PEER REVIEW OF PAPERS: All papers published in Landscape Research Record have been reviewed and accepted for publication through the Council of Educators in Landscape Architecture’s peer review process established according to procedures approved by the Board of the Council of Educators in Landscape Architecture. Reviewers are recruited by track chairs from among conference attendees and other outside experts. The track chairs also serve as co-editors in the peer review process. The Council of Educators in Landscape Architecture require a minimum of two reviews; a decision is based on reviewer comments and resultant author revision. For details about the peer review process and reviewers’ names, see REVIEWERS in Table of Contents.

IN THIS ISSUE: In 2021, the conference committee accepted 261 abstracts for presentation and rejected 51 abstracts. Authors of accepted abstracts were invited to submit a full paper. After the initial screening, a total of 37 papers were received but only 32 papers were selected and sent out for peer review. Finally, 18 papers were accepted for publications in this issue representing 7 out of 14 tracks available in CELA 2021 annual conference. The organization of this issue follows the standard conference tracks listed in the table of contents.
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Welcome to the tenth issue of Landscape Research Record, published by the Council of Educators in Landscape Architecture (CELA). In 2013, the CELA Board approved and adopted a procedure to become fully responsible for publishing peer-reviewed conference papers annually and named the publication Landscape Research Record (LRR). LRR is a post-conference publication and published online only.

This tenth issue of LRR is a collection of peer-reviewed papers presented at CELA 2021. The 2021 annual conference was the first virtual conference CELA has organized in its over 100-year history. The 2021 annual conference focused on research, scholarship and creative activity that highlighted the theme of “100+1 | Resilience” which entered into discussions and debates intended to celebrate the delayed centennial anniversary of the existence of CELA and examine the resilience of landscape architecture as an academic discipline and area of practice. The 2021 conference also formally added a new Diversity, Equity, and Inclusion track, introduced Film as a presentation method for all tracks, combined Research by Design and Design Implementation tracks to Research by Design and Implementation track and integrated the Sustainability track into the content and the language of all tracks including the theme track.

This issue contains 18 high-quality blind peer-reviewed papers resulting from the 2021 annual conference. We hope you find them to be a collection of timely, provocative, and insightful scholarly work that enriches CELA’s dialogue of research and creative inquiry on the processes of debate and discussion.

Taner R. Özdil, Ph.D., ASLA
University of Texas at Arlington
Editor-in-Chief, Landscape Research Record No.10
CELA Vice President for Research & Creative Scholarship 2020-2022
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COMMUNICATION AND VISUALIZATION

Edited by Jon D. Hunt, & Bambi L. Yost
PERSPECTIVES ON DOCUMENTATION STANDARDS IN DESIGN EDUCATION: A STRATEGIC APPROACH TO AUTOCAD IMPLEMENTATION

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1 ABSTRACT

Landscape architects have many software options for computer-generated construction documentation output. A recent survey of 482 ASLA members found AutoCAD most prevalent, with 82% of respondents using it on a daily or weekly basis (George & Summerlin, 2019). Despite its widespread use, landscape architecture students often must implement a trial-and-error approach in school or use on-the-job training upon graduation to achieve program proficiency. One threat to student learning is a lack of program proficiency amongst instructors, which may threaten effective communication in using AutoCAD for graphic production and documentation workflows. In light of these challenges, the University of Georgia College of Environment and Design (CED) implemented college-wide AutoCAD (CAD) graphic standards. The standards create a common language that is utilized by students and instructors to collaborate on graphic production and quality. Borrowing from standards used in professional practice, the college-wide standards familiarize students with basic AutoCAD concepts used in the industry and teach students how to use AutoCAD for interdisciplinary design collaboration and production of construction documents. This paper shares knowledge on the implementation of AutoCAD graphic standards in an academic setting. Additionally, we explore the foundational principles behind the standards and their application to design studio pedagogy. The investigation includes a varied assessment of the standards through case study, expert, and survey methods. Survey results show that 86% of respondents believe that the CED AutoCAD Standards helped improve their graphic output at least moderately, and 80% believe that the standards at least moderately improved their productivity upon graduation. Overarching findings reveal the importance of exposure to documentation standards while in school, as well as considerations for future application.

1.1 Keywords:  
AutoCAD, documentation, professional practice, landscape architecture
2 INTRODUCTION

AutoCAD (CAD) is the most commonly used software program for documentation in the landscape architecture industry. However, literature reveals a steep learning curve to obtain proficiency in the program (Hamade, 2011; Mohler, 1997). During the early stages of CAD adoption, a window of three weeks to six months was projected before the CAD user could develop commercial proficiency (Philak, 1992).

This study explores the adoption, use, and assessment of applying AutoCAD standards in an academic environment at the University of Georgia’s College of Environment and Design (CED.) These standards were adopted in the hope of reducing the AutoCAD learning curve, improving quality of graphic output, and preparing students for professional practice.

Development of the CED AutoCAD standards began several decades ago as a graduate thesis which tested two different pedagogical methods. Findings from this thesis were used to develop CAD standards for a large land planning firm and in teaching AutoCAD to landscape architecture students at the University of Georgia.

Over time, college administrators determined a college-wide CAD standard could be an effective pedagogical tool. The CED CAD standard was created with the goal to improve the graphic quality of student work and provide consistency in CAD instruction. It was also hoped that by using the standard students would develop a greater understanding of the collaborative nature of how CAD data is used in landscape architectural practice.

The process of creating a school-wide CAD standard began by evaluating the CAD standards that faculty members had used individually in practice. The National CAD Standard (United States National CAD Standard, n.d.), The National Park Service guidelines for design and construction drawings (National Park Service, n.d.) and a chapter from Landscape Architectural Graphic Standards were also used to develop a more robust framework. The CED CAD standards were implemented in the 2015-2016 academic year. It is a living document which is revised every year based on feedback from instructors and students.

What follows is a highly technical level case study of the software components of the CAD Standard and its applicability in an academic setting. In an attempt to determine the effectiveness of the standard, an informal survey was conducted of Alumni to assess their perceptions of the Standard and its impact on their academic and professional experience. Results from this survey are discussed along with the opinions and experience of faculty experts who have created and used the system both in professional practice and in the classroom at the University of Georgia. Finally, we conclude with a discussion of what implications this study might have for future iterations of the CAD Standard and implications for future research.

3 LITERATURE

Problem solving is defined as attempting to reach a goal with an unknown methodology (Waern 1989). Optimally, the individual is able to represent all of the various options available to them and then assess which options will assist them in reaching the goal (Anderson, 1980, Rassmussen, 1990, Waern, 1989). The problem space of a computer system such as AutoCAD encompasses all the possible command options for that system (Waern 1989.) Users of the system face several threats which prevent optimal problem solving. These are previous experience, applicability to the task at hand and the amount of effort required to reach the goal stage (Waern 1989; Waern 1990; Shaw,1990; Schindler and Schuster, 1990; Briggs,1990).

Top-down training helps address these threats by teaching the system as a set of domain specific tasks which can be used as a problem-solving heuristic (Rassmussen 90, Waern 90.) Bottom-up training provides the user a set of rules which the individual must determine how to apply to arrive at the goal state (Rassmussen 90, Waern 90.) Research by Longenecker (1997) tested how well individuals receiving the different training methods performed on a problem-solving activity. Results from this study indicated that bottom-up training produced a significantly higher level of proficiency on the study measures. Individuals who were allowed to experiment with a set of rules appeared to be more adept at applying this knowledge to a new situation. It was hypothesized that the top-down training hindered problem solving activity by providing an incomplete or incorrect heuristic.

Bottom-up training is an effective way to learn if the system’s user interface is consistent (Schindler and Schuster 90.) Top-down training is effective when it provides the user with a set of operators to arrive
at a desired goal state (Anderson, 1980; Rassmussen, 1990; Wærn, 1989). Allowing individuals to experiment with a set of consistent and reliable operators can help aid skill development (Rassmussen, 1990). Given these findings, would it be possible to combine the training techniques by creating a consistent, rule-based system of AutoCAD training that is applicable to landscape architecture students’ domain of knowledge?

This paper is a preliminary and informal attempt to assess the impact of such a system. For the last six years, AutoCAD production standards have been developed and implemented in the Landscape Architecture curriculum at the University of Georgia. The standards have been created in a manner which relates to faculty understanding of current methods in professional practice – thus attempting to provide domain specificity. Finally, the standards attempt to provide a set of tools and methods which can be consistently applied and experimented with throughout the curricula.

4 RESEARCH OBJECTIVES

While the CED CAD Standards have been in place for approximately five years, this approach has not been shared beyond the college. We believe that lessons learned from this extensive effort would be helpful to faculty and institutions outside of the University of Georgia. However, in order to share this knowledge, we felt that it was first important to explore various facets of the implementation and effects of CED CAD Standards. Therefore, the purpose of this study is to answer the following questions:

1. What do the CAD Standards consist of, so that they might be implemented at other institutions?
2. How is the implementation of AutoCAD Standards in an academic setting perceived by various internal perspectives?
3. How do alumni of the school perceive the effects of the CAD Standards on quality of work while in the program?
4. How do alumni of the school perceive the effects of the CAD Standards on productivity after graduation from the program?
5. What might be modified in the AutoCAD Standards to suit the changing needs of design students?

By answering these questions, we hope to shed some light on how digital documentation standards can be applied in an academic setting. Various perceptions of the CAD Standards are investigated for a transparent look at the benefits and setbacks of this approach.

5 METHODS

A number of methods were used to investigate the research questions, including a case study of AutoCAD standards as an intervention within the academic environment, the expert method, and an online survey distributed to program alumni. These methods relate to identifying perceptions of the benefits, setbacks, and potential further applications of the CAD Standards.

5.1 Case Study

A case study is a strategy of investigation which can be appropriate when a study focuses on variables of interest rather than data points (Yin, 1994). This research presents a case study of the application of AutoCAD design standards within an academic setting, serving as an overarching method under which the expert method and a survey are applied. The use of multiple methods within this case study results in complementarity, where findings from each approach provide a more elaborate look at the use of CAD standards in the context of a higher education teaching and learning environment. By analyzing the context and application of CAD standards through this exploration, a roadmap is created for execution of similar CAD Standards in landscape architecture and design programs outside of the UGA CED, revealing the college’s methodology for successfully creating and executing design documentation standards.

5.2 Expert Method

In order to share knowledge related to the implementation of CAD Standards in an academic setting, it is important to explore the various academic perspectives that provide insight into the execution
and applications of the standards. The expert method is based on opinions and assessments of competent
individuals in a topic, in this case, those who’ve witnessed and personally carried out the graphic
documentation standards. It helps answer the research question related to how the implementation of
AutoCAD Standards in an academic setting are perceived by various internal perspectives. The method is
effective when decisions need to be made, sometimes in relation to innovations in education including the
pedagogical process (Iriste & Katane, 2018). The method is appropriate for this study considering the
decision to apply CAD and similar standards in an academic setting may be significant for other landscape
architecture and design programs. Our article provides key insights through four academic perspectives: 1) A
teaching and professional practice perspective, where the expert has over 30 years of experience using
the program, has worked as a CAD Manager at a major landscape architecture firm, who regularly teaches
construction documentation courses in higher education, and whose Master’s thesis explored the use and
implementation of CAD Standards; 2) An academic professional perspective, where the expert has used
AutoCAD for over three decades, has a 20 year career as a CAD Manager, including for two offices of a
major landscape architectural firm, helping establish the company-wide CAD standards and who wrote the
CAD and Construction Documents sections of the popular construction documentation reference book
Landscape Architecture Graphic Standards (Hopper, 2007); 3) A new academic perspective from an
individual who recently switched to the academic realm from professional practice with over a decade of
experience using both AutoCAD and BIM software programs, regularly teaches construction documentation
and graphic communication courses at the higher education level, and whose research incorporates the
intersection of landscape architecture and technology; and, 4) An administrator perspective from an expert
with 25 years of experience using AutoCAD who has been teaching the software since 2001, has overseen
decisions related to technology within the college, and whose research has incorporated technology and
landscape architecture. These perspective opinions are written by the authors of this article and share the
various discernments of each role.

5.3 Survey
In order to answer three of the research questions related to perceptions of quality of CAD drafting
while in college, productivity of graphic output after graduation, and the needs of design professionals
related to the CED CAD Standards, an online survey was distributed to 131 alumni of the College of
Environment and Design. Alumni were located via the social media platform LinkedIn, where they were
current contacts of the research team during the time of data collection and had the term UGA College of
Environment and Design, or UGA CED, in their profile. The survey was created using Qualtrics software
and distributed individually to potential respondents using LinkedIn’s messaging system. Survey results
were open-access and anonymous, though the survey could only be taken once by each respondent.
Survey questions are as follows:

1. Did AutoCAD (CAD) Standards exist in the College of Environment and Design (CED) when
you were enrolled in the program?
2. Did the CED CAD Standards help improve the quality of your graphic output while in college?
3. Did the CED CAD Standards enhance your productivity when you entered the professional
world?
4. Does your work office currently use AutoCAD Standards?
5. How important is it that landscape architecture students learn to use digital drafting standards?
6. Please provide any additional information you’d like to share related to the implementation of
CAD Standards during college.

The survey was distributed individually to each alumnus over the course of approximately one week and
was open for responses for an additional week. The study was preliminarily reviewed by the UGA
Institutional Review Board IRB and did not qualify as human subjects research.

6 CASE STUDY CAD STANDARDS INTERVENTION RESULTS AND DISCUSSION

The CED CAD standards are comprised of a series of AutoCAD drawing templates, including both
.DWG and .DWT formats, that contain the elements of the standard, as well as a user guide with an
overview of the use of these elements and installation on student’s computers. Templates are included for
decimal, architectural, and metric unit drawings. The standards are housed on a CED website for easy
access by students and instructors. The website also contains instructional videos and CAD-related downloads, including annotatively-scaled blocks, such as detail titles and reference call-outs.

The standards are introduced and presented to students in a classroom setting in their first year in the landscape architecture program, and then subsequently are incorporated into expected class output throughout the curriculum. Students make use of the standards by installing the .DWT template files on their machines, or by opening one of the .DWG template files and using SAVEAS to place a copy in their project folder, thereby maintaining the template in original form. Instructions for both methods are included in the user guide. The user guide includes depictions of the components of the standards, a predefined page-setup, for example, along with explanatory text describing the page-setup. Students learn to navigate the software and read the ‘syntax’ of the standards through these examples, which also provide instructors with prompts for classroom presentation. The templates contain the elements of the standards. From standard layer names, to preloaded linetypes, to titleblocks created using attributes for editable preformatted text, to annotatively-defined text and dimension styles, all components are predefined in the templates, creating a simple solution for students new to AutoCAD. When students are assigned a specific task or product, such as a layout plan, for example, the components required are at-hand, providing a task-specific educational opportunity, which has been shown to be effective in software instruction (Gray, 1990).

![Figure 1: Summary poster describing main elements of the CED CAD Standard, from the User's Guide.](image)

The standards are designed to improve students’ graphic products and enhance the instruction of design communication by addressing the typical stumbling-block issues encountered in CAD use, particularly by new users, based on our observations of student progress. In so-doing, the standards present students with a professional-level example to follow when, for example, they are creating titleblocks or labelling a planting plan. Students learn what is expected in a titleblock by entering the information prompted by the standards examples. They learn to recognize what text size is appropriate for a planting plan by using the included styles, and the standard is designed to reinforce their understanding of scale by using annotatively-defined text and dimension styles. Throughout the standard, included elements not only give students an indication of graphic expectations, but also give instructors a direct way to show these expectations. The intent of the standard is to show students how to communicate graphically, to navigate a CAD standard similar to what they will likely encounter professionally, and to use new software. We
believe addressing these technical aspects in the standard improves efficiency by allowing focused studio
instruction on the crafting of a wall detail or grading plan, for example, and not the creation of a text style
or a layer-naming system.

Text, dimension, and multi-leader styles are defined by the standards. Typical of comparable
standards, the CED uses .SHX fonts (AutoCAD native fonts) for maximum compatibility. Annotatively-
defined text styles are included for decimal, architectural, and metric-unit drawings. Annotatively-defined
items in AutoCAD are those which respond to viewport scale automatically. As opposed to creating text or
dimension styles for each scale that might be needed, with the text or dimensions sized based on that
scale-factor, annotatively-defined objects adjust to the viewport scale. The standard is a tool that shows
students how to navigate these kinds of objects in model-space and paper-space (layouts) by following the
prompts given, and thereby gain proficiency using this aspect of the software while also grasping the impact
of scale in their drawings. Text, dimension, and multi-leader styles are included for the three template
formats (decimal, architectural, and metric units), as well as a specifically defined multi-leader style for
g grading plans and a text style for use in paper-space.

Titleblocks are likewise included and are a primary visual element of the standards. Each template
in the CED CAD standards includes saved page setups defined for sheet sizes from 8.5”x11” up to 36”x96”.
Each of these page setups includes a titleblock defined both vertically (along the narrow edge of the sheet)
as well as horizontally (along the long edge of the sheet). The standard page setup uses the Autodesk
DWG to PDF plot device, so that all output is created as a .PDF file for maximum compatibility. Titleblocks
are all defined as AutoCAD blocks, with the titleblock text defined as attributes of the block. Students modify
the contents of the text using the AutoCAD attribute editor. Block Attributes in AutoCAD are text
placeholders that are defined as a part of the block, but remain editable independently, while maintaining
their graphic properties. Font type, size, orientation, and so forth is retained as students edit the content of
each text entity. Once again, students are not only learning professional graphic expectations by example,
they are also learning to master AutoCAD by working with the elements included in the standards, as is
shown through observed and documented progress in courses that incorporate AutoCAD Each titleblock
includes a separately-defined scale bar and north arrow block, with increments on the scale bar included
as attributes of that block for adjustment as needed.

The standards make use of Color-Dependent Plot Style Tables (.CTB files) rather than Named Plot
Style Tables (.STB files), as this is more common in professional practice in our experience, and in
reference standards such as the previously mentioned National Park Service guidelines (National Park
Service, n.d.). Color-Dependent Plot Style Tables allow each AutoCAD standard color number (1 through
255) to be assigned a line weight and a shading value, along with many other aspects. This method of
defining and setting lineweight and value harkens to the days of the use of technical pens and ink-based
hand drafting, in which each technical pen’s width was identified by a color band near the nib. In AutoCAD,
every color can be assigned separately, creating a wide range of possible weight and value combinations.
The CED standard .CTB file is setup with a recurring sequence of twelve lineweights, from hairline to sheet
border thickness. The lineweight sequences are established to plot as full black, as six shades of gray, and
as yellow, red, and cyan. The first 120 AutoCAD colors are defined in the system, with the remaining open
for any necessary customization outside of this range.

A layer naming system can be considered critical in a formal set of CAD standards, as layers are
the primary organizational element of CAD data. The CED CAD standards employ a system commonly
seen in professional practice that is based on the National CAD Standard. The naming formula begins with
a single character Discipline Designator, followed by a four-character Major Category or Group, then
another four-character Minor Category or Group. If additional layer breakdown is required, the standards
prescribe adding additional four-character designations. A Status or Phase Category is sometimes
required, represented by a single character (e.g. X for existing conditions) at the end of the layer name.
Thus L-PLNT-TREE-STRRT would be an appropriate layer for street trees, L-SITE-WALL would contain wall
information, and L-SITE-WALL-X existing wall linework. The organizational schema for layer naming is
clearly defined, while allowing a great deal of flexibility for individual project or drawing needs. Lineweight
is set by color as we employ a .CTB based system, so object color is always set to BYLAYER individually,
so that the layer color setting ascribes a lineweight to all elements on a given layer. Likewise, linetypes are
always set to BYLAYER for individual elements, so that the layer setting applies. Lineweight is individually
set to BYLAYER (although left as “default” in the layer settings), as is Transparency. All of these are preset
to be the default setting in the CED CAD Standard template files.
<table>
<thead>
<tr>
<th>AutoCAD Color</th>
<th>Lineweight / Value</th>
<th>AutoCAD Color</th>
<th>Lineweight / Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.0508 mm Black</td>
<td>13-24</td>
<td>Repeat pattern at 75% gray</td>
</tr>
<tr>
<td>2</td>
<td>0.1778 mm Black</td>
<td>25-36</td>
<td>Repeat pattern at 50% gray</td>
</tr>
<tr>
<td>3</td>
<td>0.2794 mm Black</td>
<td>37-48</td>
<td>Repeat pattern at 40% gray</td>
</tr>
<tr>
<td>4</td>
<td>0.3810 mm Black</td>
<td>49-60</td>
<td>Repeat pattern at 30% gray</td>
</tr>
<tr>
<td>5</td>
<td>0.5080 mm Black</td>
<td>61-72</td>
<td>Repeat pattern at 20% gray</td>
</tr>
<tr>
<td>6</td>
<td>0.5588 mm Black</td>
<td>73-84</td>
<td>Repeat pattern at 0% gray</td>
</tr>
<tr>
<td>7</td>
<td>0.6096 mm Black</td>
<td>85-96</td>
<td>Repeat pattern in yellow</td>
</tr>
<tr>
<td>8</td>
<td>0.7112 mm Black</td>
<td>97-108</td>
<td>Repeat pattern in red</td>
</tr>
<tr>
<td>9</td>
<td>0.7874 mm Black</td>
<td>109-120</td>
<td>Repeat pattern in cyan</td>
</tr>
<tr>
<td>10</td>
<td>0.9906 mm Black</td>
<td>121-255</td>
<td>Unassigned</td>
</tr>
<tr>
<td>11</td>
<td>1.1938 mm Black</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>1.5748 mm Black</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Creating construction details, although a seemingly simple task, involves several decision points that are addressed in the CED CAD standards. Tools and methods for sizing and scaling of details, along with aligning details on a sheet, are included in the standards. To address overall alignment on a sheet of construction documents, the standards include a grid as a part of the template. This grid is based on a 24”x36” (Arch D) sheet, divided into 12 cells in a 4x3 arrangement. The grid is used in paper-space (layout) to guide viewport placement. Corresponding to this alignment grid, the standards include a series of detail title and area blocks, used in model-space, that are sized to fit the cells in multiple ways. The standard detail is a 1 cell block, but as some details require more sheet area to be fully documented, blocks are included for cell arrangements of 1x2, 2x1, 2x2, 1x2, 1x3, etc. As with standard page setups, it is unlikely that the entire range of these options would be needed, but flexibility is key. These detail title and area blocks are inserted in model-space, and scaled up based on the scale factor of the detail (a scale factor chart is included in the standards). If a ¾”=1'-0" detail is needed, the block is scaled up by a factor of 16. The details are drawn using CED standard annotatively-defined text and dimensions, so callouts adjust automatically, while the title and area blocks are created using standard text, so that the title text scales appropriately when the block is scaled. The text in these title and area blocks is created as block attributes, and is editable just as the text in the CED standard titleblock. For a drawing with multiple detail scales, the Annotation Scale setting is adjusted based on the detail being edited. When editing a detail at ¾”=1'-0”, the Annotation Scale is set to ¾”=1'-0”. When editing at 1”=1'-0”, the scale is likewise set to correspond. Text in the title and area blocks is unaffected, as it is a non-annotative block attribute, while text and dimensions describing the detail adjust accordingly because they are defined as annotative objects.

The standards include several additional components designed to address stumbling-blocks before they are encountered. Students often struggle, for example, in visualizing the area in model-space that their viewport will display at a particular scale. Viewport area blocks for each sheet configuration and size are included in the standards. These blocks are inserted in model-space, then scaled up according to the intended scale being explored. To determine sheet area for a 24”x36” sheet with a vertical titleblock at 1”=20’, students insert the correspondingly sized viewport block, scale it up by a factor of 20, and then move it around to visualize what can be displayed on that sheet. Further, once all adjustments are made, the student can create and save a view, using the corners of the viewport block in model-space that they then restore in their paper-space (layout) viewport. As the viewport block is an exact duplicate of the viewport in paper-space, scale will be set appropriately when the view is restored and has the added benefit of being saved in the file. Therefore, if the viewport area is reset, simply restoring the view corrects the problem. When laying out complex sites that require multiple sheets, such as a streetscape, this visualization tool becomes particularly useful.

Another useful tool for removing potential stumbling-blocks includes several typical plan and detail reference callouts within the standards. These callouts are created as annotatively scaled blocks with editable attributes. Since the entire block and included attributes are defined as annotative objects, when the callout is inserted into a drawing, it automatically sizes appropriately according to the Annotation Scale.
setting. If it is determined that the layout and materials plan, for example, is better documented at 1”=10’ rather than 1”=20’, simply changing the Annotation Scale setting corrects the size of all the callouts.

Linetypes and hatch patterns are preloaded in the templates, removing another obstacle for new-users while also providing instruction via demonstration on additional features of the software. Linetype scaling is universal, so individual object linetype scales are always set to 1 and the global variable LTSCALE is used for fine-tuning. A default setting of 0.35-0.50 is recommended. MSLTSCALE and PSLTSCALE variables are both set to 1 by default, so the overall linetype scaling always responds to the Annotative Scale setting when in model-space, and the viewport scale when in paper-space. Hatch patterns are defined annotatively, so just as with the text, dimensions, and linetypes, the pattern density responds to the Annotation Scale setting. This is not always the best application of hatch patterns, so flexibility is allowed.

CED students are required to take a professional internship as a part of their studies which can serve to reinforce the use of standards.

7 EXERT AND SURVEY METHOD RESULTS AND DISCUSSION

Two methods were used to explore the use and perceived impact of the CED AutoCAD Standards, including the expert opinions of several faculty members who carry out and put into practice or witness the use of the CAD Standards with students on a regular basis, as well as a survey distributed to alumni regarding experience with the CAD Standards. The following sections outline the results of these two investigations. First, the section highlights the experiences of the authors with the implementation of the CAD Standards, incorporating a variety of academic and professional perspectives. Then, quantitative and qualitative data findings from the survey analysis are shared.

7.1 Academic and Professional Perspectives on the CAD Standards

7.1.1 Teaching and Professional Practice Perspective

CADE Standards in a studio setting accomplishes several goals to preparing students for professional practice. First, it helps close the gap between expert and novice knowledge. By preparing detailed instructions which thoroughly explain all of the various steps involved in creating CAD output, “…the expert learner's implicit knowledge…[is]… made explicit in order to be accessible to the novice learner.” (La, Dyjur, Bair, 2018)

Secondly, it provides an opportunity for deliberate practice. Deliberate practice creates an opportunity to practice a skill in an environment which simulates reality (Grenny, 2017; Ericsson and Charness, 1994). Requiring landscape architecture students to utilize a CAD standard as the means for producing documents which successfully combine data from an outside source with their original design concepts replicates many facets of landscape architectural professional practice.

