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VRSC 2021 Conference Proceedings

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2021 Visual Resource Stewardship Conference Proceedings

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2021 Visual Resource Stewardship Conference

Exploring Landscape as Culture, Resource, Home

Pre-Conference Proceedings

Conference co-chairs: Brent Chamberlain, Robin Hoffman and Richard Smardon

Introduction

The biennial conference aims to catalyze ideas and innovation between academia, practice, NGOs and government agencies who work to address analysis, planning, valuation, design and management of visual resources. The aim of the 2021 Virtual Conference is to share ideas and discuss the issues associated with the assessment and protection of visual resources in an era of major landscape change - regionally, national and globally.

- The 2017 Visual Resource Stewardship Conference proceedings are available at https://www.srs.fs.usda.gov/pubs/57492
- The 2019 Visual Resource Stewardship Conference website and program is at https://vrconference.evs.anl.gov/ and,
- The 2019 Visual Resource Stewardship Conference proceedings are published in the SUNY College of Environmental Science and Forestry Digital Commons: https://digitalcommons.esf.edu/vrconference/

In organizing the 2021 Visual Resource Stewardship Conference, the organizing Committee submitted a call for abstracts within the overall theme of ***Exploring Landscape as Culture, Resource and Home***. Call for abstracts were sent out asking for technical papers, visual case studies, panels and student posters. These were then reviewed for acceptance, or not, by members of the conference organizing committee.

The following are the members of the 2021 Visual Resource Stewardship Conference organizing committee:

- Allysia Angus, Bureau of Land Management
- Chris Bockey, SWCA
- Brent Chamberlain, Utah State University
- Lynn Crump, Virginia Department of Natural Resources
- Paul Gobster, US Forest Service
- Morai Helfen, US Forest Service
- Robin Hoffman, SUNY College of Environmental Science and Forestry
- John McCarty, Bureau of Ocean and Energy Management
- Mark Meyer, National Park Service
- Nathan O'Neill, Scenic America
- Jim Palmer, Scenic Consultants
- Rick Smardon, SUNY College of Environmental Science and Forestry

We wish to acknowledge the conference hosts - the SUNY College of Environmental Science and Forestry (SUNY/ESF) and Utah State University (USU). We are especially grateful to USU for producing the pre-conference web page to allow the call for presentations and processing the abstracts, technical papers and visual case studies. The SUNY/ESF web site was subsequently developed to allow conference registration and administration. We wish to acknowledge our conference partners, which besides USU and SUNY/ESF include; the Bureau of Ocean and Energy Management (BOEM), the National Parks Service (NPS), Scenic America and the US Forest Service. Finally we gratefully acknowledge our sponsors including Arizona State University, Environmental Design & Research, Logan-Simpson, Saratoga Associates, Soil and Water Conservation Association (SWCA) and Terry DeWan.

The following pre-conference proceedings contains nine technical papers plus abstracts for the three plenary speakers, six workshops, three panels, and 16 visual case studies.

Plenary 1

Connecting people, **Building** collaboration, and **Inspiring** human places

Martha C. Fajardo[1]

[1]Grupo Verde LALI Columbia

CULTURAL landscapes are places affected, influenced, or shaped by human interaction. The landscape is a shared vision in which and to which a vast array of encounter converges and contribute. Interest and support for regional, local landscape initiatives are gaining adhesion around the globe. We may have different approaches to landscapes – each culture and community may have a different understanding of the concept – but there can be no doubt that landscape initiatives/projects can be the basis for improving both cities and the global environment.

We are living in difficult times, from the new and desperate challenges of COVID-19 to the longstanding tasks of climate change, urban sustainability, and inequality. All these challenges and their solutions have roots in the successes and failures of our region. The well-documented benefits of nature as a RESOURCE are often available disproportionally to people with money, power, and access. Nowhere is this truer than in Latin America. Thus, it more necessary than ever to facilitate and innovate in the creation of common and open space — landscape — a democratic chain of transmission between the will of people and decision-making entities. New policies, ideas, and on-the-ground innovations are needed to deliver real change.

The pandemic has made us all rethink public space and rethink its importance in our cities as places of refuge, community, and areas where humans and nature intertwine…our HOME. The importance of constructing a more just world where all can access the goods of the earth and have the possibility of realizing themselves as people in harmony with nature, where fundamental rights and dignity are guaranteed in our states, and for all equally, is more important than ever before.

Those familiar with landscape today are aware of the power of this practice, the integrated approach that landscape architecture represents, and its fundamental importance in securing our sustainable future. The conference aims to catalyze ideas and actions between activism, practice, to promote the recognition, valuation, protection, management, and sustainable planning of Latin American landscapes.

Consequently, the talk will focus on two levels: the regional and local levels

At Regional Level: Landscape Activism

This section highlights the Latin American Landscape Initiative LALI a regional initiative that has the potential to connect people in the common cause of safeguarding landscapes' important cultural and/or ecological values. How can we work together on behalf of the landscape?

"Philanthropy for the environment" is how one could describe the approach behind LALI's initiative, which originated back in 2012. Restoring the relationship between human beings and LALI is a well-established collective that creates a common ground for discourse and action where answers and solutions to a social and environmental crisis are proposed. LALI promotes solidarity, union, and coexistence to encourage an integral change for the benefit of urban and regional development. The landscape represents a right, and it is fundamental to recognize our responsibility to protect it.

The basic pillars of LALI in this regard are:

Participation - Collaboration of professionals, academia, and NGOs, as well as the broad mass of citizens, including children, woman and young people; Continuing education, in all age groups, interests, and professions, through various interventions and projects; Multi-level activism, from community clusters to national projects, from bottom-up and the top-down; Promotion of communication of the local spirit in new planning projects; Work towards the harmonious administration of landscape resources through local and national regulations and with a global perspective; and The initiative advocates for a Latin American Landscape Convention/ Pact, but also for a global one through international cooperation.

At Home/ Local Level: Reconciling City and Nature

Each design movement, each line drawn on paper translates into a political act, with the necessary implications in terms of exclusion or inclusion, fragmentation, or connectivity. However, urban planning, public policies, and design have not contributed to fairer, resilient, healthy, and sustainable cities ... we find fragmented landscapes that separate our communities, that destroy natural habitats, that damage identity, and cultural values, and so do not provide a caring context for our lives. The inconsistency between how landscapes are talked about and how they are managed points to an urgent need to adapt the tools that we apply when dealing with landscapes. We have spent many decades of neutral urbanism with cities designed and planned from an androcentric perspective forgetting the presence of other beings: women, children, the elderly, different groups, and other species.

The following part will focus on the Praxis through our collective Grupo Verde with some current multi-use, multi-programmed, multi-functional, infrastructures projects: projects that centered right at the intersection between urbanism, landscape, and infrastructure. It shows how we deal with these types of collective examples along with the guiding principles; how the landscape symbolizes a coming together of the natural world, human society, and people's needs, and how we as landscape architects commit to working holistically, overcoming boundaries, to recover the landscape as a driver and a former of society. 2021 is a year of reflection, opportunity, and answers; we need to adopt a planetary health perspective: healthy landscape, biodiversity, and ecosystems are vital to support human life and build social cohesion, we must restore, create, and care for the landscapes and ecosystems in a shared, ongoing, and integrative relationship.

I do hope, that working together at all levels we can build a future of life in harmony.

Plenary 2

Progress and Need for Scenic Protection Tools and Policy

Mark Falzone[1]

[1]Scenic America President, Washington DC, USA

Among members of the scenic conservation advocacy community, there is an emerging recognition of the need for new tools, technical assistance, and best practices to guide conservation policy. Partnership and coordination with the Visual Resources Stewardship community is therefore a top priority. As the state of knowledge for VRS research advances, there can be a corresponding increase in capacity for government and private-sector actors to identify and measure scenic assets, to complete scenic asset inventories, and to understand the potential scenic impacts of policy proposals.

At the same time, there is an opportunity for the experiences of policy practitioners and advocates to guide VRS research. Scenic conservation policy creation and program management can provide a rich source of data for understanding the broader impacts of VRS tool implementation. Partnership with organizations in this area can help identify new research questions, novel research design and data, and new possibilities for research support.

As the only national nonprofit that advocates for scenic beauty for all people and all communities, Scenic America's network of chapters and affiliates represents a crucially important group of VRS stakeholders. Their work related to scenic byways corridor management planning and technical assistance, and related to statewide scenic inventory development, signals a broad expansion of the use VRS tools to influence policy outcomes. At the same time, new policy proposals at the national level have the potential to significantly increase the demand for VRS-based tools.

VRS tools will play a key role in Scenic America's organization strategy, and cooperation with the VRS research community will continue to grow as this strategy is developed and implemented.

Plenary 3

Visualizing Climate Change: Principles, Cool Tools and Landscape Messaging

Stephen R. J. Sheppard[1]

[1]University of British Columbia

The book Visualizing Climate Change was published nearly a decade ago, but sadly, the messages from the book are even more urgent than in 2012, yet still largely unheeded by most governments. The central message is that we need to make climate visible, in the media, in the everyday landscape, and in our own futures, if we are to mobilize community action and support government policy change to forestall the climate emergency.

This presentation summaries the challenges with public perceptions of climate change (which is largely invisible or unrecognized), and evidence-based principles and theories for revealing what climate changes looks like and simulating visible local climate change action that can transform our communities. It outlines 'cool' visual learning tools (including landscape visualization and videogames) that have been developed for local climate change visioning and engagement based on these principles, and summarizes evaluation findings from the past nine years of research. This presentation reviews techniques for advancing low-carbon attractive resilient (Lo-CAR) landscapes, linking aesthetics to climate friendly communities. It reveals successful examples of making climate solutions visible in North American landscapes using Landscape Messaging approaches. Finally, it argues for the key role of landscape architects in applying their skills and visualization methods specifically to the challenge of engaging society in that other greater emergency beyond COVID-19.

Following on the success of the workshops offered at the 2019 Visual Resource Stewardship Conference, six workshops are being offered for the 2021 conference. Each workshop is 90 minutes in length; New York State registered landscape architects can earn 1.5 CEUs for each workshop attended. Descriptions for all six workshops are on the following pages.

There will be opportunities for questions and discussion with the workshop instructors and other workshop attendees throughout each workshop.

Workshop 1

Scenic Inventory, Assessment and Monitoring for National Trails: BLM's New Training Effort

Jeremy Call[1], Rob Sweeten[2], Carin Farley[3]

[1]Logan Simpson, Fort Collins CO, USA
[2]Bureau of Land Management, Layton UT, USA
[3]Bureau of Land Management, Anchorage AK, USA

Today there are 60,000 miles of congressionally designated National Scenic and Historic Trails—exceeding the length of the Interstate Highway System! Implementation of this system began over 50 years ago with the signing of the National Trails System Act (NTSA). The quest to adequately identify and protect this system continues. As intended by the U.S. Congress, National Scenic and Historic Trails are not only pathways, but corridors of the associated scenery, historic elements, related cultures, recreational aspects, and the surrounding natural environments. These landscape elements, in turn, directly influence trail experiences and visitor expectations. If we strive to identify these values, and keep the national trail settings intact, current visitors will enjoy and better appreciate them as intended, and we can then leave this legacy for generations yet to come.

The Bureau of Land Management (BLM) recently developed a first-of-its-kind methodology to help inventory, assess, and monitor National Scenic and Historic Trails (NSHTs) as a Technical Reference and companion Field Guide. The Methodology and Field Guide advance a consistent and repeatable approach for collecting resource-integrated baseline data for these trails and trails of all kinds.

Since National Trails often cross multiple administrative boundaries, the methodology purposefully fosters interoperability and data exchange that is so critical for these national assets and resources that cross jurisdictions and benefit from collaborative action. Representatives from the US Forest Service, FHWA, NPS, and trail associations informed its development and field tested its methods. This integrated approach provides federal, state, and local agencies and trail organizations with a common framework as they collaborate in inventorying, assessing, and monitoring each National Trail segment’s resources, qualities, values, settings and uses.

The National Trails Methodology considers four landscape elements — scenic, recreation, historic and cultural, and natural — and how they work together to define the nature, purposes, and uses of a trail. This training workshop will provide an overview of the full methodology and specific step-by-step guidance needed to carry out scenic analysis. This workshop is an ideal introduction for any visual resource specialist from any agency as well as agency decision-makers, technical professionals in each landscape element, and members of trail organizations and volunteer groups. Together as an interdisciplinary team, they determine how to study the trail—from the locations from which inventory will be conducted to how data will be collected and analyzed, and eventually to how resources will be monitored.

The methodology emphasizes the use of existing programs, skill sets, and data standards whenever possible with simple checklists and a standardized monitoring form to ensure consistency across agencies. The scenic landscape element is largely based on the BLM’s Visual Resource Management System but is adaptable to any agency methodology as National Trails cross-jurisdictional boundaries. Participants will learn how to work as an interdisciplinary team, assess the adequacy of existing visual inventories, delineate a National Trail viewshed and associated visual distance zones, and document scenic quality and public sensitivity.

Learning Outcomes

1. Participants will become familiar with what NSHTs are and why they receive different considerations than other public lands and places.
2. Participants will know that there are four landscape elements while content and training will focus on “Scenic”.
3. Participants will be acquainted with significance of the Trail’s Nature and Purposes as a foundation of each IAM data gathering effort, including scenic.

4. Participants will know what IAUs are and the relationship between IAU and scenic elements.
5. Identify and become familiar with unique scenic considerations for National Scenic Trails and National Historic Trails.
6. Identify and become familiar with the minimum inventory requirements for the scenic landscape element.
7. Identify and become familiar with scenic data sources and field data collection methods that are transferable to NSHTs, and why/when/how to intensify data collection.
8. Identify and become familiar with data sharing and reporting.

Evaluation Method

Effectively participate in a virtual evaluation of scenic quality based on maps and photographs associated with a National Trail segment through small group break-out rooms.

The learning outcomes assume that participants already have obtained moderate fluency in the language of landscapes (types of landscapes; form, line, color, and texture; etc.) and agency scenic resource methods.

Terminal Learning Objective: Develop an understanding for NSHT IAM with emphasis on the scenic landscape element and how this approach follows or differs from BLM's Visual Resource Inventory; from which participants may clearly understand the role of the IAM and more specifically, the scenic landscape element as part of cohesive management and overall trail preservation.

Workshop 2

Producing Interactive 3D landscape visualizations in Unity Using the terrainr R Package

Michael Mahoney[1], Colin Beier[1], Aidan Ackerman[1]

[1]State University of New York College of Environmental Science and Forestry, Syracuse NY, USA

Assessing visual resources to inform environmental decision-making typically requires developing 3D renderings of the landscape, allowing stakeholders to contextualize the impacts of a decision on the surrounding area (Gobster, Ribe, & Palmer, 2019). In particular, visualizations can be particularly valuable for improving public participation in decision-making activities, serving as a "common language" or "translation layer" for communication between expert and generalist audiences (Nicholson-Cole, 2005). These visualizations are more effective when they are higher resolution, with increased realism and visual fidelity (Appleton & Lovett, 2003); however, producing these sorts of highly-effective visualizations has historically required designers to have access to larger amounts of computational power and technical knowledge than more traditional forms of scientific visualization (Paar, 2006).

There has long been interest in using game engines to overcome the high computational requirements of producing these renderings (Herwig & Paar, 2002). These programs, which rapidly render landscapes at varying levels of detail as the viewer moves around a scene, are specifically designed to render terrain quickly and accurately enough that players in a video game do not notice the changing levels of detail while being efficient enough to run on mass-market computer equipment. The most popular of these engines, the Unity real-time development platform (Unity Technologies, 2020), has been used to produce 3D landscape visualizations since at least 2010 (Wang et al., 2010). However, while Unity solves many of the computational obstacles to the use of large-scale 3D renderings, it still demands a high level of skill and familiarity for users to produce landscape visualizations. Perhaps for this reason, Unity is still under-utilized as a tool for 3D landscape visualization.

In order to make this tool easier to use, this paper introduces an extension for the open source R programming language (R Core Team, 2020) which assists users in retrieving, manipulating, and transforming spatial data into formats that can be easily imported into Unity to produce visualizations. This extension – named terrainr – can be used to transform any single-band raster into terrain tiles inside Unity, and to produce overlay textures through combining aerial imagery, geospatial data, and user-specified manipulations. Additional functions assist in the retrieval of data for areas within the United States from the USGS National Map (U.S. Geological Survey National Geospatial Program, 2020), and with manipulating spatial data for visualizations through the GDAL library (GDAL/OGR contributors, 2021).

In combination, these utilities allow for the rapid production of high-resolution interactive landscape visualizations in Unity from spatial data sets. While this process is most easily done using publicly-available, real-world data sets (such as those provided by the National Map), it is equally possible to produce visualizations from simulated or otherwise altered data, allowing users to visualize landscapes both as they presently exist and as they may exist following proposed decisions or management activities.

These workflows integrate naturally with standard GIS-based workflows using the R packages sf and raster and the programmatic image manipulation tool ImageMagick via the magick R package (Pebesma, 2018; Hijmans, 2020; Ooms, 2020). This allows for a high degree of control over visualizations in an entirely reproducible workflow. And, at the same time, data can be manipulated in visual tools such as ArcGIS or Photoshop to provide complete manual control over the resulting rendering.

As a package for the R programming language, terrainr seeks to reduce the burden involved in producing interactive 3D visualizations by making it easy to translate data between the tools used for data manipulation and those used for producing large-scale landscape simulations. This shift helps to reduce the technical skill threshold required to use game engines for landscape visualization, and lets designers spend more time thinking about and developing visualizations and less on the tools and techniques required to develop them. As a result these landscape visualizations can be produced faster and easier than has been previously possible, allowing for more iteration in the development of individual visualizations and wider use of these tools overall. These tools have notable potential for visual analysis of environmental systems, with potential uses including viewshed analyses and assessing the visual impact of land management activities.

Workshop 3

Workshop Abstract: Reviewing Photosimulations

James Palmer[1], Mark Meyer[2]

[1]Scenic Quality Consultants, Burlington VT, USA

[2]National Park Service, Denver CO, USA

Photosimulations printed on a tabloid sheet of paper are a ubiquitous element of a visual impact assessment (VIA). They are the primary way that a developer and their scenic expert communicate how their proposal will visually change the landscape. As consumers of photosimulations, how can agency staff and other interested parties tell if a photosimulation is a fair and accurate representation? This workshop is intended to help answer that question.

In the spring of 2021, the National Park Service published the Photosimulations Evaluation Guide by Robert Sullivan, Mark Meyer and James Palmer. The Guide introduces reviewers to the role of photosimulations, describes the basics of how they are made, the inherent limitations of photographic representations, and common photosimulation problems. In general, reviewers of photosimulations presented with a visual impact assessment (VIA) have two concerns: that the simulated views are appropriate and that the photosimulations meet best professional practices.

Appropriateness of the View

As a general principle, photosimulations should represent a “worst case” view, otherwise the VIA is not providing a full disclosure of the potential impact severity. However, determining what is the “worst case” is a matter of professional judgement that involves optimizing three factors:

1. Project. Preference should be given to views that present the greatest extent and exposure of the project available within the KOP.
2. Place. Preference should be given to views from more sensitive places. For instance, if there are two similar viewpoints, but one is from a designated scenic resource and the other is not, the former should be selected. Or if a viewpoint is in a landscape unit that is already represented and there are similar views in unrepresented landscape units, then the latter should be selected.
3. People. The public must have legal access to the viewpoint. Preference should be given to more sensitive viewers (i.e., those for whom scenery is more important) and greater numbers of viewers.

Best Professional Practices

Three additional considerations affect the quality of the simulation:

1. Photography. The base photograph should be taken to represent conditions when the project will most contrast with the surrounding landscape context (e.g., lighting, atmospheric conditions, season). It must record the details that could be noticed by a viewer (e.g., at least the resolution of human visual acuity). It must meet best professional standards (e.g., in focus, proper exposure, large depth of field, 50mm EFL lens, minimum obscuring foreground elements, etc.)

2. Portrayal. The information used to prepare the computer representation of the project must be current, complete and accurate. The computer model view-settings and rendering must match the parameters of the base-photograph; it must include control points visible that are visible in the photograph for adequate registration.
3. Presentation. The resolution and quality of the simulation display must be adequate to faithfully represent the detail and conditions that a viewer will be able to discern.

The "textbook" for this workshop will be the Photosimulations Evaluation Guide. The instructors have prepared a dozen case studies to facilitate discussion about how to approach the evaluation of photosimulations. Other materials will include a list of references and websites useful for evaluating simulations. Participants will download and become familiar with these materials well before the workshop.

There are no special hardware or software needs for this workshop, other than access to the VRS conference Zoom meeting. The instructors will be sensitive to the fact that most participants may be using a single computer screen and very likely it is a laptop computer. Some of the "lessons" will be illustrative, such as how to determine image resolution and why it matters. However, there will be plenty of opportunity for discussion, such as what constitutes a "worst case" view and the ethics of manipulating the base-photograph.

Workshop 4

Conducting Viewshed Assessments with the ArcGIS Visual Magnitude Plugin

Brent Chamberlain[1], Garet Openshaw[1]

[1]Utah State University, Logan UT, USA

This workshop is for anyone interested in or currently uses viewshed analyses. Note: for those who participated in the 2019 workshop, this workshop will follow a similar process, but there will be additional datasets to try if you are interested.

Dr. Chamberlain has been working on developing an improved viewshed analysis plugin for ArcGIS over the past several years. While the existing viewshed analyses contributes to current impact assessments, it lacks important characteristics to aid the planning and assessment processes. The new freely available plugin developed by Dr. Chamberlain's lab was developed to improve these processes and is applicable for use by practitioners, government and academics for conducting visual analyses across an array of different landscape-scale planning problems. After ramping up development and migrating the software to the ArcGIS Pro platform in 2018, it now needs to be tested and implemented in real-world problems.

This workshop was developed to support you in understanding how to apply the plugin to your projects and help you understand the implications and benefits. Additionally, the workshop will provide a platform for improving the software, tutorials and identifying potential issues that need to be remedied. It gives an opportunity for us as developers and you as users to engage in improving the software so, collectively, we can improve our planning and assessment process in hopes to reduce project costs and mitigate negative visual impacts to our landscape.

Learning Outcomes

If you have a basic background in GIS:

1. Understand the benefits and limitations of both the standard viewshed and the plugin
2. Understand how to install and use the basic functions of the plugin
3. Apply the plugin toward different project (renewable energy, land management)
4. Learn the basic methods for symbolizing the plugin output

For those more technically inclined:

5. Evaluate the differences between the standard viewshed and visual magnitude plugin
6. Learn advanced techniques for assessing impact
7. Apply more advanced symbology toward the plugin output
8. Understand how to use advanced features of the plugin

Participant Requirements and Preparation

Required: Participants will need to have access to a computer with ArcGIS Pro installed. ArcGIS Pro is available to many companies who have ArcGIS Desktop licenses. ArcGIS Pro is the latest desktop version that ESRI is developing. For questions about your organizations licensing, please contact ESRI.

If your organization does not have access to an ArcGIS Pro license, ESRI offers ArcGIS Pro as a 21-day free trial. Please do not install this trial until two weeks before the workshop.

Note: you may share a laptop with a colleague or another participant if you do not have access to a computer. If you would like to participate but do not have a colleague with a laptop and would like to inquire about working with another participant, please contact the workshop lead, Brent Chamberlain.

Preferred: Bring prepared datasets of current or past projects where you had to use a viewshed analysis. At a minimum, these would include key observation points and a digital elevation model (DEM). Additionally, you may be interested in brining routes (recreation trails, roads, etc.), wind turbine locations, point locations of infrastructure or other data related to development. Any other dataset that may obscure the view (vegetation, buildings, etc.) may also be a useful.

Workshop 5

Digital Workflows to Compare Turbine Height and Contrast Between Visual Impact Simulations and Post-Construction Photographs

Aidan Ackerman[1]

[1]State University of New York College of Environmental Science and Forestry, Syracuse NY, USA

Visualizations such as photographs and photomontages can be a critical part of the planning process for wind energy projects. For visual impact assessments to be considered a reliable representation of a potential project at its completion, it is essential that the simulation's degree of accuracy be established. This workshop will cover digital workflows that can be used to compare visual impact simulations with their corresponding post-construction photographs in order to evaluate their degree of difference in depicting turbine heights and contrast with the landscape.

Visualizations are an important part of the planning process for wind energy projects, playing a critical role in assessing visual impacts of a project to the landscape. A visualization can help to indicate which significant views may be potentially impacted by the project, and can assist with testing of impacts to the viewshed. In order for a visualization to depict a reliable representation of a potential project's visual impact it is critical for the simulations' degree of accuracy be established so that it does not run the risk of its validity being challenged (Bates-Brkljac, 2009). This degree of accuracy is typically established through documentation which explains the methods used to develop and validate the simulations.

The process of creating photomontages for visual impact assessment requires the creator to make several decisions including color balance, natural and artificial lighting, seasonality, time of day, textures and materials, and amount of detail (MacFarlane et al., 2005). The complexity of decisions to be made when creating photomontages can lead to the potential for problems to arise throughout the project's development and after. These problems can arise due to the following reasons:

- Limitations to a photomontage's field of view which can eliminate context that could be important in understanding the true effect that the project would have on the visual landscape.
- Photomontages are static representations that are unable to capture the dynamic experience a viewer observes while physically present in the landscape.
- Some visualization styles can produce images which run the risk of containing inaccuracies in depicting the visibility, scale, and contrast of the built project.
- Visualization technology is subject to stylistic interpretation, which can cause the creator to inadvertently increase realism or add detail to a project.

The limitations of photomontages can lead to problems throughout the project's lifespan. Some studies have attempted to evaluate photomontages by directly comparing them to photographed images of the corresponding built project. Imaging software such as Adobe Photoshop has been used to calculate the percentage of differently-colored pixels in images to evaluate contrast in wind farm imagery (Bishop & Miller, 2007). In Corry (2011), the author conducted a case study where post-construction photographs were taken from the same vantage points as were used for the original visual simulations, with similar photography equipment to approximate the date, frame width, and vantage point position as was used in the original photographs. The simulations and post-construction photographs were then compared by counting turbine numbers, height, rotor diameter, and location in each image.

WORKSHOP PROCESS

This session will cover digital workflows to compare simulations with post-construction photographs to evaluate their degree of difference. The intent of this workshop is to enable attendees to validate reliable simulation methods and improve less reliable simulations for future impact assessment projects. The methodology that will be taught in the session will be as follows:

Turbine Height Comparison

- Digitally overlay simulated and post-construction photographs so that the horizon line and fixed elements such as buildings are aligned.
- Mark the top of the turbine shaft position on the digital artboard and compare to that of the corresponding turbine shaft in the post-construction photograph.
- Note the position of the top of the turbine shaft as a pixel value, with 0 representing the bottom of the image composition.
- Categorize turbines into foreground, middleground, and background.
- Measure each turbine in the post-construction photograph and compare with its counterpart's height in the simulation, noting the difference in pixels.
- Determine the height difference in pixels between the simulated and constructed turbine by calculating as a percentage of the simulation height.

Turbine Contrast Comparison

- Isolate specific areas of a simulation and the same areas within its corresponding post-construction photograph in order to evaluate the contrast in specific areas of the photograph. These areas include: Sky, including any wind turbines that were visible within the selected area; ground, vegetation, and structures, including any wind turbines that were visible within the selected area; and prominent turbines (those which are fully visible and can be distinguished easily from other turbines in the photograph).
- Run a Photoshop histogram comparison for each selected area.
- Compare the standard deviation histogram values to determine difference in contrast between the simulations and photographs.

CONCLUSION

The methods taught in this workshop serves to advance the assessment of the effectiveness of visual simulations in forecasting the height of wind turbines. The creation of photomontages includes several challenges and potential drawbacks, leading to a need for increased understanding of their accuracy in predicting visual impact to the landscape. Clear communication of the accuracy of simulations in depicting the visual impact of a project can ensure that the viewer is aware of their potential advantages as well as limitations. These efforts to assess simulations can not only lend credibility to the simulations but can also enable visual simulation professionals to improve their processes.

LEARNING OUTCOMES

1. The best practices to photograph the post-construction landscape project for comparison with visual impact simulations
2. A method to currently align two images for digital comparison
3. Techniques for drawing linework to measure and compare turbine heights between two images
4. Techniques for using the histogram to compare contrast between two images
5. Calculations for determining the degree of accuracy between two compared images

EVALUATION

Attendees will follow along with the instructor using provided example files or their own images. At the end of the workshop, all participants' files will be submitted to the instructor to be evaluating attendees' learning.

EQUIPMENT

This workshop will require a personal computer with Adobe Photoshop and Illustrator installed. Example project files will be available to be downloaded and used during the workshop.

Workshop 6

Rethinking the Role of GIS in VIA

James Palmer[1] Jeremy Owens[1]

[1]T. J. Boyle Associates, Burlington VT, USA

Photo-realistic simulations are the primary means of representing the visual conditions being evaluated in a VIA. A viewshed map is often included, but rarely discussed in any meaningful way. The problem is that a cumulative viewshed map conveys little information for evaluating whether a project causes significant visual impacts. For instance, a map of the number of turbines blade-tips that are visible at specific locations in the landscape does not indicate how far each turbine is from the viewpoint, how much of the turbine is visible, or account for the decreasing incremental impact of each additional visible turbine at that viewpoint.

VIAs typically do not present information about what parts of a project will have the greatest visual impact. Such results would have obvious value in developing less impactful alternatives and guiding mitigation. The method also provides an important balance to the dominant role in a VIA of photosimulations from viewpoints that are typically selected by the developer. The results provide a useful guide to look for the "worst case" viewpoints. In addition, metrics derived from this GIS visibility analysis provide useful indicators of impact severity, and are an effective method for determining impact to scenic resources.

The content for this workshop is drawn from two case studies—a wind and solar project. Reports for the case studies that explain the details of conducting the analyses in ArcGIS Pro can be made available.

Learning Outcomes

1. Demonstrate why the cumulative viewshed map conveys little useful information.
2. Identify the necessary missing information to conduct the analysis—effect weights for distance, exposure and extent.
3. Describe how to calculate and map (Figures 1 and 2) a weighted index of visual impact from project locations.
4. Describe how to calculate and map (Figures 3 and 4) a weighted index of visual impact to the surrounding landscape.

EQUIPMENT

There are no special hardware or software needs for this workshop, other than access to the VRS Conference Zoom meeting. The instructors will be sensitive to the fact that most participants may be using a single computer screen and very likely, a laptop computer. Some of the "lessons" will be illustrative, such as describing the GIS procedures. However, there will be plenty of opportunity for discussion, such as how to determine visual prominence weights for distance zones, individual turbine exposure, or the spatial extent of a project's visibility.

Panel 1

CDOT Visual Impact Assessment Guidelines

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This panel will present an overview of the *CDOT Visual Impact Assessment Guidelines* (Guidelines), including the development approach, methodology, templates, and training program.

- Overview and Context for CDOT's Visual Impact Assessment Guidelines
- CDOT's Visual Resource Committee (VRC) took extensive background steps leading up to the decision to initiate the preparation of the Guidelines, which included:
- Applying the Federal Highway Administration (FHWA) *Guidelines for the Visual Impact Assessment of Highway Projects* (FHWA, 2015) to the preparation of visual impact assessments (VIAs) for a broad range of transportation projects over a three-year period, beginning in 2015.
- Initiating a survey in 2017 with CDOT Regions to gather input regarding regional needs, challenges, and concerns for the evaluation of visual resources
- Conducting a statewide conformance review of recent VIA documents in 2018 Initiating the preparation of the Guidelines in July 2018
- Establishing CDOT approval and publishing the Guidelines on CDOT's website in November 2019, with refinements in Version 2, September 25, 2020
- Initiating a visual resource training program in May 2020

Goals and Objectives for Developing CDOT's Visual Impact Assessment Guidelines

Findings from the CDOT regional VIA survey and conformance reviews identified the need to improve visual resource assessments for use in National Environmental Policy Act (NEPA) documentation (environmental impact statements, environmental assessments, and categorical exclusions); develop statewide consistency for consultants and regional staff who prepare and review VIAs; and conduct a VIA training program.

Framework for CDOT's Visual Impact Assessment Guidelines

CDOT initiated the development of new guidelines starting in 2018. CDOT's Guidelines build on FHWA's 2015 Guidelines and establish a statewide standard for assessing visual resources in CDOT's NEPA documentation and decision-making. CDOT developed its Guidelines (Version 2: September 25, 2020) through a collaborative process involving CDOT's VRC and FHWA, with consultant support, over a period of approximately one year, and involved a statewide CDOT review. CDOT is currently developing a VIA training program, which will be initiated in spring 2021.

The following is a link to the Guidelines: https://www.codot.gov/programs/environmental/landscape-architecture/visual-resources (see under the resources tab at left).

The mission of CDOT's Visual Resource Program is to objectively measure the visual impacts of transportation projects, following standard methodology, to meet legal requirements and regulations, while maintaining and improving the scenic quality of the State of Colorado.

CDOT organized the Guidelines into the following chapters and appendices:

Chapter 1 - Overview

Chapter 2 - Establishment: Scoping

Chapter 3 - Inventory: Affected Environment

Chapter 4 - Analysis: Impacts Evaluation

Chapter 5 – Mitigation

Chapter 6 - References

Appendix A - Includes two templates that follow instructions from the Guidelines and provide a framework for VIA documentation:

- **VIA Memorandum** (For projects with minor visual impacts)
- **Standard VIA (**For projects with the potential for adverse visual impacts or controversy)

Appendix B - Includes CDOT's visual resource scoping documentation for identifying visual resource issues, establishing the appropriate level of VIA documentation, and informing NEPA considerations.

Appendix C - Includes a glossary that defines technical VIA terms.

Appendix D - Identifies 3D visualization software applications for preparing visual simulations.

Appendix E - Includes the strategies behind the Guidelines, including connections and refinements to the FHWA 2015 VIA Guidelines, core concepts and methods related to landscape perception, visual quality, and sense of place.

These Guidelines describe CDOT's comprehensive process for assessing visual impacts. Templates are available for preparing VIA Memoranda and Standard VIAs.

Methodology Overview

The VIA methodology connects with the overall framework of phases included in the FHWA 2015 Guidelines, including *Establishment: Scoping*, *Inventory: Affected Environment, Analysis: Impact Evaluation*, and *Mitigation*. CDOT's VIA process offers an interdisciplinary approach through collaboration between the VIA practitioners and the design and environmental resources team from project initiation. The VIA process is rooted in NEPA to inform transportation decision-making. The following are key elements in CDOT's approach to preparing effective VIAs:

- Encouraging interdisciplinary team participation.
- Applying context-sensitive criteria for the inventory of landscape character, viewers, and visual quality within the framework of the *sense of place, landscape compositions, viewer sensitivity* and *visibility, and visual harmony*.
- Involving agencies and the public in the VIA process.
- Communicating graphically through maps, site photographs, cross sections, 3D visualizations, and animation.
- Identifying adverse and beneficial visual impacts.
Establishing effective mitigation measures for project design, construction, and maintenance, based on *SMART* criteria.

CDOT developed strategies for efficiently implementing each phase of the VIA process, as shown on the Implementation flowchart included in the Guidelines.

Establishment: Scoping Process

Goals for the Establishment Phase include determining the level of VIA, establishing the study area and landscape unit(s), identifying visual resource issues and associated regulations, and initiating agency and public contacts. A VIA Scoping Documentation template, including a questionnaire, is provided to facilitate documentation. The scoping process is organized into the following steps:

Step E-1: Conduct pre-scoping

Step E-2: Characterize project information and visual attributes **Step E- 3:** Characterize visual context

Step E-4: Research policies, guidelines, and feedback

Step E-5: Prepare VIA scoping questionnaire

Step E-6: Define Area of Visual Effect (AVE)

Step E-7: Delineate landscape unit(s)

A key element in the pre-scoping step is to apply a decision-tree to assist in the review of visual resource considerations early in CDOT project planning for NEPA compliance.

Visual Inventory Process

Goals for the Inventory Phase include unifying the inventory of landscape character, viewers, and visual quality to establish a common landscape composition; placing the existing roadway into the landscape composition; and establishing the roadway's visual influence on surrounding natural and cultural features and viewsheds. The inventory process is organized into the following steps:

Step I-1: Describe landscape character

Step I-2: Identify viewers and viewpoints

Step I-3: Characterize visual quality

Templates are provided to facilitate the documentation of the visual inventory.

Analysis: Impact Evaluation Process

Goals for the Analysis Phase include determining the visually incompatible element(s) of the Proposed Action/Build Alternative(s) in the AVE relative to landscape character and sensitive viewsheds; and identifying adverse impacts to visually harmonious and vivid landscape compositions. The impact evaluations are organized into the following steps:

Step A1: Evaluate visual contrast of the project with landscape character

Step A-2: Evaluate visual impacts

Step A-3: Create visualizations of impacts

Step A-4: Evaluate cumulative visual impacts

Templates are provided to facilitate the documentation of visual impacts.

Mitigation Process

Goals for the Mitigation Phase include applying SMART criteria to NEPA mitigation and developing effective mitigation for adverse visual impacts through planning, design, construction, and maintenance.

The following steps identify the process for developing mitigation measures:

Step M1: Establish mitigation goals as a foundation

Step M2: Establish regulatory context

Panel 2

Evaluation of Visual Impacts of US Offshore Wind

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This panel session will be a panel discussion involving the representatives from the off shore wind project Applicant, BOEM and ERM- the consultant that assisted in the preparation of the Seascape and Landscape Cumulative Impact Assessment and Historic Properties Visual Effects Assessment. The panelists will discuss the analyses and outcomes of the project, and their applicability to future offshore wind permitting and operations.

Authorization of the Vineyard 1 offshore wind (OSW) project is a major milestone for the US-based renewable energy sector, enabling construction of the first of numerous commercial-scale OSW projects along the US east coast. The Bureau of Ocean Energy Management (BOEM) is the federal agency within the US Department of Interior responsible for environmental analysis of OSW projects. As part of the 3-year process to prepare the Draft, Supplemental and Final Environmental Impact Statement (EIS) and concurrent consultation required under section 106 of the National Historic Preservation Act (NHPA) for the project, BOEM, its consultants, and the Project applicant (Vineyard Wind) conducted extensive analysis of visual impacts. This involved evaluation of the potential direct impacts of the project, evaluation of the cumulative impacts of all potentially visible OSW projects in BOEM's Rhode Island and Massachusetts lease areas, and consideration of the visual effects of these projects on historic properties and traditional cultural properties (TCPs) on and surrounding Martha Vineyard and Nantucket.

The evaluation of Vineyard Wind 1's visual effects was conducted as part of an active BOEM project. While not explicitly a research effort, the analysis was intended to identify innovative methodologies for evaluating visual impacts and effects on historic resources.

Vineyard Wind prepared a Visual Impact Assessment (VIA) and Historic Properties VIA, as required components of the Vineyard Wind Project Construction and Operation Plan (COP). These analyses assessed the Project's potential visual impacts and the Projects potential visual effects on historic properties, and included simulations and evaluations of daytime and nighttime conditions.

The Seascape and Landscape Cumulative assessment characterizes the existing character of potentially affected landscape and seascape units, as well as the visual effects on those units from the Vineyard Wind 1 project and other proposed or potential OSW projects in the Rhode Island and Massachusetts lease areas. The evaluation was based on the principles underlying the preparation of BOEM's forthcoming *Seascape, Landscape and Visual Impact Assessment (SLVIA) Guidelines.*

The Historic Properties Cumulative Visual Effects Assessment describes the visual effects Vineyard 1 and other proposed and potential OSW projects in the Rhode Island and Massachusetts lease areas on selected historic and cultural resources. The analysis focused on four resources for which a sea view free of modern elements was a component of eligibility for listing on the National Register of Historic Places, including the Gay Head Light, Chappaquiddick Island TCP, Vineyard Sound and Moshup's Bridge TCP on Martha's Vineyard, as well as Nantucket Island National Historic Landmark (which encompasses the entirety of Nantucket Island and other nearby islands). This assessment helped to fulfill BOEM's NHPA Section 106 consultation requirements for the Vineyard Wind 1 project by identifying the scope of cumulative impacts from all potentially visible projects, and by estimating the proportion of that total effect attributable to Vineyard Wind 1.

Panel 3

Scenic America and the Use of VRS Methods In Achieving Scenic Conservation Policy Outcomes

Leighton Powell[1], Marge Davis[2], Gene Burr[2], Kate Angell[3] John Hock[4], Nathan O'Neill[5]

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[2]Scenic Tennessee, Mount Juliet TN, USA
[3]Scenic Pittsburgh, Pittsburgh PA, USA
[4]Scenic Missouri, Saint Louis MO, USA
[5]Scenic America, Washington DC, USA

The Panel will commence with a brief introduction of Scenic America, including our organization's history, our scenic advocacy through local, state, and national legislation, and our broad scenic mission. Pursuit of scenic conservation takes many forms, but the State and National Scenic Byways Programs offer some of the most effective policy instruments for preserving scenic areas. Designation and subsequent management of a scenic byway route requires the creation of a Corridor Management Plan, which maps the route and identifies its scenic assets, all of which requires the application of VRS tools and techniques.

Scenic America also supports and seeks to facilitate the use of VRS tools in the creation of statewide scenic asset inventories. These inventories allow our chapters to create strategies for identifying and protecting the most significant or vulnerable scenic resources within their states. One of our chapters has played a key role in developing a state-level scenic inventory, and we have more chapters who are currently beginning this process.

Scenic America, including key chapter members, will be discussing their experiences with the development of Corridor Management Plans, Scenic Inventories, and other materials to support scenic conservation, and the VRS tools and research which allow them to do this. The nature of scenic blight and the tools and research we have used in our advocacy to stop it will also be featured. Finally, we will discuss our future VRS needs and possible directions for future scenic conservation work.

The panel format will include a brief presentation from each panel member, followed by guided discussion, and a question and answer forum.

Visual Case Study _ Technical Session 1

Scenic Measures: A Selective Review and Commentary on Where We Have Been and Where We Are Going

Patrick Miller, PhD[1]

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Many advances have been made over the years in protecting, managing, and stewarding visual resources. Much of this progress has come about to protect outstanding visual resources. We seem to be poised, however, to make more progress. The concept “sense of place” is being given greater attention today in our planning and management. Much of this is due to recognizing the role of visual characteristics in creating sense of place. At the site level this recognition is dealt with through sensitive design. But, we struggle with this in the broader environment. We confront the subjective/objective dilemma. Our private property rights heritage and the resulting planning regulations favor a quantifiable approach, but we are in danger of losing the deeper meaning of the scenic landscape? The scenic value of historic landscapes would seen to be particularly vulnerable to losing part of their scenic value through quantification.

