



Risk Assessment Methodology in Connection with Transfer of Former Military Training Areas to Civilian Society in Sweden

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Disposition

- Introduction
- Work Approach
- Risk Assessment Methodology

Development

- Further Work



Introduction

The Swedish Fortifications Agency, FortV

- Landlord for the Swedish Armed Forces
- Former military training areas and firing ranges are subject to transfer to civil society
- 30 000 hectares of possibly UXO contaminated land



Land subjected to transfer to civil society

Introduction

UXO on former military training areas:

Medium caliber ammunition

- 12.7, 13.2, 20, 30 mm

Mortar munitions

- 47 mm, 8 cm and 120 mm

Artillery munitions

- 105 and 155 mm

Possibly up to 80 % of UXO are practice munitions

No CWA or ERW



(With permission from Johan Carlsson, Swedish Armed Forces.)

Unexploded ordnance



Introduction

The Swedish Defence Research Agency, FOI, began supporting FortV in 2014:

”How dangerous is UXO?”



(With permission from Göran Odbeck, National Bomb Protection Section, Swedish Police, 2016.)

UXO found and confiscated by Swedish Police

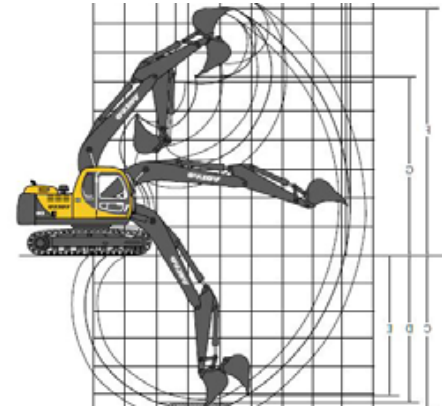


FORTIFIKATIONSVERKET



Work Approach

- Post-transfer situation
- "Worst-case" scenario
- Mechanical influence
- Representative excavator
- Maximum force applied on UXO



Work Approach

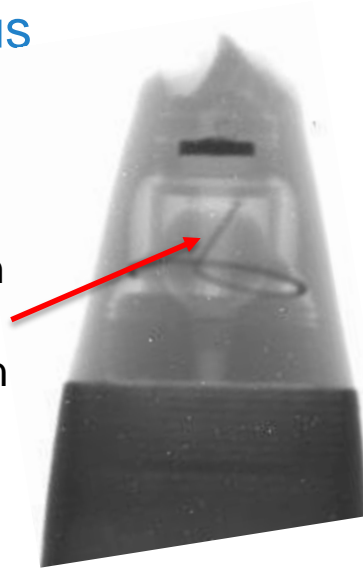
X-ray of collected UXO

- UXO type
- Fuze arming status

Test on fixed UXO

- Vertical position, or
- Horizontal

Fuze in
armed
position



UXO in vertical, fixed position



Work Approach

Mechanical Testing:

Translation of force from excavator
"worst-case" situation



Tool mounted on mechanical testing rig



Mechanical testing rig



Work Approach

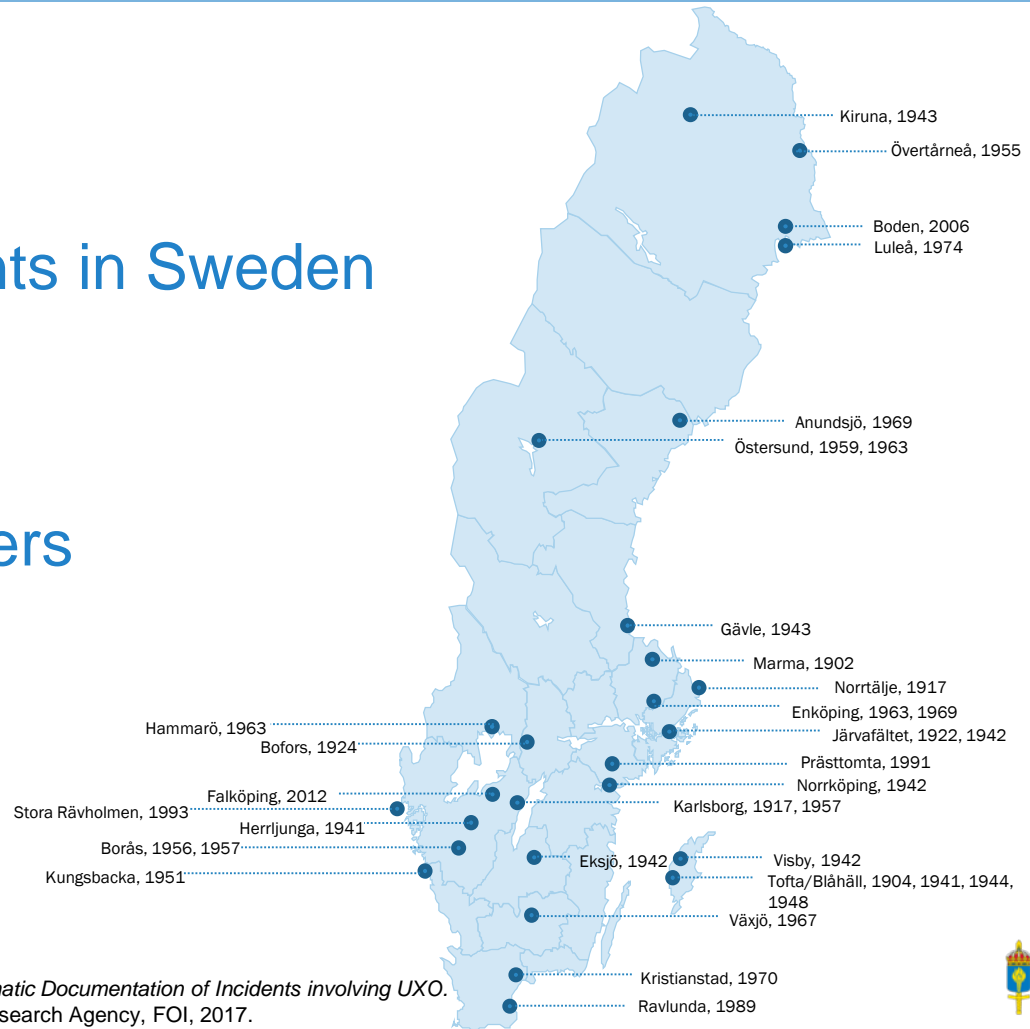
Historical UXO incidents in Sweden

Reported in media

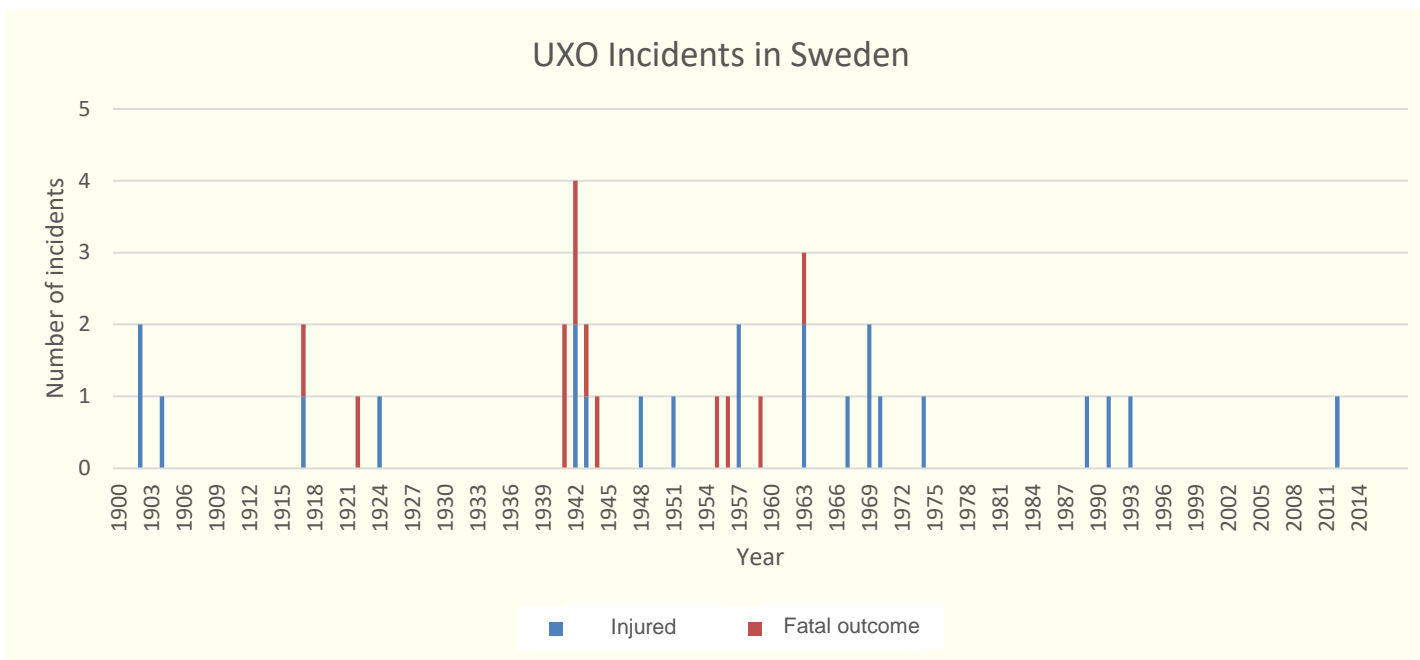
1900-2016

Four largest newspapers

Digital media archive



Work Approach



Work Approach

Inventory of existing risk assessment models
(USA, Norway, Denmark, Canada, Sweden)

Two proved to be of further interest:

- USACE's OECert

 - UXO density, estimation of exposure, named activities
 - OE hazard factor

- Swedish "RVM"

 - Uses same basic parameters as OECert + Bayesian network modeling

(With permission from Johan Carlsson, Swedish Armed Forces.)



Work Approach

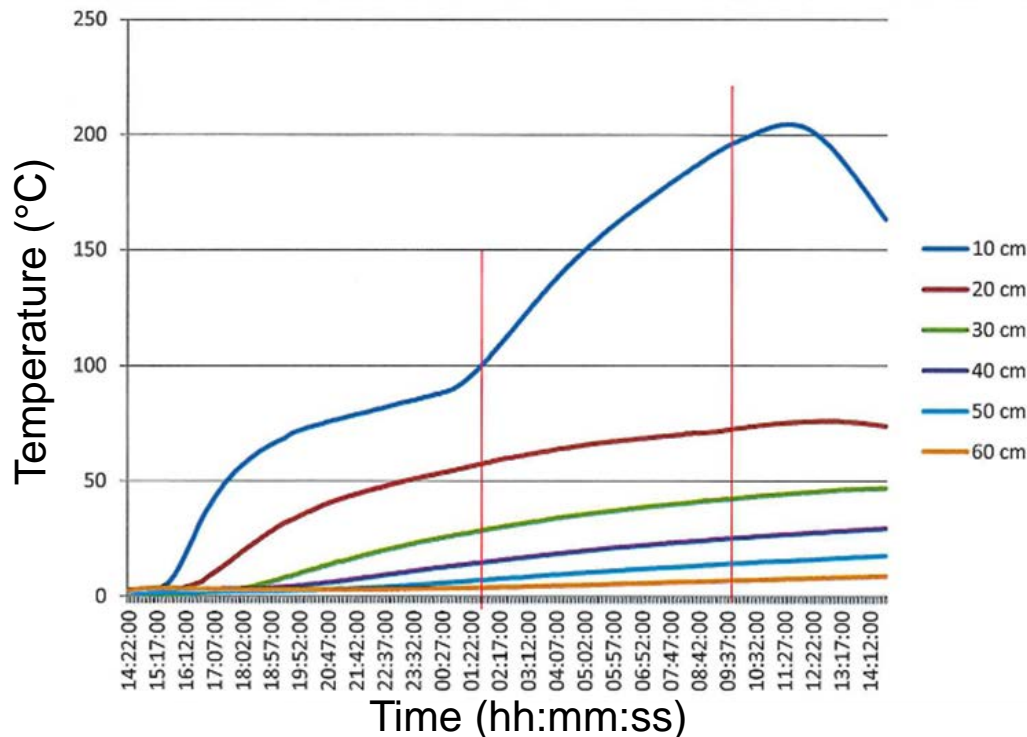
- Structuring the problem
- Listing definitions
- Identifying critical
 - Parameters
 - Activities
 - Situations
- Subdivision of UXO
- Delimiting parameter space
 - Introducing risk factors



