

# APOPO-PARADIS project

## Final report

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### Introduction

The manager of a demining campaign wants to monitor the evolution of the operations in the field and to keep track of the work done. To do this he must ensure the campaign is properly documented at the different levels (local, regional, national). Two challenges arise here: first the manager lacks recent and accurate maps for the zone of work as the latter is typically located in developing countries; second he must manage the continuous flow of data coming from the field in an efficient way.

The PARADIS system proposes a solution to those problems. PARADIS enables the use of satellite imagery as a substitute for missing maps. Moreover it contains an interface dedicated to the collection of data based on a PDA, which guarantees the integrity of the collected data at the local level. It also proposes a planning interface that allows for the efficient management and analysis of the data at the regional and national levels.

PARADIS (a Prototype for Assisting Rational Activities in Demining using Images from Satellites) is an information system dedicated to Mine Action. It improves the planning of demining campaigns and increases the global value of the demining effort. In short, PARADIS enables for:

- easy and reliable data collection in the field;
- a better understanding of the situation by the manager, thus better decisions;
- an easier access to information;
- reliable storage and management of the information;
- a faster reporting to the headquarters / operations manager.

### History

The system was developed by the Signal and Image Center (SIC) of the Royal Military Academy (RMA) of Belgium in the aim of supporting the demining activities of the Belgian bomb disposal cell<sup>1</sup>. The prototype quickly sparked interest among APOPO's managers, and together with the SIC team they set up a first field test to evaluate the system. This NGO works with rats to clear mined areas though, so the system had to be adapted to their specific needs. Thanks to funds granted by the Belgian Ministry of Foreign Affairs, the SIC was able to develop a custom version of the software tailored to APOPO's needs.

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1 SEDEE-DOVO: Service d'Enlèvement et de Destruction d'Engins Explosifs – Dienst voor de Opruiming en Vernietiging van Ontploffingstuigen

## User needs

The system was developed based on specific data needs as expressed by APOPO operations managers:

	Data needs	Remarks
Minefield / Suspect Hazardous Area (SHA)	Perimeter and size, Permanent Land Mark (PLM), Bench Mark, Start Point	
	Location of access point, control point, parking, resting room, explosive storage, mine/UXO storage	
	Estimation of vegetation density (low, med, high) and type (grass, bamboo, etc)	
10x10m box  1x1m cell	Vegetation cutter, rats and deminer results for box/cell: which rat/deminer, which day, which result	Deminer can make a partial or a complete search within a box; the System must be able to represent both methods
	Ammunition found in box/cell: type, condition, depth, state, destroyed in-situ, pulled and destroyed, removed for later demolition	
	Detection and false alarm rates for box and zone	
	"Comparison grid": rats' results compared to ground truth (GT) for box and zone	On a test minefield the GT is known a priori; on a real minefield the GT is known from the deminer's work, only if the deminer has cleared the box
Rat work	Detection and false alarms rates for each rat	
	Performances comparison in the form of a "league table"	Compute rats comparison based on detection/false alarms rate (temperature, humidity, type of soil could be taken into account)
Road clearance	Road path, seasons of practicability, state, width.	
	Cleared zone along the road (road only, road and verges, verges only), Bridges, Culverts, Tunnels.	
Mine Risk Education	Villages where MRE activities have been done; Polygon representing the zone around the village where MRE was done and representing the zone where all those people come from – Adults only, Adults and Children, Children only, Full MRE,	

	Brief/localised MRE, Prioritisation	
Surveying	Impact and Technical Surveys: Level 1&2 survey information	
Daily work	Temperature, humidity Resources spent (fuel, explosive material, etc)	
Monthly / yearly work	Resources spent, productivity indicator per zone	

## Structure of the system

PARADIS distinguishes between two types of users: the **field operator** and the **campaign manager**. The former collects data and report on his activities in the field; typically he focuses on one object at a time (ex: a minefield) and works at the local and advancement scales. The manager works at the office and monitors the campaign at the regional and national scales, but he may also want to zoom in to a finer scale, for example to examine the properties of a particular object.

From this description it comes that these users do not perform the same tasks, neither do they work at the same scale. As a consequence, they do not have the same needs towards the PARADIS system, and it was decided to split up the PARADIS system into two separate –but complementary- interfaces, one for each type of user: the **Field Interface (FI)** and the **Planning Interface (PI)**.