Using this set of explicit directions and allowing students to practice applying these tasks in a manner simulating professional practice has helped integrate application of CAD software in the studio. It provides the instructor with the opportunity to place more focus on design education in their pedagogical approach. It also assists many students in successfully transitioning their productivity from the academic studio to the landscape architectural office.

7.1.2 Academic Professional Perspective

Preparing students to enter practice with a professional degree requires not only reaching educational goals in the studio, but also continuing support outside the studio in the application of these new skills and abilities. Using the CED CAD Standard in the digital graphics sequence allows for rapid advancement into the production of “good-looking” documents that the students are proud of, and this motivates them to keep learning and push through the more difficult aspects of the software. The standard is used as a teaching tool for AutoCAD itself, as well as professional expectations.

In providing support outside of the studio, the standard often helps students structure their questions or frame the particular problem they’re having, aiding in the process of guiding them to the solution. If there is a lineweight issue, for example, students will generally present a checklist based on walking through the standard, “I’ve checked the .CTB, I’ve made sure the page setup is correct…” and so forth, and often they’ll discover the error on their own in this process… “oh, the color isn’t set to BYLAYER”
or something similar. This provides the potential to instill confidence in the use of a complex tool with encouragement from progress made.

Using the standard also addresses many common output issues that are a notorious source of technical support frustration. Students create .PDF files by default when using the standard, which of course are quite ‘portable’ and easy to send to a printer, email to an instructor, or to use in other graphic or page layout applications.

7.1.3 New Academic Perspective

AutoCAD and other documentation programs are applied in landscape architecture instruction in various contexts. For example, AutoCAD may be used in a studio course to create a site base plan, in an advanced graphics class as a foundation for more complex modeling and visualization, and in an implementation documents class as the primary platform to communicate design intention for construction purposes. As a newer faculty member who teaches computer-aided design in all these contexts, the CAD standards serve as a common thread throughout my courses. As a result, I spend less time teaching basic CAD knowledge because the students have a set standard and instructions to always refer to, with other faculty members and IT professionals also familiar with the expected CAD output.

Differentiation in instruction can benefit students and instructors when the topic being taught is subjective, such as design or planning. Here diverse expertise from different faculty members over various courses may strengthen student learning outcomes since the knowledge builds and take different shapes. However, for technical-based skillsets such as basic AutoCAD applications, disparity in instruction can potentially lead to confusion by the student, and too often students may be left to figure out the rudimentary steps in a computer program needed to execute their assignments. This is particularly true if a faculty member is not proficient in the programs needed to complete the work. The CAD Standards serve as a safety net for both faculty and students and provide a clear expectation for quality output and a clean CAD process.

7.1.4 Administrator Perspective

Perhaps the most important outcome since adopting the standards is an improvement in instructional consistency when it comes to teaching AutoCAD software. Because of our large undergraduate program, freshmen students are divided into three or four different sections of digital graphics each academic year. Each section is taught by a different faculty member or teaching assistant whose knowledge, experience, and familiarity with AutoCAD varies to some extent. The variations impact instructional consistency in terms of content and method. Before the standards were adopted, it was not uncommon for students to exit the class with good foundation in digital drafting, but students in different sections and in some cases students from the same class would set up drawing standards or execute AutoCAD commands differently as they moved forward in the curriculum. The lack of consistency caused unnecessary confusion and frustration amongst students and faculty in subsequent classes where AutoCAD was used as part of the graphic workflow.

While the introduction of the AutoCAD standards has not eliminated these issues entirely, the standards have initiated a level of teaching consistency that has reduced the occurrence of competing workflows and subsequent confusion and frustration that this causes. Because many of the survey respondents indicated the standards were just being implemented during their time in school, it is too early to conclude that the adoption of the AutoCAD standards has improved the quality of student work. However, the survey results overwhelming show that students agree that having knowledge of digital drafting standards is important as the vast majority use some type of standards in professional practice. Finally, just over 75% of survey respondents agree that the AutoCAD standards did enhance their productivity when they entered the workforce.

The next challenge is to implement the standards beyond the foundation classes and embed them throughout the entire undergraduate curriculum. This will require that studio faculty become familiar with the standards and require their use during class each semester. Only with consistent reinforcement and repetition will the full impact of the AutoCAD standards become apparent through the work our students produce while in school and after they graduate.
7.2 Survey Results

The survey received a 45% response rate, with 59 respondents out of the 131 alumni distribution. Of those who responded, 49 indicated that the CED AutoCAD standards existed while they were enrolled in the landscape architecture program at UGA, while 10 respondents did not have the standards in place. The survey was distributed to a wide-ranging age demographic of program alumni, and this reveals the variety of respondents. Furthermore, 83% of respondents specified that they have AutoCAD standards in the office where they currently work, suggesting that most respondents are familiar with the use of AutoCAD in a professional setting. Descriptive statistics were used to answer research questions related to the perceptions of alumni on various topics, and the qualitative assessment of an open-ended survey question helps to further define the research topic.

7.2.1 Quantitative Survey Results

Several survey questions used a likert-type scale to measure various potential effects of the CED CAD standards through the viewpoints of CED alumni. First, to measure the perceived relationship between the CED CAD standards and quality of graphic output while in college, we asked the question “Did the CED CAD standards help improve the quality of your graphic output while in college?”. Of those who experienced the CED AutoCAD Standards, 53% of respondents indicated that the standards improved their graphic output either considerably or very much, 33% noted that it helped them moderately, and 14% slightly or not at all. Therefore, 86% of respondents believe that the CED AutoCAD Standards helped improve their graphic output at least moderately (Figure 4).

![Figure 4: Survey response to question regarding if the CED CAD Standards helped improve the quality of the respondent's graphic output while in college.](image)

Another survey question measured the perceived relationship between having the CED AutoCAD standards while in the program and productivity upon entering the professional world. The question states, “Did the CED CAD Standards enhance your productivity when you entered the professional world?”. Of respondents who experienced the CED CAD standards, 45% indicated that the standards enhanced their post-graduation productivity either considerably or very much, 35% moderately, and 20% slightly or not at all (Figure 5). With an 80% response that the standards at least moderately improved their productivity upon graduation, we can conclude that the standards are, at a minimum, at least somewhat effective at increasing productivity when entering the workplace.
7.2.2 Qualitative Survey Results

Overall, the quantitative findings of this study support the continued use, and further reinforcement and development, of the CED AutoCAD Standards. Qualitative data strengthens this finding, revealing the perceived importance of introducing documentation standards in the college setting:

“The standards definitely helped me learn CAD for the first time and learn the importance of standards in professional practice. Our standards were also very similar to those my firm uses now which made it much easier to pick up when starting my first job.”

“CAD Standards were one of the most important things I learned in school.”

Four recommendations emerged through the thematic coding of qualitative survey responses using NVivo software. Qualitative data was gathered through the open-ended survey question, “Please provide any additional information you’d like to share related to the implementation of CAD Standards during college.” While some responses spoke generally to the benefit of having standards introduced in the college setting, many provided recommendations for how to further enhance the use and effectiveness of the standards. Recommendations which received more than three open-ended comments and a significant focus within those comments are included in the list below.

1. **Understanding AutoCAD basics well is important for student learning and future professional development.** Respondents stressed the importance of introducing CAD standards to familiarize students with basic drafting and detailing concepts, commands, and functions, as well as file management, layer management, and how to work with annotative blocks. However, alumni respondents who highlighted the importance of basic knowledge also had recommendations for further CAD learning and reinforcement of concepts beyond an introductory class.

   “Ultimately, they just need to learn the basics of CAD file management, layer management, and drawing cleanup tools. They will be able to adapt quickly to whatever office they go to.”

   “A standardized CAD curriculum - so students with a bad professor don't fall through the cracks - and/or a semester dedicated just to learning CAD would have been so helpful in school.”
2. **More advanced concepts in AutoCAD and other documentation programs should be introduced.** Several respondents mentioned more advanced concepts that they believe should be introduced in a more extensive CAD curriculum. These include an understanding of external references (XREFS), Layerstates, UCS, CTB versus STB standards, and the page and plot setup managers. These alumni indicated that AutoCAD and other documentation programs such as Revit could be taught more widely, rather than packaged with other programs in an introductory course.

“Xreffing is a huge part of CAD which I didn’t learn until after college. Manipulating blocks, troubleshooting printing, sifting through absolute garbage files you receive.. Essentially the very non glorious, confusing and custodial work..”

“... a semester dedicated just to learning CAD would have been so helpful in school.”

3. **The CED CAD Standards should be more significantly reinforced within other classes in the curriculum.** Many alumni who left qualitative feedback stated that CAD standards needed further reinforcement throughout the program. While having a set standard provides a platform for faculty and students to maintain consistent quality work in design documentation and other CAD applications, the standards are not required across the board like in a professional office setting. This was identified as a gap by survey respondents. Additionally, standards could be intentionally reinforced in a variety of classes to reach an overall goal of student CAD proficiency.

“I think continuing to learn and building upon CAD Standards throughout the curriculum would be very helpful. Learning basics in first year and building up those tools in each semester... would increase productivity in a professional setting.”

“The standards were emphasized very little while I was enrolled... in my experience, among the first questions I have been asked when interviewing is “can you do CAD?”, or something having to do with CAD competency.”

4. **Students should learn to work with multiple people on the same CAD file.** When AutoCAD is first introduced to students in the CED, they experience the program for the first time and do not share files. Later in design studios and more advanced graphics classes, work is often parsed where one student is responsible for the CAD file. Survey respondents identified that the program could intentionally teach students the value of using standards by having them share files, thereby better preparing them for what they’ll find in a professional setting.

“It's difficult as a student to understand the importance of CAD standards because to some degree you’re working on your projects alone (more or less) … In a workplace, you're either helping or hurting your team.”

“One thing I wish I experienced in school was "trading files"... When you are given a file from someone else you begin to see the value in a properly set up file.”

8 **CONCLUSIONS**

The purpose of this study is to assess the impacts associated with the development and implementation of CAD Standards into the Landscape Architecture curriculum at the University of Georgia. The intent behind creating the standards was threefold: (1) better relate AutoCAD software to professional practice and student learning; (2) minimize confusion regarding software use and application; and (3) improve instructional consistency and quality of student work across the curriculum.

The CED CAD Standards are based on industry standards and best practices. By developing the standards in this manner, students are able to associate how the software is used in a professional design office to their ongoing design work while they are in school. The standards add relevance and explain not only how, but also why the standards are important to their professional development. Early findings suggest incorporating the standards has minimized confusion and has begun to improve instructional consistency across the curriculum. However, additional studies need to be conducted in order to fully assess whether or not the quality of student work has improved.
Future work on the CAD standards centers on the development of the next version. We treat the standard as a living document and there are several components that are scheduled for improvement. One area is the use of external references (XREFS). Survey results indicate that students and practitioners recommend incorporating XREFS in order to fully prepare students for work in a professional design office. One specific example under consideration includes prescribing a workflow in which all consultant files (e.g., architectural drawings, site surveys, etc.) are included as XREFS in the design base. Additionally, a workflow incorporating XREFS could be added to the construction detail instructions in the current standard. One final addition planned for the next version is incorporating a file and folder naming structure. Adding this component will reinforce the concepts of project collaboration, file sharing, and overall organizational skills related to project management.

Beyond AutoCAD, there are plans to expand the CAD Standard to include additional software students need to enter practice. Proficiency in the use of Building Information Modeling (BIM) software, such as Revit, is one of these needs. Additionally, some aspects of the CAD standards apply to the use of other Autodesk tools such as Civil3D or Map3D, but the specifics of these tools have not yet been addressed. Finally, standardization of the use of visual simulation tools (e.g. SketchUp, Lumion, etc.) is envisioned to be part of a future revision.

Future research should include longitudinal studies that look at student learning and change over time from the freshmen to senior year and possibly during the initial years of private practice. Studies could also investigate the best way to improve faculty adoption and use of the standards in their individual classes. A study of this kind could easily expand to other Landscape Architecture programs. Additionally, future research could investigate the continued prevalence of AutoCAD in the landscape architectural industry which serves as the basis for this study, and the relationship between what is taught in higher education versus software use and choices in the industry.

9 REFERENCES


March 17-19, 2021


EMERGING POSTHUMANIST DRAWING: LANDSCAPE ARCHITECTS DRAW LANDSCAPES AND VETERINARIANS DRAW BINTURONGS

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1 ABSTRACT
Two professors, one of landscape architecture and the other of veterinary medicine, discuss their approaches to developing their students’ drawing skills and applying drawing and observational practice in their work. Both disciplines teach drawing in order to develop a higher level of perception and rigorous visual attention. Their methods in teaching drawing suggest an alterity to the currently dominated technological bent of our disciplines. The need for drawing resides in its importance for seeing complex relationships and communicating complex ideas to other professionals and scientific collaborators. Perceptions of truths developed from observation and drawing are critical to success in the practice of each discipline and making students capable of confronting the challenges of our era. The authors examine differences and similarities in their approaches for providing beginning students with a useful and revelatory skill set. Posthumanist theory, is assuming an expanding role in opposing Humanist theory which has dominated design, design thinking, and decision making by negatively affecting the balance between the human and nonhuman relationships found in Nature.

1.1 Keywords:
Posthumanism, drawing, perception, cognitive skills, veterinary education

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2 INTRODUCTION

Drawing has historically been important to scientific ideas and communication. Not that long ago in the scale of human endeavor, scientists and artists such as da Vinci, were defined as humanists. They used drawing in their scientific work, and they challenged the status of events and topics of their day. They studied the world directly and decided the ‘truth’ for themselves rather than accept the norms of their day and the dictates of the church or existing scientific dogma. Many other famous scientists, perhaps less well known as artists, have done the same.

Luminaries like Da Vinci were not hemmed in by humanism. Although, the posthumanist way of thinking embraces contemporary theory the humanists shared a fondness for asking questions about the world they inhabited like the posthumanists. Drawbacks to their contributions was their anthropocentric view in controlling the world and relying on religion, science, and politics to guide their conceptions of man (Wolfe, 2010). Other humanist thinkers such as Louis Pasteur, Santiago Ramon y Cajal the Nobel Prize laureate, and the respected botanist Maria Sibylla Merian are great examples (Dubois, 1888; Llinas, 2003; Root-Bernstein, and Root-Bernstein, 2004; Stern, 1982; Valian, 1993). Each of these talented individuals demonstrated the benefit of their drawing ability in communicating scientific research and complex ideas but also showing how it might advance society. Humanism expressed a subjectivity towards the world that favored discrimination against nonhuman animals and the earth. (Wolfe, 2010). However, many of the skills, ideas, and approaches of humanism are being questioned for appropriateness and being updated for this century. Our intent, however, is not to focus on the exceptional individuals who have contributed to the history of art and science, nor the amazing tools developed to speed the processing of images, but rather to assert that it is valuable for scientists, artists, and professionals of all kinds to be able to draw in a posthumanist era. In modifying and rejecting aspects of humanism today, one needs to create a new system of knowledge and thinking and share it across the disciplines. The authors also assert that it is possible to draw, experience, and observe to provide insights to students in professional disciplines if they are being taught to see objectively. The outcome of teaching landscape architects and veterinarians to draw is giving them a platform for rethinking current values beyond the anthropocentric views of humanism and rediscovering relationships in evolution, technology, and nature.

3 THE MERITS OF DRAWING IN A POSTHUMAN WORLD

There is value in drawing from observation. Drawing demands careful examination of the subject. For those who photograph, a quick snap of the shutter may create what may be an overload of information for the viewer. In contrast, drawings properly executed, can focus the viewer on important nuances. Time spent drawing provides meaningful information, but also a platform for reflection, witnessing, discussion, and reframing. We are self assured that teaching drawing can keep students autonomous from the machines that drive society today and allow them to imagine a world without the responses that have endangered our kinship to nature, other organisms, and our environment in the past. (Haraway, 2004).

In landscape architecture a drawing can help characterize human and nonhuman motion and its relationship with anatomy in traversing landscape space. In veterinary medicine drawing allows the identification of structural defects, injuries, or impairments, and can reveal important habitat preferences. Observing people and mirroring their movement in a park bestows insight into activity habits and interactions between individuals and the environment. The movement of one’s body through a space elicits proprioception, a neurobiological action that adjusts our body position in space. Our bodies have an automatic and unconscious brain and body system carefully tied to our senses (Root-Bernstein, 1999). Enlisting curiosity during observation promotes thought about structural, natural, and biological patterns to help in evaluation of normal and abnormal situations. Expressing those findings to others in imagery is the usefulness of drawings.

Posthumanism continues to evolve as a theory. It has a long history of philosophical and scholarly debate that has created several strands of ideology and several definitions that are forming around the topic. Individual proponents of posthumanism come from disciplines in the sciences and the humanities complicating the framing of one given definition. Due to several definitions and descriptions unfolding around the subject, this paper will apply Gary Wolfe’s description found in his book, What is Posthumanism?, to help structure this essay’s reflections of the drawing courses.
“To return, then, to the question of posthumanism, the perspective I attempt to formulate here – far from surpassing or rejecting the human- actually enables us to describe the human and its characteristic modes of communication, interaction, meaning, social significations, and affective investments with greater specificity once we have removed meaning from the ontologically closed domain of consciousness, reason, reflection, and so on. It forces us to rethink our taken-for-granted modes of human experience, including the normal perceptual modes and affective states of Homo Sapiens itself, by recontextualizing them in terms of the entire sensorium of other living beings and their own autopoietic ways of ‘bringing forth a world’ – ways that are, since we ourselves are human animals, part of the evolutionary history and behavioral and psychological repertoire of the human itself. But it also insists that we attend to the specificity of the human-its ways of being in the world, its ways of knowing, observing, and describing- by (paradoxically, for humanism) acknowledging that it is fundamentally a prosthetic creature that has coevolved with various forms of technicity and materiality, forms that are radically ‘non-human’ and yet have nevertheless made the human what it is. (Wolfe, 2010).

Wolfe invites debate and discussion around posthumanism and shifting the boundaries surrounding the philosophical understanding of humans. Wolfe encourages us to reach further into the argument by having us look at how humans epistemologically know the world around them, by questioning the humanist anthropocentric perspective of humans, by inquiring about the use of tools by humans in developing information and knowledge, and ultimately joining in changing the values established by humanism from the Enlightenment to the present.

It is precisely these points he makes that are overlapping the initial strategies for deconstructing humanism and teaching drawing in a posthumanist mode. He believes that it is through thinking or re-thinking existing situations that are needed to meet the challenges we now face having inherited a world developed by humanist efforts and actions. Wolfe considers posthumanism a call to science and the humanities to act by “… decentering of the human in relation to either evolutionary, ecological, or technological coordinates... and how thinking confronts that thematics, what thought has to become in the face of those challenges.” (Wolfe, p. xvi). He further extends his argument beyond science and the humanities to even architecture and landscape architecture. He encourages working in an interdisciplinary manner because not one discipline has all of the knowledge required to resolve environmental challenges of today.

3.1 Drawing and Communication

The power of an image in communication is cliché. Consider “a picture is worth a thousand words” or “seeing is believing.” The value of an image can often be greater than written or spoken words, which are very culturally based and not always universally comprehended. Messages based on language can be infused with assumptions, prejudices, and political biases (Luntz, 2007). People generally intuitively understand imagery. This makes drawing an excellent way to present information effectively without ambiguity (Rothenberg, 2011; Gompertz, 2015).

3.2 Can Anyone Learn to Draw?

A widely held belief is that “a good drawer” has special talents. The commonly asked question, “Can anyone learn to draw?” enters the posthumanist debate. The question is a binary question that suggests you either can or can’t draw. Posthumanist thought entertains a different perspective believing that students are on a longer evolutionary path on their way to ‘becoming-with’ and becoming intertwined with nature, skill, culture, subjects, objects, or systems. (Haraway, 2016). It gives no single person power or control over drawing more than any other human in the classroom and suggests you should something else you are becoming with as you learn to draw. Embedded within posthumanism is the discussion around defining who and how power is established in society “in a web of relations with human and non-human others.” In their evolution of ‘becoming-with’ landscape architects and veterinarians, drawing can formulate their understanding and skill as an ongoing process of becoming-with during the fast-changing times found in society. Many adult students lament, “I can’t draw.” When the statement is explored, ordinarily this opinion of self-limitation was solidified at an early age, often before entry into formal schooling. Observing this common lack of self-confidence, several psychologists have rationalized an explanation based on early developmental rigidity of the neurological pathways in the brain. These scientists limit the possibility of good
drawing ability to not only a small subset of talented individuals, but then only to the few that are encouraged to draw at very early ages. The authors of this paper take exception to this prevalent dogma and believe with proper instruction anyone can be taught to draw. All our students have the capacity to learn to draw and demonstrate this by the end of the semester. There is considerable support for revoking this misunderstanding. Advances in neuroscience and neural plasticity tell us that “mature” brains can re-pattern neuronal connectivity and generate new neurons when needed. We do not postulate such adaptations are necessary for adults to learn to draw, but clearly there is no physiological reason why they would not be able to re-pattern their behavior (Barinaga, 1998; Gage and Temple, 2013; Doetsch and Scharff, 2001; Eagleman, 2011; Ramachandran, 2004; Dweck, 2006; Rose, 2005). 

It is unfortunate that upbringing can stifle drawing ability. Some of our students’ parents have always believed they themselves cannot draw and are often saddled with the same misconception. The availability of early drawing instruction in elementary school, by competent facilitators could do much to counter the damage inflicted by well-meaning parents.

For now, graduate landscape architecture and veterinary drawing courses have begun making positive environments and creating exercises that overturn existing negativity around the ability to draw. For example, an end of semester evaluation comment of the course by an MLAEP student, “[This] drawing class has been a highlight of my MLA[EP] career thus far. He [the landscape architecture instructor] re-sparked my love for drawing and art-making. Somehow, he is able to create a classroom environment that knocks down the ego and fears that sometimes accompany art and design, and instead sets the stage where the willingness to put pencil to paper and pin up your work is a success.”

4 DRAWING COURSE BACKGROUNDS

Professor Fernando Magallanes, a landscape architect, and Professor Michael Stoskopf, a veterinarian, became friends around 1999. Since then, they have taught in their respective colleges and collaborated on design projects. They have built a friendship around design, landscape, environment, teaching, and of course drawing. In the past five years there has been more intense collaboration and communication between Stoskopf and Magallanes exchanging ideas and methods for teaching their courses and have yet to teach the drawing courses together. Stoskopf has long been a proponent of biological illustration for his veterinary students. Since his early days at Johns Hopkins University to his arrival at NC State University, he has offered drawing courses to medical and veterinary students. In his drawing courses he allows for observational study and seeing to reveal what anatomical facts learned in the classroom themselves do not reveal to the student. Magallanes has evolved a similar way of thinking about his drawing course. At first, his course was mandated to teach his students to fulfill the department’s need for drawing accurate, traditional, and well communicated plans, sections, and perspectives. Over the years, his teaching changed as he discovered new directions in the discipline were requiring students to account for more complex issues found in the landscape and environment. Drawing had to change to maintain its importance and relevance to society and engage new philosophical and scientific debates taking place.

The two drawing courses are taught separately in their respective departments of Landscape Architecture and Veterinary Medicine. The courses attempt to recontextualize the students’ thinking through an immersion of all the senses and suggest a stronger awareness of relationships with other living beings and natural systems in the world. The students arrive in class exhibiting “taken-for-granted” attitudes about humans and knowledge about their environments (Wolfe, 2010) but soon learn to discern patterns in the world questioning what they know with what they see. The marks on paper begin to engage and focus them on a world that they had forgotten or never paid attention. Both courses provide physical immersion into environments that brings about new perceptions through the physical act of being in the environment, culture, and system relationships they are assigned to draw. The dots, the lines, the scribbles, the smudges, and the values begin to expose a surface with an image that is ready for discussion and filled with cognitive insight. Maya Lin, the designer of the Vietnam Memorial has something say about what was missing in her education as an architect. She complains that she was never taught architecture or about sites of other cultures except those of Western Europeans. “The way we are taught is severely lacking.” She accounts that she had to travel to China and Denmark to fully immerse herself and learn about a culture. (Lin, 1998). This immersion she mentions is what these courses do. They immerse the students in the regions and locales where they live to make up for the severe lacking that Maya Lin expresses. A good example of posthumanist becoming-with by learning architecture with a culture.
The North Carolina State University (NCSU) Landscape Architecture department offers an elective 16-week drawing class for graduate students, who are typically between 22 and 37 years old and have little experience in drawing, art, or design. This course began as a required course that later became an elective. The course was pushed out of the core curriculum to make room for computer-based courses. This demotion separated students from nature and the environment by causing the students to spend hours in sensorially barren computer labs devoid of contact with the outside world. Over the last decade the drawing course had maintained its focus on drawing in line with the tradition of landscape architectural history. The drawings for students became stereotypical symbols of what was represented in drawings. A drawing of a tree, for example, would be represented as a symbol representing a tree in plan, section, and perspective rather than expressing the true qualities or conditions expressed by a tree in the environment showing its leaf texture, microenvironment, or response to wind movement. The course evolved, as an elective, to emphasize drawing as a tool for exploration at the intersection of human evolution, natural systems, the complexity of culture, and responding to a complex layering of information found in landscapes. The course is designed to give students the basic skills of drawing but also to interrogate and visually question the world they are drawing. It is in the re-thinking of why and what is drawn that creates an opportunity to explore rethinking what is being drawn. The use of various drawing media reinforces the re-examination of landscape representation offering an alterity to previous beliefs about landscape and its application of landscape design proposals. By the end of the semester a student should feel comfortable with various media, with using drawing in design ideations or visualizing proposed landscapes and understanding environments from a sensorial perspective.

The drawing course taught to veterinary students at NCSU is relatively novel. It is the only course of its kind in a veterinary curriculum in North America. Also taught for 10 years, the intensive studio class is uniformly fully subscribed. The course is one week-long, and approximately 40 contact hours, including a juried show on the last day, and a field excursion mid-week to draw animals from life.

