Google Earth and World Wind: remote sensing for the masses?

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Aerial photography and satellite imagery are well established tools for archaeological site prospection and monitoring throughout the world. However, many archaeologists find the data either difficult to manipulate or expensive. Expense has been an oft-cited criticism of satellite imagery (for example see Schmidt 2004). In the past few months two new tools have been developed that provide access to a wealth of multi-resolution remote sensing data for free: World Wind (http://worldwind.arc.nasa.gov/) and Google Earth (http://earth.google.com/). A comparison of the two products focussed on the Pyramids at Giza, Egypt is shown in Figure 1.

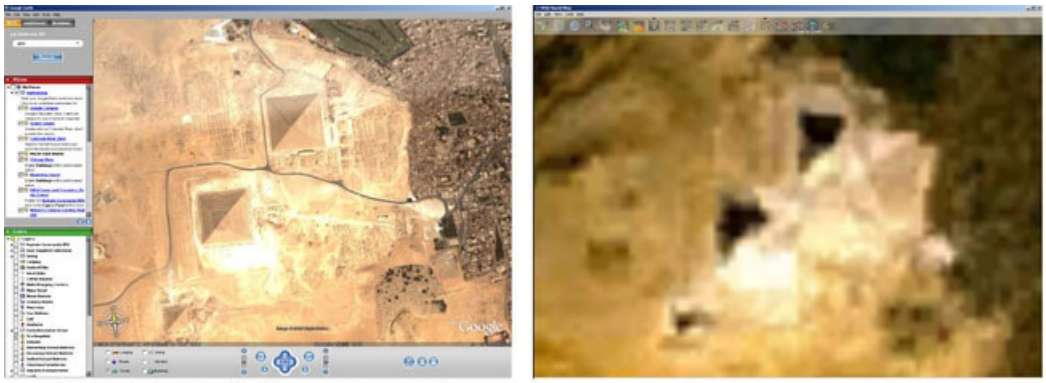


Figure 1. *Giza, World Wind screen capture.*

So what is new about these resources? Websites like the Global Landcover Facility in Maryland have been providing access to a range of different free imagery sets for a number of years. These data have been used by archaeologists for a range of purposes (for example Sherratt 2004). The difference is that the imagery is managed and processed centrally, by NASA and Google respectively, and streamed over a broadband connection to a remote viewer on a user's desktop. These systems have a number of benefits for the user:

- Specialist GIS or image processing software is not required.
- The data is pre-processed and georeferenced removing the need for data specialists.
- A wide range of aerial and satellite data is available from the websites and will be automatically updated as new data becomes available.
- Some of this data is not available under public domain licensing.

In essence, both systems provide access to a range of datasets from a remote server, the ability for the user to view their own data and limited GIS functionality. Both systems have worldwide coverage and provide data with varying spatial and spectral resolutions. Although both viewers offer similar services they are designed upon contrasting business philosophies. World Wind is an open source project that only uses data that exists in the public domain (NASA 2005). This means that in the longer term this tool is likely to be developed and supported by a world-wide user group. This group is already producing a range of bolt-on tools (including an import option for World Heritage Site locations at http://whcww.endofinternet.org). Further, the use of public domain data means that the raw data can be downloaded and analysed in a GIS or image processing software. The reliance on public domain data means that World Wind has a large amount of imagery for the US and a substantially smaller amount the rest of the world. Figure 1 shows the Giza pyramids in Landsat imagery; the highest resolution imagery that World Wind currently has outside the US.

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Google Earth is part of the suite of popular Google products. Both public domain and proprietary data are available. This includes DigitalGlobe's Quickbird satellite imagery (ground resolution of 0.6m panchromatic (pan) and 2.4m multispectral (MS)) which has enormous archaeological potential. There are also over 50 vector and attribute layers (transport, population, place names, earthquake points etc.). Users can add new layers (referred to as collections). Google Earth also has a collection for World Heritage Sites. This is all available within the free version. By upgrading to the personal version (for $20) one can import GPS waypoints and print the images at a higher resolution. By upgrading to the professional version (for $400) one can print at the highest resolution and import GIS data. As can be seen in Figure 1 the higher resolution Quickbird imagery provides a much more intuitive image with a substantially higher degree of interpretability.

However, access to all this free data does come at a small cost: the user does not get direct access to the raw data in the viewer. This is generally important for an image interpreter as it allows them to enhance the image to provide improved interpretation. Instead, a generalised product is streamed that has been compressed using a wavelet technique. This compression technique significantly reduces file size at the expense of spatial and spectral definition. The effect is seen if one compares the compressed Quickbird imagery with Ikonos multispectral imagery from the author's own study area (Beck *et al.* in prep; Philip *et al.* 2002). Figure 2 and Figure 3 respectively compare Ikonos MS and compressed Quickbird in the marl and basalt areas around Homs, Syria. Since submission of this article to Antiquity Google Earth has added pan-sharpened quickbird imagery (March 2006) which overlaps with areas in the marl and basalt zones. This has a nominal ground resolution of 0.6m and is a considerable improvement on the older imagery. Many thanks to Jason Ur for making the author aware of the release of this imagery.

