



CHARM[®]

Detection of diffuse landfill gas sources

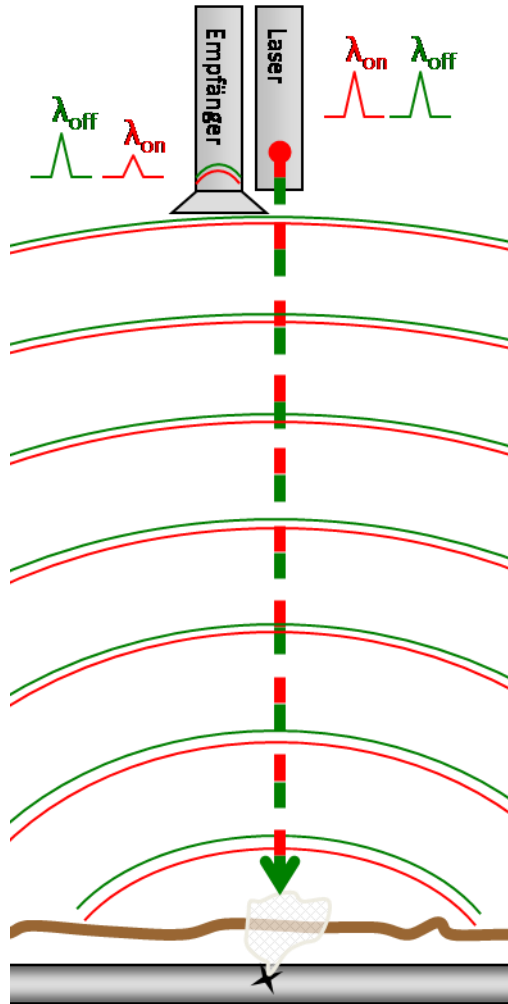
CH₄ Airborne Remote Monitoring

- Was developed to detect leaks in transport pipelines for natural gas
- Helicopter based laser system which allows for fast scanning of long tracks / large areas



Can CHARM be used for other purposes?

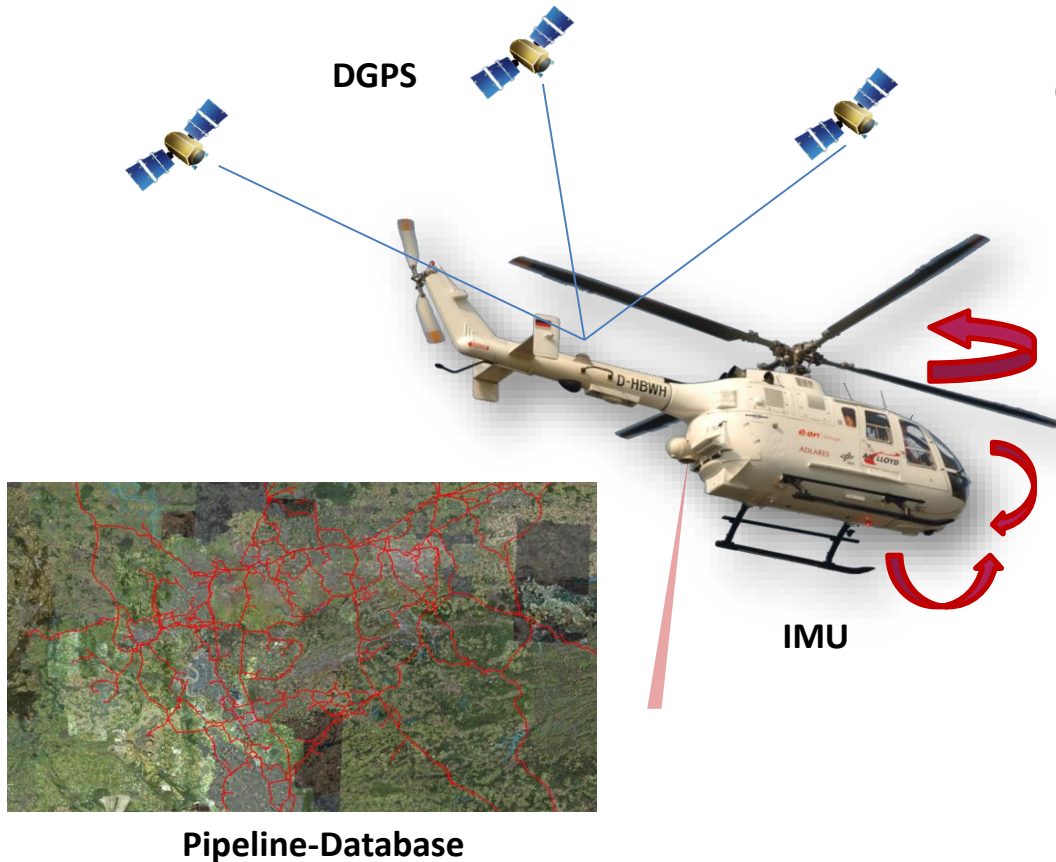
- Landfills
- Biogas plants
- ...



CHARM®-Measurement Principle

- Remote sensing using LIDAR (*Light Detection and Ranging*, a type of Laser-Radar)
- Emission of two laser pulses from the system to ground surface
- At the ground, the light is scattered in all directions, a small fraction of the light returns to the system, where it is detected
- The two laser pulses are tuned in way that the first pulse is specifically absorbed (attenuated) by methane (the main component of natural gas) while the second pulse is not influenced by methane
- The difference in the detected light intensities is a measure for the amount of methane molecules in the laser path. An elevated methane concentration is an indication for a pipeline leak.