Students enroll in the elective course through a system that uses assigned lottery numbers and student seniority to choose 12 students from a much broader pool seeking to take the course. Each enrolled student is asked to create four drawings in the early part of the semester, ahead of the start of class. These are 1) any animal in motion, 2) any animal demonstrating emotion, 3) a designated bone on one of the skeletons on display in the college, and 4) a rendered image from a provided animal photograph. These are used to assess the student’s abilities entering the course and determine how best to move them forward in their drawing.

Registration has always included at least one student with highly developed drawing skills, including students who have studied design or art as undergraduates before choosing a career in veterinary medicine. More importantly, every year the course has included several individuals with drawing skills limited to crude stick figures and students with skills between the extremes.

5 METHODS FOR TEACHING OBSERVATION

The capacity to see and understand what is seen offers advantages in application for veterinarians and landscape architects. For a landscape architect the ability to see provides a means of capturing the integration of form (shapes, geometries, proportions, textures) and the function (aesthetics, comfort, utility, safety, ornamentation, systems) of a landscape. The benefits to a veterinarian include some similar understandings, but also identification of abnormalities in stance, locomotion, or interaction in groups of animals. For both professions, improved observation through disciplined viewing, provides awareness of issues important in their practice (Tversky, 2019) and questions what accounts as ‘human’ or posthumanist (Haraway, 2004). Drawing provides a powerful tool for disrupting previous biases, for making better evaluations, and for communicating new observations discovered in about what is being studied.

5.1 Veterinary Drawing Course

The first day of the class involves the introduction of the instructor and veterinary students followed by brief warm up exercises. The instructor helps individual students with concepts and techniques identified as needing improvement from the pre-course artwork skills survey which he sends out two weeks prior to the start of class. The first two days focus on developing graphite pencil skills and most of the drawing time is self-determined.

Students are provided with a thick pad of drawing paper with a challenge to use up the pad in the course. No one has even approached meeting that challenge. The large format paper is purposeful. It
encourages students to grow out of their natural tendency to draw small. Students are also given pencils of varying hardness and are transitioned to softer leads. Other than art experienced students in the class, most are unaware of the different choices for hardness in pencils. The presence of art trained students in each class has been fortuitous. They serve as examples of what to strive for, but more important, served as important peer mentors to the other students. The effect cascades through the skill levels, with students helping students with less developed techniques than their own, magnifying the impact of the one instructor. This interesting and consistent phenomenon emerges on day 2 or 3 of the five-day class.

On the afternoon of day three, the class is introduced to ink and three techniques: hatched line, stipple, and what we call squiggle, a very rapid rendering technique that often resonates well with less experienced students (Figure 1). We work on developing signature styles and signing as a symbolic gesture of completion and acceptance. Students present self-selected images demonstrating at least one example of each technique, taught in the course for display in the show. The show is attended by 50 to 100 visitors and the 4 or 5 jurors provide primarily positive critiques of the displayed works to each student. The finale of the juried exhibition is announcing seven works chosen to be displayed in the college library. A juried team of artists, the CVM librarian, and veterinary faculty help select the work for the library. The works hang in the library so part of the criteria is show examples that read well at a distance, can connect with other veterinarians, and demonstrate a high level of graphic skill using line, value, and sometimes color. The quality of the juried show art is quite amazing, with every student demonstrating remarkable improvement over their pre-class demonstration works.

Figure 1. Three techniques taught in veterinary illustration. Rapid continuous line squiggle by V. Su. Pencil drawing by J. Griffioen. Ink stipple, by V. Isler. Photos by M. Stoskopf.

5.2 Landscape Architecture Drawing Course

The landscape architecture course begins with a focus on using a variety of media, basic drawing principles, and seeing relational elements in the landscape (shapes, patterns, textures, colors, proportions, other humans, animals, and plants). In most cases, landscape architecture students assume they know landscapes because they traverse them daily, but the class assignments serve to challenge this assumption. Students are required to walk in various landscape types (parks, campus, urban settings, trails, historic sites) throughout the semester. They are required to draw scenes they select on their walks. Stopping to draw creates decision-making moments in selecting what to draw on their walks. This encourages rigorous seeing and questioning of the landscape in all manner of detail leading to another level of consciousness in the student (Figure 2). What is the play of sunlight on the landscape? What environmental issues conflict with the human issues? What is visible and what is not visible? Is there a visible history or herstory to the landscape? Who and what inhabits our shared environment? One student from the 2020 spring semester drawing elective commented, “the walking aspect was very beneficial and important to improving observation skills and enforcing drawing concepts learned in class.” (Class
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Evaluation 5/2020). The once a week, three-hour class is divided into three parts: discussion of the previous week’s drawings, a brief lecture introducing a drawing technique, and an instructor directed demonstration inviting students to practice drawing from slide images that exhibit similar qualities to those found in the field. Group field trips are interspersed throughout the semester. The classes are moderated with discussions to allow students to present their drawings and discuss what was discovered by drawing a particular place. In discussions students often surprise you by making a comment that their drawing captured physical forces in opposition to a healthy human and nature relationship. These kinds of ideas do not surface when we take a simple walk to class. The discussions reveal the students’ thinking along with struggles with the mastery of the media. Reviewing and discussing the works introduces the student to valuing their drawing for what it can reveal through the act of drawing. A former student commented in a class evaluation from the 2020 spring semester drawing elective, “he fostered a safe space for us to freely talk about our drawings and give each other feedback.” (Class Evaluation 5/2020).

![Figure 2. Student drawings of public walks. Fate Malek (2020) 21.59cm x 27.94cm ink and markers. Sarah Dunsford (2018) 21.59cm x 27.94cm. Markers. Cartridge paper. Raleigh, NC, USA. Photo by Fernando Magallanes.](image)

6 KEY STUMBLING BLOCKS TO TEACHING POSTHUMANIST SENSIBILITY

The teaching situation is not different in the veterinary and landscape architecture course, where many of the students either believed they could not draw or struggled because they had little or no instruction prior to the course. Being highly intelligent and hyper-motivated in every aspect of their education, graduate landscape architecture and veterinary students hold themselves to unreasonably high expectations. However, many of the students need rudimentary help with basic concepts such as proportions and perspective. It is particularly important to convey to them the concept of starting over and making many attempts to achieve a desired product. In veterinary medicine this runs counter to the false but prevalent tenet of perfection in every effort and in landscape architecture those with science backgrounds respond in the same manner.

Two insights have surfaced after teaching the landscape architecture and veterinary drawing courses. Firstly, is reinforcing the concept of ‘rigorous practice’ and ‘varied challenges’ in accommodating successful learning (Duckworth, 2016). Students must learn to draw daily with time allocated to undertake the practice of their new skills they are being taught. Educational psychologists have also discovered the basis for learning something new is focused attention on a subject but also studying it from various points of view (Brown, Roediger, & McDaniel, 2014). Making the practice experience a daily event and varying the challenges each day offers the students’ brain the ability to build new neurons. For example, varied
challenges for students might be to draw a tree with a pencil one day and ink or watercolor the next. Use of different media in assignments formulates cognitive knowledge by engaging the use of different drawing materials in practice. Using various drawing media in drawing promotes thinking and exploration in one media and allows new ideas when using a different media (Haraway, 2004). Purposely designed exercises challenge the student to develop more long-term use of cognitive skills rather than short term motor skill learning.

Secondly, students must learn to accept failure to succeed. Most students entering the class have difficulty learning because they possess the Hazard of Perfectionism Syndrome, a phrase coined by Stoskopf, the instructor of the Veterinary drawing course. This syndrome prevents many students from advancing because they assess all work during the learning phase against a standard of perfection. To overcome this, students are encouraged to understand the value of failure as a means of learning (Lehrer, 2012; Syed, 2010; Duckworth, 2016). Once the class is under way and many drawings are experienced, the students become more comfortable as they see their drawings improve. One former student commented, “[The instructor] really wanted us to improve and it was okay with us making mistakes and slowly improving our skills… I wasn’t afraid to make mistakes and ask questions and I think that is a huge reason why I am better at drawing and sketching than before I took this course.” (Class Evaluation 5/2020).

7 VALUABLE TEACHING TECHNIQUES

7.1 Veterinarians

In the veterinary illustration course, speed drawing development has been particularly valuable. The technique evolved over the first several years of the course to overcome student inability to draw from life. Even the “experienced” students were unable to generate recognizable sketches of animals from life before the advent of the teaching technique. The biggest challenges for the students were movement of the animals’ poses and perfectionism stifling attempts at gesture drawing.

Projected still images of unique species of animals in relatively simple postures are displayed for 5 minutes for students to draw. Students are given repeat chances to draw the same image, but as the session continues, the time is reduced. The exact patterns of repeats and timing varies with the class response until only 2 minutes is allowed for a drawing. The students are exhausted at session end, but most seem to enjoy the chaos (Figure 3). They are amazed to discover they like the drawings executed in shorter times better than the drawings where they had longer time.

The second day of the course, another session drawing from still images starts with two minutes per drawing. Then under loud student protest, a one-minute limit is imposed. Their ability to do this startles them. After a short rest, the exercise shifts to drawing animals viewing one-minute videos. For the first attempt they are shown only the animal they are drawing. The second attempt adds a synchronized insert of the instructor’s hands drawing the same animal in an upper corner. The inset captures an unedited first attempt by the instructor showing hesitations, explorations and obvious imperfections in the renderings as normally occurs. After each one-minute attempt, the class briefly discusses what worked and how it could have gone better. The sessions desensitize the students to motion and teach them to wait for the return to position of moving parts, or to meld body parts from different postures into a coherent sketch.
The morning of the third day the class is treated to a field trip to an animal sanctuary. They are allowed to sit in field chairs and observe and draw lions, tigers, wolves, small felids (a wild cat) and binturongs going about their daily routines. Student work is not directed or timed. The instructor moves among them while also sketching. The impact of the exercises from the previous days greatly improves the quality of the sketches. Even the least confident students are drawing as well as the best students in the class. The binturong also serves an important purpose with its unique anatomy as a largely vegetarian viverrid (mammal in the civet family). It requires the students to draw what they see without including what they know or expect (Figure 4).
7.2 Landscape Architects

Early in the course students need to understand how drawing with traditional drawing media (markers, pencils, pens) hampers growth and development of skills and ideas. One valuable technique in the landscape architecture course is one that involves reshaping the students’ thinking. Drawing with twigs of various lengths and widths collected from trees is used in the introduction of the course to sever traditional ways of drawing and a posthumanist 'reframing' through the transgressions of traditional methods used in our programs. Each student is handed several twigs along with a small cup of black India ink (Figure 5). Asking them to use twigs as drawing tools helps break down pre-conceived assumptions about how to hold a manufactured drawing tool and brings attention to many new possibilities for making marks, lines, and informing the body and mind about what is being drawn.

Students are encouraged to explore as many different marks as the twig can make. The twig offers varied types of marks on the page by pushing, pulling, dotting, dragging, and rolling the twig. Holding a writing instrument to write is very distinctive from holding a drawing instrument and requires a different kind of precision and movement. Drawing with a twig allows loosely holding it and transfers the physical pressure and holding position to drawing with a pen, marker, charcoal, or watercolor brush. They also discover that it requires not only just hand movement to guide the drawing instrument on paper, but also their body. They realize they have access to the power from the wrist, the arm, the shoulder, or the entire force of their body in laying down marks. The newly experienced types of pressure and movement of the hand has them thinking about many factors open to them in drawing. Throughout the semester the use of twigs and similar activities are repeated to reinforce this new way of thinking. When they return to drawing with a traditional pen, pencil, or marker, they are more cognizant of how they hold and use their drawing instrument to yield a variety of ink marks when applied to paper and their drawings.

Figure 5: Students drawing with twigs and working in studio. Exploring mark making, hand-tool relationships, hand movement, marks, and using wet medium. (2018). Twigs, India ink, cartridge paper. Raleigh, NC, USA. Photos by F. Magallanes.

8 CONCLUSION

To draw and observe landscapes and binturongs means engaging firsthand with cognitive functions to counter existing humanist patterns of behavior and thinking. By unifying drawing with observational exercises delivered in the drawing courses, it reconnects veterinarians and landscape architects to humans, non-humans, and nature in a way the traditional anthropocentric humanist does not. The drawing approaches found in these courses have given the students an ability to reconstitute and disrupt humanist views and values that are questionable practices of humanism (Haraway, 2004). A former student recalls the valuable lesson in observation, "[the landscape architecture instructor] instilled in me
that observation is a critical component of a designer’s process. I can’t recall [another] professor who taught how to see in order to understand and store designer’s observations…”. (Documented letter 11/22/2019).

Students in these drawing courses have provided written feedback describing the benefits of learning to draw through direct observation. These individuals voiced an awakened consciousness about the environments they traversed and drew. John Griffeon, who is now a Doctor of Veterinary Medicine (DVM) at the Indianapolis Zoo, acknowledges values gained by taking both Stoskopf’s drawing class for veterinarians and a design studio experience with Magallanes where he was required to draw. Griffeon explains, “I now approach aspects of my job, including the management of endangered and threatened species, with a more holistic approach... I find myself analyzing the structure of zoo exhibits and design of holding facilities, searching for ways to improve the function, appearance, and ultimately well-being for the spaces' inhabitants.” (Documented letter, 11/19/2019).

Alignment of drawing course with posthumanism happens in four main areas:

• Information from other disciplines influences the formation of exercises and the way students are taught to sensitively approach their drawing subjects. Anthropology, Biology, Art, Anatomy, Horticulture, and History are examples of disciplinary influences prompting curiosity and questions.
• Seeking the visible and the relationships made visible. Account for a range of relationships ranging from invisible to visible.
• Observation amplifies one’s perceptions. One sees more events / consequences / affects that permits better communication between disciplines and groups of humans.
• Posthumanism strongly advocates learning about the natural world for humans to recognize the place of humans and nonhumans within it.

The authors believe this paper pleads for making drawing available to professional disciplines like landscape architecture and veterinary medicine. Drawing introduces a different framework for teaching posthumanist theory. In the overly prescribing of professional landscape architecture knowledge and veterinary anatomical knowledge of landscape and animal subjects, exposing students to drawing and direct observation becomes a new and healthier approach to seeing the world. By de-emphasizing the professional norms and instead teaching inquiry through drawing, reconnects the eye, the mind, and the hand with a more earthbound consciousness in experiencing and looking at our world. The hope of the two drawing courses are to move students from being anthropocentric individuals to being posthumanist beings who assess earthbound environments for humans and nonhumans and observe and capture the complexity of our world with a greater ability.

9 REFERENCES


March 17-19, 2021


EXPANDING THE VIRTUAL CLASSROOM

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1 ABSTRACT
With the fall 2020 semester taking place in a virtual environment, two professors, one in landscape architecture and one in ecology, hailing from different universities, came together with an experimental scenario. This study explored how the research seminar and remote teaching can take on a new form of collaboration in the classroom. Building on the two disciplines of the academics, the course provided the students with the opportunity to gain knowledge and establish a broader network outside of their current institution and field of study. Merging the courses at specific times during the semester, fostering discussion and engagement, critiquing design work, and participating with case studies that demonstrated ecological design, informed the work produced in both courses. The students were a mix of graduate landscape architecture, urban planning, and ecological science. At the end of the semester the faculty performed an anonymous survey, inquiring about the perceived benefits and challenges of the overlapping courses. The students responded positively, stating that the course expanded their thinking and was a significant benefit to their studies and perspectives in their fields. Furthermore, the students suggested future course collaborations with disciplines such as, art, architecture, information science, human ecology, indigenous studies, and real estate. Some drawbacks mentioned were, zoom fatigue, difficulty collaborating across multiple time zones, and collaborating in person due to social distancing. This paper focuses on the opportunities and outcomes from the approach, exploring how this overlap could engage more productive, and novel remote learning environment in the future.

1.1 Keywords:
Remote learning, shared teaching, interdisciplinary practice
INTRODUCTION

This research evaluates the potential in cross disciplinary and cross institutional teaching opportunities created by the online learning environment of the COVID-19 pandemic. Understanding the values that virtual learning can bring to benefit students by utilizing adapted methods of engagement, and new events for remote technologies. There were a variety of online tools available to make the course more engaging and hold the students responsible for actively participating in each class. It brought new techniques to equalize learning across the students in terms of access, as well as understanding the benefits from a collaborative semester. Lastly, this explores the opportunities of developing relationships between institutions, departments, professionals, and academics to evaluate the challenges as well as the strengths this mode can offer.

The disciplinary boundaries of landscape architecture are often discussed in both academic and professional settings (Kullmann, 2016). Its situation with the built environment often requires that projects collaborate with adjacent fields to address areas of expertise within specific scenarios. In practice, disciplinary relationships continue to strengthen, but can still be misunderstood, as building projects become larger and more complex around the world. Designers, ecologists, economists, and engineers all rely on each other’s expertise when developing densely entangled designs in our built environment. These relationships are conceptually introduced during the landscape architecture curriculum through a series of courses such as studios, history theory, and research seminars, but it is not a core component of the curriculum to have a collaborative project between landscape architecture and ecology students (Steinitz, 2020). Outside of the enhancing the virtual classroom, the other core intention of this study was to expand it, by introducing interdisciplinary engagement in the course to strengthen recognition and collaboration between design and ecology post-graduation.

These relationships are an important cornerstone in design education and practice. With the effects of climate change, gathering data on ecological restoration, habitat, resiliency, and performance is more important than ever when addressing a site. Facilitating these relationships early in a student’s academic career should be seen as important and finding new methods in which to engage with ecologists as well as other disciplines when entering the field (Handel, 2014).

A typical method of cross disciplinary engagement within institutions is to create design studios with both architecture and landscape architecture students enrolled, with the task to develop a comprehensive site proposal. Academic design disciplines are often, but not always located in the same school within an institution, with multi disciplines of students studying in one building, making it easy for them to physically collaborate. While in school, collaborative competitions are another opportunity for students to engage with each other on conceptual and tangible design proposals. Highly publicized opportunities such as the Urban Land Institute Hines student competition, teams will often be composed of landscape architecture, architecture, planning and real estate students to bring more depth to their proposals, as well as a real-world approach. The EPA hosts an annual Campus Rain Works Challenge, which is an opportunity for environmental design students to develop proposals for new ideas for green infrastructure.

METHODOLOGY

This research was conducted over two courses, research seminars in a landscape architecture department and ecology department at different universities during the same semester. Each course ran 90 minutes in length. One occurred in the early morning, with the other taking place midday. The total cohort for both courses was eleven students, all graduate students in advanced levels of their degree programs. The identification for all the students enrolled were: five female and one male student pursuing their master’s in landscape architecture. There were two male and one female dual degree students completing degrees in landscape architecture and regional planning, and one male and one female student in ecology and evolution programs. One of the female MLA students was taking the course from another country with a 12-hour time difference. While the two universities and remainder of the students were in the eastern time zone. At the time this was proposal organized during the pandemic, official scheduling that worked between institutions was challenging to coordinate. It was offered as part of the course introduction to the students but was not a requirement that all meetings were attended for the opposing course. A semester schedule was provided to each of the class groups, with specific presentation dates identified for lectures, reviews, and informal pinups.
Each course held a weekly virtual meeting to provide equitable engagement to all students enrolled. Both courses used zoom as the meeting platform. Each student had a laptop computer, equipped with a camera, microphone, speakers, and adequate internet access to participate in all discussions and presentations. Tools within zoom such as screen share, computer control, recording, and annotation were used as an additional means in which to communicate and present. Short skill tutorials were held for representation and modeling programs, such as rhinoceros 3D, to teach specific workflows. The professor would record those sessions through zoom and distribute the link after class. It gave students the ability to revisit and replay at their own speed of work to develop their projects.

The landscape architecture course topic was focused the elements typically designed for landscape. Examining their core contributions to the discipline and how they have evolved over time and with civilizations. The course was structured with a lecture on each of the identified elements; the fence, the path, the bosque, the parterre, and the folly. Followed up with readings, discussions, research analysis, and design charrettes. For the midreview assignment, the students each selected one of the elements and established a new approach or a redesign. With a self-assigned site context, they were asked to challenge traditional methods, materials, construction techniques and performance. For their final assignment, the students worked in teams of 2 and 3, and created an environment which combined their elements - speculating on a new future. The students were assigned to embed ecological and social functions into their proposals, to better understand the relationship between designer and ecologist.

The ecology course topic on urban restoration gave a series of introductory lectures on the core components of urban ecology. Additionally, the course hosted a series of guest lectures given by prominent practitioners and leaders in the field of landscape architecture who have worked on projects closely with ecologists in their work. The speakers presented projects with which they, and their firms had been actively involved in. The content of each of the lectures addressed design solutions supporting key ecological concepts. The scale of projects ranged from regional master plan to local community parks. The work presented was a complement to the focused elements presented in the landscape architecture course, grounded in real world precedents. Projects included a coastal landscape redesign, a transformation of an urban landfill into a large public park, the reaction of an urban park on a riverine island, and a dunescape design. The lectures were not recorded at the request of the speakers presenting, so students were required to attend these lectures to engage with the speakers, on the content presented.

Supplementary to zoom, the courses used Miro (Figure 1), an online virtual pinup website. Free to educators and students. Each class would have a dedicated board for their work, and students would be able to upload content to discuss at each meeting. During a normal in person semester, work would be pinned up before or during class, reviewed, annotated, and taken down at the end of class so that the next course using the room would be able to use that same pinup space. The intelligence of the online pinboard was its consistency throughout the semester to review student work. A flexible platform, it allows students to upload both images, notes, and animations of their work. Simultaneously observers could annotate and leave notes outside of typical class time, or during class time. A visual timeline for the course, it provided documentation of the progression of the work and research for the students and critics to review as a complete body of research. A physical equivalent would be, if each class was able to have the same room throughout the entire semester without having to remove and replace their work each time. Additionally, the amount of sketch, printer, and plotter paper saved from the trash bin was a considerable amount. Miro is not only a sustainable alternative to the physical pinup board, but also a platform that elevated the level of discussion as evidence of the progression of research, thought, and skill throughout the course.

Once the course was over, an anonymous online survey of 8 multiple choice and free answer questions was conducted to gather more information from the students regarding their experiences with virtual learning throughout the semester. Questions specific to the delivery of the course and the collaboration with the other students and instructor were posed. As well as questions more general to their experiences in all classes during the remote semesters. One key takeaway was students stated that they felt that online learning is more time efficient than traditional in-person education.
Figure 1. This was a sample of the Miro board showcasing the classes work. This was used as a tool to review and exhibit drawings and research throughout the semester.

4 RESULTS

There were several key findings from the survey and observations from the professors during the course. When the cross-course were proposed, the interest was incredibly high, 98% of the students who came to the first meeting continued with the course. During the first-class meetings, each instructor presented the students with the schedule, information for the alternative course login, and lecture topics and readings. Engagement in the cross collaboration the courses was high, with at least 50% of the landscape architecture students attending 3 or more of the 5 guest lecture presentations in the ecology course, and 100% participation with all progress reviews from the ecology students for the design work presented in the landscape architecture course. With each of the sessions, 100% of the students in attendance would unmute themselves and ask questions of the presenter and fellow students post presentation.

The ecology course professor as a positive impact with the landscape architecture students' design process while developing their midreview and final review landscape element proposals. Critique and discussion between both professors helped guide and frame new concepts and performance criteria within their proposals and shaped their final concepts and understandings of how to make landscape elements more productive and habitable for flora and fauna.

All the students commented in the survey that they felt the other courses' content was complementary to their graduate studies. The students were asked what additional disciplines they would be interested in collaborating with in the future, and they suggested departments such as, art, architecture, natural resources, planning, human ecology, and real estate. Many mentioned that being connected with another institution was helpful, particularly because the students were in different programs and the professors were specialists in their fields with complementary perspectives and expertise on landscape architecture and restoration ecology.

The most challenging issue of the course was the scheduling and timing of the class meetings, as some students had time conflicts during the scheduled course slot. There was a request that the lectures be recorded for those that had scheduling conflicts, though on days with guest speakers that would require notification and permission from them prior to the delivery of the content which was not confirmed. Overall, the students responded positively to the overlap, and with an 88% response rate of saying they would take a course like this in the future.
One significant benefit that was noted from multiple students was their excitement towards the level of access to engage with professionals and academics who participated. In a traditional setting, those individuals might not be able to take the time to travel to the university and meet with the class, was seen as a highly valuable networking element for their educations and their careers (Figure 2). They saw these sessions as incredibly timely and beneficial to their studies and perspectives post-graduation. Though these types of online engagements do not provide the one-on-one sidebar conversation or question one would typically have in an in person setting, they recognized the benefit. They stated excitement towards learning about the on the ground aspects of current and relevant projects from the perspectives of the individuals that are actively implementing with them and working with local environments and communities.

Another benefit that was stated on was the use of Miro as a pinup platform for the course. Being able to see and review their classmates’ work on days and times outside of the course was a beneficial review tool, which inspired and connected them when they were not able to be together (Figure 3).

Multiple students commented that virtual learning saved them time they would normally spend commuting to campus, and this was seen as a positive addition to their daily life balance. This was particularly true for the student who was unable to travel to the US because of visa restrictions. The virtual delivery allowed many students to be able to continue their studies during a challenging and stressful time. The students reported that they had hoped for a formal integration of the classes to work better with their class schedules, as many of them had another class during the time of the alternate course. They also stated that they would have liked assignments that blended with the other students to go beyond just the dialogue introduced in the lectures. Some limitations mentioned were that it is harder to sketch ideas virtually than in person because of issues with social distancing. Group work among different time zones was also mentioned as a significant challenge when it came to scheduling collaborative time to work on assignments. Utilizing the breakout rooms into smaller focused discussions was seen as a benefit to be able to connect with the professor and fellow classmates in a less formal setting.
There was also mention from multiple students of zoom fatigue (Fosslien & West Duffy, 2020). Discussions surrounding the amount of time design students spend working towards their degree is a highly concerning and criticized issue, so it should be no surprise that students are finding it difficult to concentrate in every course (Lynch, 2017). Considering the number of distractions and focused attention that must be balanced with remote learning, universities will need to develop better practices for virtual and hybrid content delivery for students and professors going forward. Design teaching will need to be reconsidered, restructured, both pedagogically and logistically (Masdéu & Fuses, 2017). A potential limitation with a hybrid scenario would be to the individuals not served with individual cameras but located in a larger room with many individuals. The lack of direct eye contact may deter some students from speaking up and attempting to engage with whomever is logging in remotely. Issues such as zoom fatigue, and multiple time zones require a critical rethinking of format and engagement at both the administrative and educator levels. This would require further studies and surveys to accommodate scheduling, platforms, and delivery to maximize the student’s experience.

