Investigation of the accuracy of hand held GPS for desert locust control operations

Introduction

The use of hand held GPS has become increasingly common in desert locust control and survey organisations over recent years. They are now considered an indispensable tool in any locust control organisation. Their primary use has been, and remains, the accurate location of locusts in the field – this data is reported back to HQ and allows plotting of the positions of populations with some accuracy. The use of GPS is important in the development of GIS systems, as the data can be fed into the system and be accurately pinpointed on digital maps.

However, GPS also has some role in control operations. Again, areas to be sprayed are recorded by GPS and the position data passed to the control teams (either ground or aerial) and the teams can find their way to the correct site. GPS has also been recommended as a way of deliminating blocks for spraying. By recording the corners of the blocks, it is thought that accurate data is obtained which allows precise spraying. While undoubtedly better than nothing, the inherent inaccuracy of GPS (which is due to selective degradation and atmospheric conditions) may give data with less accuracy than claimed by the users.

Recent trials in the use of aerial DGPS relied to some extent on hand held units plotting the positions of areas to be sprayed or to be avoided. The authors of this showed that although the DGPS was accurate enough to accurately fly the correct paths, the inaccuracy of the hand held system compromised the overall accuracy of the system.

The work reported in this technical note has a number of objectives.

1) To examine the accuracy of the hand held GPS systems.
2) To examine how accurate GPS is at recording a track.
3) To examine the use of GPS, and it's errors, in block delimination.
4) To develop methods for use in ground DGPS trials.

Methods

The GPS units used in this study were Garmin GPS 45XL units. Two units were used. Data was recorded on the unit using the internal memory, then later downloaded to computer using the Garmin PCX5 software supplied by the manufacturer. The data were downloaded either into a laptop computer (Toshiba 2110) or onto a desktop. Analysis was undertaken using the PCX5 software to measure distances and bearing.

The test methods used were based on those published by for the determination of the accuracy of ground based DGPS systems, with modifications based on the differing nature of the systems. Due to the lack of precise maps for the region, the accuracy of the hand held units was determined by self reference, rather than to an absolute reference.

In all tests, the units were allowed to warm up for 30 minutes prior to data logging. Prior to the work commencing the units were run for 2 hours to initiate and update the almanacs.

Test 1

Static stability

Static stability and accuracy are defined as the ability of the unit to find a position and reproduce it over a period of time.

Test 1A and 1B.

After the 30 minute warm-up period, the units were left with the aerials 2 m apart and data on position was logged every 15 seconds (Test 1A) or every 5 minutes (Test 1B).

Test 2

The ability to record a straight line track of known direction and length. A 500 m section of straight road was chosen for this test. The road had concrete posts on one side at 15 m intervals, which were determined to be in a straight line by observation. The orientation of the posts was determined using an accurate sighting compass.

After a warm up of 30 minutes, the units were positioned in a car with the external aerials 2 m apart mounted on the roof top. The units were set to record for 10 minutes, at 15 second intervals at the start of the run. The car was then driven in a straight line close to the posts at 5 km/hr, with the units recording position at 5 second intervals. At the end of the run, the units recorded the position for 10 minutes. The runs were repeated 3 times in each direction.

Test 3

Marking a target.