Navigation



CHARM® - Automatic Beam Guiding

- A laser scanner distributes 100 measurements per second on a 6-8 m wide section close to the pipeline centerline
- The system comprises of high accuracy navigation sub-system
 - Differential GPS with worldwide correction service OmniSTAR (via satellite)
 - Inertial measurement system to determine the spatial position and movement of the helicopter
- Integrated data base for all pipelines to be monitored
- Real-time-calculation and -control of the laser beam ensure congruence of scan sector and pipeline centerline

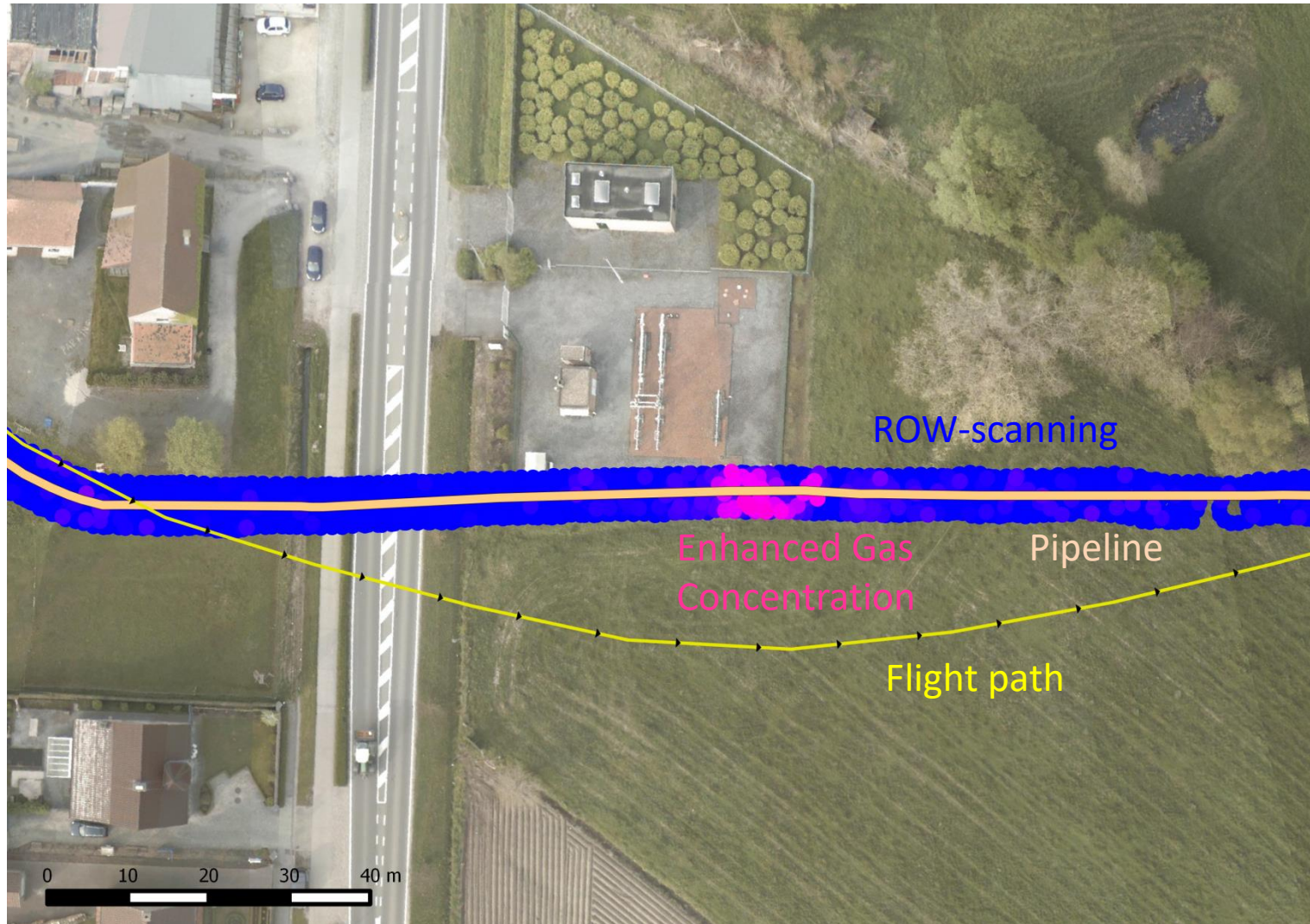
Helicopter in Use



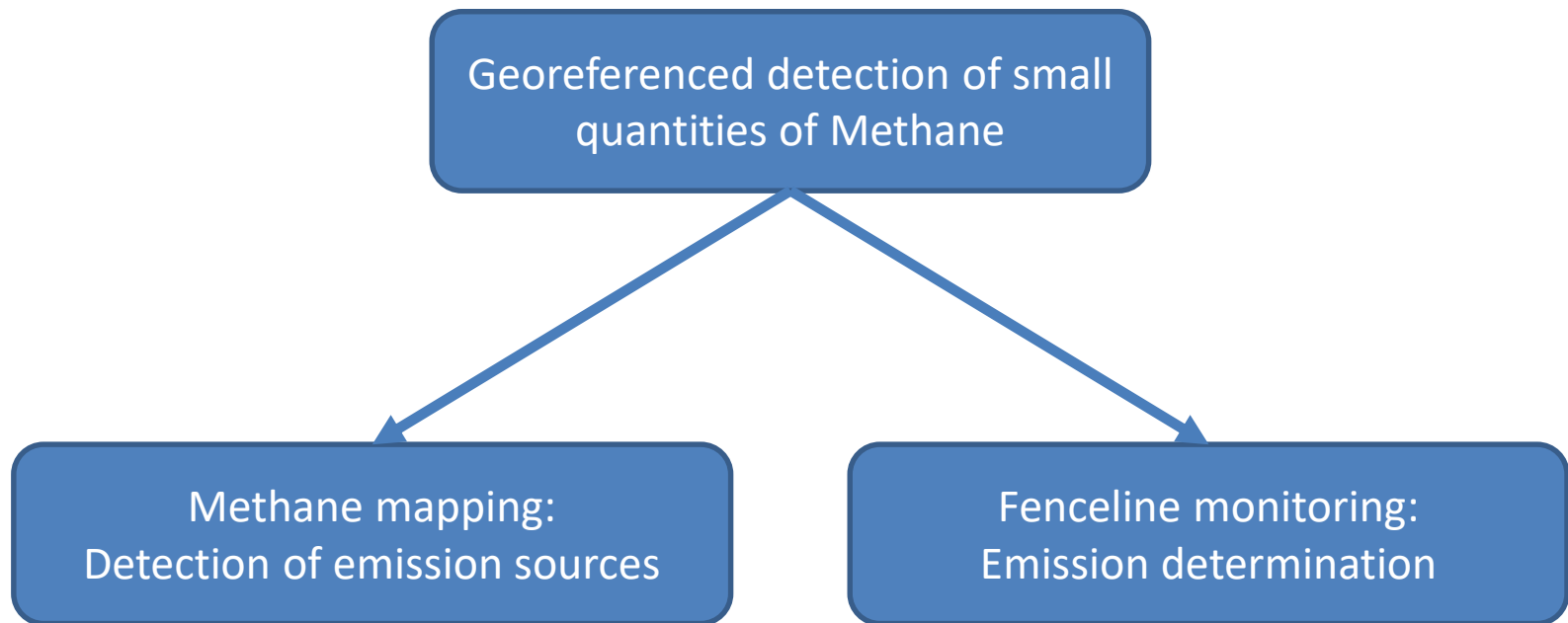
Current Helicopter in Use: BO 105

- Helicopter can follow complex pipeline networks much better than fixed wing aircraft
- CHARM® can be installed within 30 min in the helicopter
- EASA-certification for BO 105
- Flight altitude 250 – 500 ft:
 - High sensitivity
 - Visual survey of pipeline swath
- Survey speed: 30 - 40 kn (35 - 45 mph)
- Small crew: pilot and system operator
- **The only remote sensing system system with DVGW-certification**

