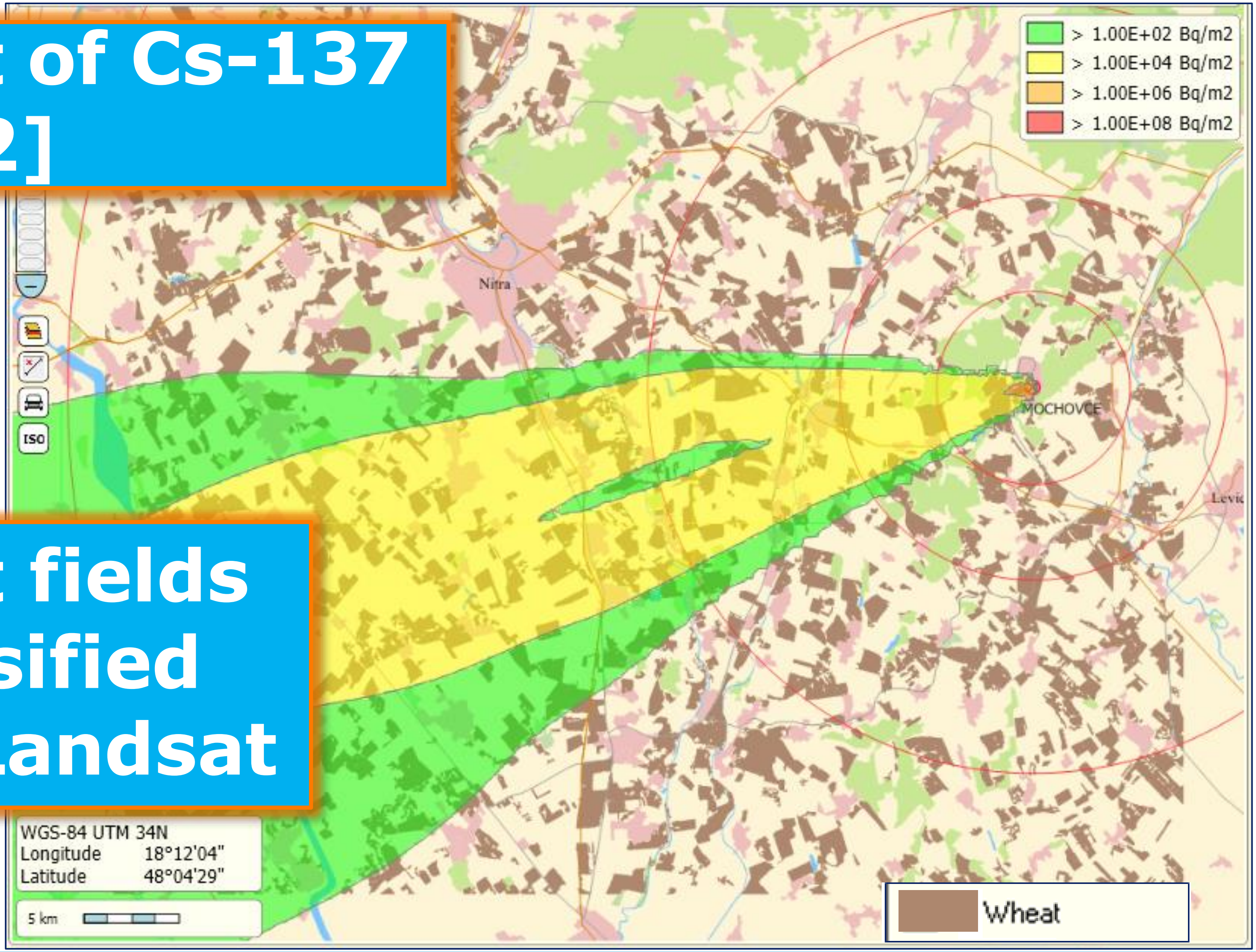


Deposit of Cs-137 [Bq/m2]

