

SHARING LANDSCAPE INFORMATION THROUGH AN ONLINE GEOGRAPHICAL VISUALISATION PORTAL

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ABSTRACT:

The access to, and visualisation of, landscape information through online websites can effectively support natural resource management and decision making. Online repositories of information are a useful resource for community members and researchers to enhance their understanding of agricultural and natural landscapes past, present and future. In this paper we report on the development of an online geographical visualisation resource in Australia that provides access to scientific outputs created through a number of visualisation techniques.

The Victorian Resources Online website (<http://www.dpi.vic.gov.au/vro>) is a collection of more than 7,500 pages of natural resource information and maps. A Geographical Visualisation Portal resides within the site that includes: (i) links to contemporary media, (ii) access to technical reports and publications, (iii) video clips depicting visualisation techniques applied for understanding real and fictitious geographies, (iv) downloadable interactive content such as KMZ files, (v) a virtual soil profile used as an educational aid to increase understanding of the complex dimensions and properties of soils and (vi) a 3D object library comprising trees, shrubs, animals, built structures and rural features. The online visualisation portal provides an alternative metaphorical interface for users to access content to better understand Victorian landscapes.

1. INTRODUCTION

1.1 Research Aim

With a number of critical issues facing society such as climate change, food supply, deforestation, biodiversity loss and water shortages, landscape information and communication tools are becoming increasingly important. Geographical visualisation provides a powerful communication vehicle for communicating past, present and future landscape change scenarios.

In this paper we introduce a novel comprehensive online Geographical Visualisation Portal which aims to: (i) improve the communication of natural resource information to end users through the use of static and interactive visualisation products, and (ii) provide a resource to the broader geographical visualisation research and practitioner communities to support the development of their own visualisation products and services

1.2 Geographical Visualisation

Geographical visualisation also known as GeoViz, draws upon many disciplines including cartography, scientific visualisation, and GIScience to provide theory, methods and tools for the visual exploration, analysis, synthesis and presentation of data that contains geographic information (MacEachren and Kraak, 2001). GeoViz software packages broadly include: standard geographical information systems (GIS); digital globe packages such as Google Earth and Microsoft Virtual Earth; multi-media and 3D animation software such as Flash and 3D Studio Max;

Virtual World platforms such as SecondLife and Cybertown; and Computer Gaming Engines such as Unity and Unreal. GeoViz software packages can be used to create two-dimensional, three-dimensional and four-dimensional (temporal) visualisation products to more fully engage or immerse end users in an exploratory information experience. GeoViz products can be developed as stand-alone products or on-line static or interactive semi and fully immersive environments. In this paper we focus on GeoViz as it is applied for sharing and exploring natural resource information.

1.3 Brief Review of Natural Resource Management Websites

There are numerous websites, portals and repositories containing natural resource information. A web search using the Google search engine (8th Nov 2009) resulted in 44,200,000 web hits on the search term 'natural resource management + website'. This clearly indicates that significant natural resource management information resources exist online. These sites contain both public and private information repositories and some comprise interactive spatial mapping tools to access and share information. Others contain only textual and report information. A limited but growing number of these online sites comprise information that can be accessed and explored through the use of interactive, three-dimensional geographical visualisation interfaces.

The Development Resource Management Portal for US AID (<http://www.rmportal.net/>) (accessed 8th Nov 2009) provides an example of a website which comprises both public access and a

dedicated members section. The Natural Resource Management Shared Land Information Portal (<http://spatial.agric.wa.gov.au/slip/index.asp>) (accessed 8th Nov 2009) provides an example where natural resource management information can be accessed via a java enabled interactive spatial viewer. There exist a number of Wikipedia-based natural resource management portals, for example the Environment Portal (<http://en.wikipedia.org/wiki/Portal:Environment>) (accessed 8th Nov 2009). None of these portals or websites enable the end user to access and explore the information using novel GeoViz techniques.

Yet, there are a growing number of online sites where natural resource information can be accessed and shared via a range new engaging GeoViz interfaces. For example the Climate Change in Google Earth site (<http://www.google.com/landing/cop15/>) (accessed 30th Nov 2009) includes five narrative virtual tours where visitors can explore a number of issues such as the impact of deforestation and subsequent increased carbon dioxide emissions, and increases in water stress brought about by changes in rainfall patterns (Figure 1). Also available from this site are downloadable Intergovernmental Panel for Climate Change (IPCC) climate predictions for low, medium and high emissions scenarios. Through these you can explore predicted changes in global decadal annual mean temperature and rainfall from 2000 to 2090.