This presentation begins by examining selected historical examples of how scenic landscapes have been measured in the past. It begins with the poetry of William Wordsworth used to attract urban dwellers to the Lake District of England during the industrial revolution. The early work of forestry-related landscape architects, Sylvia Crowe and Burt Litton Jr. are examined as well as the work of USDA Forest Service and USDI BLM landscape architects. Predictive models such as *Measuring Landscape Aesthetics: The Scenic Beauty Estimation Method* by Daniel and Boster and the *Natural Landscape Preferences: A Predictive Model* by Elwood Shafer are also examined for their stated purpose and their use of scenic measures. The range of measures and scales from the selected studies are reviewed for their potential for scenic management. Next, the presentation ventures into the epistemology of “subjective” and “objective”. The paper examines the potential use of public perception, both in perceptual studies and public input, in the planning process as a means of retaining deeper meaning in the stewardship of scenic landscapes. The presentation concludes with some observations and suggestions for using scenic measures and scales in different scenic management situations.

Visual Case Study _ Technical Session 1

Juan Bautista de Anza National Historic Trail Inventory and Retracement Trail

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The BLM tested a new methodology to comprehensively inventory four landscape elements — scenic, recreation, historic and cultural, and natural — and how they work together to define the nature, purposes, and desired uses of the Juan Bautista de Anza National Historic Trail across the Yuma and Lower Sonoran Field Offices. The methodology was codified in the BLM’s Technical Reference and companion Field Guide for National Trail Inventory, Assessment and Monitoring.

This trail commemorates the 1775-1776 Juan Bautista de Anza Expedition that led 240 men, women, and children along the Gila River through Arizona and eventually to establish San Francisco Bay area’s first non-Native settlement in California. As a “one time” event, the Anza Expedition left no original trail traces of the trail to be located on BLM-managed land, resulting in a field inventory program that largely describes and documents the visual resources and historic settings associated with selected high potential historic sites and high potential route segments, as well as recommending the establishment of a 30-mile Recreational Retracement Trail.

The integrated inventory captures the trail’s Resources Qualities, Values and Associated Settings (RQVAS), as well as the primary use and other uses of the JBHT. It complies with BLM’s Manual 6280 – Management of National Scenic and Historic Trails and Trails Under Study or Recommended as Suitable for Congressional Designation and its Trail Inventory sections, as well as BLM cultural resource and visual resource requirements.

Paper _ Technical Session 1

A National Park Service Visual Impact Assessment Methodology—V 2.0

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Abstract: Units of the National Park System encompass a wide variety of landscape types and visual settings. Visitors enjoy views at parks not only for scenic qualities but also appreciate them for their historic and cultural values. Many NPS units incorporate visible landscape features into their interpretive and educational activities. The National Park Service (NPS) visual impact assessment (VIA) methodology will provide consistency in how NPS considers and determines the potential impacts of changes to the visual landscape, the visitor experience, and NPS. It will form the basis for meeting the environment documentation requirements of the National Environmental Policy Act.

The methodology compliments the NPS Visual Resource Inventory (VRI) that assists parks in understanding the scenic and historic/cultural values of the views in the park. The VRI considers the viewer's perspective and identifies the visual qualities of views as well as other values that make views important to NPS and park visitors. The VIA methodology is consistent with the VRI in assessing impacts on a view-by-view basis. Also, as in the VRI process, some components in the VIA are to be done by a team of evaluators completing their assessment individually and then reaching a team consensus on the outcome of each factor assessed. However, rather than a direct translation of the individual inventory elements into the assessment of impacts, the elements are integrated within analysis factors that can more clearly communicate a level of visual change for a given project.

The initial version of VIA methodology was field tested in 2019. The methodology included a team evaluation of the change in the scenic quality factors and overall level of visibility of the existing transmission line that served as the test project. While successful in some respects, the results also revealed certain aspects of the initial methodology to be challenging. This paper will discuss the evolution and current approach to the NPS VIA.

Keywords: visual impact assessment, visual resource management

Introduction

The National Park Service (NPS) currently manages 423 individual units in the national park system. While officially known by many different naming designations—National Monuments, National Historic Sites, etc.—they are all commonly referred to as "parks." Parks are located in many different types of landscapes and visual settings ranging from deserts to alpine mountains, eastern forests to lake and seashores, wilderness to urban centers. The mission and purpose of parks is as varied as their landscapes. Visitors appreciate the views in parks not only for their scenic values but also for the historic and cultural values and the stories they tell.

The NPS developed a visual resource inventory (VRI) process to identify and describe the views in parks as the first step in being able to protect the valued characteristics of those views (VRI – 2018). In the VRI, each view is assessed for its scenic quality and its "importance." The importance component attempts to capture the value of a view to the park's interpretive themes and its visitors.

Developing a visual impact assessment (VIA) methodology that uses the VRI information is the next step in creating a comprehensive visual resource management program. The VIA needs to evaluate potential changes to the visual landscape in a consistent, credible way to help parks understand how the changes might affect their visitors as well as the stories the park tells. It will form the basis for meeting the environment documentation requirements of the National Environmental Policy Act (NEPA).

Background and Literature Review

Foundational aspects of several VIA approaches have been integrated into an NPS specific process (FHWA 1982/2015; BLM 1984/1986, GLVIA 2002). The factors in the NPS VRI have also been used to develop assessment criteria that allow for easier consideration of a potential change in the visual landscape from the introduction of a project.

A first draft of a VIA methodology was field tested in 2019 and made a direct evaluation of each scenic quality element from the VRI (Meyer et al. 2018). The test project was a 500Kv transmission line across the James River near Jamestown National Historic Site and the Colonial Parkway. The process included individual assessments by a 4 to 7-person team as well as a consensus evaluation of the change in the scenic quality factors and overall level of visual prominence of the existing transmission line. An assessment of changes to view importance was not included in the field test.

While successful in some respects, especially the assessment of visual prominence, the results showed that direct evaluation of the inventory components was challenging. The process also showed the positive value of doing the evaluation individually and then reaching a team consensus incorporating the thoughts of a diverse group.

In a subsequent field test, a revised approach was implemented by a consultant to assess the potential impacts of a planned pipeline crossing the Blue Ridge Parkway. The evaluation team included staff from the NPS, the landscape architects preparing the VIA, and environmental professionals responsible for coordinating the EIS. The evaluation was conducted onsite using photosimulations to represent the proposed conditions. The evaluation criteria were different than those used for the transmission line thought still closely aligned with the VRI factors. The team members completed individual assessments and the consensus evaluation process exposed different thoughts and interpretations of simulations. There was a general agreement that the process of individual assessment followed by a consensus evaluation led to a more valid result. The pipeline project was ultimately cancelled. As a result, the impact assessment report was not completed so results were not further developed into a VIA methodology that could be thoroughly reviewed.

Goals and Objectives

It is important to have a credible approach to assessing impacts to park views and that it be implemented consistently. The opportunity to test a methodology early in the VIA development identified successful and unsuccessful components to consider as the process evolved. Several principles that are accepted for incorporating scientific information into decision making provide the basis for general goals of the NPS VIA (Churchward et al. 2013). In summary, the methodology should be:

- Adequate—Use best practices to assure quality of the information and that it is credible in the context of the state of knowledge of visual impact assessment
- Relevant—Provide an assessment of impacts that is valuable for decision making
- Legitimate—Incorporate different views and experiences and remain fair and unbiased
- Effective—Have a real effect on decisions and actions

The NPS VIA Procedure

The primary purpose of the NPS VIA is to serve as the source of documented analysis required by the NEPA. The current NPS guidance for resource analysis is:

"… to move the National Park Service (NPS) away from the practice of using intensity definitions as a stand-in for impact analysis and toward a narrative method that fully discusses the potential environmental impacts…"

In keeping with this guidance, the VIA results are primarily presented as a detailed narrative description of the visual change and sensitivity of receptors. While an ordinal scale may be used to characterize overall impacts at a viewpoint, there is no threshold that determines the significance of the impact.

The NPS VIA procedure evaluates the view from specific viewpoints. Visual impact is determined by considering two different concerns. First, the degree of visual change as indicated by a project's compatibility with the existing landscape and contrast with visual elements. Second, the sensitivity of those effected by the visual change (a.k.a. receptors)—the viewers and the NPS. In keeping with the approach of the VRI, the VIA conducted in the field at each key observation point (KOP).

The remainder of this section will describe the current approach, as schematically represented in Figure 1.

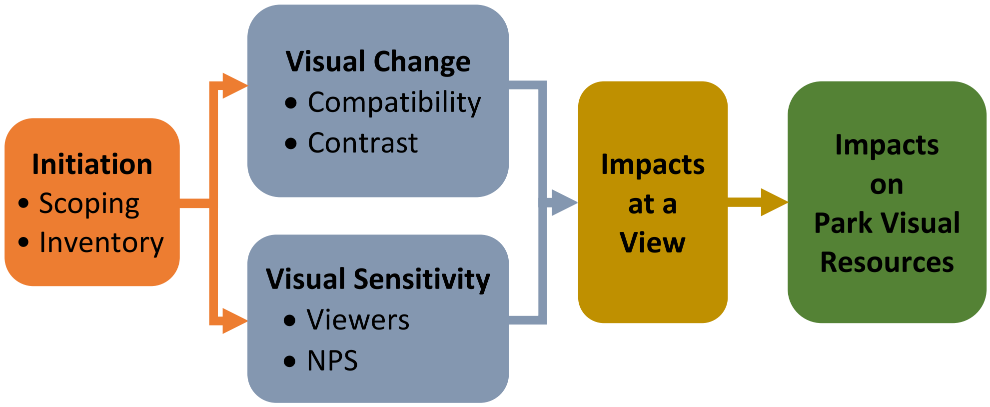

Fig. 1. *The general flow of the NPS VIA procedure.*

Scoping

A scoping phase identifies the general characteristics and context of the project, and the area of visual effect (AVE). Using GIS, Google Earth, and other tools, the AVE shows which areas of a park might have a view of a potential project. KOPs are the central focus of the NPS VIA and are tentatively identified from this analysis. The viewshed analysis may highlight locations in the park that could have a view of the project but were not included in the VRI. It may be appropriate to also include a typical viewpoint within these areas to be assessed with the other KOPs.

The final component of scoping is a series of questions about basic compatibility of the project with the landscape and its potential level of visual prominence. This might be aided by looking at a Google Earth 3D view from each KOP, where the project is represented by an extruded point or polygon on the terrain surface. This scoping process provides a park with an indication of the level of engagement they should consider in participating in the visual impact process. Scoping is planned as primarily an office exercise, though a field visit is recommended to enhance the preliminary understanding of the existing conditions in relation to the proposed project.

Inventory

The inventory step identifies the Affected Environment for a NEPA document and is the foundational component of the VIA process. The inventory goes beyond identifying key information about the existing landscape to also describing viewer groups and their potential sensitivity to visual change, as well as the NPS unit's interest in the visual experience as part of telling its stories. To set the stage for assessing impacts, an understanding of the current conditions is critical. While a visual resource inventory may exist in some situations and can be used to inform the VIA inventory, it is not a required for the VIA methodology.

Existing Landscape

The existing landscape inventory includes descriptions of landscape character, visual elements, and spatial composition of the view from a KOP. A field data sheet has been developed as a suggested way of recording these descriptions. Landscape character includes identifying a dominant landscape character type and assessing the integrity or intactness of each type—natural/natural appearing, pastoral, agricultural, rural, suburban, urban or industrial. Since many landscapes are a mix of types, additional types can be noted. Additionally, the view type—panorama, enclosed, feature, focal framed or canopied—is identified along with the predominant landforms, land covers, land uses and structures. If there are built features, the dominant materials and styles are described to the extent they can be determined.

The second landscape description component is the identification of visual elements of forms, lines, colors, and textures. Like other methodologies, noting the predominant visual elements helps form the basis for evaluating the contrast of a proposed change. They also can be used to identify effective mitigation strategies to reduce contrast if they have not been incorporated into the design of the proposed project.

The final component of the landscape inventory is the description of the spatial composition of the view. Spatial composition is described by considering the view's balance, pattern, continuity, variety, scale, and focal points.

The field-data sheet has space to characterize each component, which is assisted by an ordinal scale of 3 to 5 words that help describe its positive, neutral, or negative aspects. For example, a description of balance would be developed using the terms harmonious, balanced, discordant, or chaotic.

Viewers

The first step in assessing impacts to viewers is to understand who they are and how sensitive they might be to visual changes. There are three categories that broadly describe the different ways a viewer may approach/interact with the view. Causal (eye) tourists simply enjoying the scenery in a park. Knowledgeable (critical) observers who have special knowledge that allows them to interpret and have a deeper appreciation of the natural, cultural and/or historical details of the view. Local residents who are high repeat visitors that have a personal, even generational association with the site over time. The categories are meant to help parks describe the characteristics and potential sensitivity of viewer groups and not serve as an organization approach where viewer groups need to be fit into one of the categories. Within these categories, for any particular view, there may be more specific viewer groups and some viewer groups may exhibit the characteristics of more than one category.

Most parks can describe various viewer groups that may include casual park visitors, photographers, hikers and back country recreationists, concessionaire/business employees, occasional motorists/tourists, and neighbors/residents. The make-up of these groups may also change seasonally, by time of day or other factors. If appropriate, parks my identify groups that might associate a special meaning to the landscape in a view and be especially sensitive such as Native American's association with a sacred landscape, Japanese Americans at internment camp historic site, and re-enactors associated with Civil War battlefields. Each group may have different levels of sensitivity to a change in a particular view or to the views in the park overall.

Viewer sensitivity is related to the importance of scenery to a viewer's experience and the magnitude of visitation (i.e., the number of viewers and their duration of stay). Consistent with most VIA methodologies, NPS makes the assumption that the greater the number of viewers exposed to a change and the longer the period of time they are exposed, the greater the potential impact to them from a change in the visual landscape. However, the descriptive approach in the NPS VIA also considers situations where very low numbers of visitors might be highly sensitive to change, such as backcountry users.

NPS

NPS sensitivity is expressed as the park's interest in the views as it relates to the importance of the viewpoints and viewed landscapes to NPS as an agency and the commitment expended by the park to accommodate and enhance the viewer's experience. For many parks, viewpoints and the viewed landscapes support the park's purpose and interpretive themes. The stronger the relationship of a viewed landscape or viewpoint to the purpose and interpretive themes, the more the park will be affected by change in a particular view. Special designations can also be an indicator of the importance of the landscape in the view. Importance is heightened when a view offers a one-of-a-kind viewing opportunity or it is the only or one of few that supports the park's purpose and interpretive themes.

Additionally, parks express this importance by the extent of effort to support the viewer's experience through management, services, and facilities. Parks also may spend funds for improvements, staff time for management and maintenance, or expend efforts in other ways to accommodate and enhance the visitor experience at viewpoints. When these efforts are highest, the park may be more sensitive to changes in a visual landscape.

NPS interest in the visual landscape and level of sensitivity is described primarily for the park as whole and then the importance, uniqueness, and commitment at each view is included where it is different from the park summary.

Impact Assessment

The analysis of visual impact evaluates how the existing conditions described in the inventory are affected by the project's introduction. There are two primary considerations: visual change and receptor sensitivity. In the VIA the impacts to the viewers and the NPS are described separately and are not combined to determine the level of impact at each KOP. Summary statements can be made for overall impacts to viewers and the NPS considering the impacts from all KOPs on each receptor.

Visual Change

The assessment of visual change for the NPS VIA is designed to be done as a team exercise rather than an evaluation by one or two individuals responsible for the VIA documentation. The team for the assessment should be about 4 to 7 members; ideally the team should include park staff as well as visual resource professionals and authors of the VIA. At each KOP, team members should complete their own assessment using the simulations and viewshed analysis. The group then discusses the results to reach a consensus for each factor and ultimately the overall effect on scenic quality. While the field forms include descriptors with an ordinal value, it is important that the team provide as detailed and rich a narrative describing their evaluation as possible.

Visual change considers the compatibility of a project with the existing landscape character and its contrast with the existing visual elements and spatial composition. A viewshed analysis and high-quality visual simulations of the proposed project from each KOP are critical to a credible evaluation.

The visual change aspect of compatibility considers how the project affects the existing landscape character and whether it is intrusive. Considerations also include compatibility with existing landscape diversity, and the with design, materials, and style of existing features. Opportunities to include distance from the viewpoint and screening or other factors that affect the project's visual exposure are also included. The aspects of compatibility are characterized as ranging from not at all compatible to very compatible.

For contrast of visual elements, the assessment considers how the project might visually attract attention through the introduction of bold lines, novel forms, intense colors, and textures. Evaluations use a general scale of *none*, *weak*, *moderate*, or *strong*; and, also, include other contrasting features such as motion or bright or flashing lights that could attract the attention of a viewer.

The VIA process recommends doing the evaluations under conditions that represent the "worst case scenario." It may be that the evaluations made in the field are not done during the worst-case conditions and the simulations do not reflect these conditions either. In this case several variable factors should be considered to describe the worst-case scenario more closely, including lighting and atmospheric conditions, vegetation or topography screening from certain KOPs, seasonality, and viewpoint selection at the KOP to maximize visibility of the project.

Impacts to Viewers

The impact to the visual experience to viewers is the assessment of how the visual change potentially impacts the experience of viewer groups considering their perceived sensitivities to those changes. A narrative is developed that describes how the visual changes in landscape character, visual elements, and spatial composition could affect their visual experience based on the viewer group sensitivity identified during the Inventory of Affected Environment section of the VIA.

Considerations for assessing impacts to viewer groups include:

- Are viewer groups equally affected? Sometimes there could be a higher impact from a given change for a low number of viewers because of heightened sensitivity e.g., wilderness hikers expecting pristine landscape settings.
- Are there different viewer groups at the same view? A popular location may attract a high number of general viewers who are relatively less sensitive than a lower number of serious photographers.
- How does the proximity of the project affect viewers? As the distance to a proposed change in the landscape increases, the visual prominence of the change decreases and the viewer is less likely to focus on the details of the change. Conversely, the closer the viewer is to the change, the greater its visual prominence and the more likely they are to notice details.
- How do the seasonal variations of the visual change relate to the seasonal variations of viewer group experiences? For instance, if possible, construction should be scheduled when levels of casual park visitors are lower.
- Are there specific aspects of the visual changes to landscape character, visual elements, or spatial composition that affect a viewer group in a particular way?

Impacts to NPS

In the VIA the potential impacts to the park are focused on the value of the view from a KOP to the park's interpretive themes and stories it communicates to its visitors. The impacts discussion includes a general description of how the visual change affects the park's ability to fulfil its purpose and mission. Then any special considerations that could affect the park based on the importance of the view to the interpretive experience and the park's commitment to viewpoint are described for each KOP. While a change in a view will not directly affect the physical improvements at a KOP, a reduced value of a view for interpretation could result in the diminished use of facilities and the need for investments to replace facilities or alternative interpretive programs to other locations. To guide the narrative for the impacts to the park, the following questions have been developed:

- Does the visual change affect specific interpretive features?
- Does the visual change create a distraction in the view?
- How compatible is the visual change with the interpretive themes?
- Does the visual change present a new interpretive opportunity for the park?
- Would interpretive material need to be changed because of the visual change?
- Are there specific aspects of the visual changes to landscape character, visual elements or spatial composition that affect the interpretive themes or park commitment to the viewpoint in a particular way?

Conclusion

The evolution of the NPS VIA method has included building on the foundations of other methods and incorporating lessons learned from an initial field test. While the method will be developed for implementation by experienced practitioners, engagement by the park in providing information for the analysis as well as participating in the process will enhance the credibility and outcome of the assessment. The next steps in the continuing development of the VIA will be to develop a field implementation strategy along with the forms and tools to test the process on another project. Detailed instructional guidelines for use by parks and practitioners will also be developed.

With a credible impact assessment method completed the final step to completing the VIA will be the development of mitigation strategies. By helping parks understand how to incorporate the familiar avoid, minimize, reduce, compensate mitigation framework they can come to fully consider visual resources in the management of the park. The VIA is ultimately a critical component in creating the mindset for parks to think of visual resources as a resource that can be measured, managed, and protected the same as other park resources.

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Visual Case Study _ Technical Session 2

Design With VRM In Mind: Lessons from Three Case Studies

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Appropriate use of technology, a creative multi-discipline team, and a well-informed advisory committee are key parts of a comprehensive approach to project planning and design to successfully meet challenging scenic area Visual Resource Management (VRM) criteria. With the goal of addressing criteria - such as “not visually evident” - a deliberate, deliberative process can overcome complex challenges and result in schedule efficiency, stakeholder consensus, and project approval.

David Evans and Associates, Inc. (DEA) has been supporting a variety of agency clients (FHWA, USFS, ODOT, CDOT, OPRD, and others) on several recent projects providing process facilitation and technical expertise. These complex transportation, recreation, and access projects have utilized a replicable framework for successfully addressing relevant visual resource management criteria to advance the work within unique and sensitive environments.

A Visual Assessment: Dark Skies, Skyglow, and Christchurch's Light Dome

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Visualizing skyglow is a difficult problem that could prove to be a helpful tool. By observing and documenting various baseline conditions photographically, we hope to improve our understanding of the relationship between truly dark skies and city Skyglow. Documenting the same city subject during various times of year, weather conditions, and distances may provide valuable empirical data for clarification.

The night sky has long held wonder for humanity. Over millennia, we have looked up into the sky with wonder allowing the stars to guide us. With Edison's wonderful lightbulb, humanity put our collective heads down, and powered through the night and progressed through a century of conquests over darkness. We have electrified the world. The slow work of progress has unintended consequences as we look up to the night sky and wonder, *where are the stars?*

In 2006, John E. Bortle provided us his nine-level Bortle scale to help us compare and assess the night sky. With his 50 years of experience in astronomy, he noticed the long trend of light pollution overtaking the night. In his words: *Thirty years ago, one could find truly dark skies within an hour's drive of major population centers. Today you often need to travel 150 miles or more. In my own observing career I have watched the extent to which ever-growing light pollution has sullied the heavens. In years long past I witnessed nearly pristine skies from parts of the highly urbanized northeastern United States. This is no longer possible.*

By 2030, The UN predicts a full sixty-percent of the world's population will live in urban centers. This number could total to more than 5.1 billion people with smaller and mid-sized cities representing 2.2 billion of those people. The omnipresent light radiating from cities at night creates a skyglow that can prevent the viewing of a night sky. This phenomenon is prevalent across the world in all major cities. The new world atlas of artificial night sky brightness concludes more than ninety-nine percent of the United States and European Union, and about eighty-percent of the World population live under polluted night skies. More than one-third of humanity cannot see the Milky Way, and that number grows to sixty percent of Europeans, and nearly eighty percent of North Americans. Unfortunately, this issue is not contained to the cities. Evidence suggests that the light pollution radiating from major cities like Las Vegas can be observed from over 150 miles away. In some instances, light pollution crosses borders to contaminate a neighboring country's night sky. Further, evidence suggests that atmospheric conditions like cloudy or overcast conditions reflect stray light and expand the impact of extraneous lights beyond the typical light dome.

Christchurch is a city of 370,000 people and is uniquely located on New Zealand's South Island ~175 miles away from its nearest medium and large city neighbors of Dunedin and Wellington. This unique location makes it an opportune place to observe the general impacts of city lights while also observing night skies. New Zealand's remote location in the South Pacific and unique landscapes allow for an unobstructed nighttime viewing of the sky. This minimal light pollution creates a unique baseline to compare imagery and experience. Comparing images from truly dark skies to the skies within and around Christchurch at night identifies themes and general effects of city lights on our perception of the night sky. Contrasting images from around the world under various light pollution conditions will provide breath to the comparison.

This undertaking attempts to photograph and assess the current visual impacts of a medium sized city's lighting on the perception of stars in the night sky. These modern photographic techniques observe the relationship between "truly dark skies" and city night skies. Comparing baseline images from Christchurch to imagery locations such as the Urubamba Valley, Peru; New York City, USA; Alberta, Canada; Milford Sound, NZ; Delicate Arch, Utah; and other locations hope to answer questions such as: How does our visual perception of the night sky change when inside cities are compared to truly dark areas? What standards can be applied to best represent those perceived changes with visual simulations? How are color temperatures perceived versus realized on camera?

The primary goals of this project are:

- Observe, document, and organize a visual baseline of the night sky under various "dark" conditions. Equinox, and Winter Solstice - True Darkness, City Darkness - Various distances from a city's center - Various atmospheric conditions.
- Determine the exposure ratios between a truly dark sky and a city night sky as related to the Bortle scale.
- Understand the practical exposure implications for photographic imagery of night skies. What is a typical exposure in NYC? Christchurch? True Dark? Overcast? Moonlight?

- Create editing parameters and best practices for night time imagery to best reflect the human experience.
- Determine the best methods to experience night time imagery or visualizations.
- Gain a better understanding of the perception of night sky color temperature.

The world atlas of artificial night sky brightness does a particularly adept job at quantifying light pollution on a global scale. To further support this research, it is our effort to create realistic baseline imagery in a wide variety of known conditions and known exposures. By utilizing this baseline imagery, we can further the discussion around light pollution and visualization strategies for assessments. As the world changes to new lighting sources, such as LED, there are other issues to consider. *Assuming that the photopic flux and upward emission function remain equal, a 4000K white LED light is about 2.5 times more polluting for the scotopic band of the spectrum than is HPS lighting. ...a transition toward this technology can be expected to more than double the night sky brightness as perceived by our dark-adapted eyes (Falchi, Fabio, et al).* As we move forward, night sky visualizations are going to be necessary assessment tools. Techniques and methods for capturing accurate photographic representations of the perceived night sky combined with visualization techniques for representing accurate depictions of perceived changes will be important tools for visual resource stewardship professionals.

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Visual Case Study _ Technical Session 3

Visual Impact Assessment Mitigation Strategies Research

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This abstract presents an overview of the CDOT Visual Impact Assessment Mitigation Strategies Research and its integration with CDOT's Visual Impact Assessment Guidelines and training program.

Colorado Department of Transportation (CDOT) developed approaches for creating more effective mitigation measures to address adverse visual resource impacts through a research team of CDOT Headquarter Landscape Architects and its consultant Felsburg Holt & Ullevig. Through suggestions from Federal Highway Administration (FHWA) Region 8, CDOT decided to adapt "SMART" concepts as a tool for informing the development of more effective visual impact mitigation measures and design guidelines. The research team focused their efforts on creating a framework and guidance for writing effective visual impact mitigation measures and preparing design guidelines. In creating the framework, the research team included strategies to implement National Environmental Policy Act (NEPA) visual impact mitigation commitments for transportation project planning, design, construction, and maintenance.

Visual Case Study _ Technical Session 3

Visual Mitigation Actualization: Assuring Visual Impact Mitigations and Protections are Carried Through to Construction on Federally-Managed Lands

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As part of the National Environmental Policy Act (NEPA) process for projects proposed on federally-managed lands, mitigations are often identified to reduce visual resource impacts. However, as projects extend beyond the NEPA process and into the record of decision (ROD), right-of-way (ROW) grant, and pre-construction plan of development (POD) stages, visual mitigation measures and protections are at constant risk of being lost in the process. These risks are associated with a number of potential sticking points, including a lack of specific mitigation requirements, a lack of visual resource specialist involvement after NEPA, and competing resource and client preferences. This presentation will examine specific risks observed on several recent projects, and identify methods for assuring that visual mitigations are carried throughout the post-NEPA process into construction.

Visual Case Study _ Technical Session 3

The Use of Verified Visualisations in Visual Presentation, International Experiences in Malta and UK

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The use of Verified Visualisations in visual presentation, International experiences at sites in Malta and UK. Mike brings 30 years of visualisation experience to projects and has worked on schemes which affect the setting of UNESCO World Heritage Sites. His approach includes the use of what's been termed in the UK 'Verified Visualisations'. This means that anyone could return to the same spot and capture the same photography, survey data and generate the same perspective views. To do this Mike has opened up the bonnet with visualisations to enable an extremely transparent workflow. This includes Full Frame Sensor camera, panoramic tripod head, communication with GPS, Glonas and Galileo satellites, and using real time coordinates in his 3D modelling software. The visualisations are presented on-line and allows anyone the ability to access paperless visualisations that can be interrogated in detail.

Projects covered will include impacts of Tower Block developments on the Royal Botanic Gardens in Kew and on the setting of Valletta.

Visual Case Study _ Technical Session 4

From Quechee to Antrim and Beyond: Developing a Comprehensive Methodology for Visual Analysis and Aesthetic Review of Energy Generation and Transmission Projects in Northern New England

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Landscape Architecture has always been focused on aesthetics. Early practitioners such as Lancelot "Capability" Brown were known for espousing the benefits of beauty to his estate owning patrons, but it was Humphrey Repton, in many ways Brown's successor in the infancy of the profession as we now know it, who, in the early 19th century invented and employed the practice of visualization with his before and after watercolors as set forth in his "Red Books". At the turn of the 19th century it was Warren Manning, working in the office of Frederick Law Olmsted, who, with Charles Eliot of the firm developed overlay analysis techniques in their studies for Boston's' park system, a methodology that would become common practice as it was espoused later by the work of Ian McHarg in Design with Nature, and ultimately, in the landscape scale GIS technology as developed at the Harvard Graduate School of Design. The 20th century also gave rise to the expanding role of landscape architects in both preservation and development initiatives. Indeed, one of the first landscape architects in the employ of the National Forest Service in the mid 1920's, Arthur Carhart, was referred to by his colleagues as the "Beauty Engineer", foretelling the challenges of balancing aesthetic values with resource use and management and recreational infrastructure. This seeming dichotomy was readily evident in the evolving approach of the National Forest Service in assessing visual and environmental impacts of projects affecting National Forests. This approach culminated initially in the "Visual Management System" and ultimately in the manifesto "Landscape Aesthetics".

Robust and comprehensive reviews of landscape development projects emerged during the last half of the 20th century as the United States continued to rapidly develop and expand the built environment and the infrastructure to serve it. In 1970 a landmark environmental law, one of only a handful of such state level environmental review processes, Act 250, was adopted by the Vermont Legislature to help the state grapple with the increasing effects and impacts of extensive ski area and resort development, particularly in scenic natural landscapes. Evidence of the state's recognition of the value of aesthetics to both the state's quality of life and tourism economy, all off site signs and billboards were banned from Vermont's highways in 1968, one of the first of 4 states to do so.

It is against this backdrop that the so-called "Quechee Decision" or "Test" emerged out of legal challenge to an Act 250 decision as a means by which to address the potential aesthetic impacts of development projects proposed in Vermont. In order to provide more guidance for scenic analysis and scenic resource management, the Secretary of Vermont's Agency of Natural Resources created the Design Issues Study Committee, and the work of the committee resulted in the publication of Vermont's Scenic Landscapes – A Guide to Growth and Protection in 1991. This work has guided planning and permitting approaches in the state ever since.

Two trends brought with them the need to apply a robust review process to a new type of challenge, permitting the expanding footprint of our energy generation and transmission systems, along with the impetus to develop renewable energy projects. In Northern New England, along with Vermont, both New Hampshire and Maine instituted land use and development frameworks within which to review and permit such projects, and in particular, in the case of Maine, wind energy development, through the Wind Energy Act. Some of the components of the aesthetic review process in these two states have been informed by the Quechee Analysis/Test. However, the challenge of creating an objective, rational review process that can rate scenic values and also calculate the relative intensity of visual change on that landscape and the acceptability of that change to the public constituency remained.

Northern New England represents a specific region where natural beauty and scenery are integral to both local and visitor perception of the region's attractiveness for living, working, and vacationing. As such, these particular laws and criteria and the project review process they require have served as something of an incubator for new tools and techniques for visual, cultural and landscape analysis, as well as the evolution of an overall aesthetic sensibility to energy development projects.

It is the advent of what the presenter refers to as the "New Energy Landscape" that has resulted in an array of legal definitions, parameters and processes that landscape architects have continued to grapple with, often in opposition to each other's assessment of whether the project should or should not be built, and if built, how. A universally accepted standard, detailed, aesthetic assessment methodology has yet to truly emerge.

The Case Study

It is within this context that the methodology developed for the visual and aesthetic assessment of the Antrim Wind Energy Project represents a compelling case study. Despite being denied a permit by the New Hampshire Site Evaluation Committee for unacceptable aesthetic/visual impacts, the Antrim Wind Energy Project was supported by the town of Antrim and its Selectboard. The energy developer was not ready to abandon the project, which had widespread support (as well as some local opposition) and sought ways to initiate a new approach. As part of this renewed effort, LandWorks, a Vermont based interdisciplinary landscape architecture and planning firm, was enlisted to review the project and determine if there was a revised approach that might successfully meet the criteria set forth for review and approval.

New Hampshire Site Law 301.05 “Effects on Aesthetics” (from Statute RSA 162-H) sets forth specific requirements as to what visual/aesthetic analyses shall include, and what exhibits are to be provided to assist the Site Evaluation Committee in making a decision. The case study will identify these requirements, and demonstrate, through the walk through of the methodology, how it works and addresses both the technical/objective components of the analysis, along with considering some of the more subjective aspects.

LandWorks employed a multi-step process that was tailored to wind energy review, and one that was, and is, easily adaptable to address transmission projects as well. In our review of other regional and national technical documents and visual assessments that have developed over time, we have found that while there are standards and elements of many of these methods that are agreed upon and are employed in most visual assessments, no one methodology can be used in its entirety. Often methodologies have been developed specific to a project type or locale, such as that of the Cape Cod Commission’s VIA guidelines for assessing offshore development. Through all our work we have not encountered a single accepted approach that is as expansive in its considerations or employs the same rating and evaluation system and aesthetic “reference” points. The Case Study demonstrates how a methodology was developed and its derivation from many studies, examples and methods that have been employed by landscape architects over time. Some of these methods and work by others in the field will be referenced.

The presentation of the project methodology includes:

1. Overview and Project Context
2. Project Description, Geographic Scope and Existing Landscape Character
3. Inventory and Field Work
4. Determination of Visibility
5. Identification of Sensitive Scenic Resources
6. Determination of Visual Effect on Sensitive Scenic Resources with Potential Project Visibility
7. Determining the Project’s Potential Effect on the Viewer from Sensitive Scenic Resources
8. Findings of the Analysis regarding “Reasonable/Unreasonable” Effects (or as in Quechee “is the project shocking or offensive to the average person.”?
9. The Role of Mitigation Measures to Reduce or Eliminate Project Impacts and some examples of effective mitigation.

Given that it is lay board members that are often charged with decision-making in the environmental permitting process, there was a distinct effort to create a step-by-step process that employed accessible language, graphics and evaluation techniques that citizens and reviewers could understand and respond to. The presentation of the case study will walk through the process and provide visual and analytical reference points that lay out the approach and the outcomes. The significance of this approach was, in particular, the way in which reviewers and the public could become actively engaged in the process and therefore have an informed and open perspective on the visual assessment process and their role in it.

The case study will conclude with a short piece regarding the application of the same methodology for the Seacoast Reliability Project, an energy transmission upgrade that was permitted by the NH SEC in 2019. It will conclude by positing some overarching "takeaways" and "lessons learned". Finally, a story will take the case study full circle and connect similarities with a much earlier "ground breaking" analysis in Vermont, for the PV-20 transmission line, conducted within the parameters of the Quechee Analysis, that - instead of seeking approval for reconstruction - resulted in the burial of a the line across Lake Champlain, restoring an unfettered view of both the lake and the mountains beyond.

Conclusion

An extensive body of work exists that deals with landscape change and development and visual assessment. From landmark publications such as Robert Thayer's, Gray World Green Heart and Gary Robinette's, Energy and Environment, to the Bureau of Land Management's, Best Practices for Reducing Visual Impacts of Renewable Energy Facilities on BLM –Administered Lands and The Renewable Energy Landscape- Preserving scenic values in our sustainable future, an extraordinary wealth of information, examples, technologies and methodologies exist. The guidance this work provides is informed, supplemented and complemented by the landscape architect's actual experience of planning, assessing and developing renewable energy infrastructure and the transmission projects needed to serve them. The insights in the review provided by this presenter answer many questions, but critical concerns still remain and they will be raised and discussed in the final portion of the presentation:

- How intimate does the landscape architect need to be with the environment they are analyzing? The opening quote in Volume One of the USFS Landscape Management project states "87% of a (hu)man's perception is based on sight" (7) – but it can be argued that the practitioner needs to touch, feel, hear, smell and understand the landscape they are charged with assessing.
- Where do personal experiences, politics and predilections factor into a VIA - or should they be factored in at all?
- How does the analyst acknowledge and or address public opinion?
- Finally, how do landscape architects take on a project for a client, whether a developer, the neighbors, or the public agencies, if they are not sure what determinations their work will lead to?

What is the price of beauty? The landscape architect of the 21st century may need to grapple with the question of "how much is too much?" when it comes to visual change in the landscape, sustaining a broader perspective versus one focused purely on project approval or rejection. Aesthetics deals with the nature of beauty and judgments concerning beauty, but often the aesthetic costs are outweighed by the economic benefits. Land based wind energy is losing that battle and it is migrating offshore. The region's current drive to adopt solar energy everywhere risks undermining the region's scenic integrity one project at a time – the so-called "death by a thousand cuts". In a quote still relevant for our times Aldo Leopold famously wrote: "Like winds and sunsets, wild things are taken for granted until progress begins to do away with them. Now we face the question whether a still higher 'standard of living' is worth its cost in things still wild and free". Where does our work end and advocacy begin?

Abstract _ Technical Session 4

Landscape Character Assessment (LCA) as a Framework for Scenic Resource Management in the Central Appalachian Mountains of the USA

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The mountains of the central Appalachians contain many outstanding natural, cultural, and scenic features that because of their locations and landscape diversity seem nearly impossible to protect and manage. Contained within the region are features such as: the Appalachian National Scenic Trail which traverses the region from north to south; all or portions of three National Forests; a newly designated National Park in southern West Virginia; the entirety of the coal mountaintop mining region of the eastern United States; a number of designated wild and scenic rivers; and perhaps the most diverse extensive hardwood forest in the world. It is a landscape of rural communities and working farms, forests, and mines; rapidly developing region as well as regions that have been left behind in the modern United States; and world-class outdoor recreation and tourism opportunities recognizing the forests, rivers and mountains of the region.

Likewise, a myriad of Federal and state agencies, non-governmental organizations, volunteer groups such as trail conservancies and watershed groups, and civic boards are engaged in managing aspects of this landscape. For example, the Appalachian Trail Conservancy is an umbrella organization that coordinates numerous regional and local conservancy organizations that manage portions of the Appalachian Trail in concert with the National Park Service. The National Park Service manages the more than 100,000 acres associated with the New River National Park utilizing landscape management systems that have been developed for nationwide implementation with locale adjustments within the NPS. The US Forest Service manages a couple of million areas of land spread out over three national forests utilizing formalized planning methods such as Scenic Resource Assessment that have been developed and applied by the agency over numerous decades. Highway development and scenic byways planning, and designations have been utilizing a range of USDOT FHWA assessment and planning methods. Mining and reclamation agencies were guided by early enabling legislation but have essentially ignored scenic and landscape considerations in their planning and management activities – primarily permit review and compliance monitoring. These agencies were also actually legislatively empowered to declare areas unsuitable for mining due to considerations such as scenic and viewshed protection. For the most part, these agencies have chosen not to do so with one of the few exceptions being viewshed mining exclusions in the mountains of Tennessee. A vast network of regional and local planning agencies, as well as civic organizations such as watershed groups are landscape focused utilizing a variety of formal and often very informal assessment and planning methods and considerations in their efforts.

Within this general framework for landscape planning in the region, we have been working with and in the majority of these landscape contexts developing and applying methods for supporting landscape planning that recognizes but are also somewhat detached from specific land ownership and contexts to support multi-organization / multiple objective land planning and management in the region. It has often been due to the fractured organizational jurisdictions, methods and responsibilities in the region that has led to recognition of the importance of landscape in the region that has not carried over the actual activities of those organizations and agencies. Over the last decade we have been working with (modifying, adapting, revising, and applying) methods that were initially developed in Great Britain and now have over thirty years of development, revision, and application there. These methods are generally referred to as Landscape Character Assessment (LCA) (Tudor 2014, Fairclough and Herring 2016). Refinements to the methods in Great Britain have led to development of more specific and detailed methods for particular landscapes with Historic Landscape Character Assessment and Townscape Landscape Assessment with contemporary LCA methods being structured tiered systems that range from overall landscape pattern inventories and assessments to nested often very detailed site specific assessments.

In broad stroke terms we have been moving our work towards LCA approaches as we judged it was critical to apply methods that allowed for:

1. Landscape descriptions that were physical parameter derived that allowed describing aspects of places that make them distinctive.
2. Mapping and describing landscapes using spatially explicit methods and associated information.
3. More detailed assessments from the above for identifying measures such as uniqueness, sense of place, and visual preferences and public perceptions concerning the above.

4. Monitoring the significance and rate of changes in the landscape.

We are also focused in research methods to establish explicit linkages between landscape character assessment methods and scenic and visual resource assessments for applications ranging from landscape character baseline studies and project impact assessments to planning and management for historic / culturally significant landscapes such as battlefields, historic town locations and frontier settlement locations.

Historically, LCA projects have contained the following elements.

- Data gathering including any previous landscape assessments.
- Anticipated or desired outcomes from the assessment to determine suitable scales and scopes for collecting background landscape data.
- Data collection including:
  - Natural landscape factors such as landform, geology, hydrology, and land cover.
  - Cultural factors such as historic and current land uses, land ownership, settlement patterns, specific developed features of note, etc.
  - Cultural associations including regional histories, any or all land informal accounts involving the region, associations with events, associations with persons of interest.
- The development and test draft landscape character units / areas.
- Field studies to verify and refine the assessment units.
- Develop working / final character units.
  - Landscape character unit descriptions.
  - Landscape character unit mapping and description criteria of Landscape character units mapped.

