

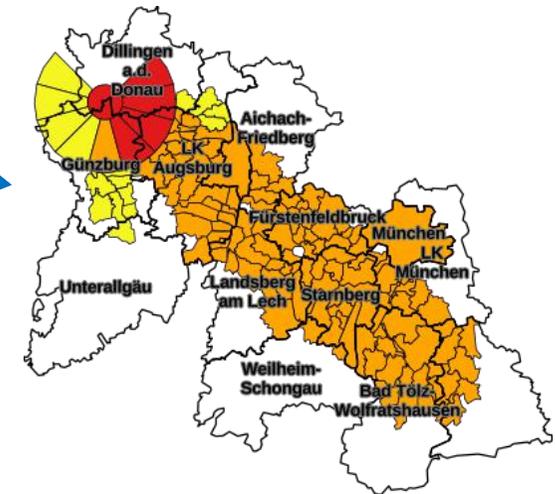
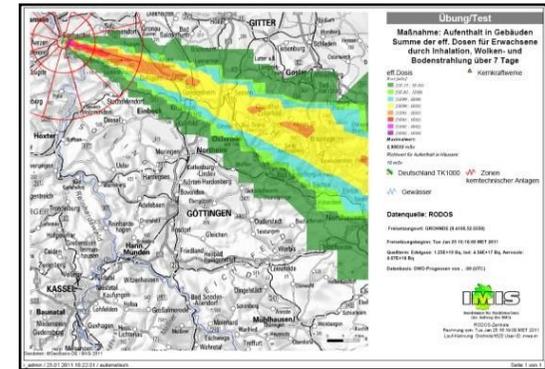
# Individual dose reconstruction after nuclear accidents based on environmental monitoring data

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# Tasks of BfS in case of nuclear emergencies

- Evaluation of the radiological situation
- Prognosis/Forecast (dispersion modelling)
- Dose estimation
- Consequence assessment
- **Dose reconstruction** (= Estimation of individual doses based on environmental monitoring data)



# RODOS dose calculation

## Standard procedure

Meteorological data,  
source term data

Atmospheric  
Dispersion Module

## New option

Measurement data  
(GDR, air  
concentration, ground  
contamination)

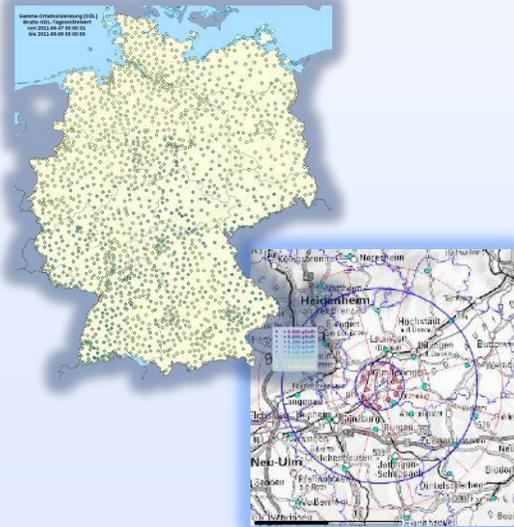
preprocessor  
dose reconstruction

**Dose calculation in FDMT**  
(RODOS Food Chain Dose Module)

# Radiological measurement data used for the dose reconstruction in Germany

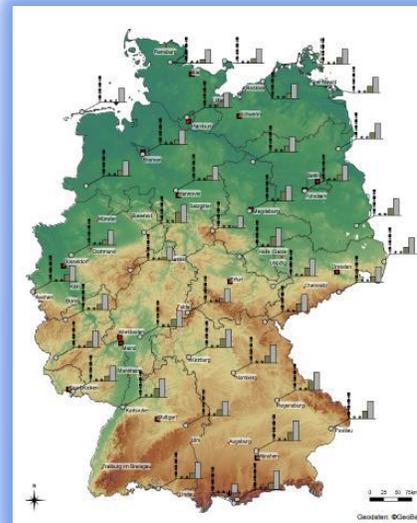
## Gamma dose rate measurements (GDR)

- Nationwide: ~1800 automatic stations plus ~300 probes (remote monitoring of NPPs)
- (~200 spectrometric probes)