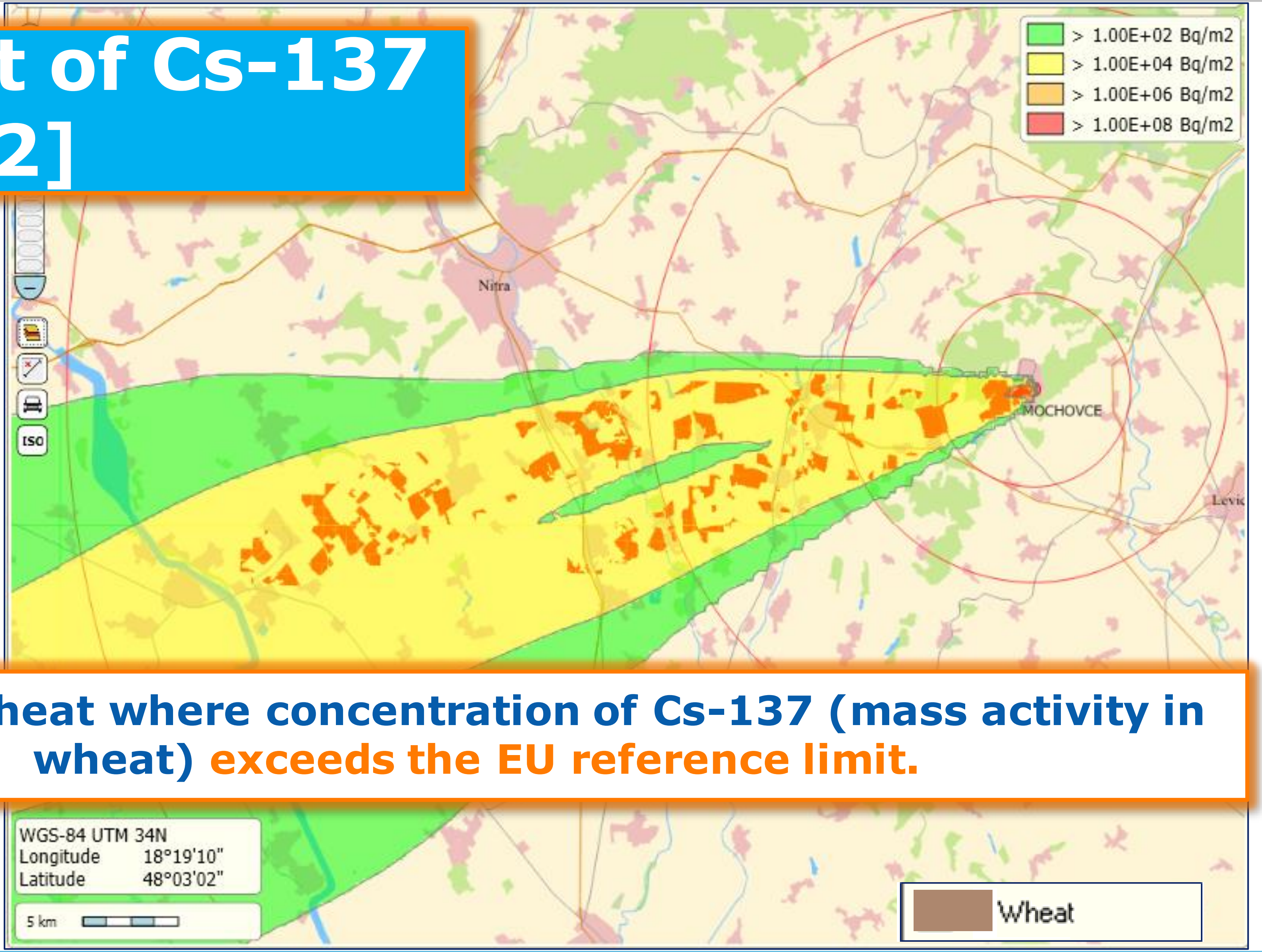


Deposit of Cs-137 [Bq/m2]

Wheat fields -classified using Landsat



Deposit of Cs-137 [Bq/m2]



Fields of wheat where concentration of Cs-137 (mass activity in wheat) exceeds the EU reference limit.