This is the “raw bones” traditional framework for implementing landscape character assessments in Great Britain. Our current work is focused on extending and refining the workability of this framework building on the nearly forty years of past research and development that has gone into LCA in Britain with few examples of such assessments in North America. In this we are also refining our methods within a couple of different broad landscape types and landscape planning and management contexts. Presently, these contexts include:

1. A three county / over a million acre region that continues to be studied for initial designation as an International Geopark, which is a UNESCO United Nations designation for landscapes with special links between the natural / geologic landscape and the evolved human cultures of the area that warrant international designations. This area is referred to as The Aspiring Appalachian Geopark. The area is primarily privately held land (a requirement for designation) though it does include the newly created New River Gorge National Park.
2. The Coal River Basin that is southwestern West Virginia, which is a rugged lightly populated region, which contains a number of the largest mountaintop mines that have been developed in Appalachia. The region was the location of continued battles between the mining industry and the US Environmental Protection Agency (USEPA) for mountaintop mining, monitoring and proposed reclamation methods.
3. The Gary Hollow region of McDowell County, West Virginia. Gary Hollow is the site of twelve related underground coalmines and historic mining towns that together formed what was for almost a century the largest coal mine in the world. As such Gary Hollow is potentially a region of national / international significance.

We have also recently initiated studies in areas adjacent to Federal and state managed areas working on establishing landscape assessment and planning guidelines for these “gateway regions”. One of the major research questions we are continuing to address are focused on incorporating methods for public perceptions and preferences into refining and delineating our landscape character units. We are also just beginning to explore utilizing machine learning methods for incorporating potential data from sources such as flickr and other crowd sourcing data for indirect and direct measures of landscape place attachment.

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Visual Case Study _ Technical Session 4

Creating and Maintaining Hudson River Views: A Handbook for Landowners

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The Hudson River Valley is known for its world-class scenery, which can be viewed from a variety of public and private areas. Many property owners and managers are interested in maintaining or creating places for people to enjoy scenic views but have few resources to help them to balance aesthetic values with the historic and ecological context of the site. The newly published **Creating and Maintaining Hudson River Views: A Handbook for Landowners** (2020) describes principles and best practices for establishing and maintaining scenic vistas within the Hudson River Valley in ways that are consistent with ecological principles and naturalistic design. This presentation will explore the best practices described in this handbook, with a particular focus on recently-created demonstration sites that showcase these view creation methods.

Paper _ Technical Session 5

Optimizing Viewpoint Selection for Route Based Experiences: Finding a Threshold Between Sampling Rate and Model Accuracy

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Abstract: Viewsheds and visual analysis are critical in understanding the impacts that our surroundings have on us, especially as they are viewed along a route. The presence and use of geospatial visual analyses techniques have existed for decades with one of the earliest as the viewshed analysis. There has been tremendous progress toward the optimization, accuracy, and techniques for these analyses. This paper is intended to further previous work by addressing shortfalls with the lack of empirical work conducted on viewshed analysis and viewpoint optimization for landscape planning, particularly focused on the identification of route-based experiences.

The purpose of this study is to identify the optimal trade-off between the number of viewpoints needed to represent an experience (e.g., highway route) and the accuracy of a visual magnitude analysis, which is an extension of the standard viewshed analysis. In this study, we focused on exploring the trade-off functions expressed in a mountainous and flat environment. The study was conducted to compare the two extremes in topography and see if and how their differences influence the trade-off between model accuracy and the sampling of viewpoints along a route.

To conduct this analysis, we employed a Visual Magnitude Plugin using publicly available DEM and roadway data. We generated a one-mile-long segment of a route for each environment and systematically discretized the route by varying the sampling distance intervals from 10-meter to 100-meter. In addition to the different environments, we compared the difference between an equal interval distance and a pseudo-random interval. Results show a linear decrease in the correlation of the visual magnitude model, with minor differences between the mountainous and flat environments. Comparing a 10-meter base sampling distance with 30-meter and 50-meters, the correlation coefficients were above 0.9 and 0.7, respectively. This suggests that for route-based analyses using visual magnitude, reducing the sampling rate can produce equivalent results with far less time and precision.

Keywords: viewshed, visual magnitude, viewpoint selection, accuracy, GIS

Introduction

The presence and use of viewshed analyses in landscape assessment has existed for decades (O Sullivan & Turner, 2001, Smardon et al., 1986), with a variety of research on the use, optimization and limitations of viewshed conducted in the late 90’s (Fisher, 1992; 1993, 1996). In the past couple decades, there has been a surge in extending the traditional binary viewshed to more nuanced forms and applications including the assessment of oceanic blue space (Qian et al., 2019), visualscape (Llobera 2003), visual exposure (Domingo-Santos, 2011), cumulative viewsheds (Wheatley 1995), the identification of key archaeological elements (Čučković, 2015) and identifying the impacts to housing prices from wind energy infrastructure (Gibbons, 2015).

There have also been significant efforts to optimize viewsheds in a geographic information system in order to improve the reliability of the analysis, the sampling techniques and the speed with which the analysis completed. For instance, Starek et al. (2020) used a simulated annealing technique to identify optimal locations for locating viewsheds to maximize the visible area using laser scans. Earlier, Gao et al (2011) and Cauchi-Saunders (2015) developed optimal approaches to viewsheds using Graphics Processing Units (GPU) with dramatic improvements over CPU-based algorithms. Andrade et al. (2011) has also provided a more efficient CPU-based algorithm.

Approaches to improved efficiency can greatly reduce the amount of time it takes to render a specific analysis. However, reducing the time it takes to conduct the analysis is only one part of the equation – the other is selecting which viewpoints should be a part of the analysis. Within the literature, there seems to be less of a focus on selecting optimal *and* appropriate viewpoints for landscape planning, instead there tends to be a focus on either the optimal number of viewpoints for a large area for maximum coverage *or* in selecting representative key observation points (KOPs). For instance, Shi and Xue (2016) provide a technique for reducing the number of viewpoints for the maximum coverage over an entire area (total viewshed), assuming that peaks are the ideal viewpoints for maximum coverage. Likewise, Wang and Dou (2019) take a similar approach toward applications where total viewshed is the key issue. However, there is limited research on systematic techniques, particularly those assessed with empirical field that identifying how to select optimal key observation points, with a recent exception by Palmer (2019) that addresses this shortfall. These limitations are compounded by Chamberlain and Meitner (2013) who argue that a singular KOP may not be adequate for representing landscapes that are experienced as a journey (route-based) rather than overrepresenting singular observation points.

The inspiration for this paper stems from: the lack of empirical work conducted on viewshed analysis and viewpoint optimization for landscape planning, particularly focused on the identification of route-based experiences. To address these shortfalls, we asked two key research questions: 1) What is the trade-off between the number of sample points and the accuracy of the visual magnitude model? 2) Further, can we identify an optimal trade-off between the number of viewpoints needed to represent an experience and the accuracy of visual magnitude analysis? To answer these questions, we developed a systematic approach toward analysing visual magnitude models in two distinct landscapes, using various sampling techniques with results highlighting the differences and errors between the sampling techniques.

Methodology

The objectives for our methodology were to 1) develop a repeatable process that could be validated further for other researchers, 2) assess the effectiveness of a random versus interval viewpoint sampling technique and 3) compare outcomes of a mountainous and flat landscape. Figure 1 gives an overview of the process we used to conduct this study. This process was utilized for both terrain types, as well as both viewpoint reduction methods. Our process included the following steps: 1) data collection, 2) site and route selection, 3) creation of viewpoint measures, 4) running the visual magnitude plug-in tool, 5) image analysis and correlation, 6) creation of graphs for correlation and other analysis.

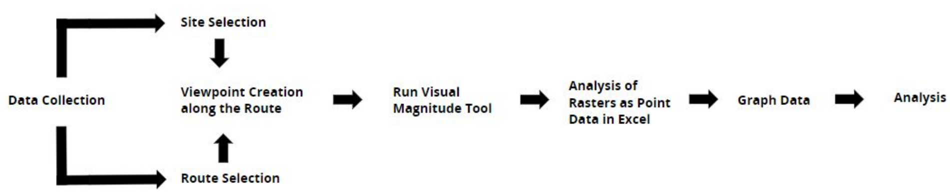
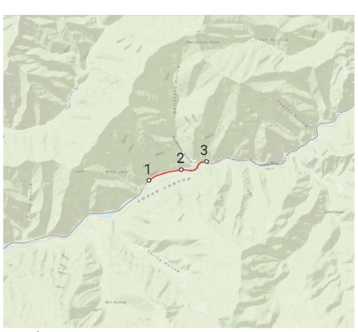


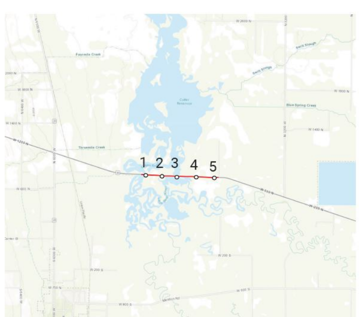
Fig. 1: Methodological Process Overview

Data Collection

All data obtained for this study were retrieved from the Utah Automated Geographic Reference Center (AGRC). This Data included transportation data for Roads and Highways and digital elevation models (DEM) for topography. ESRI ArcPro software package was used to manipulate and analyse the geospatial data.



Study Site- Mountainous Environment



Study Site- Flat Environment

The selection of sites was guided by the authors' knowledge of the study's region which consists of two large mountain ranges and an extensive valley. To minimize potential impacts from urban development, sites were selected from places that fit the topographic demands and are designated for minimal infrastructure development. The first site selected, Logan Canyon, is within the Cache National Forest just east of Logan, UT and is very mountainous environment area. The other site is along the Utah highway SR30 just outside of Benson, UT where there is a large wetland on either side of the roadway and provided sufficient terrain for our flat environment site. Both selected routes are located near popular local and regional recreational areas. A one-mile-long route was selected from each site to compare and contrast the differences of the effects of topographical properties on visual magnitude.

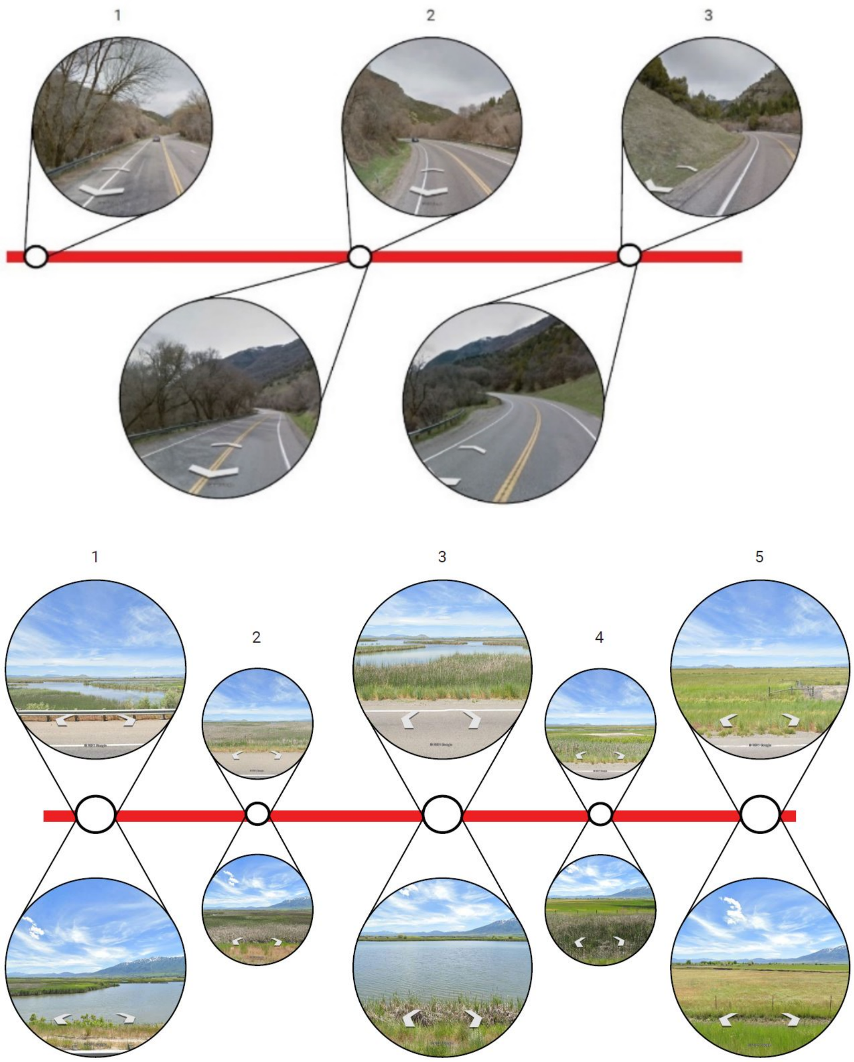


Fig. 2(b): Site images along our study route giving visual context of the surrounding environments. The first image (top) shows the mountainous environment which is in Logan Canyon just east of Logan, UT and the other image (bottom) showcases the flat environment located in Benson, UT. Both areas are local hot spots for recreational activities, images were retrieved from Google Street Maps.

A visual magnitude analysis was run across various sampling intervals, and with two sampling techniques: equal interval and randomized (explained in detail later). Following, Chamberlain and Meitner (2013) we use a 10-meter resolution DEM with 10-meter sample distance along each route section. The initial 10-meter sampling distance was used as a base to create the remaining sampling variations. Additional viewpoint intervals along the route include 20, 30, 40, 50 and 100 meters. After selecting our created route we used the Generate Points tool in ESRI's ArcPro to create points at a 10-meter distance. We then built a model to select the sample interval for the equal interval technique and used a random number generator to select five different viewpoint samples for the randomize sampling technique. The random generator assigned a percentage to each viewpoint so that the sampling frequency (e.g. 50% at 20m, 25% at 40m) selected similar number of viewpoints relative to the equal interval stratification.

This resulted in 168 viewpoints at 10-meter distance, and over 84 viewpoints at 20-meter distance in our mountain environment. In the equal interval sample these viewpoints were spread every 20 meters, while for the random sample we selected the same number of viewpoints scattered throughout the 10-meter distances (resulting in some gaps of greater than 20 meters). Generating viewpoints at these distances will help us gather an understanding of the degree that we can see the surrounding environment when viewpoints are generated in a randomized fashion along a route.

Running the Visual Magnitude Tool

The visual magnitude plugin (Chamberlain and Cook, 2019) was used to conduct the analyses. The plugin requires, at minimum, two input datasets: DEM and viewpoints. The DEM was clipped to a 3-kilometre site, which is slightly arbitrary for the purposes of the analysis but provides a reasonable radius around the one-mile route to ensure a high variety of visual magnitude values. Each of the different combinations of viewpoint sample techniques and intervals were conducted separately, with each producing a total processing time. The output of the analysis is a single, 1-band, floating point tiff file.

Statistical Analyses

Visual magnitude produces an objective normalized value from 0 to 1 for each analysis, making comparisons somewhat straight-forward. For this study, efforts focused on conducting a Pearson Correlation coefficient to identify how each of the different interval and sampling techniques compared to one another. However, before this analysis could be produced, data needed to be adjusted because of the differences in the total visible area (some intervals resulted in more visible area than others). To accomplish this, we built an analysis mask that combined all visual magnitude outputs into one raster where there were no null values in one or more outputs (a null value indicates not visible and cannot be analyzed in a coefficient). The mask was used to extract the visual magnitude values for each visible cell across all analyses, ensuring that the same cell was being compared across outputs. To conduct Pearson Correlation, each raster cell value was extracted into a one-dimensional dataset and analyzed. Additionally, we noted the total missing values (not part of the mask) for each analysis that were not part of the base, 10-meter interval. These were included as error of the difference between total visible area. The combination of the Pearson and the error provides an overall accuracy snapshot of each different sampling technique.

Results

All statistical data were analyzed in MS Excel, where we compared the number of viewpoints, processing time, and the total area percentage error, with accompanied graphs. Additionally, all maps developed were conducted using ESRI ArcPro. These results are provided below for each of the different study sites. Correlations are reported as positive (they are actually a negative relationship between the two variables studied).

Mountainous Environment Interval Results

Figure 3 showcases the total visual magnitude for each of the equal interval analysis. The one-mile route is presented, but the scale of the image is too small for the sampling interval to be noticed, except for the 100-meter condition. The same legend was used to produce the output, resulting in an expected shift from the extent to which high values and low values are represented with each interval. This is expected because with greater number of viewpoints, the cumulative impacts of visual magnitude are expected to increase relative to the lower sampling interval using the same legend.

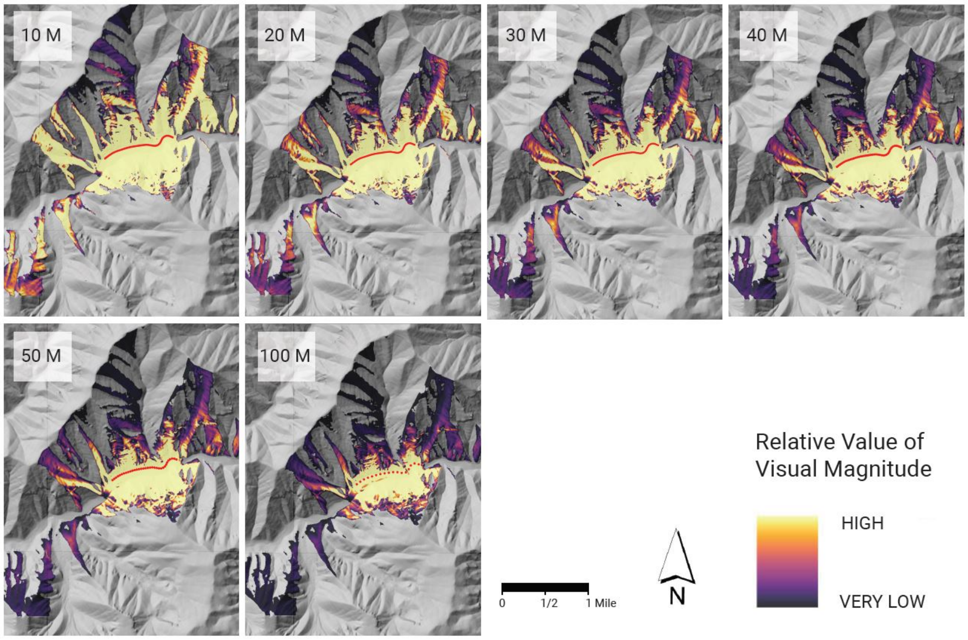


Fig. 3: *Mountainous: Equal Interval Viewpoint Reduction Method Visual Magnitude Outputs*

The visualization of the data appears to show a difference in the results according to the legend, with higher impacts being represented by the smaller sampling distance. However, the key question for this paper focuses on the relative differences, as measured through the correlation coefficient as the legends may not best represent the full story. Figure 4 shows the correlation between our interval viewpoints as we moved through our interval distance reduction process. As indicated, there is a gradual reduction in correlation between our 10-meter measure and all other resulting measures. The R^2 value is at 0.9884, indicating a very strong relationship as we reduce the number of viewpoints. The overall trend is negative and linear, providing a strong indication of predictability for how a reduction in sampling will impact the result. The slope is y= -0.0046x + 1.0292, or roughly for every one-meter increase in sampling distance, a correlation reduction of just over 0.31%.

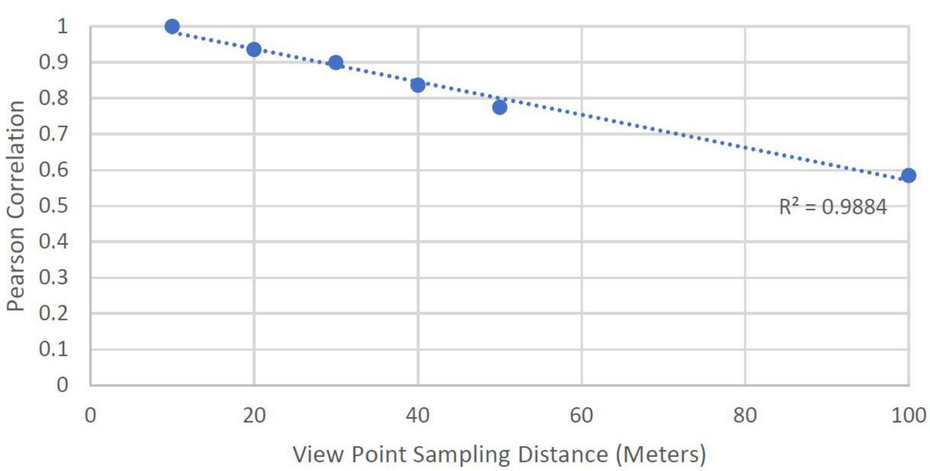


Table 1 provides the error difference for each of the sample equal interval distances, relative to the 10-meter base analysis. This table indicates the accuracy of the visible area, identifying how much less of the area was visible because of increased sampling distance. Here the loss is about 0.06% of total visible area per one-meter increase in sampling distance.

Table 1. Mountainous Environment Equal Interval Viewpoint Reduction Method Results

Mountain Environment Equal Interval Reduction Results			
VP Distance	VM Raster Correlation	% of Total Area	# of VP
10 M	1	100%	168
20 M	0.94	98%	84
30 M	0.90	97%	56
40 M	0.84	97%	42
50 M	0.77	95%	33
100 M	0.58	94%	17

Mountainous Environment Random Results

Figure 5 shows the results from the random viewpoint reduction method resulting in variation of correlation values between 5 to 10% for each viewpoint distance sampling interval. Each dot on the graph corresponds to one of the random viewpoint selection sets. Overall, the randomized viewpoint routes returned correlation values lower than their corresponding interval measures. The correlation between our randomized measures has a R^2 value of .9546, which remains high, but the slope is nearly double that of the equal interval technique at a roughly 0.065% loss of correlation per meter increase in sampling distance.

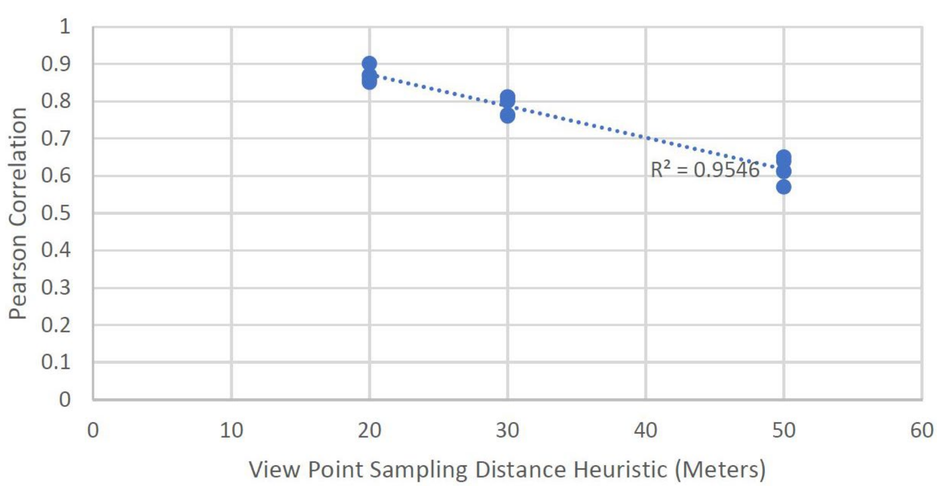


Fig. 5: *Correlation Graph Mountainous Environment Random Viewpoint Reduction Method*

Table 2 provides the error difference for each of the sampling distances. The correlation differs more substantially than the equal interval, even for the best of the five randomly selected samples for each interval. The difference in total area is similar to the equal interval sampling, with some of the randomly generated samples performing slightly better and some slightly worse. Still the total area error is negligible.

Table 2: *Mountainous Environment Randomized Viewpoint Reduction Method Results*

Mountain Environment Randomized Reduction Results			
Set	VP Distance	VM Raster Correlation	% of Total Area
Set 1	20 M	.90 to .85	99% to 97%
Set 2	30 M	.81 to .76	99% to 96%
Set 3	50 M	.65 to .57	95% to 93%

Flat Environment Interval Results

Results from the equal interval flat environment demonstrate a similar overall negative trend as we reduce our viewpoints from our 10-meter measure to 100-meter. Figure 6 showcases the relative change in visual magnitude value for the study area. Here there is a similar visual effect as in Figure 3. In Figure 7 the correlation values remain high for most of the loss in sampling distance, with roughly a 0.41% reduction in correlation for each meter increase in sampling distance. The R^2 value is 0.9838, also suggesting a high degree of predicted correlation loss over distance.

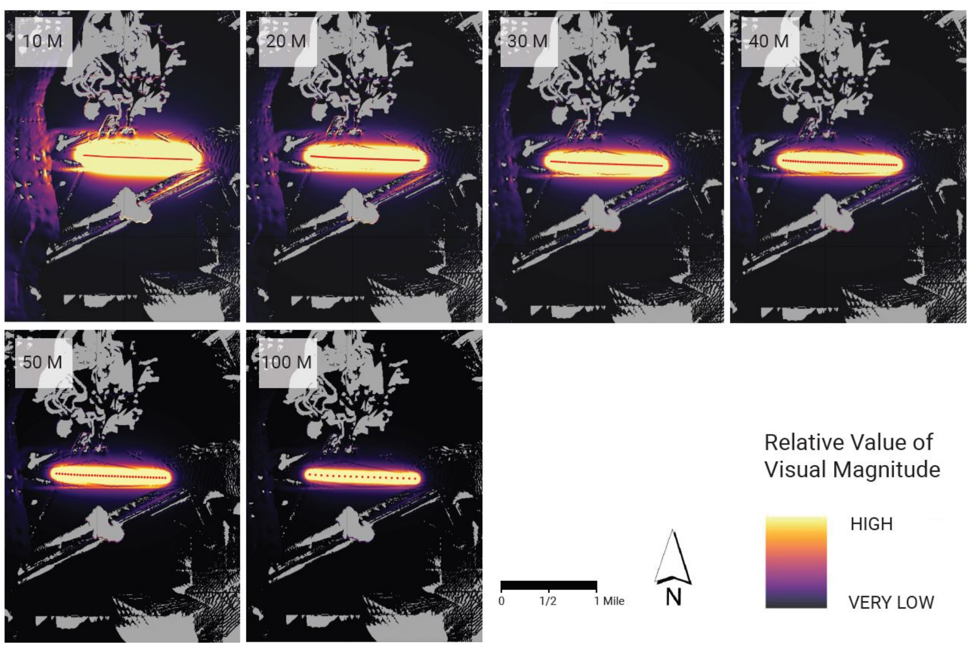


Fig. 6: *Flat: Equal Interval Viewpoint Reduction Method Visual Magnitude Outputs*

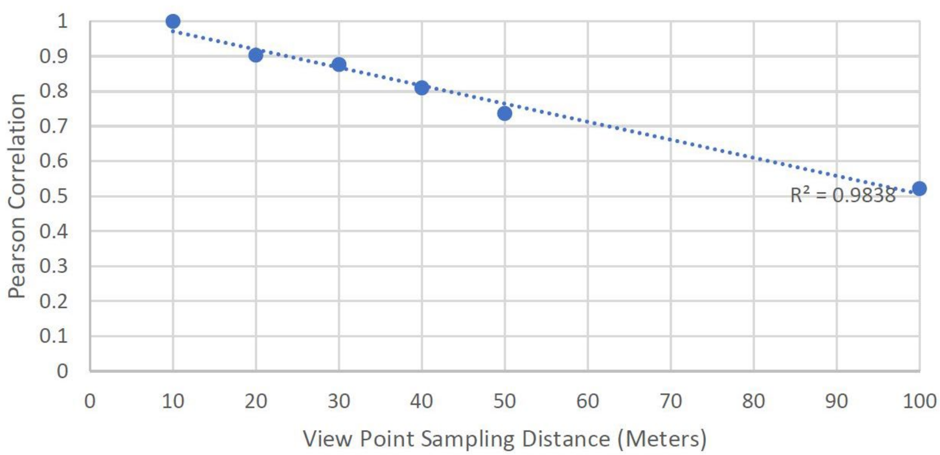


Fig. 7: *Correlation for Flat Environment Equal Interval Viewpoint Reduction Method*

Table 3 is also expectedly similar to Table 1, with the loss in total area being relatively minor as the sampling distance increases. In this study area, the total area loss is actually less than within the mountainous study area.

Table 3: Table of Flat Environment Equal Interval Viewpoint Reduction Method Results

Flat Environment Equal Interval Reduction Results			
VP Distance	VM Raster Correlation	% of Total Area	# of VP
10 M	1	100%	186
20 M	0.90	99%	94
30 M	0.88	98%	63
40 M	0.81	98%	47
50 M	0.74	97%	38
100 M	0.52	95%	19

Discussion

For this paper we sought to provide empirical evidence to address unanswered optimization questions for site selection of route-based experiences. We set out to discover the relationship between the number of sample points and the accuracy of the visual magnitude model, as well as the optimal point at which this trade-off could be exploited. The following is a discussion on the outcomes of our findings and recommendations for future research.

When we set out to analyse the differences in sampling techniques (equal interval versus random), we had not anticipated a result where all samples performed worse than the equal interval technique. We suspect running additional random samples could produce at least one higher correlation than the equal interval but doing so negates the usefulness in practice due to the amount of time needed to find a higher preforming random sample. The substantial variation of correlation with the random sample is not worth exploration. Our recommendation is to maintain and equal interval stratification of viewpoints along a route.

With the random versus equal interval sampling analysis completed, we moved toward identifying the extent to which topography would alter the outcome. The selection of two very distinct landscapes provided a means to compare differences and perhaps come away with reasonable recommendation for the sampling frequency. As indicated the overall correlation and R^2 values are high across both study areas. The Pearson Correlation reduction is linear within the sampling distances analysed, thought this would likely fall off dramatically. Extending this sampling distance could be an interesting research exercise, but from a localized planning perspective it is likely wise to maintain a higher correlation coefficient greater than the 100-meter sampling distance.

The primary goal of this research endeavour was to identify if there was an optimal point at between the trade-off of viewpoint sampling distance and correlation of visual magnitude values. The data demonstrate a negative linear relationship between these two variables, making the recommendation slightly harder than if there was some inverted logarithmic relationship where there was a clearer indication of a tipping point. So, before making a blanket recommendation, we explore the relevant context from which to make our claim. Our data analysed the 10-meter interval as the base, but who is to say that this is an effective based for a given route? In our study sites, viewpoints were selected from along a roadway; a 10-meter interval is equivalent to driving roughly 25mph or 40kph. Both of our roads have speed limits that are about double that speed. If this type of analysis were to be conducted as a hiking trail, a one-meter interval would be appropriate as a base comparison. Nevertheless, the scenic and landscape experience from our roadway example provides some indication that correlation coefficient does not drop off rapidly.

Thus, we follow recommendations from various fields that provide insight into how we can interpret the correlation coefficient. A Pearson coefficient greater than +0.9 is said to be very high (e.g., Mukaka, 2012), $\pm$0.7 is strong or high positive (e.g., Ratner, 2019). Based on these interpretations we make two recommendations (here we assume a large area visual analysis). **If the environment is highly sensitive to visual impacts, aim for a 30-meter interval, while for other**

landscapes, a 50-meter interval seems reasonable. Both substantially reduces the number of our viewpoints by 66% (30-meter) and 80% (50-meter), while keeping correlation coefficients above 0.9 and 0.7, respectively. Further, this also maintains the total area error 96% of the total area when compared to the 10-meter interval.

Until a new optimization technique for selecting viewpoints along a route emerges, we believe an equal interval sampling technique will provide consistent and accurate results across a range of landscapes. We do see some opportunities to refine and enrich this study. These include increasing the variety of environments, and differing terrains, including a hilly environment for medium sized elevation change and urban environment to evaluate the influence of the built environment. We would also like to see additional measures of viewpoints explored, in the 1-meter range and farther than the 100-meter range. A range of greater than 3km could be useful to explore for open expansive environments. Additionally, we are curious the extent to which correlation changes most rapidly ad distances away from the route. Could it be that viewpoint selection could be optimized for different distances where visual features or impacts may be most readily observed? For now, this research offers provides a foundation from which these additional explorations could be produced. There may certainly be more optimal approaches to route-based viewpoint selection, but a one-size-fits all optimization could be challenging given the variety of localized conditions.

Conclusion

This study was created to help professionals process visual impact analyses more efficiently for route-based conditions. Additionally, the study aimed to identify the extent to which accuracy of a visual magnitude model altered based on sampling distances for viewpoints along the route. This study was conducted in two distinct landscapes: mountainous and flat wetland areas. We created a systematic way to analyse how these environments impacted the outcome and the role of different sampling techniques. The analysis was conducted using a 10-meter DEM (publicly available data) and roads. Our findings suggest that 30-meters is an ideal sampling distance interval for highly sensitive environments, whereas 50-meter still produces a strongly correlated result for other landscapes. These recommendations establish a baseline, whereby future empirical studies can begin. We have identified the trade-off between the number of viewpoints being used along a highway route and the accuracy of the visual magnitude tool outputs. The result of this study carries promising results for the field of visual analysis and with the exploration of other environments, data resolutions and other variables mentioned in the discussion section the necessary input data can further optimized.

Acknowledgements

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Paper _ Technical Session 5

Do bipolarity and perceived nothing interfere with signal detection among numeric ratings of scenic beauty?

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Abstract: Researchers have the option of using a bipolar rating scale between opposing measurement constructs in public surveys eliciting aesthetic judgments of landscapes. They also have options in 'averaging' people's ratings of each landscape. These choices impact the reliability of survey results and were investigated. Three different rating scales were presented to different sets of similar people who rated the same set of photos. Eighty photos of various forests and timber harvests were rated for (1) scenic beauty on a 1 to 10 scale, (2) scenic beauty or ugliness on a -5 to +5 scale, or (3) the same bipolar scale but without a zero rating-value. The resulting ratings for each photo within each data set for each rating scale were simply averaged, and also used to calculate a measure using the Scenic Beauty Estimate (SBE) algorithm. The single-construct scenic beauty scale produced the most reliable results with either average ratings or SBEs, while the SBEs had less reliability but more stable 'well behaved' errors across levels of scenic beauty. Ratings data from either bipolar scale supported less reliable measurements than data from the unipolar, single-construct rating scale. The bipolar scale without an available zero value produced more reliable measurements than the bipolar scale with a zero value, supporting the no-zero scale's optimality in measuring aesthetic perceptions across well-matched opposing constructs. It's simply averaged ratings were more reliable and stable than corresponding measures derived by the SBE algorithm. The other bipolar rating scale with a zero value was least reliable, particularly across its SBE values. Latent measurement effects attributable to rating scales' impact on subjects' rating behaviors were identified by inspection of data plots and all three rating scales exhibited small biases at the transition between beauty and ugliness. Effect tests due to switching rating scales upon average ratings or SBEs found all three scales combined with either averaging method to be highly reliable.

Keywords: scenic beauty, ugliness, rating scales, reliability, bipolar constructs, psychophysics, visual impact assessment, Scenic Beauty Estimate

Introduction

Landscape aesthetics strikes many people as not measurable, or immeasurable at sublime places. This issue came into scientific focus when environmental protection laws were passed in the United States and elsewhere in the 1970s. These required that scenic impacts be measured, and landscapes be designed and managed to maintain as much visual quality as possible, along with other values. These public decisions required reasonably objective measurements, or at least measurement methods, that would pass evidentiary tests in legally acceptable and defensible impact assessments and decisions about project design and permits (Palmer and Hoffman, 2001). The widely accepted best scientific criteria of measurement quality are validity and reliability (Bock and Jones, 1968). Validity means a measurement method differentiates relative degrees of scenic quality that people actually perceive in their experiences, as opposed to arbitrary conjectures. Reliability means that a measurement method is not capricious and consistently produce the same, or very similar, relative measurements across different landscapes when used again and again. The best aesthetic measurements should achieve both qualities.

One frequently employed social-scientific method of measuring landscape aesthetics is to have subjects use a numeric scale to rate different landscapes, or alternative versions of one landscape for a scenic quality. From the beginning, the validity and reliability of this method was a concern, given the potential for wild capriciousness of aesthetic perceptions across people (Hull & Buhyoff, 1984; Palmer 2000). This was not a new problem. Such measurement of qualitative perceptions of stimuli is a long-standing problem in environmental psychology, known as "psychophysical" measurement. This method assumes that people can share, to a significant or substantial degree, common qualitative perceptions of an object or experience, like landscapes' scenic quality. The search for psychophysical ways to measure these perceptions is an early and theoretically elegant approach to psychological research. It has a long history of theory and method development (Thurstone, 1927; Osgood, 1952; Torgerson, 1958; Baird & Noma, 1978; Kaplan, 1992; Reber et al., 1998; Berglund, 2012).

The essential psychophysical measurement problem is to devise instruments to elicit ratings of a specified quality that 'discover' the relative degree to which all or many people share perceptions and judgments of that quality across a set of stimuli. The degree to which a rating instrument achieves validity and reliability in this measurement task depends upon several factors (Nunnally & Bernstein, 1994): (1) Are subjects instructed and stimulated to perceive and judge the same intended quality (Schaeffer & Dykema, 2020)? (2) Are subjects enabled to similarly differentiate their ratings of perceptions along a shared normative gradient, without interference by 'latent' behaviors that affect their responses in ways unrelated to that gradient or the perceptions targeted for measurement (Alwin & Krosnick, 1991; Schaeffer & Dykema, 2011)? (3) How consistently do they assign rating values to those judgments that accurately reflect their underlying perceptions and judgments, both within ratings by a single subject or ratings across different subjects (Alwin, 2007; Schaeffer & Presser, 2003)? (4) How can scientists analyze ratings data to reduce or account for biases and inconsistencies across subjects' various ways of selecting rating categories and scaling their ratings of otherwise similar or identical perceptions of the target quality (Rost, 1988)? This last step seeks to 'distill' more valid and reliable measurements of people's underlying, shared affective perceptions, if actually there. Such data analysis might 'unhide' substantially shared affective perceptions by statistically removing the confounding effects of people's different attitudes and cultural beliefs as thee affect their judgments and ratings of a shared, underlying primary aesthetic perception (Ingarden, 1973).

This study explored the feasibility of eliciting aesthetic ratings along a bipolar normative gradient between opposing aesthetic constructs: scenic beauty and ugliness (Step 2 above), as opposed to using a construct-specific, unipolar judgment scale (scenic beauty). Feasibility was assessed by comparing the reliability (step 3 above) of ratings on the two scales and compared to unipolar scales. The meta-reliability of these options was examined across levels of scenic beauty. All these tests were explored as they interacted with two different methods of synthesizing estimates of scenic quality from multiple ratings of each photo (Step 4 above). These tests were interpreted by what they suggest about how people use different rating scales.

Synthesizing Ratings of Scenic Quality

Brown and Daniel (1990) described and compared a range of methods for synthesizing numeric ratings of a landscape across many subjects (or many landscapes across a single subject) to improve the validity and reliability of a final measure of its scenic beauty. The simplest of these was to simply average the ratings. The most sophisticated option was the Scenic Beauty Estimate (SBE) method (Daniel and Boster, 1976). The SBE applies signal detection theory (Green & Swetts, 1966) to minimize the impact of the different relative criteria subjects use to scale their ratings into the perceptual 'units' associated with different rating values (Lee, 1969; Rost, 1988). The SBE algorithm compares subjects' cumulative probability distribution of ratings assigned to a landscape to an expected relative operating characteristic curve derived from how the landscape's ratings are distributed compared to other landscapes (Swetts, 1973; Baird and Noma, 1978). Daniel and Boster (1976) posited that the SBE may be the most valid and reliable way to measure scenic beauty from people's ratings of landscapes (Hull, 1986).

The SBE was often favored in psychophysical studies of landscape perceptions for about twenty years after its invention, usually in concert with a simple ascending scenic beauty rating scale of 1 to 10, as suggested in the method's manual (Daniel & Boster, 1976). A meta-analysis by Schroeder (1984) found that SBEs across photo samples of landscapes were highly correlated with simple averaged ratings and the two methods were equally reliable. Most subsequent studies abandoned the SBE data synthesis method in favor of simply averaging ratings rendered in response to each landscape representation. A detailed study of the reliability of average ratings versus SBEs has not been published. This study did so, to explore if and how the SBE still has merit in optimizing psychophysical measurement of landscape aesthetics.

All the methods for synthesizing scenic beauty ratings described by Brown and Daniel (1990), including the SBE, were derived, explained and assessed for application to ratings on a construct-specific, unipolar rating scale only of scenic beauty. Such numeric rating scales have prevailed among many psychophysical studies of aesthetic landscape perceptions, likely following the lead of the methods described and advocated by these scholars.

Measuring Negative Landscape Perceptions

This practice of having people only rate a positive aesthetic construct can be problematic when important public perceptions affecting visual impact assessments or land management decisions entail adverse, negative judgments of visual landscapes. For example, popular perceptions of the unacceptable ugliness of forest clearcuts (Bliss, 2000) led to visual protections mandated by the National Forest Management Act of 1976 (LeMaster, 1984) and those in the case law of the Northwest Forest Plan (Ribe, 2006). The same phenomena is evidently incurring opposition to new energy landscapes (Cass & Walker, 2009).

Research subjects cannot convey such negative perceptions in public surveys eliciting ratings only of a single, positive, aesthetic construct like scenic beauty. They must communicate negative judgments by rendering low positive ratings that might be comingled with, or arbitrarily segregated from, ratings of landscapes that they judge to be only slightly beautiful. But they cannot clearly communicate that their perception is actually not of the type that they are asked to rate, and which the researcher incorrectly assumes they are judging. This confusion and confounding of data violate good scientific practice (step 1 above) and likely reduces the validity of research findings (Alwin & Krosnick, 1991). It prevents direct and clear measurement of negative perceptions often of primary interest to land managers and impact assessors.

Bipolar Rating Scales?

A solution could be to employ bipolar numeric rating scales in psychophysical studies of aesthetic perceptions. One such scale would have positive rating values up to higher scenic beauty and negative values down to more ugliness. This method is not common in psychophysical research because one of this paradigm's fundamental assumptions is that ratings are elicited along just one continuous perceptual dimension (Thurstone, 1927; Torgerson 1958). Mixing qualitative measurement constructs on the same rating scale can violate mathematical and statistical attributes of psychophysical theory (Hayes, 1967; Nunnally & Bernstein, 1994; Berglund, 2012); although positive and negative valences of the same, single construct are permissible on a rating scale (Jones & Thurstone, 1955). What is the actual cost of measurements using a bipolar rating scale between different constructs? Is that cost small enough in relation to the benefits of producing more usefully meaningful measurements? Few studies, prior to this one, have compared subjects' ratings behavior, and the consequent reliability of measurement, between unipolar versus bipolar rating scales in studies of qualitative perceptions of the same stimuli by the same or similar samples of people.

