Rational Methodologies for Land Mines/Unexploded Ordnance Contaminated Land Release or Clearing Decision Making

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1 A REVIEW OF RECENT UXO/MINE CLEARANCE FINDINGS

Over recent years, the community working towards the aims of the Anti-Personnel Mine Ban Convention[1] (APMBC) has begun to struggle with fundamental questions related to the efficiency of clearance efforts and the need to release land in countries facing strong demographic and social pressures (Jordan Times, 2004).

In a series of studies on Lao PDR it was found that physically cleared ground more than 292 km^2 was less than 2% contaminated with Explosive Remnants of War (ERW), denoting a rampant and chronic waste of resources and life-saving efficiency in an industry that lives on the good will of international donors. Very costly mistakes are by and large made at tactical (local/community) decision making level, i.e. when deciding whether to clear, sample or release a SHA[2].

This appears to be indicative of operators clearing ground where, in all likelihood there may be no ERW[3], instead of undertaking a reasonable, transparent and sustainable analysis of available information and then allocating resources that would maximize the result.

Thus various entities worldwide are interested in releasing land and allowing clearance resources to be deployed to areas where mines and UXO presence is most likely. However, unless the consequences of an ERW initiation are included in the information analysis (impact on population, development etc.), i.e. unless “Risk Based Decision Making (RBDM) for Land Clearing and Releasing” is performed, then rational, transparent and sustainable portfolio prioritization at local, regional or national scale cannot be achieved.

2 THE LAO PDR CASE STUDY

The people of Lao PDR used their own resources to address the UXO contamination problem since the first day of bombing and developed their own survival strategies accordingly.

[1] Public awareness and enhanced perception about the effects of mines, driven by media and humanitarian organizations, led to a strong political movement that generated enough agreement and goodwill to ensure a significant number of nations supported an international treaty outlawing anti-personnel mines. This treaty, known informally as the Anti-Personnel Mine Ban Convention (APMBC), was signed by 122 States in December 1997 in Ottawa, Canada.
[2] Suspected Hazardous Area (SHA).
[3] L. Geddes, Seeking a safe path through the landmine debate, New Scientist, 26 November 2005

The international humanitarian response began in 1994 and the formation of UXO Lao followed in 1996. In the early days much of the work was based upon meticulous techniques of demining minefields in compliance with the APMBC (which does not apply to UXO contamination) rather than faster Battle Area Clearance (BAC) techniques used elsewhere for clearing ERW contamination. A significant Community Awareness (CA) program was also developed with the aim of educating the population of the hazards of handling UXOs and to provide alternative strategies to hazardous behaviours.
In 2005, the Government of Lao PDR established the National Regulatory Authority (NRA), to manage UXO action in the country.

Reportedly casualties still continued to occur and in 2004 they started to rise significantly.

In 2006 a RBDM model to support decisions in Lao PDR was designed by the authors under contract with the GICHD for UNDP[4]. The RBDM helps to allocate resources to areas where quantitative risks are high, rather then responding to hazard perception or personal evaluations of criticality of situations[5], and therefore is a very logical, defensible and transparent way to significantly increase life saving efficiency in a program.

The understanding of the real impact that ERW contamination has on a region/country is one of the most important elements of a situational analysis. It was difficult to get a clear understanding of the degree of remaining contamination and its impact, as well as progress of ongoing and completed work in provinces based on extant databases in Lao PDR.

It was also noted, at the time of design of the RBDM that the deployment of clearing teams was based on inadequate analysis of extant data. The existence of unique detailed bombing data by the US Government which could allow, if properly validated, analyzed and utilized, the development of innovative RBDM models was underexploited. Of course, pertinently treated bombing data would have constituted an enhanced basis for the development of both national and community-level risk maps, but unfortunately no treatment was available before the release of the model.

From the beginning of the study Lao PDR was noted as a classic case of "siloed data", i.e. a case where data may exist even in better shape than in other countries, but are stored in such a way that forbids retrieval or use to derive useful statistics. If data from various silos could have been integrated, attempts to create a RBDM model would have followed a more direct and efficient path. As a matter of fact, the key to better UXO action, including the successful implementation of RBDM model, is better information. Reliable and well directed work on extant siloed data, including a victim information system[6], would have been invaluable at development time.