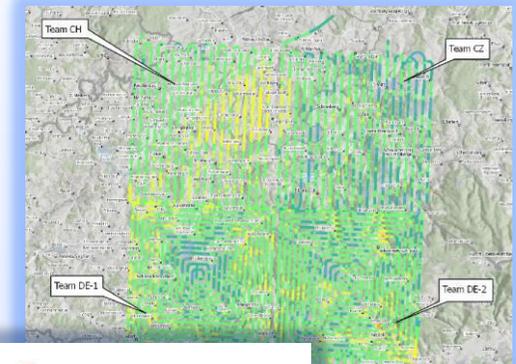
## Nuclide measurements (continuous)

- ~40 stations with nuclide information of ground contamination and activity concentration in air (DWD)
  - (*precipitation*)



## Nuclide measurements (mobile)

- Aerogamma (up to 4 helicopters)
- Car-borne (in situ, GDR; BfS: 12 cars + ...)



# Overview of the dose reconstruction approach

## Input

- **measurement data** (location, time, measured variable and value)
- **some parameters** (deposition velocity, estimated source term, etc.)



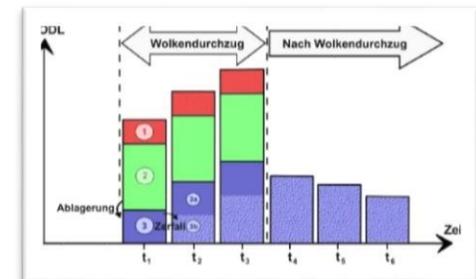
## data processing

- Generation of a spatio-temporal **computational grid**
- Definition of the **cloud passage** based on measurement data



## modelling

- Modelling of missing time steps and missing variables **in the cloud transition phase** and **after the cloud passage**
- Calculation of time-dependent, nuclide-specific **air concentration** and **ground contamination** at all measurement sites



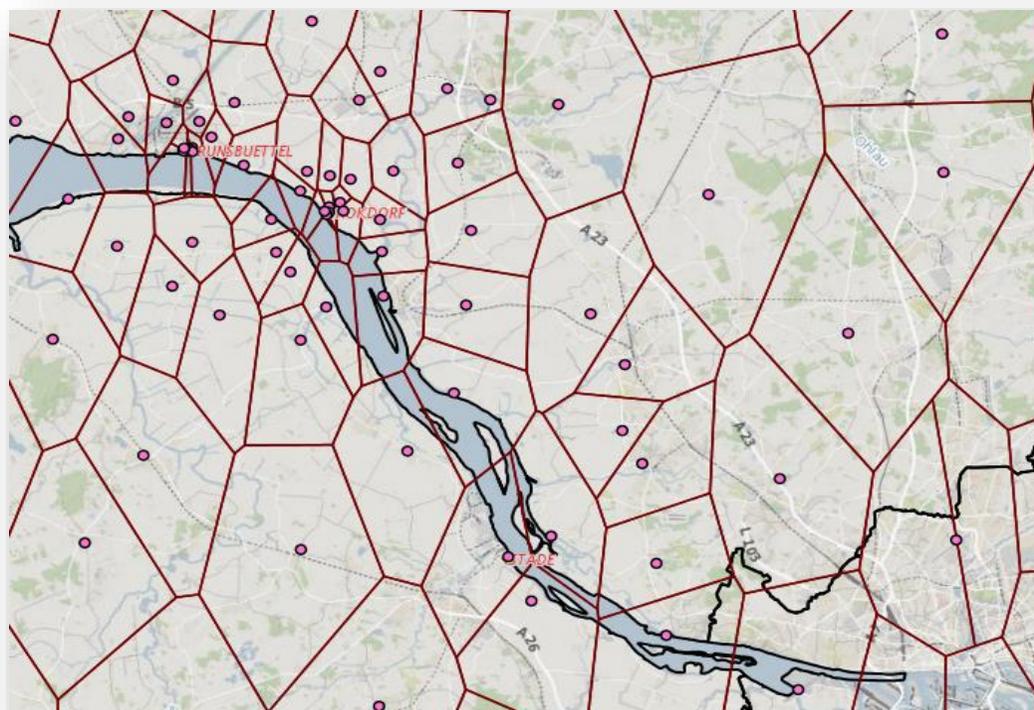
## dose calculation

- Calculation of **dose values** at all measurement sites
- **dose reconstruction for individuals** based on individual tracks and residences in a contaminated area



