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

Dennis Menning[1]; Swedish Defence Research Agency, FOI; Stockholm, Sweden

Johan Gidholm; Swedish Defence Research Agency, FOI; Stockholm, Sweden

Matilda Ågren; Swedish Defence Research Agency, FOI; Stockholm, Sweden

Patrik Blomander[2]; Swedish Fortifications Agency, FortV; Eskilstuna, Sweden

Keywords: military training areas, firing ranges, unexploded ordnance, UXO, residual risk, risk assessment methodology

Abstract

Former military training areas and firing ranges in Sweden are presently subject to transfer to civil society. Possible contamination by unexploded ordnance, UXO, poses a challenge in terms of how to resolve the issue of residual risk for the general public. Therefore, a need for a viable risk assessment methodology exist. The Swedish Defence Research Agency, FOI, supports the Swedish Fortifications Agency, FortV, with development of a safety-based risk assessment methodology, which addresses surrounding areas of former impact areas of military training areas and firing ranges subject to transfer. By a systematic, hands-on, transparent and fact-based work approach, a basis for further work has been developed. Acceptable levels of risk have been proposed. A survey of historical UXO incidents in Sweden has been conducted as well as an inventory and evaluation of a number of existing risk assessment models which address the same or similar issues. A conservative risk assessment approach minimizes the risk of a too optimistic residual risk value after risk reducing measures have been applied. The risk assessment methodology aims for a site-specific, quantitative risk model, supported by fact-based and traceable arguments. However, challenges, such as how to handle uncertainties and to incorporate other risks, remain.

Introduction

The Swedish Fortifications Agency, FortV, is one of the largest holders of real estate in Sweden and functions as the landlord for the Swedish Armed Forces. Former military training areas and firing ranges comprise about 30 000 hectares and the majority of this land is to be transferred to civil society. The challenge is posed by the potential presence of unexploded ordnance, UXO on

[1] E-mail: dennis.menning@foi.se, phone: 0046 709 277 381.
[2] E-mail: patrik.blomander@fortifikationsverket.se, phone: 0046 761 000 353.

the possibly hazardous areas surrounding the impact areas of former target locations[3], which are subject to transfer.

A major part of UXO at Swedish former military training areas consists of medium caliber ammunition (mainly 12.7 mm to 30 mm), mortar munitions (mainly 47 mm, 8 cm and 120 mm mortar grenades) (Figure 1) and artillery munitions (mainly 105 mm and 155 mm), since most of the military training areas in Sweden have been used by the Army or the Air Force.

Figure 1. UXO, 30 mm medium caliber munitions (left), found at former firing ranges in Bynäset, Sweden, and 47 mm practice mortar munition (right) in Örebro, Sweden.

From a Swedish perspective, the UXO problem may, to a large extent, differ from other European countries and the Unites States exhibiting UXO contaminated land. A large part of UXO contamination on Swedish former military training areas are practice munitions, possibly as high as 80 % of remaining UXO[4], with no chemical warfare agents, CWA, present and practically no UXO being explosive remnants of war, ERW (this is due to the fact Sweden has not experienced war on its own soil for over 200 years).

Earlier work of developing a Swedish risk assessment method addressing the issue of UXO on former military training areas and firing ranges exist (Stenström, Westrin and Ritchey 2004), but it has not been thoroughly tested and evaluated. Therefore, currently, no completed methodology for explosives safety and munitions risk management in Sweden exist, despite earlier efforts.

Today, former military training areas and firing ranges are often situated in the vicinity of expanding cities and are in the spotlight of exploitation. Other former military training areas and firing ranges are situated in rural areas and are of interest as recreational areas for the general public. FortV is responsible for the transfer of these lands back to civil society, without risking exposure to unreasonably high risks for the general public posed by possible remaining UXO contamination. Therefore, an expressed need is to determine the residual risk for all areas subject to transfer.

[3] Further referred only to as impact areas.

[4] The estimation is based on UXO findings from technical surveys and clearance operations performed by FortV on five former military training areas and firing ranges (Bynäset, Falun, Kungsbäck, Södra Sandby and Örebro) in Sweden during the time period of 2013-2016.

In 2014, The Swedish Defence Research Agency, FOI, began working to support FortV, which aims to fulfil the current need of creating a risk assessment methodology that can be implemented in the transfer of former military training areas and firing ranges in the years to come.