### *The Field Interface*

We chose to run this interface on a PDA (Personal Digital Assistant), a pocket computer that can easily be transported to the field due to its limited weight and size. Moreover the PDA can be easily connected to other hardware such as a laptop or a GPS unit through a wireless link (Bluetooth, WiFi), which eliminates the hassle of broken wires in the field. However the FI is not bound to the PDA: it can also run on a Tablet PC, standard laptop or PC.

In a real-life scenario it is highly recommended that PDAs be dustproof, water- and shock-resistant in order to avoid damage in the field. However ruggedized PDAs cost several times the price of standard models by the time of writing; a cheaper solution is to encase the PDA in a rugged plastic case.

During validation trials we only used standard (i.e. not ruggedized) PDAs: the aim was to evaluate the PARADIS software, not the hardware it runs on. Also, it makes no difference to the FI whether it runs on a standard or ruggedized PDA, hence switching to ruggedized hardware pose no problem in a real-life deployment scenario.

The PDA is coupled to a Bluetooth-compliant GPS unit; the latter enables the user to obtain the current position on the map. The GPS position is of course useful for locating oneself on the map. Moreover GPS coordinates can be attached to an object; for example a road could be created from successive GPS positions taken while driving, allowing for a rapid mapping of the road.

The following figures show some screenshots of the Field Interface.

