Does visualisation of digital landscapes serve itself? How topographic, planning, environmental and other thematic information is integrated and disseminated via web GIS

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1 Introduction

Digital landscapes provide decision makers with readily-available tools that enhance the policy-to-decision process. Malta has been witness to various processes to create digital landscapes for both the professional and the general public. This study reviews the operational and technological processes employed since the introduction of GIS in Malta and reviews the issue of 3D GIS and whether visualisation served its purpose in reaching the current state of affairs. A case-study on one particular research is reviewed which investigates whether users look at visualisation outputs as part of a larger environment or as an end in themselves.

2 Visualisation and Dissemination

The first Maltese web-mapping exercise predated the PA mapserver by a year (Formosa, 2000), which service was based on image mapping and GIS-client (Figure 1). This was followed by the launching on the mapserver in 2001 (http://www.mepa.org.mt/index.htm?links.htm&1) (Figure 2), a fully-fledged on-line GIS based on MapXSite. During this phase, research into GML was initiated in order to investigate how such technologies could enhance the process (AGIUS, 2003)

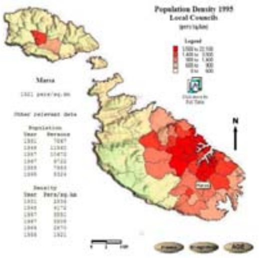

Fig. 1:Census Webmap,

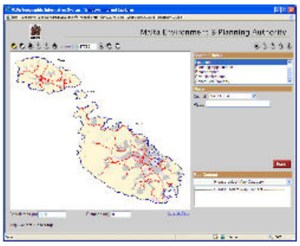

Fig. 2: MEPA mapserver

Fig. 3: MEPA eApps

The next phase used ArcGIS technology was launched in 2007 (eApplications) and takes the mapserver one step forward where users can query the data and access diverse concurrent data layers (Figure 3). This led to the free distribution of public sector information (PSI), public access to environmental information and won national awards (best e-business solution for 2007 by the Computer Society of Malta) as well as international awards (‘Special Achievement in GIS’ - 2006 ESRI International User Conference and the ePractice.eu Good Practice label for 2007). From a setup of a Town Planning Section within the Maltese Public Works the Planning Authority (PA) was established in 1992 with a remit for the administration of national mapping; carrying out of land surveys of specific areas; and maintaining an up-to-date national geographic database (DPA, 1992), which integrated the National Mapping Agency (RIZZO NAUDI, 2005). In 2002, the Environment Protection Department was integrated with the PA to form MEPA. The latter process enabled the creation of the environmental GI data layers such as Corine 2006 and habitats maps (Figures 4a-b) (FORMOSA, 2005a).. Thematic GI was taken up by the Information Resources Unit, whilst the Mapping Unit tasked with capturing data by photogrammetric methods, also digitizes the 1:1000 and 1:2500 base map (RIZZO NAUDI, 2005; RIZZO NAUDI, 2007)

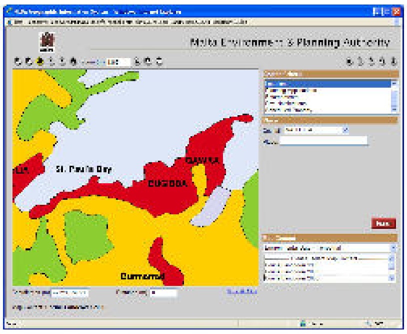

Fig. 4a: Corine 2006, MEPA

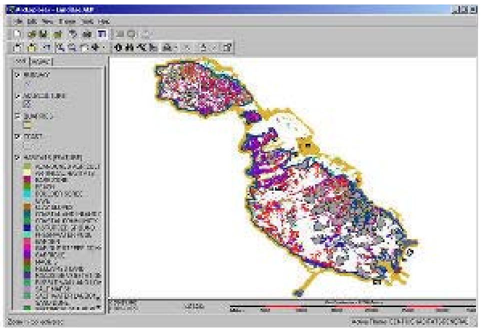

Fig. 4b: Habitats map, MEPA

3 The Methodology

3.1 Process Review

3D visualisations have become increasingly important in strategic planning or analysis of potential impacts arising from a proposed development on the existing landscape. More specifically, the flexibility offered by 3D-visualisation techniques in terms of space and time, both retrospective and prospective, makes their potential use in planning manifold (LANGE, 2001). 3D visualisation can give a substantial contribution to spatial planning, facilitating improved communication among experts and laypersons, as well as provide a more realistic and comprehensive scenario for planners to reach quicker knowledge-based decisions. The primary software package utilised by MEPA for 3D has traditionally been Mapinfo Professional supported by the Vertical Mapper Extension, as used for terrain modeling, viewshed analysis, line-of-site analysis and various overlays both in raster and in vector format. Outputs include point-to-point analysis (Figure 5) and viewshed analysis (Figure 6).

