

# Assessing methane emissions from coal mine activities in Limburg, The Netherlands

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## Scope

Methane (CH<sub>4</sub>) from the coal mines contributes around 7% to global anthropogenic methane emissions. Quantifying this source in The Netherlands is of great interest for assessing the greenhouse gas emission (GGE) from this specific source. Moreover, the risks and hazards from coal mine extraction activities may still exist in the context of explosion hazards related to the gas migration through abandoned mine activity sites.

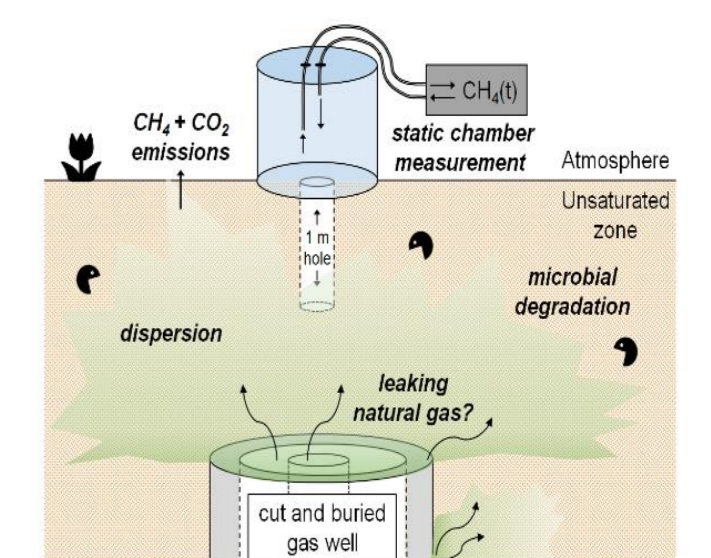
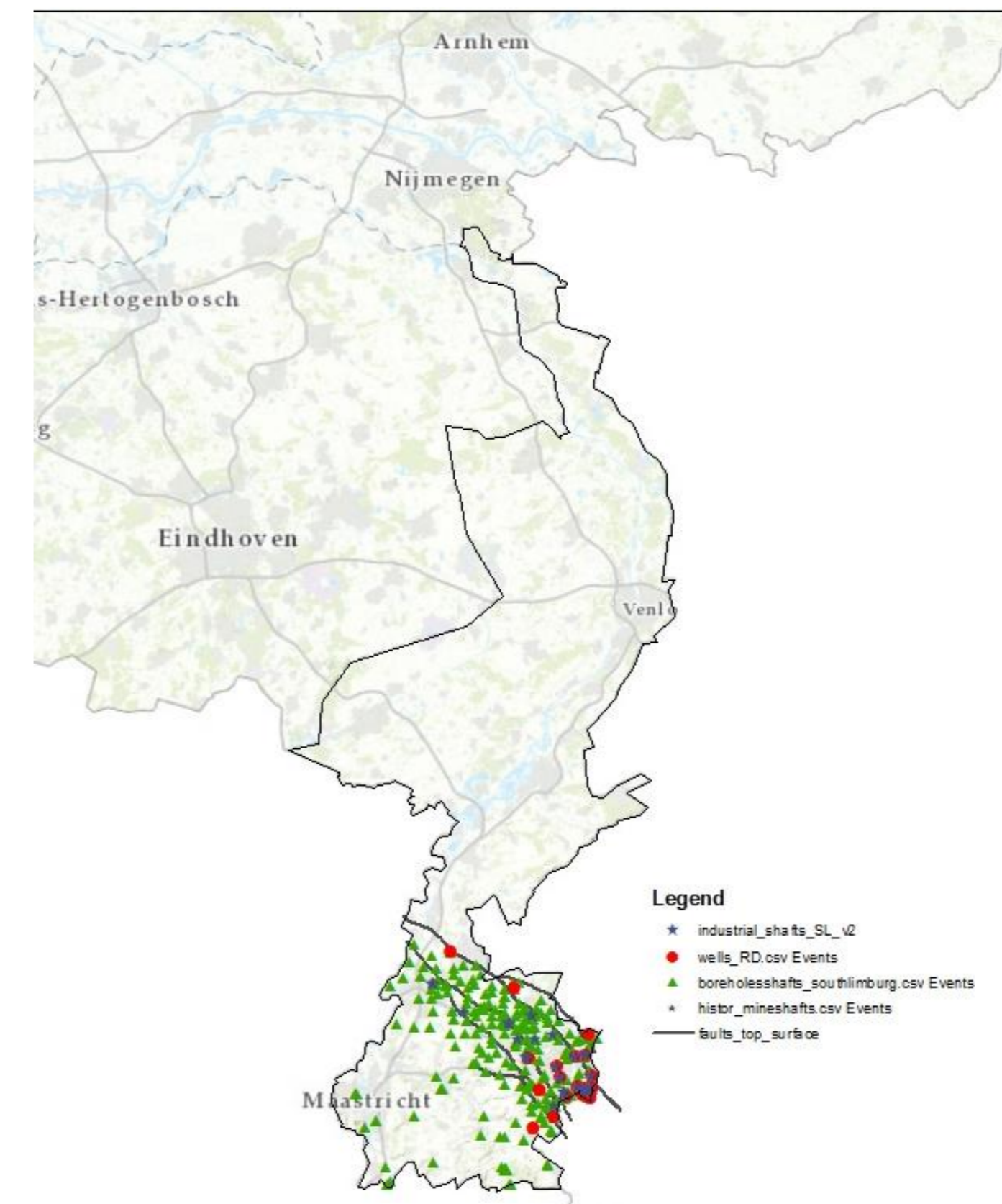
## Methods

