

WORLD WIND AFRICA: AFRICAN GIS ACCESSIBLE TO ALL

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ABSTRACT

World Wind by NASA is the first free interactive 3-D map of the globe. MadMappers' web server is providing African data, allowing GIS data to be accessible to all on a continental scale through the web for the first time ever. World Wind is the pipeline into NASA data. Landsat 7 true colour imagery and SRTM 90m grid DEM data are the base standard data sets. The user is presented with a view of the Earth, which can be rotated to find any area of interest. When the user zooms in to a location, the program displays increasingly higher resolution NASA satellite-generated Earth imagery, topological maps and other geospatial records, which it fetches from the Web.

The program, available as free download, can also overlay weather and national disaster information. Users select a date and time range, and location of the data, and the program will map the data to specific locations. In the near future users will be able to view sequences of imagery and data associated to these locations, as if they were watching a movie and even overlay their own vector data and maps.

World Wind Africa is to become the continental GIS archive with a wide selection of data, ranging from topological maps to vector data, from aerial photography and very high resolution imagery to DEMs. Most importantly World Wind will allow immediate identification and quality evaluation of available data sources by overlaying data on satellite imagery.

Practical applications are innumerable: disaster relief, search and rescue operations, peace-keeping operations, healthcare management, civil aviation, tourism, environmental management are some of the more obvious ones. Also of great importance is the fact that a centralized database will maximize efficiency, prevent data duplication and favour data exchange between countries and government departments. Furthermore easy identification of available data sources will inevitably result in increased investment by the private sector.

1. INTRODUCTION

In the past few years African countries have repeatedly committed to promote policies leading to greater public access to geo-information. Effective utilization of geo-information is widely recognized as a first step towards a sustainable development and towards enhancing capacity for emergency response, more effective and efficient government operations, natural resource management and public decision-making.

Duplication of efforts, as various institutions pursue singular, uncoordinated agendas², sudden availability of huge amounts of free spatial data⁷ with insufficient storage and distribution facilities and slow identification and implementation of standards⁴ have proved that the mere existence of data is not sufficient to ensure its use in Africa by Africans². Increased integration of disciplines such as Remote Sensing, Geographic Information Systems, Space and Atmospheric Science, Satellite Communications, Global Climate and Satellite Meteorology[d] is also needed.

The September 2002 symposium *Global Mapping - Sustainable Development and Geographic Information* at the Johannesburg World Summit led to the formation of MadMappers, a non profit initiative aimed at making *African data accessible to all*. Accessible in the sense that data should be easy to find, reasonable in cost and suitable for use in affordable and user friendly GIS software running on commodity PCs. Initially MadMappers aimed at establishing a comprehensive African GIS archive comprising of African raster, vector and GPS maps, satellite imagery, aerial photography and digital elevation data. As a result of the open data policy by the South Africa Chief Directorate of Mapping and Surveys, in March 2005 www.madmappers.com

started web distribution of South African GIS data free of charge and established a basic on-line GIS archive system of the African continent.

In August 2004 NASA Learning Technologies released to the public the first free interactive 3D map of the globe: World Wind. This is a tool that combines NASA satellite images with sophisticated 3D imaging and the internet. This task is performed, not on expensive, high-powered graphical workstations, but on home PCs[a].

World Wind Africa, a MadMappers project in collaboration with NASA Learning Technologies, is aimed at serving African data to the World Wind platform and to assist Africans in customizing the World Wind tool to meet their needs.

2. NASA WORLD WIND

NASA World Wind is a software application and constituent software componentry for interactively visualizing on low cost computers and in three dimensions, multi-resolution planetary imagery. NASA World Wind integrates Landsat 7 imagery and Shuttle Radar Topography Mission (SRTM) elevation data for 3D terrain (fig.1), provides location identification and allows multiple layers dynamical overlay of global or location specific information from a variety of sources. These include USGS topographic maps and high resolution USGS aerial imagery for the United States, NASA Goddard's Scientific Visualization Studio animations and GLOBE.gov daily data for the world.