The profession was already participating in some forms of remote communication prior to the quarantine situation of the pandemic. Clients and consultants would not always physically travel to a communal destination to hold a meeting or discuss timeline. It appears some forms of operating remotely is a method of work which will be more readily accepted as a form of professional office life (Prossack, 2021). Thereby having students fluent in the platforms and approaches to online delivery and communication would serve as a benefit to their future careers. Understanding the tools and techniques that technology can offer in delivering engaging and variable content, will continue to evolve with the ongoing realities of the future continue to develop.

Figure 3. The flexibility and endless space in Miro allowed the students to compile their finds and document them publicly throughout the course. Note features allowed others to virtually comment and provide feedback both in real time during the course, and outside of class hours at the student’s availability.

5 CONCLUSION AND FUTURE RESEARCH

This study examined an opportunity of online learning to collaborate between instructors and institutions to share more information and expand research through courses. The students engaged with the professors, professionals, and each other during the course, enriching their understanding and exposure of the cross disciplines. Future discussions should be held between departments on courses that blend disciplinary programs as well as outside institutions to bring alternative experiences for students and creating more collaborative academic scenarios.
Like professional offices, universities will most likely need to continue to address some form of virtual content delivery for students. Developing concurrent approaches to in person or hybrid teaching that accommodate scheduling, platforms, equipment, and delivery of content to maximize the learning opportunities. Issues such as zoom fatigue, and multiple time zones require a critical rethinking of format and engagement at both the administrative and educator levels.

To engage with individuals outside of the local region of the university through these digital platforms is highly beneficial for the advancement of conversations and collaborations between academia and practice. The efficiency and success of online learning in this semester suggests that the role of the virtual classroom could play a more prominent role in the physical classroom when it returns to the in-person learning, and perhaps a hybrid approach. Through video calls, and large-scale projection, professionals, specialists, critics, and academics could continue to join class meeting times, without the cost and time it traditionally takes to travel to an institution outside of their area.

The benefits from reducing the amount of paper utilized during an in-person course is significant for the economics of the student as well as the environment. Thereby platforms like Miro could continue to be utilized to present and review student work. The ability to record content is not a readily available method when teaching in a physical classroom but is something that should be carried forward into subsequent semesters to allow students to revisit content at their own pace.

The tools and strategies utilized in this course and others during the pandemic should not be dismissed when returning to pre-pandemic classroom. The virtual classroom can be utilized as a method to break down disciplinary barriers, as well as institutional barriers to further design research and expand the thinking and engagement regardless an individual’s location. More research needs to be conducted with other course types to assess the impacts and opportunities collaborations like this can promote.

6 REFERENCES


EXPLORATORY BUILDING: A MAKERS APPROACH TO LANDSCAPE ARCHITECTURAL EDUCATION

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1 ABSTRACT
The authors argue that Design-Build has been an innovative and effective method of implementing landscape architecture studios where designs are both designed and built, and students learn by thinking, reflecting, and doing. We suggest using the term Exploratory Building (EB) to better describe the academic learning model that encourages student exploration and discovery of innovative ways of designing, making, and problem solving. Its strengths include a symbiotic relationship between the acts of design and building, tangible community service, created assets, professional skill development, and ease of transition from academia to practice. Many faculty believe EB is a difficult model to implement and incorporate in their curricula. Understanding the many challenges and significant efforts required, we use decades shared experience and literature to offer strategies to develop and manage EB programs and reduce resistance to the expansion of this model within the Landscape Architecture pedagogy. We argue that the challenges of funding, time demands, liability, and the application of EB to recognition and promotion can be addressed. What remains, a critical area of further research and documentation, is to improve upon and address the pedagogical advantages that students perceive to result from this learning model. The modest number of experienced faculty and programs continually implementing EB suggests a rigorous assessment of landscape architecture EB programs is critical to document the value, or the lack of, that students place upon the EB model, and to encourage additional LA faculty to develop EB programs in their respective institutions.

1.1 Keywords:
Design-build, pedagogy, service-learning, experiential
2 INTRODUCTION

Exploratory building (EB) is a descriptive term we have applied to a specific applied experiential education model that utilizes making as the primary method to investigate space, form, materiality, ecology, meaning, broader issues of social justice, ecological design, community identity, and equity. We advocate the use of EB as the preferred term in comparison to design-build, as it more aptly describes the academic learning model where students explore and discover innovative and appropriate ways of designing, making, and problem solving. The term design-build is often associated with the professional project delivery that differs in intentionality when compared to its academic goals. EB’s prominence in landscape architecture (LA) programs is admittedly modest when compared to more conventional methods employed in design studios, and in material and construction courses. The opportunities and benefits embedded in EB are numerous, yet it is notably absent in most LA programs (Winterbottom, 2020). The effort to develop and manage an EB program is undeniably substantial, but students find the experience valuable both as a pedagogic model and for skill development especially in their transition from academia to practice (Winterbottom, 2013).

3 REVIEW OF COMMON CHALLENGES

In this paper we address four common challenges associated with (Project Funding, Liability and Safety, Faculty Recognition, and Student Assessment) and attempt to broaden the acceptance of EB by presenting strategies to benefit faculty intending to develop their own programs. Each challenge is presented with a literature review covering common themes associated with each strategy. Through review of literature and expert observations, the topics are discussed and analyzed along with potential solutions to address each challenge.

3.1 Funding and Time Constraints

Exploratory Building project success is contingent on the ability and willingness of faculty to develop achievable course objectives and secure the funding and resources to support those projects (Doyle and Whitehead, 2017). Securement of funding requires a significant time investment with agreements/contracts ideally in place at least a year prior to the start of the project. Most funding directed to academic programs is focused on research initiatives and often they are not allocated for capital (construction) related activities unless they are sourced directly through university building and grounds, facilities capital budgets, or donors willing to fund building activities (Winterbottom, 2020). These and other restrictions associated with established grant funding requirements create significant hurdles for EB programs. In addition to use restrictions, many funders require post-completion documentation with stated intended outcomes, for example student learning or community empowerment have been met. This suggests that a more rigorous evaluation component should be integrated within EB projects to evaluate if and how outcomes, such as student growth and learning are measured and their effectiveness. For example, are learning outcomes lesser than, equal to or greater than those offered in design studios without an EB component? With a wide selection of worthy endeavors to fund, EB faculty must develop a body of evidence that validates EB experiences from multiple perspectives that can be used in funding applications and open a broader source of funding streams.

EB programs rely on a variety of funding mechanisms to support projects, most of which is dedicated to implementation (Canizaro, 2012). Often a combination of sources are used to fund EB programs. For example, through a partnership between the Iowa State University Department of Landscape Architecture and the Iowa Department of Corrections (IDOC), initial funding for an EB project was allocated by IDOC within their construction budget for a newly expanded prison. Over several years, additional funds were needed and through budget tightening, additional funding from IDOC and in-kind donations, successive projects were implemented at less cost than comparable projects. A single funding source has been established at the N.C. State landscape architecture EB program that receives continuing funding through a long-term partnership with their university facilities department to design and install storm water mitigation projects across the campus. The program at University of Washington has relied on several sources including modest grants from the Seattle Department of Neighborhoods, private donors, partnerships with non-profits such as Catholic Charities, Veterans + Friends of the Puget Sound, and partnerships with public agencies such as King County Parks to garner funding and in-kind donations.
Figure 1. Funding from the Veterans + Friends of the Puget Sound made this healing garden at the Puget Sound Veterans Administration Hospital possible. By law the VA cannot solicit funds so this third-party donation was given to the University of Washington as a gift.

Due to significant time constraints, diversity of student proficiency, and unanticipated weather conditions, EB projects are inherently flexible. In an EB program the design process is often accelerated to accommodate the implementation process within an academic semester/quarter. The consequence is that there is minimal lapse in time between design completion and implementation, with the construction budget often not finalized until the building commences. Due to field conditions, budget constraints and continuing detail development, design overlaps with the construction process. This creates a cyclical process that continues throughout the project, reinforcing the deep connection between these two activities.

Material donations offer a reasonable, but potentially time-consuming means of offsetting project costs and expanding design possibilities. At ICIW, the Iowa DNR and County Conservation programs supplied prairie plant plugs and seeds. In return, students and incarcerated individuals harvested and processed seeds for future prairie reconstruction projects. Play equipment and furniture companies often provide discounted fixtures especially when the project includes a post-occupancy evaluation to review their products.

Local community groups often provide access to funding. Groups like 100 People Who Care give funds quarterly without the onerous reporting required by larger funding agencies. To make every dollar count, it is advantageous for these organizations to gift directly to the client, community partner or university. Depending on funding sources and the size of the grant/donation, universities can add a 5%-60% overhead when funding is administered through the grants and contracting department (Winterbottom, 2020).

Managing EB projects within a university context has both advantages and disadvantages. University staff have an extensive knowledge of grants and contracts and are ready to help. Developing a familiar knowledge of grant and contract processes is essential to EB program directors. In universities it is not uncommon for individual faculty to be prohibited from soliciting funds from individual donors and foundations to avoid conflicts with universities’ targeted solicitations. Foundation specialists can aid in the application and reporting processes. In larger granting agencies the overhead is understood, but many private donors may be unaware of the percentage taken and without this understanding at the beginning that it can be a limiting factor. It is important to understand the contracting protocol and overhead processes and percentages before making final contractual agreements. It is also advantageous to consider multiple avenues to manage the financial transaction between a university and community partner. Before the agreement is finalized faculty should consult with university council and contract officers to assist with drafting and managing contracts to ensure funding and liability concerns of both parties are addressed.
While funding and timing tend to be the greatest challenges in nearly all projects in and out of the university, the many benefits outweigh these challenges. This work is important and fulfilling for all involved. Users benefit from unique and intentionally designed landscapes; clients benefit from participating in the design process and making these projects come to life. Students learn countless technical skills and immeasurable soft skills that will benefit them as professionals and as members of their community and society. And faculty benefit too, despite the challenges. Faculty can enjoy the creativity of a start-to-finish design process. We can feel good about the more meaningful mentoring and relationships built with students, and members of the communities in which we work. In many cases, these feel-good projects are good for our departments and universities as well. Getting off campus lets us share what we know and love about the benefits of nature and well-designed landscapes.

3.2 Liability and Safety

Liability and safety are often a primary concern among department chairs and deans who often perceive EB as a high-risk method of experiential learning. The perceived danger of power tools, heavy equipment and materials should not be overlooked. Rather, these concerns can and should be addressed as a pedagogical opportunity. Students and faculty should complete formal safety training in line with the types of tools and equipment necessary to complete the project. For example, at ISU, the office of Environmental Health and Safety offers a skid loader training module that has been required for students working at ICIW. Furthermore, students receive additional training from the equipment rental technicians. These opportunities provide a safe space for students to learn about job site safety while becoming more effective machine and tool operators.

Exploratory Building projects require creativity throughout all aspects of project development and completion. Assessing and managing risk and liability requires foresight and familiarity with the applicable university regulations pertaining to risk management and students. One way to manage administrative and community concerns about liability is to engage the university legal counsel in conversations early in the project development and create a risk management plan to determine potential concerns and constraints. Understanding the unique needs, aspirations and concerns of clients and intended users is an important in any EB project. Understanding the inherent limitations including skill level, reasonable fabrication techniques, tool and equipment feasibility is important to access feasibility, scope, and safety. The level of risk can be managed, to a degree, by ensuring that the location, scale, and technicalities of the project are reasonable. “The scopes of projects vary widely both among programs and over time within each program. Many build pavilions, park and recreational structures, interpretive centers, and other outdoor structures, of a program. The reasons given for the selection of these projects include the desire to avoid code constraints, project visibility (as these are typically in public view and for public use), greater ease of construction, ability for students to explore structural, material, and tectonic issues, and so that projects fit neatly within an academic term” (Canizaro, 2012). For example, it may be easier to manage risk if the project is to be designed and built on the university campus, where liability may be more straightforward. Furthermore, university planning and design administrators can be helpful and well-resourced collaborators.

Not all projects can or should be contained within our home campuses. “In terms of clients, most design-build programs tend to work for public entities and/or nonprofits that work in service to those in need such as community development and housing organizations” (Canizaro, 2012). Much of the reason we design AND build is to expand our students understanding of other cultures and communities with whom we might not otherwise cross paths. In the case of the ICIW+ISU collaboration, lawyers at both ISU and the Iowa Department of Corrections met to determine where liability would fall while students travel to and from the prison and while they were working on the prison campus. But gray areas always exist. Who is liable if a student breaks their foot while loading tools into a university vehicle outside of a home improvement store? It is critical to have these complicated conversations early in the process to allow for changes in scope, scale and general operating procedures and ensure the project can still be implemented.

Design-build instructors wear many hats—educator, construction manager, contract negotiator (Doyle and Whitehead, 2017). Depending on the location, faculty should expect to “solicit consultant participation, secure permitting, and solicit bids for specialized construction methods unfit for beginning students” (Doyle and Whitehead, 2017). Because students are new to many of the tools and techniques of the trade, some fabrication or heavy equipment work may require outsourcing—another point to clarify with risk management professionals at the university and with your client. Students may be required to complete safety training prior to operating heavy equipment, but oftentimes the best lessons are taught by the
professionals we interact with throughout the project, like the contractor or heavy equipment tech who delivers equipment to the jobsite. They are often willing to provide lessons on how to safely operate their rental equipment.

Figure 2. The scope of work and complexity of building methods could be dictated by the students’ construction experience. However, the goal of EB education is help students to overcome fears and trepidations about building. When instructors guide students through the techniques, students excel well beyond their perceived limitations and the high-quality execution enhances self-confidence and often exceeds client’s expectations.

“Each project is unique as are the risks” (Winterbottom, 2020). Risk is a relative idea, and all EB projects have inherent levels of potential injury. How much risk should be accepted is often not standardized but is balanced with other factors including if the outcomes are essential to the community served and offer unique and meaningful student experiences not achievable using other processes or techniques. The COVID 19 pandemic has taught us all about balancing risks and benefits—not to mention the role of collective action and the need to support our communities. Risk, always a factor in any construction project can be managed with proper planning. “… the issues of liability for both student safety and for the protection of property (i.e. risk management) are interpreted or learned differently at every institution as each has their own tolerance for risk. Many programs reported protracted and delayed approvals when permissions were initially sought delaying projects and causing havoc with student schedules and client expectations. Others reported attempts to complete work hidden in plain sight or extolled the benefits of being far from the main campus and out of the sight of the administration” (Canizaro, 2012).

In addition to teaching and managing the projects, faculty must adhere to a safety-first mentality. Establishing clear on-site rules, behaviors, and protocols prior to commencing construction is critical to ensure students clarity and understanding of on-site safety. At the University of Washington, classes begin each session with a meeting prior to starting work where students are reminded of safety protocol and best practices. Students are encouraged to be observant at all times and remind peers if their safety measures fall short.

3.3 Recognition and Promotion

The criteria for promotion in academia typically relies on achievement in the areas of teaching, research, and service. Most EB programs contribute explicitly to promotion cases in both service and
teaching. Research has been, one could argue, less clearly embedded in the EB model. That said, many LA faculty leading EB programs have published research based papers relevant to LA practice and pedagogy. For example, EB as an important vehicle for community service (Forsyth and McGirr, 2000). The time required to manage an EB program is significantly more demanding than a non-building studio and this creates a challenge for faculty to produce the quantity and quality of research required for promotion. The time demands to develop, fund, organize and administer an EB program minimizes time allocated to seeking funding for and conducting research. This is particularly significant in programs housed in agricultural colleges where research is more narrowly defined, and expectations follow a more analytical model when compared to LA programs housed in design colleges.

Figure 3. This sauna and outdoor kitchen were implemented to increase social interchange among recent Syrian arrivals and established local inhabitants in a small rural village in Sweden. This type of community service combined with implementation offers a unique “soup to nuts” amenity that few other teaching models can replicate.

There is evidence that suggests faculty engaged in EB teaching are uncertain about their colleagues’ support and the importance of EB to the department and program. At times they may feel compelled to refute the perception that EB is technically oriented and not a scholarly endeavor. Gjertson (2011) surveyed 43 faculty from 36 architecture programs and found a perceived lack of support from colleagues and institutions. He noted that “Within the academy design/build is constantly under attack as being less that rigorous and unscholarly.” If this is a common perception within academia, and these colleagues are later asked to review the promotion cases for EB faculty, the trepidation about developing EB programs and its impact on promotion may be justified. Doyle and Whitehead (2017) argue that academic recognition needs to be re-positioned and that EB should be re tooled as a form of research relying on innovation and experimentation as intended goals, not just the simple act of building a project to fulfill the requirements of a client. The venues for dissemination of scholarship that focus on EB are understandably a modest part of thematic academic conferences. However, a growing number of architectural meetings have design/build as their focus and explore its role as a valued and innovative model of teaching/learning, and scholarship. The Association of Collegiate Schools of Architecture’s 2014 Fall Conference /WORKING OUT: Thinking While Building is one notable example. The proceedings have a strong focus on research produced within EB programs, many of which address issues current within the landscape architecture discipline. These and other annual meetings, CELA, ASLA and EDRA, offer forums to present, share and expand the role of scholarship focusing on EB processes, outcomes, and pedagogy, and use a peer review process thus qualifying for promotion.

Institutional leadership at all levels (departmental, college, and university) is often relatively conservative. Chairs and deans take a cautious approach to new “alternative” teaching/learning models,
and are at times slow to adapt to change. This conservatism is at times manifested in a lack of support or at worst a cloaked hostility towards EB programs. They may have similar reservations (EB is too trade oriented, lacks of scholarship, is light on design rigor), but also the EB teaching model is viewed as too demanding of staff and faculty time, hard to fit into the existing curriculum, and perceived as greater in its risks. The successes of EB projects and their “publicness” when garnering awards, featured in articles and media can increase positive visibility for the university. While these examples acknowledgement the impact of the work, they do not fit neatly into the review process for promotion and tenure though we argue that they can and should be.

Expectations for promotion are specific to individual departmental/college/university standards that may vary in their foci and nuance. In academia, promotion is commonly based on scholarship that is defined more broadly than research, often including creative works, national or international awards and exhibitions that in some departments are given credit equal to peer review papers. National awards, given by established design/research organizations including ASLA, EDRA, ACSA, and CELA are in most cases considered equivalent to published research. The EB model has been a growing presence in the ASLA awards particularly in the categories of student collaboration and community service, and there is a parallel emergence of EB awardees from international landscape architecture. The following are some of the programs that have received awards for EB projects from ASLA (https://www.asla.org/HonorsAwards.aspx):

<table>
<thead>
<tr>
<th>Year</th>
<th>University/Institution</th>
</tr>
</thead>
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| 2017 | University of Texas Austin  
Mississippi State University  
University of Washington |
| 2018 | Iowa State University  
University of Washington  
Illinois Institute of Technology |
| 2019 | Mississippi State University  
Cal-Poly Pomona  
Gangneug-Woniu University |
| 2020 | Texas A&M  
Mississippi State University  
Anhui University Department of Design  
University of Washington  
Peking University |

The Association of Collegiate Schools of Architecture has a Design-Build Award, “To honor the best practices in school-based design-build projects”. Projects completed in landscape architecture programs, often in collaboration with architecture students, could apply for this peer reviewed recognition (https://www.acsa-arch.org/awards/design-build/). The multi-disciplinary focused program at Mississippi State University is a good example of leveraging their work for both ASLA and ACSA awards for the same projects.

The documented service benefits of many EB programs suggest that community service might be a more significant focus and value in EB promotion cases (Forsyth, Lu, and McGirr 2000; Winterbottom, 2002; Gregory and Heiselt, 2014). While not explicitly stated, service is required but not necessarily valued in comparison to teaching and/or scholarship in promotion cases. Many EB faculty have explored service-learning as a form of scholarship through peer reviewed conference papers and presentations and many of the ASLA student awards granted to EB studios are in the category of community service and collaboration. Many of these projects also intentionally serve BIPOC and communities in need (https://www.asla.org/HonorsAwards.aspx). As equity and social justice is gaining student and faculty interest in landscape architecture, it could be a fruitful avenue of scholarly EB focused research.

### 3.4 Learning Outcomes and Student Assessment

Exploratory Building studios cover a wide range of topics and learning themes (Melcher, 2013). However, a comprehensive experience and actual engagement with that process is critical for a student to gain a wholistic view of what these courses have to offer. Documented learning outcomes have varied depending on the author’s perspective and interest. In practice, the process is not as consistent as we
might hope. Where one project might allow for a deep understanding of materials and jointing, another might reveal more about the importance of community engagement (Nicholas and Oak, 2020). Some of the most cited benefits include explorations of:

- materials and jointing,
- small-scale design refinement,
- design iteration from paper to reality,
- budgeting, and
- community engagement.

Outcomes might vary widely based on faculty, time constraints, client needs, student skills, and funding, which raises questions of creating standard outcomes for EB course typologies (Ware, 2013). It has also been noted that EB studios have the potential to explore beyond accepted practices as a form of research where students create new knowledge (Hinson, 2007). Students enter these courses with varied backgrounds and divergent skills that compliment and enrich the class experience but also suggest that each student has unique learning potential (Mohareb and Maassarani, 2018). This raises questions of parity between student efforts and outcomes (Canizaro, 2016). Another unique aspect of the EB studios is that learning outcomes must be successful while also meeting client expectations. Additionally, the safety net created by the instructor(s) can limit the risk of failure (Gjertson, 2011), which might be partially overcome when students are given a more direct hand in defining project goals (Melcher, 2013).

Figure 4: The initial EB design process is often similar to the traditional studio design process. Once in the field the flexibility and reality of EB suggest or required changes that are implemented through field sketches, on site mockups, and improvisation. It requires adaptability and flexibility that strengthens design competencies and self-confidence.

With limited empirical research on EB student assessment and most case study literature focused on project process, there is a need for exploring how best to assess student efforts in an EB class structure. With limited time and ever-present deadlines, the format itself most likely excludes more critical learning assessment. However, learning outcomes from smaller projects can have similar learning outcomes to complex projects (Melcher, 2013), which indicates that faculty might best serve students by ensuring time is allotted for more robust assessment of student learning. Because of the varied nature of EB projects and
the inherent challenges of group work, the process becomes much more critical to student learning than the final studio product (Gaber, 2014). This conflicts with typical master-apprentice pedagogical norms in design education which culminate in year-end critiques of student work by expert reviewers where the outcome is more heavily valued than the process.

The modes of assessment described in EB case study literature have been limited to journal or weekly progress/participation assessment (Winterbottom, 2020). Precedents for assessment may be more readily found in literature on broader service-learning pedagogy which stresses that assessment should be process and not product focused. This implies more traditional methods of assessing understanding of course content, which could be done through year-end exams that question processes and topics covered during the project, essays that explore themes or goals outlined through the project, and reflection through journals and writing assignments which link experience to learning, allows for feedback, and offers opportunities for further exploration (Bringle and Hatcher, 1995).

Possibilities for additional assessment might include critical peer reviews, which have shown to contribute to a more critical understanding of design theory and processes (Teixeira de Sampayo, et al., 2014). However, within the context of group work, care in implementing peer assessment should be given to avoid grievances against team members. While seemingly incongruent with the process of a design studio, exams and objective measurement tools may offer methods for ensuring student engagement through the entire process and allowing for a metric to measure how well students were engaged and absorbed content, theories, methods, and processes used over the course of the project. Similarly, essays where deep questions of meaning and impact can be explored to understand how well a student internalized the deeper goals of a project, may be utilized as part of year-end examinations or evaluations.

As EB becomes more widely adopted in landscape architecture education, educators need to expand assessment tools to ensure parity to other types of course delivery. Part of that is understanding that the EB platform is more closely aligned with a service-learning project than with a design studio. The course learning objectives are centered around process and therefore assessment of student work should test their understanding of that process.
4 DISCUSSION AND CONCLUSIONS

Terminology matters as it conveys the intent of prescribed activities. The word “exploratory”, in Exploratory Building better defines the pedagogical goals and intentional learning activities used than does the term design-build that is often associated with the connotations of the project delivery method.

Experiencing and mastering the “soft” skills of adaptability, managing complexity, and developing a comfort level with multiple and shifting roles (designer, manager, negotiator, etc.) are critical to our students’ success in professional practice. The EB model places students in these roles under the guidance of supportive mentors. The fulfillment stemming from creating a meaningful project for a community in need is a strong motivator for both faculty and students. The bonding around this endeavor has a powerful impact on students, one that reinforces the benefits of collaboration faculty frequently preach about. EB demands a high degree of instructor flexibility and adaptability. Faculty leading EB projects are tasked with sourcing multiple streams of funding, meeting deadlines within academic teaching schedules with budgets often not resolved until design is finalized. Faculty implement these projects with students, the majority of whom have little experience in building and still must meet client’s expectations. Faculty are teaching and managing these projects as they navigate a continually shifting terrain, responding to unanticipated changes throughout the project, while ensuring safety and learning outcomes. While committed to EB, faculty are investing copious amounts of time, yet many feel uncertain about their colleagues’ support and the value of EB to their department and college.

The challenges, while significant, can be overcome as demonstrated by the authors’ success in their respective programs. The EB experience is unique in academia and in landscape architecture programs. It offers an experiential comprehension of concepts often superficially understood through lectures and images. The participants, still students, must balance multiple responsibilities and make decisions in “professional” time verses academic schedules, thus the bridging of practice and academic is best manifested in the EB model. For many students the EB experience is a transformative moment when abstract concepts are fully realized and the interconnections between design and implementation are more fully understood.

Faculty responsibilities typically fall solely upon the faculty leading the projects and stresses incurred by those doing so are considerable. While committed to the pedagogy and benefits derived by students and communities, they are uncertain if their efforts will be parlayed into merit for promotion. With limited time for research and scholarship, should EB instructors consider their studios as laboratories of scholarship instead of places of production, re-vision studio goals around innovation and experimentation, offer data informing papers and presentations, and support award applications? Deans, chairs, and administrators are often quite conservative and cautious when alternative teaching/learning methods are proposed. A growing body of research that documents the beneficial learning outcomes, service-learning innovation, and success are critical to EB validation and offer evidence to support future funding applications. Most of the assessment tools used in EB literature are limited to case studies, typically relying on journals or student evaluations. A broadening of evaluative tools could bring a more substantial rigor and accuracy to EB scholarship.