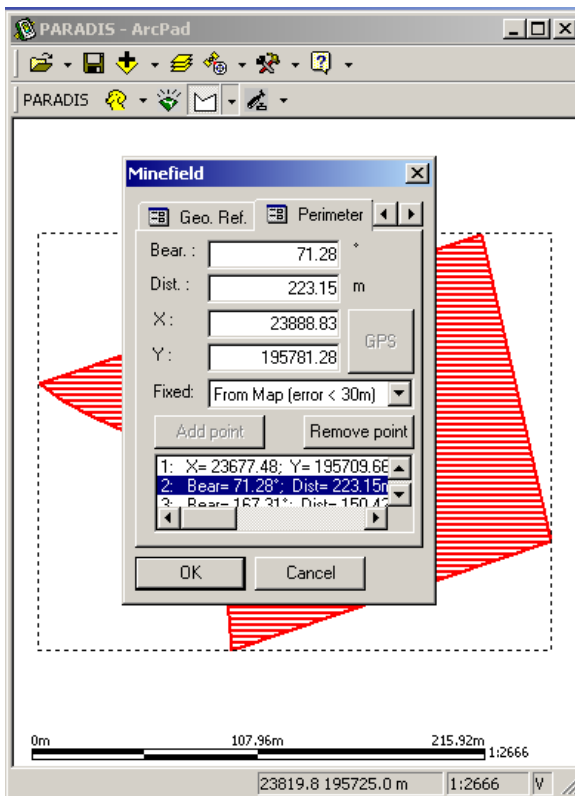


Fig. 1: Defining the perimeter of a minefield

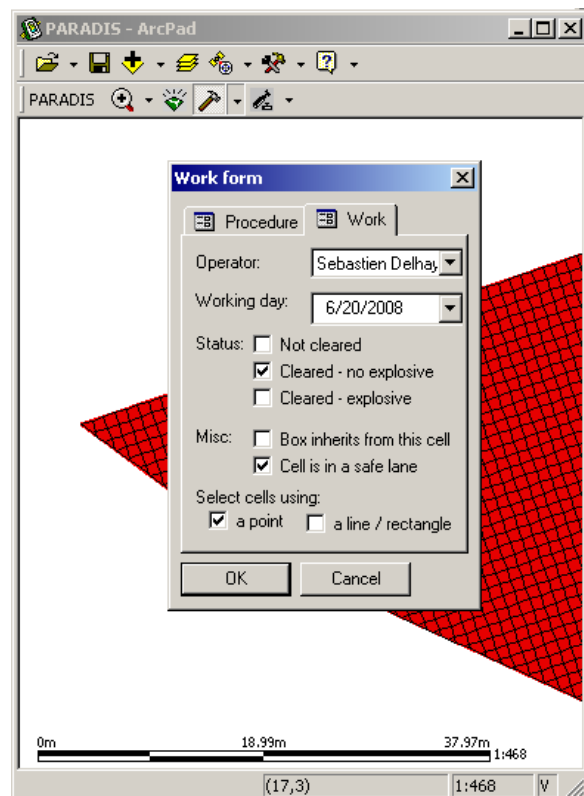


Fig. 2: Entering the work done by date

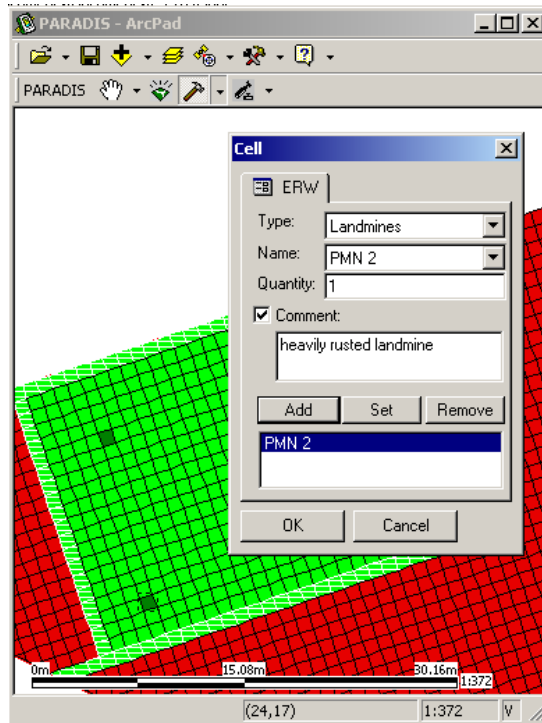


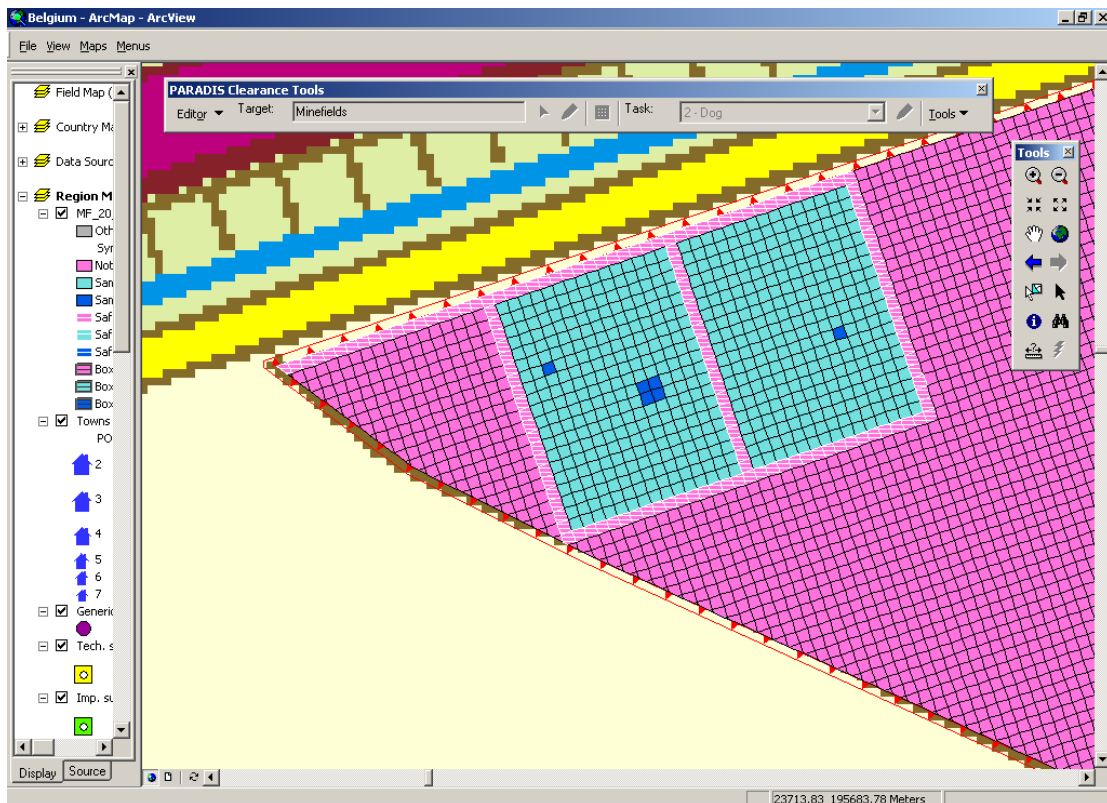
Fig. 3: Defining the ammunition found in a specific square meter of the zone

## The Planning Interface

This interface is aimed for the use of the campaign manager and the Mine Action Center user. It provides a set of toolbars, each one of them targeting a specific set of tasks in the management process:

- **EOD** toolbar: proposes tools for the management of EOD tasks;
- **Clearance** toolbar: used for the monitoring of clearance operations on UXO- and minefields;
- **Teams** toolbar: for the management of the clearance and EOD teams and their resources;
- etc.