Upon start up of the program, the user first sees the Earth (fig.2) composed of cloud-free images of NASA's Blue Marble, from about 12,000 kilometres. By simply using the mouse, the user is able to rotate the Earth or zoom closer to any point on the surface. As the user zooms closer, the imagery smoothly increases to higher and higher resolution, presenting increasing visual detail. The latitude, longitude, altitude, surface elevation, and heading, may be displayed at all times. A user may select an option to display any number of planetary data sets (various Landsat imagery, temperature (fig.3), barometric pressure, etc.) and geo-located information (Rapid Fire MODIS, etc.). The user may also select options for displaying latitude and longitude grids, measurement tools, etc. Additional data can be accessed from preconfigured servers or any WMS compliant server hosting data. Users and/or data providers can also pre-configure World Wind to display purpose-specific data and information, such as flight paths, items and imagery of historical or contemporary events and data useful in typical GIS-based planning.

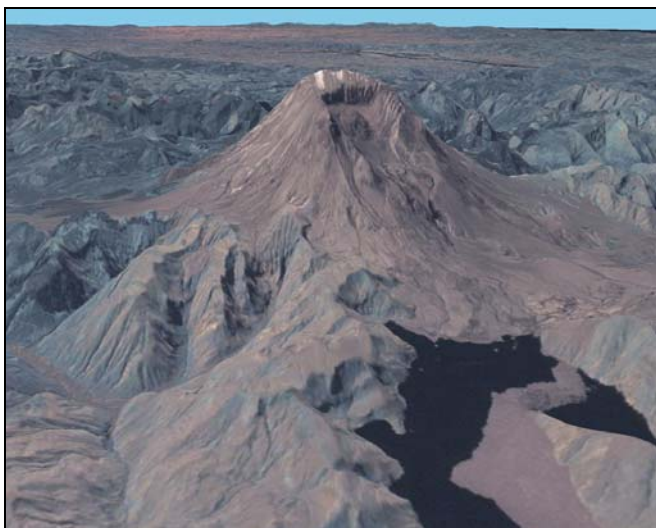


Figure 1: LandSat7-SRTM 3D view of Mt. St. Helens, USA.



Figure 2: World Wind Blue Marble layer.

Despite its voluminous download size (180Mb), World Wind has proven to be a big hit with the public having been downloaded more than 6 million times from September 2004 to March 2005³. The program is also available from numerous outlets not monitored by NASA and has been distributed in promotional CDs by several computer magazines.

Initially World Wind principal aims was to provide the general public with user-friendly access to the highest quality NASA data available. New classes of users have indeed accessed NASA imagery and data in an intuitive and easy to understand way based on the same navigation techniques used in today's video games, allowing even novice computer users to readily interact with that information. The scientific community soon realized its values in resource planning, disaster management, and research in general. World Wind provides compelling visualization of planetary processes from plate tectonics, el Niño, la Niña, the break up of Larsen B shelf Antarctic ice sheet, the seasonal flux to the ozone hole of in the Southern Hemisphere are just few examples.

NASA Landsat satellite image and elevation data server computer at the Jet Propulsion Laboratory, Pasadena, California, USA, receive more than 1,000 data requests per second¹ from users seeking to visualize some of Earth's more interesting events, including wildfires and volcanoes, from the millions of images acquired by Landsat satellites. The program can also overlay weather (fig. 4) and national disaster information. Users select a date and time range, and location of the data, and the program will map the data to specific locations.