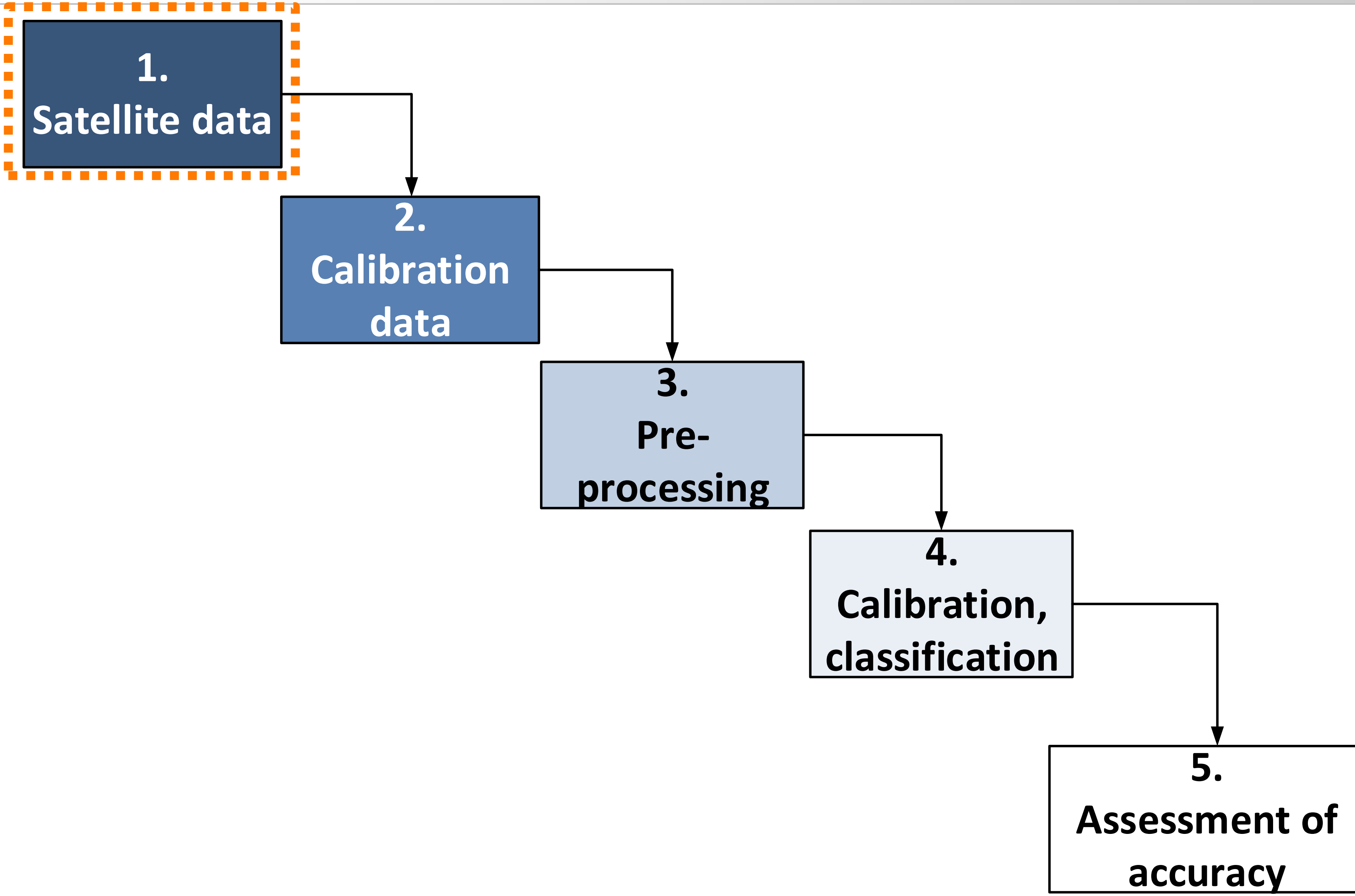
Nuclide	area of wheat fields with exceeded limits [km2]					Total amount of wheat excluded due to specif. nuclide [t]
	distance 0-5 km	distance 0-10 km	distance 0-20 km	distance 0-50 km	above 50 km	
Cs-137	3.23	7.11	16.33	24.30	0.00	13 243
Cs-134	3.29	7.62	20.99	45.35	0.00	24 715
I-131	3.36	7.71	21.39	40.63	0.00	22 143
Sr-90	0.01	0.01	0.01	0.01	0.00	6
total due to all nuclides	3.36	7.71	21.39	45.75	0.00	24 936