We measured methane and ethane concentrations using Picarro CRDS G4302 and Picarro CDRS G2301 at various locations related to the past coal mine activities such as: (Exploration) Coal wells (6), Historical mine shafts (3), Industrial mine shafts (12), Other locations (including thresholds, depressions, upward drillings) (3).

We brought together a combination of different measurement techniques:

- Chamber flux measurements
- Direct concentration measurements (Methane/Ethane) in monitoring wells in industrial mine shafts
- Mobile measurements

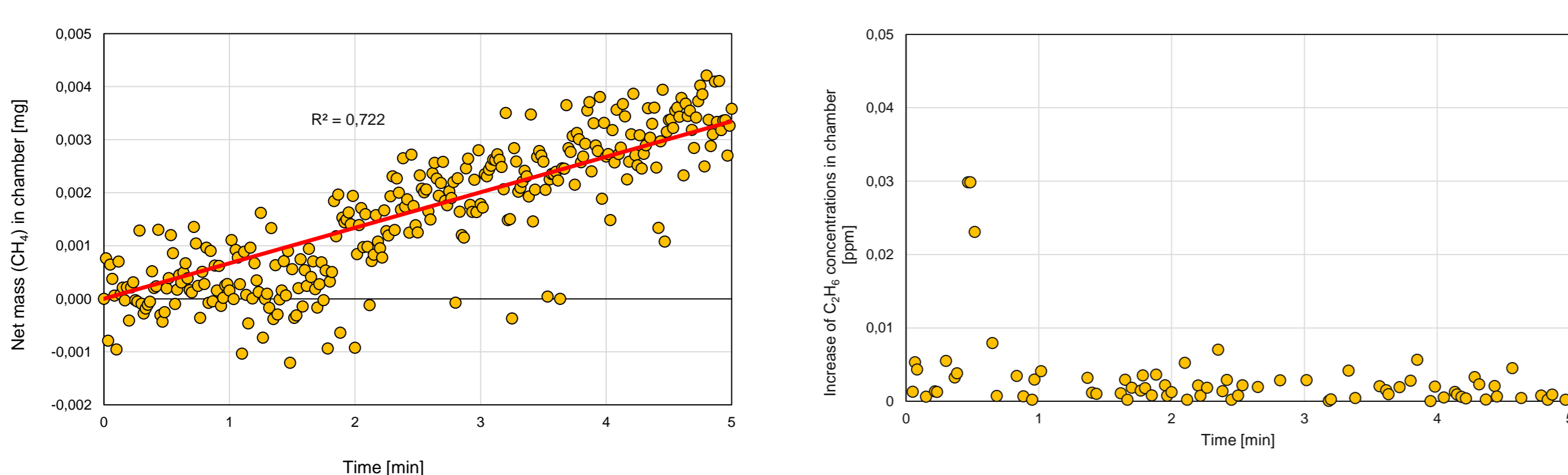
Gas samples were taken and analyzed for molecular and isotopic composition in order to delineate different sources of methane and their contribution to the hazard potential.



