Comparing methods for quantifying methane ebullition from an abandoned, leaking well in the Dutch North Sea

By: Geert de Bruin[1,2], Helge Niemann[2,7], Peter Urban[3,4], Mehdy Ghasemzadeh Diva[2], Samantha Kim[1], Mario Veloso-Alarcón[5], Jens Greinert[6], and Gert-Jan Reichart[2,7]

Quantifying methane emissions from leaking (e.g. offshore abandoned) wells is now mandated by EU legislation, but remains challenging. Remote sensing methods using satellite observations have limited sensitivity towards individual sources and can only measure methane that reaches the atmosphere. Accurate assessment of released methane from individual sources therefore requires on site measurements.

Here we aim to estimate methane emissions at one well, A15-03, in the Dutch EEZ where methane escapes from the seabed via bubble escape (de Bruin et al., 2025). We compared the following 6 methods (fig 1):

- ROV funnel (Bubble catching)
- Funnel Lander (Bubble catching)
- ROV camera (Bubble counting)
- Imaging sonar (Bubble counting)
- Single beam echosounder (Acoustic response)
- Multibeam echosounder (Acoustic response)

We captured bubbles in a ROV-controlled funnel with measuring cup and recording fill-time. We also used a newly designed lander consisting of a square-shaped funnel (1.5 by 1.5 m) with an automated measuring chamber at the top (Funnel Lander). The lander was placed over multiple bubble plumes emanating from its footprint area and recorded gas flow over a two-day period (the lander could, potentially, also be in operation for several weeks).

We used the optical camera of the ROV, i.e. measuring bubble geometries and summing the volume of all bubbles released in a certain time. However, resolving single bubbles is difficult in murky waters. To overcome poor visibility, we used an imaging sonar acoustic camera; Aris Explorer 3000 that was also mounted to the ROV. We used object detection software (YOLO) allowing to track bubbles and thus to compute gas flow.

Lastly, we used backscatter data of single and multibeam echosounder systems to estimate gas flow rates. The EK80 single beam system was calibrated using a standard target sphere which allows for quantifying bubble streams by inverting the acoustic response using bubble backscatter modelling (Veloso-Alarcón et al., 2015). This was done using VBA Lab plugin of ESP3 developed at GEOMAR. A challenge for EK80 measurements in shallow water is the limited coverage of narrow beam (7 degrees) which makes it difficult to completely ensonify bubble streams. We thus also used the multibeam echosounder Kongsberg EM2040 which has a much larger coverage but was not calibrated. Combining the Echoview software package with the open source software PING, we extracted 3D scatter points from the water column data, correct plume signals for current induced related bubble displacements (i.e. we correct for the fact that plumes do not go straight up int water columns due to currents) and computed the aggregated backscattering cross-section of the bubble streams. This allowed for relative comparison of bubble flow rates and calibration against reference measurements.

When we compared the results, we find flow rates between 65 and 313 ml/min. The flow rate depends on the type of measurement, the duration of the measurement and the year the measurement was done.

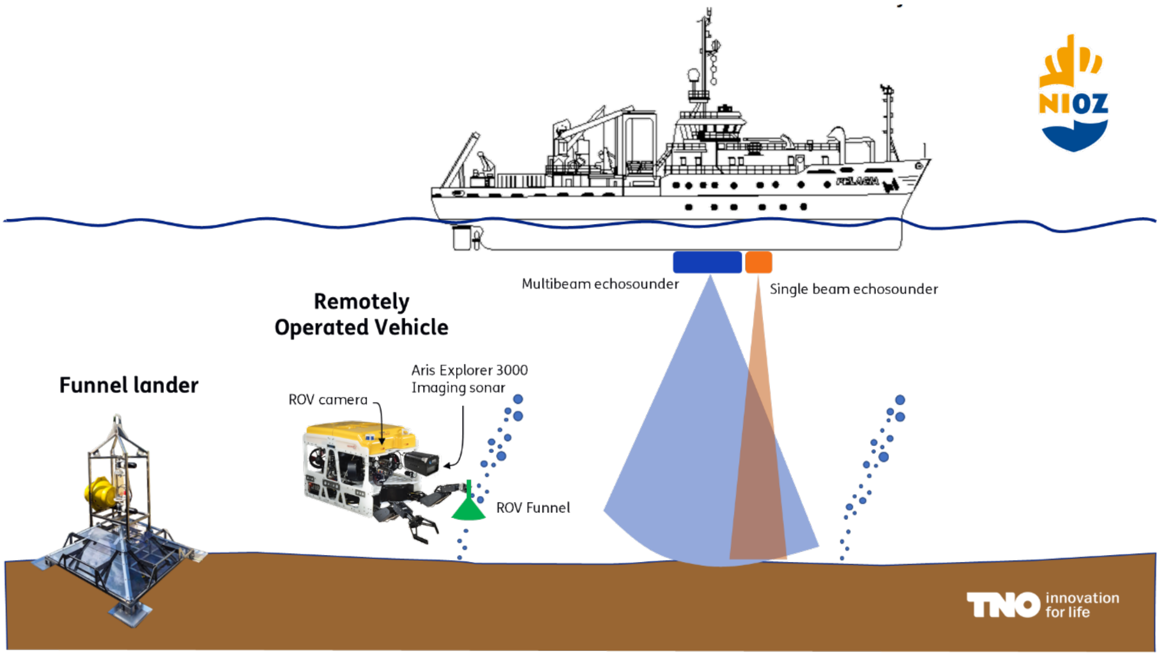

Figure 1: 6 different methods are used to measure the volume flux: Funnel Lander, ROV funnel, ROV camera, Imaging sonar, Single beam echosounder, and Multibeam echosounder.

References

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Ping https://github.com/themachinethatgoesping

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1) TNO Geological Survey of the Netherlands
2) NIOZ The Royal Netherlands Institute for Sea Research
3) Ghent University, Belgium
4) Urcoustics
5) Develogic GmbH
6) GEOMAR Helmholtz Centre for Ocean Research Kiel
7) Utrecht University, The Netherlands