

› **SIMOX – EXTENDING KEC TO INCLUDE UNDERWATER NOISE FROM VIBRATORY PILING**

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Project Partners



Sustainable Installation of XXL Monopiles (SIMOX)



grow



Deltares



RWE

seaway⁷



SIEMENS Gamesa
RENEWABLE ENERGY



TNO



Van Oord



Netherlands Enterprise Agency



TKI WIND OP ZEE
Topsector Energie

› CURRENT IMPACT ASSESSMENT FOR OFFSHORE PILING NOISE IS LIMITED TO IMPACT PILE DRIVING

› Impact pile driving produces ‘impulsive’ sound



› Vibratory pile driving produces ‘continuous’ sound



› various options currently considered:

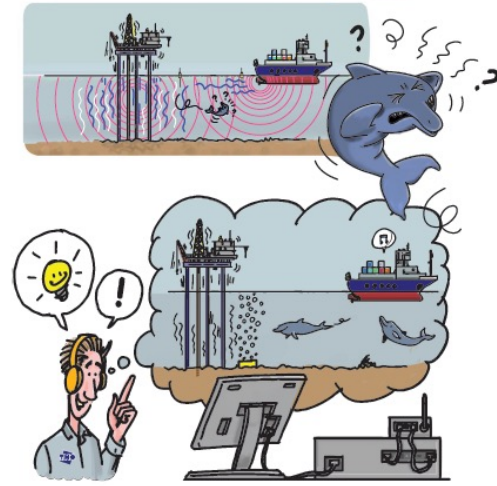
vertical vibration, vibration + jetting, torsional rotation+vibration,

› Also extraction of piles

‘impulsive’ and ‘continuous’
are not clearly defined



WP3E: ECOLOGICAL AND NOISE EMISSION STUDIES



TASKS

- Review of the ecological context and regulatory framework. Assessment of the underwater sounds produced by the selected technologies (measurements and modelling). Review of potential effects of these sounds on marine life (literature survey and stakeholder consultation)
- **Development of a draft framework for assessing the effects on marine populations of the sounds produces by the selected technologies, in collaboration with the Dutch working group on marine mammals and underwater sound**
- Generic modelling studies to produce examples of what a typical assessment according to the proposed framework would look like
- Reporting and presentation of the draft framework in a stakeholder workshop (regulators, industry and NGO's)