Gas Detection Example



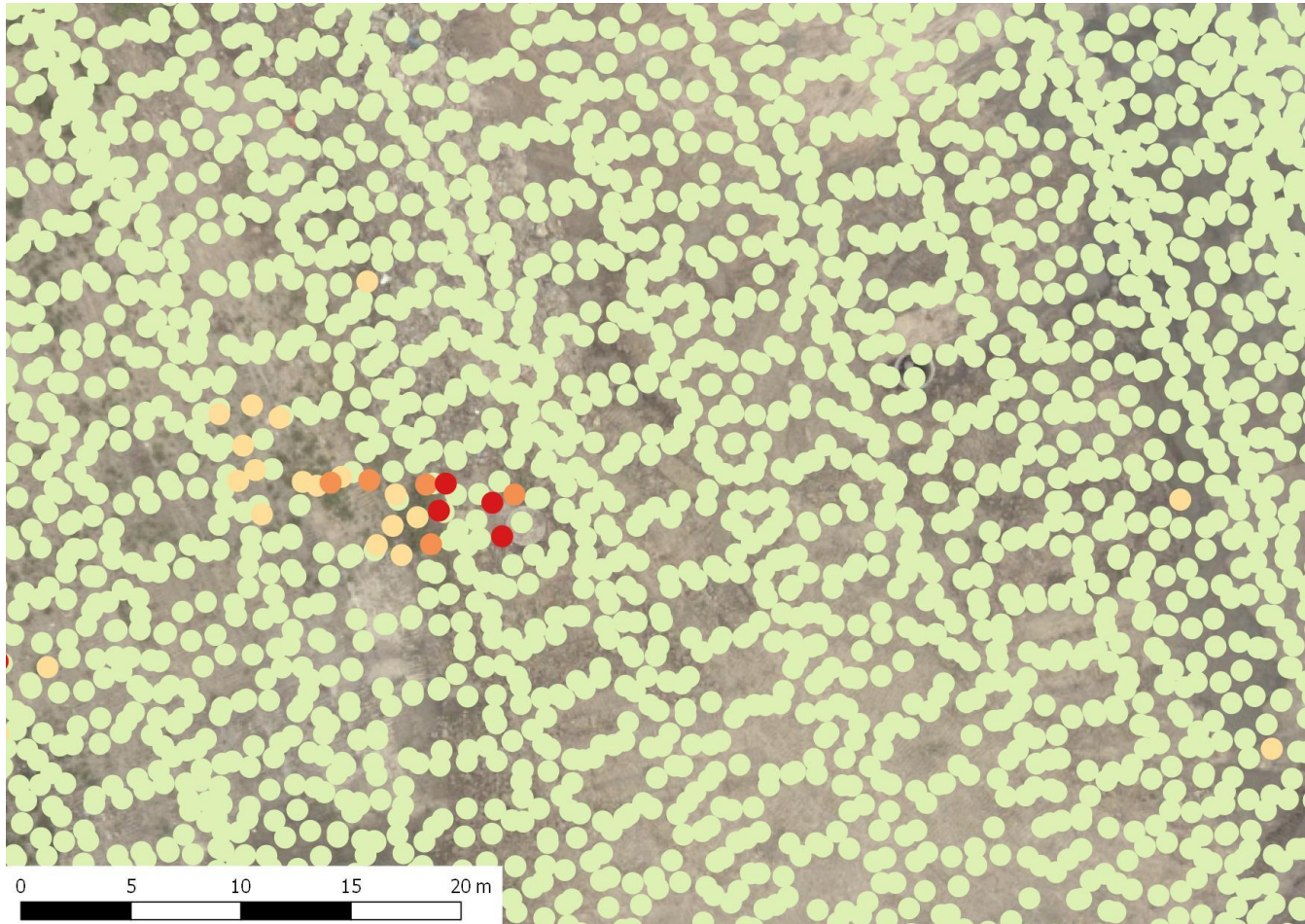
CHARM® Application on Landfills



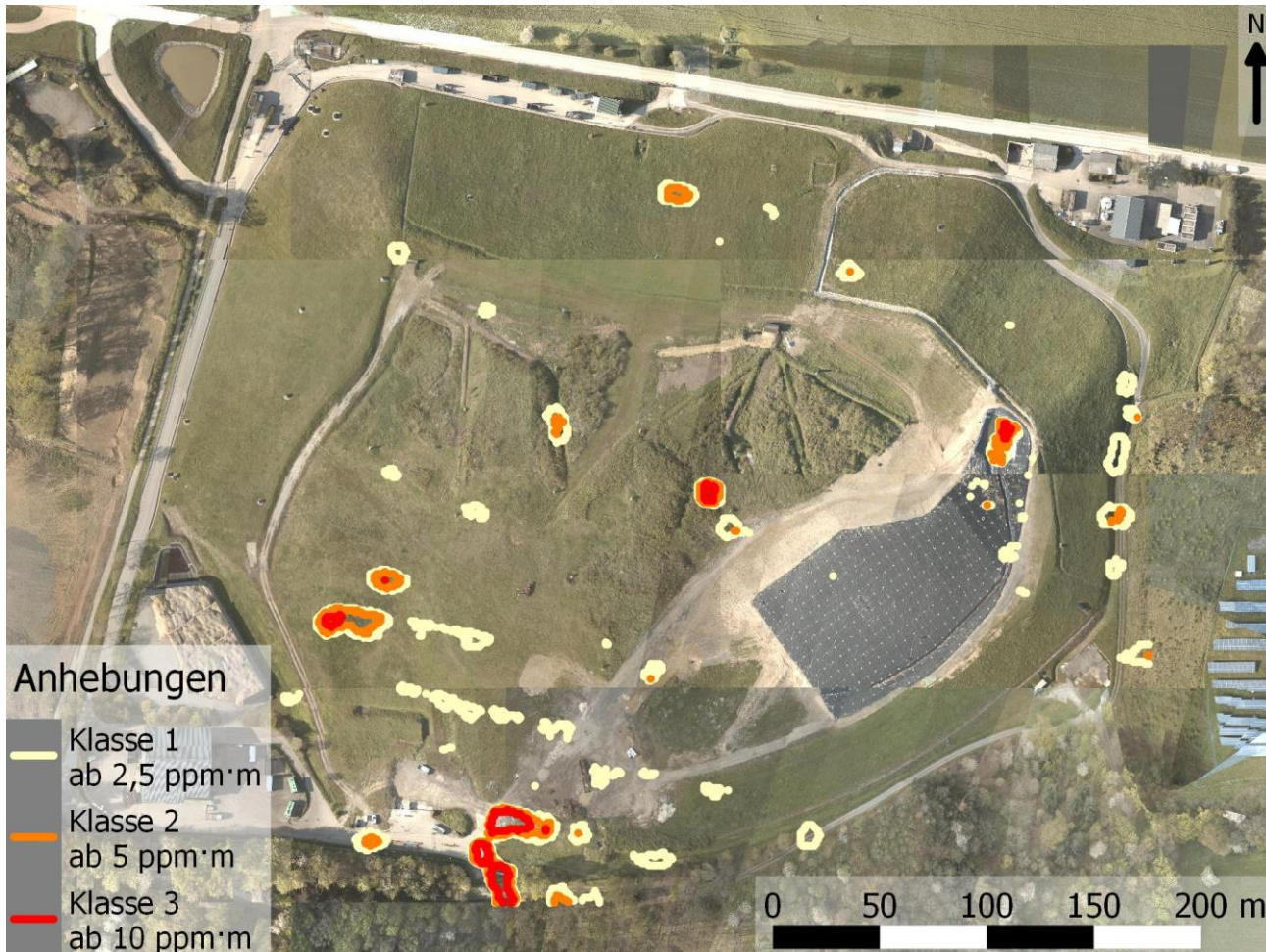
Landfill Altenberge: Aerial photo