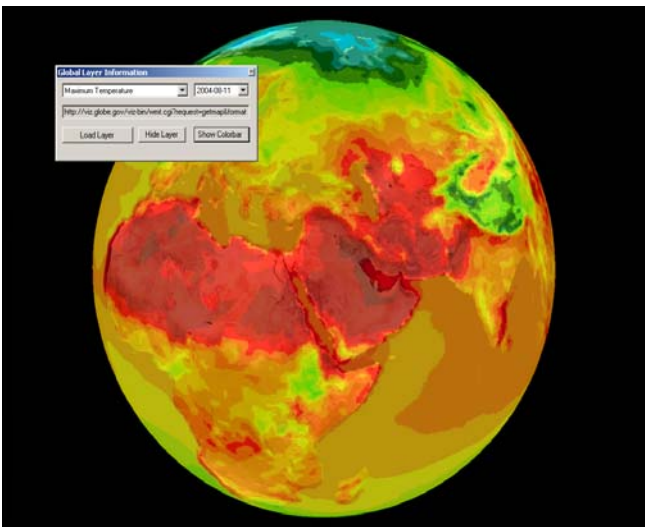


Figure 3: GLOBE 08-11-2004 Maximum temperature. Courtesy: NASA.

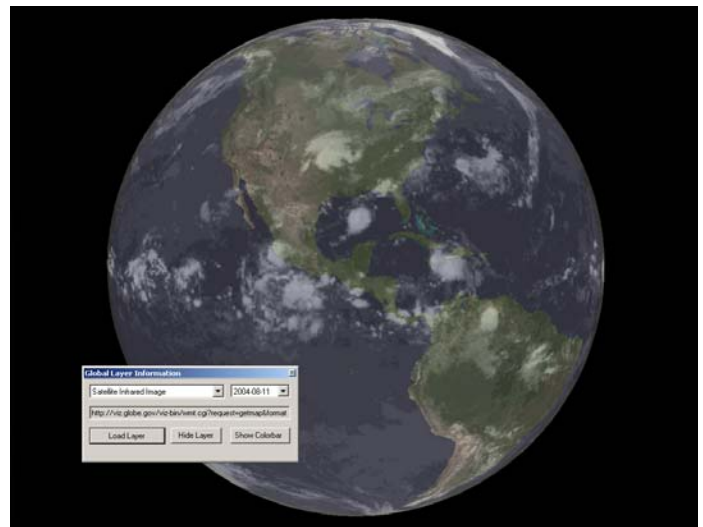


Figure 4: GLOBE - 08-11-2004 Cloud Cover. Courtesy: NASA

World Wind will take you anywhere on the planet - inside Yosemite Valley, through the Grand Canyon or over the Himalayas. The 3D capability uses the NASA SRTM 30m and 90m elevation data. Selected regions offer very high resolution street level coverage (fig.5).

Many NASA offices have also found the program useful: NASA's Geospatial Interoperability Office (GIO) deploys World Wind as the basis for a portal that allows users 3D visualization of the Digital Active Archive Centers' (DAAC) research quality data; Goddard Space Flight Center's Scientific Visualization Studio also uses World Wind to present its combined imagery sets.

Many organizations, including various UN divisions, US AID, National Geographic Society (www.NGS.org) and the National Geospatial-Intelligence Agency (www.NGA.mil) are actively pursuing collaboration with the NASA World Wind project.

Academic, research, public, and educational communities have found in World Wind a pipeline into NASA data. Additional data is also hosted by public domains and volunteers. Microsoft Corp. has indeed built a server farm for the sole purpose of delivering NASA World Wind (NWW) data (NWW.terraserver-usa.com) as part of its TerraServer project.

World Wind version 1,4 is a significant step towards meeting the requirements of the GIS community, featuring:

- Integrated multiple layers with transparency control, i.e., topographic maps transparently overlain on Landsat imagery (fig.6);
- API architecture for modular development and plug-in architecture for proprietary add-ons;
- Faster 3D terrain modelling;
- Improved ESRI Shapefile implementation and scripting tools;
- Bathymetry



