Vapour sensing using dogs in Bosnia: a test of detection capability

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Abstract

We report results of a pilot study designed to investigate the possibility that REST (Remote Explosive Scent Tracing) technology could be used to find mines in Bosnia. The find rate for mines on 88 filters was 68%. Detection success was linked to humidity and temperature at the time of sampling, and to location within Bosnia. Detection success was not linked to when the filter passed across the mine during the sampling period, or how long the filter was held over the mine. Two mines were found at similar rates (PMA3, TMA4). Success was lower for a third type (TMM1) but N was small for this mine. REST clearly can find mines in Bosnia, but the sampling and detection technology need careful tuning if detection success is to achieve acceptable operational levels.

1. Introduction

Remote Explosive Scent Tracing (REST) involves the concept of transferring a target odour to an animal detector, using a filter (see McLean *et al.* this volume, and [1]). The vapour sample is made at the suspect site by vacuuming air through the filter. Testing of the filter by the detector is undertaken in a laboratory environment, and involves a number of internal controls to ensure reliability.

REST was originally conceived by Mechem in South Africa, and was used operationally for mine detection through the early to mid-1990s. Unfortunately, little documentation of the original research on its development is available. Despite its apparent success as an efficient technology for area reduction, it was not embraced by the mine clearance industry. Mechem has always maintained a small capacity for REST detection (called MEDDS, Mechem Explosive and Drug Detection System), and the technology has been developed by a small number of other agencies, with varying success and capacity. Several agencies in Europe are trialing it for applications other than mine detection.

The GICHD has initiated a broadly-based program of research on mine detection animals (see Bach *et al.* this volume), of which further developing the potential of REST technology is a primary objective.

Here, we review a pilot study designed to determine whether REST technology can be used for effective area reduction in Bosnia-Herzegovina. Due to cool temperatures, heavy soils and wet summers, it is believed by mine clearance operators that mine detection by field dogs is relatively difficult in Bosnia, compared to countries with dryer climates and sandy soils [2]. As field dogs and REST technology both depend on the availability of explosive vapours in the minefield, it seems likely that similar difficulties will apply to the use of REST in Bosnia.

We used the pilot study to also investigate a number of related factors that potentially influence the detectability of mines on filters.

2. Research Design

The study used test minefields previously established by NPA (Norwegian Peoples Aid) near Sarajevo and Mostar. Thus all mines used had been in the ground for long periods (up to several years). The fields were established in grazing land or on sites subject to a variety of historical disturbances typical of the perimeter of a city, such as contamination from garbage and other industrial wastes.

Except for treatment variables, all aspects of sampling were standardized. The sampler operated a petrol-powered pump connected to a 1.5 m tube that was passed back and forth over the ground (see McLean *et al.*, this volume). The filter was placed in the end of the tube, and all vacuumed air passed through the filter (or filters if two were being produced at one time). The sampling team consisted of two people who alternated the roles of operating the pump, and maintaining records and assigning filters.

Factors to be studied were:

- When the machine encountered the mine (start, middle, end of the 60 sec sampling period)
- Total time filter was held over the mine (pass only, 1 sec, 2 sec, 5 sec)
- Weather variation (recorded at the time of sampling)
- Type of mine sampled (three).

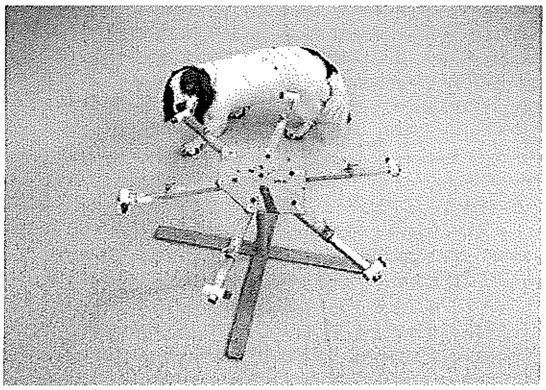
Factors to be held constant were:

- Total sampling time (60 secs)
- Sampling vacuum rate (60 litres/sec passing through the filter)
- Depth at which mine was laid (within 10 cm of surface)
- Equipment (small petrol-drive vacuum machine, and the Mechem filter)
- Sampling procedure (operator walks slowly forward passing the vacuum nozzle back and forth across the ground)
- Number of mines sampled onto one filter (one)
- Testing (all filters tested with 4 dogs)

The sampling procedure involved the operator using a mine on the edge of the test field and walking either towards or away from the mine, in order to encounter it at the required sector of the 60 sec sampling interval (beginning, middle, end). Weather factors recorded at the time of sampling were temperature and humidity at breast height. The temperature gauge was not shaded. All sampling was done in light winds or calm conditions, and at least 24 hours after heavy rain.

