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Improving mine detection dogs: an overview of the GICHD dog program

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Abstract

Although dogs have been used for mine detection (MDD) for many years, research on their use has been limited. The GICHD is running a broadly-based programme of research on the use of dogs and other animals for mine detection. The program encompasses other activities, such as operational support for agencies using MDDs, supporting the publication and dissemination of research, and networking. Here, we provide an overview of the programme and comment on its value for humanitarian mine clearance.

1. Introduction

The use of dogs for mine detection has increased dramatically since the first humanitarian mine clearance programme was initiated in Afghanistan in 1989. In 2002, an estimated 750 dogs were at work in 23 countries (GICHD, unpubl.), with the largest programmes being in Afghanistan (nationally run) and Iraq (run by the UN). Despite 15 years of empirical experience with MDD, there is still much that we don't know. This sometimes causes dogs to miss mines and prolongs the time it takes to train dogs and handlers. Poor understanding of the principles and limitations of MDD has in periods put MDD into discredit. Some countries consequently have little fait in MDD while it is more accepted in other countries.

Dogs are used because of their odor skills, and because of their long history of domestication, extending back for about 12,000 years [1]. In essence, we know how to train and work with dogs better than for any other animal, and dogs have been adjusted to service human needs in many different ways. The three special features of dogs (odor skills, trainability and domestication) make them ideally suited to many service roles.

Other animals could and do undertake a detection role. Candidates suggested or already used for detection include bacteria (genetically modified to target the desired substance), Hymenopteran insects (bees, wasps), and a variety of mammals (ferrets, pigs, rats) [1,2]. In principle, any animal with excellent odor skills could serve in a detection role. However, for mine detection, the only animal showing significant promise other than dogs is the African pouched rat (*Cricetomys gambianus*) [3].

The GICHD is running a broad programme designed to investigate many aspects of the use of animals for mine detection work, and to support that use operationally. Here, we present an overview of that research, emphasizing recent results and new initiatives.

2. Program Overview

GICHD launched a study of Mine Dog Detection (MDD) based on a desire to improve overall MDD, define its limitations, and improve its credibility. The initial aim was to develop international standards and guidelines, including conducting the necessary research to understand strengths and limitations. The study has since evolved into something more, as it now provides a platform for cooperation between research and practice. Although dogs are the main focus, elements of it now include rats and chemical vapor detection. More than 20 different activities have so far been completed or

are in progress. These activities can loosely be grouped into nine categories:

- International standards and guidelines
- Training methodology
- Understanding vapor transportation
- Remote Explosive Scent Tracing – REST
- Evaluations and operational support
- Breeds
- Dissemination of information
- Networking
- Other related activities

2.1. Standards

Five MDD standards are now formally approved by the UN as part of the IMAS (International Mine Action standards) package:

- IMAS 09.40 – Guide for the use of MDDs
- IMAS 09.41 – Operational procedures for MDD
- IMAS 09.42 – Operational accreditation of mine dogs
- IMAS 09.43 – Remote Explosive Scent Tracing
- IMAS 09.44 – Guide to medical and general health care of dogs

Initial research results within the GICHD study suggests minor revisions to some of these standards. Revision of the IMAS 09.4 series will consequently be initiated at the end of 2003.

2.2. The Standards Implementation and Support Committee (SISC)

Supported by industry representatives, the GICHD has been asked by the MDD industry to play a facilitating role ensuring that the standards are properly used and understood. A process of training and helping national mine action authorities and demining organisations has been initiated under the rubric SISC. In 2003, Sudan, Croatia, Afghanistan and Bosnia will receive targeted support, although requests for support from other agencies will also be responded to. A similar number of countries and programmes will receive support from the SISC in 2004.

2.3. Training Methodology

Training methodology is beyond doubt the single most controversial topic that the GICHD has attempted to conduct research on. Training organizations tend to treat training as a highly idiosyncratic, and even magical, process, that is difficult or impossible to study or document. There is no doubt that a variety of different training practices exist, and that all even them produce a functionally similar product (a mine detection dog). Here, issues underlying the difficulties of documenting training programs will be reviewed. Earlier attempts to document training programs were not successful, but the GICHD has been asked to formally document the training programme used by NPA in Bosnia in 2003. It is regarded as an exemplary model of what can be achieved in terms of training methodology and facilities. This perception is not simply the view of the GICHD but has been commented upon by other MDD operators within the industry (Fig. 1). We assess that the case study will be of interest to most demining organisations that use mine dogs, non-commercial and commercial. Although the GICHD does not aim to impose a particular methodology onto the global MDD community, the aim is that the case study will become an important practical reference on training methodology for MDD organisations.