Figure 5: Screenshot of Washington D.C.
Courtesy: NASA

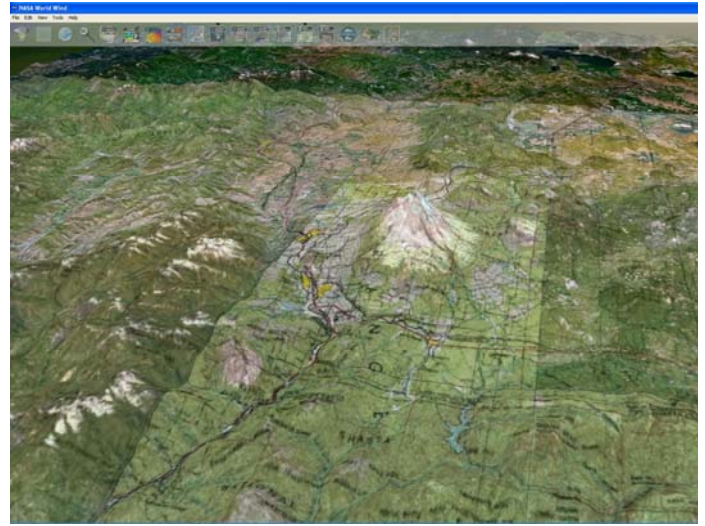


Figure 6: Multiple layers with transparency control.

3. OPEN SOURCE

World Wind is an open source project and, as a result, it is independent of any commercial process. For this very same reason it is a magnet for commercial enterprise: due to its standards-based and open source platform, it provides great potential for entrepreneurial activity in terms of proprietary add-ons and plug-in modules. In practical terms it stimulates the activity of local independent software developers who share experience and technical advice within the international open source community.

NASA Learning Technologies started work on the program two years ago. The program was released under a NASA Open Source Agreement which has stimulated an army of volunteers, researchers and commercial enterprises to contribute their own modifications and enhancement to the program.

Typically a commercial 3D visualization tool of this nature requires per-seat and other licensing fees amounting to thousands of dollars and possibly proprietary formats that do not allow for easy exchange of information. World Wind is free and aims to follow the industry open standards

Because of its plug-in architecture World Wind readily allows incorporation of proprietary modules thereby providing commercially marketable functionalities and features that enhance World Wind in entrepreneurial ways. Due to the broad user base, commercial enterprises are challenged to deliver these value-added enhancements that address specific needs thereby leading to increased value of the World Wind platform. Examples of add-ons made freely available by one of the many independent providers, the World Wind Community forum, are listed in table 1.

TABLE 1: Examples of freely available World Wind add-ons from the World Wind Community website^[1]

A	I	R
Additional Boundaries	Iditarod	Region Departement France
Aeronautical	Image Overlay (plugin)	S
Anaglyph 3D (plugin)	Impact Craters	Seismic add-on
Antarctic Snow Accumulation (US ITASE)	ISS (plugin)	Seismic Hazard Map
Antarctic Weather Stations	J	SHOM Add-On
ANZAC Cove	Joystick Control (plugin)	SW radio transmission sites
Apollo Landings	L	Simple Addon Installer
Appalachian Trail	Landmarks plugin (plugin)	Skriptor (plugin)
Aragons Center Educational Technologies	Landsat and SRTM coverage maps	Sky and Fog Plug-ins (plugin)
ArchAtlas	Layer Download (plugin)	Solar eclipses
Astrobiology Guide	Layer Edit (plugin)	Space Launch Sites
Atlantic Hurricane Tracks	Long Way Round	Spain (La Rioja) Orthophotos
Atmospheric co2 network	M	Colored SRTM add-on
Australia Add-Ons	Major continental faults	SubContinents Boundaries
Austria Boundaries Set	Map projection Plug-in	T
C	Mars (for World Wind 1.2)	Tahoe Rim Trail
Cities Layer with Citynames	Mars Missions	Tectonic Plates
Clock (plugin)	Mini Globe (plugin)	Telescopes Add-On
Country Boundaries Set - Collection	Daily images from MODIS	The Voyage of Ottar
D	Montana Color Orthophotos	Tile Render (plugin)
Darwin (The voyage of HMS Beagle)	Moon	Topographical Earth
Deathstar	Movie and Download script	TrackLog (plugin)
E	Movie Recorder (plugin)	Tsunamis
Earth No-Water Add-on	N	U
Near Realtime Earthquake Marker	2005 NASCAR Tracks	UDP Receiver (plugin)
Eclipse Path	National Parks	Urban Layer Highlighter
ECMWF Winds and Pressures	NATURA 2000	US Aquifers
Environmental Resource Web	The New Zealand Layers	US metamorphiAreas and facies
EROS Ortho Imagery	Nighttime add-on	US Coal Fields
European rivers	Nighttime add-on (high-res Tiled)	US Generalized glacial limit
F	Hook to NOAA ENC GIS WMS	US calderas & impact structures
Fake Atmosphere (plugin)	NOAA Hurricane Photography	US major geologic units
Fixed Radars France	Norway's Prehistoric Hillforts	US Maritime Limits
Fossett's Flight	NWS NEXRAD Stations	US Military Bases
France Topo maps	O	US Mineral Operations
G	Oceanic Physical Property Layers	US Ski Resorts and Areas
Global Biosphere	P	US Spread of Africanized Bees
Global EEZ Add-on	Paragliding Deltaplane and Kites	UTM Zones Grid
Global Volcanoes	Pathlist Geo Grid	V
Google Maps to Worldwind for Firefox	Philippine Geography	Volcanoes
GPS (plugin)	The Planets	W
GPS Tracker (plugin)	Planimetric Measure Tool Plug-in	Wikipedia
GPS2WorldWind	Poland add-on	World Heritage Sites
H	Political World	World Ramsar Sites
Highest Mountains	Population Density with Values	World Time Zones
Holy Places	Q	World Wide Panorama
HTML FRANCE Navigator	Quickbird Add-on	World Wind Central Add-on Pack
		Z
		Zodiaque(French Astrologie