Currently, no national program for the transfer of former military training areas and firing ranges similar to the U.S. Base Realignment and Closure Act, BRAC, or Military Munitions Response Program, MMRP (Albright 2012), exist. Presently, FortV is the sole governmental institution driving the work forward of transferring former military training areas and firing ranges to civil society in Sweden.

The approach chosen for the risk assessment methodology is to develop a quantitative risk analysis method preferably supported by quantitative, but also semi-qualitative, fact-based arguments. By reduction of parameter space by relevant delimitations, in combination with a deterministic ("worst case")-reasoning, the aim is to form a useful risk assessment methodology suitable for FortV's procedure of returning UXO contaminated land back to civil society with an acceptable level of residual risk. To facilitate an acceptable level of residual risk, FortV has the possibility to use risk reducing measures in the transfer process. Such risk reducing measures could consist of e.g. clearance of UXO, preparation and directives for camp sites and fire places as well as prepared hiking paths and open spaces.

Work Approach

Initial work started with the seemingly simple and fundamental question of: "How dangerous is UXO?"[5], a question far more complex and difficult to answer in a simplistic manner than one may first anticipate. Differing from earlier risk assessment work performed (Stenström, Westrin and Ritchey 2004), which was theoretically based and combined with statements from explosive ordnance disposal, EOD, experts, instead, a hands-on approach was chosen and work to collect fact-based arguments to form a basis for the risk assessment methodology began.

In order to determine the hazardousness of a specific type of UXO, or a range of specific types of UXO, a realistic, safety-based, post-transfer situation was described and modelled. Addressing a post-transfer situation with UXO, many (known and unknown) parameters are influencing the outcome of a specific event. It was possible to delimit the number of parameters by asking following relevant questions: "What parameters are significant in most real cases and situations involving UXO?", "What is the worst-case scenario for buried UXO, in terms of external influence?", and "In which situations might this worst-case external influence occur?". One logical outcome of these questions put in a post-transfer safety perspective is a situation where excavation is involved, exerting a possible maximum mechanical influence on UXO present. Modelling a representative excavator with a maximum force subjected to a UXO, fixed in position, was the starting point for designing a mechanical test to translate the same mechanical influence (Figure 2).

[5] From a safety perspective only.

Figure 2. A representative excavator (Volvo EC140), combined with the maximum possible exerted force on UXO, was the starting point for designing a mechanical test equipment for translating the same mechanical influence (Menning, Carlsson, et al. 2014).

The mechanical test was setup as a “worst-case” testing of actual UXO collected and identified from several Swedish former military firing ranges and were of medium caliber ammunition origin (Figure 3).

Figure 3. Deterministic, or “worst-case”, testing of mechanical influence on UXO (of 12.7 to 30 mm medium caliber ammunition origin) for determining hazardousness (Menning, Carlsson, et al. 2014).

The situation simulated for the mechanical influence was simplified by exerting gravitational force from a specified drop hammer weight and velocity onto the UXO. The UXO subjected to testing was x-rayed for fuze arming status preceding the test. Results from performed tests were documented, assessed and evaluated, based on earlier collected information for each specific UXO (Menning, Karlsson, et al. 2014). A maximum force was applied on each specific UXO fixed in a vertical or horizontal position to exert catastrophic mechanical influence on the object, crushing it (Figure 4).

Figure 4. Example of UXO (20 mm armor piercing incendiary grenade) in vertical, fixed, "worst-case" position before mechanical testing (left), x-rayed (center) and after testing (right) (Menning, Carlsson, et al. 2014).

Test results from performed mechanical tests on UXO (medium caliber ammunition), form a fact-based argument and a possibility of setting a parameter value for the hazardousness of specific UXO (at given conditions). Additionally, further tests can be performed to strengthen the argument by additional data, for the same or other types of UXO, thus, reinforcing the parameter value set.

