

MAPPING AND IMAGING AFRICA ON THE INTERNET

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ABSTRACT:

The Internet is awash with a wealth of maps and spatial imagery, some crude and basic, some refined and highly developed. The availability of maps and imagery of Africa over the Internet and the sophistication of the methods used to display such spatial images will almost certainly increase and so continue to revolutionise the way maps and remotely-sensed images are marketed and delivered worldwide. With increasing Internet access and faster bandwidths, Africa is well-placed to benefit from Internet Mapping technology. There are three possible options for delivering and viewing maps and imagery over the Internet static, animated and interactive. *Static* mapping and imagery Web sites allow the user to access fixed raster maps and remotely sensed images for viewing and downloading over the Internet. Static maps and images are usually generated by raster scanning or direct vector-to-raster conversion. *Animated* Web sites allow the user to view maps and imagery dynamically as the content changes, utilising animated Gif89a file format, delayed refresh and multi-media video technology. *Interactive* Web sites allow the user to zoom or pan high resolution raster or vector images and to make decisions on map content or design with the use of plug-ins, applets, scripts or specialist GIS Web servers. The display of large high resolution raster map files, aerial photographs and satellite images has until recently, proved to be an impractical option on desktop computers and Internet browsers, due mainly to the massive file sizes encountered. Image compression techniques used in gif and jpeg raster file formats are well established, however they do not match the impressive lossless compression ratios of 20:1-50:1 being offered by the latest Discrete Wavelet Transformations which are now revolutionising the way maps, aerial photographs and satellite images can be delivered over the Internet or on the desktop. The two main developers of wavelet compression technology for the mapping and remote sensing industries are LizardTech with their Mr SID (Multi-resolution Seamless Image Database) range of products and ERMMapping with their ECW (Enhanced Compression Wavelet) products. Both Mr Sid and ECW offer a range of compression / decompression and viewing software options either as stand alone desktop applications or free plug-ins for Internet browsers and GIS / mapping software. This paper will review and illustrate current Internet Mapping technology utilising example maps and images of Africa and in particular Tanzania.

1. INTERNET CONNECTIVITY IN AFRICA

1.1 Africa and the Internet

The Internet map of Africa has changed substantially in the past 7 years when only 30% of African countries had full Internet access, with as few as 7% enjoying a bandwidth of over 64Kbps. Today all 54 countries of Africa now have full Internet connectivity with over 70% enjoying speeds in excess of 64Kbps and an increasing number of connections transmitting at 256Kbps, 512Kbps and greater (Jensen, 2001).

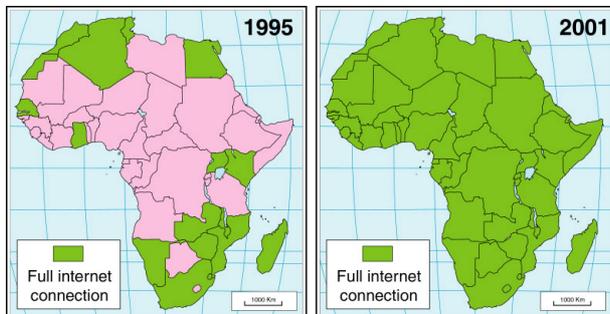


Figure 1. Internet connectivity in Africa, 1995-2001

Internet connectivity and hosting is however unevenly distributed between countries in Africa and also within the rural

and urban population of each country. South Africa alone supports approximately 55% of African subscribers and together with the North African countries of Egypt, Morocco, Tunisia and Algeria account for 75% of the total subscribers in Africa. Only in South Africa is the Internet readily available in regional towns and cities, in most African countries the vast majority of Internet service providers (ISP) and subscribers are to be found in the major urban areas – usually the capital city.

Africa, with a population of over 700 million, has only an estimated 14 million telephone lines – an average of 1 phone line per 50 persons – in Tanzania it is as high as 1:350, a not uncommon ratio in East and West Central Africa. It is also acknowledged that many African countries still rely on elderly analogue telecommunications which are frequently subject to power disruptions, voltage spikes and slow connectivity speeds. Slow connectivity and high costs has resulted in many African companies and organisations being hosted on faster Web servers based in the USA or Europe and a large proportion of e-mail users making use of free US web-based mail services such as Hotmail, Yahoo and Excite (Spangler, 1999).

1.2 Internet Developments in Africa

The importance of satellite, digital and fibre optic telecommunications has now been recognised by many governments in Africa, resulting in an increased development in advanced technology such as satellite links, digital telephone exchanges and cellular mobile phones. These advances are now

having a significant impact on the speed, density and reliability of African telecommunications and so increasing Internet connectivity and usage throughout its countries.