In order to be embraced more thoroughly as a form of pedagogy, EB courses should consider expanding and increasing assessment and academic rigor through varied tools and processes. Most notably, looking to the depth of research in service-learning, courses that focus on process and not product are most beneficial to student learning. Assessment that is centered on learning outcomes associated with process can include reflection, regular individual student assessment, and even exams that may test on practical knowledge gained or allow students to explore broader goals of the course.

Finally, why should faculty consider developing an EB program? First, it is a significant benefit to the students’ depth of learning while offering an alternative experiential learning experience. Second, it offers a tangible benefit to the community, many of whom have not received the support or resources other communities have been given. This equity of distribution should be a societal goal and certainly one of our academic service, and many EB program are exemplified by their commitment to social justice. The personal rewards, as the community receives the project are powerful, and for the authors, demonstrates the power of landscape architecture, something often lost when the learning experience is removed from the community. Finally, it has helped advance our academic careers and served as a critical component of our shared promotion processes. All three authors have garnered awards, published papers and had featured articles done on their EB programs and projects. Certainly, EB is not for all academics, but for those with the skills and aptitude, it can play a significant role in the quality of our students’ education.
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MAKING IN THE VOID: HOW CHANGING TO ONLINE DELIVERY SHIFTS THE FOCUS OF TEACHING AND LEARNING FOR LANDSCAPE STUDIO

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1 ABSTRACT
This paper interrogates how the shift from a collective physical learning environment to an isolated distance learning environment has impacted the focus of teaching and learning in the landscape studio. The research draws on the collective experience teaching six discrete landscape architecture design studios across two institutions in Melbourne, Australia. Data from faculty observations, reflective surveys, and workshops on shared teaching experience has been collected and reviewed across a full year of online teaching. For this paper, the observations and findings from this initial work have been aligned with pedagogical theory to understand how online and face-to-face learning combinations might be harnessed for future studio development. Outcomes from the research suggest differentiating the skills that are taught in the design studio and how these can be supported with online teaching formats. Further, the changing nature of social interactions including connection and isolation as integral parts of design studio teaching can be better understood considering the conditions of the online environment. These findings contribute towards the pedagogy of landscape design teaching as it continues to adapt to completely online or hybrid teaching modes.

1.1 Keywords:
Design pedagogy, remote learning, studio teaching, landscape architecture
2 INTRODUCTION

The 2020 global pandemic forced major changes to the education sector. For design teaching, moving the studio learning environment into online delivery upended many of the conventions of face-to-face learning and teaching. In Australia, the pandemic shifted learning from the classroom to online in March 2020, and the need to rapidly redevelop studio subjects highlighted some of the unique pedagogical conditions of design studio teaching for landscape architecture. This posed a dilemma for some instructors about how to recreate or replace the learning environment of face-to-face studio experience. As was feverishly discussed in Landscape Architecture press at the time (Brey, 2020), there has long been a hesitancy to move design studio online within the discipline.

2.1 From Atelier to Lab: the long tradition of learning through design studio

The pandemic has forced an exploration of the dematerialisation of the atelier as an embodied space (Dreamson, 2020). How students learn through studio is well documented. Design workflows promote an understanding of process-based learning which incorporates development of new skills and design language as an iterative and fluid way of investigating potential problems and solutions (Gazvoda, 2019a, 2019b; Ledewitz, 1985; van den Brink, Bruns, Tobi, & Bell, 2016). While student projects are often independent, studio learning culture is premised on a collaborative group experience that values experimentation, discussion, and feedback. Frequently, the process assumes that the learning activities occur in a physical space of the classroom, workshop, or lab.

Even emerging ideas about digital studios have focused on the uptake of digital tools within the physical studio environment as opposed to the digitisation of the studio environment itself (Gazvoda, 2019a; Walliss & Rahmann, 2013; Walliss & Rahmann, 2018). Within the studio learning culture, there are core assumptions about the value of a collective learning experience, which has led to some resistance to delivering design studios online. Particularly, the difficulty of translating the processes of design experimentation and feedback into a digital space. As Abbott and Bowring (2019, p. 297) explain; "While there are many digital platforms for co-creation and collaboration, during the fluid stages of design the digital environment can have the effect of designs appearing to be finished because there is a sense of resolution to the images. This can limit the explorative process, with a tendency to keep things neat rather than messy and evolving."

Subsequently, prior to 2020, there were few examples of online design studios, including landscape architecture. The previous hesitation in developing online studios left considerable gaps in online studio-specific teaching methods (Dreamson, 2020; Fleischmann, 2020). As the open discussion in Places Journal (2020) revealed, many design educators felt the loss of face to face interactions, incidental conversations and the dynamic ‘culture of studio’. Even as the technical showcasing of design work though online pin-ups become easier, the way in which teachers and students interact had fundamentally changed. Where in-class design charrettes include chatter and accompanying feedback, the online experience can lack incidental interaction and collaboration (Crolla, Hodgson, & Ho, 2019; Neal Dreamson, 2020; Jørgensen, Karadeniz, Mertens, & Stiles, 2019). Across these concerns is the role of relationships and interactions as a critical component in studio-based teaching. As Neal Dreamson (2020, p. 485) summarises, the persistent hesitancy to teach design studio online ‘are related to social components.’

Thus, the pandemic forced instructors to confront the very architecture which envelopes teaching practice and how that space influences our behaviours and responses. The online mode of teaching demanded instructors more directly enable ideation and mediate the process of studio. This included new modes for demonstrating technique alongside expanded, and sometimes forced methods of interaction and feedback. This paper is dedicated to unpacking these approaches specific to teaching landscape design studios, with the aim of highlighting where landscape design techniques can benefit from varied approaches to modes of learning interaction and connection.

2.2 Methods

The research draws on the collective experience teaching six discrete landscape architecture design studios across two institutions in Melbourne, Australia which were taught online during the COVID19 pandemic of 2020. The studios covered a range of undergraduate and masters level study including;

- Three undergraduate design studios, from the second and third years of the three year Design and Landscape Architecture bachelor degrees.
March 17-19, 2021

- Two first year masters studios
- One second year masters studio.
- One interdisciplinary masters design studio including students from architecture, landscape architecture and urban design.

The content of these studio-based subjects varied considerably from foundational design methods through to more specialised technical instruction using digital simulations. Consistent across these studios was small group learning, site-based design briefs and the introduction of design techniques and methodologies that were new to each group of students. As a collective case study, the studio subjects used here represent a landscape focused investigation of design pedagogy.

The design studio subjects used for this research were taught entirely online with no blended or face to face options. Studio sessions were conducted via the online platform Zoom alongside the collaborative digital workspace Mural. Studio classes run for six hours per week, with the expectation that students will continue with their work outside of these teaching hours.

The collection of studios used for his research were taught across the two teaching semesters in 2020. This resulted in later studios being refined based on prior learning and in response to the rapidly changing restrictions from the pandemic. Melbourne underwent some of the strictest lockdown measures in the world, including limited time outside, restrictions on distances from home and curfews (“City Locked Down for Three Months Has Bleak Lessons for the World,” 2020). In addition, many students were offshore. Considering the constraints of the online environment, certain interactions would not occur. In reconfiguring for online teaching throughout 2020, the design studio pedagogy was iterated through the interrogation of two levels of studio interaction – between student and instructor and student to student, with the aim of bridging the pre-existing gap between traditional landscape studio teaching methodologies and the exclusively online environment.

Data was assembled in two primary ways. Faculty observation was collected through ongoing discussions and feedback amongst staff throughout the semesters. These discussions were followed by a more formal end of teaching workshop with design tutors and studio coordinators. It is worth noting that many of the initial observations occurred during teaching times and these provided anecdotal evidence for the workshop structure and focus. In this way, the workshop served as a refinement of ideas more than the development of new observations. The workshop was structured as a discussion on three main points.

- What were the ongoing challenges of teaching landscape studio online?
- What online teaching techniques were most successful in the landscape studio context?
- Shared examples of student design work produced in the online studios with discussion of how these differ or compare to previous years work.

In addition, student learning experiences were reviewed via the institutional subject surveys. The name of these surveys differs among institutions, but they are run at the end of each teaching semester to understand student perspectives on individual studios and subjects. While the surveys provide a value reflection on the whole of subject experience, there are gaps in understanding the specific changes to online learning. Students are asked to reflect on factors such as the quality of learning materials and workload. For this research, this data was used to compare general student experiences against the observations of learning quality and progress made by the teaching staff. For example, tutor observations of student engagement and progress were compared against student rankings of engagement with the subject material. These comparisons helped with understanding the changing dynamics in the studio environment and how students were also adapting their expectations of learning design in new formats. The outputs from these data were then applied against general theories of adult learning.

3 HYPER-CONNECTION AND MOTIVATION IN ISOLATION

While there are obvious changes in the way content is delivered online, the move to remote learning also greatly impacted the dynamics of interactions between students and their peers and teachers. The interconnected changes in the studio learning environment, content and relationships have revealed novel outcomes in both design work and teaching methods. These outcomes suggest the need for a closer examination of the role of these interactions in different aspects of studio-based pedagogy. To maximise these novelties requires greater articulation of how learning interactions are managed, with considerable repercussions on how core design methods and techniques are taught, understood, and applied.
Specifically, how to better create and choreograph independent and collective applications of student-to-instructor and peer-to-peer learning in different studio environments. Furthermore, how the principles of design-driven teaching and learning might engage with pedagogical theories such as andragogy, alongside learning and support mechanisms for students, such as Self-Determination Theory.

For design-based studio teaching, the distinct change in online teaching begins with the instructor’s role of facilitating interaction and demonstrating skills, further leading to how students collaborate and interact together. Fundamentally student learning is not isolated. In the online environment, students have access to more layers of communication, feedback, and expression than ever before. While the noise and chatter of a studio environment cannot be replicated online, it is important to recognise where and how students already operate in the wider network of online social, formal and technical online environments (Dreamson, 2020).

One of the critical changes to university level learning in moving from the classroom to online is the necessary introduction of andragogical methods of learning with the more common pedagogical practices. In pedagogy, the emphasis is on the instructor to deliver content, performing the role of expert while assuming the learner has limited self-directed learning skills. Whereas in distance learning, the natural mentoring role of ‘checking in’ and redirecting student work is diminished, instead replaced by large periods of time in which the student is left to themselves. It is here that principles of adult learning are most useful. The adult learning theory of andragogy shifts more responsibility to the learner, making a presumption that the student brings motivation and are therefore able to self-direct their learning (Cercone, 2008; Ferreira & MacLean, 2017). The move to online learning necessitates students take ownership of their learning space and activities, but equally requires the instructor to give agency and provide trust in the students’ capacity to do this. This begins to redefine the role of the instructor as one of facilitator, someone who supports and encourages dialogue, rather than demanding action and interaction (Ferreira & MacLean, 2017; Knowles et al., 2014). As an adjunct to this, a further key assumption of an andragogical approach is that the student be encouraged to put more of their lived experience into their work, as a means of intrinsic motivation and further to promote self-confidence. While studio-based learning encourages creativity in design response, an andragogical approach further extends towards encouraging student interpretations of design methodology and style of communication. By encouraging students to utilise existing experience and knowledge, the learning approach emphasises unique responses to design tasks and techniques.

While one perceived benefit of a traditional classroom structure is that increased motivation and boosted student confidence comes from being in a collaborative learning environment. In the switch of design studio to online it was evident that students would need to maintain levels of self-motivation over the semester with less input from the classroom environment, their peers, and their instructor. The task of maintaining motivation was complicated by the COVID19 situation and the fact that students were limited in their ability to interact with other people outside the classroom for much of the teaching year. In the absence of extrinsic sources of motivation from a collaborative physical environment meant motivation strategies need to resonate at an individual level. Adult learning theory suggests that motivation is intrinsic, where managing motivation becomes as much about limiting demotivation as about inspiring greater motivation (Vollet et al., 2017). Self-determination theory, a macro theory of human motivation, indicates three factors to be cognisant of in maintaining motivation (Huxley-Binns & Ferris, 2013, Chen & Jang, 2010, Skinner et al, 2017):

- A person’s sense of their competence in being able to complete a task. In an online studio the design of tasks that were achievable for each student, intellectually stimulating while also complex enough to prove challenging.
- Connection to the subject cohort and a feeling of belonging to that group. In an online studio, where students were limited in their ability to form connections with other students, the structuring of the subject such that interactions were driven by the tutors and maintained by frequent collisions of students with one another.
- The autonomy to make one’s own decisions within the context of the tasks that are set. In an online studio an especially important method of motivation that concedes choice of method or response to the student in a way that empowers them to use their strengths to produce stronger work.
3.1 Moving the physical studio into the virtual world

In landscape design teaching, some factors remain pillars of both an online and face-to-face design studio. For example, designing outdoor environments, responding to a site, and engaging with design theory and methods. Teaching these skills in a physical design studio aligns with well-developed landscape theories and generative methods. However, the altered means of interaction in a remote learning environment begins to affect how design methods and techniques are understood interpreted by students working remotely and in isolation. These changes are strikingly highlighted through the comparison of two core landscape skills, physical and digital landform model making.

3.2 Demonstrating design tools: physical & digital landform modelling

Without the physical space of the studio, physical landform model making was shifted to student’s homes. The task of generatively modelling a landform using clay, which had previously been taught physically in class with a tutor and specific guidance on using tools, working to scale and feedback on form. However, with various lock down restrictions, many students could not access clay. Subsequently, while the core task of generating landform remained, students were given more freedom and encouraged to experiment with materials they could access. In addition, much of the instruction was switched to pre-recorded videos that aimed to illustrate the concepts of scaled topographic manipulation and landscape theory rather than just providing an online “how to” guide. In response, students utilised homemade play dough, cloth, screws (Figure 1) and repurposed materials to the task of generating landform and understanding the human scale within the abstract model space. By pairing agency with appropriate design theory that explained and illustrated generative techniques, students took more risks than those previously working in the physical studio space. Predictably these risks were also encouraged by more variable home environments, alongside constrained material palettes.

Figure 1. Early stage design exploration of landform surface generation and human scale using repurposed materials. Author Melissa Rowland

Although the use of varied physical materials is not itself innovative, the scavenge and hunt element of working with what could be found provoked enthusiasm in the students and led them to explore and interrogate the task far more than usual at this stage of learning. Further, the diversity of student approaches – from material to technique and landform design – informed a productive online class discussion about form and idea generation. Notably, students felt confident in drawing on their own independent ideas and knowledge to complete the task. Even though the instructional videos demonstrated modelling concepts such as working with scale, the students were able to translate those ideas. In this instance, the autonomy
of the working environment was effective for creating a richer outcome across the studio group. This outcome was a stark contrast to similar principles applied to teaching digital modelling skills.

Landform generation in a digital model space is a powerful medium for landscape designers, however, for early-stage learners, the creation of form can be influenced by the ease of using specific elements of the tool. As Andrea Hansen (2011) suggests, different software capabilities directly influence form making. As students learn to master digital modelling it is easy to succumb to the ease of making flat planes and terracing, rather than pursue more intentional or complex forms. While 3D modelling software such as Rhino, 3D Studio Max, Maya and many others can create form in multiple ways, the technical competence required to follow designer’s intentions often necessitates a broad range of technical skills to achieve a desired outcome. The collegial space of the physical studio lab is valuable for sharing such abilities across the group. Students often exchange tips and tricks, and tutors can address specific problems and identify consistent problems across the group and breakthroughs can be highlighted in real time conversations. These forms of interaction are the basis of ‘studio culture’ as previously discussed. That fluid and easy exchange of technical knowledge which enables new students to rapidly improve their digital modelling skills is very difficult to replicate online. Furthermore, when students are removed from the physical studio space for learning digital skills, the divide between those with previous digital tool experience very quickly separates the progress of the student group. Those with some pre-existing digital experience can progress, whereas those with little experience can quickly become lost or frustrated. For the isolated student, asking a question might require joining a discussion forum, emailing their tutor, or independently researching an answer. Each of these forms a stop in the actual activity of modelling, slowing down progress and flow. Even in live studio Zoom sessions, there can be a considerable delay in explaining a problem, sharing a screen, or switching interfaces. When students encounter technical difficulties, working in isolation both slows down the progress and the learning of some students and further shelters them from pushing through design hurdles. Students express frustration with controlling the tools they are expected to use. For example, Figure 2 shows the early stages of learning to use Rhino 3D as a modelling tool for topographic design where the student struggled to gain control over the shape and scale of the intervention. In these instances, motivation becomes difficult to maintain if the design tasks are too difficult at an individual level, as the student’s existing skillset and belief in their ability to complete tasks is challenged.

![Figure 2. Early stage topographic explorations incorporating and technical skills development in Rhino 3D. (Anonymous)](image)

Whereas physical model making in isolation became a pathway to interesting and unforeseen form-making, digital model-making became reductive to the most basic software commands. Creating the productive studio environment of sharing skills and techniques for technically complex tasks posed a different learning challenge to the more open-ended processes. The loss of this shared occupation of the
classroom impacted the methodological framework for interactions within the studio dynamic in two ways. In the first instance, it reveals the particularities of the instructor relationship to the individual and the collective student cohort. Secondly, distance fundamentally alters the dynamics of peer interaction required to support a group working at varied skill levels, generate ideation and reinforce culture essential to professional life beyond study. These simple observations in the differences between studio space, task, autonomy, confidence, and social connection became critical to the further structuring of online studios and facilitating studio interactions and dynamics.

4 FACILITATING STUDIO DYNAMICS

The loss of the physical architecture of the studio teaching space – the shared occupation of a room with surfaces for display – forced new tactics to be explored. There are numerous options for online sharing and collaboration, however for studio-based teaching simulating the wall requires a particular set of functions within the disembodied virtual space. Students need to share work, receive feedback as well as view and critique other work from within the cohort. However, simply providing a virtual wall does not create the same social and personal interactions that create studio learning culture. In addition to viewing work, students also need to trust in the group, feel connected and understand the value of cohort feedback and critique.

To create opportunity for interconnection and trust between students, small group structures were maintained to encourage student-to-student interaction, as well as to ensure an equity of feedback and attention. In the initial move to online studio, students would log in for their group consultation and share their screen to receive feedback from the instructor. However, while useful, this method alone was an unsatisfactory way of managing student interaction and cohort dynamics. The continued division of the cohort into small discrete groups had the effect of siloing students from the larger peer group, with students limited in their agency and not able to create connections to or benefit from feedback to and from a larger critical mass of voices. This approach also mirrored the inefficiencies commonly experienced with the ‘one-on-one’ method of in-class teaching, where instructors repeat feedback.

A new approach was required to enable cohesion within a larger group of students. The design studio wall provides the benefits of bringing together the cohort whilst allowing emphasis on a single work at a time. This positions individual work amongst a reassuring collection of peer works that provides an assemblage of intellectual cues and ideas. The wall, operating as a panacea to the sense of being singled out, spatially motivates both intrinsically and extrinsically. To mimic the lost wall of the design studio space, the platform Mural was used to enable visual collaboration in a cohort-based environment (Figure 3).

![Figure 3. A studio Mural board from semester 1 2020, showing students cumulative and iterative progress through the semester.](image-url)
The virtual space of Mural mirrored the pinup wall of the design studio, enabling work to be uploaded to a shared page and dynamically annotated using direct-drawing and text-based tools. This provided the ability for teaching staff to drive the focal points of discussion, with students following the tutors’ screen or the screen of others and resulted in a shared field of view. In this form, earlier discussion points could be more easily revisited - in direct reference to other student work. This clarity created points of interaction, in which the overlap between one student’s work and another provoked direct response. Students, more directly involved in the discussions, paid closer attention to each other’s work, often making pointed and direct comments about their own work in relationship to the projects of others. This created a generous atmosphere for the sharing of ideas and fostered a much stronger sense of collegial competition.

A hybrid model of the online wall and group structure was also explored, in which students shared work in small groups and alternately larger class-based dynamics was established. This was particularly effective for intensive full day studios, which more closely mirrored a ‘real’ studio working day. Within a single collective session, class was broken into three groups of students on the Mural digital workspace. Students would pin-up at start of session, set their own goals for the day and then returning to review at the end of the day. Students reported that they enjoyed listening to feedback from other students while they continued to work on their own drawings, feeling that less time was wasted but also that they were able to maintain the sense of being part of a cohort.

For instructors, the Mural wall made it possible to pinpoint students who required additional support and engagement or a change to scheduled checking in that can be either too much or too little depending upon the student. The instructor could leave comments, annotations, and suggestions directly to individual students that were visible to the whole cohort. This surreptitiously led spontaneous live exchanges between students and tutors through a series of post-its, drawings, and comments (Figure 4). Similarly, the instructor could directly mark-up conventional drawings to explain spatial and material concepts, reinstating some of the haptic qualities of face-to-face design studios. This collaborative experience was emphasised in the ways a studio leader could visually link precedent into the student’s process (Figure 5).

Figure 4. Dynamic interactions between student and tutor. Author: Remy Yuchen Shi

While there was some success in creating tutor-led feedback and discussions using Mural boards, generating dynamic student-to-student responses was harder to replicate. In addition to creating ‘space’ to share work, creating connections and feedback in the digital required more direct approach to facilitating student’s critical connection to the group. To manufacture that shared feeling of connection, tutors used two types of curated interactions – text-based and verbal.

In the text-based approach students were required to post their work and to comment on at least one other student’s work, using virtual post-it notes or comments. This approach was useful in bringing students directly into discussions and gave students the ability to reply to one another. As dialogue unfolded over time, students had a chance to consider and respond to the peer critique.
Figure 5. Activated precedents. A filmic/literary reference (George Orwell’s 1984) was translated by the student as a dystopian turn to the speculative narrative design output Author: Bonnie Zhang

The verbal approach used the breakout room functionality of Zoom in combination with the mural boards. To initiate conversation, the tutors didactically set a particular focus for each breakout room discussion. Students frequently had opportunity to speak, both to the entire group and to the break-out room. Over time, as trust within the group developed, students more frequently annotated and commented on each other’s work. In addition, the breakout conversation often spilt into the larger room as the students had the opportunity to continue to speak to the suggestions made by their peers.

Keeping in mind the need to manufacture connections and maintain student motivation, tutors were involved actively in facilitating the discussion sessions without leading them. Tutors were challenged to facilitate social interactions as well as provide design feedback. It is far easier to observe and work with social outliers in a classroom than it is in the digital void space. In some cases, instructors entered virtual rooms where the discussion had stonewalled whereas elsewhere, discussion was lively, and ran on beyond allocated time constraints. Initially randomly assigned, curation of the groups by tutors was necessary to best address the range of social confidence in the cohort.

5 DISCUSSION

While the techniques discussed here have been taught extensively in design studios in face-to-face settings, the move to online transformed both studio outcomes and the processes of delivering content. Many of the techniques applied in the revised online studios were developed as iterations of regular teaching methods. However, they had not been tested as online techniques. The outcomes highlight that there are clearly moments for strategically combining students to provide impetus and energy for motivation and for forcing them apart at times when students can drive their own learning. At the level of master’s design teaching, students can confidently be positioned as adult learners in most contexts, but even the most motivated of students need the input of their cohort to maintain their learning momentum. The social aspect of studio learning requires a balance of adult learning, such as utilising existing skills and knowledge alongside the curation of peer and tutor interactions.

Overall, the shift to online design studios has fundamentally changes the role of studio teacher as facilitator and curator of such interaction. 2020 has produced a new type of disembodied studio where instructors have learned to become drivers of technology, provide social structure and mediation concurrent to the core role of proving design feedback and review. The shift also forced the instructor to be more acutely observant of the voices in our ears. It became our duty of care to ensure students did not become further isolated – from the studio itself, from their peers and from us as their guides in this space. There is no one size fits all approach to student engagement, as is evidenced in the attempts to create class connection in Zoom, shared screens, breakout rooms and Mural boards, a system that worked well but not always.
The nature of these interactions, and the independent or collective nature of how students are asked to work, greatly influences the outcomes of teaching design techniques and methods. For example, occupying the same physical space enables peer technical support and collective problem solving, however online environments struggle to reproduce this dynamic. While question and answer forums and sessions go some way to addressing this, they are time consuming and cumbersome. For instructors, it becomes difficult to diagnose gaps in individual and group technical knowledge which would be more readily identified in the classroom.

The hybrid system of interfaces alongside the dislocation from face-to-face feedback requires a new mindset from instructors. As we have seen, the lack of physical presence and interactions challenges traditional ideas of how the design tutor guides students. While students still require feedback and guidance the social conditions of online learning need to prioritise student engagement with the tasks and learning objectives that are separate from their interactions with the design tutor or instructor. This suggests a shift in attitude away from the instructor as the owner or bearer of all knowledge towards more purposefully enabling student-led learning and enquiry. At the larger scale, studio sequences need to be constructed in ways where the instructor becomes secondary to the learning processes. In addition, at the more immediate scale, instructors need the presence of mind to recognise that students can be reluctant in their interactions and tasks and need help to move forward, to be shuffled around in some cases to facilitate conversation directly.

5.1 Curating the student experience.

For many students, studio learning shifted from a collective learning experience to a more isolated and individual experience. However, this is not universally negative. For example, the outcomes of the physical modelling were surprising and sometimes non-conventional, and these offered unique insights. The unexpected forms proved very useful for students in advancing their design rapidly. The success of the physical modelling as an independent task can be contrasted clearly when compared to the more technically challenging task of learning 3D digital modelling. Introducing digital tools produced a surprisingly limited range of outcomes. The technical acquisition of software skills to enable the students to engage in 3D modelling was tough individually. It resulted in more formally homogenised outputs. As opposed to the creativity the students exhibited in physical modelling techniques, some in the cohort became increasingly reluctant to expand their repertoire, becoming increasingly risk averse in their design exploration. As such, in technical tasks that required new skills, the aspiration of using tools to push design outcomes needed to be scaled back in terms of scope. In contrast, in cohorts with existing digital skills that did not require an introduction to technical software, a different outcome was observed. Class time was instead curated around focused formal exploration. This produced far more diverse outcomes, more closely mirroring the products of the physical modelling. The variance in outcomes between tasks performed online and expectations of those same tasks in a face-to-face studio offer useful observations for the pedagogical and andragogical framings of future landscape studios.