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[4] Geneva International Centre for Humanitarian Demining, Lao PDR Risk Management and Mitigation Model, 2007

[5] Which generally include various non-formal tools such as scoring tables, field flow charts etc. which do not comply with universally accepted definition of technical risk.

[6] An excellent model could be the Cambodian Mine Victim Information System (CIMVIS), which is able to identify for example what activity the victim was undertaking at the time of the accident, geographical data, based on a systematized format for data collection.

Albeit these difficulties the first steps in the direction of developing a real "RDBM for Land Clearing and Releasing" model geared towards rational, transparent and sustainable portfolio prioritization at local, regional or national scale were undertaken. Models for strategic and operational guidance were developed and a field trial was implemented. A solution was found to the lack of information, the siloed data and the critical budget constraints: the models were based on first estimate probabilities instead than data mining and statistics.

3 METHODOLOGY OF THE GICHD-RBDM LAO PDR MODEL

The GICHD-RBDM Lao PDR methodology uses field as well as "office[7]" data to deliver a ranking that could guide the choice between cancelling or releasing land, roving tasks, clearing using BAC techniques, clearing using "traditional" manual mine clearance techniques, and/or splitting the work into various sub-tasks. As a matter of simplification the authors were requested to reduce these categories to a traffic light (red, orange, green) representation.

Two models, one at community level, the other at larger national scale, were programmed as a MS-Excel interface, with quantitative probabilistic analyses based on *a priori* estimates and, of course, numerous assumptions running in the background.

The models use data that can be considered as "symptoms" of the possible presence of ERWs of different types at a given location. The symptoms are combined by using reliability techniques to determine the probability of duds presence, initiation etc., then the potential consequences on population at a given location from possibly more than one type of ERW. Subjective probabilities are used throughout the models for which calibration is needed both during the programming/testing phase, and later, when a field trial is implemented, before final release to the users.

The two decision-support tools evaluate risks expressed as the probability of a (first) accident and its consequence in terms of potential casualties. This definition of risk is compliant with worldwide industry definitions.

The community-level tool classes the risks into three categories which correspond to national guidance on actions to be undertaken:

- Cancel (green scenario) for the areas posing the lowest level of risk…
- Sample (orange scenario)
- Clear (red scenario) for the areas posing the highest level of risk….

The thresholds between these categories were defined using risk acceptability criteria like, for example those defined by Whitman[8] by surveying public/societal reactions to accidents in various industries.

During a trial period in early 2007, a number of operators continued to use their standard survey methodologies, while simultaneously using the model on each site they

[7] Read "bombing data" and other military action available data.

[8] Whitman, R.V., "Acceptable Risk and Decision-Making Criteria", Proceedings of the International Workshop on Risk-based Dam Safety Evaluation, Trondheim, Norway, 1997

considered for action. As the prescribed bombing data treatment was still not available at the time of the trial, each operator interpreted the data to his/her best understanding, unfortunately bringing an unwelcome fuzziness to the tests.

The preliminary version of the RBDM, calibrated by the authors at programming using examples from Europe and using Whitman's acceptability criteria reported 30% less mistakes made in selecting properties to clear than usual procedures (http://www.gichd.org/fileadmin/pdf/risk_management/workshop-june2007/Presentation-LR-RM-Workshop-FrancoOboni-June2007.pdf) (Fig. 1a, 1b).