Non-marketable amount of wheat according to our case study (situation 30 days after release).

Process:

1. Satellite data
2. Ground truth data (calibration data)
3. Satellite data pre-processing
4. Classification
5. Assessment of accuracy.

-in case of routine application of the method process consists of step 1, 3 and 4.


1.
Satellite data
2.
Calibration data
3.
Pre-processing
4.
Calibration, classification
5.
Assessment of accuracy

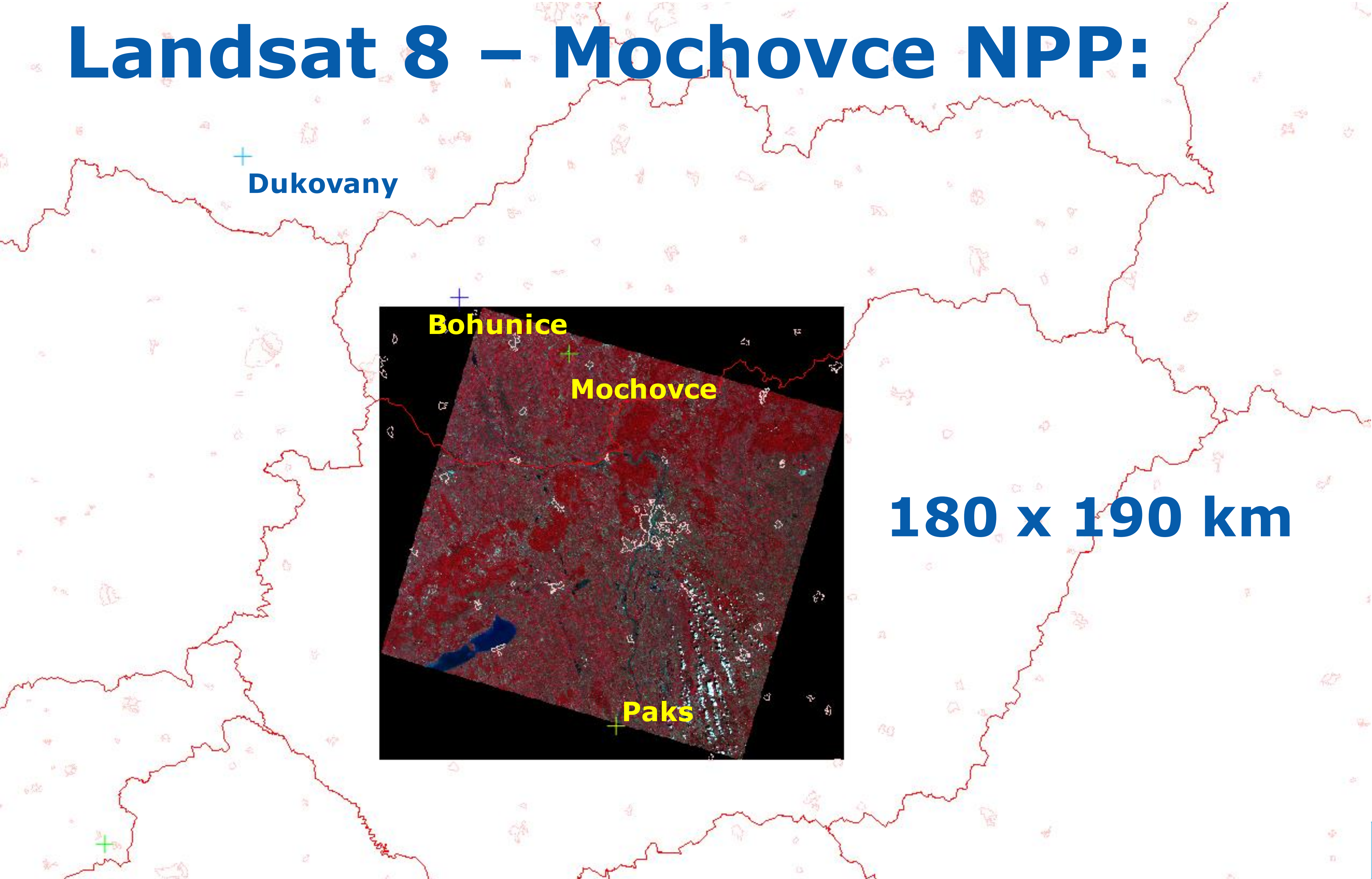
1. Satellite data

Satellite data

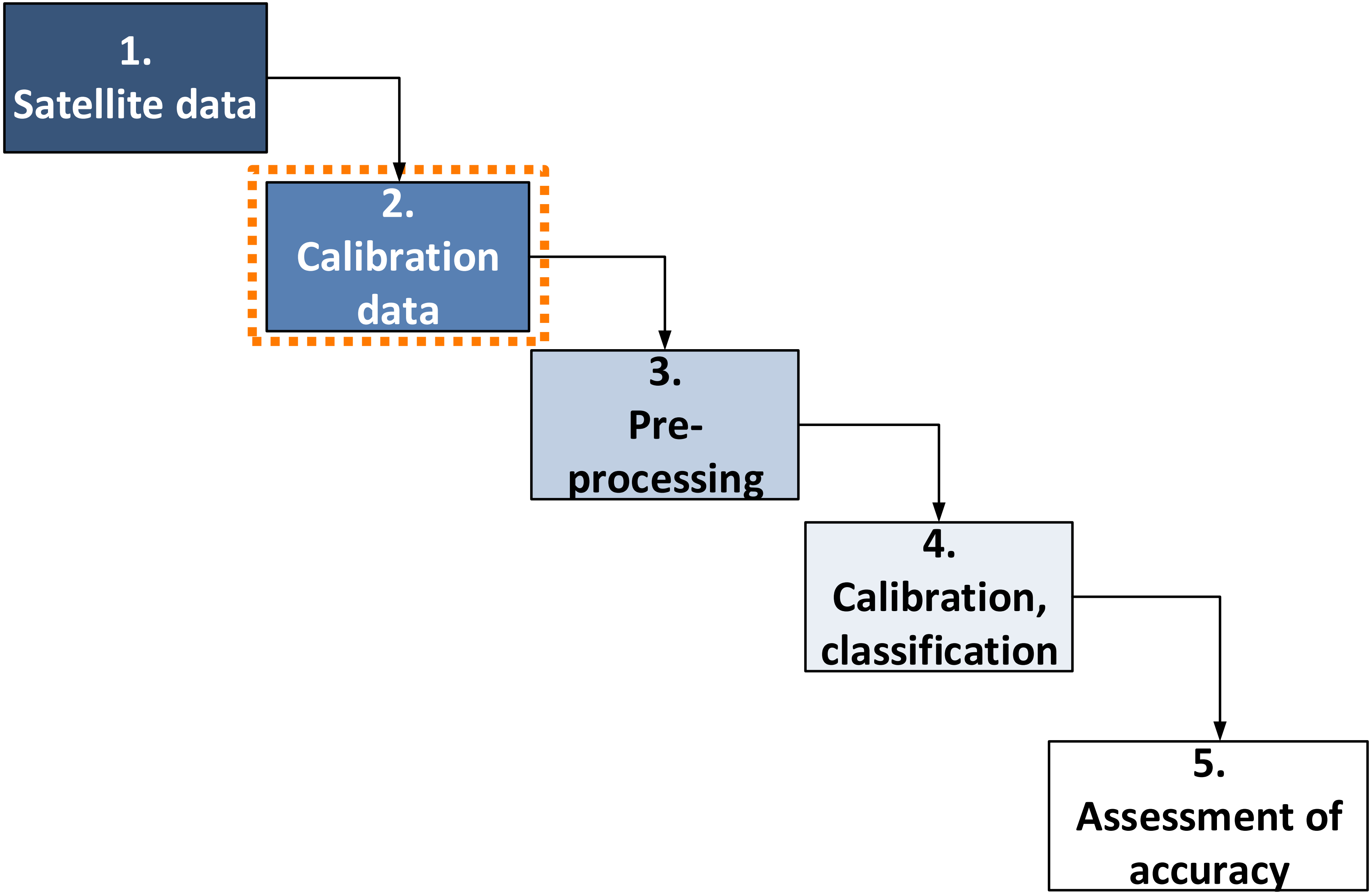
- Suitable is multispectral satellite imagery containing the wavebands of visible, near infrared and shortwave infrared EM spectra with medium-high spatial resolution (5 - 50 m).

