

Risky Business

Assessing the Potential Harm from Unexploded Ordnance

Since the end of the Cold War, the Army has closed about 20 percent of the major military bases in the United States along with a host of smaller installations. Most have been slated for transfer to civilian ownership. One problem associated with converting these former bases to civilian use is that many have firing ranges that contain unexploded ordnance (UXO), which can pose two types of hazards. One hazard is that unexploded munitions can detonate when people come in contact with or disturb them. A second is that the constituents of the munitions, primarily explosives such as TNT, can break down into hazardous chemicals and leach into the soil and water.

Congress has directed the Department of Defense (DoD) to determine the scope of the problem and devise a plan to address it. The problem is a tough one from both a technical and a public perspective. The precise nature of the hazards present is not always clear. For example, the form of the UXO (artillery rounds, bomblets, etc.) and how the UXO are distributed in the soil are difficult to determine. Also frequently unknown is the future use of the land. Many groups have a stake in these installations, and not all agree on the ultimate use of the land or on what constitutes an acceptable level of cleanup.

Risk assessment can help DoD grapple with this problem by defining the technical dimension of the UXO problem and providing a technical basis for setting priorities among sites and choosing among response options at individual sites. Researchers from RAND Arroyo Center have addressed this issue in *Unexploded Ordnance: A Critical Review of Risk Assessment Methodologies*, which evaluates the adequacy of methodologies developed to assess UXO risk, reviews risk assessment methodologies of other federal agencies, and proposes a strategy for

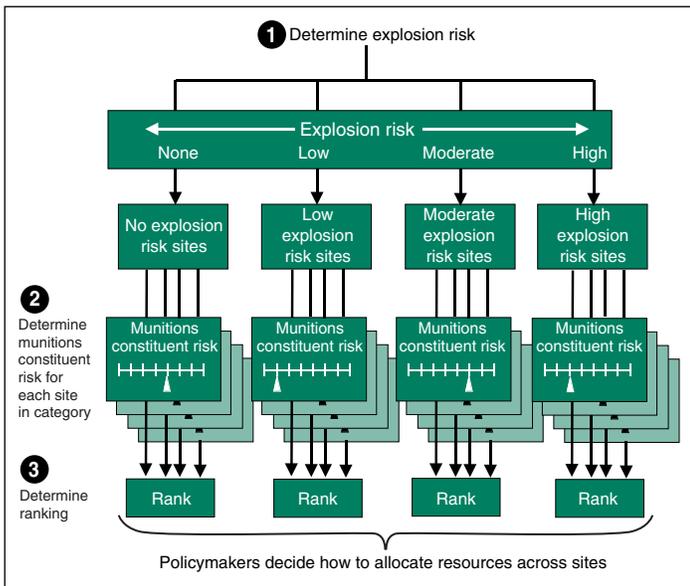
improving the application risk assessment to the UXO problem.

ADEQUACY OF EXISTING UXO RISK ASSESSMENT

A number of risk assessment methodologies for UXO and munitions constituents have been developed, and Arroyo Center researchers assessed five, identifying strengths and weaknesses. Their assessment addressed both the soundness of the methodology from a scientific and technical perspective and its adequacy from an implementation perspective. Both are important. A methodology might be scientifically sound but impractical to implement. For example, excavating a former range to a depth of 10 feet and sifting the soil would remove UXO but would be prohibitively expensive and environmentally destructive. Arroyo Center researchers concluded that none of the available UXO risk assessment methodologies satisfied all the criteria needed to be credible. Problems found included absence of sound technical models to underpin many of the calculations, absence of approaches for evaluating uncertainty, lack of sufficient opportunities for involvement of regulators and concerned citizens in making some of the nontechnical judgments underlying the assessments, and lack of transparency.

OTHER FEDERAL RISK ASSESSMENT METHODOLOGIES

Many federal agencies (National Aeronautics and Space Administration, Federal Aviation Administration, Environmental Protection Agency) use risk assessment methodologies to guide their activities. Some of these methodologies could apply directly to aspects of the UXO



Prioritization Process for UXO Sites

problem. For example, well-validated methodologies exist for assessing the risk that munitions constituents pose to soil and water. The risk from munitions constituents does not differ from risks posed by other hazardous chemicals, and no new methods need to be developed for this purpose.