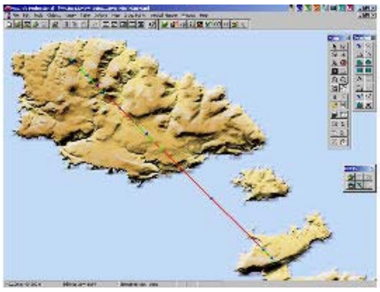

Fig. 5: Typical Point-to-Point Visibility Analysis utilising terrain model

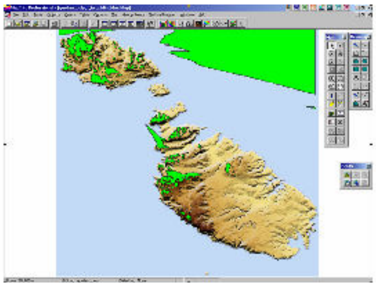

Fig. 6 Typical Viewshed analysis overlay over terrain relief map.

BORG et al (2007) developed a Heritage Management System which was envisaged to produce its first 3D interactive model of Mdina, (Figure 7) enabling viewing of planning applications to determine the effects on the fabric prior to erection (Figure 8).

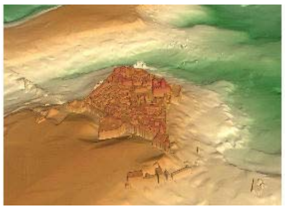

Fig. 7 Terrain modeling of the medieval city of Mdina

Fig. 8 The final VRML output. The hotspots are linked to info in an immersive environment

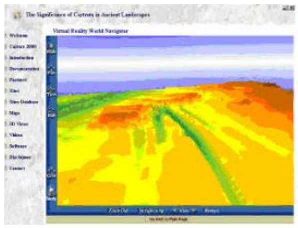

Fig. 9 Scene visualisation

Another project carried out in the heritage field was based on the mapping of 3D cartruts analysis (FORMOSA, 2005b) (Figure 9). The next phase, leading to the case-study under review in this paper, ventured into the overlaying of orthoimagery over a dem file generated from heights points. The case-study was based on the Gozo area known as Dwejra which output (Figures 10a-b) required the integration of the above-mentioned data layers. Figure 10a depicts the dem-based imagery and Figure 10b the completed model integrating buildings. Figure 10c updated the terrain model for future building analysis.

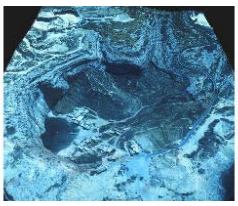

Fig. 10a: Terrain relief modeling draped with aerial orthophoto of the area under study, in this case Dwerja, Gozo.

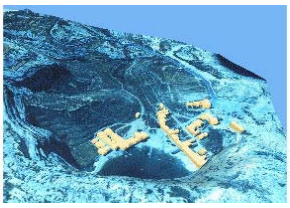

Fig. 10b: Terrain relief modeling draped with the buildings included).

Fig. 10c: Updated 2004 terrain relief map

3.2 The San Paul's Bay Case Study Methodology

The limitations of these systems were highly evident; very limited use of the visual outputs, little if any interactivity and highly laborious processing. The next phase saw the employment of an investigation into the use of more modern tools and processes and compares it to the old established regime. The main aim of the CONCHIN (2005) research was to investigate whether 3D GIS could improve MEPA's spatial decision-making process through the provision of more realistic scenario building. In order to achieve this, the study focused on a number of methods including: a review of the current GIS methodologies employed at MEPA and their application in the various stages of the decision-making process (case analysis, strategic and local planning, impact assessment, board presentation); identification of the perceptions of GIS users at MEPA; a review of the current 3D GIS software technologies and the utilisation of some of them through a case study approach in order to explore further their capabilities; and Identification of future potential application of 3D-GIS within MEPA.