› OBJECTIVE TODAY

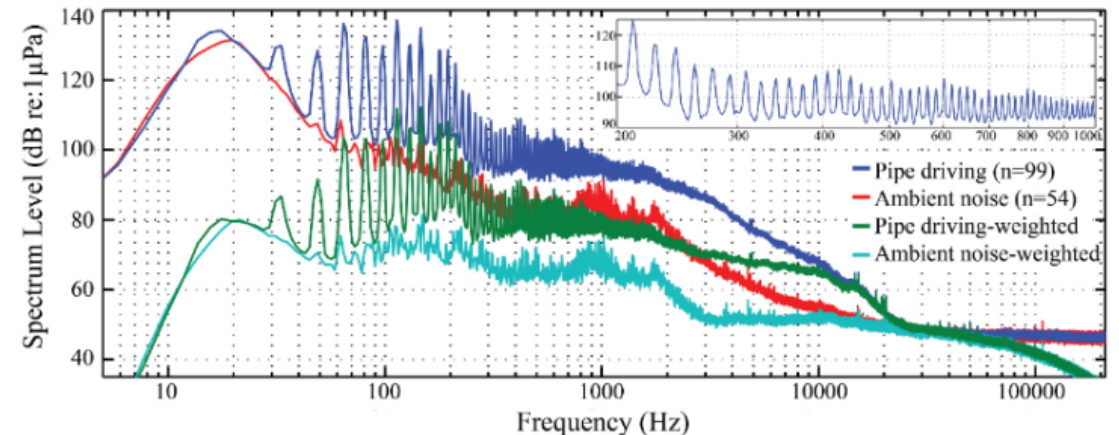
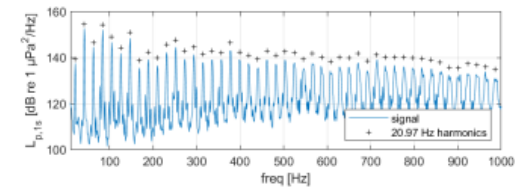
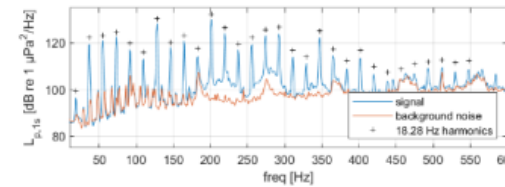
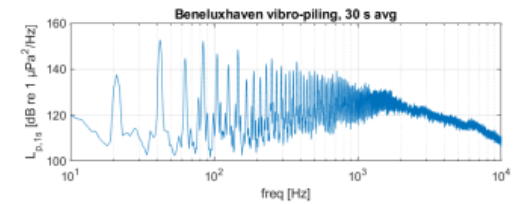
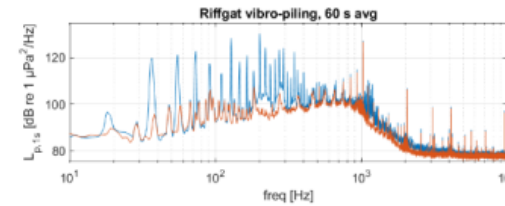
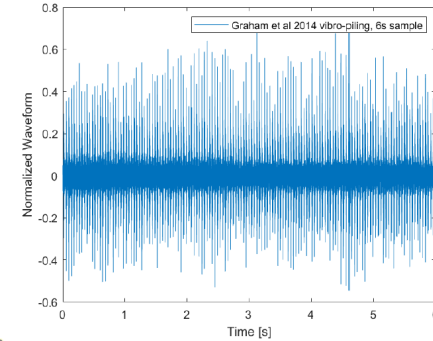
- › Inform NL werkgroep onderwatergeluid en zeezoogdieren
- › Share results literature review on sound produced by vibratory piling and effects on marine mammals
- › Discuss draft proposal for approach how KEC could be extended to include effects of vibratory piling
- › Get feedback from WG

- › Note: memo currently also being reviewed by SIMOX partners



WP3E: ECOLOGICAL AND SOUND EMISSION STUDIES

- Review of existing information on sound produced by vibro-piling
- ‘Continuous sound’
- Dominated by tonals of vibration frequency
- Many harmonics
- Not just ‘low-frequency’: up to 1 kHz and beyond
- Significant temporal variability



› NL IMPACT ASSESSMENT METHOD

KEC (SINCE 2014)

› Focus on impact piling noise

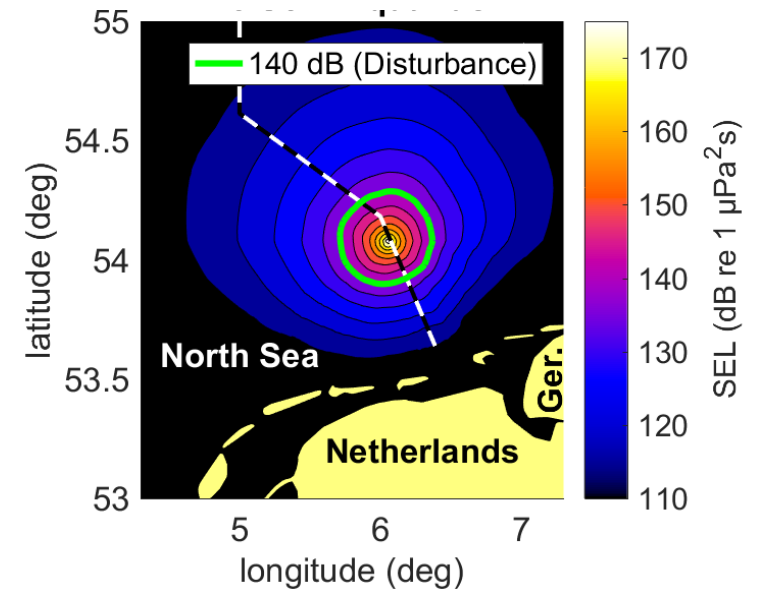
› Focus on porpoises and seals

› Focus on avoidance behaviour:

› Impact noise quantified by **SEL_{SS} in dB re 1 μPa²s**

› Avoid population effects:

piling noise limit (from 2023) **SEL_{SS} (750 m) ≤ 168 dB re 1 μPa²s**



SIMOX WP3E:
EXTEND THIS ASSESSMENT TO 'CONTINUOUS SOUND'



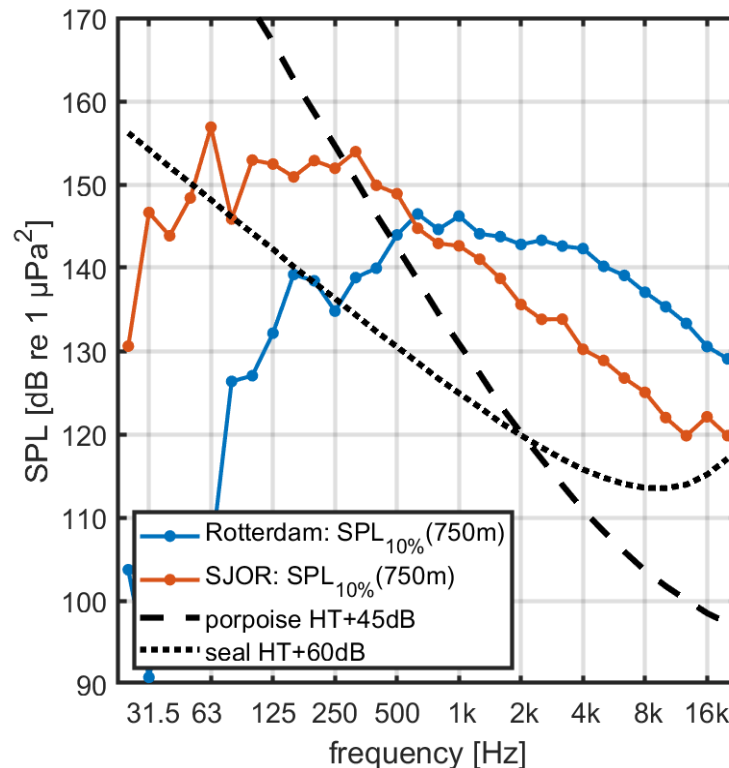
› LITERATURE REVIEW – EFFECTS ON MARINE MAMMALS

- › Little information on how animals respond to vibratory piling of large monopiles
- › Porpoises: No clear responses in Graham et al. (2017) for porpoises exposed to vibratoy piling
 - › Reported levels up to SPL = 132 dB re 1 μPa^2
 - › Small diameter (1.5 m), shallow environment (harbour)
- › Seals:
 - › Harbour/gray seal (Edren et al 2003): reduced presence at haul-out site 10 km from virb. piling + ADD
 - › Ringed seal (Moulton et al 2003): no response at SPL = 110 to 125 dB re 1 μPa^2 .
- › Other species: bottlenose dolphins (Graham et al. 2017; Brandstetter et al. 2018)
 - › Reduced presence in field at levels up to 132 dB re 1 μPa^2 (~750 m)
 - › Reduced number of clicking in captive animals, but also signs of habituation
- › Base interim criteria on proposed threshold in reviews of responses to sound (Tougaard et de Jong & von Benda-Beckmann, 2018)?