It is evident that some tasks, like physical model making, can be trusted to students with a high degree of autonomy. But that others, such as the digital skills module, where base level skills are lacking still require an instructor-led pedagogical approach to control how techniques are conveyed. In the any design studio environment, balancing these qualities is important for building confidence in new designers, where the nature of the work is highly variable, often process-based and contextual. The juxtaposition of these parts of the curriculum might not be surprising but nonetheless are a lesson in being cognisant of the outcomes we wish to achieve when we teach, the medium we are able to use and the skill level of each cohort.

Fostering motivation can occur from both intrinsic and extrinsic influences. Furthermore, maintaining individual momentum over a semester extends beyond consistent instructor feedback to towards driving student interactions with each other in an effort to encourage peer learning and model group cohesion, a task that is less akin to the instructor who brings technical knowledge and design skills, and more akin to a facilitator or manager of people. These observations illustrate Dreamson's (2020, p. 490) argument for connective engagement, where ‘multiple identities emerge from the spaces between connections where individuals’ engagement in the networked world are sustained in the learning community.’ While there are new impositions on both learner and instructor in the online teaching environment, these dynamics can be managed, potentially with very good teaching and learning outcomes. Combinations of online and face to face learning might be harnessed for future studio development. Some of the things to be considered are:
• Drawing on online studio as a mode better suited to slower interactions such as mulling over mural boards and posting responses.
• Allocating time to individual work in isolation, with consideration of intrinsic motivation and lived experience may produce unexpected outcomes.
• Regardless of teaching mode, teaching technical skills needs to be heavily supported if rapid progress quickly is required, curated on tightly programmed focused outputs.

6 CONCLUSION

The education sector was not alone within the broader design community grappling with the quandary of losing collaborative and shared workspace. Professional design studios in the Landscape Architecture faced an identical loss of a workspace-based culture, where the process of production are heavily predicated on the common occupation of the office (Stewart, 2020). There is a natural connection between how we teach design and how it is practiced. As workplaces transition to more instances of working from home, methods of collaboration will inevitably evolve. The next generation of students will need to understand what studio culture means in both an online and face to face context. This is a skill set that extends beyond technical aspects into the social dimension of practicing design. The large-scale transition to completely online learning has revealed the many of these overlaps between design techniques, environment, and interactions. These include the form of feedback and interaction and the complex modalities of design communication in support of conventional studio outcomes. Specifically, how modes of isolation and connectivity greatly influence student interactions, attitudes, and outcomes of the design studio. Across these examples, the successes and failures of the rapid shift to online studio delivery offer important insights into reviewing the pedagogical approaches of design studio learning and further, provide lessons for the future of both face to face and online design studios.

7 REFERENCES


GEO-SPATIAL AND DIGITAL ANALYTICS

Edited by Hong Wu, & Travis Flohr
ANALYZING THE TRANSFORMATION OF PRE AND POST-DEVELOPMENT WETLAND AREAS IN PURBACHAL NEW TOWN, BANGLADESH

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1 ABSTRACT
Dhaka, the capital city of Bangladesh, is one of the fastest-growing metropolitan regions in the world. Around 18 km away from Dhaka, Purbachal satellite city was planned in 1995 to solve the ever-increasing need for housing. Purbachal is the largest planned township in Bangladesh, with an area of over 25 square kilometers. Historically a low-lying wetland, Purbachal has gone through a rapid transformation in past decades. This study investigates the transformation of wetland areas in Purbachal New Town using Supervised Classification for Land Use and Land Cover (LULC) Change and Water Flow and Watershed Analysis. The study investigates whether the new developments in the Purbachal New Town followed a natural topography or was drastically modified from its natural conditions. The result shows wetlands around the new town have been filled in to create new developable land. As a result, the existing water flow patterns drastically altered, making the satellite city susceptible to flooding. By combining geospatial modeling with impact simulation, the study demonstrated a feedback process that facilitates the development of sustainable design strategies. The study’s outcomes will guide the formulation of an alternative city planning process aided by Geodesign tools and the establishment of a systematic urban planning approach for this region guided by the natural land transformation analysis to create cities where people will be able to live in harmony with nature.

1.1 Keywords:
Wetland transformation, remote sensing, watershed analysis, GIS

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2 INTRODUCTION

2.1 Site Location

Bangladesh is a country in South Asia located east of India on the Bay of Bengal (Figure 1). Roughly two-thirds of the country is constituted of the deltaic plain of the Padma (Ganges [Ganga]) and Jamuna (Brahmaputra) rivers. The landscape is a predominately flat plain of recent alluvium, except for small higher areas in the Barind and Madhupur Tract. The capital city of Bangladesh is Dhaka. Purbachal New Town is around 18 km away from Dhaka, situated in Rupganj Upazila of Narayanganj District and Kaliganj Upazila of Gazipur District. Purbachal New Town is in three administrative districts, Dhaka, Narayanganj, and Gazipur. Bangladesh is a riverine country, and all the major cities, towns, and commercial centers are located on the bank of rivers. Purbachal is also not an exception. The area is in eastern-central Bangladesh between large floodplains of Brahmaputra and terraces. Purbachal is situated at the confluence of the Shitalakhya and Balu rivers. The Balu and Sitalakkhya Rivers are on the west and east sides of the new town.

![Figure 1. Geographical location of Purbachal New Town](image)

2.2 Historical Background

From a provincial headquarters during the 14th century, Dhaka has gone through a major transformation to become the economic center of Bangladesh. The physical and environmental features largely contributed to the growth of the city (Khan, 2000). But due to rapid urbanization, human-induced changes have adversely transformed the city's natural landscape (Dewan et al., 2007). The development of Dhaka can be traced back to the 12th century AD (Mowla, 2012). Due to the strategic location to command water routes, the first urbanization of Dhaka started in the Old Natural Levees due to its suitable land elevation (Khan, 2000). In the later period, Dhaka developed gradually. But after the independence in 1971, rapid unplanned urbanization was followed that resulted in the interruption of the city's natural drainage system. Being situated in a flat plane, most of the urban areas of Dhaka have an elevation between 6-8m above sea level. Being situated in a subtropical monsoon climate, Dhaka receives around 2000 mm of annual rainfall. As a result, historically, rivers, canals, and water bodies used to play a vital role in everyday urban life (Mowla, 2010). But since the early '90s, the uncontrolled urban development in low-lying areas made the city vulnerable to urban flooding. Moreover, due to changing pattern of climate, the chances of extreme rainfall events have increased (Ahammed et al., 2014). This resulted in a reduced storm lag time and consequently increasing flood peaks (Khan, 2000). Dhaka, being a low-lying area, is surrounded by rivers and flood plains; hence the amount of developable land in Dhaka city was limited. During the late '90s, the city ran out of land that was suitable for future development. Infill and growth of residential neighborhoods put several infrastructural constraints. City authorities started searching for solutions in the fringe areas to house the ever-increasing population.

Planning and design of the satellite town was primarily the responsibility of Rajdhani Unnayan Kartripakkha (RAJUK), the capital development authority. In 1995, the plan to develop the largest satellite
town in Bangladesh was undertaken. The 6,150 acres project area was divided into 30 sectors (Dhaka Structure Plan, 2015) with a 300-meter-wide highway to ensure fast connectivity with the capital city, Dhaka.

One of the main objectives of the new master plan was to maintain the balance of the environment by proper urbanization by creating an environment-friendly and sustainable atmosphere. But the plan mainly focused on creating developable land and maximizing residential plots. By doing so, the new plans for Purbachal overlooked the previous Dhaka Metropolitan Development Plan 1995-2015. A significant portion of the proposed town was within the main flood flow area (Figure 2). Soon the area once dominated by agricultural landscape started to transform rapidly.

![Dhaka Metropolitan Development Plan 1995-2015](Source: Prepared by the DHUTS, based on Structure Plan of DMDP, 1995)

![Dhaka Structure Plan 2016-2035](Source: Dhaka structure plan 2016—2035)

**Figure 2: Conversion of areas within main flood flow zone**

**Into Growth Management and Outer Urban Areas**

Due to anthropogenic climate change, the frequency and intensity of extreme weather events like floods might increase globally. Dhaka City is recognized internationally as a hot spot for flood risk (Gain et al., 2015). The majority of channels and water bodies of the city have been filled up to create developable lands (Datta & Mandal, 2017). As a result, even moderate rainfall causes urban flooding in certain areas of the city. The low-lying wetlands around Dhaka are subjected to annual flooding and act as a water retention zone. During each monsoon, the wetlands get inundated, creating a low-lying ecosystem with unique flora and fauna. These wetlands are also vital for replenishing the groundwater table. A lowering water table could increase the rate of land subsidence. But unfortunately, a significant portion of these wetlands has
been lost during the development of Purbachal New Town. As a result, severe land subsidence is occurring in Dhaka (Erkens et al., 2015). The main flood flow areas around Dhaka historically protected the city from flood events. In 2021, most of the proposed areas within the master plan have been filled up, and road construction work is ongoing on these areas. Although much of the wetlands are filled up, there is still scope to save some existing ones and restore some of the lost wetlands.

2.3 Study Questions and Objectives

The study aims to answer the following questions:

- What percentage of wetland has been lost since the development of Purbachal?
- How has the water flow pattern changed due to wetland transformation?
- How will changing the relationship between natural factors affect the future urban environment of Purbachal?
- Is there a way to develop the area without hampering the natural landform pattern?
- Is it possible to re-establish the deep structures (Spirn, 2014) inherent in the landscape to strengthen the relationship between the natural factors?

The study has three main objectives:

- Objective 1: Identification of natural land transformation pattern
- Objective 2: Analyze the impact of anthropogenic disturbance of the natural landscape
- Objective 3: Demonstrating the application of land cover and flow analysis as tools to analyze pre and post-development flows.

The study’s main objective is to create a development plan to enhance economic growth while ensuring the protection of the environment to create a sustainable society (Farr, 2011).

3 METHODS

To study the adverse effect of human-induced land transformation, many researchers have used Remote Sensing (RS) techniques to trace the transformation pattern of a city from pre-urbanization periods to the current situation. The study combines Remote Sensing (RS) with a Geographic information system (GIS) to develop a framework for intelligent, holistic geospatial design (Figure 3). The study was divided into three main phases:

1. Land Use and Land Cover (LULC) Analysis: In the first phase, the changing urban LULC condition of Purbachal was analyzed to understand the geospatial structure (Flaxman, 2010) of the region.

2. Water Flow and Watershed Analysis: In the second phase, watershed analysis was done to identify the water flow characteristics and watershed boundaries of Purbachal New Town.

3. Result Analysis: In the third stage, the geo-hydrological aspects of Purbachal were analyzed.

![Figure 3: Study Procedure Flowchart](image-url)
3.1 Derivation of Land Cover Maps

The main source used in producing land use maps was Landsat images. Ahmed et al. (2013) mainly used Landsat images acquired from 1989, 1999, and 2009. On the other hand, Dewan & Yamaguchi (2009) and Khan (2000) used a combination of Landsat images with SPOT and aerial photography to compare pre and post-land development typologies. Landsat MMS band 7 (0.8-1.1µm) is particularly useful for analyzing the flood delineation, but some studies also suggested using TM band 7 with Band 4 in combination (Dewan & Yamaguchi 2009).

3.2 Data classification

The maximum likelihood classification method was used for the statistical characterizations of this study. The statistical characterizations were followed by the digitization of the training sites (Ahmed et al., 2012). Maximum likelihood classification is a type of supervised classification that assumes the statistics for each class in each band are normally distributed. The algorithm used for this classification calculates the probability of a given pixel belonging to a specific class. Dewan & Yamaguchi (2009) also used the supervised Maximum likelihood classification method. Each pixel is assigned to the highest probability class; hence, the name is Maximum likelihood classification. No training data used had a pixel size less than 280, and the greatest pixel size used was 7800. A common problem faced during the study was classifying landcover with Mixed Pixels due to the heterogeneous nature of the urban land cover.

3.3 Data Analysis in the context of Bangladesh

Anthropogenic causes have been the main driving factor for natural habitat destruction around the world. With the increasing population and rapid urbanization, cities in the developing world face the worst impact of changes in urban land use and land cover (LULC). Dewan et al. (2009) assessed the impact of rapid urbanization on land use/cover changes in the Greater Dhaka region of Bangladesh. Landsat data (MSS, TM, and ETM+) images from 1975 to 2003 were analyzed to assess the changing LULC conditions of the Greater Dhaka region. A ground truth map was prepared with fieldwork data collected from 200 reference points using a global positioning system (GPS). A supervised maximum likelihood classification (MLC) algorithm was used for satellite image classification. With the use of Geographic Information System (GIS) and Remote Sensing (RS), this study followed a similar procedure to evaluate the spatial and temporal dynamics of LULC.

3.4 Accuracy assessment

Accuracy assessment is perhaps the most important part of validating the results. The basics of error evaluation are to use an independent source to check the validity of the classification for each of the classes chosen for the study. The basic rules for the classification are:
1. The accuracy evaluation should be carried out with testing data that is not the same as those used to train the classifier.
2. There should be many test pixels – ideally several hundred.
3. The test pixels should be randomly placed.
4. Each class should have a minimum number of test pixels.
5. The ground reference data should be obtained independently from the data used for classification.

Typically, in remote sensing, two different types of accuracy are used: user's accuracy and producer's accuracy.

3.5 User's Accuracy

The user's accuracy is used to assess the reliability of the maps produced in the study. It predicts the chances that what is shown in the map can be accurately found in the actual condition. The user's accuracy is used to establish the level of trust one can have to a class designated on the map.

Errors of commission (if expressed as a percentage) = 100% - User's Accuracy
3.6 Producer's Accuracy

The producer's accuracy is used to assess what proportion of class has been identified correctly in the classification. It describes the chances of a pixel in an image belonging to a class is labeled in that class or not. The user's accuracy is used to establish the level of trust that areas on the map that are NOT labeled a certain class are indeed not that class.

Errors of omission (if expressed as a percentage) = 100%- Producer's accuracy

3.7 Kappa Statistics

The kappa statistics are used to explain whether the results obtained in the study are the outcome of a random chance or not. Kappa penalizes for guessing and always reduces the overall accuracy. All the reviewed studies conducted accuracy assessments. In most cases, the MSS images produced were the least accurate due to the core's spatial resolution (Dewan & Yamaguchi, 2009). The mapping accuracy ranged between 85-90%, with kappa statistics around 0.80 (Ahmed et al., 2013).

3.8 Scope and Limitations of using Remote Sensing

The combination of using RS with GIS can play a vital role in developing future planning strategies. Using RS is a comparatively cost-effective method instead of using ground-based traditional survey methods (Ahmed et al., 2013). For research carried out in developing nations like Bangladesh, RS techniques are particularly useful. With RS, it is relatively easy to collect data and analyze them for a vast area within a short period (Dewan & Yamaguchi 2009). This may result in making decisions faster to come up with the changing environment.

On the other hand, RS has its problems too. The main problem of using RS is the availability of data and the difference in the type of data. In many places of the world, high-resolution images might not be available. In most of the studies, data from many different sources and scales were used, creating many problems in the analysis phase. For the classification, due to the heterogeneous nature of the urban surface, mixed pixels were a common problem while working with Landsat Data. The Wetland class easily gets merged with the low land class due to the similar reflectance properties. Wetland and low land categories also got mixed up with cultivated lands (Dewan & Yamaguchi 2009). But despite these problems, the accuracy of the maps was satisfactory in all the studies reviewed, and the accuracy of RS classification can be further improved by using rule-based techniques and combining with GIS tools.

3.9 Flow Direction Analysis

The flow direction is one of the keys to deriving the hydrologic characteristics of an area. The flow direction map is used to derive hydrologic characteristics of terrain. The flow direction map shows the water flow direction within and around the site. This process creates a raster of flow direction from each cell to its steepest downslope neighboring cells. Eight numbers represent the eight cardinal directions. The values for each direction from the center are the following: (North=64, North-East=128, East=1, South-East=2, South=4, South-West=8, West=16, and North-West=32). So, for example, if water flows from a cell to the south direction, the flow direction would be coded as 4 and so on.

According to Qin et al., (2007), in the Multiple Flow Direction (MFD) algorithm, partitions flow from a cell to all downslope neighboring cells. A flow-partition exponent is derived from an adaptive approach based on local topography conditions. This method is used to determine the fraction of flow draining to all downslope neighbors. By choosing to 'force all edge cells to flow outward' in the flow direction command, it was assured that the process creates a path from every cell to another cell. So, all cells at the edge of the surface raster will flow outward from that surface raster.

The flow direction grid created from the filled elevation surface provides One Directional values, which are assigned based upon the path that water would likely take based upon the elevation values in eight different directions from that cell.

3.10 Watershed Analysis

A Watershed is the part of the land within which water flows down through streams or canals and drains into a larger water body like a river, lake, or sea. Watershed edges are derived from the topography
of an area. Watershed analyses were done to identify the water flow characteristics and watershed boundaries of the surrounding areas of Purbachal New Town. For this purpose, GIS-based analysis tools were used. A geographic information system (GIS) applies geographic science with various tools to collect data and map them systematically to create analysis and represent the spatial or geographic information of an area. GIS applications are tools that allow users to create queries regarding the topographical characteristics of an area, analyze spatial information to generate hydrological context, edit data in maps, and present the results of all these operations as water flow paths and watershed boundaries.

Watershed boundaries with well-defined edges make up a fundamental unit for landscape planning. Developing the delineated watershed is the final step of the watershed analysis. There are three main procedures to create the watersheds, including targeted areas in a stream as pour points, watersheds by stream segment, and off-stream delineation. For this study, the Watersheds by stream segment method was used. This method uses a stream network to generate corresponding watershed boundaries. The number and size of watersheds depend on the density of the stream network. For example, a denser stream network will result in many small watershed boundaries.

The first step is to create a stream link grid that gives a unique identifier to each stream segment where a segment is defined as the water flow on a single line between junctions. The Stream Link command creates a one-to-one relationship between each stream segment a catchment with it. This assigns unique values to each of the raster sections.

Next, the flow direction raster is used as the input for the Watershed command. From the one-to-one relationship between the stream segments, Watershed boundaries were identified. The result of this analysis is watersheds that correspond with each of the stream segments.

By moving the segment Watersheds below the stream link grid and changing their display properties to the unique categorical legend, pre and post-development watershed boundaries of Purbachal New Town were generated.

The watershed analysis offers an understanding of the watershed environment, which plays an important role in guiding the design decision-making process. Understanding the water flow mechanism of an area helps identify suitable locations for future development and categorizes areas that might be susceptible to different levels of flooding. Results from the watershed analysis can be crucial to develop ecologically sustainable planning guidelines by determining environmental needs to assist ecosystem functions. Through watershed analysis of the Purbachal New Town and surrounding areas, different areas were classified based on their inherent watershed characteristics.

4 RESULTS

4.1 Supervised Classification of Pre-development Landform

A supervised classification was carried out to create an accurate land cover map. For the accuracy statement, the number of samples needed to evaluate the classification accuracy for classification of 8 classes, 90% confidence, and 10% precision was estimated. The multinomial distribution method was followed to calculate the sample size (Jensen, 2016). By using Equalized Random distribution parameters, 142 points were generated. Next, the points were interpreted for their land class, and an accuracy report was generated. From the confusion matrix, it can be observed that the land cover class Grass' and Structure' was wrongly classified in some cases, and therefore had a lower user's accuracy.
Table 1. Accuracy Statement of pre-development landform Supervised classification.

<table>
<thead>
<tr>
<th>Producers Accuracy</th>
<th>Percentage</th>
<th>User's Accuracy</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shallow water</td>
<td>93.3 %</td>
<td>Shallow water</td>
<td>100.0 %</td>
</tr>
<tr>
<td>Tree</td>
<td>96.6 %</td>
<td>Tree</td>
<td>100.0 %</td>
</tr>
<tr>
<td>Grass</td>
<td>50.0 %</td>
<td>Grass</td>
<td>44.4 %</td>
</tr>
<tr>
<td>Structure</td>
<td>100.0 %</td>
<td>Structure</td>
<td>50.0 %</td>
</tr>
<tr>
<td>Semi wet</td>
<td>100.0 %</td>
<td>Semi wet</td>
<td>57.9 %</td>
</tr>
<tr>
<td>Bare land</td>
<td>79.4 %</td>
<td>Bare land</td>
<td>93.1 %</td>
</tr>
<tr>
<td>Sand</td>
<td>60.0 %</td>
<td>Sand</td>
<td>100.0 %</td>
</tr>
<tr>
<td>Water</td>
<td>88.9 %</td>
<td>Water</td>
<td>100.0 %</td>
</tr>
</tbody>
</table>

Table 2. Accuracy Statistics and Landform Percentage of pre-development landform.

<table>
<thead>
<tr>
<th>Statistics</th>
<th>Landform</th>
<th>Area (ha)</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>N= 142</td>
<td>Shallow Water</td>
<td>1101.24</td>
<td>8.2 %</td>
</tr>
<tr>
<td>d= 125</td>
<td>Tree</td>
<td>4729.14</td>
<td>35.3 %</td>
</tr>
<tr>
<td>q= 4820</td>
<td>Grass</td>
<td>435.15</td>
<td>3.2 %</td>
</tr>
<tr>
<td></td>
<td>Structure</td>
<td>905.13</td>
<td>6.8 %</td>
</tr>
<tr>
<td>Kappa Estimation</td>
<td>Sami-Wet</td>
<td>3555.45</td>
<td>26.6 %</td>
</tr>
<tr>
<td></td>
<td>Bare land</td>
<td>1981.35</td>
<td>14.8 %</td>
</tr>
<tr>
<td>Overall accuracy</td>
<td>Sand</td>
<td>194.67</td>
<td>1.5 %</td>
</tr>
<tr>
<td></td>
<td>Water</td>
<td>487.62</td>
<td>3.6 %</td>
</tr>
<tr>
<td>Foody 1992 statistic</td>
<td>Total</td>
<td>13389.75</td>
<td>100 %</td>
</tr>
</tbody>
</table>

From the accuracy statement in Table 1, it is observed that the classification worked well in most of the landforms. From Table 2, we can see the kappa statistics was 84.3, which suggested that the map was not a result of random classification. The overall map accuracy was 88. The map performed quite well in identifying the trees and bare land and differentiated between areas of shallow water and water.

4.2 Supervised Classification of Post-development Landform

By using Equalized Random distribution parameters, 120 points were generated. Next, the points were interpreted for their land class, and an accuracy report was generated. From the confusion matrix, it can be observed that like the pre-development map, the land cover class 'Grass' and 'Structure' was wrongly classified in some cases, and therefore had a lower user's accuracy.

Table 3. Accuracy Statement of post-development landform Supervised classification.

<table>
<thead>
<tr>
<th>Producers Accuracy</th>
<th>Percentage</th>
<th>User's Accuracy</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shallow water</td>
<td>90.0 %</td>
<td>Shallow water</td>
<td>69.2 %</td>
</tr>
<tr>
<td>Tree</td>
<td>81.3 %</td>
<td>Tree</td>
<td>76.5 %</td>
</tr>
<tr>
<td>Grass</td>
<td>66.7 %</td>
<td>Grass</td>
<td>53.3 %</td>
</tr>
<tr>
<td>Structure</td>
<td>88.9 %</td>
<td>Structure</td>
<td>53.3 %</td>
</tr>
<tr>
<td>Semi wet</td>
<td>75.0 %</td>
<td>Semi wet</td>
<td>100.0 %</td>
</tr>
<tr>
<td>Bare land</td>
<td>75.0 %</td>
<td>Bare land</td>
<td>100.0 %</td>
</tr>
<tr>
<td>Sand</td>
<td>93.8 %</td>
<td>Sand</td>
<td>100.0 %</td>
</tr>
<tr>
<td>Water</td>
<td>88.2 %</td>
<td>Water</td>
<td>100.0 %</td>
</tr>
</tbody>
</table>
Table 4. Accuracy Statistics and Landform Percentage of post-development landform.

<table>
<thead>
<tr>
<th>Statistics</th>
<th>Landform</th>
<th>Area (ha)</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>N=</td>
<td>120</td>
<td>Shallow Water</td>
<td>86.44</td>
</tr>
<tr>
<td>d=</td>
<td>98</td>
<td>Tree</td>
<td>3084.57</td>
</tr>
<tr>
<td>q=</td>
<td>1812</td>
<td>Grass</td>
<td>2487.47</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Structure</td>
<td>3549.98</td>
</tr>
<tr>
<td>Kappa Estimation</td>
<td>79.0 %</td>
<td>Sami-Wet</td>
<td>1280.94</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bare land</td>
<td>2439.44</td>
</tr>
<tr>
<td>Overall accuracy</td>
<td>81.7 %</td>
<td>Sand</td>
<td>339.07</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Water</td>
<td>331.69</td>
</tr>
<tr>
<td>Foody 1992 statistic</td>
<td>61.1 %</td>
<td>Total</td>
<td>13599.6</td>
</tr>
</tbody>
</table>

From the accuracy statement in Table 3, it is observed that the classification worked well in most of the landforms. The kappa statistics was 79.0 in Table 4, which suggested that the map was not a result of random classification. The overall map accuracy was 81.7. The post-development map had lower accuracy and a lower kappa value but still performed quite well in identifying semi-wetland areas, trees, and bare land.

4.3 Result Comparison

By comparing the Pre-development and Post-development landcover map of Purbachal New Town within its administrative boundary, we can see that the landcover has been drastically modified in the last sixteen years. All wetland categories have decreased significantly. The amount of shallow water decreased from 8.2 % to only 0.6 %. The amount of semi-wetland also decreased from 26.6 % to 9.4 %. On the other hand, Grass cover increased from 3.2 % to 18.3 %, indicating newly filled areas (Figure 4).

As wetlands were converted into developable land, the amount of structure increased from 6.8 % from the pre-development stage in 2004 to 26.1 % to the post-development stage in 2020. According to the water reservoir conservation Act 2000, areas with flowing water and the land which retains the rainwater are defined as 'Natural wetland.' This includes rivers, canals, beels (a type of shallow waterbody), ponds, streams, fountains, and flood flow lands. These wetlands should be protected and preserved according to this law. But unfortunately, RAJUK, the capital development authority itself, has violated this law.

