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Mine Detection Rats | APOPO: Efficiency and Effectiveness Study Using MDR Capability

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Geneva International Centre for Humanitarian Demining (GICHD)

Anti-Persoonsmijnen Ontmijnende Product Ontwikkeling
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MINE DETECTION RATS | APOPO

Efficiency and Effectiveness Study using MDR capability

As the laboratory rat is one of the most widely studied animals, the abundance of research on its olfactory capabilities is not surprising. However, very little information can be found on their landmine detection abilities. Consequently, in late 2015, GICHD conducted a study of APOPO's Mine Detection Rat (MDR) programs in Angola, Mozambique and Cambodia. The aim of the study was to focus on the operational efficiency and effectiveness of the MDR, as well as to determine compliance with the International Mine Action Standards (IMAS). Within the sector, MDR suffer from a cynical perception of scent detection as a result of the inaccurate and unfair reputation of mine detection dogs (MDD) in the early days of mine action. General skepticism towards MDD was a result of programs that had failed in their use. However, the capability of the management to implement MDD operations within these programs was never questioned and consequently, the dogs were unfairly held responsible for the overall program failures.

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APOPO

APOPO is a Flemish acronym for Anti-Persoonsmijnen Ontmijnende Product Ontwikkeling: *("Anti-Personnel Landmine Product Development" in English).* APOPO is a social enterprise that researches, develops and implements detection rats technology for humanitarian purposes such as mines/ERW and Tuberculosis detection. APOPO is a Belgian NGO, with headquarters in Tanzania and mine action operations in Mozambique, Angola, Zimbabwe and Cambodia.

The initial research as to the feasibility of using rats as a means of detecting landmines was carried out in Belgium in 1998. In 2000, APOPO moved its headquarters to Morogoro, Tanzania, following partnerships with the Sokoine University of Agriculture (SUA) and the Tanzanian military. APOPO has found that the African Giant Pouched Rat *(Cricetomys gambianus)* is the best species of rat to use for detection tasks due to their longevity, with a life span up to eight years, resistance to tropical diseases, calm nature and ease of training.

Geneva International Centre for Humanitarian Demining (GICHD)

In a world where human security is still hindered by explosive hazards, the Geneva International Centre for Humanitarian Demining (GICHD) works to eliminate mines, cluster munitions and other explosive remnants of war. To achieve this, the GICHD supports national authorities, international organisations and civil society in their efforts to improve the relevance and performance of mine action. Core activities include furthering knowledge, promoting norms and standards, and developing in-country and international capacity. This support covers all aspects of mine action: strategic, managerial, operational and institutional. The GICHD also contributes to the implementation of the Anti-Personnel Mine Ban Convention (APMBC), the Convention on Cluster Munitions (CCM) and other relevant instruments of international law. The GICHD follows the humanitarian principles of humanity, impartiality, neutrality and independence.

The GICHD also works for mine action that is not delivered in isolation, but as part of a broader human security framework; this effort is facilitated by the GICHD's new location within the Maison de la Paix building in Geneva. Created in 1998, the GICHD has more than 50 members of staff from many countries and receives funding from around 20 governments and organisations. It visits around 60 countries per year, while working very closely with partner organisations to achieve its goals. The GICHD stays flexible in its response to needs and to changes in its working context.

Introduction

"Without data, you're just another person with an opinion."

W. Edwards Deming

There is an emergent consensus that an excessive use of clearance resources in areas that don't contain mines/ERW represents a considerable ineffectiveness rather than justifiable prudence. Admittedly, the mine/ERW contamination in a number of countries consists of low density, irregular contamination difficult to accurately identify and define. As a consequence, some countries aim to end large scale survey and clearance operations in areas where a high proportion of the remaining sites have a low probability of actually containing hazards. To address such challenges, the mine action sector requires enhanced allocation of clearance resources and in particular improved technical survey techniques and methods for land release (in the context of mine action, the term land release describes the process of applying all reasonable effort to identify, define, and remove all presence and suspicion of mines/ERW through non-technical survey, technical survey and/or clearance). Tens of millions of dollars have been invested in survey since 2009. It can be argued that from an efficiency/effectiveness point of view, the overall results have not matched the expectations. This is a cause for concern and continues to be the single biggest obstacle to faster

and better aimed mine clearance. The ability to establish a clear baseline of the remaining mines/ERW contamination, the time and resources needed to deal with it, fundamental to the eradication of this global threat, remains a considerable challenge to the sector as a whole.

