

3-dimensional EIA – A Greener Tool to Plan and Design

Lawrence K.K. NGO, Terence S.W. TSANG & Charles Y.K. WONG

Environmental Assessment Division, Environmental Protection Department, Hong Kong Special Administrative Region (HKSAR), China

Email: lingo@epd.gov.hk, terence_tsang@epd.gov.hk & charleswong@epd.gov.hk

1. Abstract

Hong Kong (HK) has an area of about 1,100 km² which is housing more than 7.2 million populations. The green area occupies more than 70% of land of which about 400 km² is Country Parks where developments are generally not allowed. In view of limited space and high environmental standards in Hong Kong, the planning and design of major projects such as airport, highways, treatment plants, etc., are challenging.

Under the Environmental Impact Assessment Ordinance (EIAO), the Director of Environmental Protection (DEP) is the authority to enforce the provisions of the Ordinance, including the approval of an EIA report under the EIAO. The professional judgments, analysis and decision-making are based on the statutory requirements as stipulated in the EIAO. There are plenty of sensitive uses, such as Country Parks, Site of Special Scientific Interest (SSSI), Conservation Area (CA), Marine Parks, etc. in Hong Kong, which impose rather great constraints to project planning. To assist professional officers to review EIAs and planning submissions, EPD recently developed a green tool where environmental constraints can be viewed in digital models.

This paper will elaborate on the background, development, functions, implementation and benefits of the 3D green tool. The implementation of the tool reflects both vision and commitment in supporting a virtual reality 3-dimensional EIA for improved delivery of EIA studies. It is a successful example on how the latest Environmental Spatial Information Technology can provide more efficient and better quality services to serve and protect the environment for the citizens of Hong Kong.

2. Introduction

In Hong Kong, EIAs for developments were carried out since the early '80s. Initially they were carried out under an administrative framework until the enactment of the EIAO in April 1998ⁱ. Under the EIAO, proposed projects that would generate adverse impacts on the environment are classified as Designated Project (DP). There are two categories of DPs, namely Schedules 2 and 3 respectivelyⁱⁱ. The Schedule 2 DPs including major projects such as airport, railway, sewage pumping station, etc. whilst those under Schedule 3 are engineering feasibility studies for urban development / redevelopment ^[1].

The provisions of the EIAO are enforced by the DEP who also takes advice from other relevant authorities

ⁱ Environmental Impact Assessment Ordinance, Cap. 499, Laws of Hong Kong: <http://www.legislation.gov.hk/eng/home.htm>

ⁱⁱ A Guide to Environmental Impact Assessment Ordinance, EPD, HKSARG, October 2005:
<http://www.epd.gov.hk/eia/english/quid/index1.html>

on various environmental aspects, e.g. advice from Director of Drainage Services on drainage matters and Commissioner for Transport on traffic and transport mattersⁱⁱⁱ. The public can access EIA information through a dedicated web-site^{iv} or hard copies of EIA reports available in offices of project proponent and the EIAO Registry Office.

Under the HKEIA system, the first crucial step is to determine whether a proposal is a DP. There are a number of thresholds, conditions, criteria, intrusion of sensitive sites to be thoroughly studied before a concrete conclusion can be determined. Laborious steps and procedures are necessary to investigate on each consideration item by item.

With recent advancement in Geographical Information System (GIS) technologies, availability of digital data and the effort of professionals in various fields, geographic data and data management are now more widely adopted in various government departments. As such, dispersed geographic data can be integrated to reduce the time and effort needed to search, obtain and compile the data, shortening the EIA decision making process.

3. 2-dimensional to 3-dimensional

Currently, in the Geo-Info Map^v and Geo-spatial Information Hub (GIH) provided by the Hong Kong Lands Department, there is plenty of 2-dimensional web-based geospatial information, such as Rails, Country Parks, Outline Zoning Plans (OZP), etc. for sharing amongst departments^[2]. However, to locate sensitive areas, such as SSSI, CA, Marine Parks, etc., professionals still have to make reference to hard copies of maps to determine whether projects would encroach onto these areas to determine if they are DPs. Furthermore, based on segregated map resources, multi-encroachments onto sensitive areas may be overlooked and visual impact from aerial angle is difficult.

The difficult situations described above can be resolved by using a 3D platform to better represent the projects in 3D environment. With the foundation of three key concepts: integration, collaboration and sharing, a new 3D green tool implementation approach has been developed. It allows 3D streaming of terabytes of complex raster and vector data (including ASCII texts, shapefile, modeling output, etc.) for visualization in a powerful state-of-the-art Windows-based 3D client viewer.