Continued work was characterized by a systematic approach in order to scan, collect and form a basis of information and knowledge in order to start developing a risk assessment methodology. The systematic approach can be divided into the following phases of work:

1. Collecting and forming fact-based information on UXO
2. Scanning for historical data of UXO incidents
3. Inventory of existing risk assessment models
4. Structuring the problem (delimiting parameter space)
5. Developing a risk assessment methodology
    a. Forming the basis
    b. Test and revision
    c. Implementation

Two surveys to scan and list historical UXO incidents, internationally (Gustafsson, Forsén and Karlsson 2015) and domestically (Johansson 2017), were performed. The surveys formed a basis of information of how common UXO related injuries and deaths are, and to what extent UXO incidents have an impact on the general public's and decision maker's opinions regarding UXO related risks. Historical UXO incidents in Sweden between 1900 and 1980 were found by searching the media archives of the four largest newspapers in Sweden (Aftonbladet, Dagens Nyheter, Expressen and Svenska Dagbladet) at the Royal Library in Stockholm. As a complement to the newspaper articles, information between 1981 and 2016 was searched from digital media archives. A total of 70 newspaper articles published between year 1900 and 2016 were found to report UXO related incidents. Further, it was found that 37 of the UXO related incidents were unique, of which two were undated (Figure 5).

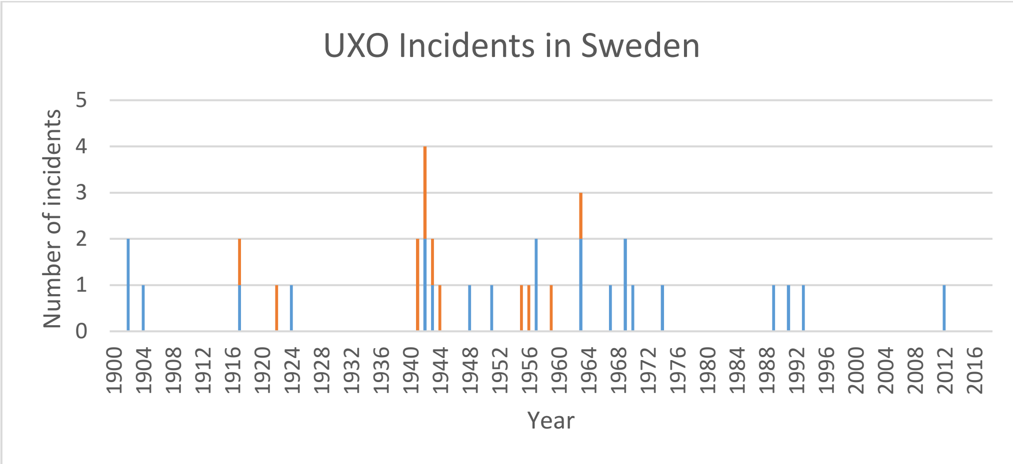

Figure 5. An illustration of 35 out of a total of 37 UXO related incidents in Sweden over time, as reported in media, during 1900-2016 (blue color depicts injured only, orange color depicts fatal outcome) (Johansson 2017).

The survey showed that out of the total 37 incidents, 14 had a deadly outcome, and a total of 21 fatalities have been reported. 23 incidents led to injuries only, with a total of 50 persons injured (survivors from incidents with a fatal outcome are included). Further, only one incident was the result of unintentional handling of UXO, in one incident the situation was unclear, and the remainder of the incidents were the result of intentional (deliberate and voluntary) handling of UXO.

Collected information shows that UXO incidents in Sweden are rare, especially since the 1970's to present. The reasons for this fact are unclear, but the data provides an indication of the frequency of incidents which can be put in context as a comparison to other incident data. This fact-based argument facilitates a sound basis for informing the general public and decision makers, trying to avoid future decisions being made based solely on psychological reasons.

Further UXO incident data has been provided by FFI in Norway from ongoing clearance operations at Hjerkinn Skytefelt, which is in the process of transferring the former military firing range to civil society. Grazing animals (musk oxen) have been present in the area for decades, not reportedly triggering any UXO incidents during this whole time. An estimation on the probability of an UXO incident has been calculated, based on this data, comparing the result with other ambient risks in present society (Dullum 2003).

The possibility exists to collect more information on UXO incidents in order to further enhance the argument of the frequency of UXO incidents.