Work Approach

Key parameters/risk factors:

- UXO type
- UXO sensitivity to initiation
 - Mechanical influence
 - Heat influence (on buried UXO)
- UXO density
- UXO depth



(With permission from Marcus Fjällgren, Swedish Armed Forces).

Fjällgren, Marcus, and Erik Löfberg. *FM2016-2211:1. Försök med värmeledning i mark (Report in Swedish)*. Eksjö, Sweden: Swedish Armed Forces, 2016.



Risk Assessment Methodology Development

Objective: Site-specific, safety-based, quantitative risk model

- Conservative approach
- Fact-based arguments (tests, external references etc.)
- Use earlier experiences gained and previous work
- Transparency, traceability
- Delimitations
 - Impact areas excluded in risk assessment
 - Neither security, nor environmental perspectives are considered



Risk Assessment Methodology Development

Steps in methodology development:

- a. Forming the basis (2018-2019)
- b. Test and revision (2019-2020)
- c. Implementation (2020-2021)



Verification of UXO indications
(Södra Sandby, 2016)



Risk Assessment Methodology Development

What is an acceptable level of risk?

Suggested levels of acceptable risk:

Individual risk

10^{-5} (lower limit, unacceptable risk)

10^{-7} (upper limit, negligible risk)

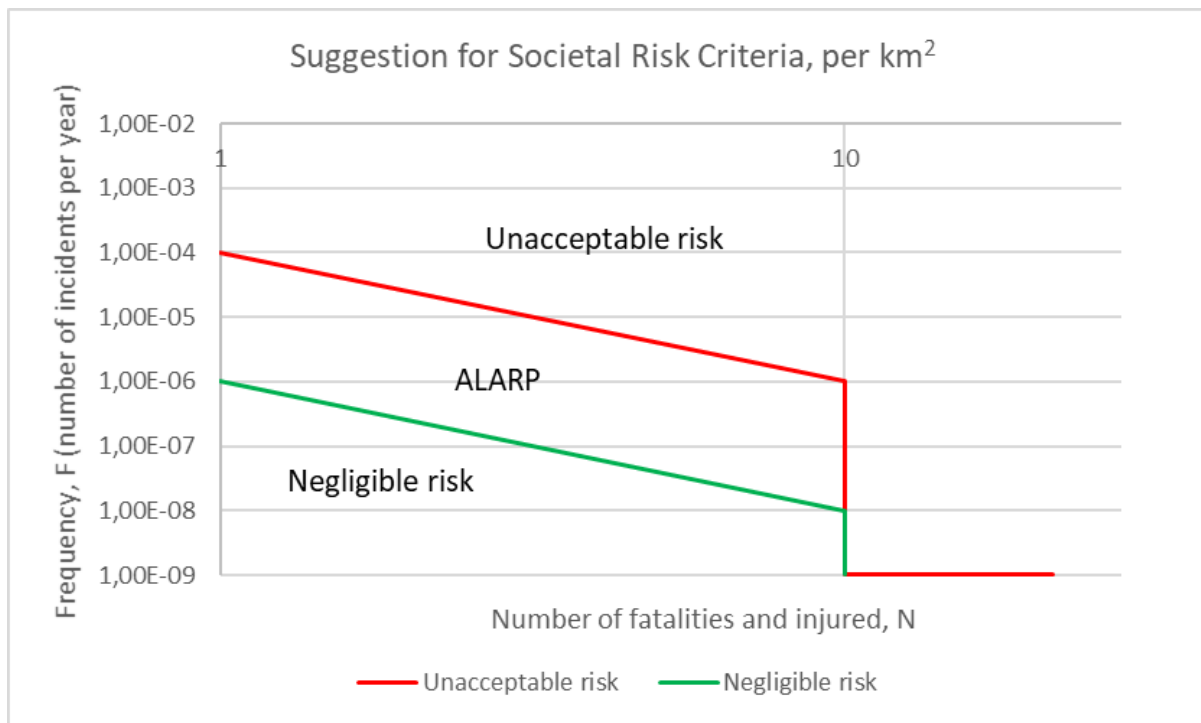
(between these limits ALARP is applied)