Non-psychophysical studies investigating attitudes, propensities and other non-qualitative perceptions using Likert and semantic differential rating scales indicate hazards in the use of bipolar rating scales (Ogden, 1932; Mordkoff, 1963; Schwarz et al., 1991; Gannon & Ostrom, 1996; Schaffer & Presser, 2003; Saris & Gallhofer, 2007; Moors, et al., 2014). Particular studies that include Likert rating scales along a agree-disagree continuum -- that may most nearly emulate psychophysical measurement -- have found that unipolar scales produce more reliable data than bipolar scales between different constructs (Saris et al., 2010; Alwin et al., 2018). Other studies, employing various bipolar Likert scales, have found these can produce at least as valid and reliable measurements as unipolar scales, if opposing conceptual constructs are well matched at the ends of the scale to instigate a single cognitive continuum, or surround a strongly shared ideal condition or clear concept of 'nothing' at the scale's center (Osgood, 1952; Stevens & Galanter, 1957; Peabody, 1962; Bentler, 1969; Ostrom, 1987; Russell, 1979; Dubois & Prade, 2006; Drasgow et al., 2010; Menold & Kemper, 2015; Batyrshin et al., 2017). Otherwise, bipolar rating scales can bias subjects to favor the middle of the scale in ambiguous and indiscriminate ways (Yorke, 2001; Kapln, 1972), particularly if the opposing constructs at the end of the scale are dissonantly unrelated (Ogden, 1932). Normative personal, political or situational contexts and factors can bias subjects' selection of the zero or central rating value, or their placement of ratings on either side of it, in ways unwanted by researchers (Rodin, 1978; Schuman & Presser, 1981; Yorke, 1989; Sturgis et al., 2014).

Offer Subjects a Zero Rating-Value?

An important choice in designing bipolar rating scales is whether to include a zero value at a scale's center. This problem has often been studied to inform the design of Likert scales (Schaeffer & Dykema, 2020). Among studies that tested numerically labeled or agree-disagree bipolar scales in studying more qualitative attitude or subjective items – that more approximate psychophysical measurement – Wang and Krosnick (2019) found that omitting the zero value did not improve data reliability, but Saris and Gallhofer (2007) and Alwin et al. (2018) found a bit more reliability. Johns (2005) found that omitting the zero value improved data reliability among agree-disagree survey items that related to broad and simple social values (without personal welfare implications) perhaps like landscape aesthetic judgments. Krosnick (1991) also found that deleting the zero value can improve the reliability and validity of ratings in the context of difficult (non-aesthetic) attitudinal questions by removing subjects' option to shortcut to an avoidance response. Other studies of Likert scales in contexts dissimilar to aesthetics tend to favor including a zero value, or equivalent, to reducing response bias and increase reliability (Kulas et al., 2008; Krosnick & Presser, 2010; Sturgis et al., 2014).

There are few if any tests of the impact of the neutral or 'none' zero rating value, or deleting this rating option, in psychophysical measurements of environmental stimuli, including landscape aesthetics. This study addressed this gap in knowledge.

Methods

Landscape Stimuli

The sample of landscape images was eighty photos taken inside Douglas fir dominated forests of the Pacific Northwest. These came from within the photos employed in another study (Ribe, 2009). The photos included 25 of mature forests, 7 of old-growth forests, 28 of thinned and un-thinned young forests, and 20 of recent harvests of mature forests. This last set of 20 photos included two of each of ten combinations of three parameters: percent of trees not harvested, pattern of not harvested trees, and high or low amounts of down on the ground.

Public Perception Surveys

The 80 photos were rated by three different sets of subjects using three correspondingly different rating protocols described below. The photos were projected to various groups as a meeting activity. The groups included service clubs, conference attendees, diverse outdoor interest groups, business clubs, state park campfire program attendees, higher education classes, and neighborhood organizations. The groups comprising each protocol's subject sample were recruited to match those of the other protocols' groups as measured by their mix of age, urban-versus-rural residence, and time of regional residence. Another study in the same region (Ribe, 2002) indicated these traits are most related to small differences in aesthetic perceptions.

All groups of subjects were instructed that the photos included examples of national forests with and without various timber harvests. Each group in all survey protocols saw the photos in a unique random order to prevent systematic sequencing-effect bias. Each subject rated each photo privately, on his or her own paper questionnaire during 6–7 seconds. Subjects answered demographic questions at the end of rating sessions.

Survey Protocol 1

The photo set was rated by 183 subjects using the unipolar construct-specific 1-10 rating scale, as is employed by most researchers who use the SBE to estimate photos' scenic beauty values. Their instructions were: "Please circle one number for each picture, according to how much scenic beauty you think it shows. The rating scale goes from 1, for very low scenic beauty, up to 10, for very high scenic beauty."

Survey Protocol 2

210 subjects used the with-zero, bi-polar rating scale to rate the photos. It ranged from -5 to +5, with a zero-value available. Their instructions were: "Please circle one number for each picture, according to how much scenic beauty or ugliness you think it shows. Circle positive numbers for beautiful scenes and negative numbers for ugly scenes."

Survey Protocol 3

192 subjects rated the photos using the no-zero, bi-polar ratio rating scale. It ranged from -5 to +5, without a zero value. Their instructions were the same as above for the with-zero scale.

Calculating Photos' Scenic Beauty Values

Two synthesized scenic beauty values were needed for each photo from data within each of the three survey protocols. The first was calculated by averaging the ratings of the photo. The second was calculated by use of the SBE algorithm. Together this produced six different scenic beauty values for each photo, corresponding to one of the three rating scales and one of the two data synthesis methods.

The SBE values calculated from the 1-10 point scaled ratings were conventional SBEs, as per Daniel and Boster (1976). The 'SBE values' calculated from both the bipolar scales are identified as Ratio Scenic Beauty Estimates (Ribe 1988). Herein, those simply called "Ratio Scenic Beauty Estimates" (RSBEs) were calculated from the -5 to +5 bipolar scale *with a zero value*. Those calculated from the bipolar rating scale *without an available zero-rating option* are identified below as "No Zero Ratio Scenic Beauty Estimates" (NZRSBEs).

Both the RSBE and NZRSBE methods standardize people's ratings of beauty or ugliness onto a common scale. These values occur along a range of negative (ugly) and positive (beautiful) values, with the zero-value corresponding to an average rating of zero, denoting a photo estimated to have neither beauty nor ugliness to the typical person. This method approximates two conventional SBE scales back-to-back. The mathematics of the RSBE or NZRSBE is identical to the SBE and changes to parameters of the SBE algorithm to account for the different number of available rating values (Ribe, 1988). It assumes that responses are distributed across the two scales as if on a single affective continuum, perhaps transitioning across a zero value between very similar landscape aesthetic constructs that differ only in valence.

The analyses described below entailed direct comparisons of a set of scenic beauty values (across the 80 photos) calculated one way to other such sets calculated from different ratings scales or 'averaging' methods. This was enabled by linear range transformations of one or more sets of scenic beauty values to match that of a 'baseline' set. These transformations are indicated in corresponding graphical figures.

Reliability of Rating Scales

Comparisons of the reliability of data derived from the three different rating scales were calculated using Hedges' g tests (Durlak, 2009; Cohen, 1988). These tests estimated the effect of changing the rating scale in altering the distribution of scenic beauty measurements across all the photos. For measurements by average ratings per photo, the distribution of all ratings by all subjects were used in the calculation. For SBE-type measurements, each photo's raw rating values were already 'embedded' in each photo's final scenic beauty measurement value, so only the distribution of those final values could be used to calculate Hedges' g values.

Reliability of Measurement Methods

A more nuanced method, by examination of measurement error distributions, was also employed to investigate detailed characteristics of each rating scale's impact on the reliability of scenic beauty measurement (Alwin, 2010). This method was conducted separately for each combination of rating scale and method of calculating scenic beauty measurements. This involved calculating the mean square error (MSE) of measurement for each photo, calculating the average and variance of these across all the photos and graphing the MSEs. For measurements by average ratings per photo, the MSEs were calculated against the average rating for each photo, as if this were an estimate of the 'true' scenic beauty. For SBE-type measurements, the MSEs were calculated against the SBE-type scenic beauty values for each photo after these were range transformed to match the range of the corresponding average ratings. The average MSEs were then compared across rating scales and scenic beauty calculation methods to see which produced the lowest overall measurement errors, or optimized reliability.

Meta-Reliability of Measurement Methods

The variances in MSEs were also compared as a measure of meta-reliability. A more meta-reliable measurement method was one for which the MSEs were more constant across levels of scenic beauty. A less meta-reliable method was one for which the magnitude of MSEs changed more from photo to photo. Inspection of the graphs of MSEs could identify measurement methods with systematic low meta-reliability where the magnitude of MSEs changed across different levels of scenic beauty. Such systematic error patterns might identify ranges of scenic beauty where a measurement method has 'accuracy gaps' where its reliability, and possibly also validity, diminishes.

Response Bias Introduced by Different Rating Scales

Different by-photo measurements of scenic beauty were plotted against each other in ascending order of all the photos' scenic beauty. Inspection of these patterns enabled conjectural identification of potential systematic differences in how rating scales or 'averaging' methods effected scenic beauty measurements.

Results

Comparing Measurement Methods' Reliability

Hedges' g tests among pairs of the six scenic beauty measurement methods (Figure 1) indicate that all are highly reliable, with test values close to zero. These indicate that the arrays of scenic beauty measurements across the photos were highly consistent with each other (Cohen, 1988). Changing rating scales had only small effects on the measurements so that they all substantially estimate the same underlying perceptions with equally acceptable reliability. The Hedges' g values among the measures that used the SBE algorithm are much smaller than among average ratings. The SBE algorithm seems particularly effective at 'averaging' ratings to 'discover' underlying shared perceptions regardless of the rating scale employed.

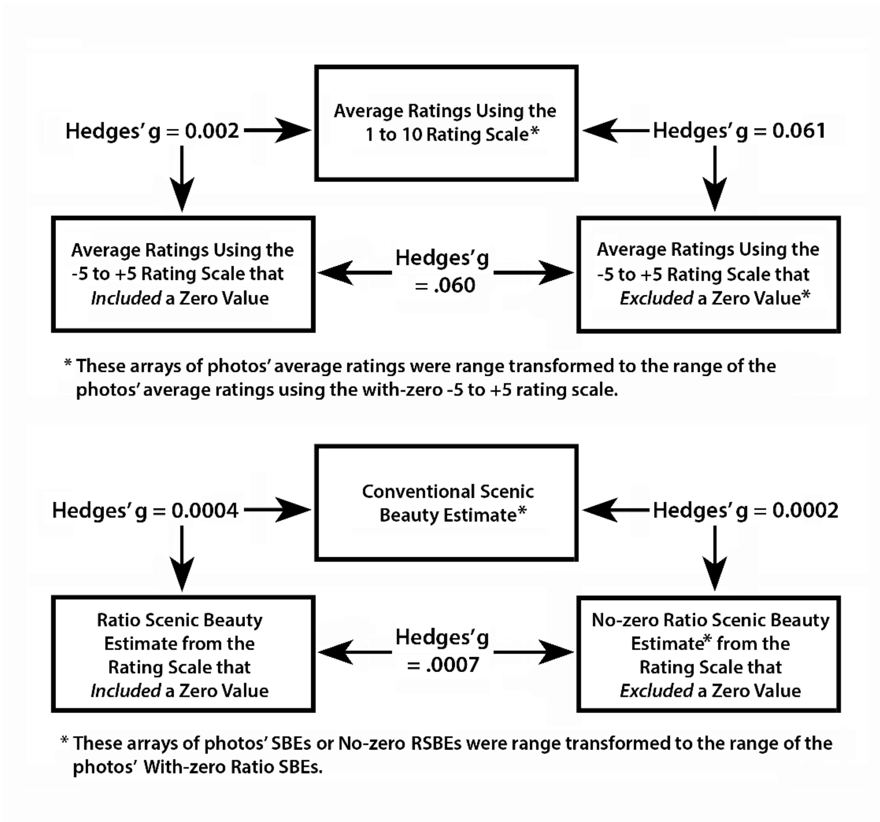

Fig. 1*: Comparing the reliability of all six measurement methods.*

Distributions of Mean Square Errors

The six graphs in Figure 2 plot the distribution of mean square errors across the 80 photos for each of the scenic beauty measurement methods. These MSE values are plotted from left to right in ascending order of the photos' corresponding scenic beauty measurement. The scenic beauty measurements derived from the SBE algorithm and found in the right-hand graphs in Figure 2 are range transformed to match the observed range of the average ratings in the corresponding left-hand graphs. The MSEs plotted in the three right-hand graphs were calculated against the same corresponding range transformed SBE-algorithm-derived scenic beauty values.

Each of the graphs in Figure 2 is labeled with two gross measures of reliability. The first is the average mean square error across all 80 photos, with lower values indicating greater reliability. Among these, the values in the left-hand-graphs are mathematically minimized, so these must be lower than in the corresponding right-hand graphs. The fractional increase in average MSE from each right-hand graph to its left-hand partner might be a measure of the reliability cost of switching to the presumably more valid SBE-algorithm-derived measurement method. These reliability costs are lowest for 1 to 10 scaled ratings (15%) and the with-zero -5 to +5 ratings (16%), and higher for the no-zero -5 to +5 ratings (20%). These costs are substantial enough to suggest reliability is optimized by averaging ratings instead of employing the SBE algorithm, and more so for bipolar rating scales.

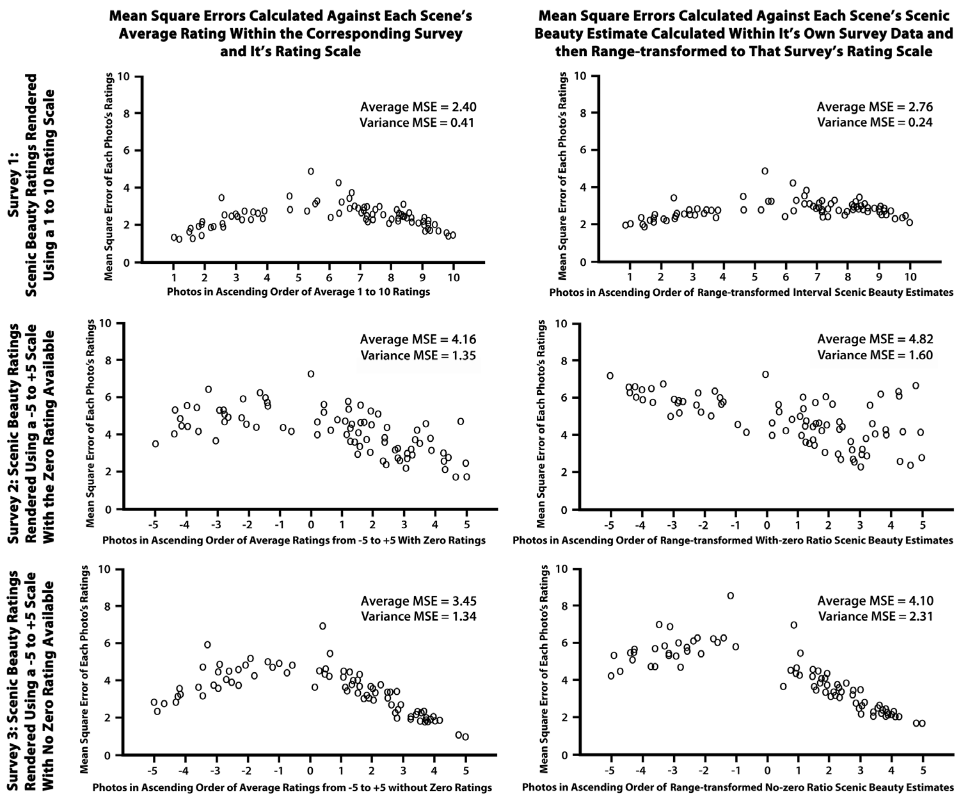

Fig. 2: *Mean square error distributions for all six measurement methods with the average and variance of each distribution.*

The average MSEs in Figure 2 suggest which measurement methods can optimize reliability among already reliable options, where lower MSE values indicate greater reliability. Among average ratings, the cost in reliability in moving from the 1 to 10 scale (MSE= 2.40) to the with-zero -5 to +5 scale (MSE = 4.16) is 73%. The cost in reliability in moving from the 1 to 10 scale (MSE= 2.40) to the no-zero -5 to +5 scale (MSE = 3.45) is 44%. The gain in reliability in moving from the with-zero -5 to +5 scale (MSE = 4.16) to the no-zero -5 to +5 scale (MSE = 3.45) is 21%. The most optimally reliable method is the construct-specific unipolar rating scale. If a bipolar scale is required, reliability is optimized by omitting the zero rating-value at the center of the scale.

Among SBE-algorithm-derived ratings, the differences are about the same. The cost in reliability in moving from the 1 to 10 scale (MSE= 2.76) to the with-zero -5 to +5 scale (MSE = 4.82) is 75%. The cost in reliability in moving from the 1 to 10 scale (MSE= 2.76) to the no-zero -5 to +5 scale (MSE = 4.10) is 49%. The gain in reliability in moving from the with-zero -5 to +5 scale (MSE = 4.82) to the no-zero -5 to +5 scale (MSE = 4.10) is 18%. The most optimally reliable method is again the construct-specific unipolar rating scale. If a bipolar scale is required, reliability is again optimized by omitting the zero rating-value at the center of the scale.

Meta-Reliability of Measurement Methods

Each graph in Figure 2 is also labeled with a variance in the photos' MSEs. This statistic measures how much the magnitude of the average disagreement across survey subjects varied across all the photos in the corresponding graph. A larger variance indicates that the graph's measurement method was more unreliable in the magnitude of its reliability with changes in the underlying scenic beauty across the photos, i.e. lower meta-reliability.

The upper-right graph in Figure 2 exhibits the greatest meta-reliability (lowest variance in MSEs = 0.24) among all six graphs there. There, the MSE values tend to stay about the same no matter how much scenic beauty the photos have, as measured by the conventional SBE. This method is evidently twice as meta-reliable as simple average ratings of the same data derived from the 1 to 10 rating scale (variance in MSE = 0.41). It is more consistently reliable with smaller 'swings' in measurement errors across the photos. This confirms an important virtue of the conventional SBE method. The way it minimizes measurement bias attributable to subjects' different rating behaviors evidently best reduces variability in the potential magnitude of measurement errors across levels of perceived scenic beauty. This virtue is compounded by the relatively small average MSEs derived from the 1 to 10 rating scale, when ‘averaged’ by either method, compared to those for the bipolar scales.

The variances in MSEs for measurement methods derived from the bipolar rating scales (bottom four graphs in Figure 2) are all substantially larger than those corresponding to unipolar, construct-specific rating scales (top two graphs). The use of bipolar scales has a cost in both reliability and meta-reliability. Unlike the unipolar rating scale, application of the SBE algorithm to data from either bipolar scale did not improve the meta-reliability of scenic beauty measurement (by the RSBE or the NZRSBE). The SBE algorithm’s ability to improve the meta-reliability of its measurements breaks down when applied to bipolar rating data, as explored below. Figure 2 also shows that data from the no-zero, bipolar scale produces a distinct pattern in the magnitude of (admittedly large) MSEs in relation to scenic beauty levels than data from the with-zero, bipolar scale. This suggests the no-zero rating scale produces scenic beauty measurements with more predictable meta-reliability.

Impact of Omitting the Zero Rating-Value

Figure 3 displays how omitting the zero value from bipolar psychophysical rating scales impacted the consequent patterns of scenic beauty measurements. These impacts were similar for average ratings and more sophisticated ‘averaging’ by use of the SBE algorithm. Inspection of both graphs in Figure 3 suggests that the choice to include the zero rating-value or not has little if any impact among negatively ugly photos, irrespective of ‘averaging’ method. Among positively beautiful photos, omitting the zero rating-value tends to bias scenic beauty measurements upward, and markedly more so when employing the SBE algorithm (bottom graph in Figure 3) instead of simply averaging ratings per photo.

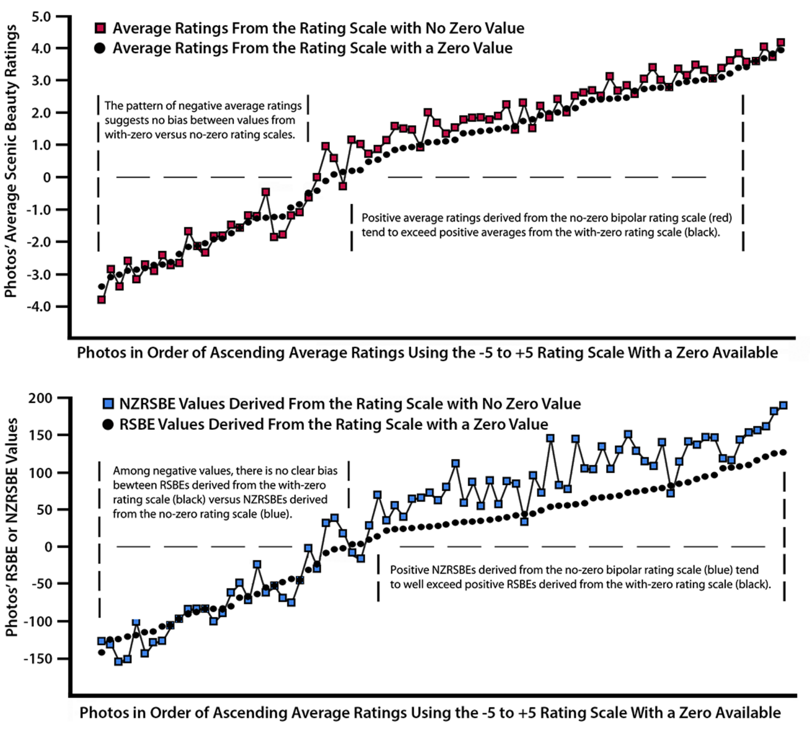

Fig. 3: *Distributions of measurements comparing the impact of omitting the zero rating value.*

Measurement Impacts Across All Three Rating Scales

Figure 4 compares the patterns of scenic beauty measurements produced across all three rating scales. The top graph in Figure 4, for averaged ratings per photo, suggests three observations: (1) It does not matter which rating scale is employed only among highly beautiful photos. (2) Among moderately beautiful photos, employing the with-zero bipolar rating scale biases average ratings downward compared to measurements from the other two rating scales. (3) Among ugly photos, employing the no-zero bipolar rating scale biases ratings upward compared to measurements from both the other rating scales. Observation 2 suggests that significant numbers of subjects selected an available zero rating for moderately beautiful photos so as to drive moderately beautiful photos’ average ratings down; whereas subjects without the zero-rating option tended to select low positive ratings to drive their averages up for these photos. Observation 3 suggests the no-zero-rating-available subjects may have tended to cognitively allocate photos into positive and negative sets and then applied lower standards in rendering higher ratings to ugly photos.

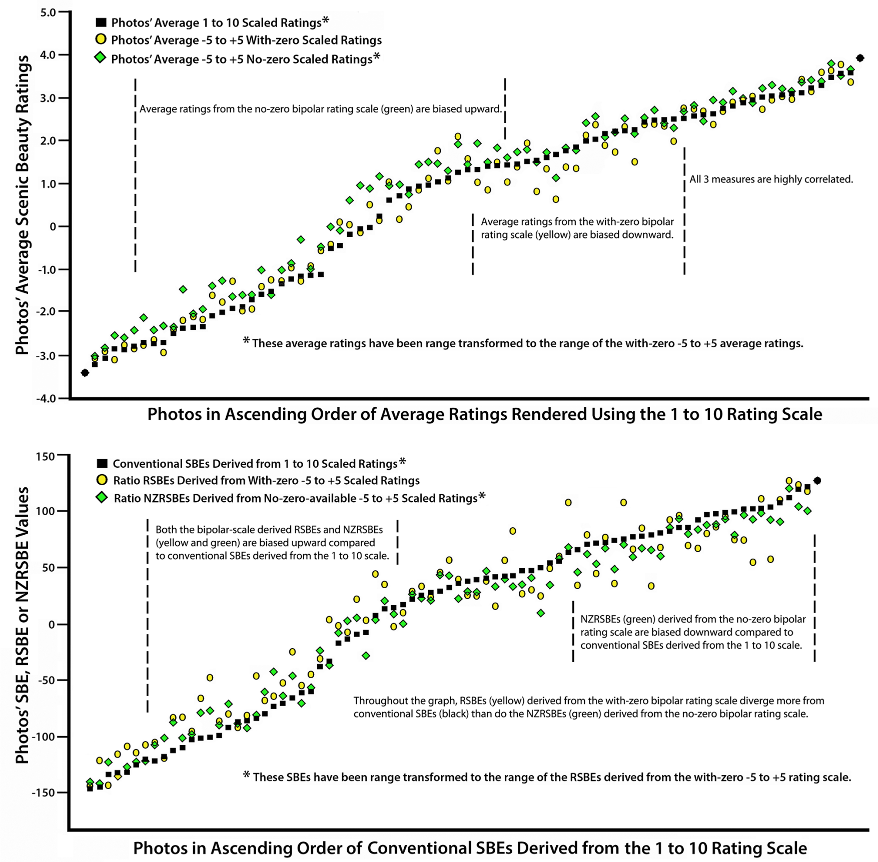

Fig. 4: *Distributions of measurements comparing the impact of using different rating scales.*

The bottom graph in Figure 4, for measurements from the SBE algorithm, suggests different impacts across the three rating scales. The overall pattern of RSBEs (with-zero bipolar scale) diverges from that of SBEs more than does the pattern of NZRSBEs (no-zero bipolar scale). This suggests that omitting the zero rating value generally produces scenic beauty measurements more similar to those from the SBE (unipolar scale). The NZRSBE method does exhibit a different 'slope' in measuring scenic beauty than the SBE. The NZRSBE tended to produce slightly lower scenic beauty measurements than corresponding SBEs among the most beautiful photos. Concomitantly, NZRSBEs were higher than SBEs among ugly photos, a pattern shared there with RSBEs. In the range of moderately beautiful photos the three SBE-based methods tend to produce roughly similar scenic beauty measurements but with as much variability between each other as elsewhere in the bottom graph in Figure 4.

Impact of Different 'Averaging' Methods

Choosing a method for estimating single scenic beauty measurements is informed by the graphs in Figure 5. The top graph corresponds to employing a unipolar 1 to 10 rating scale and shows the pattern of measurements across the photos for average ratings versus the conventional SBE. These two patterns track each other well. This is consistent with Schroeder's (1984) finding that average ratings are essentially the same as SBEs. Among photos with low beauty (average ratings from 5 to 7.5) average rating values are consistently biased downward compared to SBEs. This may be because subjects tended to intermix some ratings of high ugliness in with low beauty to drive these photos' average ratings down while the SBE algorithm does a good job of detecting these scaling behaviors and correcting for them.

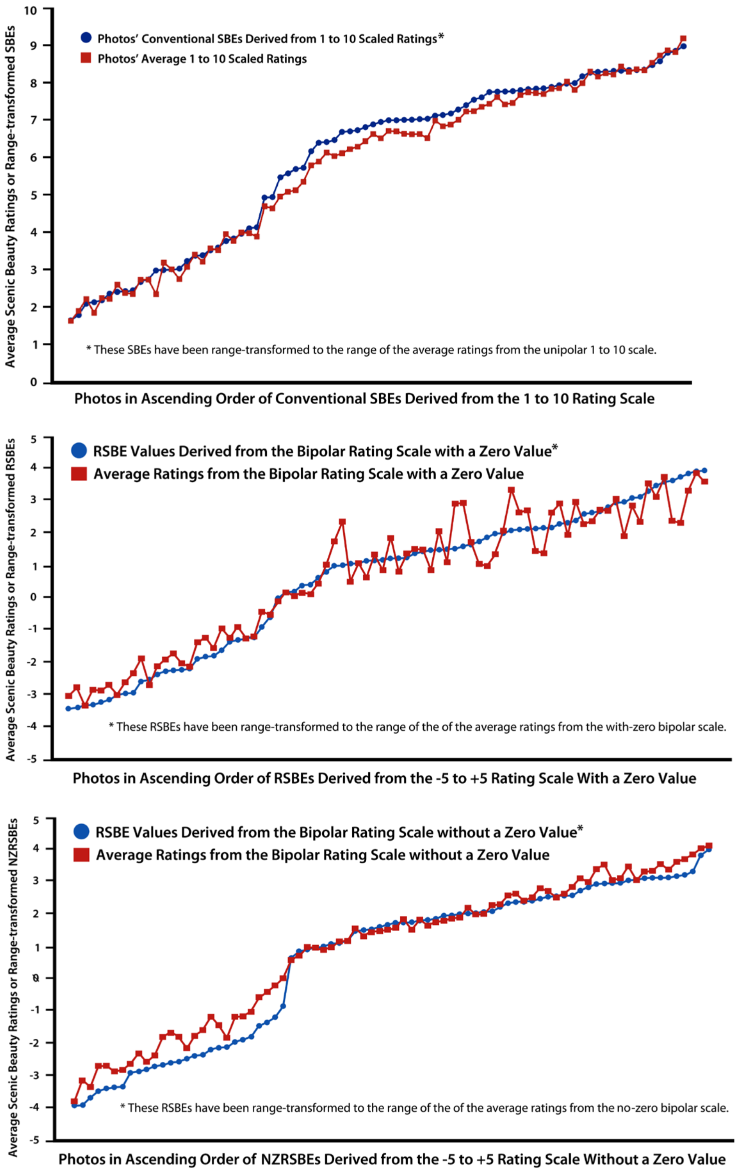

Fig. 5: *Comparing impacts of methods of 'averaging' ratings across the rating scales.*

The middle graph in Figure 5 corresponds to employing the bipolar rating scale with a middle, zero value available. The average ratings there do not track the RSBEs as well as the similar measurement methods in the top graph. This erratic relationship is most pronounced among photos with positive scenic beauty. There, providing subjects with a continuous rating scale across perceived beauty and ugliness may have produced a confused assignment of ratings that violates the normality assumptions of psychophysical measurement theory. This could have produced erratic RSBE values even if the subjects' ratings of dueling qualities were otherwise reasonable as mixed judgments. Put another way, the continuous bipolar scale may have interfered with subjects' assignment of photos to rating categories at the margins between them in ways that the RSBE algorithm somewhat well detected and accounted for in producing different rescaled values than the average ratings. Both these speculations are possible.

Among the ugly photos in the middle graph of Figure 5, the RSBE values tend to be more correlated with and biased a bit lower than average ratings. Perhaps subjects tended to be more decisive in assigning photos of timber harvests to an ugly set and then judgments of these more closely obeyed psychophysical theory. The RSBE values there may be higher because that method discounted and standardized subjects' different scaling behaviors in favor of perceptions that assigned less ugliness to timber harvests with standing trees compared to clearcuts.

The bottom graph in Figure 5 corresponds to using the bipolar rating scale without a zero value available. The average ratings there track the NZRSBEs more similarly to the similar measures in top graph than the middle graph in Figure 5. This indicates that the no-zero bipolar scale is superior to the with-zero bipolar scale in reliably measuring scenic beauty in a manner more closely approximating the use of a unipolar, construct-specific scale. This is most clearly the case among beautiful photos where the two measurements are as correlated as in the top graph.

There is a sudden drop in NZRSBE values at the transition from beautiful to ugly photos in the bottom graph in Figure 5, and less so than for average ratings. This suggests that prompting subjects to first allocate photos into beautiful and ugly sets tends to effectively create two different scaling behaviors within these separate photo sets. The NZRSBE method seems able to detect these distinct scaling behaviors within the different photo sets and provide measurements on two different scales that likely correspond to an actual difference in subjects' perceptions of two distinct qualities of beauty and ugliness. If so, the NZRSBE may be about as valid as the SBE (with a reliability cost) as long as it is understood that the NZRSBE is allocating photos to their opposing perceived aesthetic types and measuring within these opposing constructs.

The same but larger bias between the measurement methods is observed within the ugly photos in the bottom graph in Figure 5 as in the middle graph there. The basic explanation is probably the same as suggested above with reference to the middle graph. In the case of the lower graph and its no-zero bipolar rating scale, the subjects' scaling behaviors were probably 'cleaner' among photos they clearly segregated as ugly so that the NZRSBE method produced more decisively lower scenic beauty measures than average ratings.

Conclusions

A variety of numeric rating scales can measure landscapes' scenic quality using psychophysical methods with high reliability. Simple, unipolar, construct-specific rating scales, like the commonly employed 1 to 10 scale, evidently do optimize the reliability of measurement. This indicates that such ratings are not confounded by an unreliable confusion and mixing of low positive and high negative aesthetic perceptions along a unipolar, construct-specific rating scale.

Comparative patterns of scenic quality measurements from this study (Figure 5) suggest survey subjects will perceive both positively and negatively valenced scenic qualities. If researchers or managers need measurements that make this distinction, a bipolar numeric rating scale can serve them well provided that they omit the central, zero value from that scale. Data from this kind of rating scale between scenic beauty and ugliness can support measurements with more reliability and validity than data from a scale that includes a central zero value available to subjects. This finding applies irrespective of whether photos' scenic quality is calculated by averaging ratings or use of the SBE algorithm.

Employment of the SBE method for 'averaging' ratings evidently does not improve the reliability of scenic quality measurements. But it does carry advantages compared to simply averaging each photo's ratings. With data from unipolar rating scales, the SBE produces scenic quality measurements that are more meta-reliable than average ratings as the level of scenic quality changes, particularly among landscapes with neither high nor low scenic beauty. With data from no-zero bipolar rating scales, the NZRSBE more clearly distinguishes ugly from beautiful landscapes and evidently measures differences within these sets with more validity.

These findings support the existence of latency effects due to the format of rating scales upon psychophysical measurement of landscape aesthetics. These effects are not similar to latent factors affecting other formats of bipolar psychological survey questions, such as Likert scales, agree-disagree scales, or other symmetrical semantic differentials. Unlike these other scale formats, omitting the zero value from bipolar psychophysical scales evidently increases measurement reliability. This may be because people's aesthetic perceptions do not include a broad, ambiguous, indecisive or default cognitive 'territory' between beauty and ugliness that would attract zero-value ratings of uncertainty or aesthetic "nothingness". People evidently can readily segregate landscapes between well-opposed aesthetic constructs and provide usefully reliable ratings to measure both types of perceptions from a single rating scale. Aesthetic perceptions are of the simple and universal type that Johns (2005) identifies as subject to reliable bipolar measurement if the zero value is omitted from the rating scale.

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Paper _ Technical Session 6

Mapping Landscape Visual Quality: a Methodology to Construct Statistically Validated Environments

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Abstract: Scholars, natural resource specialists, citizens, and government authorities are interested in the assessment and quantification of landscapes for management purposes. The quest to produce maps representing visual and environmental quality have been in existence since the beginning of non-heuristic scientific based visual quality evaluations initiated in the late 1960s and early 1970s. However, several problems arose. First, predictive models often explained small proportions of the variance, meaning that they explained little—more was unknown than known. Second scholars were puzzled about how to assign visual quality scores to landscape settings unvisited. Without an "on-the-spot" photograph, predicting visual quality was considered difficult and unreliable. Third, there seemed no clear statistical approach to generate validated maps. This paper examines how those challenges were resolved and generated statistically validated maps addressing visual and environmental quality with an example from the Grand Canal in China, illustrating that land-use and predicted visual quality covary ($p \leq 0.025$).

Keywords: environmental psychology, cultural geography, landscape architecture, environmental design, landscape mapping

Introduction

Historical Context

For much of human history, evaluation of visual and environmental quality was conducted by experts, experts with education and training and appreciated by the elite (Burley and Machemer 2016). However, in a seminal publication, Jencks (1977) discussed how experts can see the world quite differently than the public. Adopting public perceptions and values became the basis for professional design work, such as the efforts of the late Lawrence Halprin (1916-2009) and also Bill Johnson of Johnson, Johnson, and Roy (Burley and Machemer 2016, Halprin 1970). Diversion from the expert paradigm in visual quality assessment made a notable difference with the publication of respondent driven perception models by Elwood Shafer (1969), Shafer et al. (1969), and Shafer and Tooby (1973). The beginnings were hotly debated and criticized by various authorities (Bourassa 1991, Carlson 1977, Weinstein 1976). Yet investigators kept exploring preference models.

Much was known by the mid-1980s with the publication of Foundations for Visual Project Analysis (Smardon, Palmer, Felleman 1985) and in an article by Taylor et al. (1987). It became clear that Likert scale respondent surveys had intrinsic difficulties (Daniel and Boster 1976). Paper surveys suffered problems with internal respondent effects where the placement of the image within a survey booklet could affect that image's score. Pitt and Zube (1979) promoted a method from psychology, Q-sort, a data gathering procedure which facilitated obtaining continuous values for images and allowed any image to be compared to any other image in any order. Advances in modeling seemed to plateau in the 1990s, with predictive questions explaining about 66% of the variance (Burley 1997). The competition amongst various approaches is discussed by Daniels (2001). Much of the professional landscape evaluation was still being conducted with an expert paradigm index (Jones and Jones 1981, Jones and Jones 1979). Many of the findings during this period were compiled into understandable and practical principles for practitioners to follow (Kaplan et al. 1998).

Increased predictive quality occurred when investigators began exploring other variables beyond aesthetic and traditional three-dimensional spatial quality measures-- they begin exploring variables such as cultural, ecological, functional and economic measures (Burley and Machemer 2016). The result was the development of equations that could explain 80% or more of the variance (Jin et al. 2018, Burley and Yilmaz 2014). In addition, Burley (2006) described three theories that explained the properties of the equations. With the publication of equations containing strong environmental statistical explanative power, it was possible to explore more fully the applications of such equations.

Covariance of Land-use and Visual Quality

Hundreds of images were employed in the development of these equations. Along a dimension from preferred (low numerical scores) to less preferred images (high numerical scores), it was noticed that the land-use/land cover seemed to covary with the scores of the images. If landscape use/cover spatial properties strongly covaried with the scores of images, it may be possible to construct a map by knowing the structure and composition of the landscape. However, many land-use maps did not have the landscape ecological categories necessary to make a such map. Broad categories such as urban, suburban, and rural were too coarse. Maps such as by Ellis et al. (2013), are much more suitable to construct visual quality maps as the maps divided human activity into refined ecological settings. Lothian (2017) reviews much of the history leading to mapping visual quality.

Statistical Validation Models

Early attempts at constructing visual quality maps met with limited success (Brush and Shafer 1975). The problem was that the reliability of the map was unknown. A team at Michigan State University solved this problem (Lu et al. 2012) and published a validated map of a watershed in Michigan, followed by a map of the lower portion of the peninsula (Jin et al 2018), and then a map for all of the state (Yilmaz et al. 2018). The key statistical approach is to employ a statistical test that searches for significant similarity. Most statistical tests are examining statistical differences. Kendall's Coefficient of Concordance W is a test, evaluating significant similarity and is useful to construct validated visual quality maps (Daniel 1978). This test has been around since its introduction in 1939, but unless one studies non-parametric statistics, this statistical test my remain hidden and undiscovered (Kendall and Babbington-Smith 1939; Wallis 1939). The beauty of this statistical test is that it is distribution free, it does not make any assumptions about the shape of the data distribution. To construct and validate such maps, one should follow these general guidelines:

1. Start with a land-use map that has landscape ecological land-use categories similar to Ellis et al. (2003).
2. Randomly pick at least a dozen locations in each land-use/cover category for the study area.
3. Record images from each of these points, 1.5 meters off the ground, level and in a random direction.
4. Randomly divide the pictures from each category into two sets: a prediction set and a validation set.
5. Measure the visual/environmental quality of the images from a published equation of choice.
6. Compute the mean score of each land-use/cover type from the prediction set.
7. Construct a table with a column of the mean score for each image assessed. In other words, all the images of a hardwood forest would be coded in the table with the mean expected score from those images. Pastureland images would have the mean score from their images. Do the same for all categories.
8. In a second column, place a score from one of the images of the same land-use/cover type from the validation set, repeat for the whole set. The left column should have mean scores and the right column should have individual unique scores selected from photos in the validation set without replacement.
9. Rank the scores of each column and sum the rows and square the result in each row.
10. Employ Equation 1 to compute W.

$$W = \frac{\left[12 * \sum_{j=1}^{2} R_j^2 - \left[\left(3 * m^2 * n * (n+1)^2\right)\right]\right]}{m^2 * n * (n^2 - 1)} \qquad \text{Equation 1}$$

Where:

W= coefficient of concordance

R = the sum of one row

m = the number of sets (in this case 2)

n = the number of images in a column

11. With Equation 2, W can be compared to a Chi-square distribution of $X^2_{(n-1)}$ in a table of X^2 values. Usually the p-values selected from the table are: 0.95 and 0.99, being significant and highly significant.

$$X^2 \text{ for } W = m * (n-1) * W \qquad \text{Equation 2}$$

If X^2 for W is greater than $X^2_{(n-1)}$ then the two sets are concordant at the significance level selected from the X^2 table.

12. A validated visual quality map can be constructed from the mean scores of the land-uses/land cover in set 1. The probability of any previously unvisited site on the map having the same general value at the predicted score is based upon the significance level of the X^2 p-value selected.

It should be noted that low values indicate strong preference, and high values indicate low preference. This is similar to the scoring system first presented by Shafer and colleagues where low values also indicate respondent preference. In addition, the general theory is that there is a strong preference for special temporary viewing elements in the landscape such as flowers, wildlife, and brief view of mountains; there is a neutral preference (as though one was the only person evident on the planet) for elements that are common in the landscape such as green vegetation, sky, and water; there is a strong dislike of elements that reflect disturbance by other humans such has vehicles, people, buildings, roads, utility structures, and signs, even world class architecture makes little or no improvement upon the preference (Burley 2006). The preference for greenness/nature has been long established in the literature.