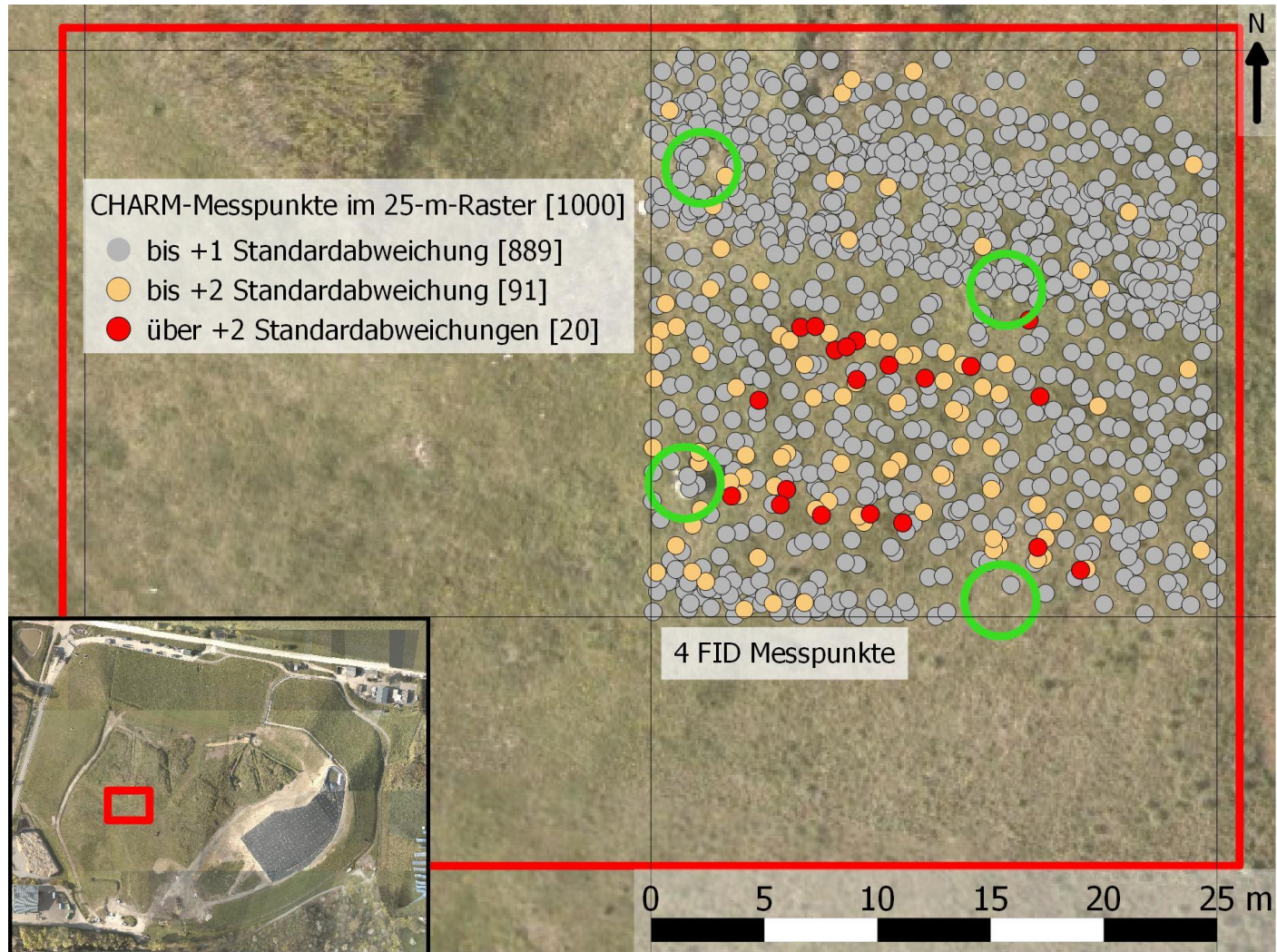
Methane emission from a gas well



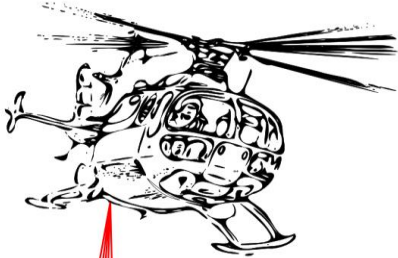
Landfill Hohberg (SW Germany): Emission Mapping