Gustafsson, Johan, Rickard Forsén, and Svante Karlsson. *FOI-R--4146--SE. OXA på Ö/S-fält: incidenter, frågeställningar och riskacceptans i samband med avveckling av f.d. skjutfält (Report in Swedish)*. Stockholm, Sweden: Swedish Defence Research Agency, FOI, 2015.

Ågren, Matilda, Johan Gidholm, and Dennis Menning. *FOI-R--4533--SE. Acceptabla risknivåer i samband med avveckling av tidigare övnings- och skjutfält efter riskreducerande åtgärder (Report in Swedish)*. Stockholm, Sweden: Swedish Defence Research Agency, FOI, 2017.



Risk Assessment Methodology Development

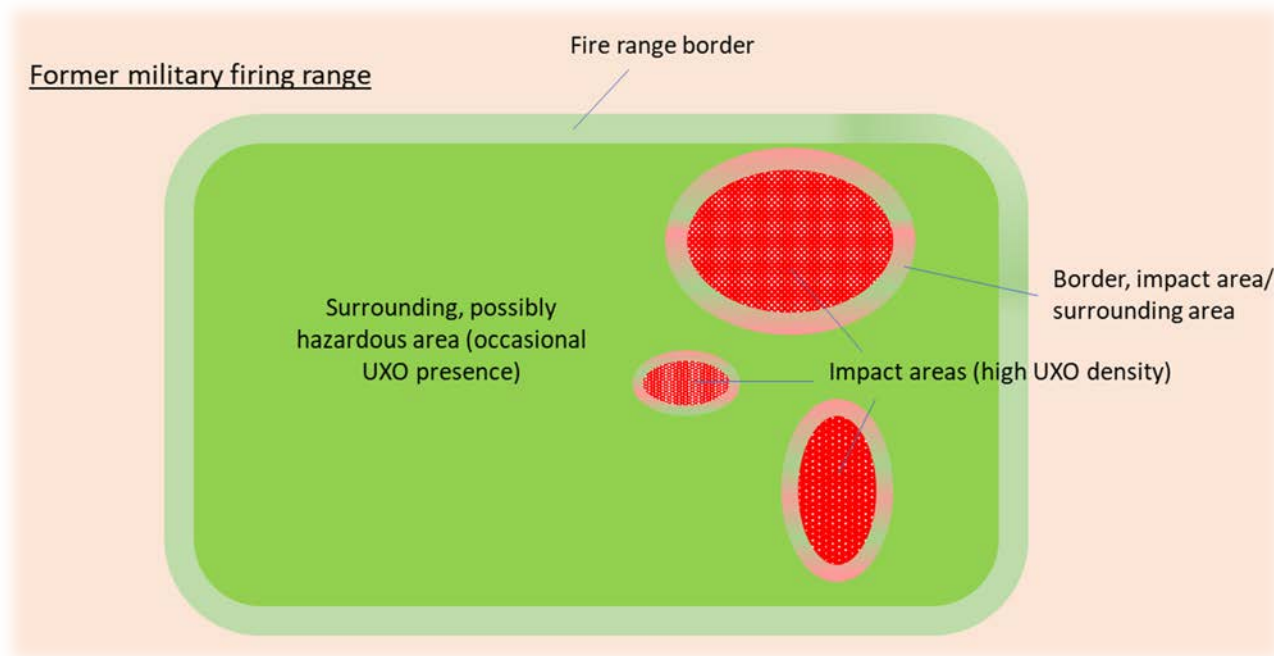


Risk Assessment Methodology Development

Impact areas

Surrounding,
possibly
hazardous
area

Borders



Risk Assessment Methodology Development

Södra Sandby, Sweden (2016)