Important developments in progress which will positively impact on Internet connectivity in Africa during 2002 include a fibre optic ring around the African continent, with further optic cables to link to Asia, Europe and S. America. An East African Co-operation (EAC) project to install a digital fibre optic backbone linking Dar es Salaam, Nairobi and Kampala has also been established; and a joint mobile phone Internet service is planned for Kenya in 2002 with the aim of increasing Internet access in highly populated rural areas (Jensen, 1999).

Internet access is rapidly expanding throughout and within the countries of Africa and is becoming more accessible with the introduction of low-cost access at internet cafes, kiosks and phone-shops often equipped with the latest computing hardware and software. With increasing internet access and faster bandwidths, Africa is well-placed to benefit from Internet Mapping technology.

2. AFRICAN MAPS AND IMAGERY ON THE INTERNET

2.1 The World Wide Web

It is now almost 10 years since the introduction of World Wide Web (WWW) browsers with the ability to distribute graphic images, including maps and remotely-sensed imagery, over the Internet. In 1993 there were only 130 Web servers worldwide mainly utilising the Web browser Mosaic from the National Centre for Supercomputer Applications (NCSA). A year later Mosaic was superseded by Netscape, followed by Microsoft Internet Explorer in 1995, this resulted in an explosion of Internet Web usage and an estimated 2.4 million Web servers worldwide by June 1998, today that figure now stands at over 100 million (Peterson, 1999).

As part of this information explosion on the Internet, maps have proved to be an important and significant component of Web browsing traffic. The demand and availability of spatial data such as maps and remotely-sensed satellite imagery has continued to significantly increase with some dedicated map server sites reporting in excess of 100,000 map requests daily. With the introduction of portable telecommunication technology such as Wireless Application Technology (WAP) phones, Personal Digital Assistants (PDA) and Global Positioning System (GPS) devices, this insatiable appetite for maps and imagery will continue apace. In Kenya mobile phone operators are reported to have sold 600,000 mobile phones in 18 months – more than double the estimated total of 250,000 fixed landline phones available nationally (BBC News, 2002).

2.2 The Use of Maps and Imagery on the Internet

The Internet is awash with a wealth of maps and spatial imagery, some crude and basic, some refined and highly developed. The availability of maps and imagery of Africa over the Internet and the sophistication of the methods used to display such spatial images will almost certainly increase and so continue to revolutionise the way maps and remotely-sensed images are marketed and delivered worldwide.

Maps and imagery on the Internet are typically made available either at no cost, as an integral part of general Web sites, or from dedicated commercial and non-commercial map server sites as a free service or for purchase online.

2.2.1 Map Uses on Web Sites: Since the inception of the WWW a large number of Web sites have included maps in some form as an integral part of their design and content. Maps are commonly used on Web sites to identify geographical locations, assist with route-finding or indicate places of interest related to the business or purpose of the hosting site.

Web sites which incorporate maps for locational purposes include those hosting news or weather services, government and non-government organisations (NGO), private companies, businesses and others which supply general information services at national, regional and local levels. An excellent example of the latter is the NewAfrica.Com Web site which includes, in addition to its vast array of general information and links for each country of Africa, comprehensive sets of topographic and thematic maps at national, regional and city levels.



Figure 2. Extract from the NewAfrica.Com Web site showing its extensive set of maps for Tanzania

Maps are also used extensively as illustrative graphics to enhance the design and appearance of Web sites, especially those in the travel and tourism industry. This is particularly true in Africa, acknowledged as the world's number one wildlife safari destination, with its plethora of travel and tourism Web sites.

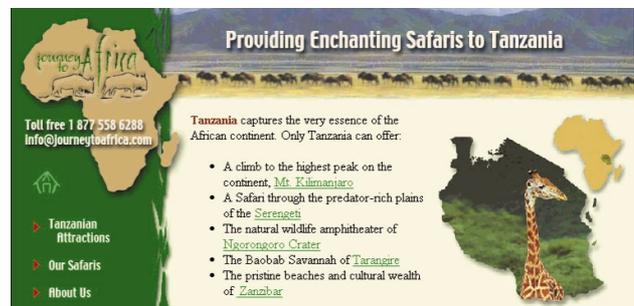


Figure 3. Examples of basic maps used to enhance a Web site

Other prolific users of the WWW for distributing maps and spatial imagery, are academic and research institutions, in Africa and internationally, who use the Internet as a medium for

the publication of geographical and environmental research findings.

On such Web sites it is often possible to freely access detailed mapping, high resolution imagery of Africa and in some instances original research data or spatial data files created in Geographical Information Systems (GIS), e.g Lake Tanganyika Biodiversity Project; Oxford University (BIOMM) Biodiversity Mapping, Monitoring and Management Group; Global Rain Forest Mapping Project.

2.2.2 Dedicated Map Server Web Sites: Some of the highest Internet hit rates can be found on those sites offering maps and imagery as a free service to Internet browser clients. The technology now exists on dedicated map servers to supply maps or plans at any scale together with satellite imagery or aerial photographs to clients, what is lacking for Africa is suitable digital data.