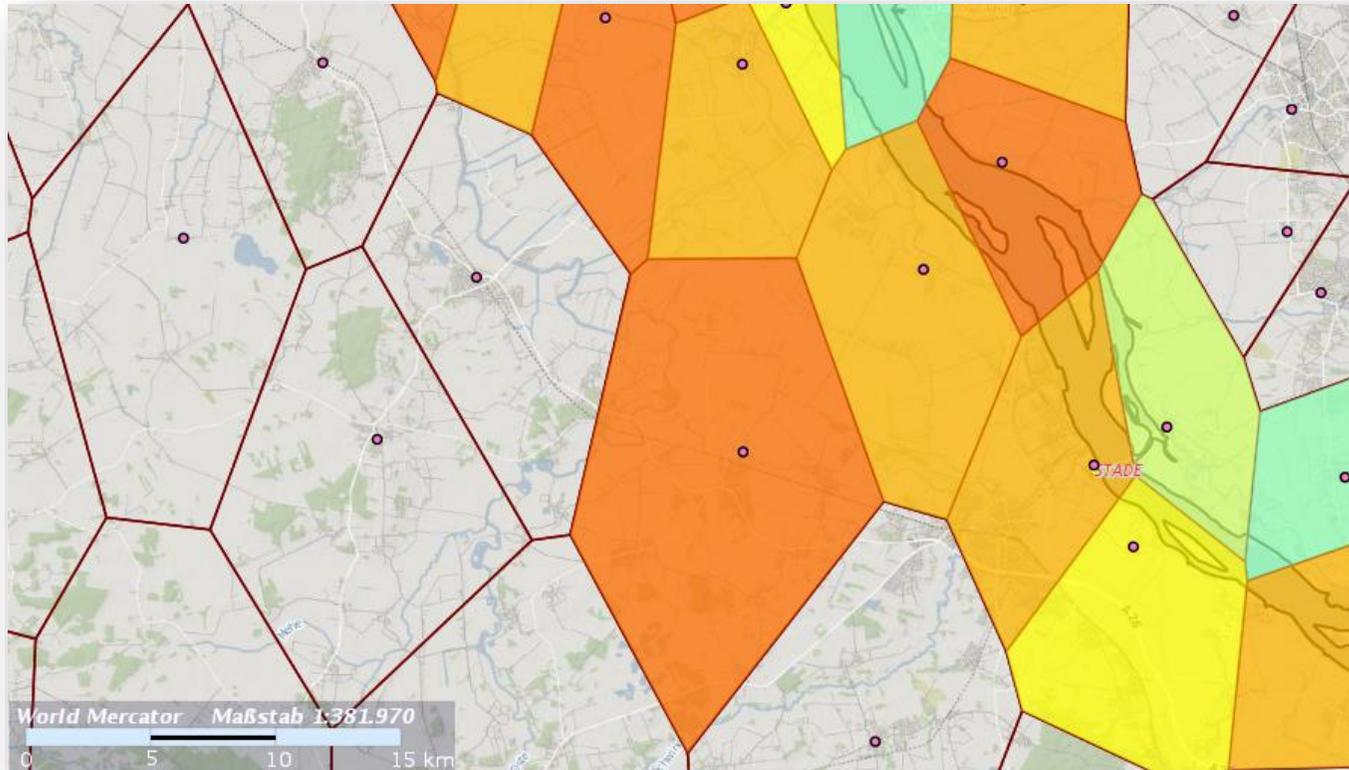
# Areas around the measurement stations: Voronoi-diagram

**Voronoi diagram:** Subdivision of a contaminated area based on the location of measurement sites in polygons („each point of the map obtains the measurement data of the nearest measurement site“, simple and robust interpolation technique)



