2. Introduction

2.1. Background to the problem

In 2008-2009, James Madison University, the Center for International Stabilization and Recovery, and C King Associates undertook a research project, “Scoping Study of the Effects of Aging on Landmines.” It was established in this pilot research initiative that very little in the way of scientific evidence is documented regarding the effects of age and environment on landmines. This initial Scoping Study provided evidence through analysis of mine samples from the field that landmines are being demonstrably affected by age and environment in their ability to function as intended. Based on these first samples of landmines from Cambodia, it was also observed that at least some landmines are being neutralized over time due to aging and climate.

A key outcome of the initial Scoping Study was the recognition that there are important questions we do not understand about landmines, aging and environment that will have implications for the future of landmine clearance, mine-risk education, detection, R&D and strategic planning. Rather than supplying answers, this initial research elicited an ever-widening array of questions, such as:

- What were the original compositions of the mine components?
- How do the compositions change as they deteriorate?
- What factors have caused deterioration?
- How localized can these factors be?
- How does deterioration lead to the inability of a mine to function?
- Are the effects relevant to similar materials in different mines?
- How do the environmental factors differ in other regions?
- To what extent can the effects be quantified or predicted?
- Can the effects be influenced (to accelerate failure, for example)?

At the conclusion of this initial Scoping Study, the research team recommended that the study of the effects of aging and environment on mines be continued in order to:

- Analyze the characteristics of key materials used in mines
- Research the causes of deterioration within these materials
- Examine the failure mechanisms within affected mines
- Broaden the range of mines within the study
- Broaden the regional and/or environmental scope of the study
- Investigate, where possible, anecdotal evidence of aging

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1 Available for public access at: http://maic.jmu.edu/aging/aging_intro.html.
2 ‘Neutralization’ is an important concept discussed in greater detail within this report; see Annex J, section 3.3.
• Analyze findings to establish the implications for:
  ○ Program funding
  ○ Military operations
  ○ Mine-risk education
  ○ Field procedures
  ○ Equipment development

It was further recommended that future research to quantify the effects observed and to validate the findings should utilize the support of specialists (in disciplines such as chemistry, geology and physics) and the use of laboratory facilities.

This current report discusses follow-on research activities undertaken as an outgrowth of these recommendations. It describes the first phase findings of what is intended to be a scientific multi-phase, multi-year research effort to understand and exploit the impacts of age and environment on mines.

2.2. Funding and partnerships

“Study of the Effects of Aging on Landmines, Phase 2, Year 1,” was funded by United States Department of State, Bureau of Political-Military Affairs/Office of Weapons Removal and Abatement from 2009-2010.

The most recent phase of research described in this report was conducted by a team consisting of the James Madison University’s Center for International Stabilization and Recovery, Department of Chemistry, Department of Geology and Environmental Science, and C King Associates Ltd.

Other organizations, particularly Golden West Humanitarian Foundation, The HALO Trust, Jordan’s National Committee for Demining and Rehabilitation, the Jordanian Armed Forces, and Norwegian People’s Aid, contributed to the success of this study by providing field access, laboratory facilities and logistical support.

2.3. Project goal

The primary goal of the “Study of the Effects of Aging on Landmines, Phase 2, Year 1,” was to provide sound technical data on the effects of aging and environment on landmines, in order to better understand the degradation process and support an approach to decision-making within mine action.

2.4. Project objectives

Overall project objectives for the Study of the Effects of Aging on Landmines were to:

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3 For Scoping Study results, see: http://maic.jmu.edu/aging/aging_intro.html.
• Collect mine and environmental field data for selected types of mines from previously studied hot/wet environment (Cambodia) and new hot/dry environment (Jordan)
• Conduct rigorous scientific analysis on components of identified mines in James Madison University laboratory settings using state-of-the-art materials-analysis and environmental-science technology
• Complete analysis based on research results and compile into project report, prioritization tool(s) for mine action, and Phase 2, Year 1 follow-on recommendations of research

The remainder of the report is divided into the following sections:

Section 3: Methodology
Section 4: Field Work and Findings
Section 5: Laboratory/Scientific Summary Findings
Section 6: Moving Beyond: Vulnerability Tools, Extrapolation, Final Analysis
Section 7: Conclusion and Recommendations
Annexes A-K