Figure 1. Google Earth used to visualise projected increase in water stress for 2050

The Mannahatta project (<http://themannahattaproject.org/>) (accessed 30th Nov 2009) provides an example of visualising New York pre-settlement ecology in 1609. This project uses geographical information system (GIS), Google Maps (see Figure 2) and 3D animation software to create a number of online interactive exploratory tools for visitors to explore both past and present New York.

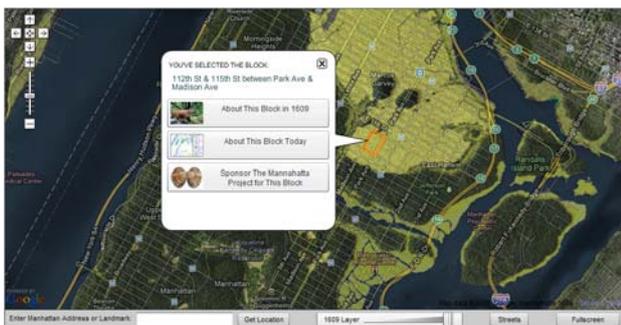


Figure 2. Mannahatta project Google Maps exploration window. Visitors can use the slider bar to see probable landscape changes from 1609 to present day New York

National Geographic has established BlogWILD (<http://blogs.nationalgeographic.com/blogs/blogwild/>) (accessed 30th November 2009) for sharing information about the planet. A posting from November 3rd reports on the use of the SecondLife immersive 3D virtual world that has been used to host New Media Consortium's 'Symposium for the Future' (see Figure 3). National Geographic used this virtual world symposium to give a presentation about the planet and how new media approaches, such as virtual worlds, can be used to assist people to better understand natural systems. Virtual World platforms such as SecondLife provide a way to present landscape information through what Cartwright (1999) refers to as the 'gaming metaphor'.



Figure 3. National Geographic communicating natural resource information via a SecondLife Virtual World online symposium

2. VICTORIAN RESOURCES ONLINE

2.1 Overview of VRO

Since 1997, the Victorian Resources Online (VRO) website has been a key means for the dissemination of natural resources information via the Internet in Victoria, Australia. The website currently consists of around 7,500 web pages as well as 1,900 maps and 1000 downloadable documents and reports. Information is provided at a range of scales—from statewide and regional overviews to more detailed catchment and sub-catchment levels. At all spatial scales, information is organised around the key 'knowledge domains' of climate, landform, land use, soil, water, biodiversity and land and water management. In 2009 the website has attracted over 1,000 unique users per day. User profiling shows a wide range of users accessing and using material—including students and teachers, researchers, consultants, librarians, advisers and farm extension staff. Information presentation on the website is continually being enhanced, more recently with incorporation of visualisations to support the more standard web content, i.e. text and graphics.

2.2 Geographical Visualisation Portal

The VRO Geographical Visualisation Portal was established in 2005. Its aim was to provide alternative ways to access and interact with natural resource data, information and knowledge. The portal was established to: (i) complement and supplement

existing online VRO content, and (ii) provide an online portal where users can access a number of geographical visualisation resources. This research endeavours to support a number of end users ranging from citizens, catchment managers and policy makers to geographical visualisation researchers and practitioners. The following sections of this paper will introduce the various components that comprise the Geographical Visualisation portal.

2.2.1 WWW Online Resources

This section of the portal provides a gateway to a number of related international geographical visualisation online resources assembled by Cartwright, (2005). The resource provides hyperlinks to a number of selected applications using contemporary media to visualise geography. The resources are categorised under a number of headings including (i) soil and landform, (ii) life sciences, (iii) map and image collections, (iv) downloadable data storages, (v) information services with maps, (vi) online map-generation services, (vii) web atlases, (viii) hybrid products, (ix) 3D products, (x) innovation and geographical visualisation tools, (xi) developing areas of interest and (xii) references. The information is arranged hierarchically with a series of image thumbnails and hyperlinks providing links to external resources.