The qualitative approach investigated a project proposal for a tall building development in St. Paul's Bay and was analysed through pre-set questions based on an open-ended approach where participants wrote in their individual perspectives and discussed them in a group (Conchin, 2005): an initial interview with the key GI users within MEPA (12 in total) aimed at gauging their opinion on GI through showing them a study area using 2D and pre-interactive GIS outputs, followed a few months later by a second interview which presented them with the various 3D visualisation outputs from each of the software packages used, aimed at eliciting their reaction to the technology. The study finally made a comparative analysis of the results obtained from both interviews including a discussion on the potential effect of 3D visualisation application within MEPA's modus operandi.

4 Results

4.1 Comparing the Rendering Options

Phase I: Mapinfo Professional v7.5 and Vertical Mapper extension v3.0 : Figures 11a-b show the process taken to gather the data reviewing the height per building plot whilst Figure 12 shows the overlaying of the 3D image over the model. In terms of 3D visualisation, Mapinfo is capable of rendering particular screenshots of the area under study, provided the relative parameters are inputted through the 3D viewer in Vertical Mapper. In this case the sky was included as a backdrop image and the aerial images draped over the relative grid. An example with the proposed tower building is shown in Figure 12. The majority of respondents stated that the image quality of the above outputs was a bit lacking in realism with slightly long rendering times and on the number of parameters that have to be inputted every time a new scene has to be rendered. Also, the way draping occurs causes the border pixels to be cascaded along the vertical walls, rendering a sometimes cluttered result. Even so the resulting images could still give a general idea of how a proposed development affected the landscape and skyline of the area.

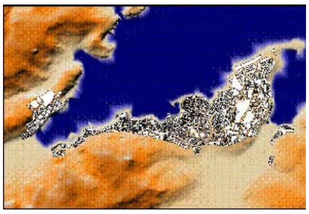

Fig. 11a Mapping the building

Fig. 11b Building the 3D model

Fig. 12 Overlaying the orthoimage onto the 3D model, proposed tower development. Source: CONCHIN (2005)

Phase II: ARCGIS 9 (ArcScene) with 3D Analyst and Spatial Analyst: ARCSCENE was used to create an 'as is' and 'as proposed' scenario. The terrain grid data layer was loaded and the aerial images draped over the study area. The building footprints with relative height data were loaded and polygons extruded as per inputted height value in metres (Figure 13). The respondents immediately noted the major advantage over MAPINFO in that the 3D scenarios created are rendered in real-time and the viewer can zoom in or out and fly around the scene as opposed to the process mentioned previously. This factor appealed to all the respondents as it provided a more realistic perspective of the area together with the facility of moving around without the need to input different parameters every time.

Fig. 13 ARCSCENE screenshots showing the site area location before (top 2 images) and after the proposed development example (bottom 2 images). Source: CONCHIN, (2005)

Phase III: ARCVIEW 3.3 with 3D Analyst, Spatial Analyst and SiteBuilder 3D: The first thing noted by the majority of the respondents was the potential to create a realistic virtual environment using Multigen Paradigm's SiteBuilder3D extension for ARCVIEW's different movement modes, including 'walk mode', 'fly mode' and 'drive mode'.

Fig. 14a ARCVIEW screenshots showing Multigen Paradigm's SiteBuilder3D in 'fly mode' – Current State. Source: CONCHIN, (2005)

Fig. 14b ARCVIEW screenshots showing Multigen Paradigm's SiteBuilder3D in 'fly mode' – Proposed State. Source: CONCHIN, (2005)

Features include images-draping over building roofs and sides; the capability of replacing point, line or polygon features with Open Flight models (.flt); and the manipulate of data in its original 2D format render and view it in real time in 3D (Figure 14). Many of the respondents were enthusiastic with the outputs presented however most of them stated that this package was more project based.