## Results and Discussion:

### Chamber flux measurements

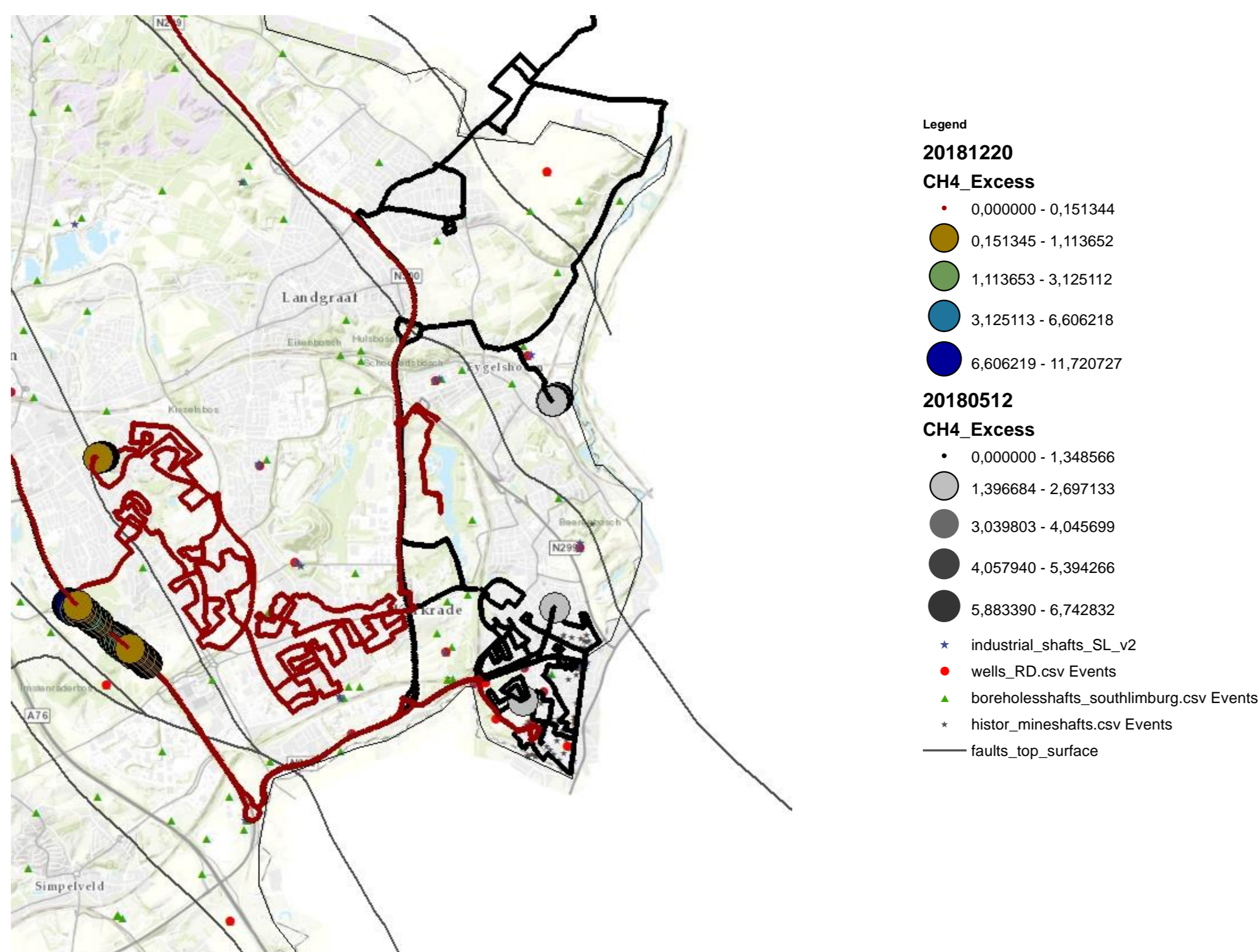
- Majority of the flux measurements do not show any significant methane flux; in some cases flux appears to be negative very likely indicating methane consumption in the soil
- Industrial mine shaft Laura is the only location where positive methane fluxes have been measured; absence of increased ethane concentrations/flux indicate that the flux is probably caused by biogenic methane



Methane flux measurements above abandoned industrial mine shaft (Laura). Ethane concentration at the same location during the flux measurement