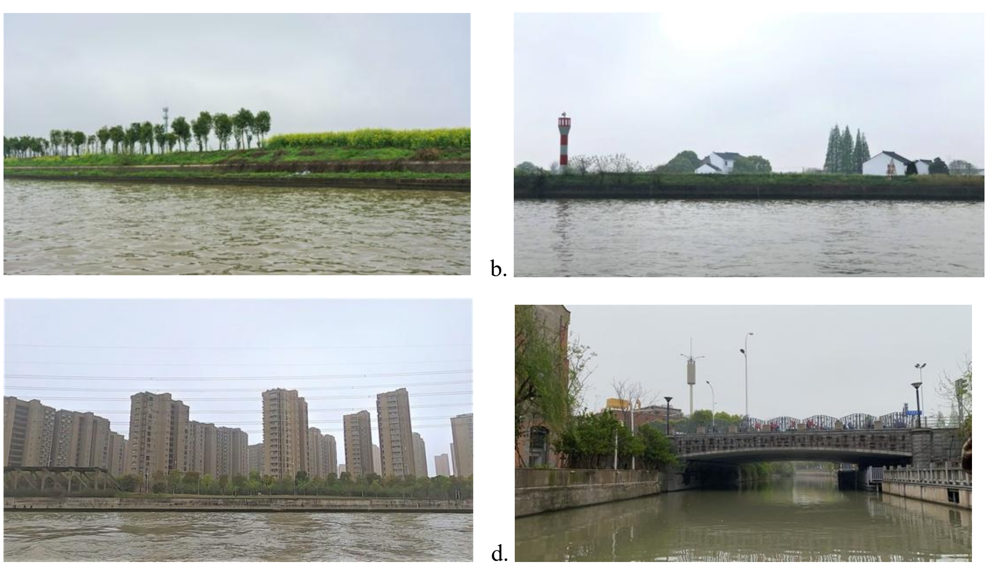
The utility of such a map is only limited by the imagination of the designer/planner. Such a map(s) may be employed to measure long term trends and guide general landscape development. With the development of validated maps, it may be possible that visual quality landscape evaluation may be entering a new period of assessment.

Methodology

To illustrate the application of the approach, a portion of the Chinese Grand Canal (Burley and Machemer 2016) near WuXi, Jiangsu Province, P.R. of China was selected. This portion of the canal is composed of agricultural lands, low rise residential dwellings, high rise residential dwellings, bridge crossings, boat docks, and industrial lands. Images were captured along the canal of each land-use in the spring of 2021. Images of the land-uses were randomly placed into two sets: a set to predict land-use visual quality and a set to compare with the predictions. Three images for each of the six land-uses were selected for study, resulting in two sets of images, each with 18 pictures. In the prediction set, visual quality scores were computer using an equation by Burley (1997). For each land-use the scores were averaged to generate a predicted value for each land-use. Then the values were compared with scores from the second set by employing the Kendall's Coefficient of Concordance W test (Daniel 1978). If the scores of the predicted set covary with the images of the second set, then it can be concluded that one can predict the visual quality of the land-uses along the canal at a calculated confidence level.

Results

Figure 1 presents examples of the images collected and includes scores for the images illustrated in the study for the six land-uses; while Table 1 presents the scores and rankings of the images from the set to predict the land-use scores (expected average score) and the set to assess the covariance of the predicted values. For Table 1, 'm,' the number of sets is 2, and 'n .' the number of images in 18. The degrees of freedom is 'n-1', or 17. W is calculated to be to be 0.941. There were six sets of ties in the table and the denominator for W had to be adjusted for ties (see Daniel 1978). The calculated Chi-square value was 31.99. In a table of Chi-square values with 17 degrees of freedom, 30.191 represented a p-value of 0.025. Therefore, the calculated Chi-square is greater than the value found in a table, meaning that the calculated value has a p-value equal to or greater than 0.025. In other words, the results indicate a concordance between significant concordance ($p \leq 0.05$) and highly significant concordance ($p \leq 0.01$). Thus, it is possible to predict visual quality based upon images of land-uses for the study area.



a. b.

c. d.

e.  f. 

Fig. 1: *Images captured from the study area:* ***a****. agricultural land with a score of 66.88;* ***b****. low rise residential land with a score of 73.76;* ***c****. high rise residential land with a score of 79.65;* ***d****. a bridge environment with a score of 87.39;* ***e****. a boat dock with a core of 88.13;* ***f****. an industrial site with a core of 93.12 (copyright 2021 © Zhi Yue, all rights reserved, used by permission)*

Table 1: Results of images scores and ranks.

Land Use	**Image scores from Set 2**	**Rank**	**Average Prediction from Set1**	**Rank**	**Sums and Square of Sums**	
Agriculture	64.87968	1	66.30122	2	3	9
Agriculture	71.37236	3	66.3012	2	5	25
Agriculture	66.21325	2	66.3012	2	4	16
Bridges	78.91427	7	81.74313	11	18	324
Bridges	87.07072	12	81.7431	11	23	529
Bridges	85.30454	11	81.7431	11	22	484
High Rise	77.27597	5	79.04266	8	13	169
High Rise	79.01152	8	79.0427	8	16	256
High Rise	79.70518	9	79.0427	8	17	289
Low Rise	81.41637	10	76.90611	5	15	225
Low Rise	78.78368	6	76.9061	5	11	121
Low Rise	73.60997	4	76.9061	5	9	81
Boat Docks	88.87725	15	88.65912	14	29	841
Boat Docks	89.12773	16	88.6591	14	30	900
Boat Docks	90.57101	17	88.6591	14	31	961
Industrial	91.04334	18	89.53296	17	35	1225
Industrial	88.11938	13	89.533	17	30	900
Industrial	88.23125	14	89.533	17	31	961
Sum		171		171		8316

Discussion

Based upon the results, it would be possible to construct a land-use corridor map indicating somewhat reliable and predictable visual quality scores ($p \leq 0.025$). The results are similar to a gradient of ranges for land-uses as illustrated in a graphic by Ives et al. (in publication), where they reported the visual quality score for a naturalistic landscape, known as an 'alvar," a rare environment, residing on shallow soils over limestone in temperate zones. The graphic illustrates the ranges of values for various land-uses/land classes. The alvar scored in the high twenties to low thirties and the graphic presents ranges for agricultural landscapes from 50 to 60, low rise residential environments from 60 to 70, urban/high rise settings from 70 to 90 and industrial landscapes ranging from the high eighties to over 100. In the study of the Grand Canal agricultural landscapes scored higher than reported in previous studies because the image contained a concrete wall and a lower compositional percentage of vegetation. The study of the Grand Canal revealed a previously unpublished category, urban bridge settings along a canal. There are many more potential categories and settings across the globe that could be visually categorized, as implicated by the bridge category in this study and the alvar study by Ives et al. (in publication).

While this study employs an equation by Burley (1997), this is only an example of the potential equations that could be used. When selecting a metric (equation), it is helpful to select a metric that can explain over 65% of the variance and is a metric that is searching for universal properties across the landscape. In the past, there have been equations that only assess specific landscape treatments and my not have construct jurisdiction across many types of landscapes. The equations produced by the Michigan State team have employed respondents from North America and Europe. Mo et al. (2011) has suggested Asian perceptions may not necessarily covary with North Americans and European perceptions.

The study team asked Dr. Burley about the process of discovery concerning visual quality mapping during his career. “When I started, it was only 20 years after Shafer and colleagues first reported their studies. There was still much work to do to develop more reliable equations to explain a greater proportion of the variance. After another 20 years, stronger equations were developed that examined new classes of variables. Some of the old standard variables remained, while new variables such as economics, culture, and ecological improved the equations. It appeared that respondents were evaluating the landscape with more than just aesthetic criteria. The next breakthrough was the finding that visual quality covaried with land-uses/classes and that there were statistical methods appropriate to assess concordance, statistical methods developed 80 years ago, waiting for an application such as visual quality mapping. My contribution was during the 20 to 50 years after Shafer first reported his studies. There is much more to do, but my career is nearing the end. A new generation of landscape scientists will have to move the science forward.” observed Dr. Burley.

It should also be remembered that the visual scores are inventory information. The interpretation of the scores for a planning or design study follow in the analysis. In addition, it can be dangerous to design by numbers; however, the metrics can be a useful guide in developing a sense concerning respondent perception of the landscape.

Conclusion

This study presents a methodology to produce a statistically predictable and reliable map of visual quality perception. It is important to employ a metric that is capable of explaining much of a respondent’s preference. Once can produce a map because preference and land-use/classes often covary. The Kendall’s Coefficient of Concordance W is a statistical approach to assess this covariance. If the results produce a p-value equal to or smaller than 0.05, a reliable map is possible to construct.

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Paper _ Technical Session 6

Interactive Landscape Simulations for Visual Resource Assessment

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Abstract: As a part of environmental decision making, visual resources management typically requires developing 3D renderings of a landscape, allowing stakeholders to contextualize the impacts of proposed management activity on the surrounding area. These visualizations can be particularly valuable for improving public participation in decision-making activities, serving as a “common language” or “translation layer” for communication between stakeholders of various backgrounds. Such visualizations are known to be more effective when they are higher resolution, with increased realism and visual fidelity; however, producing such highly-detailed visualizations has been largely out of reach for most purposes due to the high computational power and technical knowledge required.

This paper introduces a new method for developing high-resolution visualizations, leveraging the Unity 3D rendering engine and the R language to programmatically produce interactive 3D landscape simulations. By walking through how this process might be applied to a standard viewshed analysis, we demonstrate the advantages of this interactive format in allowing the user to more easily investigate presented data and modeled outcomes. By providing additional spatial context and allowing users more agency in investigating presented results, this technique has the potential to be useful in a wide array of applications within visual resources management.

Keywords: visual impact analysis, visual resource management, Unity, landscape visualization, viewshed analysis

Introduction

Environmental decision making is a complex process, requiring stakeholders of varying educational and professional backgrounds to communicate and negotiate about differing environmental value systems to come to a mutually-agreeable course of action (Metze 2020). One of the key challenges in this process is the translation of background knowledge and expertise between stakeholders, particularly as members of the public become increasingly involved in making decisions about landscape management. For this reason, visualizations have often been described as a “common language” which may help stakeholders understand one another more effectively, allowing stakeholder values, background knowledge, and statistical information to be communicated in a more intuitively understandable format (Nicholson-Cole 2005). In particular, interactive visualizations may allow stakeholders with less formal training more agency to explore data and modeled outcomes on their own, potentially identifying preferred alternatives or problematic assumptions baked into the presented analysis. To this end, interactive simulations have been used for engaging the public to great effect in domains such as transportation policy (Lovelace, Parkin, and Cohen 2020) and urban planning (Pettit et al. 2015).

However, many environmental problems do not lend themselves to the types of interactive graphics that have flourished in other domains. Although some environmental metrics (such as temperature or precipitation) lend themselves naturally to familiar line or bar plots, others (such as visual impact, ecological integrity, or land management histories) often require more context to properly interpret than can be provided through standard visualizations. While 2D maps are able to provide spatial context to data, these visualizations often still require users to think about a landscape in a highly abstract way, attempting to match colors on a map to regions of a color key, match symbols to values in a legend (or to values implicitly assumed to be understood), and to convert pixel distances and areas into their real-world equivalents. Such levels of abstraction can make maps rather difficult to understand and correctly interpret, limiting their value as translational tools (Ottosson 1988).

This limitation may be overcome by creating more true-to-life renderings of an area of interest, visualizing landscapes more similarly to how they might appear in the real world. By using realistic representations of features of interest, these renderings may allow users to apply their intuition about how areas “should” look and function more intuitively than might be possible with more abstract representations. For this reason, this practice is already prevalent in visual resources management, with realistic renderings of proposed management activity a common stage in many decision-making processes (Molina-Ruiz et al. 2011; Szumilas-Kowalczyk and Pevzner 2019). These visualizations are more effective when produced at higher resolutions, with increased realism and visual fidelity (Appleton and Lovett 2003); however, producing such highly realistic renderings typically requires more computational power and technical knowledge than more abstract 2D maps (Paar 2006).

Game engines have been proposed as a potential solution for the demanding requirements of producing these renderings (Herwig and Paar 2002). These programs, specifically tuned to render terrain at high resolutions quickly enough so that players in a video game do not experience any computational lag, can simulate large-scale landscapes using mass market computer equipment. The most popular of these engines, the Unity real-time development platform (Unity Technologies 2020), has been used to produce 3D landscape visualizations since at least 2010 (Wang et al. 2010). However, while Unity solves many of the computational obstacles to the creation of large-scale 3D renderings, it still demands a high level of technical skill. Perhaps for this reason, Unity is still under-utilized as a tool for landscape visualization.

This paper describes the terrainr package (Mahoney 2021), an extension for the open source R programming language (R Core Team 2020) which assists users in retrieving, manipulating, and transforming spatial data to import into Unity, and illustrates how this package may be used as part of a workflow for visualizing visual impacts and viewsheds. By depicting landscapes in a more concrete form than typical 2D maps, this workflow produces renderings that may be more intuitively understandable for a generalist audience, serving as an effective tool for translating between stakeholders in an environmental decision-making process.

Viewshed Analyses with terrainr

Environmental decision making can be aided by conducting a Visual Impact Assessment (VIA), defined by the United States Bureau of Land Management as "the analysis of the potential visual impacts to the landscape and landscape views resulting from a proposed development or land management action". VIAs include a large-scale viewshed analysis to evaluate visible areas of the landscape from specific viewpoints. These analyses can be used to evaluate the potential of mitigation measures to reduce or avoid impact to a particular view (Bates-Brkljac, 2009). To illustrate the potential of high-resolution 3D simulations for visual resources management, we will walk through an example viewshed analysis using both traditional 2D mapping and Unity. As an example, we will examine the viewsheds (that is, the regions which are visible from a given location) impacted by the Johns Brook Lodge building, a privately-operated resort located within the eastern High Peaks Wilderness Area of the Adirondack State Park. All code required to produce these graphics is included as Figure 1, with code required for calculating viewsheds included as Figure 2; we will not focus on defining functions and parameters here but rather defer to the documentation provided with the sf and terrainr packages and GRASS GIS (Pebesma 2018; Mahoney 2021; GRASS Development Team 2020).

```r
# Load required packages:
library(sf)
library(terrainr)
library(raster)
library(rgrass7)
# Creating a point representing the lodge location
# Create a table with point coordinates:
coords <- data.frame(y = 44.1585, x = -73.8624)
# Transform it into an "sf" object:
lodge_coords <- st_as_sf(coords,  coords = c("x", "y"))
# Assign it the WGS84 CRS (EPSG 4326):
lodge_coords <- st_set_crs(lodge_coords, 4326)
# Create a square centered on this point, with sides 12,200 meters long:
lodge_bbox <- set_bbox_side_length(lodge_coords, 12200)
# Use terrainr to download DEMs and orthoimagery from the USGS:
lodge_tiles <- get_tiles(lodge_bbox,
                         "johns_brook",
                         services = c("elevation", "ortho"))
# Merge the tiles returned by the USGS into individual raster files:
merge_rasters(lodge_tiles$elevation, "merged_johns_brook_dem.tif")
merge_rasters(lodge_tiles$ortho, "merged_johns_brook_ortho.tif")
# Create an overlay for Unity containing our central point as a red dot:
vector_to_overlay(lodge_coords,
                  "merged_johns_brook_dem.tif",
                  color = "red",
                  size = 10,
                  output_file = "point_location.tiff")
# Transform our elevation raster into heightmaps for input into Unity:
raster_to_raw_tiles("merged_johns_brook_dem.tif", "heightmap")
# Transform our overlays into map tiles for input:
raster_to_raw_tiles("merged_johns_brook_ortho.tif", "ortho", raw = FALSE)
raster_to_raw_tiles("point_location.tiff", "point", raw = FALSE)
```

Fig. 1: *R code required for creating the visualizations in this paper. Descriptions of functions and their arguments are available online at https://docs.ropensci.org/terrainr/*

The initial step in this process is to define our area of interest. We first define a point located at Johns Brook Lodge (44.1585° N, 73.8624° W), then convert it into a “simple features” object using the WGS 1984 coordinate reference system (EPSG code 4326) using functions provided by the sf package (Pebesma 2018). Next, we use functions from terrainr to define a bounding box centered on the lodge, with side lengths of 12,200 meters. We then are able to use this bounding box to download a bare earth digital elevation model (DEM) and orthoimagery from the USGS National Map (U.S. Geological Survey National Geospatial Program 2020). As the USGS National Map is not able to return rasters representing our full bounding box in a single query, the “get_tiles” function returns our data as a set of multiple map tiles, which we then must merge into cohesive individual rasters using the “merge_rasters” function. All told, this process of defining our area of interest, retrieving public domain data for this area, and processing the downloaded data into singular files requires approximately ten lines of code. We then produce map tiles for import into Unity, a process documented in the “Importing terrainr tiles into Unity” vignette included with the terrainr package, through repeated use of the “raster_to_raw_tiles” function.

With our elevation and orthoimagery prepared and ready for import into Unity, we can now turn our attention to performing a viewshed analysis. For this analysis, we calculated viewsheds using the GRASS GIS function “r.viewshed,” run using the “rgrass7" R package (GRASS Development Team 2020; Bivand 2021). The code required to produce a viewshed raster is included as Figure 2.

By instructing the program to produce a boolean raster, indicating only whether a given pixel is or is not able to be seen from the lodge, we produce the viewshed map presented as Figure 3. By changing the default coloration of the map such that the viewsheds are entirely transparent, and all other areas a slightly transparent black, we can overlay this raster upon orthoimagery to produce a map that provides additional spatial context; this is presented as Figure 4.

```r
# Load required packages:
library(terrainr)
library(raster)
library(rgrass7)
# Initialize GRASS GIS
initGRASS(system("grass --config path", intern = TRUE),
          raster::tmpDir(),
          mapset = "PERMANENT",
          override = TRUE)
# Set our CRS equal to that of our merged elevation raster
execGRASS("g.proj",
          "c",
          georef = "merged_johns_brook_dem.tif")
# Read our elevation raster into the GRASS session
execGRASS("r.in.gdal",
          c("overwrite", "o"),
          input="merged_johns_brook_dem.tif",
          band=1,
          output="elevation")
# Specify the region we want covered by the viewshed
execGRASS("g.region",
          raster="elevation")
# Calculate the viewshed
execGRASS("r.viewshed",
          c("b", "overwrite"),
          input="elevation",
          coordinates=c(coords$x, coords$y),
          memory=1000,
          output="viewshed")
# Save our viewshed raster to file
execGRASS("r.out.gdal",
          c("t", "m", "overwrite"),
          input="viewshed",
          output="viewshed.tif",
          format="GTiff",
          createopt="TFW=YES,COMPRESS=LZW")
# Load our viewshed raster
viewshed <- raster("viewshed.tif")
# Create a multi-band image from our single-band raster
# and set visible areas to transparent
alpha <- viewshed == 0
viewshed <- brick(viewshed, viewshed, viewshed, alpha)
# Save the viewshed raster
writeRaster(viewshed, "viewshed_image.tif", overwrite = TRUE)
# Transform the viewshed into tiles:
raster_to_raw_tiles("viewshed_image.tif", "viewshed", raw = FALSE)
```

Fig. 2: *R code required for implementing the viewshed analysis performed in this paper, using GRASS GIS version 7.8. The "coords" object is created in the code from Figure 1. Descriptions of functions and their arguments are available online at https://grass.osgeo.org/*

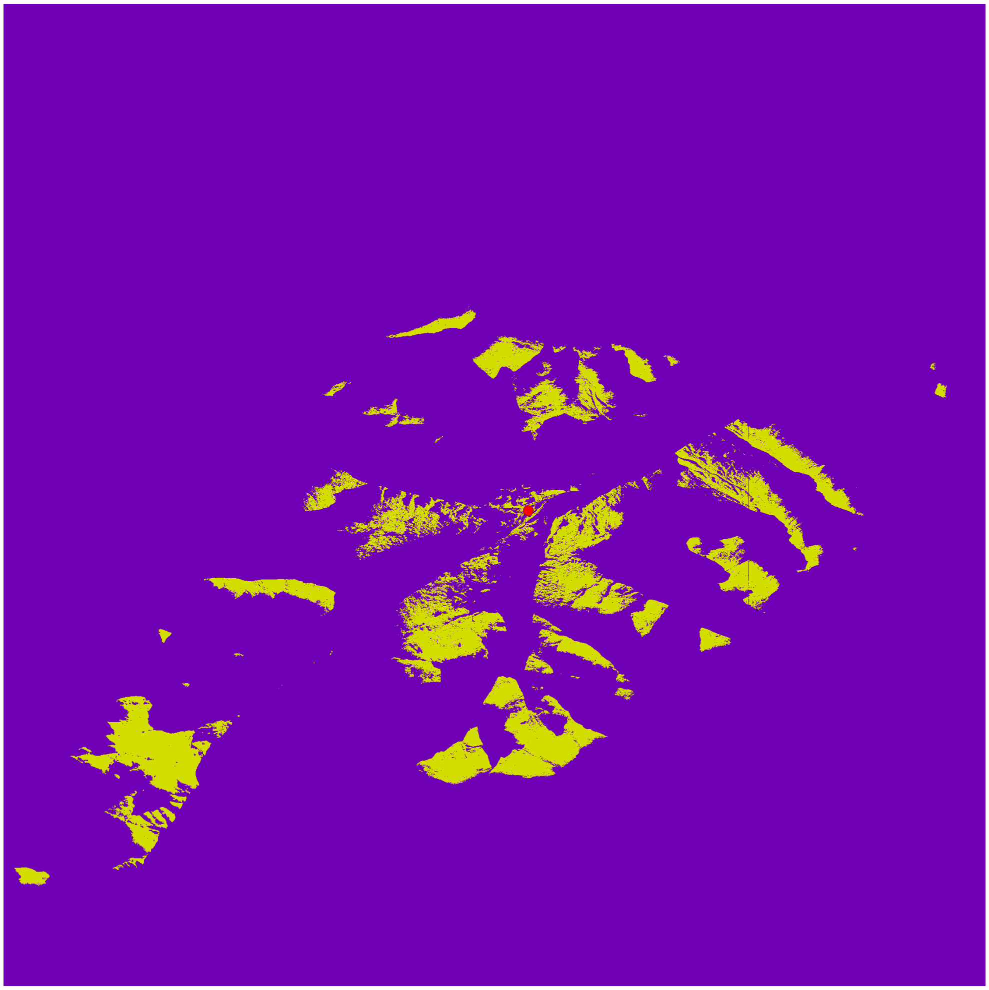

Fig. 3: *A map showing the visibility of the Johns Brook Lodge (red dot). Yellow areas are able to see the lodge, while purple regions cannot.*

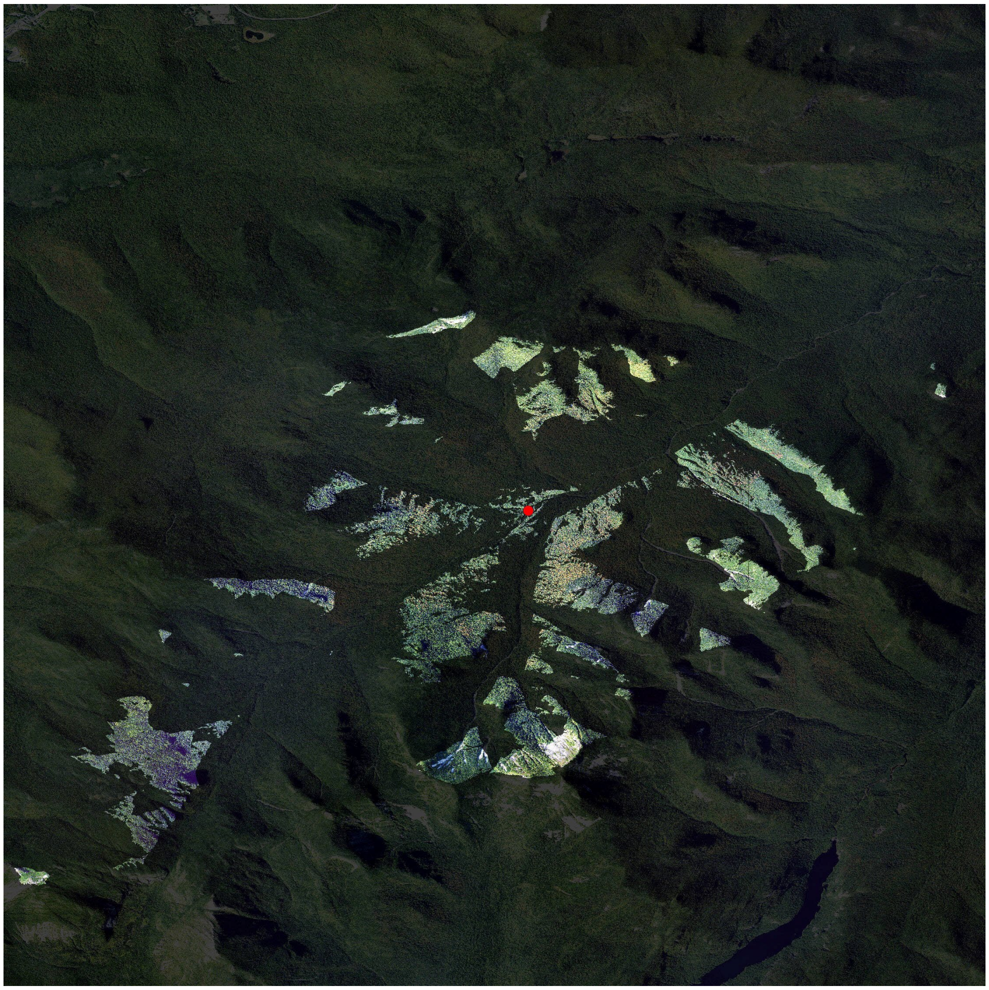

Fig. 4: *A map showing the visibility of the Johns Brook Lodge (red dot). Brighter regions are able to see the lodge, while shaded areas cannot.*

In total, producing these viewshed rasters requires approximately 30 lines of code (Figure 2). The combination of this code with the script used for data retrieval and processing (Figure 1) enables a completely reproducible workflow for viewshed analysis, with all steps of the analysis pipeline captured as code that can be run or validated by other collaborators. Another advantage of this approach is that we may recreate this analysis for any location within the United States simply by changing our initial latitude and longitude stored in the "coords" object; while writing this program may take longer than using a graphical user interface for a single viewshed analysis, the time saved by automation can become significant when calculating multiple viewsheds. Finally, this analysis uses only freely available open-source software which may be downloaded and installed by anyone with internet access, as well as data from the public domain which has no restriction on its use.

We have so far focused our attention on using terrainr within R as a method for reproducible viewshed analyses. For users looking to visualize the outputs of these calculations, terrainr additionally provides methods (via the "raster_to_raw_tiles" function in Figures 1 and 2) for transforming data into tiles which may be imported into the Unity 3D rendering engine. By importing these tiles into Unity, a process documented in the "Importing terrainr tiles into Unity" vignette included with the terrainr package, we are able to quickly produce a 3D replica of our viewshed visualization. When viewed isometrically from above (Figure 5), this rendering is incredibly similar to Figure 4; the only obvious evidence this is a different image are some slight differences in hue.

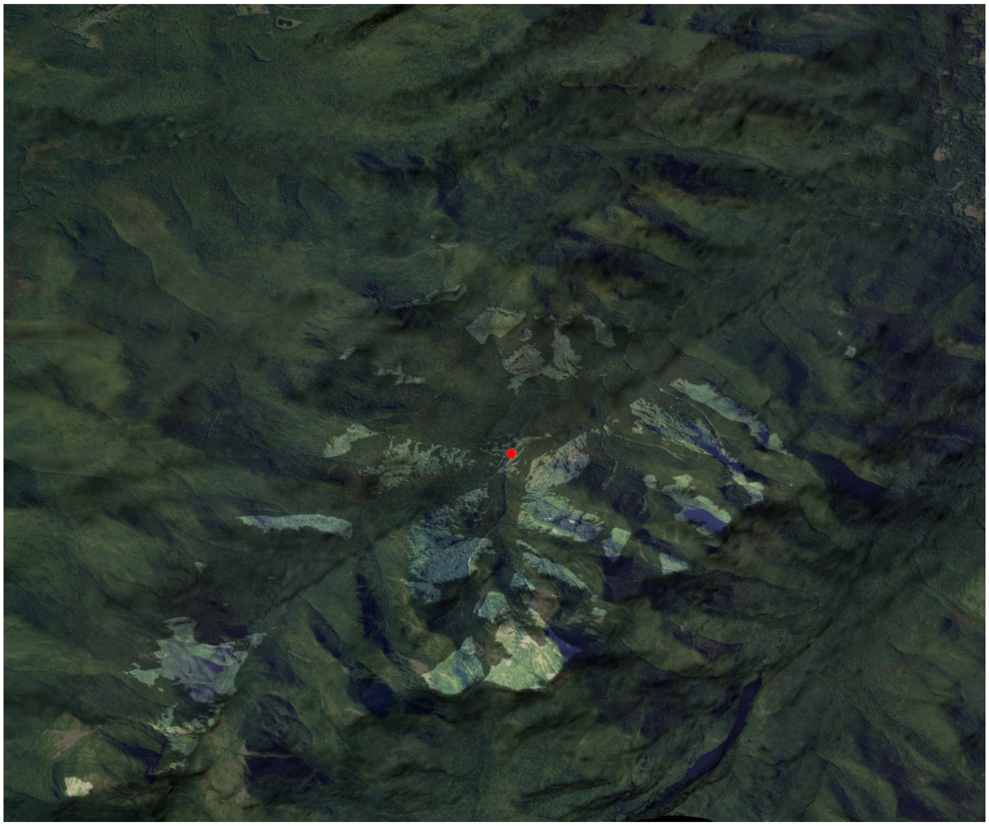

Fig. 5: *A map showing the visibility of the Johns Brook Lodge (red dot), produced using the Unity rendering engine. Brighter regions are able to see the lodge, while shaded areas cannot.*

One of the chief benefits of this 3D rendition, however, is that users are no longer restricted to viewing their landscape as a flat surface from above. By moving the camera throughout the scene, users are able to investigate how viewsheds interact with terrain and features in orthoimagery (Figure 6; Figure 7). This control allows for a new depth of interactivity with the visualization of model outputs; for instance, a user might validate the results of the viewshed operation by placing themselves at the feature of interest and searching for shaded regions (Figure 8). In total, this interactive 3D model allows users a greater degree of autonomy when exploring model results and provides additional context not present in the 2D map incorporating the same data.

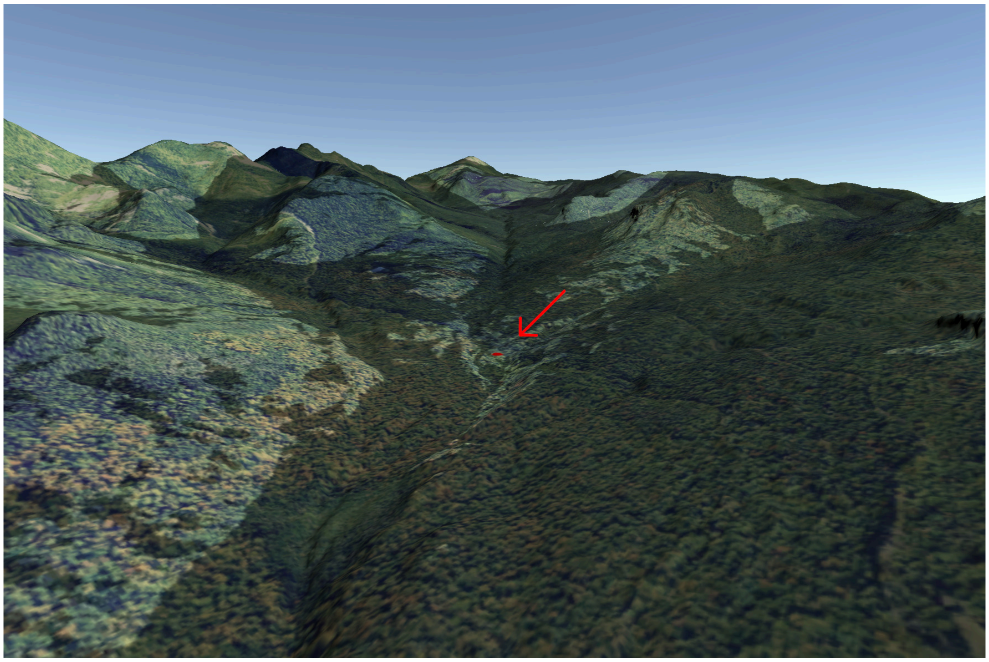

Fig. 6: *A map showing the visibility of the Johns Brook Lodge (red dot highlighted by arrow), produced using the Unity rendering engine. Brighter regions are able to see the lodge, while shaded areas cannot. This image is taken facing towards the southwest, so that Mt. Marcy is approximately centered in the horizon. Users are able to manipulate the camera to reposition themselves throughout this scene and investigate model outputs in various regions.*

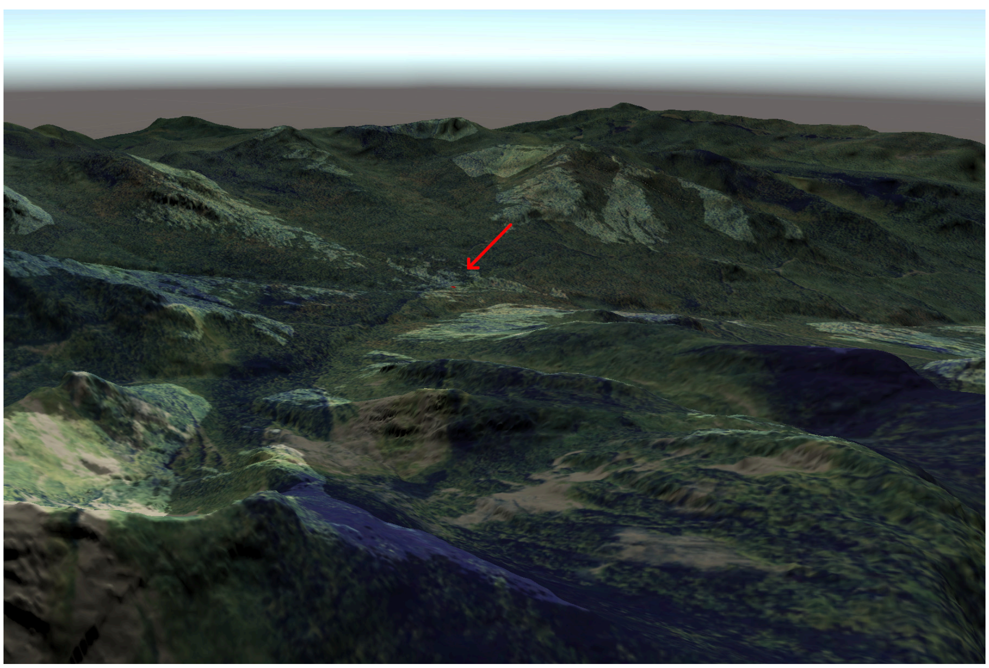

Fig. 7: *A map showing the visibility of the Johns Brook Lodge (red dot, with an arrow to highlight), produced using the Unity rendering engine. Brighter regions are able to see the lodge, while shaded areas cannot. This image is taken from Algonquin Peak facing east towards Giant Mountain. Users are able to manipulate the camera to reposition themselves throughout this scene and investigate model outputs in various regions.*

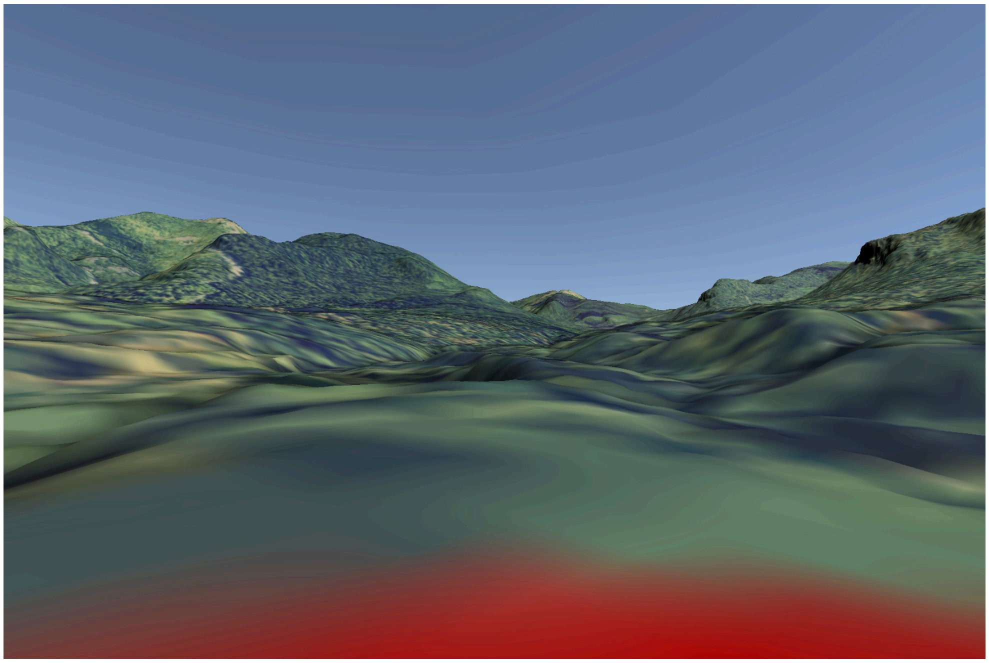

Fig. 8: *A map showing the visibility of the Johns Brook Lodge (red dot), produced using the Unity rendering engine. This image, taken facing south from the location of the lodge itself, is entirely highlighted, allowing users to verify that the viewshed algorithm has correctly identified areas which may be seen from the lodge.*

Discussion

Interactive visualizations present an exciting opportunity for engaging non-specialist participants in environmental decision-making processes, helping stakeholders investigate data and models in a more intuitive fashion than the data analysis programs used by the professional analyst or researcher provides. In particular, high-resolution interactive landscape visualizations are particularly well suited for communicating many classes of environmental data, given the importance of spatial context to the interpretation of data and results. Through its set of data retrieval and processing functions, the terrainr package aims to make producing such visuals faster, easier, and more reproducibly for land managers and researchers so that these visualizations may be incorporated into decision making and outreach programs.

These 3D simulations are capable of effectively reproducing the outputs from traditional GIS-based analyses (Figure 3, Figure 4), and additionally allow users the freedom to explore the presented results in order to develop questions and draw their own conclusions about the performed analysis. This freedom may be useful when seeking to engage external stakeholders in a decision-making process, as the interactivity allows users to surface and focus on oddities and assumptions in results which may have been masked by static visuals. By the same token, however, these visualizations are inherently less directed than static graphics or pre-developed videos of renderings, which may make it harder to use these tools to advance an argument or persuade an audience. Whether this is a benefit or a limitation of the approach will inherently depend upon the goals of a particular visualization project, as well as one's beliefs about the roles of researchers and other stakeholders in interpreting results and reaching decisions.

The visualizations presented in this paper have purposefully been restricted so that data processing could be performed programmatically using only terrainr and other publicly available open-source software products, without requiring a large degree of manual design or manipulation to produce. However, the Unity engine is capable of displaying hundreds or thousands of objects on top of these terrain layers for more realistic simulations. This allows users to place, for example, purchased models of trees at strategic points throughout the landscape to more accurately capture the aesthetic and feeling of a setting, or to place models of wind turbines or buildings to demonstrate the expected impact of a development project. There does not exist at this time a way to programmatically develop objects for these renderings in the way terrainr aids in the development of terrain tiles, and as such this currently would require users to be more familiar with Unity than is needed for producing landscape visualizations; this gap presents a clear direction for future work.

Conclusion

Effective visualizations can serve as a critical "translation layer" for environmental decision making, aiding in the communication of information and value systems between stakeholders of different educational and professional backgrounds. The increasing importance of public involvement in decision making processes has driven an increase in the use of interactive visualizations, which may allow nonspecialists greater agency in investigating data and models and identifying alternative solutions. To this end, this paper has presented a new method for producing interactive 3D landscape visualizations, including a demonstration of how the method might be applied to viewshed analyses. This method allows users to explore and validate presented results, and provides these results with more spatial context than most traditional 2D mapping approaches. Particularly if combined with manual placement of objects such as trees, buildings, or wind turbines, this class of visualization presents an exciting opportunity for many aspects of visual resources management.

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Visual Case Study _ Technical Session 7

A Tailored Approach to Assessing Visual Impacts from Offshore Wind Energy Development on the Outer Continental Shelf of the United States

John McCarty[2]

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This presentation focuses on the differences between seascape/landscape impact assessment and visual impact assessment, why seascape/landscape impact assessment is important, and the benefits and challenges of adding a seascape/landscape impact assessment to a more traditional visual impact assessment.

As the United States begins large-scale deployment of offshore wind energy facilities, an important challenge for developers and regulators is the assessment of potential seascape, landscape, and visual impacts on important coastal scenic, historic, and recreational resources; Native American tribal properties and treasured seascapes; commercial interests dependent on tourism; and the private property of coastal residents. This paper will describe the methodology for seascape, landscape, and visual impact assessment (SLVIA) that the U.S. Department of the Interior (DOI) Bureau of Ocean Energy Management (BOEM) plans on using to identify the potential impacts of offshore wind energy developments in Federal waters on the Outer Continental Shelf (OCS) of the United States.

The BOEM SLVIA methodology is modeled on the methodology in use in the United Kingdom. It considers seascape and landscape impacts assessment (SLIA) and visual impacts assessment (VIA) as two closely related but separate impact assessments. Both use similar impact assessment processes, and the majority of potential impacts for both the SLIA and the VIA are associated with the visibility of the offshore and onshore wind project components. However, the SLIA impact receptors and types of potential impacts differ from those in the VIA, leading to different conclusions about the ultimate effects of the project on seascape/landscape (assessed in SLIA) and on people (assessed in VIA).

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Paper _ Technical Session 7

Build Back Solar: A Socially Just Model for Community Solar Aggregation

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Abstract: The scale of deployment of renewable energy infrastructure required to meet the challenge of the climate crisis will transform our cities and landscapes in unprecedented ways, impacting our visual resources as well as our social and cultural ecosystems. This paper presents a model for solar deployment that brings together the often-siloed disciplines of energy development and community-centered design within the fields of architecture, landscape architecture, and urban planning. The model proposes that by co-designing solar energy landscapes with the people who live in proximity to them, we can expand urban solar deployment and preserve remote landscapes. Participatory design practices for energy development can also ensure a just and equitable clean energy future and leverage the many co-benefits of solar power infrastructure when it shares land uses with parks, gardens, canals, riverfronts, and streetscapes. The wealth of proven technologies for aesthetic solar photovoltaic integration within architecture and landscape architecture offers a path to implementation for a far more ambitious deployment of distributed energy within cities than is ordinarily considered by urban planners and real estate developers.