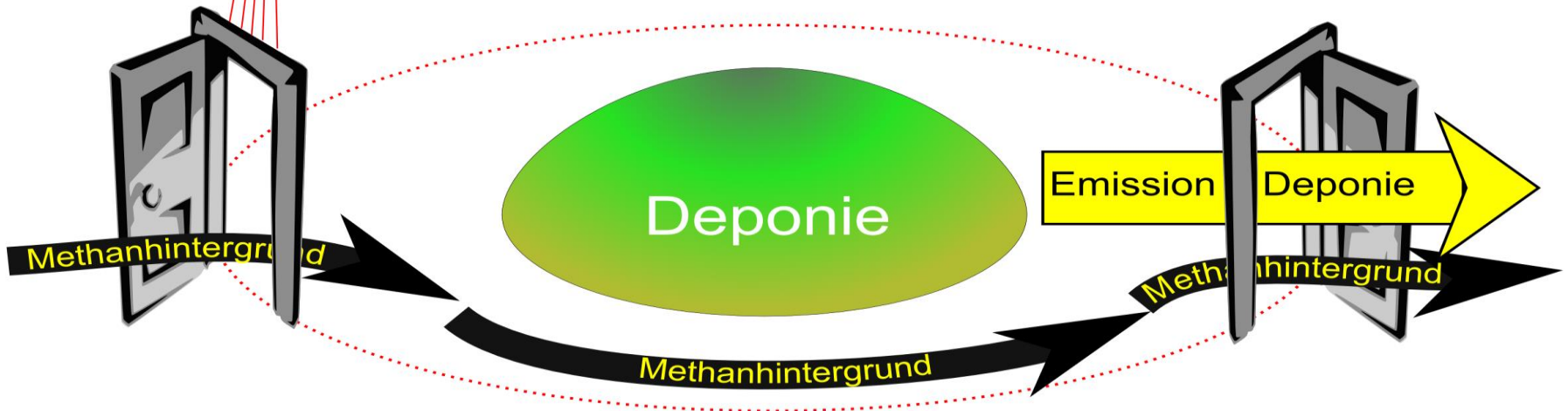
Details Emission Mapping



Quantitative Emission Determination



- Gauss-Theorem:
Emission = net flux on border
- Flux = concentration * windspeed
- Knowledge of windspeed is required

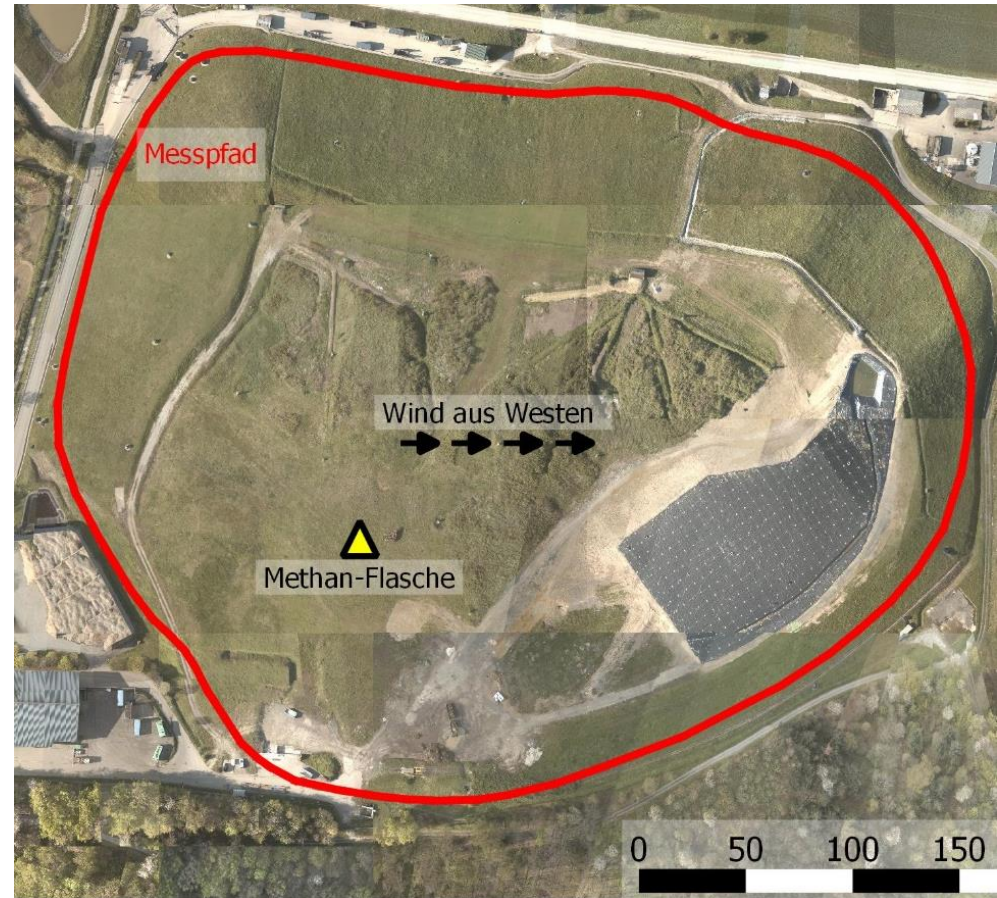


Wind measurement



Landfill Hohberg: Total Emission Determination

- Measurement track encloses the complete landfill
- Westerly wind 3 - 6 m/s
- **Total Methane - emission**
3 m³/h = 20 t/a