Executive Summary

As the laboratory rat is one of the most widely studied animals, the abundance of available research material on its olfactory capabilities is not surprising. However, very little information can be found on their mine/ERW detection abilities. Consequently, in late 2015, GICHD conducted a study of APOPO's Mine Detection Rat (MDR) programs in Angola, Mozambique and Cambodia. The aim of the study was to focus on the operational efficiency and effectiveness of the MDR, as well as to determine compliance with the International Mine Action Standards (IMAS). Within the sector, MDR suffer from a negative perception of scent detection as a result of the inaccurate and unfairly poor reputation of mine detection dogs (MDD) in the early days of mine action. General scepticism towards MDD was a result of programs that had failed in their use. However, the capability of the management to implement MDD operations within these programs was never questioned and consequently, the dogs were incorrectly held responsible for the overall program failures.

APOPO has been using MDR in operations since 2004 when they were first tested in accordance with IMAS, in Mozambique under the supervision by the National Institute for Demining (IND) and GICHD. The MDR are used primarily in technical survey where their role is to confirm the presence or absence of mines/ERW, providing important additional evidence of the mine/ERW threat level in specific areas within a SHA/CHA.

The results from the GICHD study indicates that the MDR are able to both very efficiently and effectively locate mines/ERW. On average, one MDR is ten times more productive than a deminer and a MDR team is as productive as a MDD team, but with a potential for considerable cost savings. The success rate for MDR on formal testing and accreditation, as per IMAS, is the same as for MDD. On average, more than 85% of MDR pass the test on the first attempt. Another important advantage of the MDR is their independence from a personal trainer/handler. Generally, most MDR remain with the same trainer/handler, but show no difference in performance when taken over by other trained staff. One handler team, consisting of two people, could thus easily operate ten MDR consecutively. Hence, the MDR system can be a cost-efficient option capable of increasing productivity.

MDR Search Methods

The two search methods that APOPO applies are the pole method (one rat and one handler) or the rope method (one rat and two handlers). Although both methods are equally effective, the most suitable method depends on a number of factors. All APOPO rats and handlers are trained and tested on both methods.

The pole method (one rat and one handler) is typically used when a ground preparation machine to cut vegetation is not suitable or cannot gain access to the minefield site. In this instance, manual deminers will cut the vegetation with hand-tools, or motorized hand-held grass cutters. This manual vegetation cutting is carried out in half meter increments across the front of the area to be searched and facilitates a linear search of the ground by the rat, using the pole method. The pole method is where a handler directs a rat that is harnessed and attached to a long light-weight pole by a short cable and searches a specific area of ground. If the rat indicates on a potential mine/ERW, the indication is marked and a manual deminer will check the indication with a metal detector. Once this half meter front has been searched and all indications checked, the baseline can then be moved forward and the process commenced again. The process is continuously applied until the entire area that needs to be searched is completed.

Pole Method

The rope method (one rat and two handlers) is typically used where a ground preparation machine can be deployed for vegetation removal (grass and light bushes). After the vegetation has been cut, manual deminers then clear 1m wide safe lanes and create 10m x 20m boxes. This allows the handlers to stand in a safe area on either side of a 10m x 20m contaminated box. The two handlers are joined by a light rope and the rat is attached to the rope by a harness and a short cable. The rat then moves from one handler to the other searching the ground as it is walking from one side of the box to the other. Once the rat has reached the other side of the box, both handlers take a sideways step in the same direction and the rat is sent back to the other handler, searching the ground in between.

Rope Method

If the rat indicates, the location is marked and the search continues until the entire 10m x 20m box has been searched. All indications are then investigated by a manual deminer with a metal detector to locate the potential mines/ERW.

APOPO MDR Programs

Mine Detection Rats (MDR) have been instrumental in increasing operational output in APOPO's mine action programme in Mozambique as well as in APOPO's partnership programme with Norwegian People's Aid in Angola and the Cambodian Mine Action Centre in Cambodia. The MDR play their most important role in technical survey (TS), reducing suspected areas that will receive follow-on clearance by manual deminers. The strength of the MDR is that they are able to quickly confirm the presence or absence of a mine/ERW threat within a Suspect Hazardous Area (SHA) or Confirmed Hazardous Area (CHA) when deployed as part of an integrated capacity. The work of the MDR consequently reduces the effort needed by manual deminers, which accelerates productivity and reduces the time needed to release a CHA. Because of the achievements of the

MDR in Mozambique and Angola, APOPO deployed MDR for the first time outside of Africa, in Cambodia, May 2015.

