Protecting Urban River Views with Geodesign Approach

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Abstract: The James River holds an undeniable importance in the foundation and development of the City of Richmond. The Richmond Riverfront Viewshed Project, initiated in 2013, aims to find the balance between the conservation of scenic river views and appropriate development along the James River. A series of Geodesign techniques and methods have been applied to each stage of the project. First, the combination of community engagement and crowd-sourcing approaches created an inventory of river views. Second, 3D spatial analysis reveals favorite views in the city, as well as the important landscape elements in those views. Finally, a web-based design evaluation tool is developed for users to assess the visual impacts of newly proposed development projects. Such evidence-based, instant feedback to the design process highlights the value of Geodesign in landscape design and planning.

Keywords: Geodesign, viewshed, GIS, riverfront

1 Introduction

In 2014, the New York Times published a series of articles to cover the controversy around the LG North America Headquarters project in Englewood Cliffs, New Jersey. Estimated to create $1.3 million of additional tax revenue, 5,000 temporary construction jobs, and 1,200 full-time employees, LG's $300 million project on the west side of the Hudson River was warmly welcomed by the state of New Jersey. However, when designs for the environmentally friendly building were completed and publicized in 2012, several lawsuits were filed by residents and other environment groups. The central dispute was about if the height of the new headquarters building would create an eyesore to the beautiful Palisades cliff skyline over the Hudson River. In 2015, LG conceded and lowered the building height, but financially suffered $10 million from 3 years of construction delays (DWYER 2015, KIMMELMAN 2014). The LG headquarters case is not alone. In Richmond, Virginia, an urban renewal project near the Libby Hill planned to demolish an old cement plant in 2014, a long-time eyesore on the James River riverfront, and replace it with a mixed-use, multi-story building. The residents in the Libby Hill neighborhood initially welcomed the removal of the cement tower and celebrated the restoration of the sweeping view over the James River, but they soon realized that the newly proposed building might block the river view from the neighborhood again (MARTZ 2013).

Protecting urban viewsheds through regulations is not new. Kyoto, for example, has a long tradition of creating viewshed corridors in historic districts to the surrounding scenic mountains (KYOTO CITY PLANNING BUREAU 2012). In the US, Seattle, Denver, and many other cities have adopted ordinances that aim to maintain open vistas from public open spaces in the city to the surrounding natural landscapes (BROWN 2016). In almost all these cases, the viewpoint or the origin of a vista is often well-defined along with the targeted landscape elements under protection. But in the cases of Englewood Cliffs and Richmond, there were no official designations of vistas or visual corridors. The outcry from the public against a new project simply comes from a shared sense of appreciation. Particularly in the case of Eng-

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lewood Cliffs, the objection did not originate in the local community, but from residents in a different state miles away across the wide Hudson River.

Moreover, in both the Englewood Cliffs and Richmond cases, the controversies over river views were surfaced and escalated much later after the design was finished and presented. Not only the developers and designers but also the local officials did not foresee the scale and severity of the visual damage at the beginning. Both sides of the controversies cited sharply different computer renderings to justify their arguments. Evidently, the lack of shared information about basic geographic contexts and the coverages of views has caused the emergence of such controversies. Moreover, the lack of proper tools to present spatial dimensions of the design and affected views make it harder to bring both parties to the same page.

This is where the Geodesign techniques and methodologies could be applied. In the framework for Geodesign, Steinitz mentioned the important contributions that geospatial technology has made to landscape representation, change modeling, and landscape evaluation (STEINITZ 2012), each of which is crucial in addressing the visual landscape controversies. Researchers have used location information in crowdsourced photos and social media to understand the public perception of the landscape (DUNKEL 2015, HU et al. 2015), offsetting traditional expert landscape assessment approaches (DANIEL 2001). Many GIS tools have been developed to model landscape aesthetics with landscape attributes (SAHRAOUI, CLAUZEL & FOLTÊTE 2016), and to assess visual impact in planning (DANESE, NOLÈ & MURGANTE 2009, FISHER 1996). The inclusion of geospatial technology in data management and data analysis could benefit design decision-making as well (MILLER 2012). It helps bring all the parties involved in the controversy to the same platform where geographic features and potential consequences are presented with real world coordinates, eliminating the misrepresentation of data during photo montaging or computer rendering typical to a design process. This technological platform is where both sides could start negotiation and reconciliation (HUANG & ZHOU 2016). All these features of Geodesign could lead to a much broader and deeper understanding of the public's visual preference, addressing the issues discussed in the Englewood Cliffs and Richmond cases.