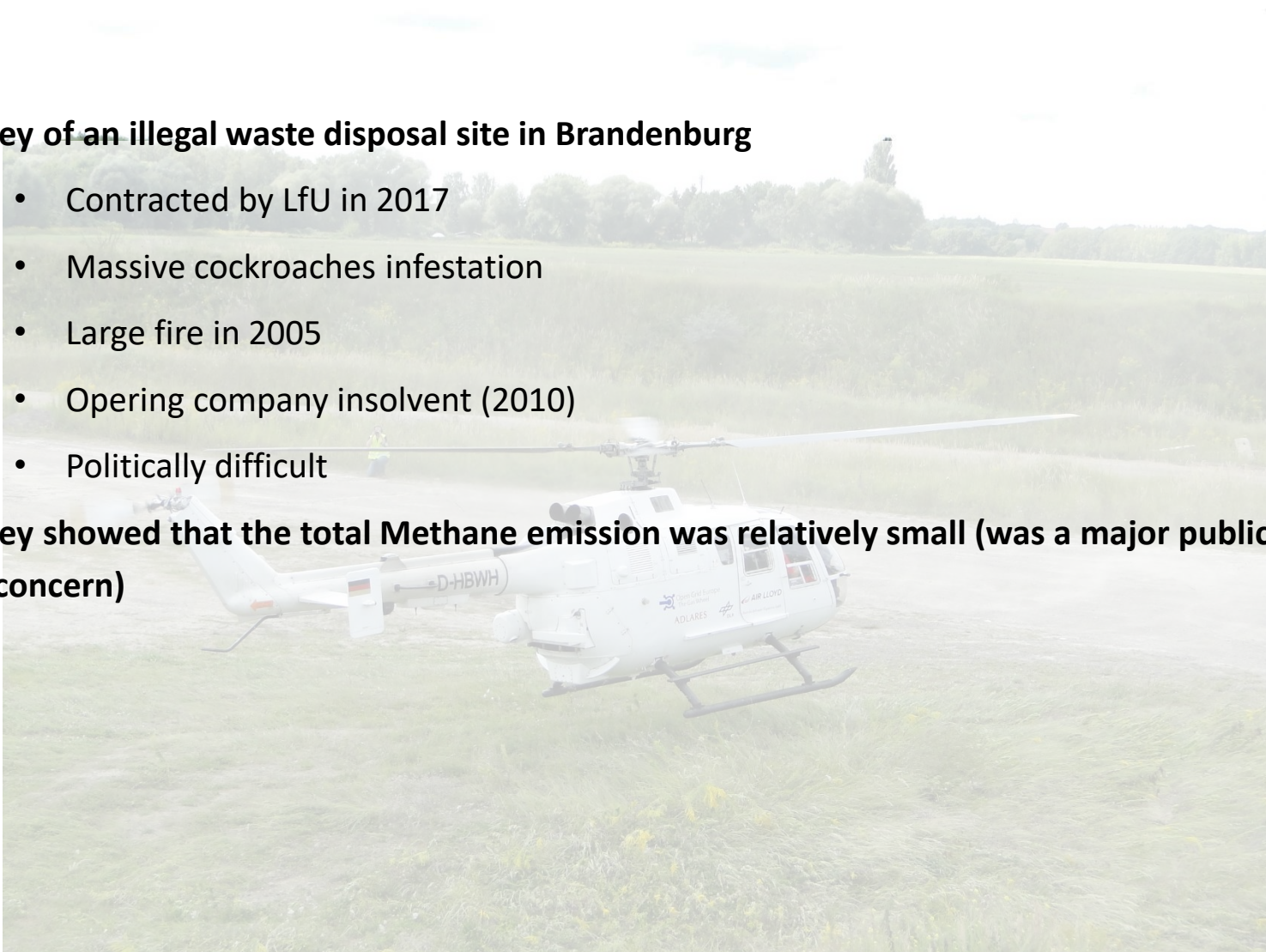


Survey of an Illegal Waste Disposal Site

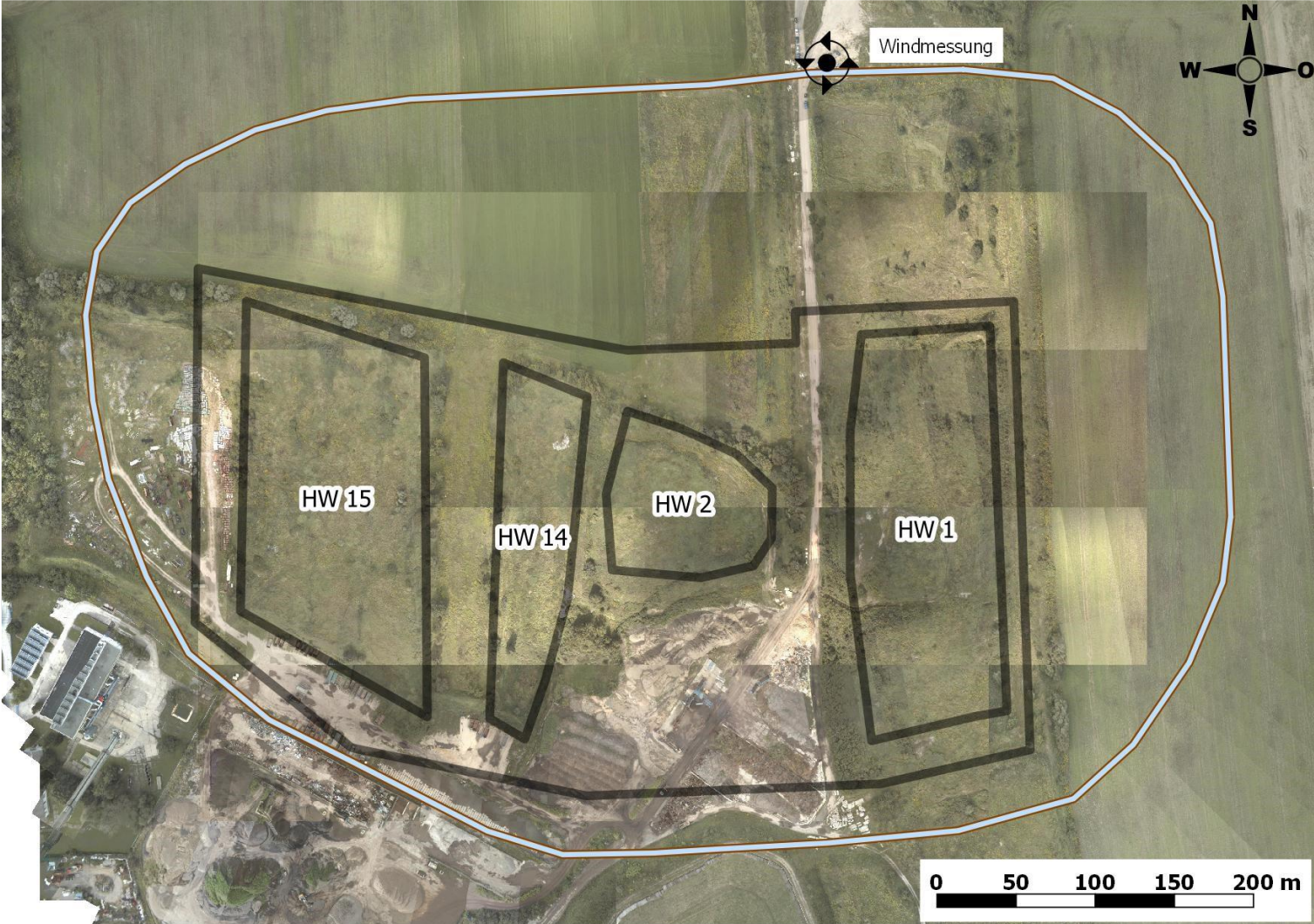
Survey of an illegal waste disposal site in Brandenburg