4.2 The Case Study Interviews Outcome

The role of GIS in spatial planning and analysis within MEPA is very significant. Most respondents stated that GIS constitutes more than half of their work namely: the analysis of GI layers to assess the impacts of development applications; planning and environmental policy formulation; creation and maintenance of new map data layers and creation of models for holistic decision-making such as 3D noise maps within an urban construct. In the preliminary interview only one respondent had claimed to use GIS for visualisation purposes, which is still the case today since although projects requiring 3D analysis and output have increased, landscape visualisation is still not a standard requirement of development application review. This is potentially due to that fact that for day-to-day operations at an authority-wide level access to GIS is restricted to MAPINFO. In view of this, decisions on development applications are still dependent on 2D knowledge-based data and the visualisations provided by the developer/architect, in the form of photomontages or 3D images, which can be manipulated to the developers' advantage. There is also little investment towards online virtual worlds. This said, the respondents saw drastic change in opinion following the completion of the secondary interview. Whilst in the preliminary interview half of the interviewees stated that MAPINFO does satisfy their work requirements, in the secondary interview all respondents went for the more ARCGIS and ARCVIEW option. The interest focused primarily towards the defined 3D models. This is understandable when considering the increase in development proposals constituting a significant visual impact to the surrounding landscape in recent years. These include tall buildings (especially those in excess of ten storeys), landfills, quarry restoration projects, land reclamation, and new buildings within urban conservation areas, noise maps, air pollution, water columns, amongst others. In view of this, all the interviewees strongly agreed that 3D visualisation is essential in the spatial planning realm both as a communications tool and as a means for assessing the impacts of a proposed development on the landscape and urban form. The secondary interview results showed that this support is predominantly strong from the policy-making sections within the organisation. This enhances the view that there is support to introduce 3D visualisation as part of the current *modus operandi* at a much earlier stage within the overall decision-making process than simply as a communications tool for the final assessment of individual developments in a scenario where the real is clashed against the virtual (Figure 15).

An important element resulting from this study is that visualisation is perceived as a more important aspect for the spatial planner than the potential spatial capabilities that a full-blown GIS could provide. The MAPINFO output was considered as limited due to the amount of time and significant knowledge required to manually render individual scenes. On the other hand the outputs generated by both ARCGIS (ArcScene) and ARCVIEW (SiteBuilder3D) generated more interest amongst the interviewees. All the comments were positive and some even stated that it gave them a new perspective to the meaning of ‘3D visualisation’. SiteBuilder3D was deemed the most popular particularly for its ability to include considerable detail and realism to the virtual scenario. Unlike the other packages this one contains an in-built 3D image library of trees, shrubs, lampposts etc., which can also be updated with objects reflecting the local environment. This gives users the possibility of creating a virtual environment that is very similar to the real thing. This allows decision-makers to gain familiarity with the rendered scene.

Fig. 15 Reality versus Virtual Reality. Source: CONCHIN, (2005)

New technologies: The creation of Google Earth has brought about a complete revolution in the 3D visualisation realm particularly for the fact that the information is readily available online at lttle or no cost. The Google 3D engine provides the users with the ability to accurately upload local 3D spatial datum and provide viewers with a very high level of detail and hence a significant element of realism (Figure 16). One must keep in mind that this tool is strictly visual and that none of the GIS capabilities offered by the other software packages highlighted in the study CONCHIN (2005) are present requiring the use of Sketchup to extrude the GI layers is being investigated as shown in Figure 17.

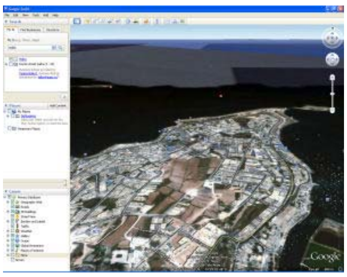

Fig. 16 Google Earth: perspective view

Fig. 17 Sketchup output – work in progress

5 Conclusions

The improvements brought about the application of 3D technologies in the realm of spatial planning are evident especially in terms of visualization and aid to the decision-making process. 2D images can be more manipulated than a 3D-extract particularly since the GIS data is utilised from a controlled environment (not directly accessible to external users). The analytical procedures shown in the case study model are based on the extrusion of 2D objects. Its use is recommended as the area under study can be viewed in 3D means that the decision-maker can familiarise better with the issue being discussed without having to imagine how his/her decision would in fact result in reality. Another recommendation is that when 3D visualisation is coupled with GIS, which is considered a multi-disciplinary tool, it too can be combined to many topic areas including coastal and marine planning, quarry management, development impact assessment etc. which in turn increases its potential further. The use of 'cleaner' and more realistic visualisations as employed by ArcView increase familiarity with the area and the greater detail coupled with the advantage of having GIS tools close at hand aid in more relevant and quicker spatial planning decision is further recommended. The spatial planner/decision-maker has the responsibility of taking important decisions that affect the general environment in many ways. Visualisation has been seen as an addendum to other tools, however interactive media will take the data beyond mere visual aids to immersive environments that enhance decision-making. Thus the purpose of visualization goes beyond its mere use of imagery creation for imagery sake but goes hand in hand with the integration of GI in the decision-making process as well as enabling long-term strategic planning enabling smoother transition from the data to information to knowledge to action process.

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