- For example Landsat 8 data with 30 m spatial resolution can be applied.

Landsat 8 – Mochovce NPP:



180 x 190 km


1.
Satellite data
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4.
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5.
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2.
Calibration data

Ground truth (calibration data):

- Field survey is performed to obtain large dataset of ground truth data about spatial distribution of agricultural crops (spectroradiometer measurements).
- Some part of ground truth data are left for later assessment of accuracy, as ground truth reference values.
- In routine application of the method the ground truth data are not needed.

Ground truth (calibration data):

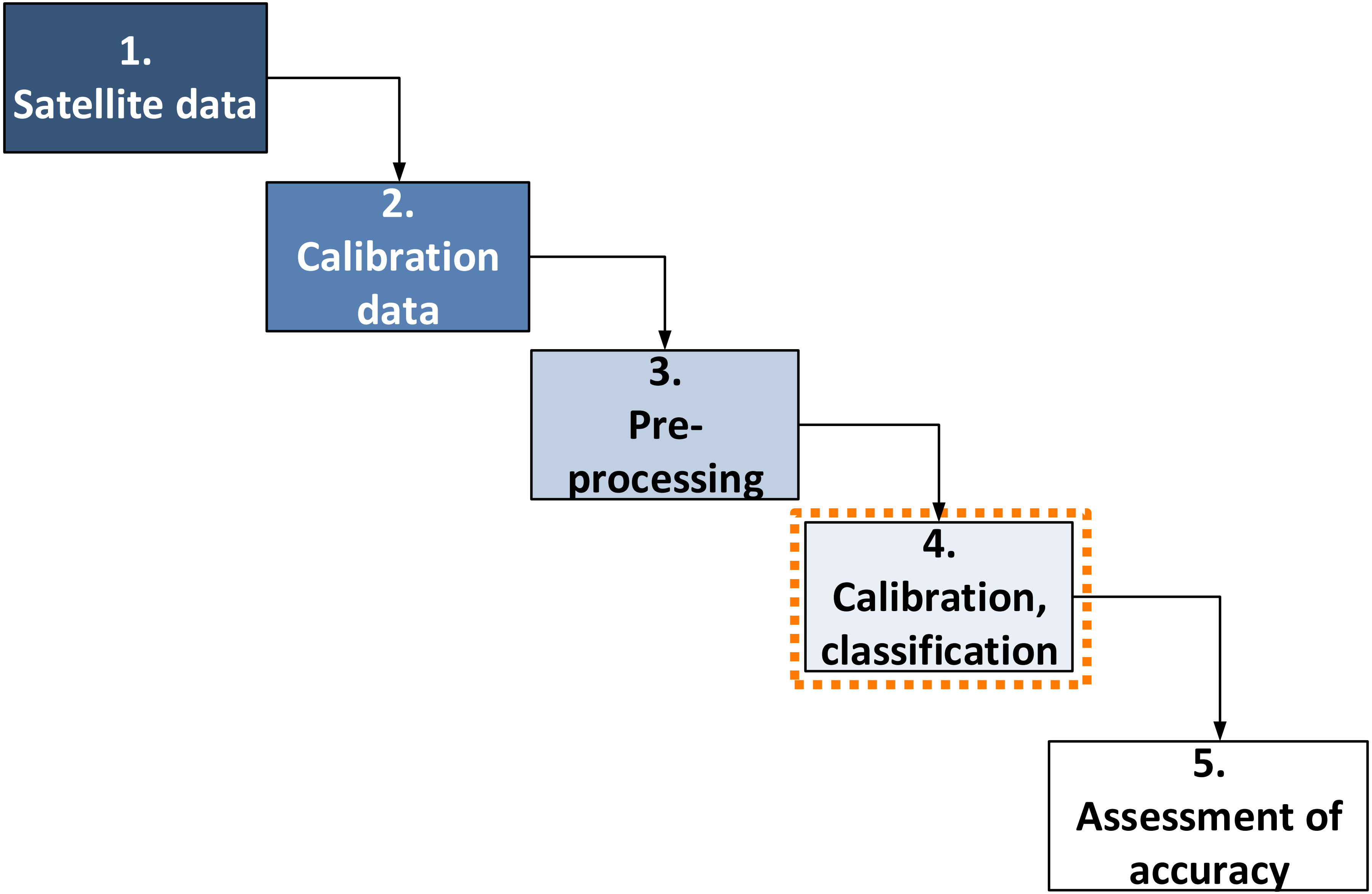
- In our case study ground truth data were gathered from the area of about 200 km x 200 km and approximately 4000 agricultural fields were measured.