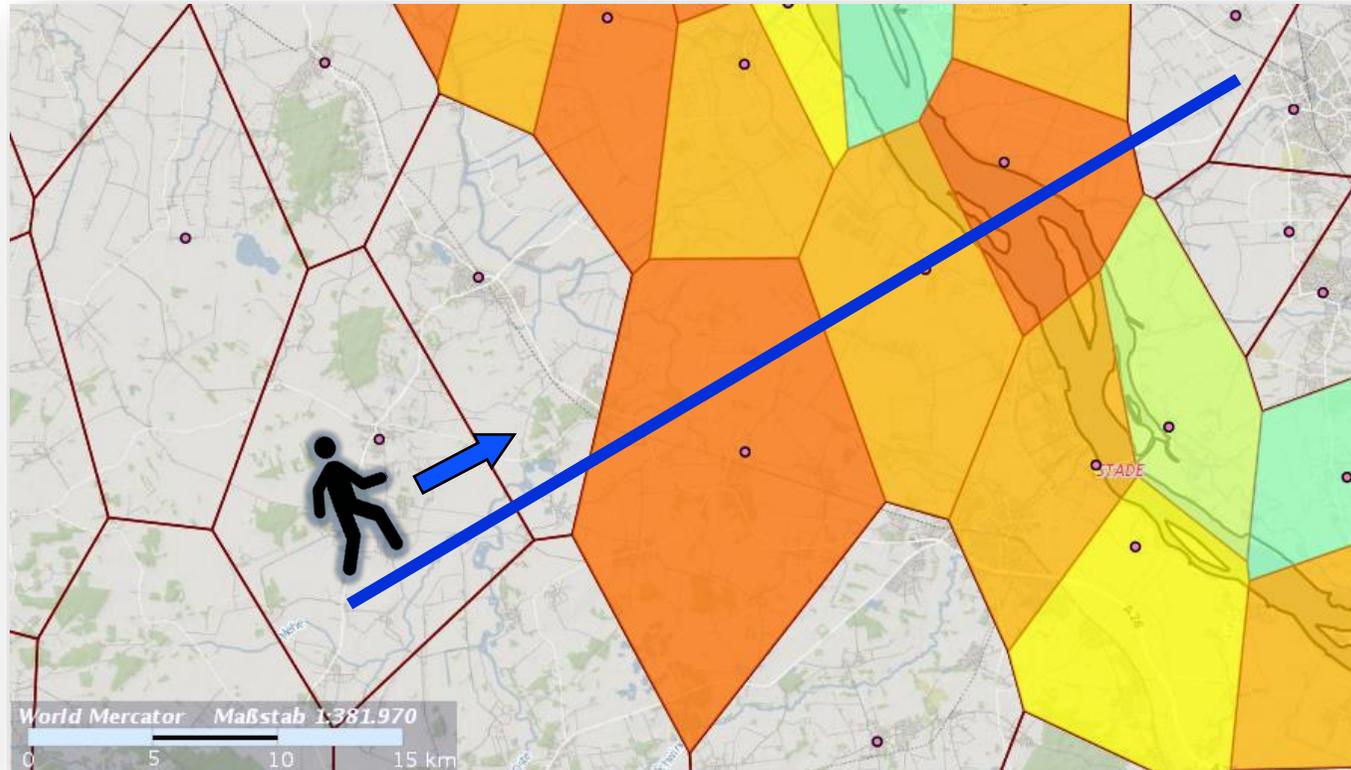
# Individual dose reconstruction

For persons in contaminated areas:  
Estimation of doses based on individual tracks and residences