4. LEARNING TECHNOLOGIES

Children and parents can readily share a compelling educational experiences with this type of freely available application and the data it can deliver, be it history, geography, geology or other planetary scientific concepts.

NASA Learning Technologies has established international agreements to support use of the NASA World Wind software by schools and students from countries other than the USA. An "International Space Act Agreement" was signed in October 2004 between Australia, the United Kingdom and NASA to develop a 10-week, 10th grade curriculum on the 'Origin of Life' based on World Wind and other NASA Learning Technology tools.

In South Africa, the National Working Group on Space Science and Technology, in collaboration with NASA-LT and MadMappers, produced a Southern Africa Space Atlas based on World Wind soon to be distributed in South African schools. This as a direct response to the "Khartoum Vision" call for *awareness raising beginning with children through the education system as well as with the media*⁶ and for promotion of the annual World Space Week (4-10 October) within member countries.

5. ENVIRONMENTAL AND DISASTER MANAGEMENT

World Wind finds practical applications in almost all aspects of life on our planet.

The Asian Tsunami of December 2004 was an unexpected demonstration of World Wind flexibility: within days high resolution Quickbird imagery was made available in support of the relief effort. With the incorporation of bathymetry World Wind has now the ability to provide not only valuable educational content but also a visualization tool for a global tsunami early detection/warning system.

SERVIR, the Regional Monitoring and Visualization System for Mesoamerica (<http://servir.nsstc.nasa.gov>) is a joint project among NASA, the US Agency for International Development, the World Bank, and the Central American Commission for Environment and Development that intensively utilizes satellite imagery and other data sources for environmental management, disaster support and decision making. Slash and burn agriculture, illegal deforestation and other destructive activities are monitored by the system.

World Wind was recently used by the Environmental Minister of Panama to examine the existing border between Panama and Costa Rica along the Sixaola River which was affected - and perhaps modified - by severe floods in January 2005. World Wind enabled the Environmental Minister to better understand the border and the potential effects of the flooding in changing the river course and hence the international border. This has led to a follow-on satellite and in situ analysis of the border which is currently being negotiated by the two countries.

The UN Food and Agricultural Organization is currently examining ways to deliver dynamically data relative to locust migration into World Wind thus not only to become able to promptly intervene and minimize negative effects on affected population but ultimately to prevent such natural disaster from taking place.



Figure 7: MODIS - Hurricane Kate.