- Calibration data were gathered on the territory of Slovakia, Czech Republic, Austria and Hungary.

Preparation of specific ROI – region of interests

- Training / calibration dataset:

Regions of Interest
- value_31_LUCERNE
- value_20_SOYA
- value_19_RAPE_SEEDS
- value_18_SUNFLOWER
- value_16_SUGAR_BEET
- value_11_MAIZE
- value_8_BARLEY
- value_6_WHEAT
- roads
- urban_areas
- water_areas
- pasture
- deciduous_forest


1.
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4. Calibration, classification

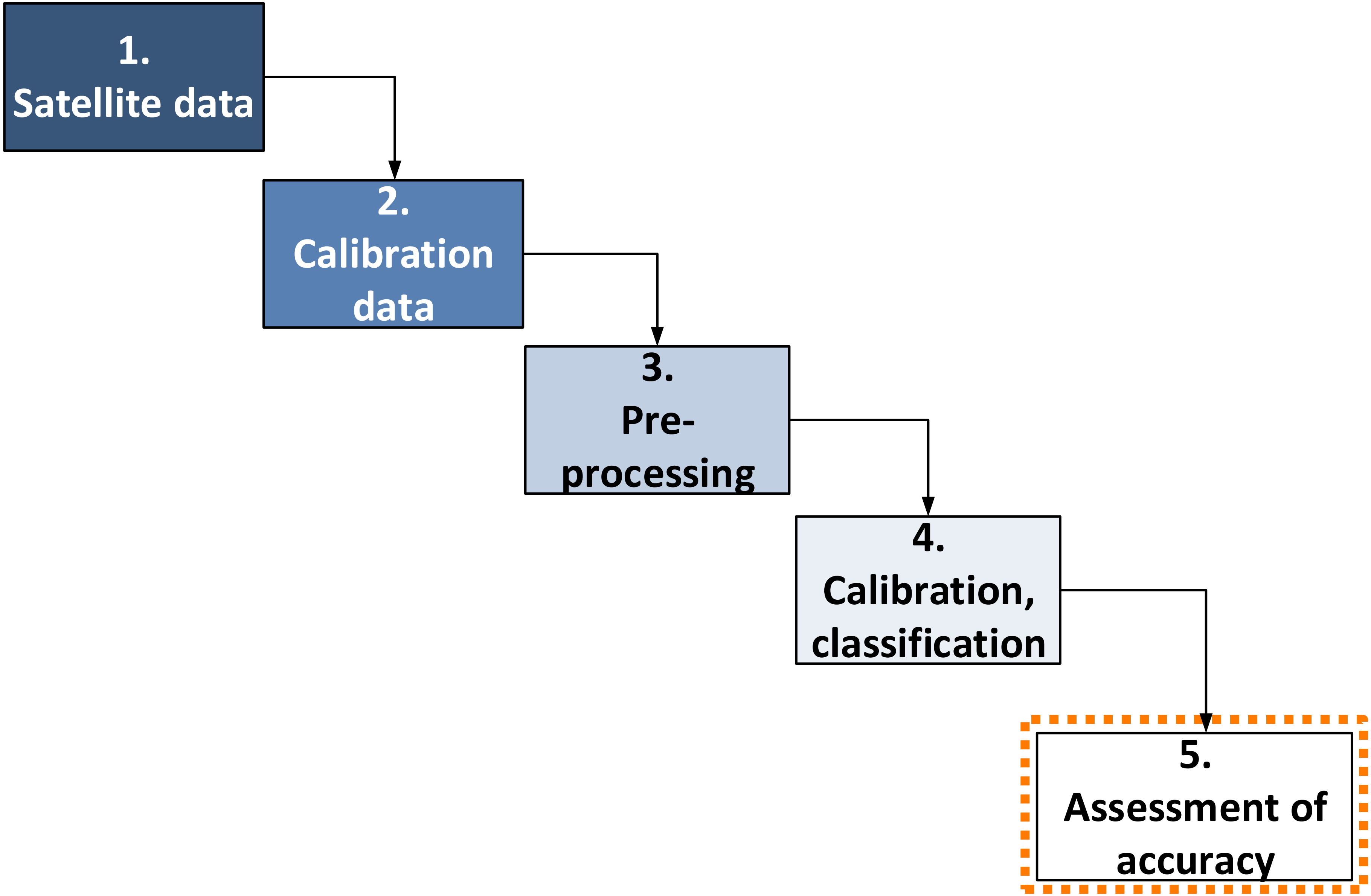
Calibration and classification:

- Ground truth data are utilized for calibration (creating training dataset) of classification algorithm.
- Classification means process which assigns digital values of satellite data to categories of agricultural crops (wheat, maize, etc.)

Calibration and classification:

- In our case study 2 classification methods were applied: Maximum Likelihood and Support Vector Machine.

- Results of calibration are spectral responses (signatures/endmembers), which will be later used in routine application of the method.


1.
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5.