Figure 1. NPA instructors from Bosnia teaching Angolan dog handlers how to establish a micro search.

2.4. Vapor Transportation

Environmental and chemical factors strongly influence an animal's capability for scent detection [4].

Dogs may therefore end up being used under environmental conditions that are unfavourable, resulting in reduced effectiveness of detection.

The broad aims of this project are i) to quantify the effects of all known weather related factors that influence mine dog detection and identify other limiting factors, currently not recognised, and ii) to understand the relationship between flux rate, target scent at surface level, and the effects of weather and soil properties on migration of vapor through the soil. Defining the limits of detection will assist in the optimal deployment of animal detector systems and should also improve productivity and safety. The study has been broken down into five modules.

- Historic references on environmental factors
- Vapor sensing guidelines
- Leakage (flux) rate from landmines
- Relationship between influencing factors (computer simulation)
- Scent detection threshold – dogs and rats

Historic references and vapor sensing guidelines have already been completed and are published in GICHD (2003). Leakage rate from various landmine types is currently being measured and a computer model able to predict scent availability is being developed. Knowledge about the first is essential in order to develop the latter.

It has proven too difficult to establish the detection threshold for dogs and rats. A major problem has been that there is no instrument able to measure these low concentrations. Furthermore, animals may have different detection sensitivity depending on the way they have been trained. Test undertaken by the GICHD in collaboration with Sandia National Laboratories nevertheless suggest that dogs in use by 3-4 different demining organisations can detect extremely low concentrations. Comparison between dogs and African Giant Pouched rats showed that the rats were similarly sensitive (Fig. 2).

The GICHD has recently expanded its partnership with Sandia National Laboratory. Two new projects have been designed: one will address flux rate from landmines, the other will enable computerized simulation of the vapor transportation process.

A well-sealed landmine may remain undetected by a dog under perfect conditions simply because no or little scent has been transported to the surface. To determine the availability of vapor at the soil surface, it is necessary to take flux rate (leakage) from landmines into account. It is known that some mines are easier to detect than others, but very little research has been undertaken to determine the flux rate from different landmines. A landmine leakage library could become as valuable to an MDD organisation in the future as technical data about metal content in landmines is for a manual mine clearance organisation today.

Figure 2. Jim Phelan (Sandia) testing odor detection skills of the African Giant Pouched rats (Morogoro, Tanzania).

The GICHD works with Sandia and several demining organisations to determine flux rate from 30 different mine types. Acquisition of sufficient landmine types for flux testing is a challenge for analysis at Sandia National Laboratories. The best landmines for testing are those recently recovered from the field. These landmines have been aged in the local soils and landmine flux tests will more closely mimic actual field situations.

To predict whether detection potential is above or below detection benchmarks for different equipment (including dogs and rats), we must understand the relationship between flux rate, target scent at surface level, and the effects of weather and soil properties on migration of vapor through the soil. Defining the limits of detection will assist in understanding the optimal deployment of animal detector systems, and productivity and safety should also be improved. In order to fully evaluate field performance results, simulation modelling should be performed to estimate the landmine chemical vapor

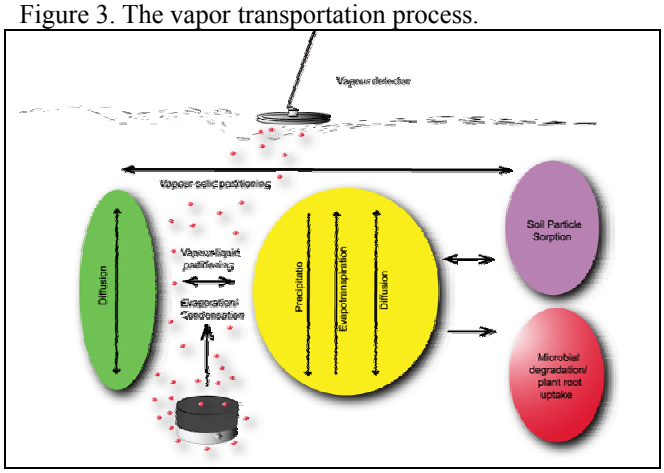
emanations and surface soil residues that might be expected in various daily and seasonal time periods. The simulation model requires appropriate input data including mine source emission rates, soil-water-air partitioning, and the full compliment of weather data. Model improvements may depend on geographical location of the mine dog performance tests (for inclusion of plants), whether surface rainfall runoff is important and whether vapor plume definition is desired (surface soil-atmosphere interface).