An inventory of existing risk assessment models was made in order to identify and possibly utilize promising models or parts of models as well as experiences, good ideas etc. in current work (Forsén 2017). Two risk assessment models were found to be of further interest: U.S. Army Corps of Engineer's Ordnance and Explosives Cost-Effectiveness Risk Tool, OECert, reviewed in (MacDonald, et al. 2004) and the Swedish "RVM" (Stenström, Westrin and Ritchey 2004). OECert divides a UXO contaminated site into sectors, where the sectors are spatially homogeneous regarding the distribution of ordnance and explosives. Also, OECert addresses an estimation of exposure, based on a number of named activities. The activities are combined with information on UXO density to produce a number of expected exposures, which then is multiplied with a "OE hazard factor", determined by expert judgement. The Swedish RVM takes the same basic parameters as OECert into consideration and uses Bayesian network modeling for risk assessment calculations (Ahl, Lindberg and Stenérus 2008), however details of the model configuration have not been found to be reported.

Work has started with structuring the problem of a post-transfer situation after completed transfer of a specific military training area. A listing of definitions for terms used has been made to create a common understanding. Defining parameters and activities, which are similar to the approach in OECert, but also delimiting parameter space and activities possible, have resulted in an initial number of "risk factors". Risk factors represent a structuring of parameters, activities and situations of significance, affecting the residual risk. An attempt to subdivide UXO based on the properties of the same also has been described (Menning 2017).

Apparently, some parameters have a large influence on the outcome of the residual risk, such as direct mechanical influence on UXO and heat influence on buried UXO. Therefore, as work has progressed, a thorough and detailed evaluation of these parameters has been prioritized. Heat influence on remaining, buried UXO, put in different post-transfer contexts and situations, may have a major effect on the outcome, when in interaction with remaining UXO. Separate works have been performed by FFI in Norway (Skriudalen, Fykse and Dullum 2009) and by the Swedish Armed Forces, SAF, in Sweden (Fjällgren and Löfberg 2016) and the results (Figure 6) are used as fact-based arguments to address possible, proposed risk factors.

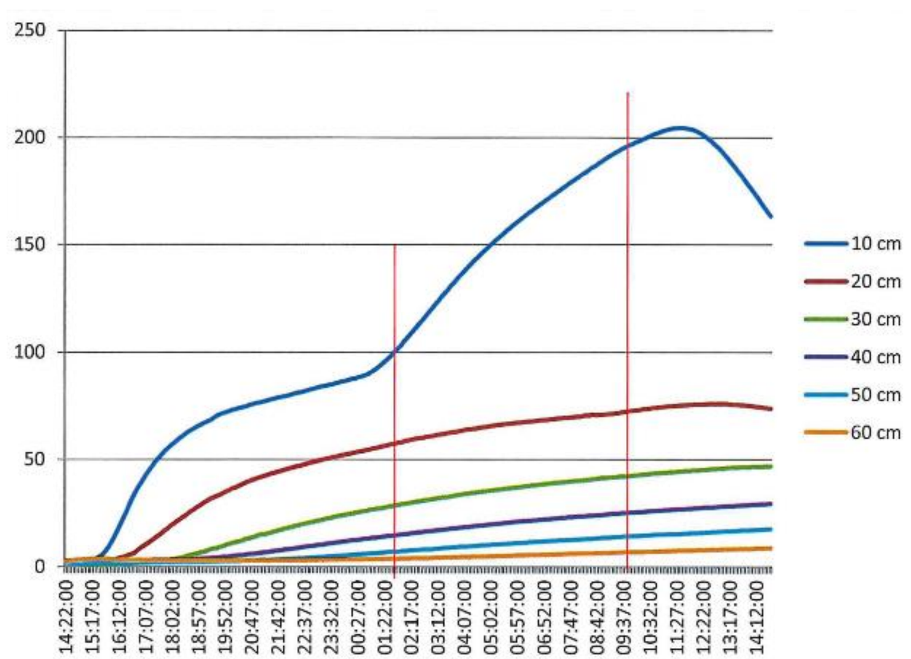

Figure 6. Example of an illustration of heat transfer in soil from an instrumented test, with a specified fire place and soil type, continuously burning for 19 hours, with temperature sensors placed at given depths (illustrated by the colored temperature curves). X-axis depicts time (hh:mm:ss) and Y-axis temperature (degrees Celsius). The vertical red lines highlight the time lapse for heat transfer in dry sand after evaporation of initial moisture (with permission from Marcus Fjällgren, Swedish Armed Forces) (Fjällgren and Löfberg 2016).