4. 3D EIA - A Greener Tool

The 3D green tool is installed with GIS data, terrain details, building height information, satellite images and aerial photos covering the entire Hong Kong territory (see Figure 1). Using 3D green tool, one can browse the territory in 3D environment and build unlimited digital models (or projects) freely on both terrain and marine surfaces.

ⁱⁱⁱ Technical Memorandum on Environmental Impact Assessment Process, EIA Ordinance, Cap.499, S.16, Laws of Hong Kong: <http://www.epd.gov.hk/eia/english/legis/index3.html>

^{iv} Environmental Protection Department HKSARG (2014), the website of the EIA Ordinance: <http://www.epd.gov.hk/eia/index.html>

^v HKSAR Geo-Info Map: <http://www2.map.gov.hk/gih3/view/index.jsp>

Based on the World Wind^{vi} technology, the 3D green tool provides faster, more efficient and powerful 3D viewing experience allowing users to preview, interrogate and navigate through terabytes of remotely hosted raster with true 3D GIS data. The 3D green tool also comes with a plug-in utility so that users can develop their own custom plug-ins to provide additional user-specific functions such as integration with in-house modeling systems and provision of additional features.

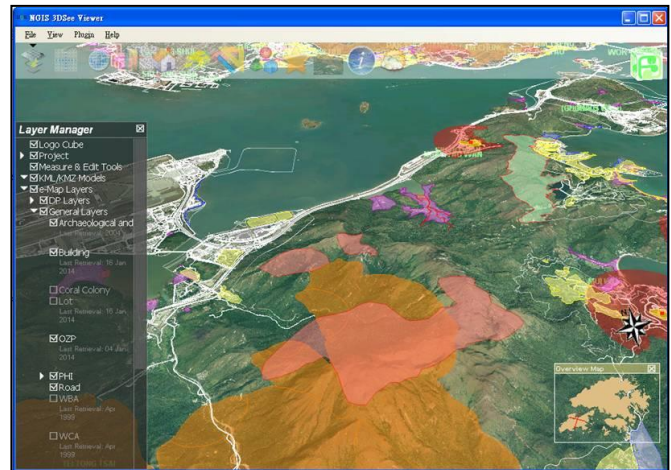


Figure 1: Multi-layers on 3D Green Tool

All the latest GIS data in relation to DP determination are integrated into the 3D green tool from various government departments. While most of the GIS data are updated quarterly, on-line digital streaming from “Geo-info One-Step Web Services” is also established to synchronize OZP data.

When users mouse-over on the virtual terrain, they can preview the Principal Datum (mPD) and associated GIS data with individual building heights surrounding the mouse icon. Various electronic maps are integrated as layers which can be switched on/off to suit the requirements and presentation style of the users. Layer color scheme templates and handy measurement tools are also provided, such as distance, area and topographic determinations.



Figure 2: Some 130 3D Models

Examples are illustrated in Figure 2. Through this function, 3D models which can be adjusted by users to different orientation; to specific location with coordination reference and in various scale and can also be assembled with various scalable elementary structures / parts, such as chimney, oil tank, chlorine storage, etc. The molding of 3D models can take into account proper fitting on slope and uneven terrain; and the thresholds can be examined should the proposed project is a DP.

Designated Project Assessment Function

This function integrated 3D DPs models into the 3D green tool and it can embrace relevant physical parameters and spatial characteristics of the projects to facilitate professionals to consider the DP status.

There are some 130 congregated 3D models which cover 17 categories and 88 project types under the EIAO Schedule 2.

^{vi} National Aeronautics and Space Administration (NASA) <http://worldwind.arc.nasa.gov/features.html>

Plain interface allows input of parameters on specific 3D models which can be modified with various operating conditions, such as road alignment, treatment capacity, distance of discharge point, etc. All related thresholds and criteria of DP will be highlighted on screen and displayed side by side with the summary of analysis results.

Environmental Data Management

The 3D green tool uses a knowledge management approach to consolidate environmental data (e.g. Air, Noise, Waste and Water) as shown in Figure 3. On-site monitoring and modelled environmental data from EIA reports can be retrieved in layer format per user's preference which can give professionals a preliminary idea whether there is still carrying capacity to accommodate the proposed project(s).