Keywords: solar photovoltaic, distributed energy resources, urban planning, equity, just transition, community energy

Introduction: The Urban Versus Rural Debate

By mid-century, the entire world must transition to a low carbon economy if we are to restrict global temperature rise to 2 degrees Celsius (IPCC). In a 100% clean energy economy—one where we have electrified transportation and heating—solar power will be a significant contributor, providing up to 40% of total energy (Jacobson, 2017). To get there we will need to install around 80 billion commercial solar modules globally—more than ten 72-cell modules for every person on the planet. So far, we have installed less than 1.5 billion modules. Solar power provides less than 2% of total energy (EIA, 2021) and yet we are already seeing pressures on land use. Solar energy landscapes are increasingly competing with other interests such as agriculture, recreation, visual resources stewardship, land conservation, forest preservation, and biodiversity. The answer to the question of where we should install solar panels is fundamental to the success of the energy transition.

Over the past decade there has been a robust debate regarding the most beneficial mix of distributed versus centralized renewable energy infrastructure to provide the most economical and reliable electricity grid for a post-carbon economy. This debate has benefitted recently from grid modeling tools developed by Vibrant Clean Energy (VCE) (C.T.M. Clack et. al, 2020) that consider a more complete set of variables and feedback loops than older modeling tools. The results of VCE's more comprehensive analysis are challenging long-held assumptions regarding the costs and benefits of distributed energy resources.

Conventional wisdom has held that centralized infrastructures are more cost effective than distributed infrastructures nearer to large population centers. This extant way of thinking may be inherited from incumbent thermal power systems, which see major benefits from economies of scale that make large centralized systems preferable to distributed systems. Solar photovoltaic systems do not require operational economies of scale (a coal-fired boiler operates at greater efficiency when it is larger, but a single solar panel does not operate more efficiently when placed next to other solar panels).

Distributed energy resources (DER) tend to have higher soft costs and require the duplication of many small balance-of-system components such as inverters, which can be efficiently consolidated in centralized solar power arrays. But the added marginal costs of DER must be considered against the cost of the construction, operation, and maintenance of the distribution and transmission infrastructure required to deliver remotely generated electricity to population centers. Another important consideration is the raft of political and regulatory barriers to permitting new overhead transmission lines and establishing new rights of way (Reed, et. al. 2020). Such barriers have led to the study and recommended pursuit of Non-Transmission Alternatives (NTA) of which DER is one of the most important (Kasam-Griffith, et. al. 2020).

Pathways to deep decarbonization will require rapid electrification of transportation, domestic heating, and heavy industry, which will require (at least) a doubling of existing electrical generation infrastructure (Griffith, et. al. 2020). The more this added generation capacity is located in remote landscapes, the more long-distance transmission infrastructure will be required. When considered together all these factors indicate a prioritization of DER over centralized energy systems may provide a more rapid pathway to decarbonization. When cost of transmission and distribution is taken fully into consideration, DER, if designed well, can also be more economical and reliable.

While there will always be a need for large centralized solar landscapes in remote areas, according to VCE, the mix of distributed energy resources may be as much as ten times previous assumptions to arrive at the most cost effective and reliable grid. Assuming the validity of VCE's grid modeling, what are the social and cultural ramifications that follow from a prioritization of distributed solar plus storage over centralized solar energy generation infrastructure? Deploying ten times more solar energy infrastructure within the built environment over what we have recently assumed may require new models for design and development that can expand permissible site opportunities. This is where community engagement is key to success.

Challenges to Urban Deployment

The standard model of solar energy development on vacant urban parcels is often characterized by ground-mounted modules surrounded by barbed wire topped cyclone fences and security cameras. Community engagement is often limited to the most basic level required to obtain permits after design has been completed, and in many cases, there may not be any community engagement at all. If the land use is allowed by right, there is a limit to what design concessions the public can expect to receive from urban solar development projects. Expanding this conventional model to meet the level of deployment necessary to establish a 100% renewable energy grid, we can expect to find solar developers soon meeting localized resistance to new deployments, especially for sites that are considered significant from an urban planning perspective or for historical significance. In general, the design outcomes that result from the conventional model of solar development do not serve to advance the overall energy transition movement from a political or cultural perspective.
This situation threatens to pose a danger to the success of decarbonization strategies. If the perception of solar energy in the minds of the public carries negative connotations related to aesthetics and real estate values, then it will be difficult to build the political will necessary to implement pro-solar public policy, and at the local level we may see more projects rejected due to public opposition.

Potential Opportunities and Intersectional Benefits

Providing carbon free energy in the fight against climate change is the most obvious benefit of solar power. What may be overlooked are the benefits of distributed solar for local economies and DER’s potential to increase social equity and quality of life. Thoughtfully planned and implemented, city-integrated solar infrastructure can provide a wide array of co-benefits.
The application of solar infrastructure can increase the energy resilience and independence of municipalities. Cities are already taking advantage of long-term power purchase agreements for clean energy to establish pricing stability. By bringing solar installations into urban neighborhoods, cities can accomplish the same goal while also contributing to resilience and efficiency by limiting reliance on monopoly utilities and eliminating maintenance costs for remote distribution infrastructures. Localized supply chains can emerge to provide good paying jobs while locally produced solar components may decrease the embodied environmental footprint of PV modules.
When designed in collaboration with communities, solar installations can improve quality of life and the beauty of public spaces. PV modules can provide aesthetic shade, creating new microclimates that expand the comfort zone in hotter climates into the summer months for human activities in outdoor public spaces and reduce heat island effects (See Figure 1).
Cities can benefit from new visual icons and cultural markers of what solar looks like for their city. Improvements to interstitial or liminal spaces in the margins of the city (think of the neglected slivers of property near highway on ramps) can make productive use of neglected land.
The more we can integrate solar within population centers, the more we can conserve rural landscapes and reduce the tension with exurban land uses such as agriculture, recreation, forest preservation, biodiversity, and the protection of cherished visual resources.
Increasing the mix of distributed generation also reduces the need to construct more transmission and distribution infrastructure, which are typically more challenging to permit than the generation facilities themselves.
By considering innovative shared land uses for solar development projects, the benefits to cities of distributed solar will not only include urban sustainability and resilience, but also increased liveability, cultural expression, storytelling, food security, racial and economic justice, and economic development. These co-benefits can potentially improve overall social equity and quality of life.
Solar on reservoirs reduces losses from evaporation. The body of water also acts as a heat sink, keeping the solar modules cool and therefore operating more efficiently.
Solar can make urban gardens more productive and help harvest rainwater.
Creative uses of solar power technology can enhance public spaces as works of civic art. Examples can be seen in Figures 2 and 3.
Community solar projects can provide opportunities for small individual investors to see low-risk rates of return and help tackle issues of energy poverty when designed with an eye on social return on investment.
Community solar with storage can offer additional revenue streams through energy services like demand management that keep the grid stable through periods of peak demand or remote outages.

Fig. 1: *Top: Agrivoltaics at the University of Massachusetts Crop Animal Research and Education Center. Image by National Renewable Energy Laboratory (NREL). Bottom Left: Solar Canopy at Arizona State University by Power Parasol (replace with approved image). Bottom Right: Aquavoltaic solar installation at a water treatment plant retention pond in New Jersey. Image by Ciel & Terre.*

Fig. 2: *Left: Solar "Trees" at Alliant Energy in Madison, Wisconsin. Image by Lumos Solar. Right: Solar "Trees" installed by CPWD at the National Salt Satyagraha Memorial in Dandi, Gujarat, India. Image by Ajay Agrawal, and Dr K M Soni, Former ADGs, Central Public Works Dept.*

Fig. 3: *Top: "Light Up" by Martin Heide, Dean Boothroyd, Emily Van Monger, David Allouf, Takasumi Inoue, Liam Oxlade, Michael Strack, Richard Le (NH Architecture); Mike Rainbow, Jan Talacko (Ark Resources); John Bahoric (John Bahoric Design); Bryan Chung, Chea Yuen Yeow Chong, Anna Lee, Amelie Noren (RMIT students) generates 2,220 MWh per year using laminated monocrystalline Si solar (1st Place Winner, LAGI 2018 Melbourne). Bottom Left: "Nest" by Robert Flottemesch generates 6,633 MWh per year using monocrystalline bifacial PERC solar modules (LAGI 2019 Abu Dhabi). Bottom Right: "Beyond the Wave" by Jaesik Lim, Ahyoung Lee, Sunpil Choi, Dohyoung Kim, Hoeyoung Jung, Jaeyeol Kim, Hansaem Kim (Heerim Architects & Planners) generates 4,229 MWh per year using organic photovoltaic solar (LAGI 2014 Copenhagen).*

To incentivize solar development that adds value to public space, cities can adopt more stringent standards for design and community engagement. But strengthening design and engagement standards will present additional barriers to energy developers. Therefore, it is critical that cities proactively identify land areas for solar aggregation within their strategic plans and zoning ordinances so that solar deployments within urban contexts can be accomplished wholesale in megawatt capacity installations rather than piecemeal with a few kilowatts here and there. The goal should be to present a development environment for urban contexts that can come close to parity with rural installations with regard to the levelized cost of energy.

For the reasons stated in the previous section, turning this vision into a reality will likely require an evolution from the current development paradigm for solar infrastructure and the coordination of public and private capital. Presently, the business models of private solar development companies are designed to profit from strategies that limit soft costs related to community engagement and project complexity. A more holistic life-cycle model for DER development might internalize considerations related to the range of social benefits possible through well-planned community solar projects and recognize the value streams created by site activation and creative placemaking that are familiar to mixed-use real estate developers and city planners.

Looking at a broader spectrum of co-benefits besides electrons can also lead to more inclusive models for financing solar deployment in cities and can expand the base of the public who are personally invested in a clean energy future. Community energy projects and energy cooperatives can provide a low risk means of wealth building for marginalized populations who have been intergenerationally excluded from investment opportunities. By working in partnership with cities, solar developer business models may begin to bring more externalities into the calculation for return on investment. Innovative revenue models may be established that provide income streams from sources in addition to kilowatt-hours.

By breaking down the silos of developer models (energy developer vs community developer) we can begin to expand the realm of what is possible for urban solar integration. Cities and energy developers can work together to improve public perceptions of renewable energy infrastructure. By doing so we might accelerate renewable energy deployment, meet the most beneficial mix of distributed versus centralized infrastructure, increase support for pro-solar policy agendas, help to lessen the intergenerational wealth gap, and make cities more vibrant, liveable, resilient, and sustainable.

Community Co-design and Creative Placemaking

Incorporating community and stakeholder engagement into the energy developer business model can provide lasting benefits throughout the life cycle of projects and instill positive associations with renewable energy infrastructure at the neighborhood level. This can be accomplished by learning from best practices in urban planning and creative placemaking, which include community and stakeholder engagement from the pre-planning stage of development.

There are many resources available to developers who see the benefit of a multifaceted approach to energy projects. These include the Project for Public Places, who provide guidance through their *Eleven Principles For Creating Great Community Places*; the Trust for Public Land, who published the *Field Guide For Creative Placemaking In Parks*; the American Planning Association; EcoDistricts®, who provide protocols and certification for city makers; the American Society of Landscape Architects; the Landscape Architecture Foundation, who host the Landscape Performance Series of online resources; the National Endowment for the Arts; and Art Place America, a collaboration of foundations with an excellent set of resources, including the field survey *Farther, Faster, Together: How Arts And Culture Can Accelerate Environmental Progress*.

The *Build Back Solar* Proposal

Build Back Solar (BBS) is a proposal by the Land Art Generator Initiative to advance the installation of utility scale solar in cities by co-designing shared land uses and improvements to the built environment with the communities where the solar is installed. For the purposes of this paper, we use the City of Pittsburgh, Pennsylvania as a model. With modifications related to population density, solar irradiation, and other local variables, the BBS model could be applied to any city in the world.

At the heart of the proposal is an open-call design challenge combined with robust community engagement that can bring expanded public awareness and increase the quality of solar infrastructure design. The pre-development costs of community engagement and design are proposed to be borne by the public sector (in collaboration with local foundations when applicable). With the soft costs of development carried by the public sector, and with multiple small and medium size sites aggregated into one large bid package, developers are incentivized to invest in urban solar projects while the BBS process ensures that an equitable and just transition is a centerpiece of each project plan.

Solar Power and Social Justice

Assuming that we will be installing a significant percentage of solar power infrastructure in cities, it will be important to learn lessons from the unintended consequences of past infrastructure development that contributed to racially biased spatial and environmental injustices. The destruction of inner city neighborhoods through mid-20th century interstate highway planning is one example of the kind of top-down planning that should be avoided during the deployment of new energy infrastructures in the 21st century. Communities can instead be engaged in the decision-making processes for significant solar installations proposed in their neighborhoods so that the resulting energy landscapes are designed to add value to the built environment, contribute to economic development, and provide co-benefits to people beyond kilowatt hours.

Other social risks of the energy transition include the furtherance of structural wealth disparities. Centralized infrastructures are typically financed by institutional investors with the returns accruing over time to benefit the already wealthy. With trillions of dollars in near future investment and low risk returns for solar deployments, it is critically important that the opportunity for wealth generation be offered to a broad array of stakeholders and not be limited to Wall Street investors.

Proposal

In broad community collaboration BBS will identify several suitable sites over a total of 60-90 acres in the City of Pittsburgh that will come together in a coordinated design for a total 30 megawatts (MW) of solar power infrastructure. See Figure 4 for a scale reference of what 60 acres of probable sites looks like for the City of Pittsburgh. By aggregating a utility-scale project (65,000 commercial solar panels) across multiple sites, the project will meet the kind of economies of scale that are standard for exurban installations while bringing greater resilience and reliability to the city grid, directly conserving 60-90 acres of countryside, and bringing a suite of co-benefits to neighborhoods.

BBS will be managed by a consortium of project partners representing the fields of sustainable community design and planning; diversity, equity, and inclusion; solar energy policy; land use law; ecology and biodiversity; geography and spatial analysis; riverfront and reservoir development; marketing and communications; and education and outreach.

This consortium will coordinate closely with local stakeholders, including city and county commissions, local community groups and development corporations, elected officials, utility companies, regulatory agencies, and individual citizens.

Process Overview

The first phase of work will include a spatial analysis and solar survey; establishment of legal constraints; outreach to solar developers and market experts; meetings with city officials; and recommendations for inclusive financing models.

Partnerships will be established with 24 local community representative organizations who will assist in coordinating public events and design workshops.

Community engagement begins with an initial meeting with community leaders, followed by a public presentation of the idea and open discussion. Subsequent meetings will include interactive mapping; storytelling; site selection and analysis; co-benefit ideation workshops; procurement strategy; solar financing and equity workshops; and the co-creation of the design brief documents with key members of the community. At any step of the process a community can decide how to participate in the project, or not to participate at all.

An open call international design challenge will be at the heart of the overall program. For the communities who have decided to participate, BBS will launch an interdisciplinary design challenge following 18 months of community engagement. In parallel, some communities may opt to engage in a community co-design project with a local artist or designer.

The unique design briefs for each of the sites will reflect the stated aspirations of each community for shared land uses and co-benefits of community solar.

Based on the participation levels of past Land Art Generator design competitions, hundreds of participating design teams will respond to one or more of the site-specific design briefs with concept design proposals that illustrate the idea and outline the co-benefits of the shared land use.

At the conclusion of the design challenge, the community juries will select their preferred project for each of the selected sites. The project will unveil all the design proposals to the world through exhibitions, publications, and media coverage, presenting an exemplary blueprint to the world for equitable urban solar development. Projects will be selected by community representatives to receive detailed design commissions.

By supporting the development of community-driven bid packages, the soft costs and risks of development are removed from the balance sheets of the solar energy developers who will come forward to install the projects that are selected by local stakeholders.

With their soft costs covered and with the good will and support of the communities within which they will be working, energy developers are therefore strongly incentivized to invest in urban solar projects while the BBS design brief ensures that an equitable and just transition is a centerpiece of each project plan.

The initial investment by the public sector in BBS will cover the cost of the community engagement, design challenge, selection process, co-design, construction documents (design and engineering), and permitting. The public sector investment thus functions as a kind of subsidy to the development of socially responsible solar energy landscapes within population centers.

Phase 1

The first phase of work after establishing the local consultant partnerships will include:

- City-wide GIS spatial analysis and solar survey
- Establishment of legal framework and constraints
- Outreach to solar developers and market experts
- Meetings with city officials and commissions. Municipal responsibilities might include:
    - Access to neighborhood planners
    - Dedicated BBS city representative
    - Sharing of GIS data
    - Provision of city-owned land
    - Power purchasing of energy generated on BBS sites
    - Coordination with commissions and departments
    - Zoning and approvals
    - Coordination with city staff overseeing diversity, equity, and inclusion
- Identify Options for Inclusive Ownership
- Establish Community Partnerships

Fig. 4: Scale of BBS project sites aggregating 30 MW across the City of Pittsburgh. Energy density at 30 MW across 60 acres equals 124 MW/km2. Image by the author.

Phase 2

Once the team and plan are in place, the second phase of the project will comprise the primary public outreach and co-design process including:

Initial meetings with community leaders

- Public presentation (one presentation per neighborhood group)
- Interactive mapping and co-benefit ideation
- Determination of the design delivery model
- Co-create design guidelines document with community
- All-neighborhood networking meetings

At the conclusion of phase two the aggregated sites will be determined and their capacity for solar energy generation will be known. Certain of the originally identified sites may not be selected because they are deemed less viable, and neighborhoods may decide against pursuing the project.

Subsequent Phases

Subsequent phases of the project will include the development and management of the open call design challenge for participating sites, the selection process led by communities, public display of the shortlisted design proposals, educational outreach activities, and the local artist-led co-design for sites that opted out of the design challenge process.

Following the selection of the concept designs for each site, detailed design proposals are solicited, and the architecture and engineering (A/E) firms are chosen to develop documents for fabrication and construction. At each step in the detailed design process, the community will be re-engaged through a series of public presentations and workshops coordinated by the A/E.

With all the soft costs of community engagement and detailed design covered by the public sector, solar developers will bid on the projects that can be categorized at this stage as "Notice to Proceed," the lowest risk investment for solar development. Tenders for development will include the specific requirements for solar developers to meet the standards of equity, inclusion, and co-benefit of land use established by each community.

Conclusion: Impacts and Potential Benefits

Between ten and twenty neighborhoods will be the beneficiaries of well-designed solar infrastructure that adds value to public space, providing new places for recreation, outdoor enjoyment, education, urban farming, and open-air markets.
Equitable financing models will bring wealth to residents who sign up for and/or buy into the program.
30 MW or more of power capacity will be added to the distributed energy generation network of the city, providing opportunities for expanding energy services through interconnected microgrids with battery storage.
Public opinion regarding solar energy may be improved, helping to advance the deployment of other installations throughout the city.
The solar infrastructure, because it is designed to share land uses with civic amenities may increase the useability of outdoor spaces (protecting them from urban heat island effects and from winter weather) and may create lasting cultural landmarks for future generations.
The hosting city's leadership role in advanced urban solar integration may help to raise the positive profile of the city for the climate conscious public nationally and internationally, attracting new people and businesses, and increasing retention of the existing population.
The BBS model—by focusing on the social aspects of solar deployment at the city and neighborhood scales—may establish an attractive blueprint for replication, eventually leading to the proliferation of thousands of megawatts of solar installations within cities across the country and the world for land areas that would have previously been considered impractical for solar development. If scaled nationally or internationally, the overall impact of the project could contribute significantly to rapid decarbonization goals in line with the consensus recommendations of climate scientists while preserving thousands of acres of rural land.

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Visual Case Study _ Technical Session 7

An Introduction and Review of a Visual Resources Learning Module Included in a Contemporary Landscape Architecture Curriculum

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Introduction

The practice of a visual resource specialist—or whatever the title might be—often is undertaken by landscape architects. The subject of visual resources has also recently been added by the American Society of Landscape Architects (ASLA) to the subject areas of which some level of proficiency is expected and is projected to be included in the Landscape Architect Registration Exam in the future. However, few landscape architecture programs include visual resources in their curriculum in a substantial way. Following the 2019 Visual Resource Stewardship conference, Arizona State University (ASU) teamed with SWCA Environmental Consultants and the National Park Service (NPS) to create an introductory visual resource module to be included in its advanced geographic information systems (GIS) class that is taken in the 4th year of the ASU landscape architecture program. Originally planned to be five weeks, the module was modified to four weeks and was transitioned to a virtual online module because of the COVID-19 pandemic. This presentation will provide an overview of the module along with examples of students' work, the challenges of switching to a virtual class and the results of a survey the students completed to help inform future course development.

Background

The Visual Resource Stewardship conference is a biennial conference first held in 2017 that brings together academia, agencies, private companies, and non-profit organizations to exchange ideas and present current research and innovative solutions for the planning and management of the visual landscape. Based on a concern identified by the planning committee, the 2019 conference ended with a guided discussion and interactive session about the “need to adequately train a future generation of visual resource practitioners" (2019 Conference Proceedings). Among the ideas to come from the session were developing content for visual impacts assessment methods, the cultural and historical significance of the visual landscape, a legal and ethics framework, mitigation, and best practices methods. Included in the ideas for developing teaching resources was understanding the various methods developed by federal agencies including the Bureau of Land Management (BLM), United States Forest Service (USFS) and the National Park Service (NPS).

Introduction to Visual Resource Inventory and Analysis LAP 494/598 Advanced GIS Applications in Environmental Design is an upper division course in the Landscape Architecture curriculum at ASU Herberger’s Institute for Design and the Arts. The course addresses advanced concepts in GIS as they relate to applications leveraged by environmental planners and designers, with a special focus on using GIS as a tool for landscape research design. The objective of the visual resource module for the course was: Understand the foundational concepts of visual resources and the basic methodologies to inventory and evaluate changes to them. Using GIS tools and available data, apply a method to assess the effects of a specific project on the visual landscape. The visual resource module was the final four weeks of the class and all sessions were conducted virtually using ZOOM. SWCA provided anonymized background information and spatial data for a “real world” wind farm project to be used for the analysis components. The first session of the module covered an introduction to the concepts of visual resources as a topic area for environmental analysis and the subsequent inventory methods established by the BLM, USFS and NPS. There was additional detail provided on the BLM visual resource inventory and visual resource management program (known as VRM) as it was to be used in the analysis of the project. The project was introduced, and wind farm research assigned for the next session. In sessions two and three, the project was discussed in detail, data on the wind farm and surrounding area was provided and working in teams the students performed various GIS analysis for the final assignment. The teams reported their findings during the last session and were asked to complete a short survey on the module content which included questions on what they liked and disliked, their general interest in visual resources, and any additional thoughts about the virtual format. The final projects showed a reasonable understanding of visual resource basics, though the GIS analysis was challenging at times because of the remote situation and some inconsistencies in availability of technology to students. The module generated some interest among the students in a subject area that they previously did not know existed and ASU is considering adding an updated module as a regular part of the landscape architecture curriculum.

Paper _ Technical Session 8

Revitalizing Urban Waterway Hydroscapes: Streams of Environmental Justice?

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Abstract: There are many reports of physical demonstration projects that attempt to restore portions of urban waterways, yet no consensus about what to do and how to do it from a social or environmental justice perspective. This research explores approaches to urban creek and river revitalization by analyzing Environmental Justice (EJ) leadership and intergenerational continuity with five case studies; Anacostia River, Washington, D.C., Bronx River, New York, NY, Mill Creek, Philadelphia, PA, Chattanooga Creek, Chattanooga, TN, and Onondaga Creek, Syracuse, NY. Each case was profiled with attention to leadership characterization, neighborhood demographics, initiation of revitalization process, reasons for initiating process, strategies used, and landscape outcomes. The analysis shows most of the communities that experience significant contamination along the creeks, streams, and rivers are marginalized in terms of racial, demographic, or socio-economic status. Despite this, there have been a number of initiatives that have taken place to assist with revitalization efforts, ranging from funding with large-scale events, to environmental education programs targeting the younger generation within these communities. Much work needs to be done though on ensuring that there is intergenerational continuity to allow for hydroscape revitalization efforts to be sustained.

Keywords: river revitalization; environmental justice; intergenerational continuity; river restoration; stream restoration

Introduction

There is a need for social process models that can remedy historical environmental justice issues with urban waterway communities not being involved with revitalization or naturalization of such water bodies (Hillman 2004 & 2005, Moran 2007, Platt 2006). In many cases, these urban waterways have been historically industrialized, subject to water pollution, storm water flows with attendant flooding, and are literally inaccessible to nearby urban residents. So the environmental justice issue is that these same urban residents have been forced to live adjacent to high flooding risk and water-polluted areas, while also being denied any greenspace benefits from such urban water bodies. When efforts are made to address these issues, there is often conflict between expert ecology/hydrology goals versus public knowledge and preferences (Tunstall et al 1999 & 2000). What is key going forward, is addressing the communication and inclusiveness issues.

The terms used in this paper are not very precise, but overall, restoration implies speaking mainly from a biophysical restorative functional capacity, e.g., hydrology, water quality, aquatic, and riparian habitat. Using the term revitalization implies social and economic improvement or revitalized creek neighborhoods with economically sustainable land use patterns as well as some level of biophysical restoration of the water body. Naturalization implies some degree of biophysical restoration of the water body or the hydroscape.

Historical waterway development and impacts

Urban waterway development in North America has supported water-dependent industry, water transportation, and economic development, with attendant problems of water quality, flooding, and riparian habitat degradation. During the golden age of channelization, many urban creeks were channelized to move floodwaters away from urban areas as well as carry waste materials (Figure 1). As a result, for many urban rivers and creeks, morphology and hydrology were radically changed. In addition, there are severe physical, economic, and jurisdictional constraints for waterway revitalization.

Fig 1: Channelization of Onondaga Creek, Syracuse, NY. Source: Photo by R Smardon

Similarly, European urban waterways suffered a similar fate such as historical waterway degradation including water quality and habitat issues. Waterway restoration in Europe started in the 1970s and 1980s and policy guidance is now more unified, in part because of the role of the European Union. Discussions of both North American and European waterway policies and history are contained within Smardon et al. (2018).

In addressing issues of river revitalization and restoration, one of the early innovators was Judith Petts, now with Plymouth University in the UK. She developed a comprehensive deliberative social learning process for urban river restoration (Petts 2006). Key principles include: maintaining engagement, expert vs. lay knowledge, information for mutual learning, developing a shared vision, and managing the unexpected. These principles were taken into consideration in the Smardon et al. (2018) along with incorporating principles of environmental justice and political ecology.

US Environmental Justice Policy Context

There are a number of policy initiatives within the US that set the context for environmental justice work at a number of different levels. Recently, the Biden-Harris administration passed an executive order specifically addressing environmental justice, which includes:

- A formalized commitment to make environmental justice a part of the mission of every agency by directing federal agencies to develop programs, policies, and activities to address the disproportionate health, environmental, economic, and climate impacts on disadvantaged communities.
- A White House Environmental Justice Interagency Council and a White House Environmental Justice Advisory Council to prioritize environmental justice and ensure a whole-of-government approach to addressing current and historical environmental injustices, including strengthening environmental justice monitoring and enforcement through new or strengthened offices at the Environmental Protection Agency, Department of Justice, and Department of Health and Human Services. The new bodies are also tasked with advising about ways to update Executive Order 12898 of February 11, 1994.
- A government-wide Justice40 Initiative with the goal of delivering 40 percent of the overall benefits of relevant federal investments to disadvantaged communities, and tracking performance toward that goal through the establishment of an Environmental Justice Scorecard.
- The development of a Climate and Environmental Justice Screening Tool, building off EPA's EJSCREEN, to identify disadvantaged communities, support the Justice40 Initiative, and inform equitable decision making across the federal government (US White House 2021).

In addition, the American Society of Landscape Architects has proposed recommendations to the Biden Harris administration addressing environmental justice. Part of their statement encourages the administration to "…join stakeholders across the country to advancing the tenets of Environmental Justice for all Act (US Congress HR 5986 2020) which helps to ensure that all communities are protected from pollution and that all voices are heard in federal environmental decision making" (ASLA 2020 p. 4). Finally, some landscape architecture students have designed a course guide for incorporating environmental justice concerns into a design studio (Spiegelhatter et al 2018).

Framing Environmental Justice (EJ) for stream restoration

An EJ definition utilized in the US is "fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies" (EPA 2020). Several other authors of environmental justice concepts or frames are discussed below (Bullard 1990, Capek 1993, Taylor 2002, Pellow 2000).

Bullard (1990) presents marginalized communities as being 'paths of least resistance' so that they become targets for environmental waste sites or other kinds of environmental degradation. Capek (1993) discusses EJ components such as the right to accurate information, unbiased hearing, democratic participation, compensation, plus development of solidarity between/across groups. Taylor (2002) presents an EJ paradigm that includes six principles; 1) ecological principles, 2) justice, 3) autonomy, 4) corporate relations, 5) policy, politics and economic processes, and 6) social movement building. Pellow (2000) developed the Environmental Inequality Formation, which states that injustices result from a socio-historical process and not a discrete event, involves multiple stakeholders, and should incorporate life cycle analysis.

The above classic frames all rely on two key EJ principles that will be the focus throughout the remainder of this paper: *distributive* and *procedural* justice. Distributive justice examines who benefits or incurs costs and procedural justice looks at who is included particularly in decision-making processes, when, and how.

Urban river restoration takes place against a backdrop of "proposing designs that are harmonious with nature and ecological processes" (Honey-Roses 2016 p. 2070), yet there is recognition that social justice elements are key to restoration (Metzger et al 2006). Similarly, Moran (2007) explains that stream restoration, though intended to serve multiple roles, may often privilege a single view of nature; she calls for a more comprehensive and equitable way of approaching stream restoration or greenway development, in order to help realize environmental justice goals.

One of the prominent themes that have been raised by EJ scholars is the way in which citizens are involved in the river restoration projects. Procedural justice is raised in questions of "who made the restoration decisions, who paid, [and] who benefitted" (Honey- Roses 2008 p. 2070). Moran (2007) indicates that many early movements that pushed for stream restoration, were initiated by local communities, which were often independent and self-financed. However, more public funds are now available for stream restoration. This shift in financing has the potential to shift the dynamic of who is involved in the decision-making processes: Moran (2007) stated that differential government spending may act to re-create unjust relationships in the local landscape.

Within procedural justice, the question of who makes the restoration decisions further highlights the issue of whose voices are being heard. Moran (2007) indicates that often, urban residents are not included in planning green spaces, though they are the ones who live in the areas where these green spaces are being developed. A case by Metzger and Lendvay (2006) is one of the few studies that show how EJ is incorporated into environmental decision-making at the community level. In this case, the community of Bayview Hunters' Point, San Francisco, California, participated in gathering data that was to be used in the watershed restoration project. Data from community-based projects are more readily accepted than information provided by scientists from outside the community, and community research assistants are recognized as valuable partners in observing long-term changes and identifying pollution sources. Hence, local participation in environmental monitoring is crucial (Davenport et al 2010). Such projects can provide access to community feedback, enhance local awareness and build capacity to address environmental challenges (Davenport et al 2010).

Moran (2007) suggests that metrics help drive many government programs, and reviews how the metrics used for stream restoration do not take into consideration the urban context, and by extension, the equity concerns. As such, stream miles restored do not take the level of human interaction into consideration. Essentially Moran [2007] argues that the current measures used for stream restoration privilege the rural or spaces that are already rich in ecological attributes, which are often the spaces where marginalized communities may not be located. Hence these voices are not included in the decision-making process of urban stream restoration.

Another reason community equity is not considered involves the technical scientific and engineering details that are used to talk about stream restoration. This can be related to the principles of access to information raised by Capek (1990) in the EJ frame. Capek (1990) argued that communities need access to accurate information and that this information should be in a form that is easily understood and readily accessible to the layperson. Moran (2007) explains that using scientific and engineering vocabulary, exclusively, when speaking about stream restoration, can act to shut out a wide range of constituents who should be included in the conversation. A third theme that is raised, as a barrier to procedural justice is the way stream restoration efforts are organized. Moran (2007) claims that in many of these projects, though multiple stakeholders are involved, there are no clear lines of responsibility or accountability, thwarting effective advocacy.

Metzger and Lendvay (2006), in their case on the Bayview river revitalization, found challenges with community involvement, and by extension, moving toward procedural justice. First, community members did not feel comfortable engaging in public speaking, which was a part of the process of involvement in the project. This is something that should be addressed if public participation is to be effective. Second, having more elders involved in the project was recommended, as there was a *generational gap* between those doing the data collection and those receiving the information. As such, there needed to be better representation across the spectrum of community members.

Studies increasingly suggest that including citizens at the local level in the management of wetlands and other restoration projects is important for the success of effective management (Metzger et al. 2006, Ioris & Costa 2009). They also indicate that residents want to be consulted before restoration projects so they can provide input in the planning process (Davenport et al. 2010). Indeed, "what is missing in most of the environmental debate today is an acceptance of the transformative role of public participation, not only as an element of improved decision-making, but the cornerstone of active citizenship and environmental justice" (Ioris & Costa 2009 p. 136).

In a comparative study of river revitalization in the Duwamish Valley in Seattle, the project had two different visions associated with different stakeholders. The government leaders saw the project as one of economic development—that is, jobs—while the grassroots citizens' groups saw the project as one of protecting the surrounding communities' interest (McKendry & Janos 2015). These differing interests can lead to conflicts where the stakeholders with the greater power often get the most benefit in having their interests met.

A second theme that was raised was the element of *solidarity* in river restoration projects. In the Duwamish River case, solidarity was seen among the community members surrounding the restoration project (McKendry & Janos 2015). Here the community got actively involved in the planning of the cleanup process. The community members' goal was to make the community, rather than the planned economic development, the center of the conversation. The organization pushed for the community character to be maintained in an effort to avoid gentrification of the community with the new environmental amenities. In the Calumet River case, as documented by McKendry and Janos (2015), there was no unified vision of how environmental cleanup connected to jobs being created through the restoration process. This resulted in a fragmented approach to achieving restoration, showing the importance of solidarity in these revitalization projects.

A third theme in the literature on restoration is the question of *who benefits* from the restoration process. This goes to the heart of distributive justice, which examines how environmental burdens and hydroscape benefits are dispersed among various stakeholders. It also relates to where the need for revitalization is the greatest: Moran (2010) pointed out that, historically, the urban waterways co-located with marginalized communities have frequently been among the first to suffer erasure in connection with urbanization, and thus they often represent the locations where revitalization may have the greatest benefit to stakeholders. In a study about wetland restoration in the Cache River Wetlands in Illinois, Davenport et al. (2010] indicated that when asked about community perspectives on wetlands restoration, respondents mentioned four main issues of importance:

1. Community participation in project planning;
2. Community burdens of the restoration project;
3. Community benefits of the restoration project; and
4. Fear and uncertainty around restoration outcomes.

The second and third points deal with distributive justice. The local community at times bears burdens that are not considered in the restoration process. For example, land acquisition for restoration or greenspace development may affect the local government resource base. Additionally, there was an allusion to residents being concerned about poverty and meeting those needs rather than protecting biodiversity, which is not considered under restoration projects. Lave (2016) made the point that the unequal exposure to environmental harms through health impacts by avoiding stream restoration in marginalized communities is another burden that must be considered in revitalization projects.

In terms of benefits, there were community expectations from greenspace development, such as for recreational opportunities, and increased revenue from tourism, both of which were not realized in the Davenport et al. (2010) case study. Another study (McKendry & Janos 2015) also highlighted the importance of community benefits from hydroscape restoration projects. In this study on the Calumet River in Illinois and the Duwamish River in Seattle, though the plans to clean up the rivers were proposed by city officials, the approaches were categorized as technocratic, focusing on removing invasive species and cleaning up industrial slag, sewage and chemicals while also adding recreational amenities. However, these approaches were critiqued by community members who questioned who would benefit from these changes.

A final theme that was raised about river restoration projects, though not widespread, was that of *displacement* of communities. Greening, under which stream restoration or greenspace development might fall, is being used as a way to develop economies in some industrialized cities (McKendry & Janos 2015). This phenomenon has been most pronounced in urban cores, and critics of the use of greening as an economic development strategy have noted that such processes are often accompanied by the displacement of poor and working-class people (McKendry & Janos 2015). This was tied to gentrification, as was seen in the Calumet River case. With the proposal for wetland and river restoration, there were concerns about gentrification in the Calumet area. The main reason for this fear of gentrification was the fact that the city had not been responsive to requests from low-income residents for environmental goods, yet rushed to provide these greening amenities with the arrival of the middle class to the area (McKendry & Janos 2015), indicating the notion of displacement of marginalized communities in the face of restoration initiatives. Such procedural and distributive environmental justice issues are explored in five urban waterway revitalization case studies within the continental US.

Methodology

Approach

We analyzed EJ leadership and intergenerational continuity with five case studies: Anacostia River, Washington, D.C., Bronx River, New York, NY, Mill Creek, Philadelphia, PA, Chattanooga Creek, Chattanooga, TN, and Onondaga Creek, Syracuse, NY. An intensive literature review was utilized to document key sources including the organizations' websites, publications that they produced, and key publications that have been written about the organization. The authors had extensive involvement with the Onondaga Creek in Syracuse New York, plus key interviews of the parties involved in the Bronx River, New York. Each case was profiled with attention to leadership characterization, neighborhood demographics, initiation of revitalization process, reasons for initiating process, strategies used, and outcomes. Much more detail is provided in Baptiste (2018).

Description of the five case studies

The Anacostia River, Washington, D.C. runs through a number of demographically diverse communities (Figure 2). On the north end of the city is a predominantly white demographic that becomes progressively Black as you move toward the south end of the city (Baptiste 2018). The communities that are most impacted by the river contamination are located on the southeast end of the city, and residents there are predominantly Black and low income.

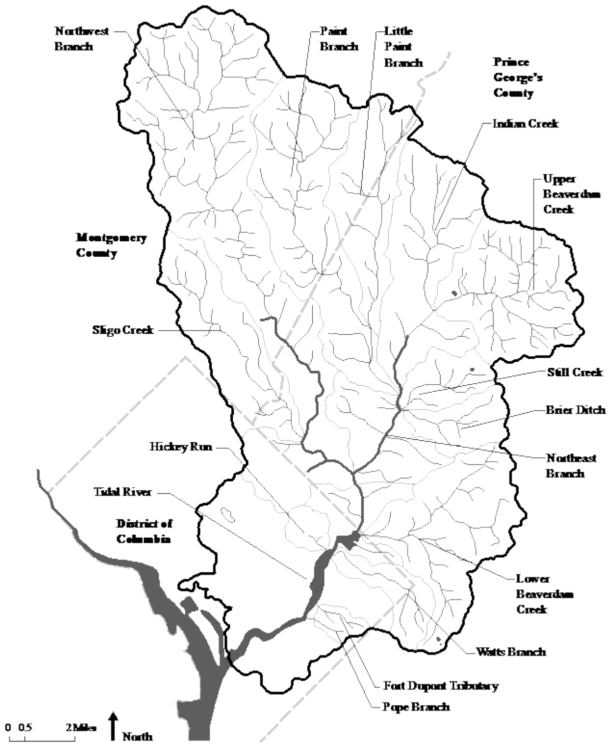

Fig. 2: *The Anacostia River Watershed Source: Smardon et al (2018)*

The Bronx River, New York, NY is approximately 23 miles long. Due to historic disregard, the river experienced significant pollution, most of which was concentrated in the greater New York City area (Figure 3). The river runs through some of the most economically depressed neighborhoods in New York City. With little disposable income for travel, the river can be a critical natural asset for local residents, providing it is accessible and safe. Efforts around the Bronx River have affected nearby communities. Some of the first people to promote cleaning the Bronx River in the 1970s sought recreational opportunities such as fishing, boating, or bird watching. After 30 years, Bronx environmental and community activists have transformed a grassroots effort into a major river stewardship organization (Baptiste 2018).

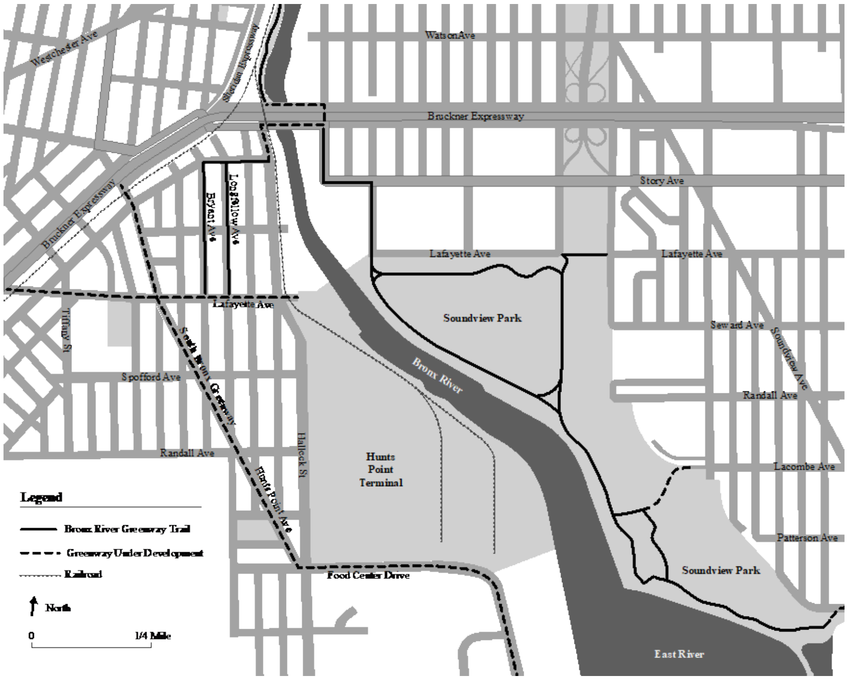

Fig. 3: *The South Bronx River Source: Smardon et al [2018]*

Chattanooga Creek Tennessee: The communities that are located closest to the creek are majority Black with high percentages of poverty in the Alton Park neighborhood while the Pinewood neighborhood is predominantly white and have lower levels of poverty (Baptiste 2018). The communities surrounding the creek contain “remnants of the once powerful manufacturing region in southern Chattanooga” (Rogge et al 2005 p. 42). The most infamous of the many contaminated sites affecting communities is “the 2.5-mile section of Chattanooga Creek, a tributary of the Tennessee River that runs alongside the Alton Wood/Pinewood neighborhood” (Rogge et al 2005 p. 43). Residents often come into contact with this contamination through fishing and other recreational activities. Given the contamination of the creek, revitalization efforts were initiated. The Tennessee Riverfront in Chattanooga, Tennessee is considered a legendary project in terms of urban riverfront revitalization, given the large number of partners involved and the scope of the project (Baptiste 2018).