The MDR are bred and trained at the APOPO training centre in Morogoro, Tanzania. Each MDR undergoes intensive training and is then tested in accordance with IMAS chapter 09.42 – Operational Testing of MDD and Handlers, before it is deployed operationally to a mine/ERW affected country. The rats start their training once they are six weeks old and the entire process normally takes up to nine months to complete. During the training they are gradually conditioned to associate the smell of explosive vapour with food, which serves as their motivation and reward.

Once the MDR arrive in-country they undergo a period of acclimatization and calibration where they are also partnered with their respective handlers and placed in teams. Each MDR is then subjected to external accreditation testing by the respective national mine action authority. All MDR once again undergo the testing and accreditation criteria as detailed in IMAS chapter 09.42 – Operational Testing of MDD and Handlers as well as the respective National Mine Action Standard (NMAS). Each MDR needs to pass this accreditation test before it is permitted to deploy in SHAs/CHAs.

APOPO's methodology focuses on the principles of Land Release, with high-quality non-technical survey (NTS) followed by TS using MDR where possible. This methodology minimizes the manual clearance effort which is comparatively slow and more expensive. A high-quality NTS is the first step in defining a SHA and determining the appropriate level of response. Failing to conduct a proper NTS typically results in exaggerated estimates and subsequent clearance of vast mine/ERW-free areas wasting time and resources. Following NTS, the next step is to conduct TS to identify the actual mine/ERW-contaminated area to ensure that only these undergo full clearance in line with direct evidence found.

Tanzania

APOPO's Training Centre, situated at Sokoine University of Agriculture (SUA) in Tanzania, was established in 2000 to initially accommodate training and testing of mine detection rats in simulated conditions and was subsequently expanded in 2003 to include the training of rats for the detection of tuberculosis. The MDR training facilities at SUA comprise 24 hectares of test minefields with over 1,500 deactivated buried landmines. The nearby headquarters houses research and training rooms, laboratory and sample preparation areas, kennels, outdoor play and breeding enclosures, a data processing room and office space. The Centre trains indigenous rats as a solution for nearby countries affected by mines/ERW. Today, APOPO breeds and trains all of the MDR at the headquarters and training field, and then deploys them to country programs for operational work. In addition to training, APOPO carries out research to optimize the training process. This is mainly behavioural research which addresses training issues, but also analytical chemistry which supports the olfactory component of the detection process. Research is also conducted to optimize breeding conditions and learn more about the ecology of the Giant African Pouched Rat. APOPO has been heavily involved in scent detection research, much of which also applies to dog training.

Mozambique

APOPO's mine action programme in Mozambique started in 2004 and has helped rid five provinces from landmines and ERW. The MDR have been a key part of the integrated effort that included manual deminers and machines. In October 2008, the National Institute of Demining (IND) tasked APOPO as sole operator to clear all known mined areas in Gaza Province (one of the most heavily contaminated in the country) with a deadline of March 2014. Through their combined efforts the integrated APOPO teams completed this task on December 2012, more than one year earlier than expected. On the 17th of September 2015, at a ceremony in Maputo, His Excellency, Minister Oldemiro Júlio Margues Baloi, Minister of Foreign Affairs, declared the country 'Free of all known mined areas'.

Data from APOPO shows that when using MDR in combination with mechanical and manual assets time savings up to 45% were achieved. This was compared to areas when only manual and mechanical assets were deployed.

Case Study - Mozambique

Introduction

This case study considers the experiences and lessons learned from releasing 44 power-line towers located in Mozambique's southern province of Maputo. APOPO worked on this task during the course of 2013 and 2014 with MDR teams deployed alongside traditional manual and mechanical teams. APOPO's overall finding is that the MDR played an important role in accelerating clearance operations resulting in significant time and cost savings. Deploying the MDR allowed other capacities (manual and mechanical) to target other high priority task areas, thereby increasing overall programme productivity.