2.2.2 Publication Repository

This section of the portal provides a PDF version of a number of visualisation publications including: technical reports, conference papers and factsheets. There are links to peer papers published by the ISPRS working group II/6 'Geographical Visualisation and Virtual Reality'. Links are also available for each of these presentations that have been published as YouTube movies. This document repository by no means provides a comprehensive library of papers, reports and factsheets on the topic of geographical visualisation. Rather the repository provides a number of downloadable documents that are accessible to range of audiences from the public and policy makers to geographical visualisation researchers and practitioners. These reports and papers are scientific outputs produced by the Victorian Department of Primary Industries Geographical Visualisation Team and collaborators.

2.2.3 Video Clips

With the continual advances in Information Communication and Technology (ICT) there is a growing number of software tools available to create geographical visualisation products. These include open source software such as Virtual Reality Mark Up Language (VRML) and X3D, photorealistic visualisation packages such as Visual Nature Studio (VNS), GIS tools such as ESRI's ArcScene, and Digital Globe products such as NASA World Wind, Biopshere, Google Earth and Microsoft's Virtual Earth. Each of these products has strengths and weakness. For a comparative review of digital globe products see Aurambout et al. (2008).

VRML has been used to create a 3D interactive virtual Knowledge Arcade for natural resource management in Victoria. This virtual arcade includes 19 virtual shop fronts for a number of key agencies including catchment management authorities, water authorities, state government departments and universities (Pettit et al. 2008). A virtual tour of the Knowledge

Arcade has been created as a video clip file embedded within the Geographical Visualisation Portal (see Figure 4).



Figure 4. Natural Resource Management Virtual Knowledge Arcade video clip

There are a number of photorealistic visualisation software packages which can be used to create GeoViz products depicting past, present and future landscapes. For example Appleton et al. (2002) has produced photorealistic landscape visualisations to communicate climate change futures in agricultural areas in the United Kingdom. Figure 5 provides an example of the photorealistic landscape visualisations created for illustrating the concept of tree fencing a farm paddock in rural Victoria. This video clip shows the creation of a tree fence using fallen branches and trunks to encourage native vegetation regrowth by protecting the area from sheep grazing.



Figure 5. Photorealistic visualisation of the concept of tree fencing a farm paddock created using Visual Nature Studio

ArcScene is a GIS-based visualisation extension used to create 3D scenes and fly-through movies. The Mt Elephant video clip was created using this software (Figure 6). The basic requirements for creating the 3D movie included a digital elevation model (DEM) or LIDAR (light detection and ranging) data and a geo-referenced airphoto raster. Base height values and extrusion settings are derived from the DEM. The airphoto imagery is draped across the DEM and the render effects function enables a hypothetical illumination of the surface by creating hillshade. The ArcScene Fly tool facilitates a realistic fly-over effect to investigate the scene. A simple recording is

achieved using controls that resemble a VCR (Video Cassette Recorder) on the Animation Controls dialog box that creates a movie file.



Figure 6. 3D Fly-through video clip of the Mt Elephant Geological Significant Site

The information provided on the ‘Sites of Geomorphological and Geological Significance’ section of the VRO website has been derived from a number of limited distribution publications and developed in association with retired geological specialists. The VRO website provides maps showing locations of many hundreds of these sites, as well as associated text and images. Video clips are now being routinely used to provide enhanced web content and animations. Content includes landscape fly-overs that have been developed to provide a ‘virtual tour’ of these sites (e.g. ‘virtual tour’ of Mt Elephant example shown in Figure 6), including historical footage and audio-visual recordings of retired experts describing landscapes in the field.

2.2.4 Interactive Content

A section of the portal contains downloadable interactive content. The content has been developed predominantly as OGC compliant Extensible Keyhole Markup Language (KML) files (KMZs). Visitors who have a KML compliant digital globe application can download these files and explore and interact with the digital content provided. Fishtrack is one such project where a downloadable KMZ file has been created (Figure 7). The Fishtrack project visualised the movement of a single black bream fish through the Gippsland Lakes for 1 year (2005–2006). The input data has been captured through monitoring the movement of the fish as tracked via proximity to known sensors within the lakes. Such visual information can provide insights into the migratory patterns and breeding behaviours of fish over time.

