Risk assessment model for dumped Chemical Warfare Agents

VRAKA-CWA

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Introduction

Succeeding the end of WWII, large stockpiles of conventional and chemical munitions were left in the northern parts of former Nazi Germany. This constituted a large problem and it was decided that damaged or old ships where to be filled with munitions from the stockpiles and sunk in deep water areas in the Baltic Sea and Skagerrak. Approximately 65 000 ton chemical warfare agents (CWA), e.g. Yperite (mustard gas), Clark I, Clark II, Lewisite and Adamsite, where dumped in the sea between 1947–1948.

Method and results

As part of DAIMON, Chalmers has developed a model (VRAKA-CWA) for assessing the risk associated with dumped chemical warfare agents. The work is based on a quantitative risk model for providing decision support, to facilitate prioritization among dumping areas.

VRAKA-CWA uses a Bayesian approach to integrate data and expert judgements on a number of input variables, to calculate the probability of different activities causing damage to a munition unit and release of CWA. The risk is calculated as a function of the probability of release, the toxic unit of the specific CWA and the mass of CWA:

$$\text{Risk} = P_{\text{Release}} \times \text{CWA}_{\text{Toxicity}} \times \text{CWA}_{\text{Mass}}$$

By applying the model the user can:

- Compare the risk level between areas
- Identify areas with highest risk

The results of the model may be illustrated as shown to the right, i.e. as cumulative functions representing the probability and the resulting risk level. It is a probabilistic model considering uncertainties in input data and results.

VRAKA-CWA

General data

Site	Example site
Position	
Name of assessor	
Date	October 2018

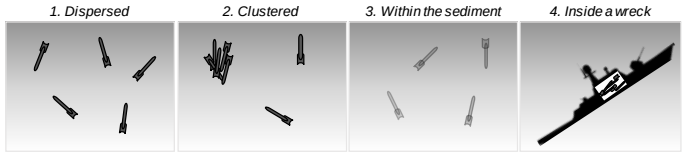
Site specific indicators	Unit	Lowest reasonable	Highest reasonable	*Min*	*Max*
Average sea-floor oxygen concentration	*ml/l*	6.8	7.4	*0*	*8*
Average sea-floor salinity	*PSU*	34	34	*1*	*35*
Average sea-floor temperature	*C*	5	7	*3*	*9*
Average sea-floor current strenght	*m/s*	0	1	*0*	*1*
Average hull thickness at construction	*mm*	0	14	*0*	*14*
Depth	*m*	190	220	*0*	*459*
Time since dumped	*years*	71	72	*0*	*100*
Bottom character	*Select:*	B - Erosional seafloor other than			

Activities	Unit	Lowest reasonable	Highest reasonable
Construction	*times/year*	0.01	0.1
Diving	*times/year*	0.001	0.01
Military activity	*times/year*	0.01	0.1
Shipping traffic	*times/year*	0.001	0.01
Storms	*times/year*	0.001	0.01
Trawling	*times/year*	1	2
Unstable seabed	*times/year*	0.01	0.1

Munition specific data

Arrangement of objects — *Select:* 4 - Inside a wreck

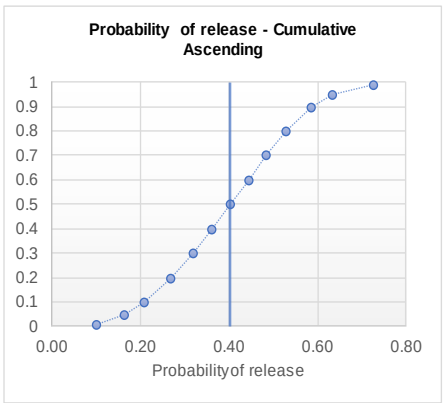
1. Dispersed | *2. Clustered* | *3. Within the sediment* | *4. Inside a wreck*

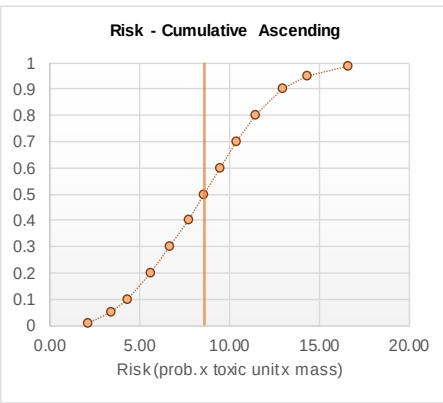


	Unit	Lowest reasonable	Highest reasonable	*Primary*	*Secondary*
Mass of toxic substance per unit	*kg*	200	300		
CWA - Toxic Unit	*Select:*	Clark I		*0.41*	*0.086*

Run simulation

The user interface of VRAKA-CWA.





The solid lines represent the mean probability and risk value, respectively.

daimon
Decision Aid for Marine Munitions

www.daimonproject.com

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