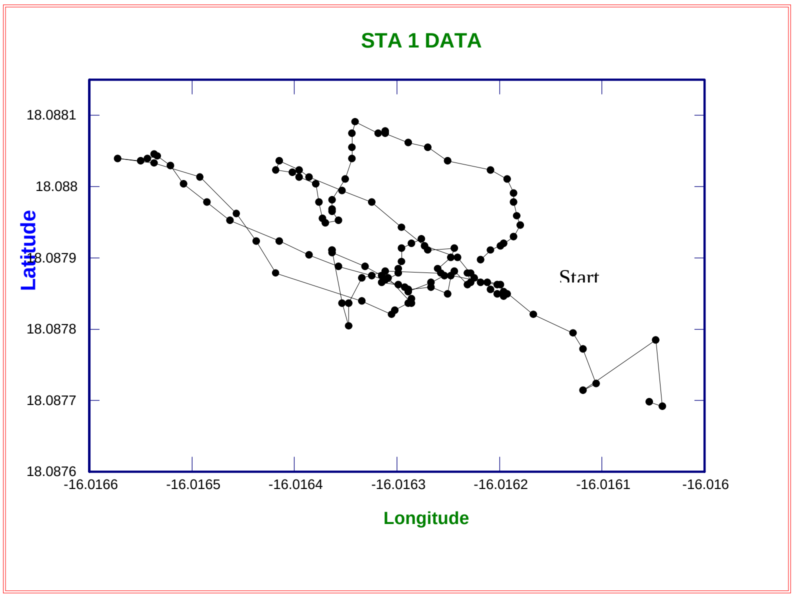
A plot of exactly 50 m x 50 m was marked out in open desert. Only one unit was used for this trial, using the integral aerial of the unit (Unit GPS Unit 2). At each corner of the plot, the unit recorded the position. This was repeated twice for each corner.

Results

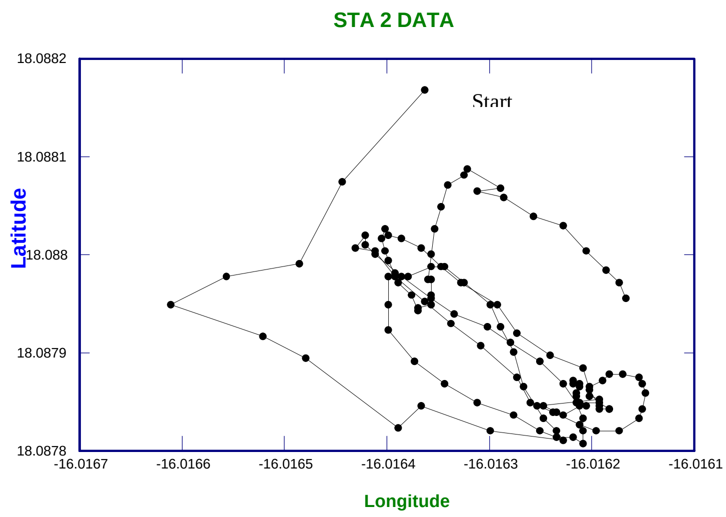
Note that the results are presented graphically, and there may be some distortion due to transforming the data. The error distances are noted under each figure. Only example data is presented.

Test 1.