For maps of Africa most of these sites currently only offer small scale mapping usually limited to screen-sized raster images extracted from a larger database at a range of map scales that can be zoomed or panned, e.g MultiMap. Some such as Penn State DCW; GeoCommunity GIS Data Depot also offer GIS data for free downloading. The main digital data source for such map servers is the 1:1,000,000 scale Digital Chart of the World.

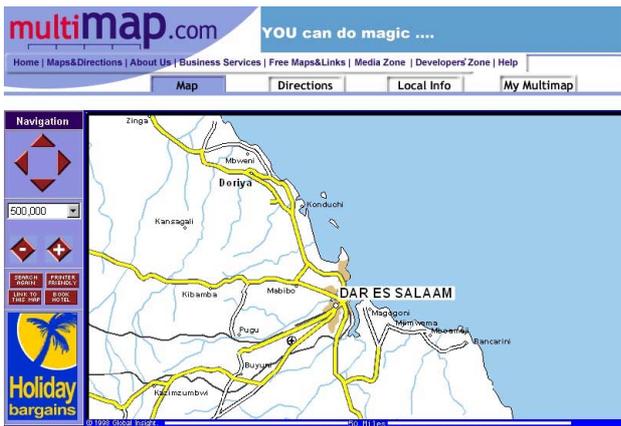


Figure 4. An example of the small scale mapping supplied on a dedicated international Web map server

The unavailability of comprehensive, up-to-date medium and small scale topographic maps and digital data for many African countries is a serious impediment to the distribution of maps of Africa on the Internet. In Africa, while most countries are covered by dual-scale topographic maps published at scales of 1:200,000 – 1:50,000 (Petrie, 1997), many of these maps are seriously out of date and lack proper revision by National Mapping Organisations (NMO). While this problem is being addressed by a number of NMO's, it will be many years before up-to-date topographic mapping is available throughout Africa.

A small number of NMO's in Africa now have a presence on the Internet making available a mapping information service to promote their mapping product range to potential users, they include Botswana, Ethiopia, Madagascar and South Africa. Typical content on such Web sites may include an index map or listing of coverage, sheet availability, scales and cost together with organisational structures or contact details.

The South African Surveys and Mapping Web site is one of the most developed examples and also includes a facility to order and purchase map products online, whereas other NMO sites contain only basic information on the organisation.

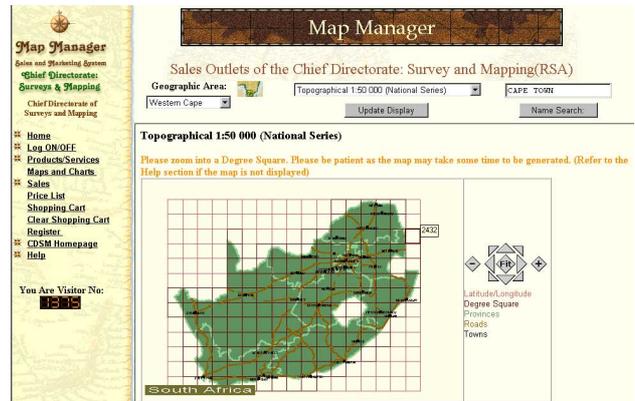


Figure 5. The online ordering Web page of the Chief Directorate: Surveys and Mapping, South Africa

In Tanzania, national mapping and digital data products are made available through co-operation with a commercial mapping/GIS company, Infobridge Consultants who act as their map agents.

In recent years a number of non-government organisations (NGO), who are active in environmental and food security monitoring in Africa, have also become involved in creating maps and GIS spatial datasets for free distribution on dedicated map server sites over the Internet. e.g. FEWS Net (Famine Early Warning System), Africa Data Dissemination Service (ADDS); Food and Agriculture (FAO) (GIEWS) Global Information and Early Warning System, ReliefWeb and the United Nations (UN) Cartographic Section.

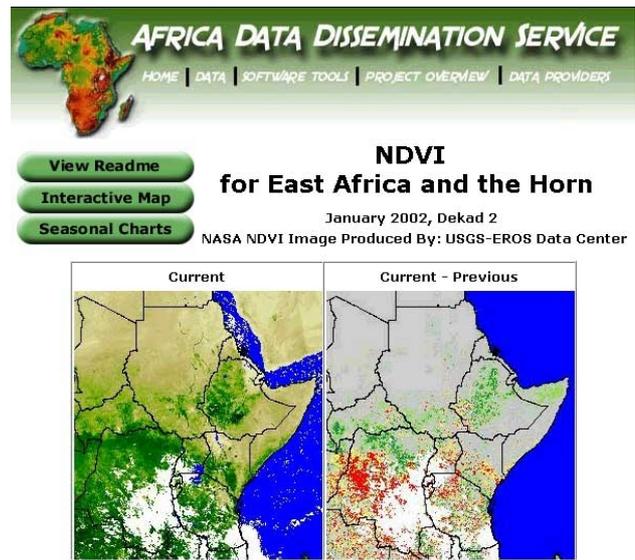


Figure 6. A dedicated map site hosted by the U.S. Geological Survey (USGS) EROS Data Center (EDC)