- Contracted by LfU in 2017
- Massive cockroaches infestation
- Large fire in 2005
- Operating company insolvent (2010)
- Politically difficult

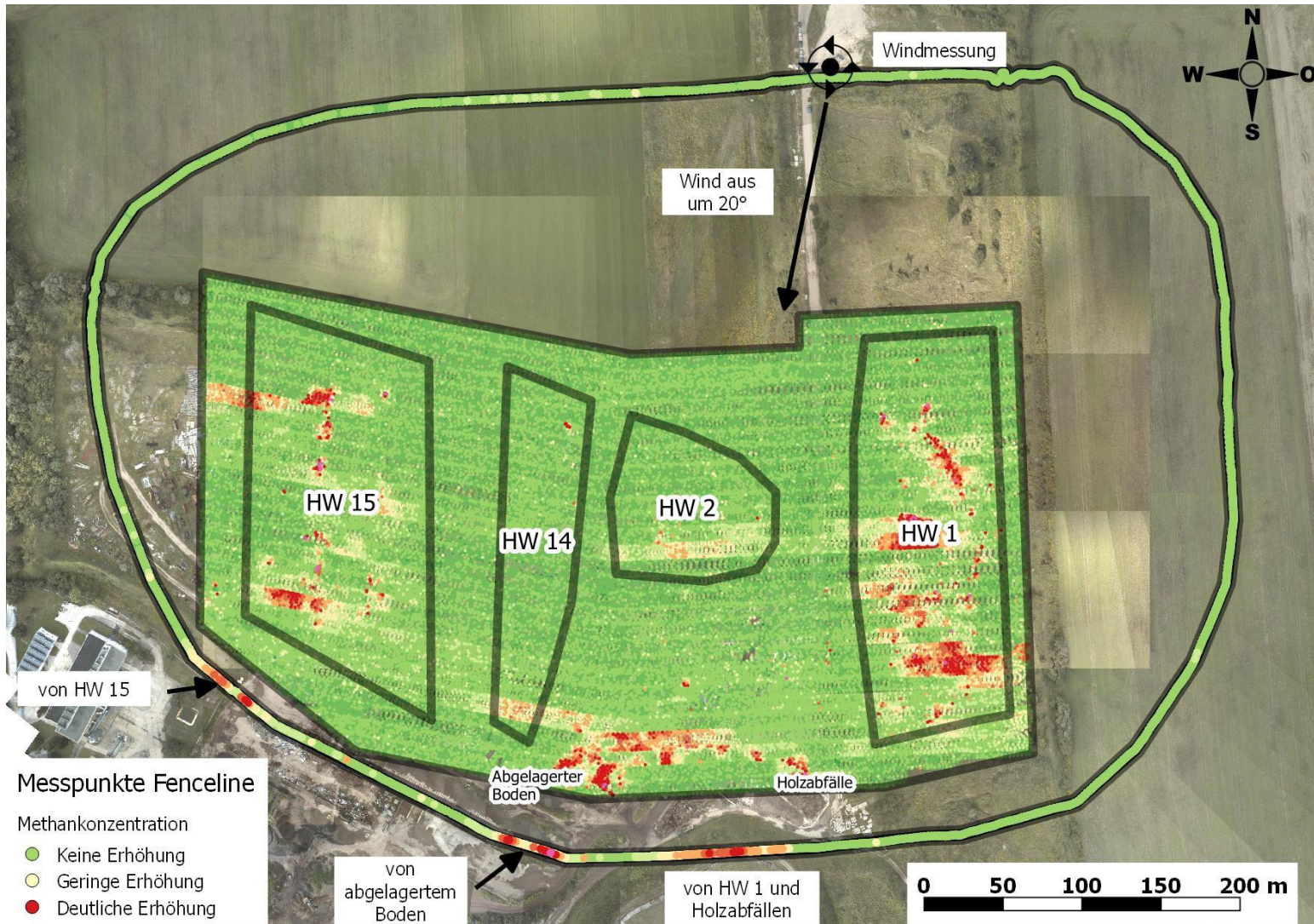
Survey showed that the total Methane emission was relatively small (was a major public concern)



Survey of an Illegal Waste Disposal Site



Survey of an Illegal Waste Disposal Site



Comparison CHARM – FID – LAS

Compared with FID and LAS CHARM finds:

- About the same emission sources identified by FID /LAS
- Emission sources which "fall through the FID / LAS grid"
- Emission sources not accessible by FID / LAS

FID / LAS may find very small emissions which are too small to be detected by CHARM

Thank you for Your Attention