From the 2020 post-development land cover map, we can also see large patches of sand around the Purbachal New Town administrative boundary (Figure 4). This suggests that wetlands around the town are still getting filled up with sand. Illegal land encroachment must be stopped to prevent further ecological disturbance, and initiatives should be taken to recover the lost wetlands in and around the Purbachal New Town.

4.4 Water Flow and Watershed Analysis Result

By analyzing the pre-development flow direction map, the western part of the site has a large area where water is flowing towards the south (Figure 5). The water flows from the patches of relatively higher ground to the adjacent river on the east or towards the wetland on the west, and the general flow direction is towards the south.

In contrast, the post-development flow direction map clearly shows the drastic change in the water flow pattern. The area on the western side of the site has been filled up, interrupting the natural flow direction. As a result of this, water is diverted into different directions, causing flood risk for newly developed areas as well as the existing eastern part of Dhaka city.
Figure 4. Comparison between Pre-development and Post-development landcover map of Purbachal New Town
Figure 5. Water Flow and Watershed Boundaries Comparison

By analyzing the watershed boundaries of Purbachal New Town, a major change in the watershed can be observed (Figure 5). Due to filling up low lands, the post-development flow direction map clearly shows the drastic change in the water flow pattern. The area on the western side of the site has been filled up, which interrupted the natural flow direction. This can create flood risk for newly developed areas as well as the existing eastern part of Dhaka city.

5 DISCUSSION

More than half of the world's population now lives in cities, making humanity a predominantly urban species for the first time in its history. This trend is expected to continue. By 2050, with the urban population more than doubling its current size, nearly 7 of 10 people in the world will live in cities (Cohen, 2003). It is important to develop sustainable development strategies to make future cities environment-friendly (Calthorpe, 2010). The impact of cities on the world's resources is, in fact, disproportionate to their share of the population. Urban activities are estimated to account for some 67% of total energy consumption and 70% of greenhouse gas emissions (Tanaka, 2010). Similar dominance of the global demand for resources can be observed in urban consumption of freshwater, wood, and other raw materials.

Cities around the world are struggling to provide resources to sustain the huge influx of urban population. Therefore, cities should develop sustainable planning strategies to meet this ever-growing demand for resources. This is much more important in the case of developing countries like Bangladesh.
So, it is vital to develop planning strategies based on the understanding of natural landscape patterns. From the land use and land cover (LULC) maps, it is evident that despite being surrounded by low-lying areas, there are lands that can be potentially developed for commercial and residential purposes in Purbachal. From the Pre-development LULC map, it is observed that there were patches of high lands in Purbachal where the land was relatively free from annual flooding.

Instead of implementing a superimposed grid system that requires extensive cuts and fills to modify the existing landform dramatically, the new town plan should have followed the natural topography by creating a harmonious design that maximizes the use of flood-free lands for residential districts and housing infrastructure, commercial, and administrative districts. The low-lying natural areas could have served as a buffer to protect the city from annual and major flooding events. This type of planning strategy could have protected the city from potential flooding as well as preserved the flood flow areas to minimize the flood hazard of Dhaka city, which is further downstream. By minimizing cut and fill, the risk of soil liquefaction could also have been minimized.

6 CONCLUSION

The low-lying areas around the Purbachal play a crucial role in protecting Dhaka from major flooding. The surrounding wetlands support a wide range of agricultural activities, fish cultivation. A variety of natural vegetation in this area has created a unique ecosystem. The current masterplan of Purbachal altered this ecosystem and increased the risk of flooding and land subsidence. This study revealed how the landform and water flow of an area could be drastically altered when a topdown approach is implemented without properly analyzing the existing topography and hydrological conditions.

The process of analyzing natural landscape patterns in the context of Bangladesh has been demonstrated in this study. This can result in a new approach to urban development particularly suited for low-lying areas in Bangladesh. By analyzing the geo-hydrological aspects, a realistic city planning process suited for the context of Bangladesh can be formulated. By integrating natural ecosystems with urban planning, future cities will be able better equipped to face the challenges of climate change. The future resilient cities should not fight with the natural adversaries to survive, but it should generate a collaborative understanding with natural elements.

7 REFERENCES


ABSTRACT
A century of wildfire suppression, growing development at the edge of wildland, and a rapidly changing climate is increasing the risk of catastrophic wildfire in the American West. In the field of landscape architecture, designing and advocating for community and ecological resilience in response to these events has become paramount. The study outlined in this paper supports the idea that the wildland-urban interface (WUI), which is particularly vulnerable to the effects of wildfire, is where multi-scalar design and planning ideas can make a profound impact and where landscape architects can employ their expertise and become stewards of change. The study explores how descriptive geospatial mapping techniques might help communities grow and develop with wildfire in mind by positioning landscape architects as advocates for land use planning strategies that have the potential to bolster resilience. In particular, the study involves the mapping of 55 growing mid-sized communities across the state of California. A broad visual analysis of these maps revealed communities with WUI areas and a history of past wildfire events. This information was then used to formulate a new urban design studio to explore future development scenarios for one of these communities. Over the course of five weeks, students explored a new paradigm of growth for the community by focusing on two centrally-located infill sites. Findings from the study point toward a development framework for growing mid-sized California cities that are vulnerable to wildfire. The framework employs mapping to identify potential risks and to speculate about potential infill areas that are less vulnerable to wildfire and areas that promote the densification of traditionally sprawling communities.

Keywords:
Mapping, wildland-urban interface, wildfire, resilience, climate change adaptation
2 INTRODUCTION

Over the last several decades, wildfires in the western United States have increased in size, and large wildfires have become more frequent (Calkin et al., 2005; Westerling et al. 2006; Miller et al. 2009; Miller et al. 2012). This shift has been primarily attributed to local changes in the quantity of wildland fuels and human development, with climate change exacerbating these conditions (Power et al. 2008; Whitlock et al. 2008; Bowman et al. 2009; Marlon et al. 2009). In California, a century of wildfire suppression has contributed to an accumulation of wildland fuels that has, in turn, increased the risk of large and frequent wildfire events (Steel et al., 2015). Furthermore, the state has experienced significant growth in the WUI. For example, from 1990 to 2010, the WUI in California expanded from 8,732 to 10,435 square miles (Radeloff et al., 2018). In the WUI, human activity has increased the risk of ignition, and fringe development has increased community vulnerability to the effects of wildland fires (Radeloff et al., 2018). The WUI has been described qualitatively, in very general terms, as a space where humans and their development meet wildland fuel, and it has also been described quantitatively, using housing units per acre and vegetation coverage percentages as criteria (Stein et al., 2013; Radeloff et al., 2018; Radeloff et al., 2005).

2.1 Designing for Resilience

In this paper, the term “resilience” does not just refer to a system bouncing back after a wildfire disturbance; rather, it refers to how key components of a system can change—adaptive resilience—and how novel systems can be created—transformative resilience. Expanding the definition of resilience is necessary in the context of wildfire because of rapidly changing conditions and the inability to return a landscape or community back to a pre-fire state (McWethy et al., 2019).

In the field of landscape architecture, designing to increase resilience in the WUI in response to these increasingly large and frequent wildfire events has become paramount. And while landscape architects have traditionally focused on residential-scale defensible space approaches when dealing with these landscapes (Kent, 2019; Soles, 2014; Gilmer, 1994), in recent years, this role has broadened in scale and scope, both professionally and academically. The following illustrates some examples.

Professionally, there has been a rise in landscape architects engaging with this topic. For example, following the devastating 2019-2020 bushfire season in Australia, Hassell Studio published an interview focused on community resilience in the face of fire (Mullane & Kochanowski, 2020). Additionally, in 2020, Rios collaborated with the Resource Conservation District of the Santa Monica Mountains (RCDSMM) to develop a program to shift residents’ perceptions about fire safety (Rios, 2020). That same year, Design Workshop was awarded a contract to help develop a wildfire resilience and recreation master plan for Mariposa County in California (Mariposa, 2020). As one last example, SWA recently completed a project in Rancho Mission Viejo using fire resilience as a primary component of their site strategy (ULI, 2020).

Furthermore, a number of academics in the field of landscape architecture are increasingly mentoring students on the topic of wildfire, using it as a driver in studio or studying aspects of wildfire in their research programs. For example, in 2016 and 2018, two large-scale speculative student projects focused on planning for and mitigating fire risk received National ASLA awards (Duke, 2016; Toth, 2018). Furthermore, over the past two years, faculty members at a range of universities, including UC Davis, MIT, and Harvard University, have been structuring studios around the topic of wildfire. Lastly, several professors are actively engaged in wildfire-related research. This includes the work of Kelly Shannon at USC (Shannon & Kaufman, 2018), Alan Berger at MIT (Berger & Susskind, 2018), Robert Ribe, Bart Johnson, David Hulse, and Chris Enright at the University of Oregon (Hulse et al., 2016; Nielsen-Pincus et al., 2015), Travis Flohr at Penn State (Flohr, 2019; Flohr, 2017; Flohr, 2016), among others.

2.2 Purpose

The study outlined in this paper builds upon this growing body of work to speculate about the expanded role of landscape architects in building resilience to the increasing threat of wildland fire in the WUI. The study is a part of a larger project that seeks to understand how designers might modify the built environment or advocate for policies to lessen the impact of wildland fires on communities. It supports the idea that the WUI is a place where design ideas can make a profound impact and where landscape architects can effectively employ their expertise and become stewards of change (Mowery, 2021; Syphard & Keeley, 2019; Cohen, 2000). It also upholds the notion that wildland fire is a wicked problem and that resilience-building tactics must come in a range of shapes and sizes – from watershed-level strategies.
focused on decreasing wildland fuel loads to municipal-level strategies focused on development planning to neighborhood-level strategies focused on reducing edges to parcel-level strategies focused on the arrangement of site elements, and to planting-level strategies focused on the prioritization of fire-adapted species. Lastly, the study acknowledges that at the largest tactic scales—watershed and municipal—landscape architects must often work collaboratively with other stakeholders to advocate for change.

In particular, this study focuses on spatially analyzing growing mid-sized California communities to better understand the relationship of these communities to the WUI and historical wildfire events. It explores how descriptive geospatial mapping techniques might help these communities grow and develop with wildfire in mind by positioning landscape architects as advocates for land use planning strategies that have the potential to bolster resilience.

3 METHODS

The methodological approach for this study focused on descriptive geospatial mapping. The approach for the study was two-fold. The first part focused on a broad visual analysis of growing mid-sized communities across California and their relationship to the WUI and past wildfire events. This analysis then led to the second part of the study, which focused on analyzing one of the 55 communities.

I began part one by developing a list of growing mid-sized communities. To do this, two filters were used. The first filter was a 2018 population between 50,000 and 300,000 people, targeting mid-sized cities. This was done for two reasons. First, I wanted to compare a similar set of California cities in the study. Secondly, I wanted to focus on cities that were large enough to consider infill development and cities that were small enough not to have pursued climate action planning. The second filter was a higher-than-average population growth rate (over 7.46%) between 2010 and 2018. Both sets of data came from the US Census Bureau. This exercise resulted in a list of 55 growing communities across the state of California in descending order of population growth rate. The second step of the study involved the mapping of these 55 communities at the same scale. First, road networks in each of the growing communities were mapped to reveal existing development patterns. Data for this were extracted at a county scale from the 2019 United States Census Bureau’s TIGER database. After mapping road networks, a 3-mile buffer was made around each of the 55 municipal boundaries in ArcMap. This was done because our primary focus was wildfire within the municipal boundary, and we used the buffer to account for direct fire spread and potential ember travel, primary contributors to wildfire growth and structure loss (Quarles et al., 2010). The next step of the study involved mapping WUI areas in and around the 55 municipal boundaries described above. To do this, 2010 WUI data from the University of Wisconsin Silvis Lab were employed. After mapping WUI areas, historical wildfire perimeters were mapped in and around the 55 communities. For this, data from the USGS Wildland Fire Decision Support System were used. When displaying the historical wildfire data, an overlay technique was used so that areas that had been impacted by fire more often would appear darker. The last step of this part of the study involved a broad visual analysis of the 55 maps produced to understand the relationship of these communities to the WUI and historical wildfire events. For this, communities were tabulated if they had a WUI area or historical fire perimeters within three miles of their municipal boundaries.

The second part of the study focused on analyzing one of the 55 communities with WUI areas and a history of past wildfire events. For this part of the study, the growing community of Vacaville was selected for two reasons: roughly half of Vacaville’s municipal land area is designated as WUI, and the city has a history of past wildfire events. With its proximity to undeveloped wildlands to the west, a pattern of growth at its periphery, shifts in land management, and changes in the climate, the community was shown to be at risk. The Norman Fire of 2014, the Wragg Fire of 2015, the Keating Fire of 2015, and the Nelson Fire of 2018 further highlighted this susceptibility. The second reason Vacaville was selected for further study was its proximity to the University of California, Davis campus, where the urban design studio was based. By studying a site within a 30-minute radius of campus, the hope was that students would be able to visit the site over the course of the quarter to better understand the conditions of the community and its adjacent wildlands. Please note that due to COVID-19, these site visits did not occur.
4 FINDINGS AND DISCUSSION

4.1 Community Catalog

Fig. 1 illustrates findings from the first part of the study, which focused on a broad visual analysis of growing communities across California and their relationship to the WUI and past wildfire events. These maps show the historical fire perimeters in orange and the WUI designation in gray. The fire perimeters are overlaid on top of one another, so darker orange indicates an area that has had multiple fires. Two broad-scale findings from the exercise were that, within three miles of their municipal boundaries, 96% of the cities mapped had wildland-urban interface areas, and 84% had historical fire perimeters. Another finding was that communities with the strongest relationship to the WUI and past wildfire events tended to be located in the southern reaches of the state, typically in the exurban areas of Los Angeles and San Diego. These communities included: 1. Irvine, 2. Lake Elsinore, 7. Menifee, 13. San Marcos, 17. Temecula, 23. Chino Hills, 24. Chula Vista, 27. Murietta, 30. Corona, 32. Lake Forest, 41. Santee, 42. Fontana, 45. Hemet, 48. Moreno Valley and 54. Rancho Cucamonga. The only major outlier of this list that was not located in southern California was 38. Chico. Another finding was that the two communities with the highest rate of population growth, 1. Irvine and 2. Lake Elsinore, showed a strong relationship with the WUI and historical fire perimeters.

Figure 1. WUI (gray) and historical fire perimeters (orange) mapping of 55 growing California Communities.
4.2 Community Case Study

Fig. 2 illustrates a zoomed-in view of Vacaville, the community selected for the second part of the study. This map shows the historical fire perimeters in orange and the WUI designation in gray. The fire perimeters are overlaid on top of one another, so darker orange indicates an area that has had multiple fires. This figure illustrates that a significant portion of the community sits within the WUI and that there is a history of fire to the west and southwest of the city. For the urban design studio at the University of California, Davis, this map was used as a starting point. In the studio, students were asked to acknowledge the complex and contested terminology of “urban” and “wild” and explore what it might mean to design in the gray area between the two. One of the early assignments in the studio involved an in-depth mapping of the community to better understand potential development areas and associated vulnerabilities. For example, figure 3 shows a land use mapping of Vacaville that was used to analyze access to transit, jobs, shopping, and services. Additionally, Fig. 4 shows a natural hazard mapping of Vacaville using wildfire perimeters and flood risk as primary drivers. The darker tones show areas with increased risk, and the yellow tones show areas with lower risk. Ultimately, all of this information contributed to selecting two centrally-located infill sites in Vacaville (Fig. 5). These two sites were selected because they had not been challenged by fire in the past and are unlikely to be challenged by fire in the future due to their interior location, away from the wildland periphery. Furthermore, these sites have the potential to sustain denser development, supported urban infrastructure, and nearby city amenities. Once selected, students spent five weeks exploring a new paradigm of growth for the community by proposing a range of mixed-use infill projects for the two sites. Coincidentally, two months after the completion of the studio, parts of Vacaville were impacted by the LNU Lightning Complex wildfire, but this event did not impact the two infill sites selected for the studio.
Figure 3. Land use mapping of Vacaville.

Figure 4. Natural hazard mapping of Vacaville.

Figure 5. Locations of the two infill sites selected for the urban design studio.
4.3 Limitations

This study has several limitations that could be addressed in future studies moving forward. First, future projects could take into account other data related to wildfire risk, including Fire Hazard Severity Zones (FHSV), Wildfire Hazard Potential (WHP), or spatial fuels and vegetation data from LANDFIRE. Alternatively, future studies could more deeply engage fire ecologists and those focused on mapping and modeling fire behavior. Additionally, future projects could also employ spatial statistics to quantitatively analyze the series of maps produced for the project. Furthermore, a more systematic approach for evaluating potential sites for development in these higher-risk growing communities could be developed, including the use of suitability studies.

5 CONCLUSION

As the threat of wildfire in the WUI increases, it is imperative that landscape architects explore new strategies for bolstering community and ecological resilience. Given that wildfire in the American West is a wicked problem, designers cannot rely on a single strategy or a single scale; rather, they must lean into strategies and scales not typically associated with professional practice.

In California, it is clear that many mid-sized growing cities are situated within or near the WUI and have a history of wildfire events. Thus, this study puts forth a potential development framework for communities that are vulnerable to wildfire by positioning landscape architects as advocates for land use planning strategies that have the potential to bolster resilience. The framework involves geospatial mapping at the city scale to assess potential risks and identify potential infill areas that are less vulnerable to wildfire. These infill areas also promote densification in traditionally sprawling WUI communities.

While the study outlined in this paper is imperfect on many fronts, the hope is that it begins to turn the needle on the increasing threat of wildland fire in the WUI and the potential role of landscape architects in designing for resilience.

6 REFERENCES


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March 17-19, 2021


1 ABSTRACT
Planning for land use change can quickly become contentious when the protection of water resources is at risk and when previous planning projects have already led to concerns over public trust. This paper highlights how Penn State University developed a hybrid ‘community conversation’ engagement strategy for future plans for a sensitive, 356-acre University-owned property. Through a tightly structured design and community input process, an interdisciplinary team of faculty and students worked with a non-profit organization, community-group leaders, and municipal officials, the public, and university leaders to provide a range of viable management strategies for the property in question. Using Geodesign’s transparent planning process to give community members a strong voice, this paper highlights a unique community engagement process where traditional community engagement tools (presentation, interview, charette) are augmented by digital tools – including ArcGIS Pro as a source of data and systems mapping, Geodesignhub to allow stakeholders to create their own design scenarios and StoryMap as a presentation tool to convey outcomes. The process worked through three iterative loops within the project timeline to determine design strategies for the site, all of which were continually rooted in the research of the site and checked against community input and shared with the public. This process allowed stakeholders and landowners to reach a consensus regarding complex land use and development issues in an engaging, trusting, and collaborative way.

1.1 Keywords:
Landscape architecture, community engagement, GeoDesign, ArcGIS, digital tools

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2 INTRODUCTION

When a community’s largest employer seeks to alter a unique piece of natural and agricultural land near the region’s drinking water wells, issues can arise. The President of the Pennsylvania State University requested design assistance from its own Landscape Architecture Department and Geodesign Program to study this complex issue involving multiple systems and stakeholders. The University’s charge to the project team was clear: use science-based research to understand the property and its context, develop a transparent community engagement strategy that will build trust and gain consensus to ultimately inform future efforts regarding the long-term ecological and conservation needs of the site. The goal was to integrate Geodesign’s data-aware, transparent, and synchronous capabilities into the outreach process to give all community stakeholders a strong voice while helping guide decisions about what happens on the land in a democratic way. By connecting experts with the users, the process becomes adaptable and transparent, further building trust amongst all stakeholders (Ruggeri and Szilagyi-Nagy, 2019).

Through a tightly structured process, a faculty/staff-led team worked with students, a non-profit organization, community-group leaders, municipal officials, the public, and university leadership to study a 355-acre assemblage of university-owned peri-urban property in State College, Pennsylvania. The property, referred to as the Musser Gap to Valleylands Project, or “MG2V” is shown in Figure 1.

An overview of the planning process is shown in Figure 2. In the analysis phase, students completed a deep dive to study the existing condition of the site. In the second phase, the community engagement phase, students developed preliminary landscape design and management strategy scenarios that were informed by a series of public meetings, community group interviews, and key stakeholder input. Another iteration of design scenarios took the student-generated design ideas, based on information gathered from the community, into account before being presented to leadership. The scenarios, values, and themes from these two phases of work informed the third phase of the project, the decision-maker engagement phase, to further develop and select preferred scenarios with University administrators, including the President, who would be making the actual decisions about what happens on the land.

3 RESEARCH OBJECTIVES

The goal of this study is to pilot a research and engagement strategy that builds on the collaborative planning process through a case study using Geodesign in a sustainability context (Slotterback et al., 2016). Digital tools and media have been shown to aid designers in obtaining participatory data, gaining a more comprehensive view from the eyes of the user (Ruggeri and Young, 2016). Building on the advancement of current technology digital tools, the intention is that this process can be replicated for projects with contentious sites to help stakeholders and landowners make hard decisions and reach
consensus regarding complex land use and development issues in an engaging, collaborative way while also building on engagement frameworks used in creative practice (Sarkissian et al., 2010).

Figure 2: An overview of the planning process

4 METHODS

4.1 Analysis Phase

The first phase of the study was to complete a deep analytical study of the land and its context within a seminar-style course offering comprised of students from various degree programs including Landscape Architecture, Ecology, Geodesign, Geology, Forestry, and Recreation Parks and Tourism Management. The students began by visiting the property to observe how the land was being used on a day-to-day basis and to provide a better understanding of topography and land cover. The 355-acre tract, shown in Figure 3, is owned by the University but is currently leased out to a local farming family on a year-by-year basis. The family has been farming this land for over six generations and has indicated that they would like to continue farming the property into the future. Most of the land, approximately 215 acres, is being used for conventional agriculture, including oats, corn, soybean, hay, and pumpkin. The students studied and mapped many other facets of the land, including geology, hydrology, soils, flora, and fauna.

Geospatial information was collected to create maps showing elevation, slope, aspect, water flow, soils, and viewsheds. Model My Watershed, an online tool to measure ecosystem services, was implemented to learn more about the potential impacts of land use changes. Local zoning ordinances were also studied to further understand potential land use changes. Historical maps dating as far back as 1861 were also included as part of the in-depth study performed by the students. A key observation was that the site sits upstream of the area's drinking water wells and is approximately a seven-day traverse down the watershed to the Chesapeake Bay. Students created a final report memorializing their findings in written form and via StoryMap as a presentation tool to convey outcomes (Tamminga et al., 2018).

Figure 3: Map of the 355-acre tract of property known as MG2V (Musser Gap to Valleylands) and its context. (Credit: D. Meehan/PSU Geodesign Program)
4.2 Community Engagement Phase

The next phase, community outreach, built on the information collected in phase one and again used an interdisciplinary group of students to develop and execute a community engagement strategy. The strategy incorporated a Geodesign framework that has been described by Carl Steinitz (2012). Students in this course were given the task of gauging community interest in this project and of getting ideas of what the residents, students, farmers, business owners, and local organizations would like to see happen on this land. Because of the contentious nature of the site and the project, the faculty-led team developed a strategy around a series of “community conversations,” a hybrid approach to engagement using in-person engagement techniques augmented with digital tools to increase reach and participation.

To jumpstart the outreach work, faculty identified key influencers and stakeholder groups to informally interview. A spokesperson for each group was identified to determine what tangible or intangible aspects of the site they valued as well as how they would rate and weigh those values. In addition to interviews, an online survey was conducted and collected over 1,000 responses from the community to further gather information, collect additional ideas, and further understand how the community feels about the trustworthiness of the University to enact change that is beneficial to all.

The University engaged ClearWater Conservancy, a local non-profit organization that specializes in land conservation and preservation, to host a series of community conversations facilitated by the students. The first conversation, “Site Understanding and Listening Session,” was open to the public and allowed community members to provide input by drawing on paper maps to depict what they wanted to see on the land. Using the information gleaned from key stakeholder interviews and the input from the online survey, the students developed five key themes to help organize community input at the first community conversation listening session: Agriculture/Farming, Habitat/Biodiversity, Water Resources, Recreation, and Other.

In preparation for the second community conversation, a Geodesign Workshop, students used ArcGIS Pro to create digital geospatial data to capture the input so it could be shared in an open and transparent manner. Geoforage.io is a simple online survey tool that allows anyone with an internet connection to provide their input. Users can digitize, or draw, an area on the map to show and then describe their own ideas for land use change. This tool was integral as it allowed those who could not make it to a community meeting to know that their input was still valued and captured.

Key stakeholders then participated in a student-facilitated workshop using Geodesignhub, an online, open-source mapping tool for negotiation and evaluation to assess community values and needs. Geodesignhub utilized the project-specific GIS data and allowed for groups to choose from ideas that came from public input or add and refine their own diagrams that represented ideas for change on the land. The diagrams were separated into ten categories: blue infrastructure, biodiversity, transportation, amenities, forestry, utilities, recreation, mixed-use, and agriculture. Participants were organized into multiple design groups, based on their backgrounds and expertise, and instructed to select a series of the previously created student diagrams to make a preferred design for the land. Designs were then compared with each other to help visualize and understand the different opinions of the people of the place.

Figure 4. Students gather input from community members by having them draw important existing features and possible design opportunities on a map of the site. (Credit: D. Heltman-Gray)
All the information gleaned from the surveys, meetings, workshops, and community feedback was synthesized by students who created four individual design ideas for what could happen on the land. The scenarios were based on the themes of water resource protection, enhancing biodiversity, agritourism, and passive recreation, building on the key themes present throughout the process. This information was presented back to the community in a community conversation, where the public was invited to give feedback on each idea in an open house setting, shown in Figure 4. Feedback from the public was captured in real-time and used to inform the following community conversation, which was to share final ideas. Revisions to the previous ideas were completed, and a fifth idea was added: minimal intervention. All ideas are represented in Figure 5. A final community conversation was held to share the five ideas, where the President of the University greeted attendees and again invited the community to offer input and feedback. Students created a final report memorializing their findings and used StoryMap as a presentation tool to convey outcomes (DuRussel et al., 2019)

Figure 5: Students generated design ideas inspired by input gathered from the community and refined. (Credit: Students of LARCH497, Spring 2019)

4.3 Decisionmaker Engagement Phase

Once the final design strategies were presented to the public, the faculty-led team facilitated the next phase of the project, the University administration phase. The team would address the community input and student-created ideas and work with University leadership groups, the decision-makers, to determine the ideas that would be implemented and study the feasibility of these ideas.