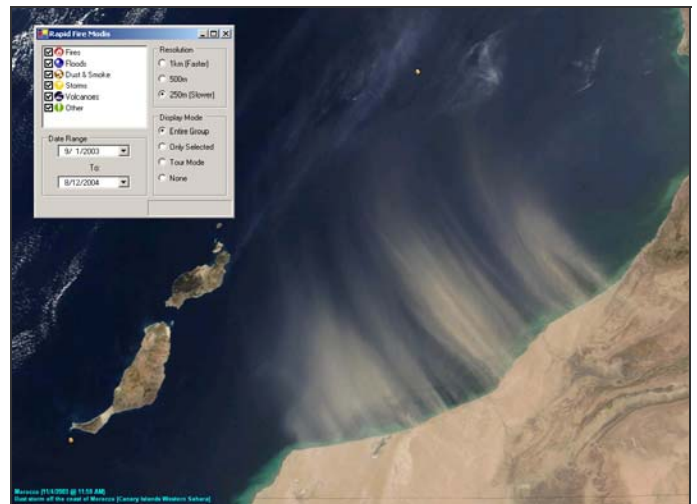


Figure 8: MODIS - Dust storm in Morocco.

6. WORLD WIND AFRICA

The World Wind Africa Server brings African geo-information into the World Wind platform. The initial focus of project has been South Africa, due to the open data policy and the endorsement by S.A. Chief Directorate of Mapping and Surveys of the initiative. CDSM Raster maps (scale 1:50.000), aerial photography and orthophotos (from 0,5 to 1,0m/pixel) been prepared for use in World Wind (fig.9) through a process which involves re-projection (World Wind requires data in Equidistant Cylindrical projection) and pre-processing to specific World Wind format tiles for various altitude levels. This approach is labour and time consuming and has been chosen for the following reasons:

- To minimize hardware requirements and response time during serving of images. This is particularly important to maintain capital investment and running costs of the web server as low as possible. The large user base is likely to put standard web-servers under tremendous strain;
- Compilation of World Wind data-packs to be distributed on media (CD/DVD) so to minimize internet access requirements in areas where broadband is not available. This makes World Wind Africa a versatile mobile tool which may be used on computer notebooks and tablet PCs;
- Active involvement of the community in data preparation and development of a know-how suitable to be easily replicated in limited resource settings;
- Data so prepared is only suitable for use in World Wind and cannot be reverse engineered for use into other software as it is the case with other type of public web servers. This is done to protect intellectual owners of data from its unauthorized use and to offer providers of high resolution satellite imagery a secure platform from which to promote their products both with the GIS community and with the wider public.