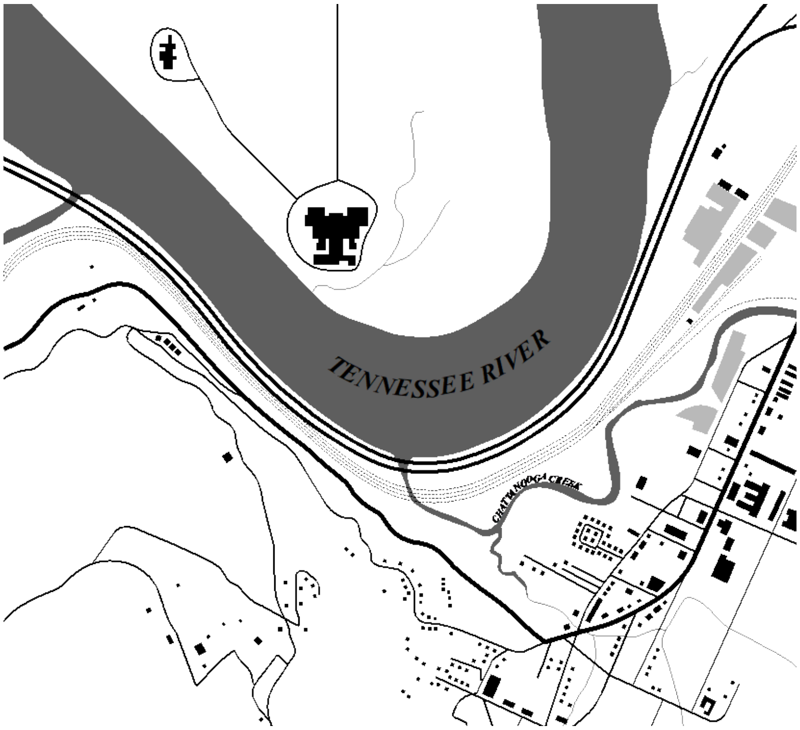

Fig. 4: *The Chattanooga Creek meets the Tennessee River Source: Smardon et al (2018])*

Mill River, Philadelphia, PA is located in the West Philadelphia neighborhood (Figure 5). The community is economically depressed, predominantly Black and considered to be one of the poorest neighborhoods in Philadelphia (Baptiste 2018). The surrounding neighborhood of the creek experienced flooding, subsidence, water pollution and other environmental justice issues. The restoration of Mill Creek was spurred by an academic engaged in landscape literacy with middle school students. Developing a historical timeline of the creek and its activities allowed for the degradation of the river to be recognized while also allowing restoration initiatives to be started (Baptiste 2018, Sprin 2005).

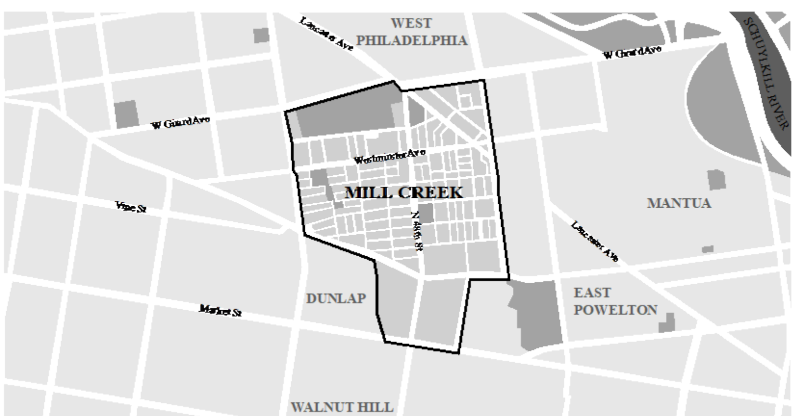

Fig. 5: *The Mill Creek Neighborhood Source; Smardon et al (2018)*

The Onondaga Creek, Syracuse, NY is expansive in that the watershed in the upper reaches includes rural and suburban communities: the Onondaga Nation is in the central part of the watershed, and the lowest part of the watershed includes urban neighborhoods in Syracuse‘s Valley and Southside districts. There are two primary communities with EJ issues – the Onondaga Nation, which is one of six Indigenous groups of the Haudenosaunee (Perreault et al. 2012) and Onondaga Nation is dependent on the aquatic riparian and upland environments, while the Southside neighborhood residents live along Onondaga Creek and are predominantly Black and low income (Baptiste 2018). Both communities are adversely impacted by the centuries of industrial use, channelization, and pollution that have pervaded the creek and its watershed (see Figure 1). The Onondaga Creek Revitalization Planning effort in Central New York was a watershed wide planning process which transcended political and economic stratification of a metropolitan region, including both rural and urban stakeholders, and even a sovereign nation (Perreault et al. 2012) in an attempt to overcome the historic environmental justice issues.

Results

In order to understand the ways in which environmental justice plays a role in the river restoration process, we examined the structure of the organizations, the leadership and member composition of these organizations, how the project was initiated, and the resultant outcomes, as shown in Table 1. Across the five cases that were examined, the neighborhood demographics were strikingly though unsurprisingly similar. In many of the cases, there was a deep historical connection to Indigenous communities, their dependence on the hydroscape as well as the expulsion and dislocation of these groups from rightful resources (Baptiste 2018). Further, the current demographic composition of the communities surrounding the rivers, streams, or creeks are all marginalized either in terms of their race/ethnic composition and/or their socio-economic status. Here we see that in all cases the surrounding populations are either predominantly Black or live in poverty. These demographics help to contextualize the environmental injustices that are experienced by the communities that surround the contaminated rivers, streams, and creeks. It is well established that marginalized communities, i.e., those that are predominantly of racial minority groups and those that are low income, are often targeted for environmental harms (Bullard 1990, Holifield 2001,Mohai et al 2009, Pellow 2005). The historical context of these neighborhoods provides an insight into the distributive injustices they face (Baptiste 2018).

One of the common themes seen across the cases is that the groups that engage in the restoration and revitalization work tend to be demographically representative of the communities that they are working in. For example, in the Bronx River case, the group, which initiated the revitalization project, included environmental justice groups. In its current form, there are a number of community and environmental activists that are not considered as part of the elites within the community (Baptiste 2018, Campbell 2006). Hence "in both iterations of the Bronx group the board and leadership were gender-balanced and ethnically, economically and geographically diverse, which was a deliberate attempt to represent the population experiencing the contamination" (Baptiste 2018 p. 76). In three of the other cases, a similar trend was seen: Anacostia River, Chattanooga Creek and Onondaga Creek. In these cases, the organizations that push for revitalization made deliberate attempts to include members of the communities most impacted by the contamination and lack of waterway access in the leadership of their organizations. In all three of these cases, the groups that initiated the process were from the community, which allowed for community interests to be more fully represented. It was only in the Mill Creek case where we saw that an outsider led the revitalization project, and whose demographic was not representative of that of the community, though there was significant collaboration with community members through the form of students in the middle school in the area.

A second theme across the cases showed commonality in terms of who initiated the project and the strategies that were used to engage in the restoration work. In almost all of the cases; revitalization projects in marginalized communities were initiated by community members, either individually or through the creation of collective groups. Following the initiation by community groups, the government, whether local, state, or federal, often pitched in. In terms of strategies used to get the restoration projects up and running, there was commonality among the EJ principles that were applied across these cases. Confrontational tactics were often commonplace for example organizing protests as seen in the Bronx case and the use of litigation as seen in both the Anacostia and Onondaga cases (See Baptiste 2018 for more details). In both the Mill Creek and Chattanooga Creek cases, though, non-confrontational strategies were used. In the former, environmental education was used as an indirect way of mobilizing the community to be aware of the problem, while in the latter public meetings with charrettes were held. Combinations of top-down and bottom-up strategies were used across the cases, where the former included community mobilization and the latter involved working with management agencies and elected officials.

Table 1. *Summary of environmental justice themes across cases (adapted from Baptiste [2018] re-printed with permission)*

Case study	Characteristics				
	Organization Leadership Number of organizations involved, demographics of the management team	**Who initiated the process?**	**Reasons for the revitalization?**	**Strategies used**	**Outcomes of revitalization**
Anacostia River, Washington, D.C.	Two organizations involved (Anacostia Watershed Restoration Partnership [AWRP]; Groundwork DC) Management of AWRP were members of governmental agencies; 60:40 male to female ratio; no indication of the extent of racial diversity; Groundwork DC has a racially diverse leadership and a balanced gender dynamic	Joint effort by government, environmental organizations and private citizens	Re-establishing the original ecosystem Focused on health of the ecosystem Vehicle for community development Provide human recreation	Lawsuits, media campaigns	Some displacement of communities
Bronx River, New York, NY	One main group under two iterations (Bronx River Working Group and Bronx River Alliance) Bronx working group: ethnically, economically and geographical diverse board; seems to be government led Bronx River Alliance: some racial diversity in leadership; more women represented in leadership; seems to be citizen led	Community activists – initiated in 1974 Since 1997 multiple community organizations, public agencies and businesses have been involved	Restore the river Improve access to the river for the surrounding community	Collaboration between civil society and government Confrontational tactics at times	Achieved significant gains in land along the river Raised public awareness about the river

Chattanooga Creek, TN	Two main organizations STOP (Stop Toxic Pollution) and APDC (Alton Park Development Corporation)	Community groups	Section of creek placed on National Priority List Heavy contamination from industry Wanted to address the pollution	Public meetings held by Trust for public land Charrette held in surrounding communities to determine redevelopment priorities Meetings held with regional EPA office	Improvement in neighbourhood conditions in health services, educational opportunities, housing, job training and abandoned properties
Mill Creek, Philadelphia, PA	The Landscape Literacy Project - Anne Whiston Spirn – white female researcher engaged in community project; research assistants were students from University of Pennsylvania Mill Creek Coalition started in 1999	Initiated by outside individual and then community	Raise awareness of the environmental hazards of Mill Creek among community members Interested in impact of creek on community including flooded basements, raise awareness of community members	Weekly workshops led by Penn students with middle-school students on history of Mill Creek; summer program with urban gardens	Recognition given to the landscape literacy project; spurred interest to clean up Mill Creek
Onondaga Creek, Syracuse, NY	Two main groups pushed for revitalization Onondaga Nation Partnership for Onondaga Creek Government was mainly responsible for implementing the remediation	Onondaga Nation through land rights lawsuit County government got involved because of court order (Amended Consent Judgment)	To bring water quality of creek in compliance with regulations	Use gray infrastructure Regional treatment facility to be built around the city of Syracuse Lawsuits Onondaga Nation claims treaties led to illegal taking of land Partnership for Onondaga Creek – filed lawsuit against county to block the RTF from being built Raise awareness Highlight the indigenous significance of the creek	Combination of green and gray infrastructure used along the creek

A final theme that emerged among these cases was the similarities in the outcomes of the revitalization projects. In the majority of the cases, there was evidence of environmental justice principles being incorporated. Across the cases, with some exception in the Anacostia case, we see that the spaces were revitalized and that the initial impacted communities benefited. For example, in the Bronx case there was significant creation of physical space with parkland being created along the river. This allowed for waterfront and recreational facilities to be developed for the community as well. Further, in the Bronx case, community groups were able to benefit from the funding opportunities that were created from the revitalization projects. In the Chattanooga Creek case, “there has been improvement in neighborhood conditions in health services, educational opportunities, housing, job training and abandoned properties” (Baptiste 2018 p. 81), while in Mill Creek there was an addition of the creek back to the watershed map, recognizing its existence, history, and impact on the West Philly community. For Onondaga Creek there was a mobilization around the use of green infrastructure in order to drive the restoration project, which many communities have benefitted from. It was only in the Anacostia River case where we saw the displacement of communities during the revitalization process that was not amended.

Discussion

In looking at the cases profiled in this paper, there are a few things that we observed. First, it is important for the leadership of restoration movements to be representative of the beneficiaries of the revitalization work. For environmental justice, racial diversity is important, particularly as those communities who tend to experience “environmental bads” are often those who are from underrepresented groups (Honey-Roses 2008, Pellow 2005). In the cases that were profiled, we do see that, with the exception of one case, the leadership in the groups was representative of the marginalized communities that they work. Further, having these groups not only be representative of the communities but also include voices from the communities was also seen across the cases. This has allowed for there to be more attention to issues of environmental injustices with respect to river contamination being brought to the forefront as well as waterway access. Baptiste (2018 p. 91.) indicated that “here the claim is being made that even though for decades the rivers and creeks that ran through Black, brown and indigenous communities were used as waste dumps, those in power, often white and wealthy, did not see the need to address the contamination. These “black bottoms” (Spirn 2005) were out of sight and hence out of mind for those in power. As such efficacy is important as... in these cases, community groups sought to push for their voices to be heard in order to improve the living standards in their spaces.”

Second, one of the implications that we see across the cases was the importance of solidarity. Even though there were a small number of groups that were involved in both initiating and continuing the revitalization work, these groups built strong collaborations with other community groups, private organizations, and government. For example, in the Bronx case a coalition was developed by the lead organization with over 65 groups, most of which were community based organizations and nonprofits with some partnership from local and federal government agencies. For the Chattanooga Creek case, it was the community’s cohesiveness and identity that allowed for the revitalization project to be successful (Rogge et al 2005) while in the Onondaga Creek case, there was mutual support between the leadership of the main activist group and the indigenous political leadership (Perreault et al. 2012). Solidarity within revitalization work has been successful for a number of reasons, as stated by Baptiste (2018 pp. 78-79) listed below:

1. It provides an avenue for clear and consistent goals to be advanced providing direction for the groups involved;
2. It allows for there to be split responsibilities among the organizations that are involved in the coalition. This allows for there to be an egalitarian ethos among the different groups; and
3. Solidarity allows for collaborative organizations to share resources. These resources can be both tangible and intangible. Having shared resources reduces the need for competition for scarce or limited resources and may allow for more causes to be advanced

Third, the way in which environmental justice principles were seen across all the cases was the allusion to the importance of sustainability of the hydroscape. Here there was an attempt to find a balance between traditional environmental goals and environmental justice goals. Environmental goals refer to the protection of the physical natural resource and its intrinsic values outside of the community context. Environmental justice goals speak to the consideration of community needs as central to the decision making process and centering these while engaging in the protection of natural resources (Baptiste 2018). While the balance is important, conflicts may arise in trying to achieve this balance. For example, in both the Anacostia and Chattanooga cases, traditional environmental goals were not prioritized where economic development of the area was seen as the main concern. As such, the actual ecological importance and cleanup of the rivers were not achieved. Still, the Bronx River case showed how a sustainability balance might be achieved as laid out in Baptiste (2018). In assessing the five case studies, several challenges were identified with the environmental justice analysis and frames, including the following:

1. There was often difficulty working across time with corporate and government negligence. When funding or leadership or municipal jurisdictions change, this can cause a lack of continuity of actions and implementation;

2. There is a lack of maintenance and enforcement (Rogge et al. 2005). Even in Superfund cleanup cases, such as Chattanooga Creek, there is a lack of state or federal enforcement plus industry malfeasance limits action;
3. Changes in local project management can often hamper the revitalization work for example shifts in agency jurisdiction and funding such as the Onondaga Lake Cleanup affect implementation;
4. Internalized racism can be a consequence for example; the Mill Creek neighborhood became labeled as the "bottom" not only by outsiders but also by those living in the community. For Mill Creek, the local school students did not connect the word bottom as an environmentally degrading term nor recognized the social and economic implications. This may lead to lack of efficacy which hampers restoration progress (Spirn 2005); and
5. There is concern about intergenerational equity work continuation. This is a concern with environmental NGOs in terms of leadership and continuation, as the original members age or disengage.

A detailed description of how to address these challenges is beyond the scope of this paper. However as a starting place, Smardon et al. (2018) have suggested that some of these can be addressed by enhancing public engagement, using co-production of knowledge, community mapping, or using creative engagements, such as murals and other forms of artworks to name a few.

Conclusion

Environmental justice and political ecology have not been widely used as a frame for urban waterway revitalization. Historically disadvantaged communities have rarely found a voice in the process. Five different urban waterways are examined from a combined environmental justice/political ecology frame (Smardon et al. 2018). Specific attributes of leadership, demographics, initiation, reasons for, strategies used, and outcomes from waterway revitalization processes are examined. In addition, social learning processes are presented to allow positive addressing of procedural and distributive environmental justice issues. These processes include public engagement participation, restoring community waterway relationships, co-production of knowledge, interactive graphic mapping exercises, use of green infrastructure, assessing ecosystem benefits, and use of creative arts, all to reconnect waterway and community.

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Visual Case Study _ Technical Session 8

Six-Step Guide for Making Nature-Based Infrastructure Decisions Comparing the Benefits of Multiple Ecosystem Services: Case Examples from Greater Houston, TX

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Natural landscapes serve our well-being in a variety of ways including water purification, flood protection, hurricane protection, carbon capture, recreation and other cultural benefits, and wildlife enhancement. Identifying and understanding the benefits of services provided by local ecosystems can lead to cost-effective solutions to infrastructural and environmental problems while also creating enhanced biodiversity in urban/suburban areas. For the storm-prone Greater Houston region, the critical need to better connect the ecosystem services (ES) provided by the diverse assemblages of forests, prairies, wetlands, riparian waterways and estuaries to long-term resilience and disaster protection is taking shape following four years of increased rain events, severe hurricane destruction and sea level rise, and the need to provide more outdoor spaces for physical and visual use.

Adding to these challenges are the region's unique, clay-rich soil composition, made up largely of vertisols and alfisols which greatly influence watershed infiltration and runoff, especially during heavy rain events. These same soils affect environmental enhancement and recovery efforts in the region's rivers, bayous, bays and estuaries, where the dynamics of various commercial industries intersect with riverine systems, fisheries, coastal wetlands and marine life.

This Houston Wilderness' Ecosystem Services (HW ES) Primer, 2nd Edition discusses ways for determining ecosystem services (ES) benefits and values using different established study/valuation methods depending on targeted infrastructure/project goals. In Six Steps designed to aid decision-makers in infrastructure options, this Primer follows a framework for comparison and valuation of the natural environment and how to improve ES and the critical services that they provide. The Six Steps include: determining the nature-based infrastructure goals, understanding the role of various ES in decision making, establishing an ES baseline for the targeted area(s), evaluating benefit relevant indicators, considering regional/local challenges, and using optimal ES valuation methods. In this way, the HW ES Primer considers the environment as a whole – bringing together land, water, air, soil and biodiversity, recognizing that their linkages provide a wide variety of services and benefits that are not specific to any one part. Local and regional stream and riparian-based case examples are discussed, where science-based ES benefits and valuation options are analyzed and practical nature-based solutions were implemented, often as alternatives to more structural, gray infrastructure options.

Abstract _ Technical Session 8

Vacant Lot Visual Assessment: Landscape Change and the Benefits of Urban Land Stewardship

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Condition and care are key expressions of landscape stewardship and are especially important in managing vacant urban lands, which are pervasive in many older, legacy cities of the Midwestern and Northwestern US. Over the last five years we have been assessing the changes and benefits resulting from visible stewardship of city-owned vacant lots transferred to local residents under the Chicago Large Lot program. The program focuses on high vacancy, historically disenfranchised African-American communities on the city's south and west sides, and encourages property owners to purchase 1 or 2 lots on their block for $1 each for greening or development with the goals of creating wealth in the community and giving residents greater local control of land, reducing municipal maintenance and tax burden, and increasing safety and building community. As a land reuse and community revitalization strategy, the Large Lot Program is one of several initiatives being implemented in legacy cities across the US for bringing amenities into marginalized neighborhoods and helping to remediate longstanding environmental, social, and economic injustices.

Drawing from the literatures on visual assessment and systematic social observation, we developed a fine-scale landscape change analysis based on aerial and street-level imagery. Our assessment, which included 20 different indicators of lot condition and care, was applied to 424 "large lots" one year before (2014) and after (2015) purchase. The detailed analysis revealed significant changes in several condition/care indicators, including increases in the proportion of lots with gardens and trees in good condition, and reductions in lots with erosion and parked cars.

Based on this experience we developed s simpler 7-point condition-care scale to provide planners and researchers with a rapid visual assessment tool for field or virtual application (i.e., Google Street View) to help monitor change. We applied the scale in assessments over a five-year period in the five Chicago community areas. Further tests of the scale support its reliability and validity, and a "difference-in –differences" analysis shows that the improvements in vacant lot stewardship were casually tied to the Large Lot Program and did not happen by chance.

While visual stewardship is an important goal in and of itself and in the context of urban vacant lands can lead to more attractive neighborhoods, improvements in condition and care can also lead to broader personal and social outcomes. In additional work we have tied our visual assessment to social data from mail survey, focus group, and secondary sources. And find that resident engagement in vacant lot stewardship can help empower individuals, strengthen community cohesion and attachment to place, and reduce some forms of crime. In the context of these broader outcomes we discuss the utility of our approach for evaluating the success of vacant land reuse programs and extending its application to addressing the needs of urban greening professionals.

Paper _ Technical Session 9

Designing for History and Safety along the Baltimore-Washington Parkway

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Abstract: The Baltimore-Washington Parkway is an ambiguous roadway that hybridizes parkway characteristics with highway alignment and travel speeds. It is listed on the National Register of Historic Places and carries heavy traffic loads between Washington DC, and Baltimore, MD, and this leads to conflicts between historic preservation. This paper presents a series of design proposals grounded in the history of the parkway that are aimed at fine-tuning a major redesign of the parkway in the 1990s that improved the parkway's safety and also rehabilitated its historic character. Since then, safety measures have diminished the parkway's character, and this new set of recommendations seeks to improve its historic character again.

The treatment recommendations are part of a larger Cultural Landscape Report for the National Park Service, and they are grounded in the parkway's planning and design history as well as current conditions of the landscape. As defined in the report, part of the historical significance of the parkway is that it shows that an ordinary highway can be designed as a parkway with careful attention to design decisions. As such, care is taken to develop new design details that are consistent with the character of the parkway and reaffirm its status as a parkway while maintaining its safety as a modern highway.

Keywords: historic landscape preservation, highway safety, cultural landscape preservation, parkways, national capital landscape

Introduction

Ambiguity has dogged the Baltimore-Washington Parkway throughout its history: Is it a true parkway? Or a modern highway? The ambiguity is not just a rhetorical matter but leads to challenges in balancing historic preservation and highway safety management. The parkway is listed on the National Register of Historic Places, which brings with it a mandate to preserve the parkway's historic integrity. (National Park Service 1991) However, it is also a major traffic artery between Baltimore, MD and Washington, DC, second only to I-95, and consequently it has highway safety issues commensurate with a modern, high-speed roadway. Many of the safety issues are directly related to design decisions that define the parkway's character, so meeting these safety concerns threatens the historic integrity of the parkway itself.

In order to address the most recent safety concerns while maintaining historic integrity, the National Park Service commissioned a Cultural Landscape Report with me and four landscape architecture graduate students at Virginia Tech's Washington Alexandria Architecture Campus. (Kelsch, et al 2021) The goal of the report is to document the history and current conditions of the parkway, and to use that historical information to propose treatment recommendations and guidelines to direct future management. Specific concerns of parkway managers had to do with policing infrastructure, driver safety, and forest edge management; other issues emerged through the documentation process concerning the lack of integrity of planting designs and other threats to the parkway's character. All of these are addressed with direct reference to the history and character of the parkway as identified through the Cultural Landscape Report.

In this paper, I present our treatment recommendations and their grounding in the history and present-day conditions of the parkway. I begin with an historical narrative to show that the ambiguity between parkway and highway is inherent in the history of the landscape, and then I explain how a major redesign of the parkway in the 1990s addressed many of the most glaring safety concerns, and in the process, rehabilitated the historic character of the landscape and reinforced its status as a parkway. In the 2000s, other smaller scale safety issues were identified and addressed, but these changes degraded the parkway character. (National Park Service 2001, Eastern Federal Lands Highway Division 2003) Additional problems surfaced in the 2010s, and in meeting these needs, the Park Service seeks to affirm the parkway's character yet again.

Historical Background

Planning history

The ambiguity between parkway and highway is rooted in the roadway's planning and design. (HAER MD-129 undated, 38-40) Although the parkway was not designed and built until the late 1940s and '50s, planning for it began in the 1920s. Throughout its development, different purposes were added to the parkway, each staking a claim for the future roadway's identity, and these differing visions for the roadway led to its ambiguous character.

The first vision for a memorial highway was proposed in 1920 by Baltimore architect William M. Ellicott as part of a revision to his earlier proposal for a national forest northeast of Washington. (Ellicott & Besley 1910, Ellicott 1920) In the wake of World War I, Ellicott envisioned a "splendid avenue" to memorialize fallen soldiers as part of the national forest that he described as the "glory of the nation's capital". Though his proposal for a national forest was voted down in the 1930s, Ellicott established the first identity for the parkway as an important component of regional forest conservation.

Charles Eliot II, a planner at the National Capital Park and Planning Commission, proposed the first true parkway in 1927 running parallel to the upper reaches of the Anacostia River and leading to Fort Meade, MD. (HAER MD-129 undated, 38) In Eliot's proposal, the parkway gained a second identity as a strategic military connection between Washington and Fort Meade. (Figure 1)

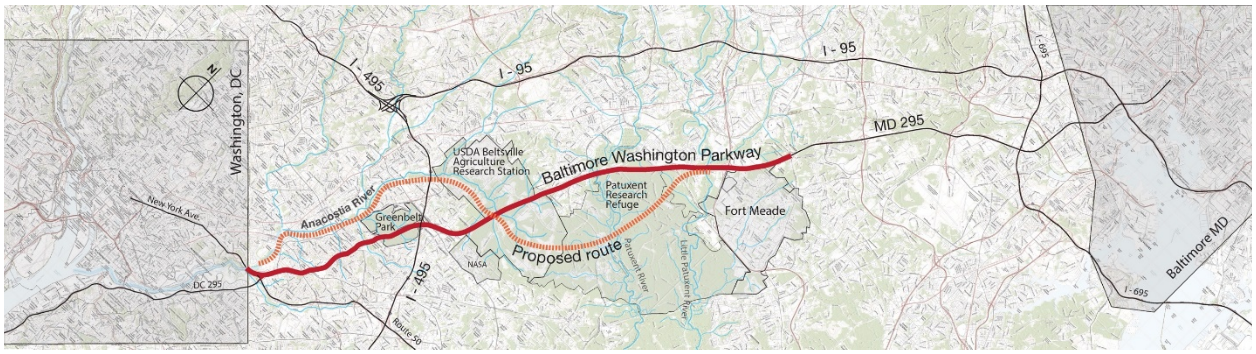

Fig. 1: *Map showing proposed and final alignments with federal properties indicated.*

In 1930, Congress passed the Capper-Crampton act, funding a system of parkways radiating out from the capital (HAER MD-129 undated, 40) Planning activity for the Baltimore-Washington Parkway increased significantly in this period, and all the various parkways were envisioned as beautiful entrances into the capital. Significantly, in this period, the proposed road came to be seen a connector to Baltimore, an alternative to U.S. Route 1, which was becoming increasingly congested with traffic.

These diverse roles for the roadway – forest conservation, military transport, entrance to the capital and intercity connector – laid the foundations for the ambiguity of the roadway as a scenic parkway and also an efficient expressway. The ambiguity was reinforced by the division of the roadway into two portions, a nineteen-mile, federally-built segment carrying only passenger vehicles from Washington to Fort Meade, and a twelve-mile, Maryland-built segment carrying commercial traffic northward from Fort Meade to Baltimore.

Designed Ambiguity

The specific design of the parkway further contributed to this ambiguity. The parkway was designed nearly two decades after the earliest Washington parkways, and its alignment and specific design decisions reflect more modern sensibilities. The roadway was shifted away from the Anacostia River onto higher ground and through undeveloped forestland. This made land acquisition and construction easier, but it made for a less diverse and scenic experience for drivers, diminishing one of the key attributes of a parkway. (HAER MD-129 undated, 61)

The final alignment led to various federal properties, including the National Park Service's Greenbelt Park, the Department of Agriculture's Beltsville Agriculture Research Center, the U.S. Fish and Wildlife Service's Patuxent Research Refuge, and the Army's Fort Meade. Collectively, these properties conserved much of William Ellicott's proposed national forest land, and the forested swath of the parkway itself created a corridor between them, reinforcing its role in regional forest conservation. Nearly continuous forest edges became the central character defining vegetation of the parkway, giving it a distinct character among Washington's parkways.

Fig. 2: *Historic photos with parkway character (left) and highway character (right)*

The roadway itself was designed according to rural highway standards set by the Public Roads Administration. (Figure 2) It was graded for three twelve-foot-wide lanes, but only two were paved with one set aside for future expansion, and this left a wider swath of open space alongside the paved roadways. (HAER MD-129 undated, 92-94) There were no paved shoulders in the original design, and cars were expected to pull off directly onto the grass edges. In this original design, the parkway was a dual ribbon of 24-foot-wide concrete roadways leading through a continuous swath of forest and open grassland where the forest had been disturbed during construction. In some early photos it does appear as a convincingly scenic drive through the Maryland piedmont, while in others it appears more like a modern highway. Regardless, the narrow roadways were not conducive to the high-speed commuter traffic that evolved with suburbanization.

1990s Rehabilitation and Parkway Character

Even before the parkway was completed in 1954, the National Park Service, Public Roads Administration, and the State of Maryland debated transfer of ownership from the Park Service to Maryland. The Park Service argued that it was not truly a parkway, because it did not lead to significant other parklands nor was it especially scenic since it has no specific views other than the forested corridor itself. Others argued for its importance because it led to so many federal properties outside the District of Columbia. For its part, the State of Maryland would only accept it if it were reconstructed to carry commercial traffic. By 1981, reconstruction was deemed too expensive, and the Park Service retained ownership and stewardship of the property. (HAER MD-129 undated, 111-120)

Following this decision, the parkway was redesigned in the 1990s to handle traffic more safely. Dangerous congestion occurred at interchanges because the deceleration lanes were abrupt and bridges too narrow to carry traffic quickly away from the parkway. Frequently and dangerously, traffic backed up onto the actual driving lanes. In the 1990s, numerous problematic interchange ramps were redesigned, and four bridges were doubled in width to increase traffic flow. New shoulders were carefully designed with mountable curbs to maintain a defined edge consistent with the original design intention, while also allowing drivers to pull safely onto the grass. (Figure 3, left) Original white-painted, steel guardrails were replaced with concrete guard walls formed to match the stone bridge abutments of the original design. (HAER MD-129 undated, 130-134) For the first time, planting plans were developed for the entire parkway instead of just at specific interchanges, and these used specimen trees indigenous to the regional forests and a variety of mostly-native trees, shrubs, grasses and wildflowers, to diversify the parkway's landscape. (National Park Service 1993, 1996a, 1996b)

The overall impact of this redesign was to make the parkway safer, and significantly, it also rehabilitated its parkway character. It reinforced the claim that the road is indeed a parkway. In effect, the redesign embraced the ambiguity of the parkway, and in doing so, added to its historic significance as a designed landscape. With the redesign, the parkway shows that an ordinary highway can be designed to be a parkway, at least aesthetically, with careful attention to design decisions.

Comparing the rehabilitated Baltimore-Washington Parkway with MD 295 (the northern extension to Baltimore) the collective impact of the design decisions is evident. (Figure 3) Equivalent images of the two roadways show these distinctions in ordinary stretches of each roadway. Although the alignment of the two roadways is quite similar, they differ in key characteristics that distinguish the Baltimore-Washington Parkway as a modern *parkway* whereas MD 295 is a typical modern *highway*. In the parkway, the roadbed is narrower; the adjoining forests are more robust; the median is varied in its spatial character; the roadway edge is precise; and guard walls give a more refined appearance than MD 295's conventional steel guardrails. These aesthetic distinctions do not address other concerns about the road's parkway status, like the lack of access to park facilities, but they do show that the driving experience can indeed be more beautiful than that of a conventional highway. (Kelsch, et al. 2021, 41)

Fig. 3: *Comparable photos of Baltimore-Washington Parkway (left) and MD 295 (right)*

Methodology: Crossovers as Example

Our study of the parkway combined multiple methods of investigation to document its current and historical conditions. We mapped the landscape at three distinct scales to identify physical conditions that shape the character of the landscape; we documented and interpreted the diving experience through a series of sequential sections every half mile along the route; we used direct field observation as well as ‘driving’ the parkway via Google Maps street view to relate mapped analysis to the experienced conditions of the landscape; we used historic planting plans and other documents, to identify actual construction and design intention; and we examined historic photographs to understand prior conditions of the landscape. (Kelsch, et al. 2021, 41)

The combination of these methods is perhaps best illustrated by explaining the treatment recommendations for emergency crossovers. Crossovers are rather ordinary and unproblematic pieces of safety infrastructure, yet they embody the ambiguity between parkway design and safety. The need is simple: park police need more places to cross from one set of lanes to the other. Currently there are seven crossovers and thirteen interchanges in nineteen miles, which seem like a lot of places to cross over already. The problem lies with the design of the parkway itself. Because the parkway has grass shoulders and close vegetation, park police cannot easily drive down a paved shoulder if they can get stuck in traffic. More crossovers would provide more frequent access in emergencies to the opposite lanes.

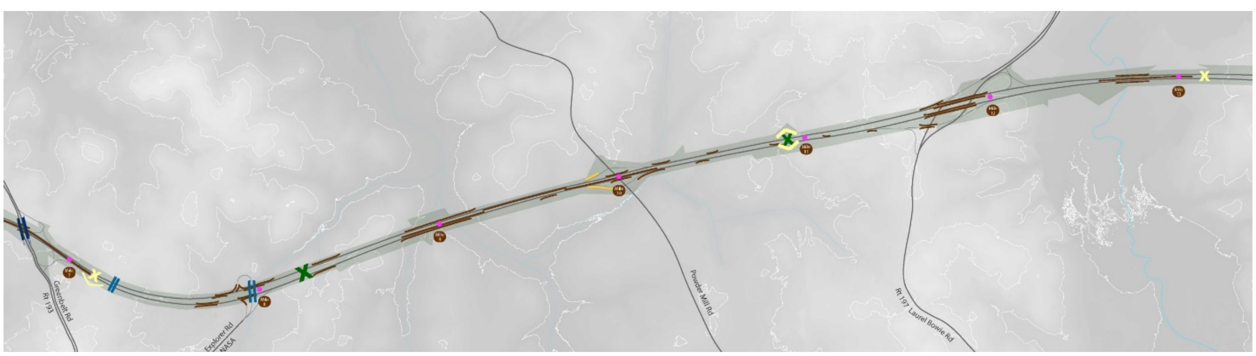

Fig. 4: *Highway Infrastructure. Existing & proposed crossovers in green & yellow X’s.*

We mapped the interchanges and crossovers at 1”=2000’ and identified four segments between interchanges where there currently is no crossover. (Figure 4) Since new crossovers require limited and common-sensible conditions, we sought places through direct observation and Google Maps, where the median is narrow and level enough to drive across, mostly open, and far enough from existing interchanges to be useful. We identified the most fitting places for each of the four segments that don’t already have a crossover. (Kelsch, et al. 2021, 168-173)

But are they historically appropriate? Are they consistent with the historic character of the parkway? To answer these questions, we turned to historical documents.

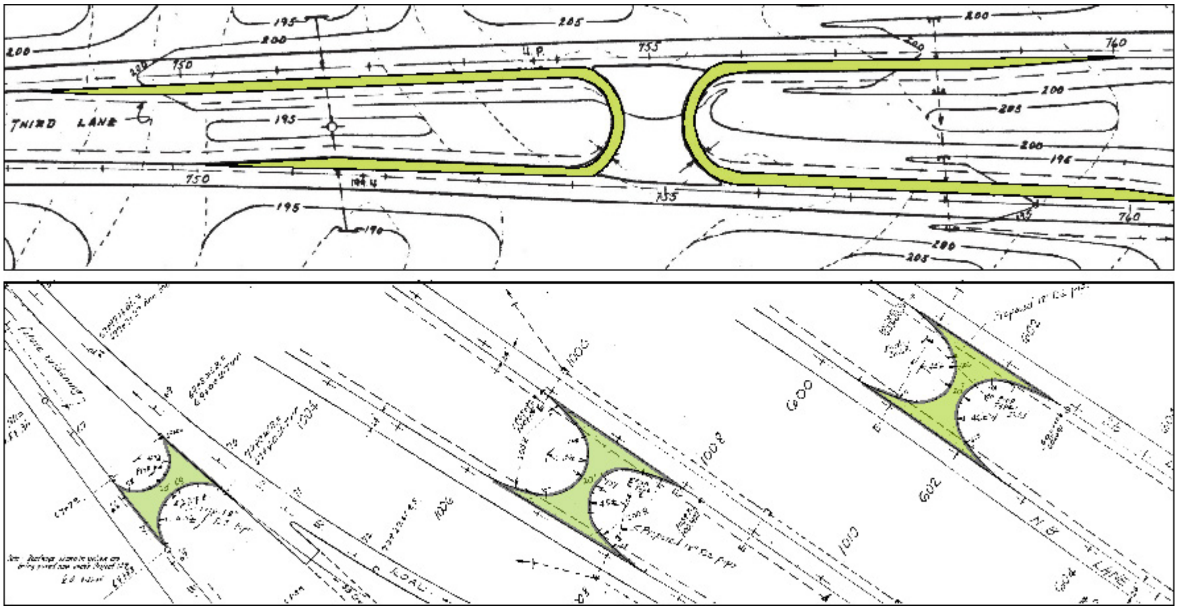

Fig. 5: *Historical crossover detail plans. 1952 (top) and 1954 (bottom)*

Fig. 6: *Colorized perspective of current crossover design*

In 1952, engineers proposed an inventive design for two turnarounds, one-third and two-thirds of the way along the parkway, and each was composed of two elongated, horseshoe turnarounds, back-to-back to each other. (Figure 5) (National Park Service, 1952) Two years later, simpler plans for three crossings were proposed, one at each end and one at the halfway point. (National Park Service, 1954) It's unclear if any of these were built, but they show that crossovers were part of the early design intention, and that designers were seeking a fitting design in keeping with the parkway's aesthetic.

Planting plans from the 1990s rehabilitation show the current crossings, and these approximate the 1954 designs, so we used that as the model for new ones. This includes grass pavers and light vegetative screening to minimize the visual impact of the crossover. (Figure 6) Significantly, two of our recommended locations for new crossovers are near the two locations proposed in 1952, which reaffirms our proposed locations. (Kelsch, et al. 2021, 180-181)

Crossovers were not at all controversial, but this case illustrates the interplay of history and safety. The grass shoulders compound the need for crossovers in the first place, and historical documents show that early designers planned for their inclusion from the outset, even identifying similar locations to those that already exist or that we proposed.

Other safety measures included emergency pull-offs, a long guard wall preventing accidental crossovers, and forest edge clearing. Each of these necessitated similar historical study and careful, subtle design.

Other Treatment Recommendations

Providing Pull-offs for Police

Fig. 7: *Emergency pull-off and crossover with grass pavers to minimize visual impact.*

In addition to crossovers, parkway police requested four pull-offs to enforce traffic violations. Although mountable curbs and grass margins allow drivers to pull off the roadway in an emergency, police are unable to pull over buses, trucks and other commercial vehicles that use the parkway illegally. They literally are unable to enforce the driving restrictions that help define this as a parkway. However, conspicuous pull-offs might undermine the use of the mountable curbs and grass shoulders as safety infrastructure. If drivers see the pull-offs as the appropriate places to pull over in an emergency, they are less likely to use the grass shoulders.

Historically, tiny pull-offs were included in the original design. (Fig 2, left) We proposed that new pull-offs be sited along with crossovers, so they would be seen as part of police infrastructure and not as rest areas. Again, with a combination of 1:2000 mapping and field observation, we identified four locations that met a few criteria: existing or proposed crossovers with level terrain and no adjacent guard walls, and they are in locations where police could monitor traffic. (Kelsch, et al. 2021, 168-173)

The proposed design modifies a conventional pull-off design in order to minimize the visual impact of the pull-off. First, it uses the five-foot paved shoulder for much of the deceleration lane, defining it with a diagonal flat curb within the shoulder itself. Another flat curb defines the straight line of the parkway edge and distinguishes it from a wider area of grass pavers that meet the required width for the pull-off. The pull-off is sized to accommodate two police vehicles and a full-sized bus, but the design downplays its visual presence. (Figure 7) (Kelsch, et al. 2021, 182-183)

Replacing Guardrails with Guard Walls

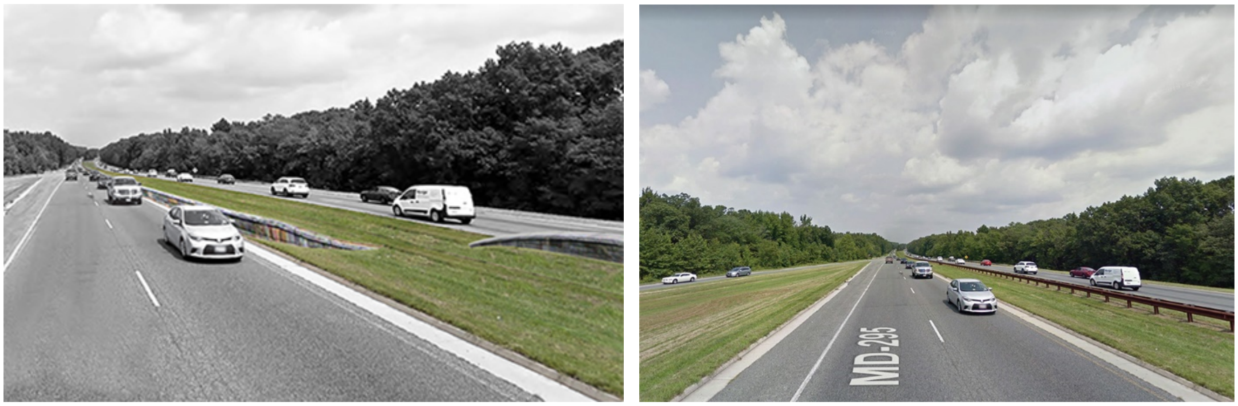

Fig. 8: *Proposed guard walls (left), existing guard rail (right).*

In the 2000s, new Corten steel, W-shaped guardrails were added in places where the recently constructed guard walls were deemed insufficient. A single, mile-and-a-half guardrail in the longest open median was the most egregious. (Figure 8, right) Not only is the guardrail inconsistent with the historic character of the parkway, but the driving experience is nearly unchanging for the entire distance.