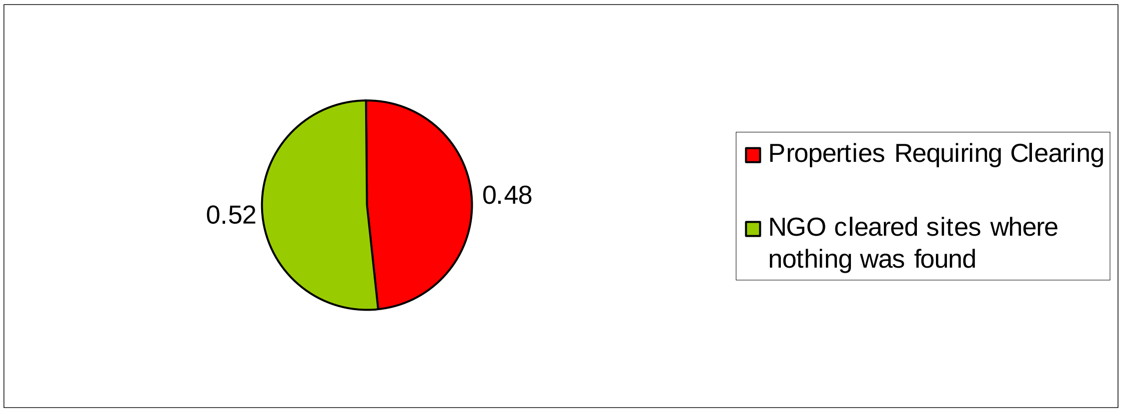

Fig. 1a Results by operators using usual procedures: 52% of properties where nothing is found is cleared anyways

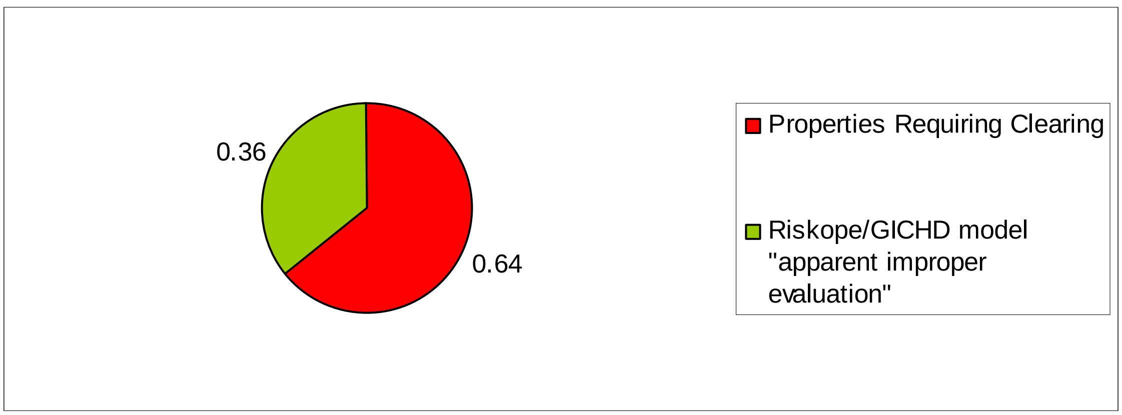

Fig. 1b Results by operators using the RBDM: the improper evaluation is reduced to 36%, i.e. 30% less "mistakes" than using usual procedures.

This result confirms the nowadays generally accepted concept that Humans seem to be overly confident in their decision-making skills and human misjudgment is a source of wide-spread budget and resource wastes[9]. Those who resist this type of model's findings, generally a majority at first, are typically quite willing to admit that models will be right more often than human experts "on average", but love to point out special cases

[9] Financial Times, How computers killed the experts, FT, London, Saturday September 1, 2007; P. E. Meehl, Clinical versus statistical prediction: A theoretical analysis and a review of the evidence. Northvale, NJ: Jason Aronson. (Original work published 1954), 1996.

and the inevitable exceptions. To the authors' dismay the models were tampered with shortly after their release, most likely as a result of this train of thoughts.

4 WHAT CAN BE DONE TO ENHANCE THE LAO-PDR PRELIMINARY MODEL?

The preliminary models were based on a priori probabilities to overcome the lack of data and the siloed data syndrome described above. Despite their limitations, such probabilistic models are perfectly acceptable, and are the only possible way to proceed in many industries. Possible enhancements would come from pertinent use of the available data and development of proper statistics.

The 2006 GICHD models showed it was possible to significantly reduce inefficiencies due to poor judgment in a UXO contaminated area with a probabilistic model using limited information. The authors believe a statistical model based on extant data, once the data silos syndrome is overcome and bombing data are pertinently processed, would certainly outperform the former and bring great advantage to the world of humanitarian demining. Moreover such an approach, pertinently modified could work for the landmine contamination case as well.

Over the last few months the meager set of results derived from the field trial of the preliminary Lao-PDR RBDM method enabled the authors to pursue under their own financing and free of any contractual obligation the development of such an enhanced model for the evaluation of the probability of existence of an ERW on a considered property.