Assessment of accuracy

Assessment of accuracy:

- Using Ground Truth data (part of)
- In our case study overall accuracy for Maximum Likelihood classification method was 87.8 %, the accuracy for Support Vector Machine method was 88.5%.
- The best results were obtained for agricultural category - rape seeds.

Example of validation results:

Classifier vs. Ground Truth

	lucerne	rape seeds	sunflower	sugar beet	maize	barley	wheat
lucerne	26.95	0.00	15.82	0.00	36.91	5.27	0.00
rape seeds	0.00	99.81	0.00	0.00	0.00	0.00	0.16
sunflower	0.00	0.00	33.80	0.40	58.95	0.00	0.00
sugar beet	0.00	0.00	0.00	84.52	0.00	7.39	7.09
maize	0.06	0.00	8.38	0.00	62.12	0.12	7.89
barley	0.00	0.44	0.00	17.89	1.91	63.49	13.05
wheat	0.00	2.10	0.03	0.44	1.58	15.55	77.57

Method is applied in:

1. Algorithms for prediction of **mass activity** in various agricultural crops in case of nuclear **accident**

2. Analyses for **estimated food contamination**, predicted results to support **management of food chain monitoring**

3. Analyses of needs of **protective measures in agriculture** and food/nutrition production

Thank you

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