Task Background

In 2013 Mozambique's national demining authority, the National Institute of Demining (IND), tasked APOPO to clear key power-line infrastructure in the southern province of Maputo. Serving southern Mozambique and neighbouring South Africa with energy, the Maputo Power-line towers were mined to protect the infrastructure from sabotage during Mozambique's civil war from 1977-1992.

Non-Technical Survey Results

In line with non-technical survey (NTS) results, and in close coordination with Mozambique's national mine action authority, the IND, the clearance plan for each power-line tower consisted of clearing a polygon of 80 metres by 80 metres around the base of each tower to a depth of 13 centimetres for a total confirmed hazardous area (CHA) of 6,400 metres square for each tower. With 44 pylon towers to complete, compliance with this clearance plan set a high burden of effort and demanded a time and resource intensive intervention.

Operational Approach and Results

Based on NTS findings, APOPO deployed an inside-out clearance/survey approach. Therefore, manual deminers were deployed to work close to the base of the pylon (as shown in the maps below, Figures 1 and 2) where there was a high probability of finding landmines. A tiller was deployed outside of this clearance area and followed up by MDR that were deployed to search boxes further from the base where there was less probability of landmines.

Figure 1

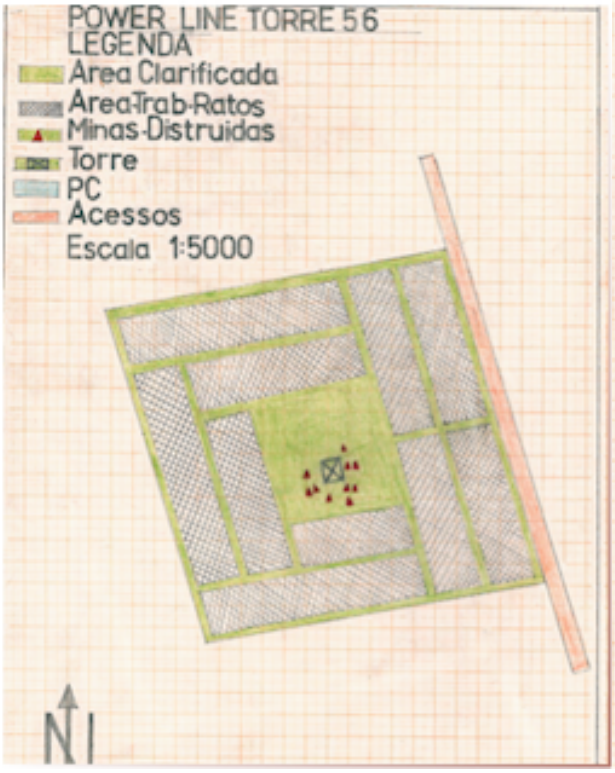

Figure 2

In Figure 1 above, as part of the implementation plan for the Maputo Pylon task, manual deminers were required to clear an 80m x 80m box around each of the 44 pylons as this area was considered to have a high probability of landmines - this is depicted in the sketch by the solid green box. On the remaining area outside the solid green box, a tiller was used and then it was searched by 1 MDR and released through TS - shaded boxed areas.

In Figure 2, the scenario initially followed the same approach as Figure 1, however because the MDR detected landmines outside the expected mined area, the area cleared by manual deminers was subsequently expanded and more landmines were then found further out from the base of the pylon.

In both examples, manual deminers supported the MDR teams by creating safe lanes from which the MDR handlers worked using the two-handler rope system (pictured below). When an indication from an MDR located a landmine, landmine fragment or piece of explosives then follow-on manual clearance was expanded around the target to form the appropriate buffer zone. In some instances, where a hazardous item was encountered close to the boundary of the planned polygon, the buffer was extended resulting in a larger cleared area.

APOPO approached each tower as a unique task with an initial clearance size of 6,400 metres square, resulting in 44 very small individual tasks requiring effective planning and logistics due to safety distances and space considerations. The small size of each task (tower) negatively affected the productivity of both manual and MDR teams. APOPO found it necessary to split manual teams across two pylons to maintain adequate safety distances resulting in additional movement from site to site. In addition, the full MDR team could not be deployed at full capacity due to safety distance constraints.