3. INTERNET MAPPING TECHNOLOGY

3.1 File Formats Used on the Internet

There are two distinct graphical file formats used for mapping and imagery – raster and vector. It is important that cartographers and Web designers have a sound understanding of the properties of raster and vector formats and how their size and resolution are affected by the viewing software adopted on a Web site.

In digital mapping and remote-sensing, raster and vector file structures are used extensively throughout the processes of data capture, manipulation, file conversion and the cartographic design and production stages. When selecting a file format for displaying maps and imagery on WWW sites, cartographers should take into consideration such factors as file size, resolution, suitability for purpose and how they affect Internet download times and access costs.

3.2 Raster File Formats on the Internet

The two most common standard raster file formats currently used on the Internet for direct viewing from within Web pages are GIF (.gif) and JPEG (.jpg; .jpeg). It is also possible to view PNG (Portable Network Graphics) and TIFF (Tagged Image File Format) raster files, however these are not supported by all Web browsers and may require additional “plug-in” software such as Adobe Quicktime or AlternaTIFF to be installed. Two other raster file formats, Lizardtech’s MrSid (.sid) and ERMapper’s ECW (.ecw) are also of considerable importance to mapping and imaging Africa on the Internet, they will be dealt with separately in a later chapter.

Raster data comprises of individual cells or picture elements commonly known as “pixels” structured to form a grid matrix or bitmap to represent an image. Each pixel is located by an x and y co-ordinate value which can record geo-referencing, resolution, and colour or grey scale values. Raster images on Web sites can be displayed at any fixed resolution but are not suitable for viewing outwith their original resolution value as the image gradually becomes “pixelised” or blurred as the image is zoomed in or out.



Figure 7. The effect of zooming on raster images

Characteristics important to Internet mapping and supported by raster formats include transparency, interlacing, anti-aliasing and animation. Transparency allows the background colour of an irregular shape such as an outline map to take on the background colour of a Web page (see figure 3). Interlaced images allow the quick initial downloading of a low-resolution

image followed by the gradual appearance to maximum resolution at completion of file downloading. Anti-aliasing is an interpolation technique used to remove the jagged edge appearance on raster files by creating an image that is made readable by smoothing the edges of the image.

The GIF (Graphics Interchange Format) file format uses a “lossless” method of compression which stores pixels in linear rows and columns without loss of detail. GIF files are limited to a palette of 256 colours and are ideal for topographic and thematic maps which contain large areas of flat colour (e.g. sea, forest), however GIF files are not well-suited to handling gradients with no noticeable colour or grey scale banding.

The JPEG (Joint Photographic Experts Group) file format uses a “lossy” compression method which stores pixels in square area blocks by selectively discarding parts of the image. It is possible with JPEG files to define the compression ratios for file size and resolution. JPEG files support 24 bit colour and is best suited to displaying remotely-sensed satellite imagery and aerial photographs which contain natural graduated tones and complex colour or grey scale images.

3.3 Vector File Formats on the Internet

Vector data can be discrete or continuous in nature with cartographic elements such as points, symbols, lines and area polygons being located and recorded as x and y co-ordinate values linking angle and distance “vectors” between points creating spatial relationships. As vector images are “object-orientated”, they can be viewed on Web sites at any scale without any degradation of the vector image quality. Vectorised text remains as text which can be scalable, editable or searchable.



Figure 8. Vector images retain quality when zoomed in

Unlike the raster format, there is no standard vector file format universally adopted for displaying maps and imagery on Web sites. One of the main benefits of the vector format for displaying maps are the ability to allow maps to be zoomed, panned, rotated, queried or animated interactively by Web users. It should be considered that as digital mapping is today’s preferred option for map production, the majority of new maps and GIS databases created in Africa already exist in vector format.

There are four vector file formats currently in use which are capable of displaying maps on Web sites – PDF (Portable Document Format); SHOCKWAVE (Macromedia Flash, Director, and Authorware); SVG (Scaleable Vector Graphics); and VRML (Virtual Reality Modelling Language). In most

cases separate application software plug-ins, scripts or applets are required to be pre-installed onto the user (client) computer to allow these vector formats to be displayed. Usually these plug-ins are available at no cost and are relatively quick and easy to download or install automatically online.