› PROPOSED UPDATE FOR VIBRATORY PILING

- › Vibratory piling noise quantified by spectrum of **SPL in dB re 1 μ Pa**
- › Proposed threshold for disturbance at **X dB above hearing threshold**
 - › Harbour porpoise: X = 45; Harbour seal and Grey seal: X = 60

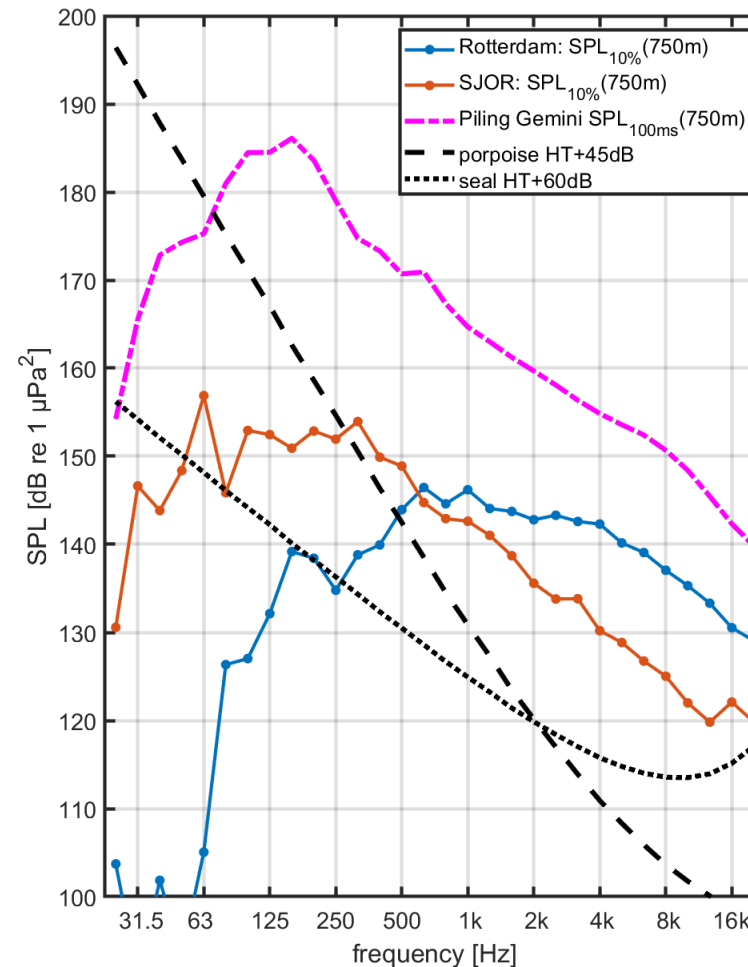


SJOR = 4 m diameter

Rotterdam = 1.7 m diameter

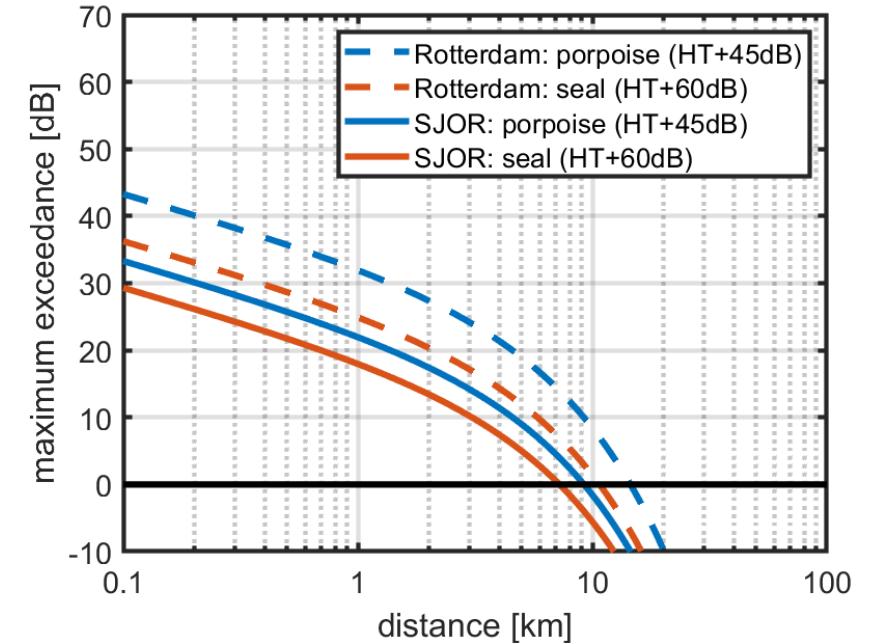
› COMPARISON WITH IMPACT PILING

- › Comparison with piling sound
- › Gemini U8 pile, 2015, no mitigation
- › Impulsive sound
- › Duration ~100 ms
- › $L_{p,100ms} \approx L_E + 10 \text{ dB}$
- › Different environment, pile and hammer
- › Vibro-piling SPL is significantly lower, but not negligible re animal disturbance



› PREDICTING EFFECT DISTANCES

- › Currently no reliable model for predicting output from vibratory piling...
- › Ongoing work by TNO and TU Delft to develop and validate source model
- › Some data available from literature
- › SIMOX field test planned in 2023



(Preliminary simplified predictions)

- › Clearly information on responses of seals and porpoises required!
- › More information on harbour porpoises responses to vibratory piling expected to come from German studies (KASKASI, ...) in 2023

› NEXT STEPS

- › Incorporate feedback from this meeting
 - › Incorporate feedback from SIMOX partners
 - › Proceed with preparation for nearshore tests (2023)
 - › Prepare for model predictions for nearshore test configurations (2023)
 - › Updated proposal for extending KEC
 - › Consult stakeholders
-
- › Aim to finalize Q3-2023
 - › SIMOX ends Q1-2024