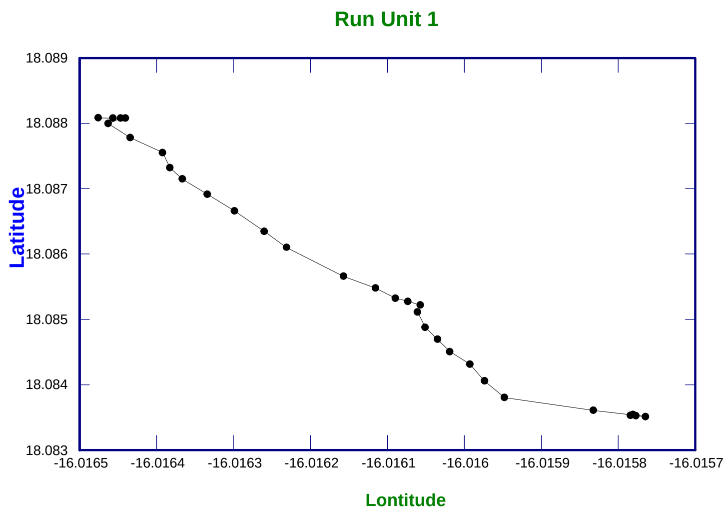
Static Stability



Static Position Unit 1
Max N-S Distance – 84 m
Max E-W Distance – 119 m



Static position Unit 2
Max N-S Distance - 64 m
Max E-W Distance – 79 m

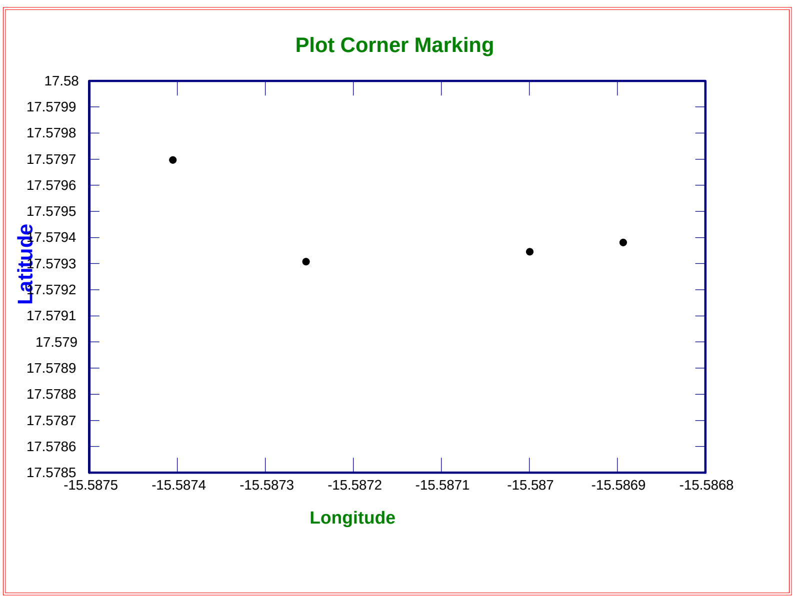


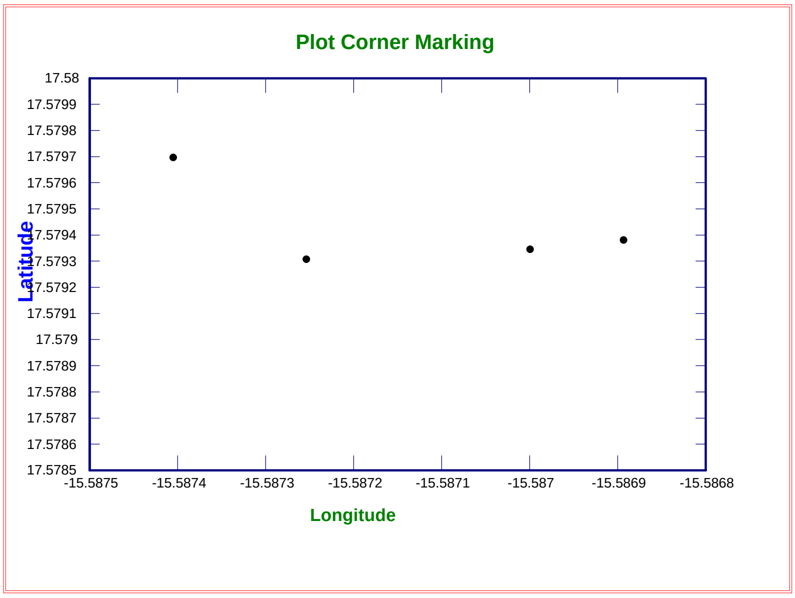
Measuring a straight line run
Actual Distance – 500 m
Measured GPS Distance – 838 m
Actual Bearing – 021° Magnetic
GPS Bearing – 352.8 °

Stationary Position

Run	NS Range (m)	EW Range (m)
1	83.7	119.8
2	152.3	131.8
3	64.8	79.1
4	73.5	95.5
Mean	**93.58**	**106.55**

Plot Corner Marking





Plot Corners as Marked by GPS

Discussion

The nature of this study meant that there was no absolute reference to measure the accuracy of the GPS units. Therefore, instead of talking of "error", the term "range" is used to describe the accuracy of the GPS units.