4. HOW TO CREATE AND VIEW MAPS AND IMAGERY OF AFRICA ON THE INTERNET

It is possible to identify three options for delivering and viewing maps and imagery over the Internet – static, animated and interactive (Shand, 2000).

4.1 Static Maps and Imagery

Static mapping and imagery Web sites allow the user to access fixed raster maps and remotely sensed images for direct viewing and downloading over the Internet. The majority of static images can be displayed directly from within a standard Web page by the use of Hypertext Mark Up Language (HTML) It is also possible to make static images, or selected areas within them, to act as “clickable image maps” allowing the user to link direct from a map to another version of the same a map, a new Web page, photograph or multimedia file. Static maps and images are usually generated by raster *scanning* or direct vector-to-raster *file conversion* and are the most utilised form of display used on Web sites.

4.1.1 Raster Scanning: The most common method used to create static maps and imagery is to raster scan existing hard copy maps or images. The main *advantages* of this method is its ease of use and its ability to allow graphical manipulation of the raster images before placing them on the Web. Raster maps and imagery can be resized, cropped, enhanced, manipulated, edited and converted into several file formats with image processing software such as Adobe Photoshop, Paintshop Pro or Corel Photo-Paint.

The *disadvantage* of this method is the constant trade off between file size and image resolution. High quality scans can result in large file sizes and slow download times from Web sites. The quality of a scanned map or image will be affected by the quality of the original map, the chosen scanning resolution and by screen resolution. Unfortunately there are more bad examples of scanned maps than good ones on the WWW.

4.1.2 File Conversion: It is possible to convert vector map files created in software packages such as Adobe Illustrator, Macromedia Freehand, CorelDraw, ArcView, MapInfo (eg .AI, .EPS, .FH9, .CDR, .SHP, .MID/MIF) into a raster file format such as GIF or JPEG. File conversion may be accomplished directly from within vector graphics and GIS software or with intermediate graphics software which support both formats (eg Adobe Photoshop; Paintshop Pro, Corel Photo-Paint); or via file conversion utilities (eg GraphicConverter, GIFConverter). Most graphics and mapping software now offer a Web option for file export and conversion.

4.2 Animated Maps and Imagery

Animated Web sites allow the user to view maps and imagery dynamically as the content changes, utilising animated Gif89a file format, delayed refresh, applets, scripts and multi-media video technology (e.g MPEG, VRML). Animated maps can be

created from vector maps produced in graphics software packages (eg Illustrator, Freehand, CorelDraw) by saving each map layer or view as a separate raster file (GIF or JPEG). Animated imagery can be created by simply overlaying a series of matching air photos or satellite images.

MPEG allows multiple raster images to be viewed as video clips. GIF89a file format allows multiple GIF images to be included in one file using graphics programs such as Photoshop or shareware such as GifBuilder and Animagic. Delayed refresh makes it is possible within an HTML file to place a time factor on how long an image can be viewed before it is automatically replaced by the next image or page. An increasing number of animated maps are now generated by utilising applets or scripts such as Javascript. Scripts allow specialist animated actions useful in mapping such as “pop-up” windows for map legends or zoomed map insets and for image changing with “mouse-over” actions to switch on or off map layers (Kraak and Brown, 2000).

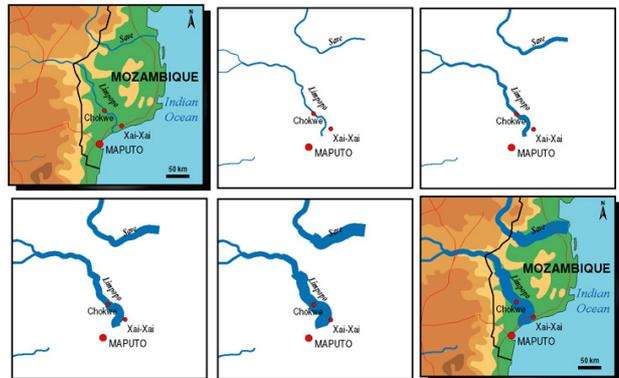


Figure 9. Example of files making up an animated map

It is important to note that each map or layer to be used for an animation must be contained with the same bounding box to ensure registration of the images. This is easily achieved in vector graphics packages by creating a master bounding box on the first map file and duplicating the box and its position on each subsequent overlay file.

4.3 Interactive Maps and Imagery

Interactive Web sites allow the user to zoom or pan high resolution raster or vector images, to query spatial databases and to make decisions on content or design with the use of plug-ins, applets, scripts, submitted forms or specialist GIS Web map servers. With the aid of a plug-in, vector maps can be viewed in Web pages at very high resolution and zoom factors with no loss of quality while zooming or panning (roaming).