Two measures for probability of detection were available: i) the proportion of "positive" filters that were detected, and ii) the proportion of dogs that detected each "positive" filter. Each dog was given one opportunity to detect a filter, although on some runs it could pass the filter twice because of the circular array presentation (Fig. 1). Most presented analyses use values from the second, more sensitive, measure.

Figure 1. Circular array presentation of filters. Dogs were trained to circle the array once, but some overlap at start and end of the circle sometimes occurred. During testing, the array presented 12 filters



Details of the testing procedure are described in [1]. The dogs were given no assistance during testing trials as personnel in the testing room stand behind blinds while testing is underway. All testing used three personnel: a dog handler, a recorder, and a technician who dealt with the filters. All personnel worked in each role at different times. The dog handler and recorder were blind for the origin of each filter, and the technician (who assigned filters) left the room during testing. However, the technician was also blind because no information on the sampling identity of each filter was provided from Bosnia until all testing was completed.

It was assumed that all of the four dogs were working at equivalent detection sensitivity and capability. Internal checks using known positives and negatives tested for reliability. A "miss" is a filter that is supposed to be positive, but which is not indicated by the dog. A "false alert" is a filter that is supposed to be negative, but is indicated by the dog as positive.

3. Results

Overall, 60 of 88 positive filters were found (68%). Detection was significantly more successful for filters from Mostar (72%) than Sarajevo (53%) (X^2=5.25, P=0.02; data lumped for number of dogs finding the positive filter; Table 1). Temperatures at time of sampling were generally higher at Mostar than at Sarajevo (see below).

Table 1. Number of positive filters found by 4 dogs at two locations in Bosnia. "0" dogs means that the filter was missed by all dogs.

No Dogs	0	1	2	3	4
Mostar	13	3	10	12	8
Sarajevo	15	5	10	0	2

No significant effects were found for:

- Position in the 60 sec sampling period (beginning, middle, end; X^2_5=0.79)
- Whether the sampling nozzle passed over, or paused over, the mine (pass, 1, 2, 5 sec; X^2=0.07; 1, 2 and 5 lumped for this analysis)
- Type of mine (PMA3, TMA4, TMM1; Table 2). The find rate for TMM1mines was lower than for the other two types, but N was small, and TMM1 mines were only sampled at Sarajevo where the find rate was lower.

Table 2. Number of positive filters found in relation to type of mine by 4 dogs.

No Dogs	0	1	2	3	4
PMA3	10	3	6	8	9
TMA4	12	4	13	4	11
TMM1	6	1	1	0	0

Significant effects were found for humidity (detection success was higher when humidity was lower, $R^2 = 0.145$, $F_{1,82}$ = 13.9, P=0.0004; Fig. 2) and for temperature (detection success was higher at higher temperatures, R^2 = 0.061, $F_{1,82}$ = 5.7, P=0.02; Fig. 3). Temperature and humidity are correlated variables (humidity declines as temperature increases, Fig. 4), thus these two effects are likely to be linked. The effect of humidity was stronger than the effect of temperature, and the effect of temperature did not add significantly to the effect of humidity (multiple regression analysis, NS). The effect of temperature appeared to be attributable to low detection success at temperatures below 15°C and it is likely that the effect reflects a threshold rather than a trend.

Figure 2. Relationship between number of dogs finding a positive filter and humidity. Each point represents one filter, and humidity was recorded at time of sampling.