Data from SAF's work show that heat influence on buried UXO rapidly decreases at shallow depths, since high explosive contents normally does not start to rapidly decompose at temperatures below 100 degrees Celsius in specified time of exposure. This fact-based argument and conclusions provide information to be used in further risk assessment, considering possible future situations with remaining, buried UXO, and the situations that may occur involving heat influence for longer durations of time, such as setup fireplaces or forest fires.

Other apparently and fundamentally important parameters are: UXO density[6], UXO depth, UXO type, UXO sensitivity to initiation etc. These parameters shape the outcome of the risk assessment and are listed in (Menning 2017).

Parameters where the influence on residual risk is unclear, such as frost heave, presence of copper azide in remaining UXO etc., the approach is to try and determine parameter values from facts, whenever possible. If it is not possible to determine a parameter value, a conservative approach and parameter value will be chosen.

An important part of the work performed, as well as future work, is transparency, providing a possibility for external insight into all parts of documented tests, literature surveys, evaluations, listings, use of facts and references, reasonings, suggestions and subsequent development of risk assessment methodology. This is a deliberate work approach, facilitating external review and the possibility to follow through work as it progresses.

Risk Assessment Methodology Development

Starting development of a risk assessment methodology another fundamental question needs to be answered: What is an acceptable risk level? A literature survey of risk assessment models of interest showed it was uncommon to find quantifiable criteria for use in risk calculations (Gustafsson, Forsén and Karlsson 2015). However, it is frequently mentioned risks need to be at acceptable levels or as low as reasonably practicable, ALARP. What is obvious for a post-transfer situation with UXO contaminated land is that a zero risk never can be guaranteed. Therefore, criteria for levels of acceptable risk need to be established. In this context it is of fundamental importance to understand there is a difference between the term residual risk and the number of remaining UXO, separating the two in future risk assessment calculations (Gustafsson, Forsén and Karlsson 2015).

Criteria for acceptable risk levels have been suggested, based on performed literature surveys, scanning other existing risk criteria. Suggested levels of acceptable risk are comparable with risk levels in use for the transportation of dangerous goods in civil society in Sweden. Acceptable levels of individual risk[7] are suggested to be 10^{-5} per year as lower limit for unacceptable risk and 10^{-7} per year as the upper limit for negligible risk. In the region between these limits ALARP should be applied (Gustafsson, Forsén and Karlsson 2015) (Ågren, Gidholm and Menning 2017).

Suggested acceptable levels of societal (collective) risk[8] criteria are proposed as an upper limit, over which the risk is always unacceptable, is set as an FN criterion of $F=10^{-4}$ for $N=1$, and the inclination -2. The limit under which the risk can be considered negligible should be an FN criterion with $F=10^{-6}$ for $N=1$, and the same inclination (Figure 7).

[6] Number of UXO present in soil, per m^3.
[7] The risk for an individual to be killed or seriously injured by UXO, per time period, surface area, distance traveled etc.
[8] The risk for a group of people to be killed or seriously injured by UXO per surface area, distance traveled, per year etc.

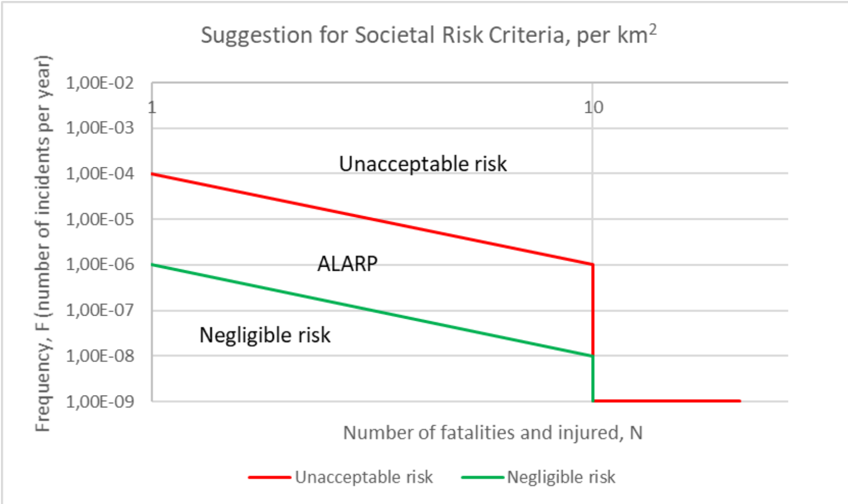

Figure 7. Illustration of suggested criteria for acceptable levels of societal risk (FN curve) (Ågren, Gidholm and Menning 2017).