Plug-ins used for mapping include Macromedia Shockwave and Adobe Acrobat, SVG and VRML. GIS plug-ins include Autodesk Mapguide, Intergraph Geomedia Web Map, ESRI Internet Map Server, and Dataview Solutions Pavan Web.Publisher. Access to spatial databases can be by user entry to submitted forms or directly via browser or client/server plug-ins, applets or scripts. Using submitted forms, interactive maps or imagery (raster or vector) can also be viewed by user query of a database via keyboard entry. This allows the user to make decisions on content or design within a given set of parameters offered on a form as a list of options or check boxes

on a Web site. Completed forms can be submitted to the server by e-mail or be handled the Common Gateway Interface (CGI).

4.3.1 Mapping Plug-ins: The Adobe Acrobat Reader plug-in allows vector map files created in graphics packages (eg Illustrator, Freehand and CorelDraw) to be embedded and viewed within Web pages once the files have been converted to Adobe Acrobat (.pdf) format. Acrobat Reader is supported by both Macintosh and Windows platforms. In addition to zooming and panning of map files it is also possible to undertake a name search while viewing an Acrobat page and to select and copy / paste text as text or any part of the file as a raster image.

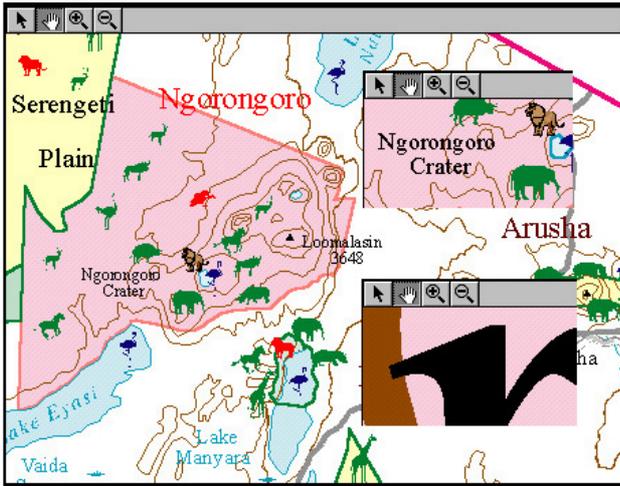


Figure 10. Example of a Web site using a Vector Plug-in with interactive tools to allow zooming and panning

The Macromedia Shockwave Freehand plug-in (Flash, Director, Authorware) allows binary files created in FreeHand (.fh*) or files imported into FreeHand (eg Illustrator and CorelDraw export files) to be embedded and viewed as static or animated images within Web pages. Shockwave for FreeHand is supported by both Macintosh and Windows platforms.

4.3.2 GIS Plug-ins and GIS Web software: A number of specialist tools, classified as Internet Map Servers, for delivering and browsing maps and spatial data have recently become available, allowing greater online interactivity between maps and GIS datasets (Forrest et al., 2000). Internet Web Servers are part of a suite of Web mapping products for creating and editing GIS data for delivery and viewing as maps on the Internet.

The Intergraph Geomedia WebMap serves real-time links to GIS data for viewing raster and vector data with a plug-in for Netscape and ActiveX control for Internet Explorer, both are available free to users. Geomedia Web Map creates smart vector-based maps in a compact ActiveCGM format on the fly, directly from a live, operating GIS database. Geomedia WebMap is an open GIS solution that reads ArcView, ArcInfo, MapInfo, MicroStation, AutoCAD, MGE, FRAMME, Oracle, SQL and Access data directly without translation (Intergraph, 2002).

The ESRI MapObjects Internet Map Server (IMS) is a free viewer which can create dynamic Web mapping applications for publishing geographic data. It supports industry standard

GIS databases, including ESRI shapefiles, ARC/INFO coverages, SDE layers, AutoCAD DWG, DXF and DGN, to let you quickly web-enable your database for the creation of interactive maps. MapObjects offers three viewing options - .static images within HTML documents; ActiveX embedded in a Web page; or with the ArcExplorer stand alone programme ArcView IMS allows users to view, pan, search and download maps served over the Internet (ESRI, 2002).



Figure 11. Extract from an ESRI MapObjects Map Server for Africa Tourism based in South Africa

The Autodesk MapGuide Viewer plug-in allows map and GIS files to be viewed and authored within Web pages of standard browsers such as Netscape and Internet Explorer. MapGuide supports vector files (ArcView shapefile, ArcInfo coverages, Intergraph .dgn, MapInfo .mid/.mif, Atlas .bna and AutoCad .dxf .dwg), raster files (.sid, .ecw, .gif, .jpg, .tif, .bmp), geo-referenced files (Geotiff, GeoSPOT, ESRI and MapInfo) and database formats such as Oracle and MS Access. In addition to zooming and panning this plug-in incorporates layer control, database query, distance calculation, buffering, address or name based zooming and dynamic labelling of map features. MapGuide Viewer works in conjunction with maps created with MapGuide Server and SDF Loader. Autodesk MapGuide is supported by Windows, Unix and Macintosh platforms (Autodesk, 2002).