Our sectional analysis had identified that the most parkway-like driving experience changes every half mile. Consequently, we proposed replacing the single, steel guardrail with three, half-mile long guard walls. The guard walls would alternate from one side of the median to the other, creating a subtle rhythm that changes every half mile. The new walls would maintain the historic openness of the corridor, but provide safety for drivers and a subtle rhythm to the driving experience. (Figure 8, left) (Kelsch, et al. 2021, 174-177)

Managing Forest Edges

Fig. 9: *Forest edge with long grasses shown in perspective and shaded plantings in section*

Perhaps the biggest threat to the character of the parkway is a mandate to keep a thirty-foot clear zone adjacent to the roadway. Along much of the parkway, forests grow very close to the roadway, and clearing thirty feet threatens their ecological integrity along the entire length of the parkway as well as the historic integrity of the landscape. As of 2018, the Park Service had already cleared the edge vegetation from about ten miles of forest, though not always cutting it back thirty feet. This provided intriguing views into the depths of the forest, but it also has led to rapid growth of new vegetation along the edge, including many invasive plant species that threaten to overwhelm the forests. Our challenge was to design a new strategy that would allow for a sustainable edge and relatively easy maintenance.

We proposed a generic section for the forest edge as a strategy to protect the forests and create a visually engaging edge. (Kelsch, et al. 2021, 188-189) It would need site specific testing and application, but this generic section relies on seasonal mowing and shade from the overstory to help control invasive species and re-establish a native shrub layer. Since invasive species often outcompete native species in full sun, our proposal is to mow underneath the outermost trees of the forest seasonally to keep the sunniest zone in long grasses. (Figure 9) Understory species that are more shade tolerant would be planted thickly where there is light shade and they could more easily compete and form a denser edge. Individual canopy trees and some planted ornamental trees like dogwoods and American holly would stand out from this edge and create a more spatially diverse and visually engaging edge.

There are several precedents for this proposal. One is the early history of the parkway itself, when long grasses and expanding forests made for similarly diverse edges. (Figure 2, left) Another is the George Washington Memorial Parkway, which included flowering trees in its original design to cultivate a more engaging edge to the existing forests. A third is a Park Service article from the same era as the Baltimore-Washington Parkway that illustrates strategies for managing vegetated edges. Notably, it treats the canopy and shrub layer as two distinct components that can be used independently to create different edge effects. (Bayliss, 1957)

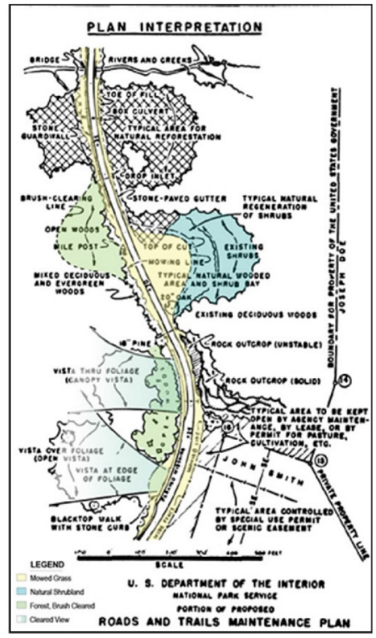

Fig. 10: *Dogwoods along the George Washington Memorial Parkway (left) and Park Service diagram illustrating edge management strategies (right)*

In time, the forest edges of the B-W Parkway will likely expand again to correspond with the line of trunks as mowing retreats, but in the interim, this strategy should help reestablish a forest edge consistent with the history and ecology of the parkway's forests.

Restoring Planting Designs

Very few of the plantings from the 1990s rehabilitation have survived the twenty-five years since planting. Even though this is not specifically a safety concern, it is important to document the planting history and offer strategies for replanting when funds are available or when other projects disturb the parkway and require mitigation. We studied the double-interchange at Landover Road and Annapolis Road as a model for restoration, because it was planted twice, in 1955 and again in the 1993, and it embodies almost all issues related to planted vegetation. (National Park Service 1955, 1993, Kelsch, et al. 2021, 194-205)

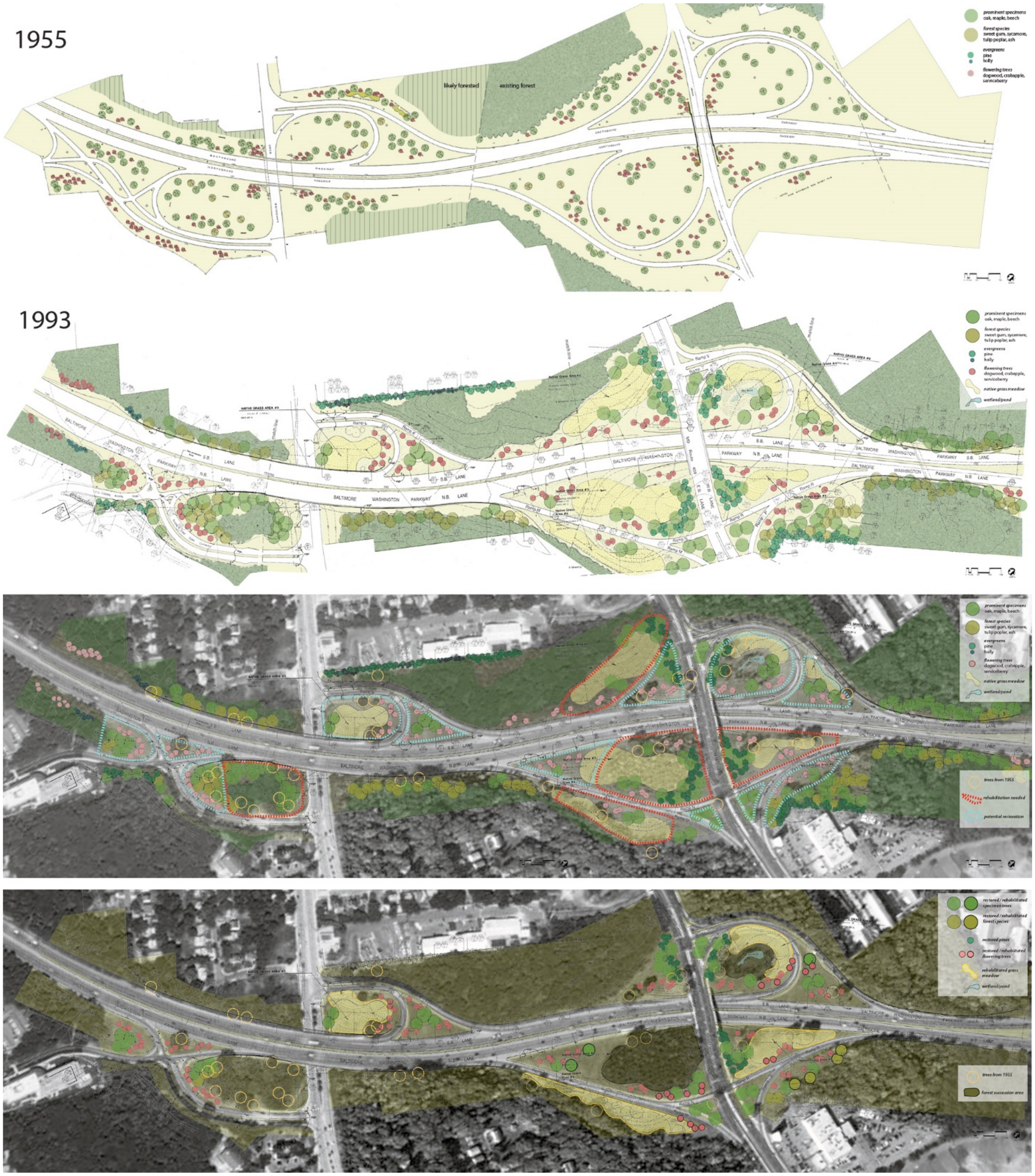

Fig. 11: *1955 and 1993 planting plans for Landover Rd. & Annapolis Rd. interchanges. (top, second) Plans superimposed on current aerial photograph, (third) and restoration plan (bottom)*

For each of the planting plans, we compiled construction documents into coherent plans for the interchanges and colorized them to reveal planting patterns. We overlaid them on current aerial photographs to identify the legacy of each plan, including yellow circles to indicate all the extant oaks from the original 1955 plan. These are the oldest trees along the parkway. Areas outlined in blue can reasonably be restored and areas in red need redesign because forests have succeeded open land or roadways have been altered.

Both historic plans focused most of the plantings on interchanges, using specimen oaks and maples and native ornamental trees to make the space more diverse and intricate and to create a transition between the surrounding suburban landscape and the forested corridor of the parkway. Currently, the interchanges and medians are mostly open grass and have little or none of the spatial and planting variety called for in the planting designs. (Figure 3, left) This seriously diminishes the driving experience and spatial character of the parkway. If these plantings were intact, it is fair to suggest that they parkway would be deemed far more beautiful and parkway-like than it is currently. Knowing that planting and maintenance budgets are unlikely to increase, we concentrated recommended plantings among the loops and ramps of the interchanges, and we reshaped meadows to conform better to topography and mowing patterns.

Maintaining the Open Ribbon of Sky

Fig. 12: *Overhead wires & signs disrupt the open ribbon of sky that characterizes the parkway.*

The most subtle recommendation is potentially the most important: to maintain the open corridor of the parkway itself. (Kelsch, et al. 2021, 186-187) One of the most pervasive aspects of the parkway's character is the uninterrupted ribbon of sky between the forest edges. In the original design there were six bridges in nineteen miles and two other crossings that interrupted the open sky. The two extra crossings were removed during the 1990s rehabilitation, but three additional bridges have been added along with high-tension power lines and signage that spans the parkway in several locations. (Figure 12) Slowly and incrementally the open ribbon of the sky has diminished. Recent plans have called for a 'can-of-worms' interchange over the parkway as part of an expansion of the Capital Beltway (I-495). Currently, the beltway crosses underneath the parkway, almost unnoticed, and the new enormous interchange would seriously and permanently degrade the integrity of the parkway's open space. This recommendation to maintain the open sky is specifically included in our document to give the Park Service greater authority to combat the complicated interchange, but it also aims to focus attention on the importance of removing overhead signs and fighting future overhead crossings.

Conclusion

Individually, these treatment recommendations are quite small and they are unlikely to be obvious if implemented. Indeed, the goal is for them to NOT be noticed, since the goal is to maintain the subtle parkway character of the current landscape. If the parkway can continue to increase safety for drivers and remain ambiguously a scenic parkway and a safe highway, these proposals will be a success.

The challenge set forth by the designers of the 1990s rehabilitation is one that resonates across the parkways of the national capital region. As envisioned in the early decades of the twentieth century, they are important components of the landscape of the capital. Suburbanization has rendered them as heavily used commuter routes, and the increase in traffic places greater emphasis on driver safety. Managing those safety risks while maintaining and even improving the parkways' scenic and symbolic importance is a vital task if they are to remain vital components of the capital landscape.

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Visual Case Study _ Technical Session 9

Border to Border: Highway 89 and the making of the Landscapes of the American West from Mexico to Canada

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I am a visual thinker, artist, landscape architect, and planner with an urban design focus. My work is both local and global, focusing on both landscapes and marginalized communities in both the American West and internationally. In this context, I am interested in scenic America, specifically the American West landscape, exploring the influence of water, the role of transportation, threats in urban and rural development, communities.

My research and visual art aim to communicate better the role and the identity of a landscape. For this project, I explore US Highway 89, its borders, region, and character to increase our understanding of large-scale landscapes. This qualitative and creative project aims to get at a gestalt of the American West. I chose Highway 89 because it provides a cross-section of and an avenue of investigation into the large-scale landscapes of the West, its borders, and its communities. Highway 89, approximately 1,800 miles one way, meanders from Alberta, Canada to Nogales, Mexico. Highway 89 flows through Montana, Wyoming, Idaho, Utah, Arizona, the Rocky Mountains, the Colorado Plateau, Basin and Range locations, Native American reservations, scenic areas, National Forests, BLM lands, and National and State Parks.

Highway 89 is scenic America, as my project demonstrates. During summer and fall 2019, I drove the length, visited sites, and recorded my visual and sensorial experience of the American West from the Canadian border to the Mexican border, using Highway 89 as the link and conduit of the experience. I filmed the whole 3600 miles with a GoPro (more than 20 hours of footage) as a visual aid while also drawing and sketching the experience. This material establishes the basis for organizing a future public exhibition that will grow out of this project. I have collected raw data and have drawn a sketchbook full of my sketches and quick drawings, capturing the essence of the landscape in motion. I am currently working on studio artwork on Highway 89 and its landscapes. The film and the sketches—many drawn from a moving vehicle—show moving images, capturing the essence of the landscape and the experience of Highway 89. The film shows Highway 89 as a long ribbon, tying together landscapes and their communities.

Broadly speaking, this project aims to better connect communities with the landscapes they inhabit. My research and drawings unpack the complexity of Highway 89. I ask the following questions: First, how is the landscape perceived and inhabited along Highway 89, from border to border, and what is the role of Highway 89 in transforming these landscapes and communities? Second, how may we better understand the large-scale landscapes of the West, including the roles of human habitation and use, agriculture, native lands, and the natural state?

Using phenomenological experience as a framework, my research questions are explored using motion drawing and still drawing (with later interpretation of these drawings), still photography, and film (all showing the landscapes of Highway 89, its form and process). The drawings explore the role of movement and perception of the landscape. In this qualitative interdisciplinary project, the drawings, photos, and film are then placed within their historical, geographical, geomorphological context.

The West includes multi-layered physiographic, ecological, and socio-political landscapes. Using different modes of visual inquiry seen from the road (video clips, archival research of old maps and photos, sketching in motion), my work will draw the larger landscape system, and explore a continuous sense of landscape, not constrained by political boundaries and borders, but driven by my perception of the road and the communities inhabiting the landscape along the way.

Following the border-to-border drive and multiple site visits, I use historical mapping to better understand the geography, water systems, and watersheds, investigating human relationships with the geology of each state I crossed. This helps to better understand how the road has both caused damage and served to protect the watersheds. My project shows how the river crosses the road and how the road crosses the river. Historically mapping the watersheds and pre-and post-Highway 89, I can show how it shifted and where the landscape cannot be read any longer because of transportation development (especially along the Wasatch Front in Utah). Then, I also consider a cross-section of natural and human-made landscapes and their communities, from native communities to early Mormon settlers and beyond. In taking this multifaceted approach, I look at how the road "belongs" to the landscape, here recruiting the theoretical perspective of J.B. Jackson (1994) and building on D. Appleyard and all (1965). In addition, I draw on my previous theoretical work on drawing and collective memory in the landscapes of the West (Lavoie and Sleipness 2018, Lavoie 2011, 2005).

My methods of drawing have evolved to help us better understand and communicate scale, complexity, and process. Based on the foundations of my previous work related to movement in the large-scale landscape, this project represents different speeds and conditions (e.g., driving and walking, day and night, views from the road, and above, in different weather light conditions).

The results are a multi-dimensional perception of the landscapes of Highway 89 with drawings, photos, films, narratives, and maps. I have collected raw data and have drawn a sketchbook full of my sketches and quick drawings, capturing the essence of the landscape in motion. I am currently researching historical maps and readings in geography, geology, and environmental writing, in preparation for an exhibition of artwork. This exhibition and additional drawings and analysis will help answer my complex research questions (in a future book project). The drawings represent an interpretation of my journey through the landscapes and communities and refine my research and approach.

This is part of a larger project; the outcome will be a book and exhibition. As I have witnessed at my past exhibitions in the US and abroad, people connect with the drawings and the vast landscapes of the West—its water, its deserts, its road, its rocks, its people, its past—all are thus translated into simple lines, since I am drawing their essence and the human experiences within them.

I offer a unique visual and qualitative project that can inform more scientific and qualitative research projects in other fields. My background in Landscape Architecture and Urban Design and as skills and perspective as a visual artist provides a new way of capturing and understanding large scale landscapes of the West, which can help study forestry, stream ecology, geology, and beyond (I have given past workshops to scientists showing how drawing can be a useful tool and perspective). In addition, my research could be of interest to a broad professional or academic audience, addressing community themes, regional themes, and ecosystems themes.

Drawing the landscape and other aspects of my methodology can complement the scientific method, preceding the scientific methods, understanding the gestalt or interaction between landscape and road and perception. Drawing provides a more intuitive and artistic interpretation of the landscape, using sketching at specific locations and in motion. This project demonstrates the value of viewing the world through movement and drawing highlights the landscape qualities.

On another level, I would like to foster further academic and professional interest in how to better approach analysis and design and visual resource stewardship.

This qualitative research project endeavors to enrich our understanding of landscapes that we have through data, GIS, and other technology, by using a phenomenological approach to capture the landscape's experience and its communities through drawing and moving images. It also provides a template for using qualitative methods and drawing similarly for other regions. The project shows the value of drawing and a qualitative approach to help those working in different fields.

There is no current published work on 89 or all these regions that combines art, drawing, design, and landscape architecture. This research's contribution is a unique interdisciplinary methodological and theoretical approach for better awareness of place—the first step for action to lead to better design and ways to keep people in touch with their nearby communities and landscapes.

This presentation ends with a two-minute video that emphasizes landscape transitions from one border to the other. This video provides a window of how the landscape changes, underlying the similarities, various rates of changes, and nuances that the US Highway 89 can provide. This conclusion responds to the conference theme and provides an example of what a visual resource can reveal to us when experienced from within, its sense of place.

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Paper _ Technical Session 6

Visual Impact Assessment for Linear Transportation Development: A Proposed Framework for Kuala Lumpur-Singapore High-Speed Rail Project.

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Abstract: This paper will discuss methods used to develop and conduct the visual assessment framework for Kuala Lumpur-Singapore High Speed Rail project (KL-SG HSR) in Malaysia. Since visual impact assessment is relatively new in Malaysia, there is a need to find the best approach to conduct a VIA study that could protect and minimize the physical impact caused by the HSR development. In particular, this paper will highlight how the U.S. Forest Service Scenery Management System (SMS) was used as a basis to develop the VIA method for KL-SG HSR Project. The system was chosen as a basis for the KL-SG HSR VIA framework due its proven reliability, flexibility and required simpler baseline data needed for the analysis. Although there were issues related to the proposed VIA procedures, the results somehow managed to provide meaningful insight that may impact both the environment and the stakeholders. It also enabled the project proponent to better understand the existing visual quality, sensitivity, and impact mitigations needed within the project area. The study also provides essential information to the public and other federal agencies in their efforts to provide feedbacks to the EIA governing body in Malaysia.

Keywords: visual impact assessment, high speed rail, assessment framework

Introduction

The KL-SG HSR, is considered a mega project planned by both the Malaysian and the Singaporean Government to shorten the traveling time between the two-nations capital roughly from 5 hours into 90 minutes and targeted to be operationalized by 2031[1].The project aims to become an alternative mode of land transportation and was estimated to be around USD 17-25 billion, covering a total distance of 350km within the central and southern regions of Peninsula Malaysia. In addition, seven stations were planned along the HSR alignment by using the transit-oriented development[2] (TOD) approach and were expected to become the future economic catalyst of the area.

Currently, Singapore is Malaysian's second-largest economic partner in 2020 and 2021, with a total import and export of approximately USD 108.5 billion (Corporation, 2019). In terms of workforce, particularly before the pandemic, approximately around 300,000 Malaysian would commute across the border for daily works from 500,000 Malaysian workings in Singapore. Singapore's heavy reliance on the Malaysian workforce is due to their limited labour supply, fewer immigration restrictions, and strong cultural relationship. Meanwhile, the Malaysian tourism market is dominated by Singapore tourists, with approximately 10.1 million visitors in 2019, or 40% of the overall tourist arrivals (Malaysia, 2019). A large number of tourists arriving from Singapore significantly contributed towards Malaysian's tourism market that generated around USD 20.5 billion into the local economy in 2019.

Based on these factors, the development of KL-SG HSR is deemed relevant and highly important not only for the economic growth of both countries but also for better environmental performance. According to the KL-SG HSR EIA report (DOE, 2018), it is projected that the project would be able to save an estimated 19 million liters of fuel per year by reducing the number of motor vehicles on the roads within ten years of its operation. Besides, the development of HSR is predicted to generate more than 100,000 job opportunities that would contribute toward the growth of Malaysia and Singapore's domestic economy soon.

To obtain the planning approval of this project, MyHSR Corp, the Malaysian project delivery vehicle company, is required to conduct the environmental impact assessment (EIA) study as stated by the Environmental Quality Act 1972. However, this task posed several challenges that are considered crucial in conducting the assessment, such as the massive scale of the project and the absence of visual impact assessment standards or procedures established in Malaysia.

[1] The KL-SG HSR project was officially cancelled on 1st January 2021 after both governments failed to achieve an agreement to renegotiate the development terms. Nevertheless, the Malaysian government is actively looking for alternatives, including a purely domestic HSR line.

[2] TOD is a land use solution that focuses on enhancing accessibility, by encouraging compact, high density and mixed-use development, within an easy walk of a transit station (Federal Department of Town and Country Planning Malaysia, 2016).

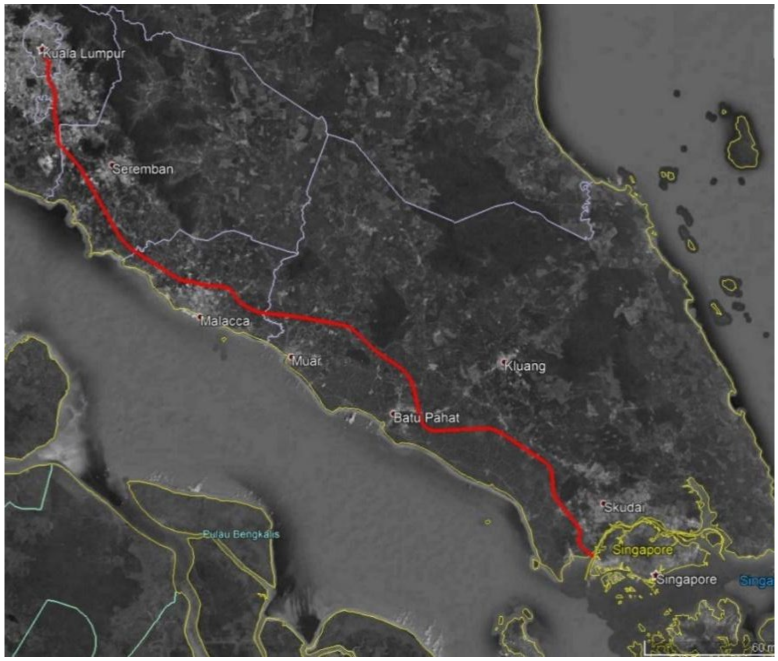

***Fig.1**: KL-SG HSR alignment (within Malaysian Peninsular only)*

Many studies have found that the negative impact caused by land-based transport development is inevitable (Anciaes, 2021; Dorsey et al., 2015; Kortazar et al., 2021). For example, according to Wang et al., (2020), besides environmental pollution, other impacts of HSR may include damages on surface vegetation, original topography, nature reserve, natural or cultural landscape, and historical sites. In addition, supporting infrastructures for HSR such as elevated structures, sound barriers, and the power line can also significantly impact and possibly caused irreversible visual damage to the surrounding area. However, compared to other typical EIA studies such as noise, vibration, marine and aquatic, flora, fauna, water, or air quality, assessing the visual impact is considered relatively new within the EIA process in Malaysia.

Random reviews on previous Malaysian EIA reports (e.g., railways, logging, powerline, hydropower plant) available in the Malaysian Department of Environment (Environment, n.d.) revealed that VIA is absent or only briefly discussed in the reports. Although it was anticipated, failure to emphasize visuals as an essential component for EIA study in Malaysia can be associated with several factors. These include lack of exposure and understanding among the stakeholders and EIA practitioners towards visual assessment and management, recognition towards visual as an essential resource, lack of visual resource experts, and a vague governing body to verify and validate VIA reports (e.g., Malaysian DOE focuses only on air, water, noise and vibration, flora and fauna).

Nevertheless, for KL-SG HSR, visual was identified as one of the EIA studies that need to be investigated to avoid and minimize changes potentially caused by the related development within the existing landscape. The inclusion of the VIA by the project proponents was probably due to the scale and the sensitivity of the project that required detailed investigation of existing resources available within and adjacent to the proposed HSR alignment. However, for KL-SGH HSR, the absence of existing standards for VIA and the project's massive scale posed both fundamental and logistical challenges to the study. One of the critical questions raised from this scenario was what would be the best model or paradigm to approach the KL-SG VIA study? Since VIA involved measurement of aesthetics qualities, the "objectivist paradigm" is considered the suitable approach since the study would rely heavily on expert evaluation and assessment. The "objectivist paradigm," as suggested by classical philosophers associated aesthetic beauty with an object's physical representation. Objectivist paradigms assumed that aesthetic quality is determined by the objects' features and its physical characteristics. On the other hand, the "subjectivist paradigm" as claims by contemporary philosopher argued that aesthetic beauty lies in the eyes of the beholder, in which aesthetic beauty depends on individual perception. Although subjectivist paradigm is considered scientifically and statistically more reliable and able to represent the collective perception of a larger population, it is a slow process to undertake and is not cost-effective for KL-SG VIA. Based on this paradigm, this study aims to establish a VIA framework suitable for the KL-SG HSR in Malaysia. The following study objectives are necessary to achieve this goal:

- To assess relevant expert-based visual assessment systems suitable for the VIA framework.
- Identify suitable criteria and establish a visual impact assessment framework relevant to the KL-SG VIA study.

Methodology

Three visual assessment models based on the objectivist paradigm were chosen. These were i) Visual Resource Management (VRM) developed by USDI BLM, ii) the Scenery Management System (SMS) by USDA Forest Service and iii) Landscape Character Assessment (LCA) developed by Natural England, UK.

These systems were selected as the primary reference to develop the framework due to several factors, such as the systems are "recognized at a national level," "widely used in visual assessment study," and "rely heavily on expert assessment." The reviews' outcome was used to determine the most suitable system, phases, and criteria suitable to establish the KL-SG HSR VIA framework. In addition, these phases and criteria have to be relevant to the scope outlined by the project proponent, the context of the KL-SG VIA application (urban, semi-urban, rural, natural areas), duration of the study, and existing data availability. The study is also limited within a 500m buffer of the KL-SG HSR alignment centerline, including the future proposed stations.

Results

Reviews on these systems suggested that Scenery Management System (SMS) by USDA Forest Service would be the best possible option that could be used to establish the KL-SG HSR VIA framework. Besides its history and proven reliabilities, the system was highly flexible for different applications and required simpler baseline data for the assessment. One of the vital phases in the SMS that can contribute significantly to the VIA framework is its landscape character (LC) descriptions. Based on SMS (States. & Service., 1995), the LC descriptions can be established at any scale through layers of existing physical elements, relevant cultural and landscape attributes. The representation of distinct or shared similarities in these layers will partly define the LC uniqueness and serve as the baseline reference for the following assessment stage. The LC is considered valueless and later serves as a reference unit for scenic attractiveness and scenic integrity rating assessment.

For comparison, the process of defining the landscape characters using the LCA approach by Swanwick (2002) is much more complex since it involved different scales of spatial hierarchy. Specifically, the LCA prefer datasets that fit together into a hierarchical series of landscape character/types that correspond from regional, district, county and local level. This approach is considered too exhaustive, and the absence of an existing hierarchical landscape information dataset within the Malaysian context made the LCA approach impossible to be used.

Besides, the concept of scenic classes used in SMS also offers a practical approach to assess the quality of landscape values critical for the VIA. The quality of individual landscape characters can be evaluated and categorized according to their level of importance through the scenic classes concept. Another suitable concept in SMS that would enhance a better understanding of the impact assessment is the landscape visibility and visual sensitivity analysis. The use of distance zones, visual absorption capability, types of viewers, and their activities as potential criteria that will influence visual sensitivity provides a logical understanding of how the analysis can be achieved. In addition to these criteria, other's viewers' related factors such as "number of viewers," viewing duration, and viewers' perception can also be included in KL-SG HSR VIA as suggested by the SMS.

Nevertheless, not all sections or stages of SMS were found applicable and suitable to be included for the KL-SG HSR VIA. For instance, the need to gauge visitors' opinions as "constituent information" to enrich the expert's understanding and evaluation was excluded from the KL-SG HSR VIA framework. This is due to time limitation, availability of human resources to manage the study and financial cost. Furthermore, both the "alternative development evaluation" and "alternative selection" phases outlined in the final stage of SMS are considered irrelevant to this VIA framework based on the scopes required by the project's proponent. On the other hand, several improvements were made regarding the criteria's weightage and scoring used in the study. The proposed framework was finalized according to the phases stated in Figure 2 below.

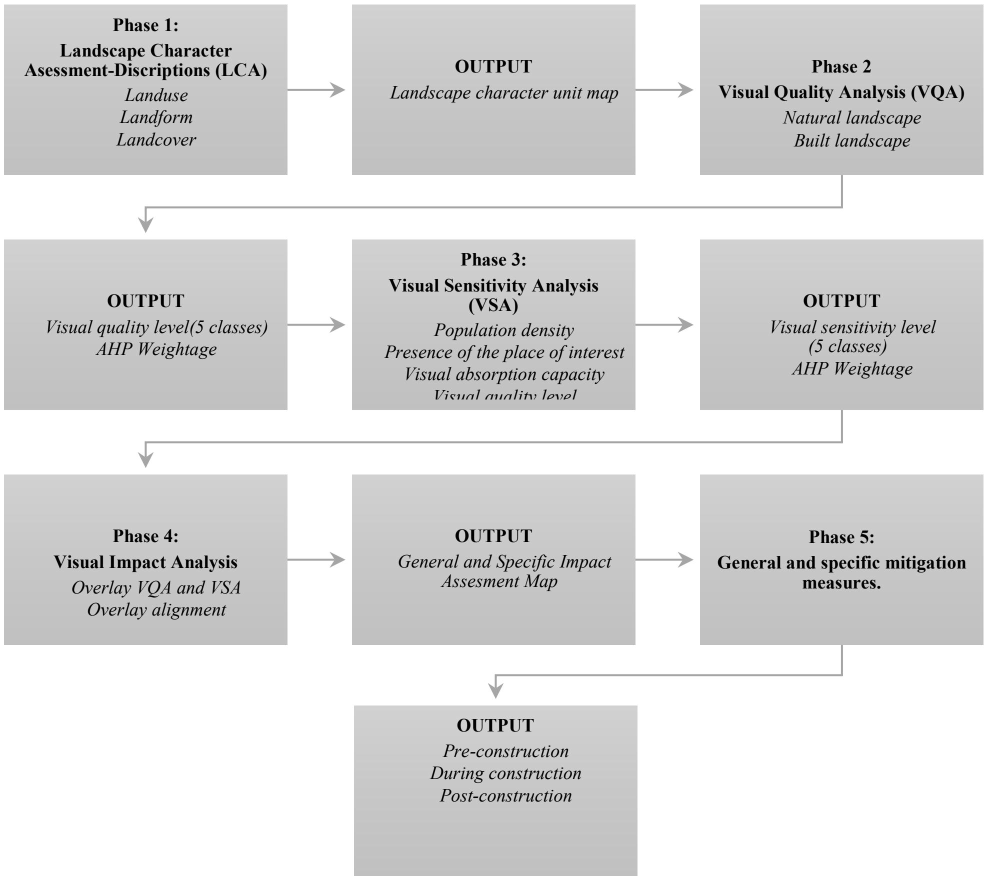

Fig. 2*: Framework for KL-SG HSR visual impact assessment study.*

Detail Assessment Procedures

Phase 1- Landscape Character Assessment-Descriptions

In this study, landscape character along the HSR alignment will be classified into several landscape character units in which similar landscape characteristics will distinguish each unit. At this stage, the landscape characteristics remain valueless and later will become the basis for visual quality and visual sensitivity analysis. Three (3) factors (cultural +physical) were used to determine or describe the landscape character.

- Land uses,
- Land covers: natural landscape (rivers, lakes, pond, forest, wetlands, vegetation) and built landscape (settlement, parks, roads, commercial areas),
- Landforms

Phase 2- Visual Quality Assessment

Visual quality involves the synthesis of two (2) visual quality parameters, which are:

- Natural landscape (NL)
- Built landscape (BL)

Natural landscapes refer to natural features such as rivers, lakes, ponds, forests, pastures, and wetlands while built landscape features are urban parks, fields, religious structures, plazas, public buildings, and buildings with unique architecture. For the KL-SG HSR Project, the analysis of both features for each landscape character was done according to the rating score, as shown in Table 1.

Table 1: Natural Landscape Rating and Description.

Level	Landscap e Features	Description	Value Rating
High	NL	Presence of high volume of plants and water body	5
	BL	Presence of a high amount of significant +unique BL	
Moderately High	NL	Presence of moderately high volume of plants + water body	4
	BL	Presence of moderately high amount of significant+unique BL	
Moderate	NL	Presence of moderate volume of plants and water body	3
	BL	Presence of moderate amount of significant+unique BL	
Moderately Low	NL	Presence of moderately low volume of plants + water body	2
	BL	Presence of moderately low amount of significant+unique BL	
Low	NL	Presence of low volume of plants and water body	1
	BL	Presence of a low amount of significant+unique BL	

Visual Quality Level (VQ)

Upon completing the expert ratings for both natural and built landscapes, the visual quality score for each landscape character was calculated. In addition, Analytical Hierarchy Process (AHP) was used to determine suitable weightage for both criteria to enhance the scoring process. Since nature is consistently identified as the best predictor for high visual quality, natural landscapes were given a weightage of (0.7) while the built landscape was given a weightage of (0.3). Based on the scoring, all landscape character units along the HSR alignment were categorized into five visual quality categories as tabulated in Table 2.

Table 2: Visual Quality Level

Visual Quality Classification and Level	Score Value
Low	0.0 – 0.99
Moderately Low	1.0 – 1.99
Moderate	2.0 – 2.99
Moderately High	3.0 – 3.99
High	4.0 – 5.0

Phase 3: Visual Sensitivity Assessment

Visual sensitivity areas are areas that are vulnerable or important for people as well as the environment. They are areas that influence people's concern for visual quality. Four (4) parameters were identified and analyzed for the visual sensitive areas. These are: -

- Population density,
- Presence of the place of interest,
- Visual absorption capacity, and
- Visual quality levels

Population Density (PD)

Studies have shown that the landscape is considered more sensitive if it is to be viewed by a large number of people. Therefore, data derived from the Malaysian Department of Statistic Census of Population and Household were used to estimate potential viewers' volume and classified according to the category outlined in Table 3.

Table 3: Viewers Volume and Category.

Features Level	Description	Value Rating
High	Area with a population of more than 60,000	5
Moderately High	Area with a population between 45,000 to 60,000	4
Moderate	Area with a population between 30,000 to 45,000	3
Moderately Low	Area with a population between 15,000 to 30,000	2

Low	Area with a population of less than 15,000	1

Places of Interest (PI)

This factor takes into consideration what people "like to see and do" in a particular area. People are concerned about landscapes in which they can participate or use or places that have cultural and religious significance. PI includes mosques, temples, parks, civic buildings, and unique natural features significant at national, state, and local levels (Table 4).

Table 4: Place of Interest Rating and Description.

Features Level	Description	Value Rating
High	Primary historical site, archaeological site, a royal mausoleum, national parks, protected areas, and recreational forest are located within the zone of impact	5
Moderately High	Prominent national or state landmark such as a museum, mosque, monuments, gateway are located within the zone of impact	4
Moderate	Local attractions such as public parks, urban parks, recreational complex, parks, or religious building, including mosque and temple, are located within the zone of impact	3
Moderately Low	Local nodes such as government building, public transportation hub, train station, bus terminal, school, and open public spaces	2
Low	Small-scale public infrastructures such as police stations or the marketplace are located within the zone of impact.	1
None	No place of interest can be located within the zone of impact	0

Visual Absorption Capacity (VAC)

The landscape can undergo modifications without significant visual changes. Landscape with high VAC, such as urban areas, is more likely to absorb changes than natural areas. It is because landscapes with a high degree of visual complexity (urban) will absorb more changes than less visually complex landscapes (natural). The KL-SG HSR alignment will go through various landscape characters, and therefore various VACs will be observed (Table 5).

Table 5: Visual Absorption Capacity Rating and Description

Features Level	Description	Value Rating
High	Highly extensive green spaces with unique geographical or natural landscape features can be located within the zone of impact	5
Moderately High	Extensive green space with unique geographical or natural landscape features can be located within the zone of impact	4
Moderate	Semi-urban area with moderate extensive of green space and no unique geographical or natural landscape features can be located within the zone of impact	3
Moderately Low	Urbanize area with a moderate low of green space and no unique geographical or natural landscape features can be located within the zone of impact	2
Low	Highly urbanize area without a significant amount of green space and no unique geographical or natural landscape features can be located within the zone of impact	1

Upon completing the PD, PI, VAC, and visual quality rating of each landscape character unit, the visual sensitivity score (VSS) for each landscape character was calculated. It is important to note that there is a different degree of importance for each factor. The study acknowledged that PI is the most important factor for sensitivity, followed by VAC, VQ quality, and PD for landscape sensitivity. Based on AHP, PI was given a weightage value of (0.4), VAC, VQ (0.1), and PD (0.1). Upon calculation of the AHP score, all landscape character units along the HSR alignment were classified according to five visual sensitivity categories, as shown in Table 6.

Table 6: Visual Sensitivity Classification and Level

Visual Sensitivity Levels	Value
Low	0.0 – 0.99
Moderately Low	1.0 – 1.99
Moderate	2.0 – 2.99
Moderately High	3.0 – 3.99
High	4.0 – 5.0

Phase 4-Visual Impact Assessment (VIA)

The assessment of the impacts of the KL-SG HSR Project on the visual quality and sensitivity of each landscape character will focus on the visual zone of impact, which is within 500 m corridor (250 m from the centerline) of the alignment. However, consideration was given to the visual zone outside of the 500 m zone of impacts if there are significant views or vistas. The assessment of visual impacts is at two levels: general impacts and detail impacts.

- General visual impacts assessment – to assess the visual impacts to the landscape characters based on the matrix analysis of visual quality and visual sensitivity levels if any development to occur.
- Detail visual impacts assessment - to assess the detailed visual impacts of the KL-SG HSR project to the landscape characters based on general visual impacts analysis results.

General Impacts Assessment

In order to examine the potential impact of the Project on the existing landscape visual quality within 500 m zone of impact, the Visual Quality (VQA) and Visual Sensitivity (VSA) levels of each landscape character segments were overlapped and analyzed by using a visual impact matrix (Table 8). The matrix table categorized the landscape characters segments into high, moderate, and low visual impacts.

Table 8: Visual Impact Matrix

Criteria and Impact Segments		Visual Quality				
		Low	Moderately Low	Moderate	Moderately High	High
Visual Sensitivity	Low	Low	Low	Low	Moderate	Moderate
	Moderately Low	Low	Low	Low	Moderate	Moderate
	Moderate	Low	Low	Moderate	High	High
	Moderately High	Moderate	Moderate	High	High	High
	High	Moderate	Moderate	High	High	High

Detail Impacts Assessment

For the detailed visual impacts assessment, the KL-SG HSR alignment was overlapped with the visual impacts map, and the impacts were observed and analyzed. The factors that were examined during the detail impact assessment were the changes to the landscape characters visual quality. These were due to the:

- the presences of HSR structures – refer to the location or alignment of Project structures within the 500 m zone of impacts.
- construction on of the types of structures – refers to the type of structures to be built along the Project corridor includes station, depot, maintenance base, tunnel, elevated structure, and at-grade track.

The outputs of the details VIA were classified into three types: Minor Adverse (MinA), Adverse (A), and Major Adverse (MajA). It is proposed that if the Project alignment or structures overlapped with the general "high impact zone," the detailed impact will be “MajA” and if the alignments and structures are overlapped with the general "moderate impact" zone, the detailed impact will be “A”. Finally, if the HSR alignment and structures overlapped with the general "low impact zone," the detailed impact will be “MinA” (Table 9). Therefore, it is also noted that some of the landscape characters within the zone of impact will not be affected at all by the development (no contact with HSR structures), and these areas will be classified as having non-applicable or no impacts.

Table 9: Relationship between General Visual Impacts and Detail Visual Impact

General Visual Impacts	Detail Visual Impacts	Description of Detail Visual Impacts
Not applicable	No impact	No changes to the landscape character of the development (no contact with HSR structures).
Low	Minor adverse	Minor changes to the landscape character of the development areas causing a minimal decrease in visual quality due to the presence of HSR alignment
Moderate	Adverse	Noticeable changes to the landscape character of the development areas causing a noticeable decrease in visual quality due to the presence of HSR alignment
High	Major adverse	Total changes to the landscape character of the development areas causing a substantial decrease in visual quality due to the presence of HSR alignment

Upon completing the detail impacts analysis, the detailed impacts will be examined for their temporal dimension (TD) and extent of impacts (EI). For TD, the impacts were evaluated based on whether they are reversible or irreversible. Meanwhile, for EI the evaluation is on whether the detail impacts will influence the conditions at the site, local, regional or at the national levels.

Phase 5: General and Details Mitigation Measures

Based on the visual impact analysis, recommendations for suitable mitigation measures that will help to protect, reduce, restore, and replace will be made accordingly to ensure the Project developments are compatible with the surrounding visual environment. Besides the technical and environmental considerations, recommendations also include cultural inputs unique to the local context. It is noted that the majority of the impacts are irreversible because the Project structures will permanently be constructed on the ground and will continue influencing existing environmental visual quality. Therefore, mitigation measures must be taken into account during pre-construction (design phase), construction, and post-construction period.

Conclusion

Developing the Kl-SG HSR Visual Impact Assessment (VIA) Framework based on the Scenery Management System (SMS) was highly beneficial and led to a systematic approach on how visual resources and impacts within the proposed project alignment can be assessed. The framework also provides a basic foundation for VIA within the context of Malaysia's EIA study. Although some of the criteria suggested in the framework still need further refinement and evaluation, the framework offers logical procedures and rationale on how it can be operationalized. On a side note, continuous changes affecting the KL-SG HSR alignment due to technical and political reasons during the duration of this study also pose significant challenges to the VIA process. The study also revealed that the KL-SG HSR alignment could be more exciting if visual resources and experience are considered significant factors that will determine the final layout of the alignment.

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