In 2013, The Virginia Chapter of the American Society of Landscape Architects (ASLA) initiated the Richmond Riverfront Viewshed Project as its community service project. The project planned to study the viewsheds of the James River in Richmond and determine how they could be protected for future generations while realizing its potential for social-economic development. Therefore, this project became a perfect opportunity to implement the geospatial interventions discussed earlier. The James River holds an undeniable importance in the foundation and development of the City of Richmond. The City attained its name from a view from Libby Hill towards the River, and the River has served as the backbone of the City's growth during the last 300 years. Today, Richmond's river views are a mix of urban wilds and constructed landscapes, which together document the history of the City. During the recent approval process of the City of Richmond's Riverfront Plan by the landscape architecture firm of Hargreaves Associates, it became clear that both professionals and the public have increased their attention towards the scenic resources along the James River. However, this attention also leads to a spectrum of opinions about how to use and manage the scenic resources, often causing conflict between new development and viewshed protection, as evidenced by the recently proposed project and subsequent protests near Libby Hill. The City has to find the appropriate balance on the spectrum: acknowledge the value of river views, protect property rights, and encourage/facilitate proper development.

2 Data Collection

The first step of the Viewshed Project was to understand the general public's visual preference through a comprehensive survey. A hybrid data collection approach was adopted to receive nominations for favorite river views from the general public, combining traditional public engagement and new crowd-sourcing on social media. In November 2013, a public meeting was held in Richmond inviting all the urban residents from different neighborhoods along the James River to vote for their favorite river views. The attendees were asked to label up to five favorite views towards the James River on a paper map using arrow stickers. The starting point of the arrow sticker represented the location of the nominated viewpoint, and the tip of the arrow indicated the central direction of the angle of view from the viewpoint (Fig. 1). After the meeting, all the arrow stickers on the paper maps were manually turned into GIS data points with attributes documenting angles of views and the geographic origins of the voters. At the meeting, as well as at other public spaces in the city, student helpers used iPads with Avenza PDF Maps app to show the interviewees the same map in a geoPDF format. The interviewees could use the tablet to create a marker directly on the map to indicate the location of their favorite river views, the view angles, and other required information.

The crowd-sourcing approach identified the image-hosting website Flickr.com as the data feeder. Unlike other image-hosting websites and social media that only show location coordinates but block the metadata of photos, Flickr allows a user to query through an Application Program Interface (API) the original metadata of photos which includes the image direction information crucial to a viewshed study (Fig. 1). Landscape photos associated with keywords "James River" were downloaded from Flickr with their metadata in EXIF. Meanwhile, a call for photos representing favorite river views was also sent out by the ASLA Virginia chapter. The instructions in the call required photos to be taken by a GPS enabled smartphone so that all the photos, including those from Flickr, could be directly turned into data points in GIS with location and image direction information. After merging data points from paper maps, digital maps, and photos, the actual angle of view was calculated from the center of view angle information assuming each view had a 90-degree field of view.

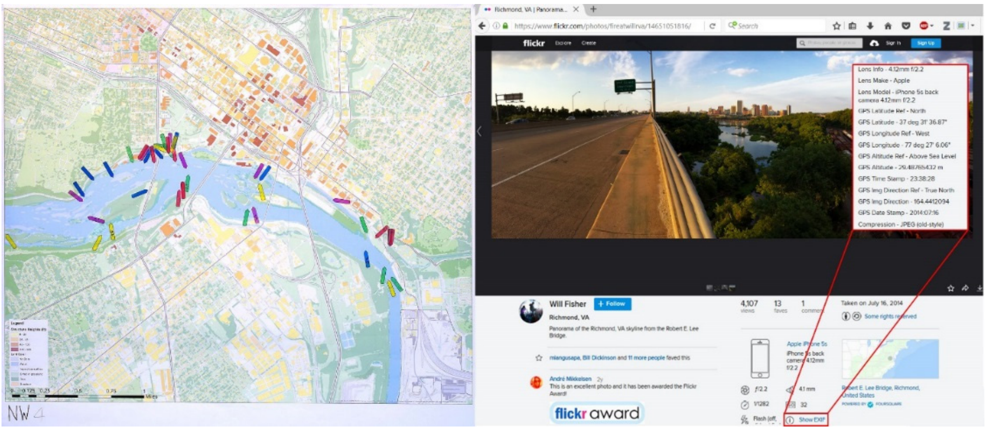

Fig. 1: A paper map showing votes represented by arrow stickers, and a screen capture of Flickr website showing GPS location and image direction info of a photo