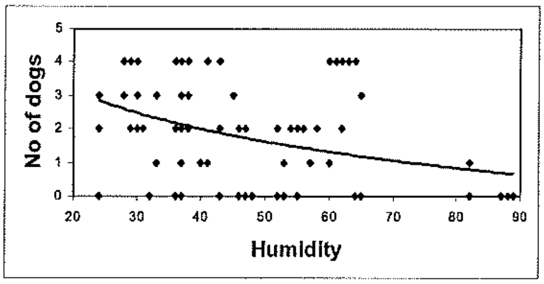


Figure 3. Relationship between number of dogs finding a positive filter and temperature. Each point represents one filter and temperature was recorded at time of sampling.

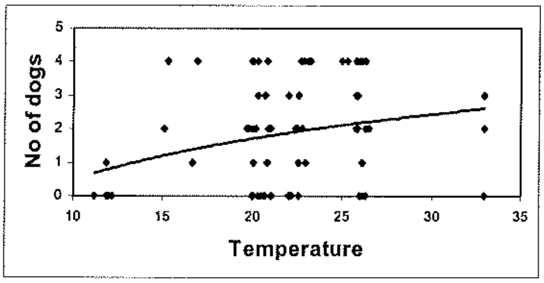
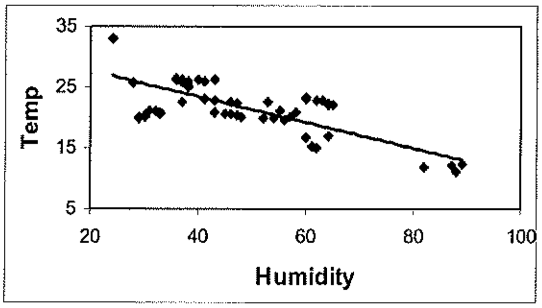


Figure 4. Relationship between humidity and temperature in Bosnia. Data are for the times at which filter samples were made.



4. Discussion

Although this was a pilot study, we conclude that the REST concept can be used to find mines in Bosnia, or more specifically, it can be used to find REST filters made over mines in Bosnia. Issues of detection success and reliability require further research.

The sampling technology was robust with respect to the details studied here, as no effects on detection success were found for: moment of time in the sampling period when mine is encountered, length of encounter with mine, and type of mine. TMM1 mines are known to be difficult for dogs to find, but the N's for this mine were small in this study and all were located in the area where detection success was lower overall (Sarajevo). Thus it is premature to draw any conclusions about this mine type.

Clearly, there needs to be further tuning of the sampling process, particularly in relation to the effects of humidity. The effects of temperature may be less important, although operational field experiences [2] combined with evidence from this study suggest that there is a minimum temperature below which sampling should not occur. For the moment, that temperature should be set at 15°C, although clearly more data are needed at lower temperatures before this is treated as a definitive value. NPA field dogs work at lower temperatures than 15 C, although it is known that detection becomes more difficult at these lower temperatures, and dogs are worked very slowly. Field dogs do not work at the highest temperatures at which sampling was undertaken here, so can give no insight into the possibility that there is an upper limit above which detection success declines.

Further tuning of the detection process is also clearly required, as detection success here was considerably lower than is necessary for operational use of REST technology. In this study, 4 dogs were used, and the probability of detection by those dogs varied. For the moment, the cause of that variation is not understood. Certainly, an important requirement is to tune the dogs on prepared filters from the operational sites before detection begins, and there was only limited opportunity to undertake such tuning for this study. Any operational use of REST technology incorporates the assumption that all detectors (in this case, dogs) are working equally effectively. This assumption is unrealistic, and there is a need to investigate whether variation in detection success is a random factor (implying that larger numbers of detectors will give a higher probability of detection), or is correlated (implying that larger numbers of detectors will not improve detection rate).

Experiences from the few organizations training REST detectors suggest that training takes between 6 and 12 months. The two species currently in training (dogs, rats *Cricetomys gambianus* [3]) both appear to require similar amounts of time to train. However, it is also clear that considerable work needs to be invested in tuning the detector in order to obtain high levels of detection success, once the detector is operational. At the end of training, the dogs used in this study were giving detection success of about 95% [4], suggesting that the success rate in this study could be considerably improved. Further attention to the problem of fine tuning the detection process is clearly required.

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5. References

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