Remote sensing of archaeological ruins: a comparison

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Aerial photographs have long been used to survey stone walled ruins in South Africa [1, 2, 3]. Google Earth (GE), which was launched in 2005 has grown in popularity among archaeologists [4, 5, 6]. To compare the relative efficacy of GE with standard aerial photographs (AP) we recorded pre-colonial stone walled settlements in a part of the Suikerbosrand Nature Reserve (Gauteng) using different types of imagery and statistically compared the results with ground surveys. GE is in many ways preferable to AP.

Spotting stone walled ruins on GE and AP is straightforward: in treeless environments they stand out clearly, especially against dry grass (Figs. 1 and 2). Once spotted, we copied images of the ruins and geo-referenced them into a well known GIS program. For this exercise, we focussed on a 25 km² area in the northwestern part of Suikerbosrand Nature Reserve. The clearest images were selected from the array of historical images available for this area in GE, but we used only one set of black and white AP covering this area. We drew all the stone walls visible on the GE and AP imagery as polyline and polygon shapefiles. The polygons of outer walls allowed estimation of the area of each compound while the polylines of all the walls allowed a quantification of the total wall length in each compound.

The second part of data collection involved ground truthing the structures. One of us (Pam MacQuilkan) visited the Suikerbosrand Nature Reserve over a period of three weeks during the winter of 2009 when the grass was sufficiently low to allow good ground visibility. Twenty-two stone walled structures were thus ground truthed against GE and AP images. Once the field work was complete, the ground truthed walls were added to GIS as separate shapefiles.

Data analysis

The total length of walling and area of each structure was calculated for each of three types of data: the ground truthed plans, GE and AP images. These were then exported to a spreadsheet for quantitative analysis. A comparison of the lengths and areas allowed an assessment of the relative
accuracy of the different image types. Fig. 3 provides a visual comparison of one of the structures.

Table 1 shows the quantitative comparison of wall lengths obtained by the three methods. As an average from 22 structures, 78% of the walling was visible on GE images, while on AP the average is 75%. The standard deviation in the average visibility of walls on GE is 8.48%, while on AP it is 10.24%. Table 2 shows the statistical comparison of the compound areas in square metres. Although in general, AP seems to give better results for area calculations, a compound by compound comparison reveals that GE imagery is significantly less inaccurate than AP. On average, the area of each compound measured on GE differs from the true area by only 4.33% (range from 0.69 – 19.62%; median 2.15%; standard deviation 5.12%), while a similar calculation for AP shows a nearly 15% difference in compound area (range 0.19 – 46.44%; median 11.81%; standard deviation 11.88%).

Further advantages of GE

Although this pilot study has a number of limitations, such as relying only on one series of AP and investigating only one small area of the highveld, a number of GE features proved to be very useful for locating and analysing the stone walled settlements in this test area. First, GE is free, easy to download and to use. The ability of GE to display oblique as well as vertical views is an advantage. GE colour imagery helps to differentiate between features such as stone walls, vegetation and open ground. The GE historical imagery enables a viewer to access satellite images from different seasons. Some images might show clearly areas that are poorly visible in others. A disadvantage of GE is that not all the regions are covered in equally high resolution imagery, and thus such remote sensing will not be feasible in some areas. An advantage of AP is that resolution is uniformly good and there is a longer sequence of historical images available. Nonetheless, even with multiple photos of the same area, the lack of colour makes them, in our opinion, slightly less useful than the high resolution images in GE for this type of remote sensing. In addition, AP are not freely available, and when one gets bored looking at ruins on AP, one cannot simply switch into flight simulator mode and perform a couple of loop de loops.

References


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