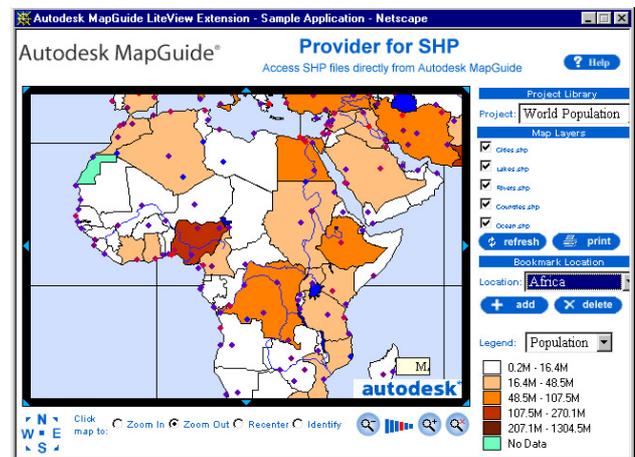


Figure 12. Extract from an Autodesk MapGuide Internet Map Server showing Population Distribution in Africa

The Pavan Web.Publisher software allows maps and spatial data extracted from GIS software to be published and queried on the Web in a fast and easy manner by generating image maps and “hot-linked” attribute tables which can be simultaneously viewed on a Web page. Web.Publisher operates as an added module or extension into MapInfo or ArcView GIS software.

4.3.3 Imagery Plug-ins: Spatial imagery such as satellite images and aerial photographs are best viewed in specialist compression plug-ins such as Lizardtech Mr SID (.sid) or ERMapper ECW (.ecw) and JPEG2000 (.jp2). These plug-ins utilise multi-level discrete wavelet and cosine transformations (DWT, DCT) for compression. Each format can be displayed on most cross-platform Web browsers. Compression ratios of 1:20 – 1:50 and compression speeds of 25-50Mb per minute are possible with MrSID and ECW resulting in very fast download times on Web sites and within GIS software.

4.3.3.1 Lizardtech - Mr SID: The MrSID (Multi-resolution Seamless Image Database) file format is made available from Lizardtech Inc. as part of a suite of wavlet products designed for compressing and viewing high-resolution imagery or scanned maps. The product range includes MrSID Geo, MrSID Photo and DjVu.

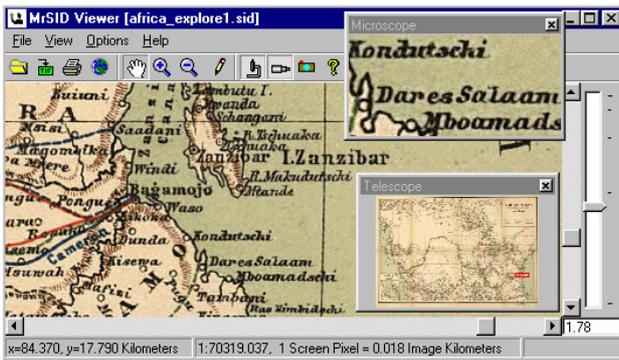


Figure 13. The MrSid Viewer interface showing an extract of a MrSID file of Africa from the Library of Congress Archive

The MrSID Web browser plug-in is free and can be installed on Netscape or Internet Explorer Web browsers. In addition MrSID files can be also viewed directly with the free stand alone viewer or using application plug-ins from within software. e.g. ArcView; ArcInfo, MapInfo; MicroStation; AutoCAD, Smallworld and Photoshop. File access time are also dramatically reduced. e.g. a 50Mb TIFF file can sometimes take 20 minutes to open - using MrSID format it is possible to open the same file in 5 seconds (LizardTech, 2001). For compression, MrSID Geo will handle both TIFF and JPEG file formats and is well suited to creating high resolution raster maps and images at very small files sizes. In tests a geo-referenced TIFF file of 412.5Mb was compressed in 16 minutes to a 17Mb MrSID file, a ratio of 1:24 (Triglav, 2000).

4.3.3.2 ERMapper - ECW: The Enhanced Compression Wavelet (ECW) file format was created by Earth Resource Mapping as an open standard to compress and display images at higher quality and fast speeds than existing raster formats. It is ideally suited for compressing very high resolution satellite images, aerial photographs or scanned maps

for display on the Internet. e.g. an RGB orthophoto image of 16000x12000 pixels covering 25cm x 25cm on ground with a file size 576 Mb can be compressed with a ratio 1:20 to 29MB (Triglav, 1999).