Since 1997, work supported by the United States Defence Advanced Research Projects Agency, Electronic Dog's Nose Project, investigated many aspects of environmental processes, including laboratory and field results of chemical transport in soils from buried landmines (Fig. 3). As part of this effort, the computer code T2TNT [5] was developed by Sandia National Laboratory to simulate the chemical movement from landmines including the impact of environmental conditions such as wind, rain, and temperature. The effect of weather cycles on the surface flux of various chemicals has been demonstrated by Webb and Phelan (2000), which indicated orders of magnitude variation in short time periods due to wetting and drying cycles. The GICHD has expanded the project to involve additional T2TNT simulations. There are two separate tasks. The first is analysis of environmental factors for three different locales. In addition, Sandia will use the mine flux data for three different mine types being obtained at Sandia in order to try to assess the difference in chemical signature between different mine types. The second task is further evaluation of the predictive capability of T2TNT.

The T2TNT model is being developed for use in support of humanitarian demining worldwide. However, users of this tool require special training to understand data input requirements and interpretation of results. While T2TNT is not currently available for widespread use, it is intended for a broader users group when desired. This would provide dual benefit in increasing the analysis capability worldwide for chemical sensing for buried landmines, and to provide feedback for improvements needed in this simulation tool.

Results from these two projects are expected in 2003.

Figure 3. The vapor transportation process.



2.5. Information

The GICHD has recently released a bibliographic CD summarizing about 300 articles on detection issues and dog behavior. The CD will be updated regularly. The bibliography can also be downloaded at www.gichd.ch.

There will be an ongoing focus on dissemination of research products to the MDD community. As research chapters are completed, publications will be made and distributed. However, research reports alone may not be the best way to disseminate information. Complex issues, such as the vapor transportation process or training methodology, are hard to explain in writing in a way that is clear to operational staff. For some, it may be difficult to relate written information to field or training situations. It is therefore important to use a variety of presentation approaches. Video films, as a supplement to written reports, should increase the understanding of facts and recommendations from research, and could additionally stimulate use of research reports as reference material.

The Centre is currently preparing a series of 4 videos (each about 30 mins) as a pilot project, three of which describe issues within the animal detection research program, and one reviews the Mechanical project (see Griffiths *et al*., this volume). Filming has taken place in Bosnia, Croatia, Cambodia, Afghanistan, Tanzania, South Africa, Angola and Norway. The final product will be completed in late 2003. The three videos on animals summarize issues described in more detail in [5].

The GICHD continues to regularly produce reports on

many topics. The full list is available at www.gichd.ch.

2.6. Environmental influences on detection

Research projects are underway in Afghanistan and Bosnia which use dogs searching in test minefields to investigate the conditions under which dogs might miss mines. Trials are conducted at different times of the operational year (to cover normal weather variation). During each trial, a full video record is kept of the searching dog and weather parameters are recorded each time a mine is encountered. Soil samples are taken from over the mine and tested for the availability of explosive molecules in a chemistry laboratory.

The combination of data (dog search behaviour, availability of explosive molecules, weather) from two very different locations will provide a significantly improved understanding of the conditions under which dogs might miss mines or give false indications.

2.7. Remote Explosive Scent Tracing

Despite its potential, REST cannot yet claim to have a significant impact on the global demining process. In early 2003, just four organisations had capacity for mine detection using REST. Two of these are research centers and have never undertaken operational demining, although they may do so in the future. Of the other two, Mechem is using its REST capacity to support a research contract, and NPA is rebuilding its capacity after the program had difficulties in 2002. REST does, however, have considerable potential for area reduction if the technology can be properly proven and implemented. In essence, the minefield is brought to the detector (a dog or rat) on a filter (Fig. 4).