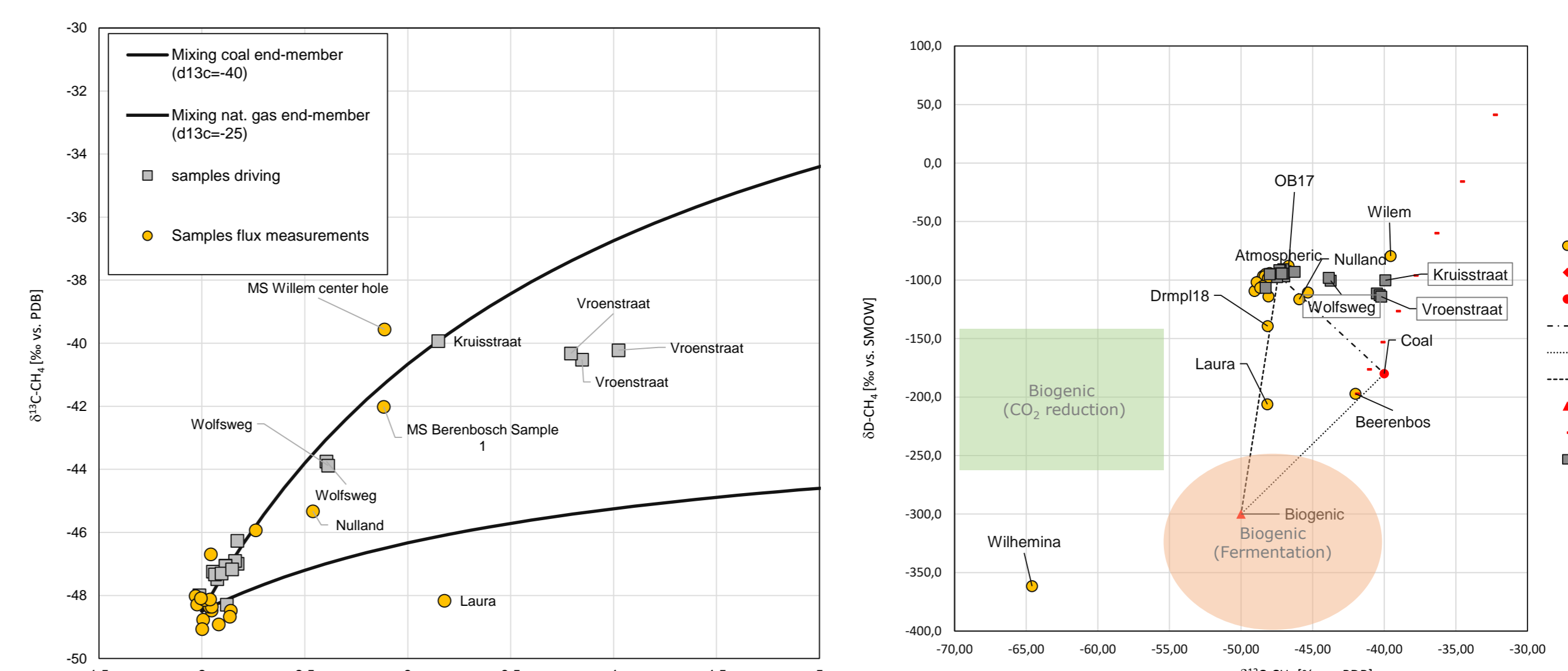
### Mobile concentrations measurements:

- Elevated concentrations during driving were most notably observed in the area of historical (pre-industrial) mining in Kerkrade
- The isotopic composition of samples collected at these locations does not clearly identify either a natural gas (leaking pipeline?) or coal methane origin. Some of the observed peaks appear to be correlated with the locations of mining-induced ground movement



Mobile methane concentration on two days (05Dec2019 and 20Dec2019), symbol size depicts increase above the average methane concentrations on that day

### Isotopic measurements- methane sources and geochemical processes:



- Methane concentrations in three abandoned mine shafts were elevated and indicated mixing with methane of thermogenic origin
- Wilhelmina mine shaft with its most negative isotopic values, most likely represents some of the specific biogenic processes in the soil
- The enriched isotopic composition in the Willem mineshafts suggests isotopic fractionation due to oxidation had occurred
- Some of the samples taken in the streets during the mobile measurements in the Kerkrade municipality indicate presence of the coal methane. Concentrations of methane measured at those locations are generally higher than in the surroundings

### Conclusions:

- Overall, methane fluxes from abandoned mining infrastructure appear to be negligible and do not pose an explosion hazard
- However, elevated methane concentrations with a thermogenic signature observed at three industrial mineshafts indicate a connection with the coal bearing layers, in spite of abandonment procedures
- These connections are confined to areas where the coal bearing layers have not yet been flooded by rising groundwater

### Future research:

- Repeat sampling focused on ethane concentrations may help to further constrain the origin of these leaks