The following screenshots illustrate some key functions offered by the system.



*Fig. 4: Mapping a square meter grid on a minefield and following the status of each sq m as reported by PDA users;*

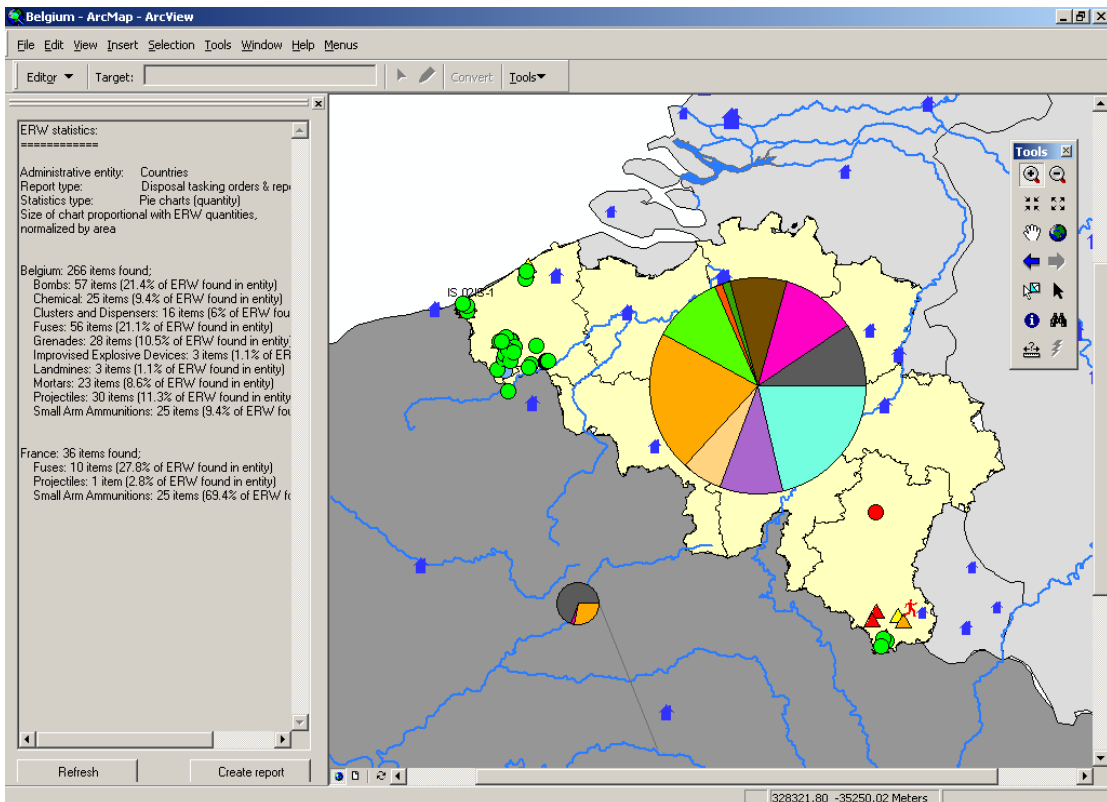


Fig. 5: Displaying regional- and national-level statistics about the ammunition found (Note: these data are fake and were generated for illustrative purposes only)