Additional operational considerations for this task included:

- The inconsistent nature of each tower including the terrain (e.g. hard, rocky soil) and the indiscriminate landmine-laying pattern;

- Inadequate detector performance by some brands/models due to the combination of highly ironized, metallic soil and electro-magnetic interference from the power-line itself;

- The threat of minimum metal landmines rendering some detector brands ineffective.

The factors described above greatly affected the manual demining performance, however had no adverse effect on the performance of the MDR as they were unaffected by soil type, the landmine metal content or the electro-magnetic influence of the power-lines.

Figure 3. ***MDR operations with rope system after a tiller, Maputo Power-line Task, Maputo Mozambique***

In total, 306,244 square metres of land was released, of which 213,885 square metres was searched by the manual demining teams (full clearance) and 92,359 square metres processed by tiller and searched by the MDR teams (technical survey) with 556 landmines and 37 items of UXO safely located and destroyed.

Results

The Maputo Power-line task was quite restrictive in that APOPO were constrained to conducting an 80m x 80m full clearance approach around each pylon. This could only be conducted by manual deminers. Therefore, the MDR were limited to conducting TS outside of this 6,400 sqm polygon. Ideally in a normal scenario there would be much more TS conducted with the MDR. Despite the limited use of TS in this particular task, the MDR were still able to increase the overall productivity, as illustrated in the table below.

The table below illustrates the total actual results for the 44 towers APOPO were tasked to release along the Maputo power-line task using manual deminers & machines integrated with MDR. The table also highlights a hypothetical scenario if this same task was conducted without the MDR.

MOZAMBIQUE		
	Actual - manual **with MDR**	Hypothetical - manual **without MDR**
Total m^2 cleared	306,244	306,244
Total m^2 manual	213,885	306,244
Average monthly m^2/manual	16,453	16,453
Total m^2 MDR*	92,359	N/A
Average monthly m^2/MDR*	9,236	N/A
Total months to complete the task:	**13**	**18.6**
Total cost manual	€332,250	€475,360
Monthly cost manual	€25,557	€25,557
Total cost MDR	€53,007	N/A
Monthly cost MDR	€5,300	N/A
Total cost of the project	**€385,257**	**€475,360**
Months saved with MDR	**5.6 months**	
Additional cost without MDR	**€90,103**	

* The MDR were deployed for a total of 10 months to this task.

Given the recent declaration by the Mozambique government of compliance with the Ottawa Treaty Article 5, APOPO now remains in the country at the request of the IND. This is, to continue providing technical expertise and support capacity for any residual or remaining battle area clearance (BAC) work for unexploded ordnance (UXO) such as the former ammunition depot in Malhazine that exploded in 2007 killing over 100 people. The MDR in Mozambique have been adapted from a landmine detection approach to a BAC approach, with 16 MDR supporting the BAC operations on the Malhazine task.

Angola

Since 2012, APOPO has been supporting its partner Norwegian People´s Aid (NPA) with 31 MDR as an integral part of an integrated system applying the whole “operational tool box”. The operations in Angola includes technical survey and clearance. The joint effort by APOPO and NPA aims at combining the strengths of both organisations for increased cost efficiency and accelerated results. As in Mozambique, data shows that productivity was increased when using MDR integrated with manual assets. For Angola, the integrated MDR approach created time and effort savings of up to 50% when compared to if only manual assets were deployed.

Case Study Angola

Introduction

This case study illustrates the benefit of integrating manual deminers, machines and MDR within a minefield in Zaire Province, Angola. As detailed below, and in contrast to Mozambique, APOPO operates in partnership with NPA and not as a stand-alone entity.

The APOPO-NPA Partnership

APOPO and NPA (Norwegian People's Aid) are two international mine action NGOs working in partnership to eliminate the threat of landmines and explosive remnants of war (ERW) in Angola. Sharing this goal, the two organizations joined forces in a strategic partnership in 2012 to deliver enhanced mine action services in Angola. Together the APOPO-NPA partnership is engaged in the development of an efficient and resource-maximizing land release methodology to speed up efforts and lower costs.

Within the APOPO-NPA partnership, APOPO provides trained mine detection rats (MDR) to supplement the efforts of NPA. APOPO's MDRs are integrated with NPA's existing manual demining and mechanical capacity as a complimentary tool for TS. The joint effort by APOPO and NPA aims at combining the strengths of both organisations for increased cost efficiency and accelerated results.