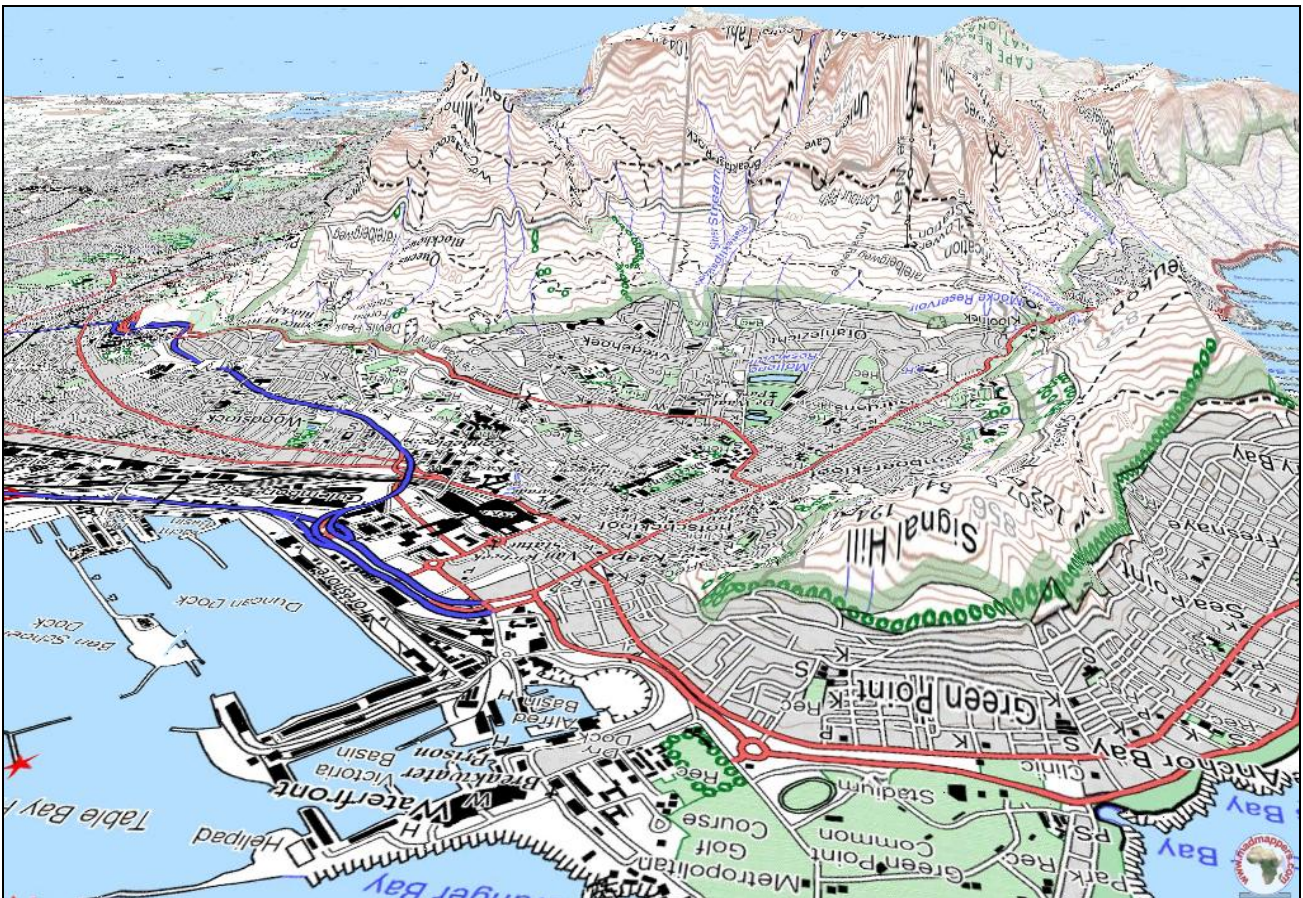


Figure 9: Cape Town 1:50 000 map layer - South Africa. Source: MadMappers

An unexpected development of the World Wind Africa initiative has been the positive interaction between members of local and international GIS and IT communities which has resulted in a passionate exchange of concepts and ideas to the enrichment of both. All data processing has been performed utilizing software modules, compiled by volunteers for the specific task, based on the freely accessible open source FWtools/GDAL/mapserver GIS software. The MadMappers community is today capable of implementing minor customization to World Wind modules and plug-ins in response to specific end user requirements.

A complete World Wind Africa starter kit has been compiled: it includes the tool and a considerable amount of data. Additional data-packs of African Landsat 7 imagery and SRTM elevation have also been prepared.

Vector datasets in the form of add-on packs have been compiled as well in response to specific needs: the Tracks4Africa GPS mapset (www.tracks4africa.com) is of particular note due to its high accuracy, continental coverage and practical demonstration of results which can be achieved through community efforts (fig.10). The T4A GPS map of Africa is the result of contributions in excess of 4.000.000Km of genuine GPS tracklogs suitably filtered, verified against Landsat7 imagery and consolidated into a database of roads/tracks uncontaminated by the presence of external data.

The open data policy of the South African authorities has obtained another positive result with the implementation of the South Africa layers on the World Wind Africa servers. MadMappers invites communities in other African countries to join in the effort of putting the whole of continent on the World map.

World Wind Africa is the ideal platform for African data, a window of Africa to the world and of the world to Africa.