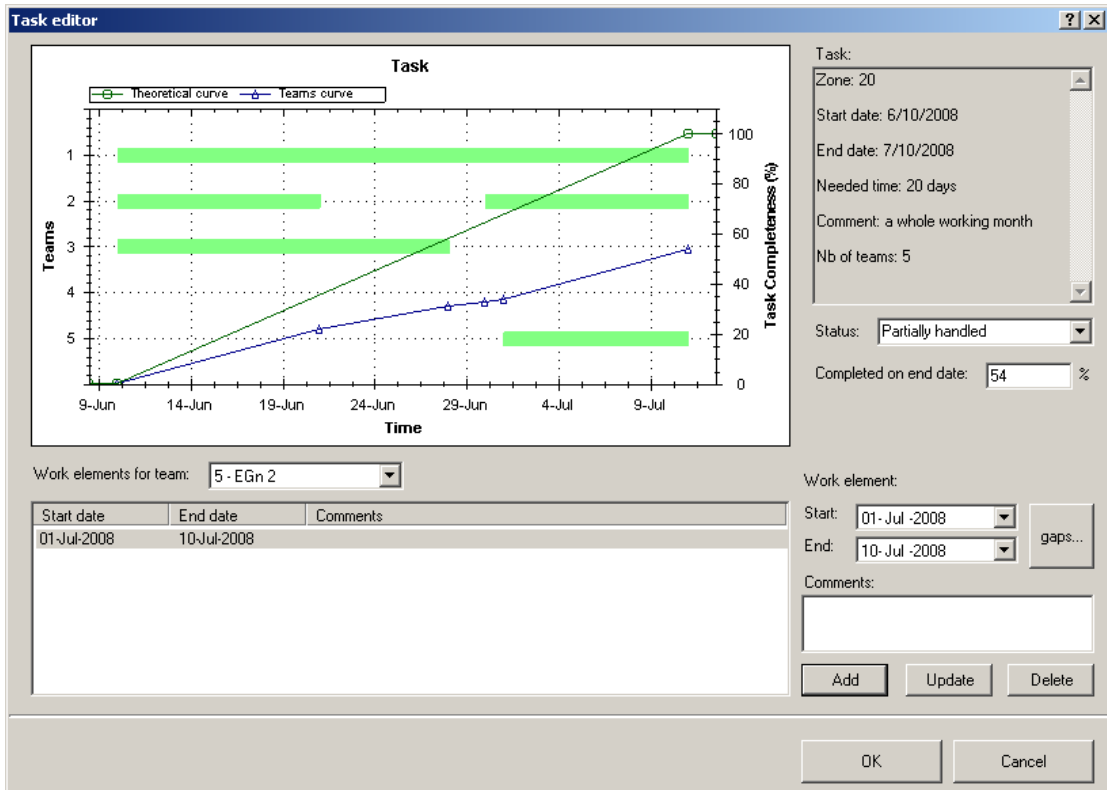


Fig. 6: Monitoring the work on a certain zone depending on the allocated resources and surface area; estimating the time needed to complete the clearance of the zone