3 Spatial Analysis

The data analysis started with an analysis of the density of nominated viewpoints. The analysis was done using a Kernel Density function in ArcGIS to generate a curved surface representing the frequency of points occurring within a certain fixed search radius (Fig. 2). The results showed very high concentrations of nominated viewpoints near the Libby Hill area looking towards the west and the Hollywood Cemetery areas looking towards the south. Other places with high densities of viewpoints included the waterfront near Byrd Street right next to downtown and the south bank of the James River near Belle Isle. This density map also revealed the fact that some places right on the riverfront did not receive many nominations largely because of lack of accessibility. For example, East Byrd Road between downtown Richmond and the River received no votes because there are no accessible open spaces for urban residents to enjoy the scenic river view there (Fig. 3).

The second analysis performed was the viewshed analysis. The purpose of this analysis was to capture what kinds of landscape elements or features were visible in those nominated views in order to understand why the public liked these views. The viewshed function in ArcGIS calculates the visible and invisible surface areas from a given viewpoint, which in this case is the 90-degree view from 5ft above a nominated viewpoint towards a certain direction. A digital surface model was prepared in a two-step process in advance for this analysis. The first step was to generate a raster-based 10ft resolution digital elevation model (DEM) from existing 2ft interval contour data. The second step was to create a surface height raster data by merging structure height from appraisal data and vegetation height from the land cover and tree canopy data. In the case of tree canopy over a building roof, the maximum value out of these two datasets was selected to represent the surface height of this particular location. Finally, the digital surface model (DSM) data was generated from the sum of DEM

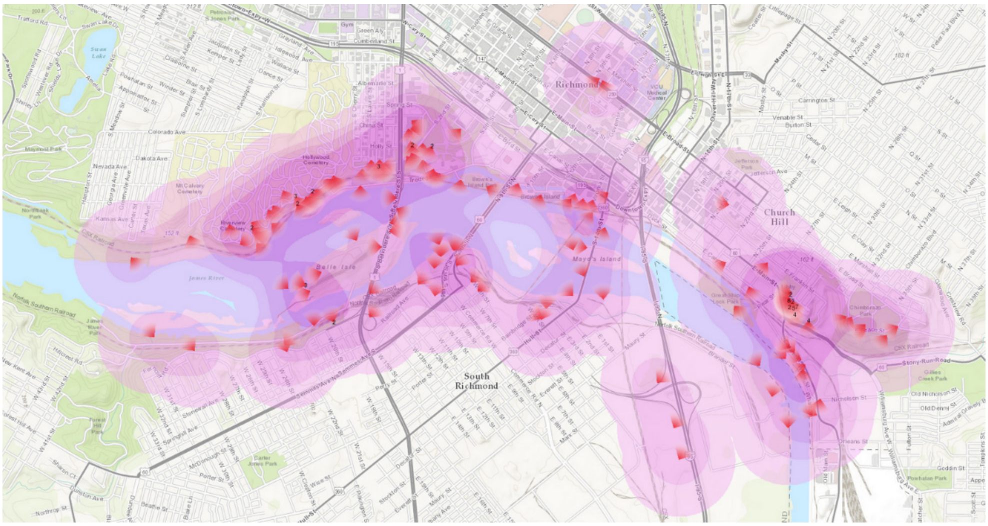

Fig. 2: Distribution of all the collected votes and the kernel density heat map showing the concentration of votes

Fig. 3: Best river views summarized from all the votes with the number in the circle representing the rank of popularity

and the maximum of surface object height. The viewshed function was performed on each nominated viewpoint over the entire DSM data with 1-pixel expansion towards the buildings in order to reveal the visible building façade in the result (Fig. 4).