Issues underlying the development and implementation of REST were reviewed at a workshop in February 2003 [7]. The details are described by McLean *et al.* in this volume.

2.8. Evaluation and Operational Support

The GICHD is regularly requested by governments, mine action authorities, demining organisations and donors to assist mine dog detection programmes in a consultancy role. Almost all such requests are accepted. Every review has different objectives, but the primary role of the GICHD in each case is to focus on improving operations. Operational MDD support provided by GICHD has involved evaluations of, and support to, NPA in Bosnia, Angola and Mozambique; help to CMAC by evaluating the mine dog detection programme in Cambodia and advice on how to institutionalise this capacity within CMAC; help to APOPO by evaluating their rat detection programme and giving advice on how to improve their operational concept; and general advice to a number of demining organisations. Evaluations and operational support has also been given to several UN programmes and victim state governments, including Angola and Croatia.

Figure 4. A Labrador Retriever analyzing filter cartridges in Southern Angola.

2.9. The Operations Study

This study is designed to document the details of MDD operations in the field. Essentially a time and motion study, it provides a quantitative documentation of the daily cycle of activities of the MDD teams. Such an analysis allows the organization to assess and adjust the details of its operations, including fine tuning for improved efficiency. Comparison between programs is possible because a similar methodology is used in each case study, and allows assessment of the benefits and

costs of alternative operational styles. Three case studies have been completed to date, and three more are planned. Countries where operations studies have been undertaken are:

- Afghanistan
- Cambodia
- Bosnia

Some of the results from studies in these countries show surprising dependencies between speed and applied procedures, dependencies that the demining organisations themselves had not observed or recognised.

2.10. Breed Options

A significant issue for the mine dog industry has been to identify dogs that are suitable for mine dog detection. A range of different criteria affect the suitability of a dog and these criteria may vary dependent on the type of work and the climate in which the dog will work. Most MDDs are German shepherds and Belgian malinois, with a scattering of other breeds. An analysis of the suitability of these and other breeds was completed in 2001 [1]. The report concludes that there are potentially four routes to "producing" a mine dog. The advantages and disadvantages for each of these four routes were discussed. 11 different breeds were examined during this process and their strengths and weaknesses were scaled using 14 different property indicators. The analysis may encourage training and demining organisations to use alternative breeds than the ones typically used. One radically alternative breed (the Swedish drever, Fig. 5) was suggested for trial. So far, 8 drevers have been donated to MDD organizations for training as MDDs. Preliminary results are mixed because of socialization difficulties, but some of the dogs are showing considerable promise.

2.11. Other Activities

Other activities within the framework of the MDD study include networking (as a consequence of GICHD sponsored meetings), introduction of weather recording in MDD operations, publication of studies conducted by demining organisations (such as the socialization report by the MDC-South Africa), and improving the quality of research conducted by the industry.

Figure 5. The Swedish drever. Preliminary feedback from organisations training the drever suggest good training progress, which has caused a stronger interest among other MDD organisations. 8-10 additional drevers will thus be purchased by the GICHD and given to various demining organisations in 2003 and 2004. In return, these organisations are obliged to share experience from the training of drevers.

It is generally understood that the environment significantly impacts the availability of vapor at surface level. We now have a fair understanding of which environmental factors have strongest influence and the correlation between influencing factors. Key when defining limitations of vapor detection and the use of dogs, is the ability to measure climatic effects.

The use of weather stations have traditionally been limited within the MDD community. The GICHD has thus purchased weather stations and given them to MDD organisations involved in research and operational activities. The aim has been to encourage the use of these stations, learn more about their effect and be able to record weather data during research. Weather stations have been purchased by the GICHD and distributed to programmes in:

- Mozambique
- Angola
- Bosnia
- Afghanistan
- Somaliland

- Tanzania

Empirical experience suggests that too little attention has been paid by demining organisations in the past to follow up and socialize puppies from young age. A lack of sound socialisation has made many potential mine dogs unsuited for training and this becomes a problem when knowing how difficult it is to find potentially suitable MDD dogs. Mine Dog Centre (MDC) in South Africa thus decided to purchase young puppies and run them through a puppy socialisation programme. This has resulted in fewer dogs failing the training and a much easier dog selection process. The puppy socialisation program of MDC is described in [8].

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