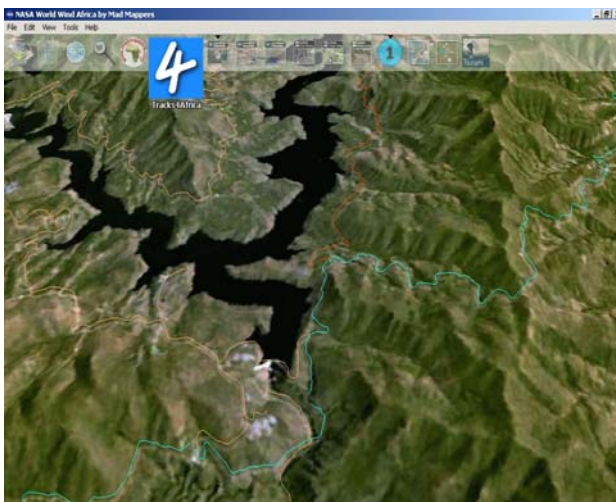


Figure 10: T4A GPS map Layer, Katse dam, Lesotho

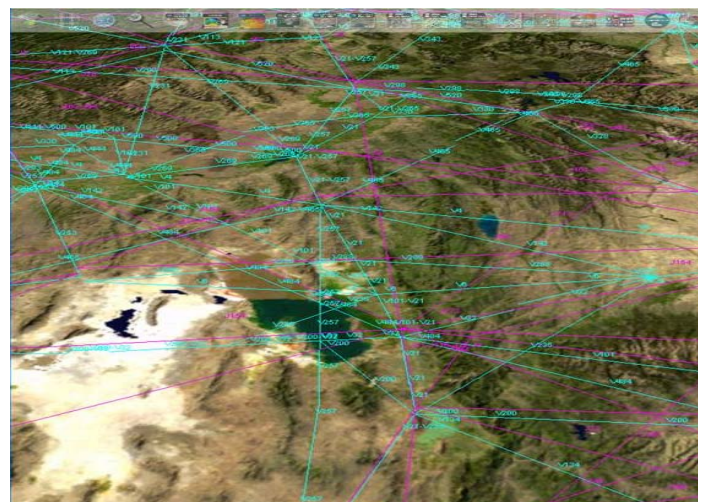


Figure 11: Digital Aeronautical Flight Information File

7. PRACTICAL APPLICATIONS

Practical applications are innumerable: disaster relief, search and rescue operations, peace-keeping operations, healthcare and environmental management, civil aviation (fig.11) and tourism are some of the obvious. In general the World Wind platform is capable at the touch of the mouse of graphically displaying, in real time, any type of geo-environmental information, static or dynamic, commonly needed in education, opinion forming or prevention.

World Wind Africa is an invaluable tool in the drive to educate African youth about the benefits of geosciences. Heritage, geology and wildlife take a complete new meaning when transposed in a 3D virtual reality.

World Wind Africa is a powerful tool for the scientific community: it enables immediate correlation between geo-images and demographic, geographic and ecological data in a manner easy to understand and interpret.

World Wind Africa is a standard platform which the GIS community might consider not as an alternative processing tool but as a free visualization tool capable of being readily understood by everyone. A common African interface would without doubt reduce the risk of data duplications, favour data exchange between countries and government departments and enable prompt identification and evaluation of existing data sets.

8. CONCLUSION

NASA World Wind open source modular platform and plug-in architecture is well suited for purpose specific add-ons created by local developers and free from proprietary restrictions. World Wind is also a pipeline into terabytes of high quality NASA data. World Wind is the ideal candidate to become the global geo-information visualization tool of choice.

World Wind Africa is a MadMappers initiative aimed at creating the African data layer of the popular World Wind tool. South African GIS data of the highest quality is currently being served to World Wind from the World Wind Africa web server. Software is free and so is web access to data. DVD starter kits aimed at individuals and organizations with limited internet access have been prepared. A variety of data-packs containing Landsat 7, SRTM and vector data have also been compiled to meet the needs of the African scientific community.

Propagation of geo-information in Africa would be greatly enhanced by a truly continental World Wind Africa service. The African educational and scientific community would have at their disposal an invaluable tool able to visually display information against readily available geo-data sets in a manner easy to use, understand and interpret.

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