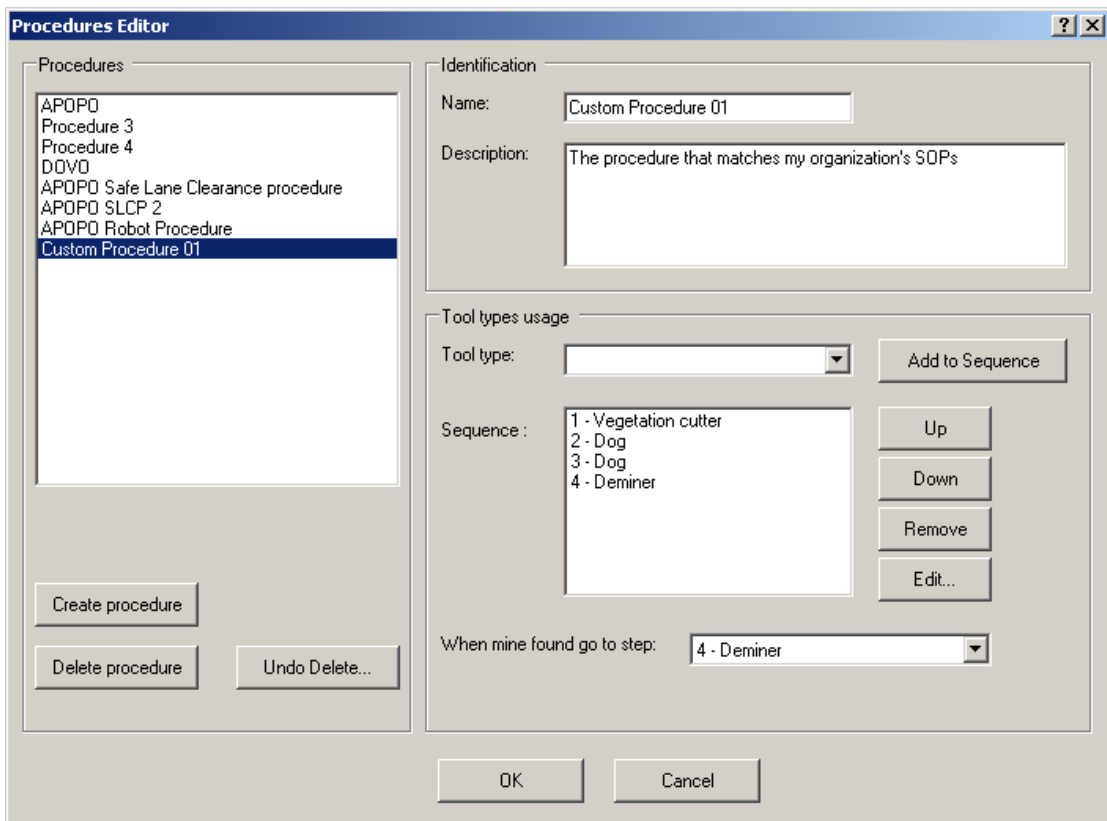


Fig. 7: Defining specific demining procedures

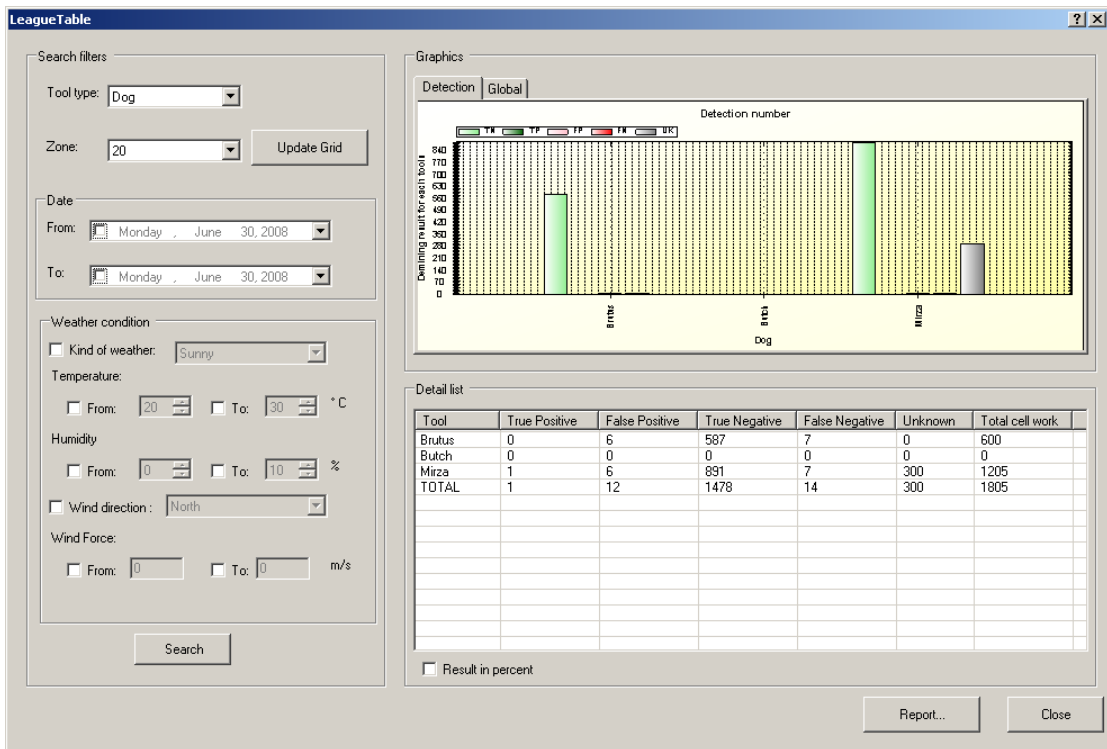


Fig. 8: Evaluate the performances of a specific operator / tool (ex: deminer, rat, dog, etc) in terms of time needed to clear one sq m, false alarms, etc

## Conclusions

### Strengths:

- the system contains original ideas not proposed by other widely accepted systems, namely regarding the planning of operations (while other tools mainly focused on reporting tasks);
- the tool offers the ability to customize the procedures in order to fit the needs of any demining organization;
- the system replaces paper maps and reports, avoiding data loss / deterioration;
- it allows for rapid and accurate reporting through the automatic generation of reports from the database.

### Weaknesses:

- the tool was developed by a research lab, not a software development company; hence only limited maintenance could be proposed to the end-user;
- even though IMSMA did not at the time provide all planning functions proposed in PARADIS, it has since been refined and now matches more closely APOPO's data needs;
- some core features of the field interface are too difficult to use; for example, locating a square meter within a wide grid on the small screen of the PDA is tough. Alternatively these features are spoiled by the insufficient accuracy of the measuring device; ex: achieving the 1-m accuracy of the grid is difficult using non-differential GPS.
- the use of expensive equipment (one PDA per rat was planned) leads to poor cost-effectiveness.

Even though field tests were very promising, these limiting factors prevented APOPO from using PARADIS in an operational way.