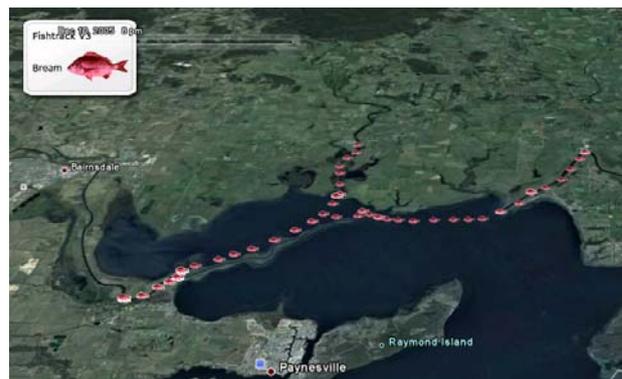


Figure 7. Fishtrack example of temporal mapping of a single black bream fish through the Gippsland Lakes

2.2.5 Virtual Soil Profile

The ‘Virtual Soil Profile’ (VSP) is an educational aid to increase understanding of the complex dimensions and properties of soils (Imhof et al. 2008). It is being developed as a visualisation tool to enhance soils education and training through improved awareness and understanding of soils and their function (see Figure 8). The initial objective is to display aspects of soil morphology and biology and their relationship to soil aggregation and management as well as depicting key processes (e.g. carbon cycle). The VSP was initially developed to support soils education and training as a stand-alone application but is being progressively incorporated into the VRO website for access by a broad range of users. Zooming functionality allows viewing at increasingly finer scales—from the pedon and its component soil horizons, to peds, through to macro- and micro-aggregates. Soil biology can also be viewed at increasing levels of detail—ranging from soil litter organisms (e.g. collembola and mites), earthworms, organisms associated with soil minerals and the living plant (e.g. protozoa), as well as bacteria and fungi.

The VSP is made up of 4 orientated digital images: north, east, west and floor images. These are used to construct the 3D VSP. It is developed and run through Coppercube 3D flash engine. The VSP is set in a panoramic scene. The panorama camera view is as if you were inside the soil pit itself. This additionally allows the panorama profiles to be used as navigation using the mouse or keyboard through the VSP features by applying hotspots to the profile textures. The 3D Coppercube engine also includes an action scripting reference. This reference allows the development of events to interact with the VSP. We used this to develop navigation menus based on soil structure and elements to move your way through and interact with the VSP by using the Coppercube actionscript switchToScene reference. The hotspots on the VSP are one of two navigation methods. By using these hotspots (links), a user can move their way between scenes and zoom in from VSP scale and macro scale down to 50 micrometres to view scanning electron microscope (SEM) imagery.

At different (zoom levels) scales, 2D and 3D animations are made available to the user to further immerse the user in the structure and processes that make up soil. The second method of navigation is through the frozen tree menu.



Figure 8. 3D VSP panorama with hotspots and tree menu

The 2D and 3D animations are developed as a means of depicting processes such as decomposition that happen in soil as opposed to the VSP that show features such as nematodes that are part of the makeup of soil. The VSP will be run online or alternatively off a DVD in flash and html format as an interactive application to present the features and processes that soil consists of.

2.2.6 3D Object Library

In working towards a 3D Spatial Data infrastructure the VRO Geographical Visualisation Portal contains a selection of 3D objects that can be downloaded by end users to create their own custom landscape visualisation products. The 3D object library contains over 75 individual files that represent Australian vegetation, animals, built infrastructure and rural landscapes (see Figure 9). Objects are provided in a number of file formats including GIF, WRL, FLT, 3DS and SKB. Each object can be downloaded as a ZIP file containing multiple file formats so that the objects can be used in a number of visualisation software packages (Pettit et al. 2009). The current object library is similar to the Google 3D warehouse site, <http://sketchup.google.com/3dwarehouse>, however focus is placed on supporting multiple file formats and objects that represent Australian landscapes.

The current object library exists as a series of cascading style sheets (CSS) web pages under four broad categories. Ongoing research is focused on developing and testing a prototype geodatabase structure for accommodating a much large volume of objects and also to enable increased upload and search and discovery functionality (Bishop et al. 2009).

3. EVALUATION

Google Analytics reporting is integrated within the portal to collect user data and also provide a tool to analysis and report on usage and user trends. Analytical reports for the portal shows a consistent trend against data collected for the whole VRO web site. Usage of the portal can be seen to increase during the academic year with a peak at the end of term, usage then drops during academic holidays.