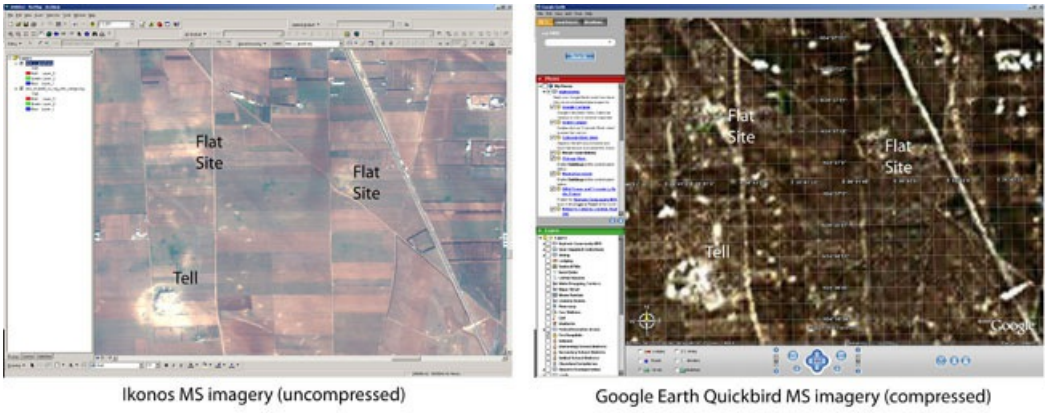


Figure 2. *Comparison of uncompressed Ikonos MS imagery and compressed Quickbird imagery (from Google Earth) in the Marl zone.*

The Ikonos MS imagery has a ground resolution of 4m (as opposed to the 2.4m of Quickbird), therefore, in theory greater detail should be seen in the Quickbird data. However, the degradation in image quality caused by the compression technique means that the Ikonos imagery provides a better tool for archaeological prospection.

In the basalt zone one is hard-pressed to identify any of the field-systems which are so obvious in the Ikonos. Hence, the Google Earth data is only viable for archaeological prospection in the marl environment and even there great care needs to be taken in its interpretation. The utility of Goggle Earth in other areas with different environmental, geological, land management and data characteristics has yet to be ascertained. However, irrespective of these limitations this is still a resource that has archaeological utility allowing access to data, although in a compressed format, that would otherwise be very expensive. This may make Google Earth an ideal tool to preview data before purchase. It also provides a context within which landscape archaeological data can be viewed and interpreted. However, one should always bear in mind that the compressed imagery offered from Google Earth is no substitute for raw data.

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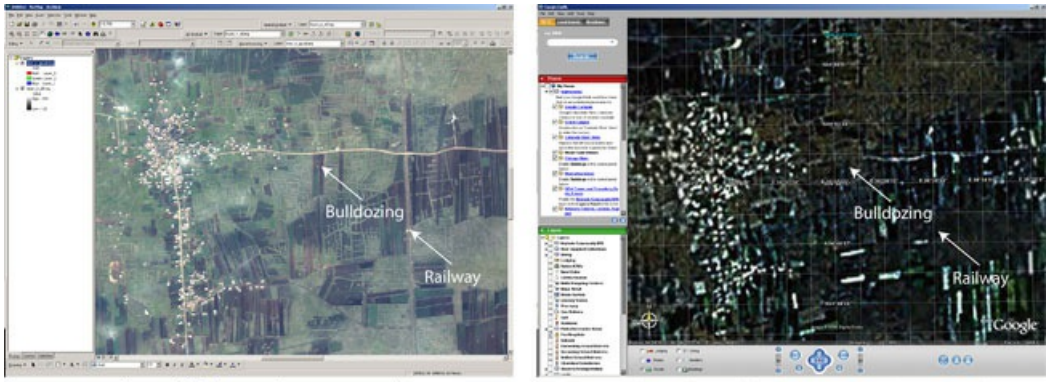


Figure 3. *Comparison of uncompressed Ikonos MS imagery and compressed Quickbird imagery (from Google Earth) in the Basalt zone.*

Discussion

The existence of these viewers is an interesting development. For a number of years aerial and satellite data has been freely available through sites such as the Global LandCover Facility (GLCF) in Maryland. However, the need to process this data meant that there was a relatively small uptake outside the research community. Google Earth and World Wind provide access to different 'flavours' of data in a manner which is easy for a lay-person to use. These viewers essentially mean that the data is more accessible. Over time an increasing range of data will be made available either in the public domain or through Google's proprietary purchase scheme. The current structures indicate that Google Earth will have data of archaeological significance before World Wind. It is likely that these data will have improved spatial and spectral characteristics which may make them more archaeologically pertinent. Although not of immediate archaeological significance, Google Earth has high resolution aerial photography of many areas of the world, including most European capitals.

There is, however, a cautionary aspect to the use of these systems. There is still uncertainty about how the data can be accessed, who owns the copyright and how the data should be archived (Harris 2005).

Irrespective of the present limitations, both viewers provide an intuitive mechanism for viewing landscapes. This provides a powerful framework within which to contextualise archaeological data. Further, all the images can be rendered in three dimensions. The synergy generated by using multi-resolution remotely sensed and elevation data can provide insights into the vegetation, geology, hydrology and geomorphology of a study area. As the data is available for the whole world these viewers provide a significant resource for those studying areas where access to imagery is difficult. Finally, the ability to seamlessly enhance high quality geographical data by linking it to media rich web-sites has enormous educational potential for a mass audience.

Acknowledgements

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