The table below offers an analysis based on data for completion rates and time for a minefield, in Zaire Province, Angola. The table below shows the 12-month period from November 2014 through October 2015, and illustrates actual square meter results achieved, for an area of 494,625 square metres. The assets deployed on this task were, manual deminers, Caterpillar brush-cutter for ground preparation and MDR. The table focuses on the output of the manual deminers and MDR capacity and also provides an analysis of the same task if it was conducted with manual deminers and brush-cutter, without the use of the MDR. The cost comparison has not been included here as the NPA manual demining costs were not available.

ANGOLA		
	Actual - manual **with MDR**	Hypothetical - manual **without MDR**
Total m^2 cleared	494,625	494,625
Total m^2 manual	332,969	494,625
Average monthly m^2/manual	26,637	26,637
Total m^2 MDR	161,656	N/A
Average monthly m^2/MDR*	50,517	N/A
Total months to complete the task:	**12.5**	**18.5**
Months saved with MDR	**6 months**	

* The MDR were deployed for a total of 64 days to this task.

Cambodia

In April, 2015, for the first time, APOPO deployed 14 MDR outside of the African continent to Cambodia following successful mine action projects in Angola and Mozambique. APOPO is implementing a project with local partner the Cambodian Mine Action Centre (CMAC). After a 2-week period of acclimatisation to their new environment the MDR were teamed with their newly trained Cambodian handlers. The testing and accreditation of the MDR was overseen by the Cambodian Mine Action Authorities (CMAA) and experts of CMAC in line with IMAS chapter 09.42 – Operational Testing of MDD and Handlers. All MDR passed the test and are now deployed on operations in live minefields.

At the time of writing, the MDR have been operational for four months conducting technical survey. Collectively the MDR have averaged over 2,800 sqm/day. Until now they have only able to work at 50-70% capacity due to limited manual demining capacity, meaning insufficient prepared area for the rats to search. This manual capacity will soon expand which will allow the MDR to work to full capacity and thereby increase their daily productivity. Operational statistics from 2016 can be seen below.

CAMBODIA			
Month	**Square Meters**	**Operational Days**	**Daily Average**
February 2016	28,826m^2	16	1,801m^2/day
March 2016	61,380m^2	20	3,069m^2/day
April 2016	16,300m^2	7	2,328m^2/day
May 2016	55,408m^2	13	4,262m^2/day
TOTAL	**161,914m^2**	**56**	**2,891m^2/day**

MDR Study Findings

Introduction

The study of APOPO's MDR capability showed nothing irregular compared to other demining assets, in terms of safety and accuracy. The MDR system is reliable, safe, relatively cheap and follows a standardised approach. The MDR system is backed up by extensive research and testing in a similar manner as their counterpart- the mine detection dog system. When used efficiently as part of an integrated approach they clearly create significant time and cost savings. The MDR system can with advantage be used in areas where mechanical assets are limited in mobility and in areas contaminated by metal scrap and fragmentation, which would severely affect the use of mine detectors. Furthermore, the MDR system effectively reduce false indications compared to traditional mine detectors since they only indicate on explosive scent.

Current Global MDR Footprint

As of 2016 APOPO has MDR supporting operations in three countries as per below:

- 39 MDR in Angola
- 30 MDR in Mozambique
- 13 MDR in Cambodia

Training Advantages

APOPO principally uses a combination of clicker training and food rewarding to condition the rats to find mines/ERW. Probably the main difference to most dog training is that the rats are not taught obedience and do not need to have a strong bond with their handler. As such, the total training period is relatively short. In APOPO's experience the training of rats can be completed in eight to nine months. Training starts at the age of six weeks, when juveniles are weaned from the mother.

The rats can learn repetitive tasks relatively quickly, which means it is not difficult to condition them to standardized procedures, a big advantage for systematic search in mine detection operations. The reward for the MDR is food which can normally be sourced locally such as fruits, vegetables and peanuts. This provides a readily available and cheap source of motivation. During operations in live minefields the MDR are not rewarded as the handlers can't distinguish between a possible false indication or a mine/ERW. Even though false indications are rare, rewarding in minefields could result in undesired consequences. Since MDR do not get rewarded during live operations they need to undergo reinforcement training at least every third day to reward their good behaviour. This reinforcement training needs to be taken into account when planning MDR operations.