For accidents with more than 10 people involved the general tolerance in society is low. The upper limit is therefore set as F=10^{-9} for N>10. In the region between the upper and lower limits ALARP should be applied (Ågren, Gidholm and Menning 2017). Suggested risk criteria refers to voluntary presence on a former military training area, where risk reducing measures have been applied. The criteria apply to people dying or being seriously injured. Definition of serious injury is an injury resulting in permanent loss of health corresponding to a "medical invalidity" of one per cent or more and is the same as used by the Swedish Transportation Administration and approved for general use by the Swedish Government (Regeringens proposition 2008/09:93 2009).

To control the maximum societal risk for the general public, the number of people allowed to simultaneously stay or reside at a specific area have to be restricted, in combination with a limitation of the degree of use of the same area (Ågren, Gidholm and Menning 2017).

The objective of the risk assessment methodology is to, in a systematic and transparent way, show whether a certain area should be considered safe from UXO (or not), based on site-specific data and results from possible, previous clearance operations. Many parameters are discussed in this context and may be included in a model to determine the risk. However, many of the parameters pose a high degree of speculation, since there are no or very few rigid experiments or other studies conducted on their influence. Instead, in this work, a conservative approach is used, assuming all parameters adding to a 100 % probability for an incident to occur, unless it can be shown to be otherwise and then only to the degree that can be shown with reasonable confidence.

Much work on risk assessment in this area has already been done and the ambition in current development of a risk assessment methodology is not to start from the beginning, but to learn from earlier works and try to use experiences gained and apply them for the situation in Sweden. As mentioned in the introduction, the Swedish UXO contamination problem on former military training areas and firing ranges differs from many other countries, and the risk assessment methodology is developed with two major delimitations. The first delimitation is that impact areas are excluded in the risk assessment and only surrounding, possibly hazardous areas are subjected to risk assessment (Figure 8).

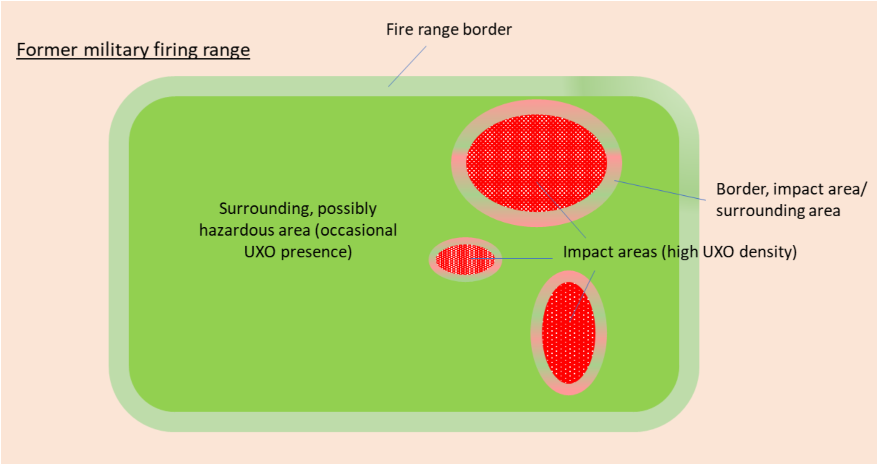

Figure 8. Schematic, simplified illustration of a former military firing range, with high UXO density impact areas and adjacent, surrounding, possibly hazardous area, with an occasional UXO presence.

The second delimitation is that the risk assessment methodology only assesses the safety perspective of UXO. Thereby, it neither includes security, nor environmental perspectives. However, security and environmental aspects are discussed for possible implementation, because these risks may well be determining decision makers' standpoint in the future, since the Swedish State's responsibility for its own domestic pollution is recently reported (Åberg and Engström 2016).

Risk factors combined with historical and other background information for the military training area and the types of ammunition used and to what extent, together form a background material for each specific site subjected to risk assessment.

The risk factors (including parameters, activities and situations) of critical importance are to be determined and this work has started. By collecting facts about a specific risk factor, such as the hazardousness of specific types of UXO, values may be set for quantitative risk assessment calculations.