Interestingly the analysis of the limited field trial data lead to preliminary conclusions which either "confirm" the general experts' beliefs on UXO presence or go in a counter intuitive direction, as exemplified below. For example, the authors found that:

- The probability to find a generic UXO (p_{GU}) while clearing a piece of land where someone has declared seeing a UXO is 76%.
- The p_{GU} while clearing a piece of land where no one saw a UXO is 53%.

These two statements "confirm" the general experts' belief that an eye witness is important to guide decisions, but interestingly the probabilities are not so dramatically different. The authors also found that:

- The p_{GU} on a parcel of land where an accident has been reported is 38%.
- The p_{GU} where an accident has not been reported is 75%.

This second set says that one has better chances to find UXO on a piece of land where an accident was not reported than where an accident was reported. There will go the "feeling" that if a site has a "history" of accidents, then it is a high priority, if these findings are confirmed!

These examples show that measurable relationships exist between extant data. Models using these relationships, that may sometimes be counter-intuitive, would certainly outperform what has been produced to date and be self-adapting to any ERW, any environment, in any country, leading to a "universal model".

Under the authors' R&D program analyses of the data relationships allowed to derive two pioneering models of the second generation.

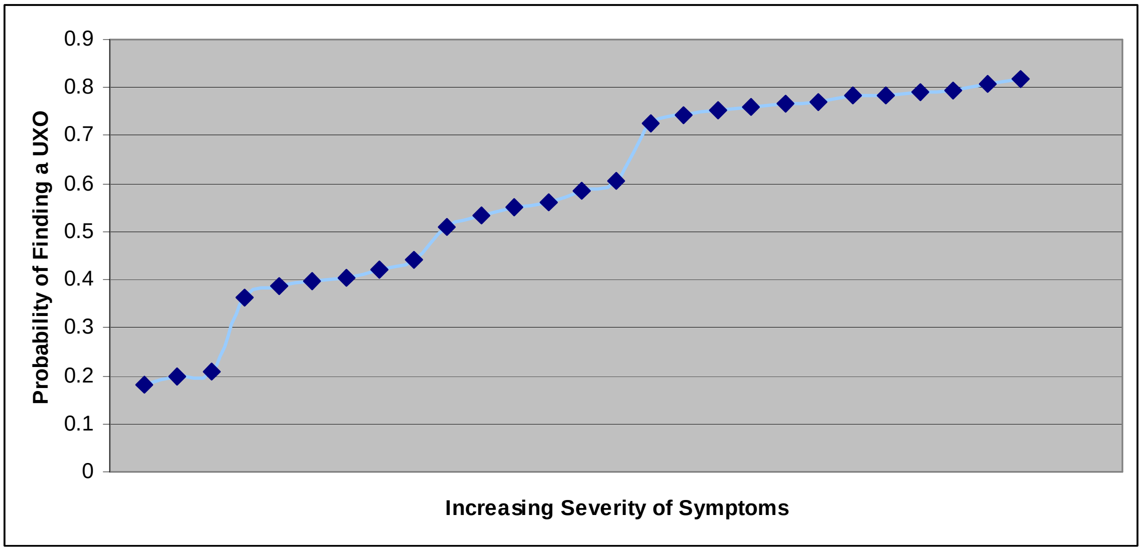

Fig. 2 By analyzing analytically derived data relationships, a function can be defined which leads to a well spread value of the probability of finding a UXO as a function of increasing severity of significant symptoms in a given perimeter. The lower value (i.e. appx. 0.2) means that it is very unlikely to find a UXO, whereas the higher value (i.e. appx. 0.8) means that a positive find is very likely. The spread (rather than a simple Y/N) is key to the ability of prioritizing a wide portfolio of SHAs, and thus to concentrate life saving efforts in areas that actually warrant the commitment of resources.

By obtaining more data, further data analyses can be performed and relationship can be studied, proving or disproving good old “experience based” flair and methodologies based on non-scientific agglomeration of data under the form of tables, flowcharts etc.

The authors of this paper pledge their time for the development of a predictive method for UXO/landmine contamination based on the data that the public/NGOs/other entities will return to them for treatment (contact us via www.riskope.com to receive instruction on formats and data requirements). The results of this endeavor will remain available to all the contributors and will not be the object of any commercial activity by the authors.

If we all work together we will be able to deliver a tool that will save lives by allowing optimum deployment of demining/clearing efforts in entire countries.