7. Conclusion and Recommendations

7.1. Conclusions

In more general terms, at the beginning of this project little was understood about landmine aging. As a result of the work done to date the situation has become a good deal clearer. While it is clear that more work needs to be done it is already apparent that landmine aging is of importance now, to field operators and to policymakers and planners.

Specifically, development of user tools has highlighted the following conclusions:

- Landmine aging is an issue now; it will become more and more important as time passes.
- The vulnerability of different mine types to degradation over time can be assessed and indexed.
- Further statistical analysis should help predict the likely lifespan of different mine types under various conditions;
- Policy makers should consider the implications of landmine aging for residual capacity and public health questions.
- Policy makers may wish to consider the implications of landmine aging for ‘end state’ questions about landmine contamination situations;
- User tools can be improved and expanded to more mine types through the (safe) collection of as much field data as possible.
- Further review of existing literary sources is likely to yield useful input to help refine aging models.
- Further laboratory investigation of the most vulnerable components of mines will help refine aging models.

7.2. Conclusions from field evaluation

- The comparison of various mine types of similar age\textsuperscript{24} within differing climates gave the study team an insight into the various causes of degradation. Although there are many factors that may contribute to the speed and nature of the aging process, the majority are of little significance. Basic environmental elements, such as temperature, rainfall, exposure to sunlight and fire, account for the vast majority of the effects.
- Analysis of recovered mines revealed a number of failure mechanisms. Many, such as the rusting of springs or seizure of moving components, are applicable to a range of mine types.

\textsuperscript{24} Most date from the 60's and 70s, and have been laid for around 30 years.
The major complication for this study was that, with the exception of the Russian PMN, different types of mine were found in the regions visited. This severely limited the opportunity for direct comparison; however, many of the mines examined did use similar materials and incorporated comparable mechanisms.

Overall, the mines in Cambodia were in worse condition than those seen in Jordan, Afghanistan or the Falkland Islands. This appears to be due primarily to the action of water on vulnerable materials, such as wood, rubber and mild steel.

The Russian PMN offers the greatest insight into the factors governing deterioration since it is present in both Afghanistan and Cambodia. The PMNs in Afghanistan are mostly in better condition than those of similar age in Cambodia; this suggests that the wet climate of Cambodia accelerates degradation and contributes significantly to the failure of these mines.

Mines in the extremely harsh, wet climate of the Falklands were in surprisingly good condition. This is evidence that climate alone does not dictate the rate of degradation. The mines in the Falklands have robust outer casings and have, mostly, remained watertight.

There study offers compelling evidence that the presence of water within the casing substantially accelerates the deterioration process. There are, therefore, two distinct stages in the degradation process:

- Effects leading to the breach of the outer casing
- The accelerated degradation of internal components once water enters the mine.

The consistency of degradation within vulnerable materials\(^{25}\) allows extrapolation to similar materials and components in other mines. Where degradation contributes to a failure mechanism, this too can be expected in mines with similar structures and fusing systems.

The study indicates that all mines will eventually become incapable of functioning as designed due to the effects of aging. The rate at which this occurs is largely dependent on the local environment and the materials used for vital components.

Degradation effects such as the rotting of wood, perishing of rubber and rusting of mild steel are so well known and well documented that their existence and primary consequences need little justification.

All of the mines examined were becoming less likely to function (and therefore safer) as they aged; however, there are a few mines\(^ {26}\) which might become more sensitive before they eventually become safer. It is also possible that some mines containing pyrotechnic compositions\(^ {27}\) might become non-functional when damp, but then become viable again if they dry out.

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\(^{25}\) Degradation effects such as the rotting of wood, perishing of rubber and rusting of mild steel are so well known and well documented that their existence and primary consequences need little justification.

\(^{26}\) In most instances, failure of the mine was due to degradation of mechanical fuse components. The explosive train tended to remain intact for longer than the fusing mechanisms.

\(^{27}\) Pyrotechnic compositions often feature at the beginning of the explosive train, in order to translate a mechanical action into ignition, similar to striking a match.
7.3. **Recommendations**

It is recommended that:

- Field data is collected systematically. Understanding landmine aging at the country level requires extensive statistical analysis. That analysis can only yield reliable results when there is a substantial body of data to work from. It has not been normal practice for clearance operators to collect and report information about the condition of landmines discovered in the field. It is of the utmost importance that such data be collected on a routine basis from now on. An example template for capturing the required data is at *Annex K.*

- The initial aging models developed within this project should be refined, enhanced and extended to incorporate improved statistical techniques and to encompass other common types of mines.

- National authorities, Mine Action Centers and field operators should be strongly encouraged to start collecting and reporting information relating to the condition of landmines as and when they are discovered. Understanding landmine aging at the country level requires extensive statistical analysis; that analysis can only yield reliable results when there is a substantial body of data to work from. It has not been normal practice for clearance operators to collect and report information about the condition of landmines discovered in the field. It is of the utmost importance that such data be collected on a routine basis from now on.

- Statisticians become involved in the study. As field data become available, thorough analysis by statistical specialists should be carried out to identify failure patterns and to make projections about the likely lifespan of different mine types in different areas. The reliability of such projections is likely to increase as more data become available and over time.

- The study is continued.