UXO density and UXO depth are considered two key parameters. UXO density determines the borders between impact areas and surrounding, possibly hazardous areas with occasional UXO presence. UXO depth determines the outcome of the hazardousness of the UXO, in combination with other parameters. Topography, soil type, vegetation etc. are other parameters adding to the outcome of the residual risk.

For each and every military training area a specific risk assessment model is setup, with local conditions for each specific situation. The military training area is subdivided in areas based on similar properties, in order to differentiate between impact areas and surrounding possibly hazardous areas with occasional UXO presence. To a large extent, the locations of impact areas are unknown (since documentation is often missing), inadequate, or misleading. A consequence of this fact is that, often, localization methods have to be used in order to find clusters of UXO to indicate where the impact areas are (Figure 9).

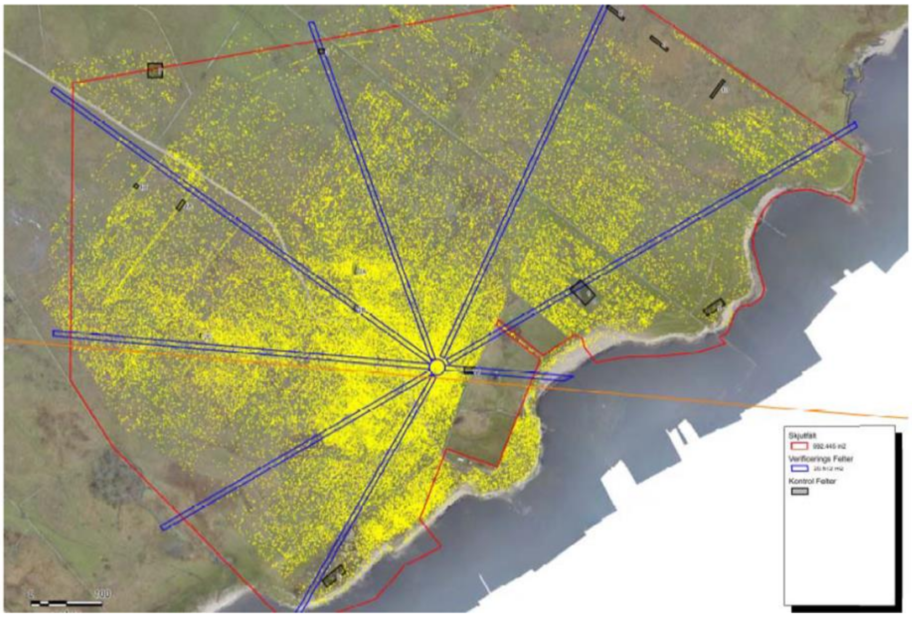

Figure 9. A technical survey map of a former military firing range at Sandby, Öland, Sweden, showing a confirmed 61 270 indications from performed measurements by magnetometry (Damasec 2015).

Current approach is to try and utilize data from localization or clearance operations performed at an initial technical survey phase of a specified area subject to transfer. A smaller clearance operation, considered as a representative area of the larger former military training area, is a better option and provides the initial information to proceed with risk assessment. So far, five technical surveys and clearance operations to various extent have been performed by FortV between 2013 to 2016 and verified data of UXO findings of the UXO localization data is utilized to form a basis of information to be used in the first steps to determine localization of impact areas.

A current and challenging issue is to evaluate localization methods, mainly detailed search methods such as magnetometry etc., to determine to what extent they can be used to determine UXO density and UXO depth and therefore, indirectly contribute to the determination of residual risk.

An alternative, possible approach for calculating remaining number of UXO, when clearance operations is an option in the transfer process, is to use the methodology used at Hjerkinn Skytefelt (Dullum 2014).

Currently, work is progressing with forming the basis of the risk assessment methodology (Gidholm, Ågren and Menning 2017), but risk assessment calculations are still set for a subsequent testing phase.

Technical challenges remain, such as:

- 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

Several general challenges remain to be solved:

- How to deal with uncertainties
- Acceptance by society of a developed risk assessment methodology
- Acceptance by society of an acceptable level of remaining risk
- How to combine developed risk models with other risks, such as security and environmental related risks (which are not included in present work)

Additionally, maybe the most important challenge remains which is how to, in a pedagogical way, describe and explain to decision makers and the general public how the risk assessment methodology is implemented and what the remaining risk is for a transferred area at hand. The approach chosen is to compare the residual risk to other risks present in everyday life for the general public, such as resulting risk in situations involving transportation of dangerous goods, exposure to industrial facilities handling hazardous chemicals etc.