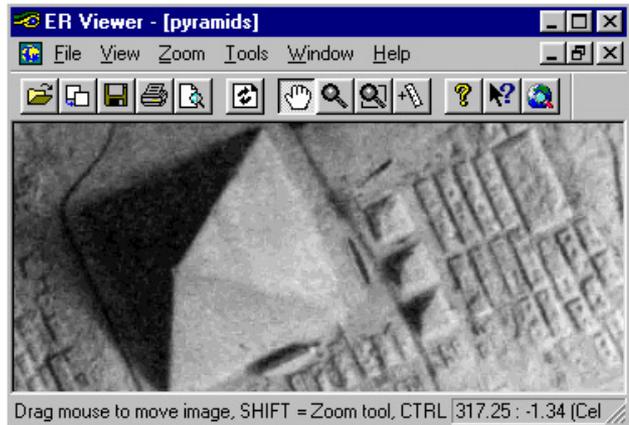


Figure 14. The ER Viewer interface showing an extract of an ECW file of the Pyramids in Egypt

The ECW Web browser plug-in is free and easily installed for Netscape or Internet Explorer. In addition ECW files can be viewed directly with the free stand alone ER Viewer using application plug-ins from within software. e.g. ArcView; MapInfo; AutoCAD; Photoshop; Microsoft Office. ERMapper also offer separate ECW software (including a free version) which can handle a wide range of raster, vector and GIS formats e.g. TIFF, JPEG, BMP, ESRI BIL, SPOTview, ArcInfo and AutoCAD (ERMapper, 2002).

4.3.3.3 JPEG2000: This is a new file format currently under development which is expected to provide better quality files than the existing JPEG format at substantially smaller sizes, that are scaleable and allow for both lossless and lossy compression. Compression ratios of 1:200 are expected with no appreciable degradation of image quality (Mosch, 2000).

5. CONCLUSION

As the Internet has created a new medium for map and spatial data use, it is important that the mapping industry rises to the visual and technological challenges created by Web cartography. The International Cartographic Association Commission on Maps and the Internet have posed a number of broad research questions associated to current and future of Internet Mapping. The Commission suggest the development of guidelines and instructional materials for Web map design and the promotion of international Web map interfaces (ICA, 1999). Another research development is the Web Mapping Testbed Project (WMT) initiative of Open GIS Consortium (OGC) which has recently been created with the aim of making Web browser access seamless across the diverse and widely distributed sources of geo-spatial data sets existing on the Internet (McKee, 2001).

What is certain, is that Internet mapping technology will not stand still, it will continue to be driven by user demand for faster methods of map input and distribution, more user interaction and a continued improvement in map quality and diversity. The development of new methods of coding spatial

data such as XML and GML (Extensible and Geography Markup Language) will create simpler, more powerful and more efficient ways of linking and delivering spatial and non-spatial data in any form. In the fast developing area of telecommunications which is now making a serious impact in Africa, some devices such as PDA's, WAP cellular phones, laptops and in-car computers are already XML enabled and incorporate built-in GPS software (Lake, 2001).

The real challenge for the mapping community in Africa, if it wishes to participate in the Internet mapping revolution, is to make available up-to-date topographic mapping and high resolution imagery at national levels. Ideally such mapping should be in digital mapping and GIS formats, this will allow the countries of Africa to take advantage of Internet technology as an option for supply and delivery to the increasing number of customers operating in the digital environment of the Internet.

INDEX TO MAPPING WEB SITES AND LINKS

An increasing number of useful online Web guides containing "bookmark" links to mapping and imagery Web sites now exist on the Internet. Some are simply "links to links", other such as Roelof Oddens's Bookmarks, are fully indexed and searchable. There are also a number of Web sites which offer online "live" Internet Mapping tutorials and workshops or information on current research. Below is a short list of those Web guides which contain links to some of the sites accessed and quoted in this paper and to Web sites dealing with Internet Mapping technology.

ITC Web Cartography: developments and prospects
<http://kartoweb.itc.nl/webcartography/webbook/index1.htm>

Odden's Bookmarks
<http://oddens.geog.uu.nl/index.html>

Peterson, M.P. ICA Commission on Maps and the Internet
<http://maps.unomaha.edu/ICA/Maps%26Internet/Research/Questions.html>

Petrie G. Web Links Database and Bookmarks
<http://www.geog.gla.ac.uk/~gpetrie/index.htm>

Shand Mike. Mapping the Web Workshop
<http://www.geog.gla.ac.uk/~mshand/Thompson2000/www2000/mapindex.htm>

University of Iowa – CGRER
http://www.cgrer.uiowa.edu/servers/servers_references.html

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Shand, M.C., 2000. Mapping for the Web. Glasgow, Scotland. <http://www.geog.gla.ac.uk/~mshand/Thompson2000/www2000/webtitle.htm> (accessed 21 Jan. 2002)

Spangler, T., 1999. Znet News. The Net in Africa: Diamond in the Rough. <http://www.zdnet.com/zdnn/stories/news/0,4586,2399828-1,00.html> (accessed 24 Dec. 2001)

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