Raw data

Indications

Search pattern

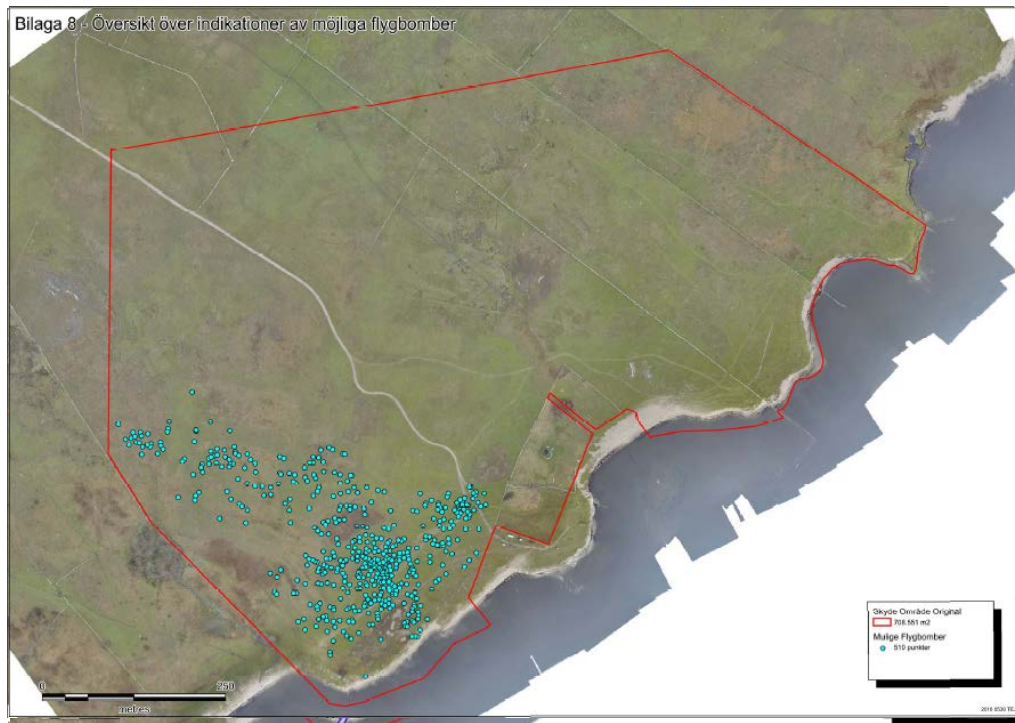
Search

UXO: Med. cal.

UXO: Bombs

UXO: Rockets

Possible bombs



Further Work

Technical Challenges

- How to find and determine a procedure for defining borders between impact areas and surrounding, possibly hazardous areas
- How to determine a procedure for locating and defining the border of the military training area or firing range

General challenges

- How to deal with uncertainties
- Acceptance by society of an acceptable level of residual risk
- Acceptance by society of a developed risk assessment methodology
- How to combine developed risk models with other risks (e.g. security and environmental risks)



Thank you for listening

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