An important advantage of the rats, compared to MDDs, is their independence from a personal handler. Generally, most rats remain with the same handler, but show no difference in performance when taken over by somebody else in the absence of the handler. A rat could thus be trained by several people, or more importantly, be trained by one person and be tested or handled in the field by another. One handler team consisting of two people could thus easily operate ten rats consecutively. This also implies that the training of the handlers and the training of the animals can be separated.

Size Factors

African giant pouched rats weigh between 0.7 and 1.5 kilograms. The average body length is 30-40 centimeters, excluding the tail of 40 centimeters. A disadvantage of this small size is that the rat cannot be observed in long dense grass. On the other hand, its small size also offers several advantages. The housing requirements of the rats are considerably less than for dogs. APOPO is housing the animals in cages of about 80 cm x 50 cm x 50 cm. This allows 100 cages or 100 rats in a room of 6 m x 13 m. Temporary housing during transport can be considerably smaller, and some dozens of animals can be transported in a terrain vehicle.

In the field, their small size has the main advantage that the rats' nose is always close to the ground, even if the head is raised. The highest vapor concentration and the lowest wind speed are found close to the ground. Their size also gives the animals a good pace for scanning the field. In some situations, their small size enables rats to access areas which dogs cannot access. Their low weight makes it highly unlikely they would set off a mine by scratching or pointing, which increases overall safety.

Phytosanitary Realities and Rat Care

Being endemic to the whole of Sub-Saharan Africa, the African pouched rats are quite resistant to tropical disease. So far, no serious illness has ever been recorded among the APOPO rats.

There is no substantial evidence that mine detection rats can change the eco system and spread diseases in the unlikely event they would escape. This is merely a false but normal perception from humans whose predominant image of rats is as vermin. Before each MDR is exported to another country they undergo a rigorous health check and receive a medical certificate. In addition to this each MDR is neutered so that it is impossible for them to inter-breed, and finally each MDR has a micro-chip for ease of identification. APOPO can also conduct blood based laboratory work to ensure rats are not carrying any harmful pathogens.

Rats also require less food than dogs and do not need expensive specialized food. The MDR live on a diet consisting mainly of banana`s, peanuts, tomatoes and other fruit that are normally readily available in the various countries they operate. Apart from this, they can be fed and kept healthy

with grains, maize, carrots, fish, insects and many other kinds of locally available foods. Thus food supply is relatively easy to acquire.

Rats do not need a daily walk out. APOPO provides a free open run where the rats can play or habituate to the outside environment. Other rats get a free walk in the animal house during the cleanup of their cages. Because the rats have been trained and conditioned by humans from a very early age they do not attempt to escape.

Limitations

One MDR can typically search up to 400 square metres a day provided that there is sufficient area prepared.

The temperature and the endurance of the rats also has a major influence on the efficiency of the MDR as it does for MDD. However, this can be mitigated by two handlers who can manage up to 10 MDR and interchange them from work to rest if the animal becomes affected by the temperature and working time.

Training and Accreditation

All MDR are tested and accredited in line with the current IMAS on MDD - IMAS chapter 09.42 – Operational Testing of MDD and Handlers. They are first tested in Tanzania before they are deployed to a mine/ERW affected country and they are again tested by the respective mine action authority upon arrival. The pass/fail criteria as described in the IMAS chapter states:

- The MDD must indicate all the test items in a test box with two or fewer false indications.
- All positive indications are to be within a 1meter radius of the exact location of the test item.
- Any MDD and handler that does not apply the search pattern and procedures as described in the demining organisations SOPs is deemed to have failed the test.

Even though the current IMAS was written when dogs were the only animal detection tool, the same principles apply for any animal detection system. MDR testing and accreditation has been applied and supervised successfully by national authorities in Mozambique, Angola and Cambodia without any concerns. Typically, more than 85% of the MDR pass the test on the first attempt. In addition, there has never been a reported incident of MDR missing mines since they began operations in 2006. Cumulatively, in Mozambique, Angola and Cambodia, the rats have been responsible for searching over 1.5 million square meters of land.