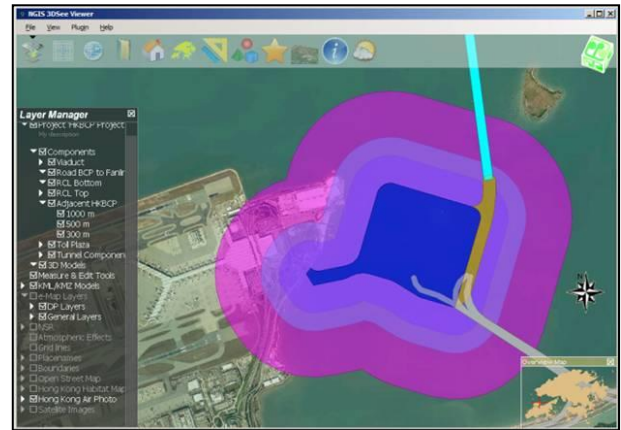


Figure 3: Multi-consultation Zones

With the consolidation of various environmental data, professionals can retrieve not only the previous data, but also the modeling data spatially with desired criteria, such as by project, year, type of pollutant, etc. The environmental data can be adopted into the described DP assessment function by displaying the data spectrum of selected project or confined study area, say 300m, 500m or 1000m from the user-defined site boundary.

5. Challenges and Opportunities of 3D EIA

To incorporate and share different electronic spatial data from various government departments and divisions within EPD, suitable digitization tools are adopted according to the type of data source, format and resolution. In doing so, it is necessary to transform antique paper map into digital data using data matching conversion applications. Furthermore, a lengthy process was involved in liaising with GIS data owners for authorizing and releasing user right, resolving the data security concerns of implanting restricted GIS contents and ensuring the compatibility of electronic data. Good communication with clear explanations and close interactions with map owners are of paramount importance to solicit electronic data, especially the restricted materials.

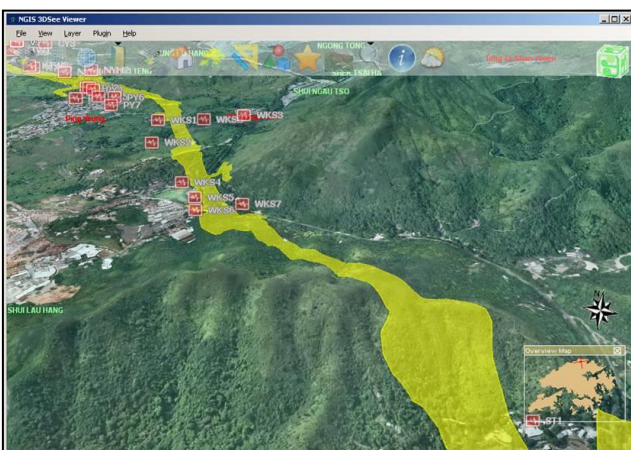


Figure 4: Project Layer on Terrain

The topographies of Hong Kong are largely hilly which generates difficulty to overlay projects and 3D models onto the rough surface. A draping mechanism for vector-based linear site boundary components such as road or drainage is so designed to enhance the aesthetic display in the 3D green tool. The mechanism enables users to drape and to toggle between the linear

features over the terrain thus ensuring that the feature can be in the correct planimetric position in relation to underlying aerial photography. Figure 4 illustrates one of the project layers on terrain.

In many occasions, there are needs to superimpose location plan, sketches, layout plan, etc. (Figure 5 refers) together for complete review and reconsideration of options and alternatives in project development. Capability to incorporate and overlay these associated background materials will be possible by putting together the layers into the 3D green tool platform.

6. Way Forward and Enhancement

Given the 3D green tool capabilities, there are many opportunities to further foster supplementary 3D features to streamline the EIA review process, such as 3D visualization of air pollutants dispersion, virtual screening and scoping, automation of Potential Hazardous Installation (PHI) risk assessment, etc.

Screening and scoping is an essential procedure to conduct EIA study. There is no doubt that on-site inspection can provide the latest circumambient information. However, limitations during surveillance will be encountered if there is structure beyond eye-sight level, such as installation behind building or terrain. The 3D green tool provides aerial views from many angles to enable a virtual screening and scoping to pre-determine the inconspicuous pollutant sources and unobtrusive sensitive receivers [3].

The quantification of fatality and risk assessment due to PHI is complicated and tedious. Given a particular PHI consultation zone, the specialists have to determine whether individual and societal risks arising from the PHI are acceptable. Multi-consultation zones feature of the 3D green tool will be a practicable solution to address this spatial evaluation. In Hong Kong, it is not uncommon to have concurrent PHI consultation zones in close proximity, the ability of the 3D green tool can assess not only the risk of individual PHI, but also the cumulative risk arising from overlapping PHIs consultation zones.