› THANKS

TNO innovation
for life

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› NEXT STEPS

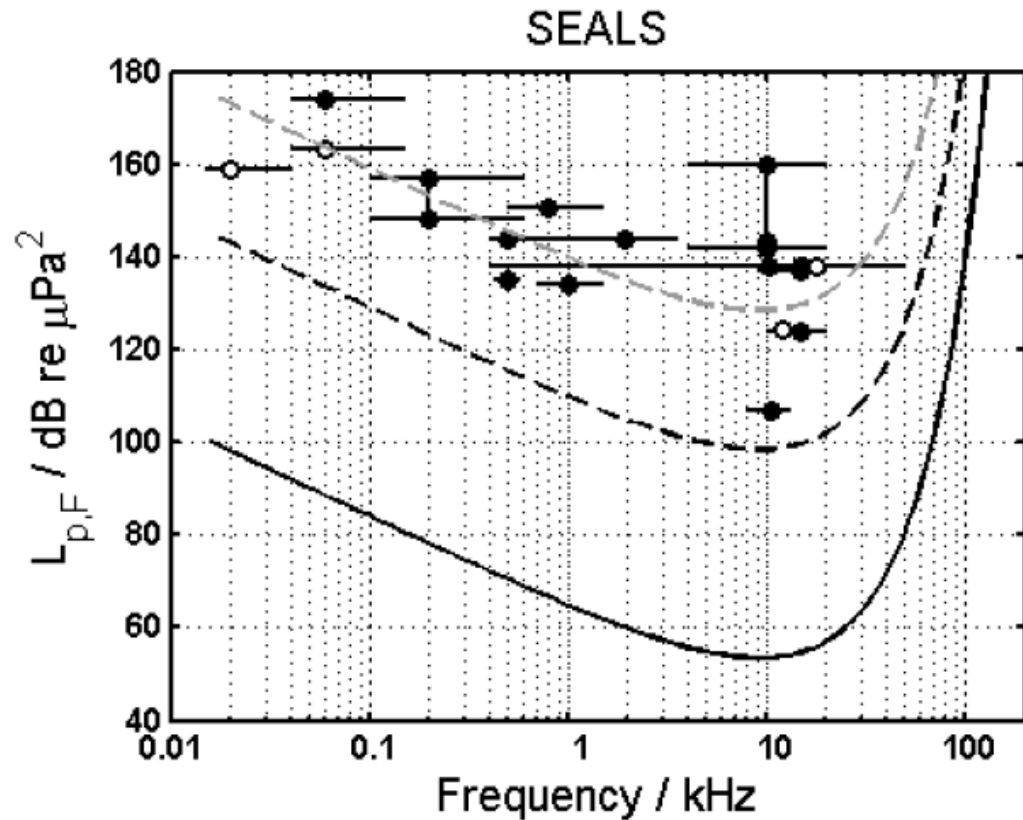


Figure 20 Threshold levels ($L_{p,F}$) of various sounds at which avoidance (or similar) behaviour has been observed in seals, compared with (solid line) the NMFS composite audiogram for phocid pinnipeds in water (see Figure 4) and with (dashed lines) curves at 45 dB and 75 dB above the composite audiogram.