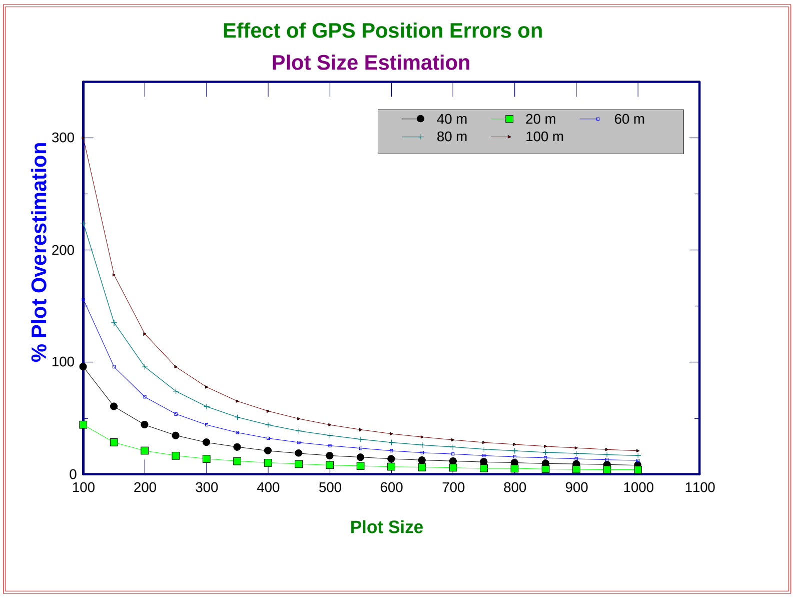
It is clear from the static tests that the range of positions given by the units is in line with the selective degradation of the signal (ie in a stationary position, the unit can locate itself within a square approximately 100 m x 100 m) – although of course, in this test there is no way of knowing the real position.

For the marking of a straight line, the line was reasonably straight, but instead of recording the distance travelled as 500 m, the distance was given as over 800 m. This is slightly greater than the range of 100 m of position would lead one to expect, but the inaccuracy of this measurement is compounded by inaccuracy in measuring the distance using the vehicle odometer. What is surprising from this result is that the bearing calculated by the GPS unit (at 352°) is very different from the compass measured bearing of 021° magnetic. Even allowing for variation (9°W) – which was autoset on the GPS unit, the bearing difference is over 20°.

The plot corner marking was subject to great inaccuracy. Even ignoring the true position, neither test (on a perfectly marked square) gave a good representation of the corners of the plot.

Use of Hand held GPS for Locust Control Spraying Operations

The use of GPS in spraying operations, based on the data generated above, is not suitable for anything other than a relatively general indication of the position of the target. The failure of the unit to provide a reasonable approximation of a square target makes its use for delimiting a locust target of little value. The errors associated with the inaccuracies of plot corner marking are shown in the graph below:



It can be seen from this graph that at a error of 100 m, the plot size must be a minimum of 1050 m x 1050 m - ie 110 ha before the error associated with the inaccuracy of the GPS unit is less than 20 %. Obviously, if the GPS error is smaller, then the plot size to maintain an error of less than 20% also decreases – at 20 m error, the plot needs to be a minimum of 250 m x 250 m – ie 6.25 ha. This analysis is somewhat simplified, as it assumes all errors exaggerate the plot size – of course it is equally probable that the error in the GPS data could underestimate the plot size, in which case the infested area would not be covered. It is also equally true that the position given will lie anywhere within the radius of the GPS range.

Careful consideration therefore needs to be given in how GPS units are used in desert locust control. The perceived accuracy of the units may in fact lead to significant errors; the problem is in knowing how accurate the unit is at any one time.

This problem was highlighted in the trials undertaken by the project on aerial DGPS. Although DGPS is known to be accurate to within a few metres, this accuracy is of little use if the basis on which it is used is based on much less accurate GPS data. In the aerial trials, an exclusion block was marked with hand held GPS units, but when flown with DGPS, clearly showed up the error. There may therefore be a false confidence in marking environmentally sensitive areas (ESA) with hand held GPS, and then spraying with DGPS, unless the error associated with hand held GPS is allowed for (ie marked position plus 100 m further away from the ESA).

Further Work

Further work on hand held GPS units will continue as time permits; this will be aimed at improving the accuracy of the units for target delimitation, possibly through the use of low cost Differential GPS receivers, or combining data from more than one unit.

Recording, downloading and managing data is also an area than needs further development – particularly systems that can be easily used by the CLAA in routine desert locust operations.

Further work is planned on the use of DGPS for spraying, and ideas and techniques developed in this current preliminary study will aid in these trials.

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