One important fact to bear in mind in this context is that, currently, in Sweden, the general public is allowed to enter active military training areas and firing ranges outside military exercise hours, despite the presence of UXO.

References

Ahl, Alexander, Anna Lindberg, and Ann-Sofie Stenérus. *FOI-R--2680--SE. To Design Bayesian Networks (Report in Swedish).* Stockholm, Sweden: Swedish Defence Research Agency, FOI, 2008.

Albright, Richard. *Cleanup of Chemical and Explosive Munitions. Second Edition.* Oxford, United Kingdom: Elsevier Inc., 2012.

Damasec. *Utvärderingsrapport verifieringsarbeten vid Sandby skjutmål (Report in Swedish).* Gothenburg, Sweden: RGS 90 Sverige AB, 2015.

Dullum, Ove. *FFI/Rapport-2003/01788. Blindgjengerfaren i Hjerkinn skytefelt - En statistisk analyse (Report in Norwegian).* Kjeller, Norway: Norwegian Defence Research Establishment, FFI, 2003.

Dullum, Ove. *FFI-rapport 2014/01042. Ryddingen av Hjerkinn skytefelt - en oppdatert vurdering (Report in Norwegian).* Norway: Norwegian Defence Research Establishment, FFI, 2014.

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

Forsén, Rickard. *FOI-R--4411--SE. Unexploded Ordnance, UXO, at Military Firing Ranges and Training Areas.* Stockholm, Sweden: Swedish Defence Research Agency, FOI, 2017.

Gidholm, Johan, Matilda Ågren, and Dennis Menning. *Draft: Methodology for Assessing Remaining Risk at Former Military Firing Ranges and Training Areas after Risk Reducing Measures (Report in Swedish).* Stockholm, Sweden: Swedish Defence Research Agency, FOI, 2017.

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.

Johansson, Ida. *FOI-R--4412--SE. Systematic Documentation of Incidents involving UXO.* Stockholm, Sweden: Swedish Defence Research Agency, FOI, 2017.

MacDonald, Jacqueline, Debra Knopman, J.R. Lockwood, Gary Cecchine, and Henry Willis. *Unexploded Ordnance. A Critical Review of Risk Assessment Methods.* Santa Monica, USA: RAND Corporation, 2004.

Menning, Dennis. *FOI-R--4410--SE. Subdivision of Unexploded Ordnance on Military Firing Ranges and Training Areas.* Stockholm, Sweden: Swedish Defence Research Agency, FOI, 2017.

Menning, Dennis, Johan Carlsson, Magnus Lindström, Svante Karlsson, and Stefan Olsson. *FOI-R--3911--SE. Riskutvärdering av akanammunition i form av OXA efter genomförda mekaniska prov (Report in Swedish).* Stockholm, Sweden: Swedish Defence Research Agency, 2014, 61.

Menning, Dennis, Svante Karlsson, Johan Carlsson, and Sara Leonardsson. *FOI-R--3869--SE. Teoretisk riskutvärdering av vissa typer av akanammunition i form av OXA (Report in Swedish).* Stockholm, Sweden: Swedish Defence Research Agency, FOI, 2014.

Regeringens proposition 2008/09:93. Stockholm, Sweden: The Swedish Government, 2009.

Skriudalen, Stian, Haakon Fykse, and Ove Dullum. *FFI-rapport 2009/01429. Testing av blindjengere fra 12,7 mm og 20 mm MP-ammunisjon mot åpen ild - risiko ved utilsiktet oppvarming (Report in Norwegian).* Norwegian Defence Research Establishment, FFI, 2009.

Stenström, Maria, Peter Westrin, and Tom Ritchey. *Living with UXO. Using Morphological Analysis for Decision Support in Phasing out Military Firing Ranges.* Stockholm, Sweden: Swedish Defence Research Agency, FOI, 2004.

Åberg, Margareta, and Fredrik Engström. *RiR 2016:25. The State's Contaminated Areas (Report in Swedish).* Stockholm, Sweden: Swedish National Audit Office, 2016.

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.