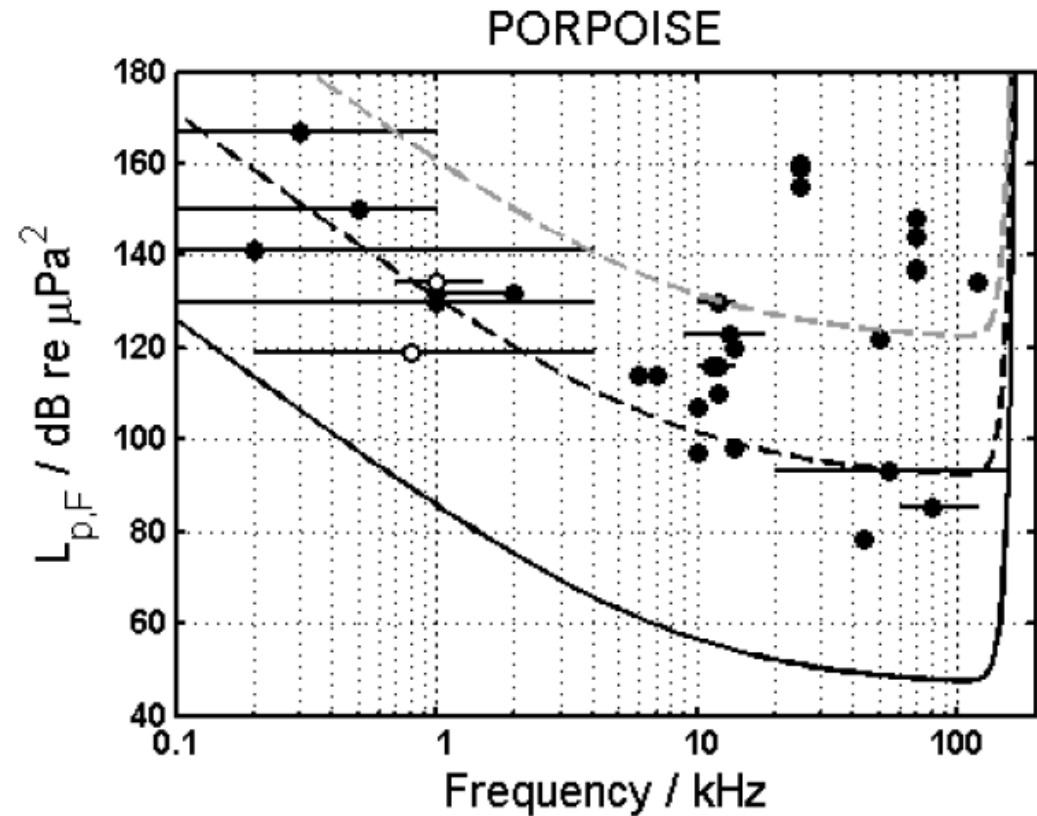


Figure 18 Threshold levels ($L_{p,F}$) of various sounds at which avoidance (or similar) behaviour has been observed in harbour porpoises (closed symbols), compared with (solid line) the NMFS composite audiogram for high frequency cetaceans (see Figure 4) and with (dashed lines) curves at 45 dB and 75 dB above the composite audiogram. Open symbols indicate levels at which no significant response was observed.