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UXO survey in the Hammerfest harbour using the Innomar Quattro multi-transducer sub-bottom profiler

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UXO Survey in Hammerfest harbour



Norkyst



From data to opportunities



Data collection

Norkyst uses survey vessels, drones, existing data sets, and in the future satellites.



Analysis

Collected data will be processed, scrubbed, and handled using our AI algorithms and finally quality checked by our in-house experts.



Visualisation The decision-making basis for planning, budgeting, and execution.



Monitoring Keep track of changes over time, letting you know the latest reality with confidence and make good decisions.

Introduction

- Background for the survey
- Survey aims
- Choice of survey equipment
- Data acquisition
- Data processing and target analysis
- Finding







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www.innomar.com/applications/user-workshop/seabed-acoustics-2022
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Hammerfest harbour – the work





 Most of the harbour will be cleaned and deepened

However,

- UXO findings recently
- Unknown number of UXO is still in the harbour
- Remaining UXO can be buried under a layer of sediments

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Survey equipment: Pole-mounted Innomar "quatro" SBP



Water Depth Range	0.5 – 100 m (single transducer); 1 – 1,000 m (2×2 transducer matrix)		
Sediment Penetration	up to 20 m (single transducer); up to 50 m (2x2 transducer matrix); depending or sediment-type and noise		
Sample / Range Resolution	≥1 cm / up to 5 cm (depending on pulse settings)		
Transmit Beam Width (-3dB)	$c_{\rm c}\pm 2.5^{\rm c}$ (single transducer), $t_{\rm c}\pm 1.5^{\rm c}$ (2×3 transducer matrix), for all frequencies		
Ping Rate	up to 60 pings/s		
Heave / Roll / Pitch Compensation	neave (depending on external sensor data); roll + pitch in post-processing		
Primary Frequencies (PHF)	C 100 kHz (frequency band 85–115 kHz)		
PHF Source Level / Acoustic Power	+235 dB//µPare Tm (single transducer), +245 dB//µPare Tm (2x2 transducer matrix)		
Secondary Low Frequency (SLF)	centre frequency user selectable: 4, 5, 6, 8, 10, 12, 15 kHz		
SLF Total Frequency Band	2 - 22 kHz		
SLF Pulse Type	Ricker, GW		
Pulse Width	user selectable 0.07 - 1.0 ms (EW)		
Data Acquisition and Recording	digital 24 oit / 96 kHz (SLF full waveform, PHF envelope)		
Data File Format	Innomar "SES3" (24 bit), "SEGV" (via šESconvert)		
External Sensor Interfaces	HRP (motion), GNSS position, depth (all #5232 / UDP), trigger (BNC)		
Bottom Detection	Internal (PHF and SLF data) of external depth		
Depth Acouracy	(3 cm @ 100 kHz / 5 cm @ 10 kHz) + 0.1% of water depth		

NORKY

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Data acquisition: Sub-bottom profiling

- Line interval - 1 m for dense coverage of the survey area



SBP targets example 1





 $\label{eq:looking} \mbox{ Looking for hyperbolas} - \mbox{ diffraction patterns in seismic sections}$







Targets list from SBP data



- Targets transferred and visualized in Eiva NaviModel

	EU89, UTM35			
Navn	Eastings	Northings	Dybde fra sjøb	unn (opp +)
T2	377326.8	7843410	-0.69	
тз	377327	7843409	-0.82	
T4	377504	7843404	-2.21	
Т5	377522.6	7843402	-3.27	
T6	377383.3	7843406	-1.78	
17	377406.9	7843415	-1.46	
T8	377400.9	7843414	-1.93	
Т9	377408.3	7843415	-1.45	
T10	377512.4	7843416	-3.46	
T15	377439.6	7843395	-0.9	
T16	377349.1	7843402	0.54	
T17	377321.8	7843398	0.35	
T18	377339.7	7843398	0.36	
T19	377344.5	7843398	0.18	
T20	377321.9	7843398	0.57	
T21	377335.9	7843406	0.39	
T22	377332.6	7843402	0.31	
700	777240 7	7040400	0.41	





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Only the targets detectable by both MBES and SBP on the surface of the sea bed were classified as "interesting"













Conclusion



- Combination of MBES and SBP data has given a good coverage of targets both on an bellow the sea floor
- However, unprocessed targets result in excessive lists
- Targets list can be reduced by generalization based on expected target size (1m was used in this project)
- Moreover, shape can be incorporated as a discriminating factor (e.g. for elongated targets)
- Success of UXO survey using SBP depends on the sub-surface composition
- SBP data should be complemented with magnetometer data in the absence of metal debris for better UXO detection