Consistently the most popular areas within the portal (26th November 2009) are the 3D Object Library and the geographical visualisation video clips section, with 43% and 23% of total traffic over the past 12 months respectively.

During the past 12 months data has been collected and a geographical profile of users has been calculated. The reports

show (26th November 2009) that 48% of our users are from Australia, followed by USA (27%) and UK (4%). The Australian data can be further analysed to show that 61% of users are Victorian, 16% from NSW, 7% from Queensland and the remaining 16% are from the remaining states and territories. Interestingly, these metrics indicate that the resource has international exposure. Further research will investigate end user feedback both qualitative and quantitative, on the value of the Geographical Visualisation Portal as both an educational and decision-making resource.

Vegetation A - G

[3D Object Library](#) | [Vegetation](#) | [Animals](#) | [Built Structures](#) | [Rural Landscape](#)

[Common name A to G](#) | [Common name H to R](#) | [Common name S to Z](#)

Title	Thumbnail	Download
Alpine Ash <i>Eucalyptus delegatensis</i>		Alpine Ash (ZIP - 750KB) Provided in .WRL, .FLT and .GIF format
Black Sheoak <i>Allocasuarina littoralis</i>		Black Sheoak (ZIP - 1.67MB) Provided in .WRL and .GIF format
Box Ironbark <i>Eucalyptus sideroxylon</i>		Box Ironbark (ZIP - 130KB) Provided in .WRL and .GIF format
Box Ironbark <i>Eucalyptus sideroxylon</i>		Box Ironbark (ZIP - 133KB) Provided in .WRL and .GIF format

Figure 9. 3D object library downloadable vegetation trees and shrubs

4. LIMITATIONS

Victorian Government Departmental websites need: “to give citizens ready access to government websites, without discrimination.” (<http://www.egov.vic.gov.au/victorian-government-resources/standards-victoria/accessibility-standard.html>) (accessed 26th November 2009). Content published in the Geographical Visualisation Portal had to comply with these accessibility guidelines that state how information should be provided. In brief, consideration needs to be made to people with disabilities, people using older technology and people with poor telecommunications infrastructure, often in regional and remote areas.

Users with a disability may need access to information published within the portal, therefore the different ways they interact with the web page needs to be accounted for and solutions implemented so they not face discrimination.

To ensure content is available to people using older technologies and with poor telecommunications infrastructure we restricted the number of file formats supported so users only need to install one application to see all the objects we provide. Flash video capability has been utilised to provide quick access to a preview within the internet browser of some objects before the user needs to download it. Interactive content has been created in KMZ file format that is an Open Geospatial

Consortium (OGC) compliant format which can be viewed via a number of GIS and digital globe platforms.

The government website guidelines provide challenges in being able to serve-up visualisation outputs which require plug-ins and other web components to run. Also, larger more complex visualisation outputs need to be made available as smaller files as well as optional larger downloads or higher definition files to accommodate end users with poor telecommunication infrastructure. Therefore, for example the Virtual Knowledge Arcade discussed in Section 2.2.3 that was created in VRML cannot be hosted via VRO. This is because even though VRML is a web compliant format it requires a third party plug-in to enter the virtual world. Also the Virtual Knowledge Arcade is over 600 MGBs and exceeds the permissible download standards. The video clip functionality provides a current work around for such web hosting limitations.

5. FUTURE WORK

There are a number of ongoing developments within the Geographical Visualisation Portal. These include the completion of the virtual soil profile and continual uploading of new objects into the 3D object library. Also a Virtual DemoDairy section is currently being developed. This site will enable visitors to undertake virtual tours of a dairy in south-west Victoria under current and future forecast climate change scenarios.

The next important phase of this research is to obtain metrics from end users of the value of the Geographical Visualisation Portal as both an educational and decision support resource.

6. CONCLUSIONS

In this paper we have presented the Victoria Resources Online Geographical Visualisation Portal. The site provides a number of resources to support the communication and sharing of natural resource information. The site incorporates both static and dynamic geographical visualisation products and includes a 3D object library resource to support end users in creating their own virtual landscapes.

One of the challenges facing online resources such as the VRO Geographical Visualisation portal is being able to enable a truly collaborative Web 2.0 interactive information-sharing environment. This is a current challenge to many government organisations in being able to provide online user-centred designed experiences.

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