Since the MDR programme started in Tanzania in 2004, 178 MDR has been trained and tested as per the matrix below:

Total number of MDR`s passed from 2004-2016			
Year	Total No: of Rat	Status	No: of Rat
2004	8	Operational (Moz)	8
2005	8	Operational (Moz)	8
2007	12	Operational (Moz)	12
2010	16	Operational (Moz)	16
2011	20	Operational (Moz)	20
2012	47	Operational (Moz)	24
		Operational (Ang)	20
		Passed but remained in HQ	3
2013	15	Operational (Moz)	12
		Passed but remained in HQ	3
2014	43	Operational (Ang)	20
		Operational (Camb)	16
		Passed but remained in HQ	7
2016	9	Under training in HQ	9
		TOTAL	**178**

Efficiency and Effectiveness

The term efficiency in IMAS refers to a measure of how economically resources/inputs are converted to outputs. The term effectiveness in IMAS refers to the extent to which the intervention's objectives were achieved, or are expected to be achieved, taking into account their relative importance. In a simpler way this can be explained as; Being effective is about doing the right thing, while being efficient is about doing the thing right.

The study highlighted that although the MDR are effective at detecting landmines and ERW, the amount of downtime, where the rats are waiting for ground preparation, could be improved with careful management and/or an acceptance of the MA community to share unused capacity. The MDR are most efficient when they are integrated with manual deminers and machines, whereby the collective strengths of each asset is utilized to maximize productivity. Sufficient ground needs to be prepared prior to the deployment of the MDR to ensure that they are able to work uninterrupted and by that minimize downtime. This requires effective planning as well as an acceptance within the MA community to utilize additional capacity.

In summary, demining tools will neither be efficient nor effective unless used in combination with other assets. Task specific asset requirements should be based on direct evidence and findings after NTS and be in line with the national mine action strategy. Data from many mine/ERW affected countries shows that there is an unbalanced approach to dealing with type of assets vs. threats vs. environment vs. impact. Consequently, effectiveness leading to impact can only be achieved by good information management, prioritisation and planning.

Observation

In Angola and Mozambique, APOPO realized that the efficiency of their MDR team was being impeded by the fact they had probably sent too many MDR compared to their own and partner's capacity. APOPO reached out to a variety of mine action organisations to express interest in partnering at no cost. Due to ongoing and unfounded concerns from some within the mine action

community, and the stigma associated with rats, APOPO was never taken up on their offer. This experience almost certainly led to unnecessary cost and time inefficiencies in both countries.

Conclusions

Logically – any detection system that comes with extensive research data and that can pass a strict international testing procedure, where the system either fails or passes based on true measurements, should be accepted by the mine action community. During the initial operational years, MDD underwent significant documented research and passed strict international testing procedures, yet their industry wide acceptance took many more years than it should have. This lead to millions of dollars of loss in efficiency and unnecessary drawn-out mine action efforts that could have been reduced by the proper use of MDD.

- Strict testing and accreditation procedures for MDD are in place today, which equally applies for MDR.
- MDR have undergone significant documented research and passed strict international testing procedures, and yet they are still met with general skepticism by the mine action community.
- MDR has a well-documented and a good track record of passing the testing and accreditation procedures described in IMAS for MDD.
- MDR suffers from similar confidence and trust issues related to MDD in the early days of Mine Action. However, very few donors and operators actually have practical operational experience in the use of mine detection rats.

Recommendations

There is a need for a change in attitude towards an operational asset which actually has passed rigorous testing.

In order to increase the acceptance and use of MDR by partner organizations as a cost-efficient and effective asset, APOPO is advised to implement formal training on all levels (staff, managers, donors and national authorities) covering all aspects of land release, planning and operational efficiency and how MDR can make the process significantly more efficient.

APOPO and potential future providers of MDR are advised to be more realistic in the number of rats it sends over to a country. While the downtime in Angola and Mozambique was partially a result of not having enough manual and human capacity to match the pace of work with the rats, APOPO should have anticipated this and simply sent fewer rats in the first place.

APOPO should improve their data collection system in order to collect real time, streamlined data on the cost and time savings associated with implementing MDR across programs. This data should be highly robust and allow the MA community to get a deeper sense of the MDR value added across a variety of mine/ERW contamination scenarios, geographical locations, weather conditions and other variable factors. APOPO or independent partners should use this data to publish annual or bi annual reports in well regarded publications that transparently highlights the value added of using MDR within standard demining operations. APOPO should also make every effort to widely distribute these finding to the MA community, and arrange presentations at international gatherings of industry experts.