Although none of the methodologies used by other agencies can apply directly to the explosion risk, some could serve as models for developing methods to assess the risk of explosion at specific sites. The probabilistic risk assessment (PRA) approaches used by the Army Chemical Stockpile Disposal Program, the Federal Aviation Administration, the National Aeronautics and Space Administration, and the Nuclear Regulatory Commission provide representative examples. In particular, the fault-tree and event-tree analysis tools used in PRA seem most relevant. These tools are used for systematic mapping of the steps necessary to trigger acute events, for example a major malfunction of a nuclear plant. The approaches are widely used not only in the federal government but also in industry for determining the probability of system failures and identifying the most important contributors to the risks of those failures. No existing method is adequate for considering both explosion risk and munitions constituents risk when prioritizing sites. A new process will have to be developed for this purpose.

THE ARMY NEEDS MULTIPLE RISK ASSESSMENT METHODS

An important conclusion of this study is that the Army needs to employ multiple risk assessment methods

that operate at different levels and employ different designs. One set of methods would operate at the program level and establish priorities for the program. This method could serve as a relatively coarse screen for many sites. That is, such methods could tell decisionmakers which installations and sites within installations pose the greatest risk and thus warrant the most immediate attention. This type of information is useful for allocating financial and other resources, such as equipment and personnel. A second set of risk assessment methods would operate at the site level and provide detailed analyses of specific areas contaminated with UXO within installations. These risk assessment methods could provide quantitative information about the potential for harm to people living near UXO sites and to local ecosystems. They also could estimate the effectiveness of alternative cleanup approaches in reducing those risks.

These method sets would be applied sequentially. The programmatic methods would determine where to focus attention, and the site methods would gather the detailed information necessary to understand the risks fully. The figure provides a notional depiction of the process.

Even the best-designed set of risk assessment methods will not resolve all the controversies that arise at UXO sites, but it can help to educate the participants in the decision process about the nature and magnitude of risk involved. Put another way, risk assessment can illuminate the nature of risks at UXO sites and lead to better-informed decisions, but it cannot make people agree on what amount of risk is acceptable.

RECOMMENDATIONS

The Arroyo Center research team recommends that the Army do the following:

- Develop a new UXO prioritization process that (1) sorts sites by explosion risk and (2) within this category, sorts sites by munition constituents risks.
- Use the EPA Hazard Ranking System or Defense Environmental Restoration Program Relative Risk Site Evaluation Primer for stage two of the prioritization process in which munition constituents risk is characterized.
- Produce two UXO site priority lists: one for sites with known and documented future land use and another for sites with uncertain future land use.
- Use available processes for site-specific assessment of munitions constituents risks.
- Develop a new, probabilistic approach using fault

and event trees or similar methods for site-specific assessment of explosion risks.

- Create a set of fault or event trees that could serve as templates for local assessments and guidelines for use of those trees in computing probabilistic risk estimates.
- Appoint an independent technical review board and an advisory committee of stakeholders to oversee development of the prioritization process and involve them from the outset in the development of the probabilistic, site-specific risk assessment process.

RAND research briefs summarize research that has been more fully documented elsewhere. The research summarized in this brief was carried out in the RAND Arroyo Center; it is documented in Unexploded Ordnance: A Critical Review of Risk Assessment Methods, by Jacqueline MacDonald, Debra Knopman, J.R. Lockwood, Gary Cecchine, and Henry H. Willis, MR-1674-A, 2003, 182 pp., \$24.00, ISBN: 0-8330-3432-4, available from RAND Distribution Services (Telephone: toll free 877-584-8642; FAX: 310-451-6915; or Internet: order@rand.org). Abstracts of all RAND documents may be viewed on the World Wide Web (<http://www.rand.org>). Arroyo Center URL: <http://www.rand.org/ard/>. Publications are distributed to the trade by NBN. RAND® is a registered trademark. RAND is a nonprofit institution that helps improve policy and decisionmaking through research and analysis; its publications do not necessarily reflect the opinions or policies of its research sponsors.

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RB-3043-A (2003)