7. Discussion and Conclusion

Hong Kong, a densely populated and highly sophisticated city, requires a meticulous EIA system to facilitate effective investigation, design and construction of infrastructures for both public and private projects.

Application of 3D appraisal to assist and streamline EIA analysis is introduced since the last decade [4], [5]. The development was initially slow and imperceptible due to expensive and relatively low performance of computer hardware and software, and limited source of electronic spatial data. Given the recent geometrically elevation of computer aid technology and availability of detailed spatial data available from government and commercial sectors, 3D green tool becomes a convenient and common platform to integrate all pragmatic spatial,

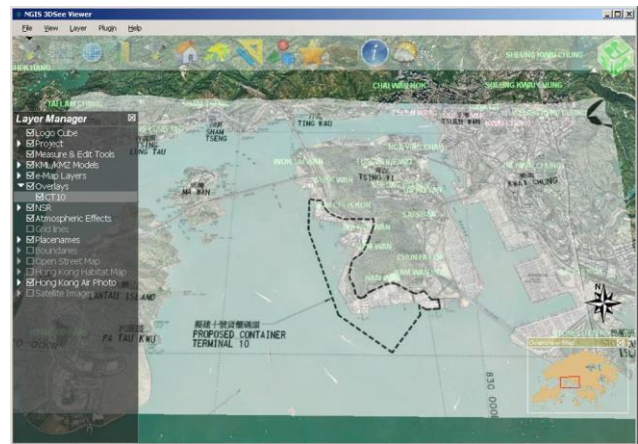


Figure 5: 2D Map Stamps on 3D Green Tool

physical, environmental data into a single system. Boundless contrivance can be designed and developed based on this tool to complement and shorten the current EIA process.

It is well elaborated in the Hong Kong EPD IAIA ('05, '08 and '13) papers that 3D visualization models can facilitate a meaningful dialogue between environmental experts with the public and various stakeholders in early EIA stage^{[4],[5]}. Hong Kong government has consolidated dedicated 3D visualization web resources^{vii} to facilitate the public to understand and visualize the complicated proposals and their environmental impacts, and also to expedite fruitful communication^[6].

The presentation of environmental findings using 3D visualization models in continuous public involvement (CPI) activities is welcomed and appreciated by both the public and EIA specialists^[7]. 3D green tool not only tallies with the thinking behind Hong Kong's CPI policy, but also illustrates how future EIAs may be carried out with genuine public participation processes, leading to win-win outcomes for all^[8].

8. References

- [1] Simon Ho, *et al.* (2013). A Comparison of EIA Quality Practice in Hong Kong and the United Kingdom. *IAIA 2013 Calgary, Alberta, Canada.*
- [2] Tsoi C.W. (2007). HKSAR Geospatial Information Hub (GIH) - A Common Geospatial Information Platform and Spatial Data Portal. *Strategic Integration of Surveying Services.*
- [3] Chris Hoar & Raymond Wong (2014). 3DSee Viewer, an Effective Screening and Scoping Tool for Impact Assessment. *HKIEIA Regional EIA Symposium, HKSAR, P.R. China.*
- [4] Simon Y.M. Hui, Stanley Lau & Anthony Y.K. Ho (2005). EIA – Towards a New Era through Continuous Public Involvement. *IAIA 2005, Boston, Massachusetts, USA.*
- [5] Simon Y.M. Hui & Anthony Y.K. Ho (2008). Hong Kong's Innovative Techniques in Public Engagement. *IAIA 2008 Perth, Australia.*
- [6] Anthony Y.K. Ho (2013). Strategic Environmental Assessment – Implementation Mechanisms & Tools for the Future. *IAIA 2013 Calgary, Alberta, Canada.*
- [7] Ng, Co Nam, *et al.* (2013). One Country, Two EIA Systems, the public engagement in the EIA system of Hong Kong and China. *IAIA 2013 Calgary, Alberta, Canada.*
- [8] Terence S.W. Tsang (2008). Application of 3D EIA Public Engagement Tool – Putting Concepts into Practice. *IAIA 2008 Perth, Australia.*

The Authors

Lawrence NGO and Terence TSANG are Senior Environmental Protection Officers and Charles WONG is Environmental Protection Officer in the Environmental Protection Department, Hong Kong SAR, China, responsible for Environmental Impact Assessment and Planning, and I.T. development of the division. They are Chartered Engineers with more than twenty years of experience in Environmental field.

^{vii} Examples of Electronic Visualizations of the Major Findings and Elements of the EIA Reports, EPD (2014):
<http://www.epd.gov.hk/eia/3d/index.html>