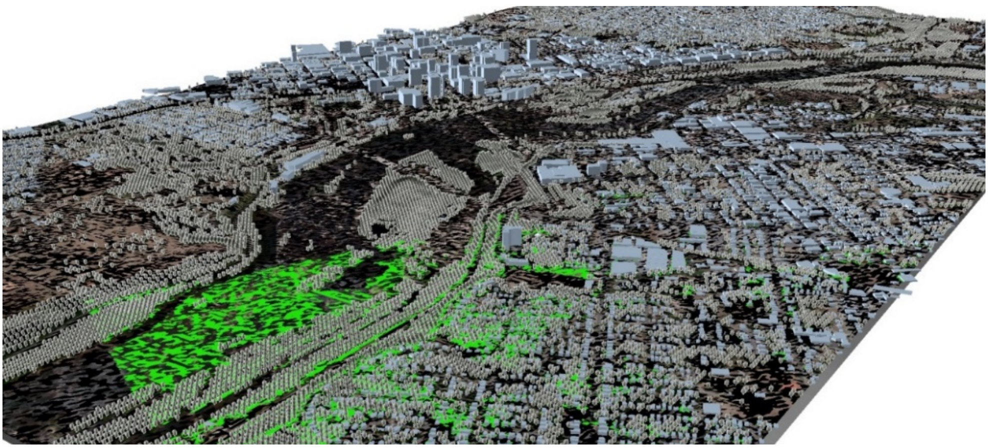

Fig. 4: 3D simulation of a sample viewshed from one nominated viewpoint (in green) on digital surface model

In the end, all the viewsheds from all the nominated viewpoints were combined to create an overlay showing the frequency of different landscape features appearing in those viewsheds. Places visible in more viewsheds are shown as brighter spots on the overlay (Fig. 5). According to the results, Richmond residents like to see the portion of the James River near Belle Isle where the water is running actively over the rocks more than other places. Although the downtown skyline to the north of the James River has often been captured together with the River to represent the City of Richmond on many postcards, the analysis showed that the skyline on the other side of the river is also important as it provides an important backdrop for many river views from the higher density north bank of the River. Therefore, this overlay map can also be regarded as a visual sensitivity map, i. e. any design change in brighter places will affect the quality of multiple nominated views towards the James River.

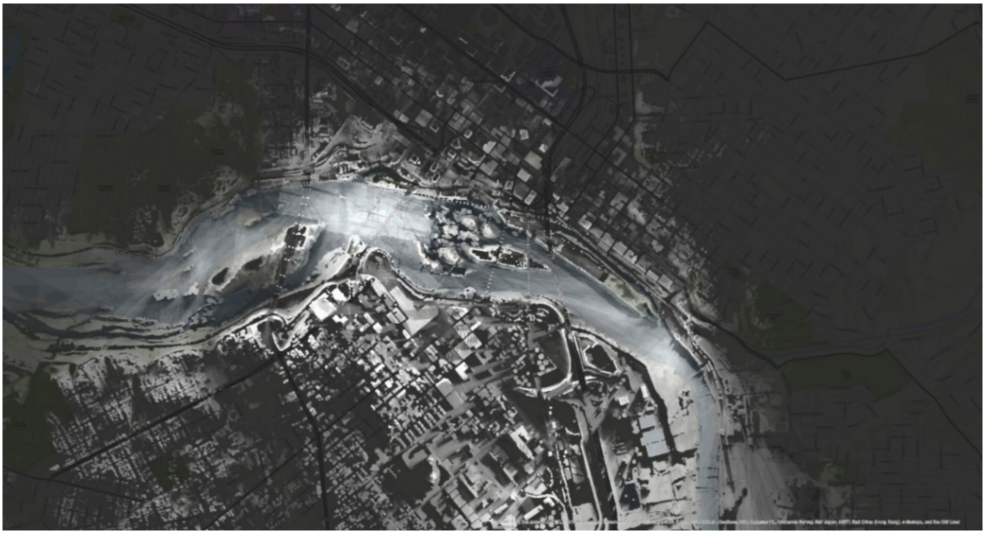

Fig. 5: Overlay of viewsheds of all the nominated viewpoints with brighter area meaning more visible from those nominated viewpoints

4 Planning and Design Implications

This project has provided a documented summary of viewpoints that were important for a public input process, and a set of techniques and procedures for the City of Richmond to use for future studies. According to this analysis, the scenic resources along the Richmond James River corridor have not been fully enjoyed by the public due to poor accessibility. During the industrial era, the City celebrated the engineering wonder of overlaying railways along the James River. Today, the City has to work hard to adapt the underused infrastructure for public use.

The analysis also revealed important landscape elements that need protection. The City of Richmond could take advantage of the datasets and analytical results from this study to examine how future developments might impact existing viewsheds. As part of the spatial analysis, a geoprocessing tool was developed in ArcGIS to evaluate the potential visual impact of a newly proposed building design. The tool first imports a new building 3D model and converts its height and location to update the existing DSM. The viewshed generated from the nominated views with the new DSM is then compared with the old one to see if there is any notable difference. If yes, the result will flag it as a potential visual impact on the existing favorite river view. If the occurred difference is located in a high sensitivity area in the viewshed overlay map, the tool should suggest a close examination by the designer, developer, and public officials.