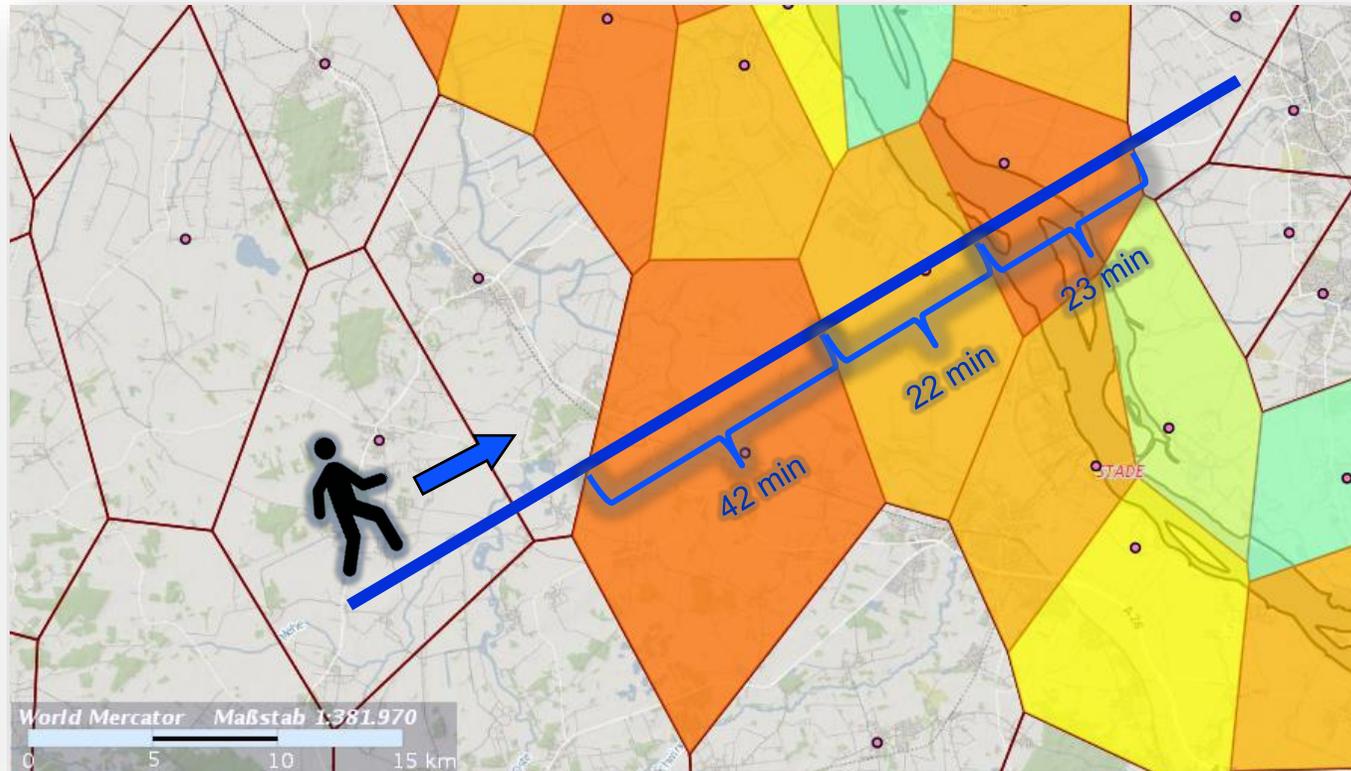
# Individual dose reconstruction

For persons in contaminated areas:  
Estimation of doses based on individual tracks and residences



# Individual dose reconstruction

For persons in contaminated areas:  
Estimation of doses based on individual tracks and residences



# Graphical User Interface (e.g. for emergency care stations)

Open Street Map:  
Click to create  
individual tracks  
of the potentially  
exposed person

Personal  
information: ID  
code, age, gender

**Dosisrekonstruktion**

**Persönliche Daten**

Identifikation:

Altersklasse:

Geschlecht:

**Ergebnis Dosisberechnung:**

Organ	Wert in [mSv]
Effektive Dosis	bnis
Schilddrüse	bnis
rotes Knochenmark	Rechnung liefert Ergebnis

lösché Wegbezeichnung	Anfangspunkt	Endpunkt	Beginn	Ende	Aufenthaltsort	Schutzmaßnahmen
✗ drive to work	8.4379,49.3165	8.5492,49.321	02.06.2015 08:00	02.06.2015 08:30	im Freien/Auto	keine
✗ at work	8.5492,49.321	8.5492,49.321	02.06.2015 08:30	02.06.2015 12:00	Haus	keine
✗ drive to kindergarten	8.5492,49.321	8.5629,49.2937	02.06.2015 12:00	02.06.2015 12:15	im Freien/Auto	Schutzmaske
✗ drive to emergency care station	8.5629,49.2937	8.7071,49.2206	02.06.2015 12:15	02.06.2015 13:00	im Freien/Auto	Schutzmaske, Jodtablette

Formular zurücksetzen Dosisberechnung starten

Results of the dose  
calculation:  
effective dose,  
thyroid dose and  
red bone marrow  
dose

Listing of all track sequences including information about their duration  
and protective measures (e.g. sheltering; iodine tablets, protective masks)



# Individual dose reconstruction: first successful test

## Large emergency response exercise (including an emergency care center) in Berlin in Oct 2017

- **Goal:** Testing the concepts of the emergency management plan for the research reactor BER II of the Helmholtz Center Berlin
- **Scenario:** plane crash, one-hour release of radioactive material, predefined weather conditions
- **Dose reconstruction:** Three BfS employees on site: Supervision of the “dose reconstruction” sub-station: Reconstructed doses for individuals on the basis of radiological measurement data, plausibility check of the skin contamination and thyroid measurement data