Finally, it is important to maintain good communication with the public about visual resources and viewshed management. This study provides a public website (http://gis.arch.virginia.edu/James/) with ArcGIS Online technology to disseminate the data and images collected in the public input process, the visualization of results from the spatial analysis, and the geoprocessing tool for visual impact assessment. This means that designers and decision-makers who do not have necessary GIS skills can simply submit a 3D design model georeferenced in popular modeling programs like SketchUp and Rhino to the project website, then see the potentially impacted favorite river views nominated by the general public (Fig. 6). This mechanism allows the traditionally unforeseeable visual impact to become visible, so that an early intervention in the design process is possible.

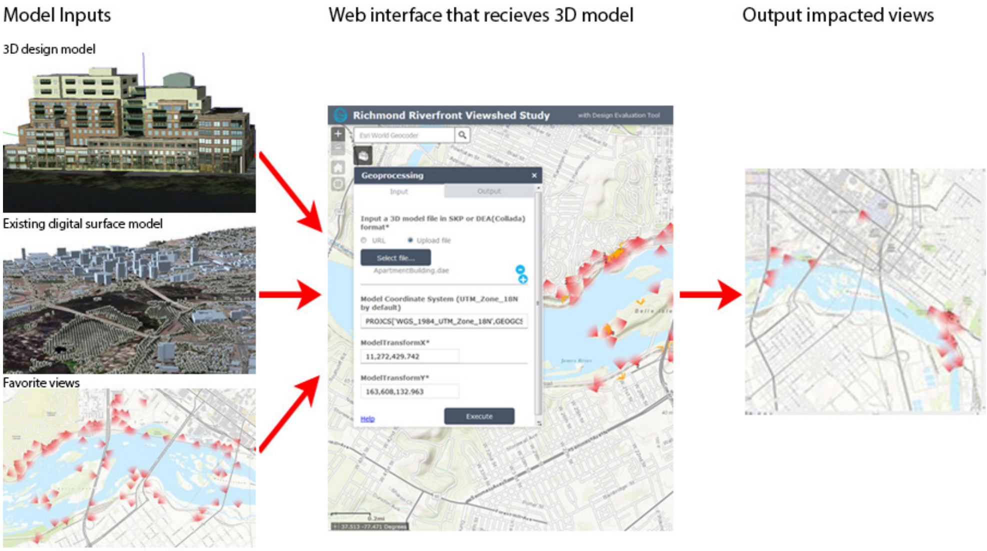

Fig. 6: A web-based design assessment tool that compares existing viewsheds and modified viewsheds because of new building proposal, then displays impacted views

5 Reflection and Discussion

Viewshed protection in cities is not a new topic in landscape management. Many cities have adopted viewshed protection policies and strategies, and many visual studies have been done with different methods in cities (DANIEL 2001, DANESE et al. 2009). The implementation of geospatial techniques and methodologies in the Richmond Riverfront Viewshed Project has further suggested new solutions to address some contemporary issues as discussed in the introduction section. Geospatial technology could document and present the location and angle of important scenic views from public engagement meetings and social media. This hybrid approach gives the public a much louder voice in visual resource management, potentially bringing environmental justice study to the realm of scenic resource management.

When the data from public inputs become available on the web, developers and designers could become aware of the potential visual impacts, many of which are in places well beyond the project site as illustrated in the Englewood Cliffs case. The spatial analysis on the views further reveals visual preference so that important landscape elements could be given special attention in the design process. As research has concluded that it is important to address the visual impact issue before construction (STAMPS III et al. 2005), the interactive web-based visual assessment tool designed specifically for non-GIS users allows intervention to take place earlier in the design process to save huge financial losses. This tool bridges traditional design modeling program with a GIS program, opening door for similar tools that can provide vital instant feedback to the designers regarding the potential impact on different landscape systems.

Geodesign is an iterative design approach by which a design is constantly shaped by spatial intelligence from the involved stakeholders and geographical context (LEE, DIAS & SCHOLTEN 2014). The inclusion of new geospatial techniques in the Richmond Riverfront Viewshed Study facilitates communication between stakeholders, designers, developers, and the public to address some visual concerns together earlier. With the emergence of Augmented Reality (AR) techniques, designers and the public could even overlay the proposed change with the real geographic context from those viewpoints in the future, enhancing our understanding of the visual impact. The instant feedback mechanism by the web-based tool and AR will even make it easier for designers to test "what if" scenarios, which embodies the essence of "Geodesign thinking" (LEE et al. 2014). In summary, Geodesign has great potential to promote an evidence-based design process to better protect and manage our scenic resources in cities.

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