The team again facilitated a Geodesign workshop, utilizing the Geodesignhub tool with upper-level University leadership to get a sense of their values, ideas, and priorities. The team met individually with the senior management from Business & Finance, Facilities & Planning, Local Government & Community Relations, and finally, the President. Each of these groups was designated as a design team and went through the same process as the earlier community Geodesignhub workshop. The leadership groups then selected a series of diagrams to make up their own design for the land. Once each leadership group had completed the process, the team used Esri’s GeoPlanner to create dashboards to provide real-time feedback on different design scenarios.

After these team meetings, leadership groups were all brought back into the same room to analyze and review the designs. Evaluation tools allowed decision-makers to see the various scenarios which
were compared to further understand areas of agreement and areas of contention. The team created a GeoPlanner project file to help synthesize the information to fully convey how themes related to the assessment of ecosystem services could be made visible in the decision-making framework (Dailey et al., 2009). This enabled project participants and the team to see the impacts their choices had with regard to desired criteria for the property and how alternative options compare with each other. The process was structured to ensure that the design decisions are influenced by the people's values of the place and reinforced by the data to support the decisions. The team created a final report memorializing their findings (Cole et al., 2020).

5 RESULTS

The resulting effort identified seven key design elements related to the identified themes of water, biodiversity, agriculture, and recreation that have been apparent through the process as priorities for implementation. The University has moved forward with awarding a project via a request for proposal process to further study the feasibility of the identified interventions, interventions which have each been community-driven. The project moving forward on behalf of the University acknowledges the community’s call for transparency and trust.

6 CONCLUSIONS

The design and engagement process for this project is unique in that it is not often that an academic program gets the opportunity to undertake a practical project in this manner. The actions taken throughout this project allowed the team to work through three iterative loops within the project timeline - all continually rooted in the research of the site and checked against community input to build public trust.

The use of traditional community engagement tools (e.g., presentation, interview, charette) augmented by digital tools (e.g., ArcGIS Pro, Geodesignhub, StoryMap) was successful in that it extended the reach of participation, allowing the community to participate in ways they felt most comfortable. This hybrid engagement strategy allowed the community to guide the conversation, influencing initial themes for the student-led team to explore through initial interviews and surveys. Digital tools allowed for a synchronous experience of public design participation, putting the experts in a room with the non-experts to further enhance and encourage conversation and negotiation.

The process worked through three iterative loops within the project timeline to determine design strategies for the site, all of which were continually rooted in the research of the site and checked against community input and shared with the public. The final decisions that were made had an agreement among decision-makers, had community buy-in, and met the original values outlined by the President. The process allowed for research and design work to be checked against the charge from the University, corroborated by community input to build authentic public trust.

7 ACKNOWLEDGEMENTS

Support for this project was provided by The Pennsylvania State University Administration, with additional in-kind support from The Pennsylvania State University Landscape Architecture and Geodesign Programs and ClearWater Conservancy.

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HISTORY, THEORY, AND CULTURE

Edited by Lisa Orr, Stefania Staniscia, & Judith Wasserman
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1 ABSTRACT
This paper addresses how digital humanities methods are being used to advance the interpretation and documentation of a rural cultural landscape in the United States. Due to the size and scope of rural landscapes, innovative methods for collecting and analyzing data are critical for advancing landscape preservation initiatives. The New Deal’s Prairie States Forestry Project, the largest afforestation project to date in the United States, lends itself to one such preservation initiative. Using an in-progress online project, the authors show how digital humanities methods for digital preservation and metadata entry are an important first step to disseminating thousands of previously inaccessible primary source documents in a web-based platform. The collaborative digital humanities project is an act of preservation that creates new opportunities for documenting and managing cultural resources. The archive incorporates geospatial, landowner, and plant species as metadata, allowing search functions to correlate diverse primary source materials, including photography and planting records, to landowners in different geographic locations. This allows stakeholders, including landowners, the U.S. Forest Service, State Historic Preservation Office, and historical researchers, to not only identify a baseline inventory of historical plantings, but to connect the shelterbelts to those who planted and/or still maintain them. The collaborative curation of source material for the digital archive not only provides immediate access to thousands of primary source documents, but digital features and organization of the archive itself expand the questions that landscape architects practicing in historic preservation and forestry can ask when evaluating this large-scale cultural landscape.

1.1 Keywords:
New deal, cultural landscape documentation, digital humanities, digital archiving

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INTRODUCTION

Due to the size and scope of rural landscapes, innovative methods for collecting and analyzing data are critical for advancing landscape preservation and conservation initiatives. This paper addresses how digital humanities methods for digital preservation and metadata entry are being used to advance the documentation and interpretation of a rural cultural landscape in the United States. The ability to read a landscape with both contextual depth and site specificity is a critical step in evaluating historic integrity as well as developing landscape management plans. Using an in-progress digital humanities project focusing on the New Deal’s Prairie States Forestry Project (PSFP), a dynamic landscape intervention that continues to shape and sustain the Great Plains region, the authors show how the process for digitizing and defining metadata entry for thousands of previously inaccessible primary source documents creates new opportunities for interpreting and documenting cultural resources.

Digital humanities, an interdisciplinary field at the intersection of digital technology and humanistic discipline[s] (Whiston Spirn, 2020, p. 125) can offer landscape architecture and landscape history digital archival methods for working with primary source material to interpret and document landscapes in both time and space. In this respect, the PSFP digital archive incorporates metadata on geospatial positions, landowner names, and plant species, allowing search functions to correlate diverse primary source materials, including photographs and planting records, to landowners in different geographic locations. This allows stakeholders—including landowners, the U.S. Forest Service, state forestry agencies, the State Historic Preservation Office, and historical researchers—to not only identify a baseline inventory of historical plantings, but to connect the shelterbelts to those who planted and/or still maintain them.

2.1 Prairie States Forestry Project Background

Part of American agricultural heritage, the Prairie States Forestry Project (1935-1942) was a federally funded New Deal program in which the U.S. Forest Service partnered with landowners to plant trees in a designated zone stretching from the Texas panhandle to the Canadian border (Perry, 1942, 1) (see Figure 1). Nearly 220 million seedlings were planted, creating 18,600 miles of shelterbelts occupying 240,000 acres on 30,000 farms. This landscape intervention was groundbreaking for the time, as forest service researchers used regional data for spatial assessments across six states. Soil conservation, a central concern during the 1930s Dust Bowl period, was the primary goal of this massive afforestation project, led by President Franklin Delano Roosevelt’s belief that soil conservation on private land should be a public concern. The establishment of the Soil Erosion Service “marked the first federal commitment to preservation of natural resources on public land,” and the experimental PSFP shelterbelt planting program was implemented in 1935 as part of federal soil conservation efforts (Woolner, 2010).

The concept for a massive wall of trees planted in a 100-mile-wide zone traversing the center of the United States was first presented to the American public in a 1934 New York Times article, “To Insure Against Drought, A Vast Plan Takes Shape," by F.A. Silcox, then chief forester for the United States Department of Agriculture. Despite presidential support for the PSFP, the project was controversial both in Congress and among the professional forestry community. In contrast to other New Deal programs the PSFP provided federal funding for conservation work on private land, using unproven agroforestry methods in a struggling agricultural region. Despite these concerns, federal funding was awarded to the Forest Service and planting began in 1935. The project was administered by U.S. Forest Service employee Paul Roberts, who was headquartered in Lincoln, Nebraska, and this collaboration with local landowners led to the largest afforestation project in United States history.

The massive infrastructural planting provided the groundwork for the agroforestry practices of today, and the PSFP shelterbelts are a dynamic landscape intervention that continue to play critical roles in shaping and sustaining the Great Plains region. Due to climate change, the importance of ecosystem services provided by these multigenerational legacies will continue to increase. However, this heritage is at risk due to a lack of coordinated monitoring efforts, and the current status of existing PSFP shelterbelts remains unknown, making it difficult to identify, analyze, and create management plans for this evolving large-scale cultural landscape.
Figure 1. Final published shelterbelt zone. February 1935.
Originally published in Possibilities of Shelterbelt Planting in the Plains Region.
Courtesy of the Forest Service, U.S.D.A.
When discussing the PSFP and other New Deal programs, it is important to acknowledge that while some of these initiatives reached out to marginalized groups in unprecedented ways, others, such as the Social Security and National Labor Relations Acts of 1935, specifically excluded African Americans and Chicanos, with New Deal policies as a whole unable to overcome the nation’s “entrenched racial order” (Walker, 2019b). Like other programs of its time, the Prairie States Forestry Project provided funding to landowners whose families had been granted land through a homestead system that unjustly favored white landowners, and who had previously benefited from westward expansion that occurred through the genocide and suppression of countless Native Americans.

2.2 Archival Record

Unlikely as it may seem, the PSFP’s organizers were aware of its historical importance and had the foresight to plan for its preservation in later decades. In 1940, then project director Paul Roberts wrote a letter to all participating Forest Service state directors and division chiefs encouraging them to keep a permanent record of the project, saying, “You may not attach much importance to some of them, but send them in anyway, for out of all of this someday someone will write a saga of the Shelterbelt.” Roberts’s foresight resulted in the USDA National Agroforestry Center, located on the University of Nebraska campus, retaining the archival record for the three participating northern states, Nebraska, South Dakota, and North Dakota, in addition to limited records for the southern states, Kansas, Oklahoma, and Texas.

The collection contains records for all seven years of the project (1935-1942) and can be organized into the following categories: government correspondence, photographic documentation taken by New Deal photographers, maps documenting planting locations, and descriptive records between the Forest Service and landowners. Correspondence with these private landowners (referred to as “cooperators”) includes a Record of Individual Strip form for each cooperator’s shelterbelt planting(s) and includes information on the quantity of species planted, year of planting, and the length and width of each shelterbelt. The primary source textual material, including correspondence and cooperative planting agreements between the Forest Service project administrators and private landowners, was kept in filing cabinets organized by participating state; Nebraska, for example, has 150 county maps, 1,000 township maps, and over 6,000 descriptive records (see Figures 2 & 3).

Similar to the Vanderbilt classification system created for archiving New Deal photography by subject matter, the photographic collection is not organized by geographic location but by category (Arnold et al., 2017). Example categories include shelterbelt, utilization, damage, field windbreaks, crop protection, and human interest. This thematic archival photographic classification system makes identifying and spatially locating photographs challenging. Individual photographs may include location (usually a state or county), which is typically listed with a supporting description of the planting site and the name of the cooperator (if included) (see Figure 4).

2.3 Digital Preservation Efforts for New Deal Landscapes

The importance of New Deal programs and projects to the development of the landscape architecture profession in the public realm is well documented (Cutler, 1985). A deeper understanding of the legacies of New Deal projects such as the Prairie States Forestry Project at both the local and national levels can expand our knowledge of homestead systems as well as create opportunities for contemporary forms of preservation. Such an understanding can be achieved through digital preservation methods aimed at organizing, searching, and visualizing primary source material. One such project, Yale Photogrammar, uses digital tools to aggregate New Deal photographs as maps georeferencing thousands of photos taken across the United States, categorically and thematically, categorized both in a timeline and by individual photographer. In this manner, digital preservation of New Deal initiatives provides accessible web-based platforms for engaging a diverse audience in humanistic exploration expanding collaborative opportunities (Cox & Tilton, 2019).

Another example is The Living New Deal (https://livingnewdeal.org/), which introduces archival documents to new audiences by disseminating and georeferencing primary source material. Housed in the geography department at the University of California, Berkley, the website has become a significant New Deal resource connecting local preservation initiatives to users throughout the US. The project team works with volunteers across the country to map New Deal public work projects, a vital initiative considering the number of New Deal projects in each state. Because New Deal public works are largely invisible
and were rarely marked as such, “the era’s contribution to American life goes largely unseen and unappreciated” (Walker, 2019a).

Tangible New Deal heritage initiatives are also occurring within State Historic Preservation Offices (SHPO) across the United States for nominations to the National Register. For example, the state of Nebraska has developed a Multiple Property Documentation Form (MPDF) for listing New Deal-related resources to the National Register. Nebraska’s MPDF form identifies the Prairie States Forestry Project as a nationally significant New Deal conservation effort that shaped the state’s landscape heritage from 1935 to 1942. (Loughlin et al., 2019, SF_2). Despite the project’s national significance, limited access to primary source material that can aid in justifying a landscape’s historical integrity is often an obstacle that keeps important cultural landscapes from being considered for the National Register. In the case of the Prairie States Forestry Project, the process for preparing a digital archive has made primary source documents available, creating opportunities for future large-scale landscape conservation projects (Karle & Carman, 2020, 15).

Figure 2. Archival Descriptive Record.
2.4 Digital Humanities and Landscape Architecture

Furthermore, digital humanities can offer landscape architecture and landscape history digital archival methods for working with primary source material to interpret and document landscapes in time and space. One such project, the Marnas Digital Archive, documents the evolution of the Scandinavian landscape architect and designer/theorist Sven-Ingvar Andersson’s personal garden (Whiston Spirn, 2020). The website grants users two critical experiences in viewing the garden, allowing them to view it as it existed during the designer’s lifetime, and see how it evolved over time (www.Marnasgarden.com). This digital humanities project not only disseminates important primary source documents, but creates a new model for reading landscapes described by Anne Whinston Spirn (2020) as the “virtual experience of moving through a place in space and time, exploring change and the mutual shaping of ideas and place” (p. 125).

The Center for Cultural Landscapes at the University of Virginia is pioneering further scholarly projects through The Landscape Studies Initiative (LSI) (www.arch.virginia.edu/ccl). According to Meyer and Lee (n.d.), the concept of “digital inquiry” utilizes technology to present primary source material in new and exciting combinations. Using digital humanities methods and a web-based platform, their work creates new readings of archival material on designed cultural landscapes; for example, LSI is utilizing a digital humanities platform to “transform how the history of designed landscapes is taught and researched.” Focusing on two pilot projects, Central Park, New York and Park Muskau, Germany, Meyer and Lee apply digital resources with the goal of expanding pedagogical approaches to teaching landscape history in the classroom.

In addition to these pilot projects, Meyer and Lee offer a seminar course, Digital Landscape Studies, that allows students studying landscape architecture to gain exposure to the process for creating a digital archival project, an important step for expanding the collaborative potential between landscape architecture and the field of digital humanities.

3 RESEARCH OBJECTIVES

This paper discusses the initial phases of descriptive metadata development for a rural New Deal landscape, an essential component for creating a digital archive. Typically, landscape architects lack formal archival training, and collaborative partnerships with experts in library studies are essential for preparing a digital archival project. As previously discussed, several collaborative digital humanities projects are occurring in landscape architecture programs across the United States; however, limited publications exist in the field of landscape architecture documenting their methodological approaches to archival development. Using the ongoing Prairie States Forestry Archival Project as a case study, this paper discusses the process for defining archival metadata for thousands of previously inaccessible primary source documents. The project creates new opportunities for interpreting and documenting cultural resources in two ways:

(a) Preserving thousands of previously inaccessible primary source documents through the establishment of a digital archive, with the goal of future dissemination in a web-based platform.
(b) Developing descriptive archival metadata that enables stakeholders—including landowners, the U.S. Forest Service, state forestry agencies, the State Historic Preservation Office, and historical researchers—to not only identify a baseline inventory of historical plantings, but to connect the shelterbelts to those who planted and/or still maintain them.

4 METHODS

4.1 Digital Archiving

Because the primary source materials for the Prairie States Forestry Archive were created on behalf of the United States government, access to and use of the collection is unrestricted. Unfortunately, the original materials on the University of Nebraska campus remain inaccessible and unarchived, making it challenging for scholars or the public to locate important primary source documents to advance research and/or share personal and public history. Similar to the role Paul Roberts played in preserving the archive during the Great Depression, retired NAC employee Richard Carman has served as steward of
Due to the national significance and relevant local public history of the PSFP, a collaborative partnership was established between the authors of this paper, the National Agroforestry Center, and the University of Nebraska’s Center of Digital Research in the Humanities (CDRH) to use digital humanities best practices to preserve and disseminate these materials. The team’s primary goal was to digitize the documents as a form of preservation and for greater access. In addition, the scholars seek to create a digital humanities website to take advantage of the research possibilities surrounding these historical materials. Utilizing established international metadata standards, digital tools, and technologies, the team seeks to facilitate new readings incorporating contextual depth and data in aggregate and expanded understanding of individual records.

The researchers decided that because of the amount of physical material, initial funding would focus on digitizing the records for the state of Nebraska. As part of the initial research phase over 6,000 descriptive records and over 6,000 photographs were digitized with corresponding metadata. By limiting the scope to one state the team is able to develop a repeatable framework for digitization and metadata entry of additional states as well as test best strategies for presenting the archival material through a searchable website.

Additionally, while the physical NAC collection includes comprehensive archival sources for the three participating northern states (Nebraska, South Dakota, and North Dakota), the NAC archive contains limited documentation for the three participating southern states (Texas, Oklahoma, and Kansas), creating a barrier to documenting the entire six-state project with similar archival data at this time. It is our hope that a framework for digitization and dissemination will raise awareness and aid in locating primary source material for the three southern states, making it possible to digitally archive the entire six-state project in the future.

4.2 Metadata
The team decided that because of the large number of documents to be digitized, it was not yet feasible to transcribe the entirety of every document. Instead, to allow the largest possible audience to search the records, the team determined that the following categories were necessary for metadata entry on both the descriptive records and photographs: geospatial information, names of landowners and photographers, and planting records, including original species planted, length and width of planting, and year of planting. For photography, the original thematic categories used to organize the photographs in the physical archive were also included as metadata (see Table 1 and Table 2).

4.3 Geospatial Data
The descriptive archival documents were tagged with geographic information, including state, county, and town, along with section, township, and range. The photographs were also tagged with a level of geographic information when it was present in their captions. In some cases, this might only include the name of a state, county, or town. Research assistants reviewed the archival sources to adjust for changes in historical counties and town names and boundaries. Because Texas is the only state in the archive not on the Public Land Survey System, one additional step could be to tag all archival documents with latitude and longitude coordinates to unify the geospatial data between states.

The ability to connect multiple primary source documents using similar geospatial data can aid in historic preservation efforts such as the ongoing Black Homestead digital humanities research effort in the Center for Great Plains Studies at the University of Nebraska (https://www.unl.edu/plains/homesteading-research). The archive allows users to search for a document using section, township, and range tags, making it possible to locate both individual records within the aggregate and coordinating digital homestead records for the same location. For example, landowners in Cherry County, Nebraska participated in the Prairie States Forestry Project and historically had one of the largest communities of Black homestead families in the Great Plains. While race itself was not indicated on the PSFP forms, the use of geospatial information and regularized names can benefit researchers on projects such as the Black Homestead effort by allowing users of the archive to understand more about the evolution of these homesteads and their owners.
Figure 3. Archival Source Record of Individual Strip.
On average, shelterbelt plantings would have ten rows of planting and each cooperator would have a Record of Individual Strip per each shelterbelt planted on his or her property.

<table>
<thead>
<tr>
<th>1.1 Personal Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Last Name</td>
</tr>
<tr>
<td>Helmricks</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>1.2 Geospatial Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>State</td>
</tr>
<tr>
<td>Nebraska</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>1.3 Planting Record</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year Planted</td>
</tr>
<tr>
<td>1937</td>
</tr>
</tbody>
</table>

Table 1. Descriptive archival record metadata categories for Record of Individual Strip
Table 2. Photography metadata categories.

In the process of metadata entry, a census check discovered the name of the cooperator was Art Helmricks, not Art Helmrick as written in the descriptive caption of the archival photograph.

4.4 People

For descriptive records, all documents are tagged with the cooperator’s first and last name. Research assistants checked the spelling of each name against the 1930 census and corrected for accuracy when necessary. The photographer’s name was also entered as metadata and when identified in the descriptive text the cooperator’s first and last name is tagged. This ability to view PSFP photographers and cooperators by first and last name allows users to easily identify the demographics of participants in the program, creating new opportunities for reviewing the PSFP through the lens of gender and/or ethnicity and allowing greater insight into female cooperators and possible Black cooperators, female-owned farms, and Black-owned farms.

The ability to connect a cooperator’s descriptive record to photographs of his or her property in the collection was also not easily accomplished in the physical archive. Members of the general public searching for their own family’s documents can now easily locate descriptive records and supporting photographs in the digital archive through a search by first and last name. This ability to connect geography with people provides a deeper understanding of place and the cooperator’s connection to the land (see Figure 5).
4.5 Planting Record

In the descriptive records, planting information includes species planted, year of planting, and length and width of shelterbelts planted, all of which were tagged as metadata. The planting description for individual shelterbelts serves as important information when evaluating historic landscape integrity for a national register nomination. For example, several Nebraska farms and ranches are eligible for nomination to the National Register, and access to historically significant planting documents such as the PSFP shelterbelts (as a New Deal conservation method) makes it possible to include the entire farm (historic land, agriculture production, and buildings) in the listing.

Additionally, the archival records can be read and quantified in aggregate, providing an understanding of the historical project’s ecological impact and environmental performance. For instance, the number and type of species planted, and the number of shelterbelts planted per year can provide insights into the ecological effects of a large-scale afforestation effort in an agricultural landscape. The length and width of the shelterbelts can further provide spatial data needed to help evaluate the project’s environmental performance. The reduction of soil erosion on the leeward side of shelterbelts generally extends 10 times tree height (Ticknor, 1988), and assuming a conservative shelterbelt height of 30 feet, the area protected from soil erosion by the PSFP could extend up to 1,000 square miles.

Figure 5. Examples of correlated archival records. U.S. Department of Agriculture, Forest Service. Credit: National Agroforestry Center – Forest Service. The metadata entry makes it possible to locate descriptive and photographic archival records for the Cooperator J.P. Nolan’s shelterbelt planting.

5 FUTURE RESEARCH

As the team is excited by the possibility of the digital humanities methods summarized above, the archive’s next step is developing a user-friendly platform connecting the primary source material to a larger public audience. A University of Nebraska digital humanities project, Nebraska Portal, provides a space for teams of interdisciplinary scholars to prototype such websites. The website will be built with consideration
of other successful New Deal digital archives, including The University of California Berkley’s Living New Deal and Yale’s Photogrammar site (http://photogrammar.yale.edu/). Additionally, archives such as Francesca Ammon’s Preserving Society Hill (https://pennds.org/societyhill/, n.d.), developed to aid local preservation initiatives, and Anne Whinston Spirn’s Marnas Archive provide insights into enhancing a digital experience, both for scholars focused on advancing preservation initiatives and members of the general public interested in 20th century photography and history.

To construct our Nebraska Portal website for the Prairie States Forestry Project we have established an interdisciplinary team that includes the present authors, an archival specialist, and programmers. The team’s subject matter expertise includes history, library science, preservation, and GIS technology in addition to landscape architecture, and this interdisciplinary cooperation has been essential in obtaining grants as well as designing the archive itself. The project, funded by a U.S. Forest Service grant and two University of Nebraska start-up grants, provided the opportunity to establish this collaborative team and aided in the digitization and metadata entry process.

Due to the size of the physical archive, geospatial archival material has been organized and digitized by state. The initial phase of the project was to digitize and enter metadata for the state of Nebraska as well as the collection’s photographic record. The second phase will be to launch the state of Nebraska archive website, which will include advanced search features, narrative text, and interactive maps. Our team is also already in the process of digitizing the archival records for South Dakota and will then move on to digitizing the North Dakota records in the coming years.

Building on the descriptive metadata data process, the goal of the web-based platform will be to connect government records to familial history and spatial narratives. Our team will organize the archival documents into pages, allowing users to search documents by “People” (Landowners), “Place” (Nebraska, South Dakota, and North Dakota), and “Planting.” The photographic record will also be displayed as a page and categorized by theme. Taking inspiration from Yale’s Photogrammar, we will also aggregate photographs into a “treemap” (https://photogrammar.org/themes/root) that allows users to explore the photographs by both category and theme and visually shows which categories include more photographs by displaying larger-sized thematic images on the page. We also envision an additional mapping page for the website overlaying the historical GIS data set with contemporary aerial photography. This interpretive map will allow users to compare the original shelterbelts with what remains today. Our metadata process will also allow us to create choropleth maps aggregating archival documents at a state and county scale in the manner applied by the Photogrammar team to aggregate photographs to location. These interactive maps will support teaching and engagement and generate new forms and opportunities for scholarship. For instance, the archive can be used in conjunction with other spatial and historical data to investigate the influence of culture on the adoption and retention of shelterbelts, since many of the communities in the region had distinct cultural identities based around immigration at the time of the PSFP.

Leveraging the archival data with current aerial photography further allows the status of the original plantings to be determined, offering additional opportunities for multidisciplinary research. In one example from Antelope County in northeast Nebraska, original plantings were compared to 2010 aerial photography. This remote sensing analysis found that 38% of the original shelterbelt locations were still intact, with 40% partially intact and 22% no longer in existence (Kellerman et al., 2019). Spatial assessment of the intact shelterbelts versus those that were completely removed is providing insights on the drivers of retention. The archival data, along with the current remote sensing data, will also be used in a 2022 windbreak adoption survey of eastern Nebraska landowners as a follow-up to surveys conducted in 1983 and 2009. The combination of data sets will allow for evaluation of the potential effects of PFSP shelterbelts on the adoption and retention of windbreaks over time. Additional planned research includes conducting an economic assessment of the PSFP to determine the costs and benefits of the program over the decades.

As Yale’s Photogrammar team clearly stated, “As we move forward, collaboration has served as a guiding principle and allowed the project to flourish in exciting directions” (Arnold et al., 2017), and so too does the spirit of collaboration on our project connect research in the humanities and natural sciences to design. It is our goal that this digital humanities project will ultimately lead to the preservation of shelterbelts in Nebraska and provide a model for similar work to be completed in the additional five participating states.
6 CONCLUSIONS

This collaborative digital humanities project can contribute to the profession of landscape architecture in several ways, from supporting historic landscape preservation to informing large-scale regional planning efforts addressing pressing issues such as climate change.

The process for digitizing and disseminating previously inaccessible primary source documents opens up opportunities for large-scale landscape conservation projects. The digital archive pulls together the physical evidence required to nominate a site for the National Register of Historic Places and allows a cultural resource manager to determine a shelterbelt’s significance and assess its integrity within the context of the enormous PSFP. The historical GIS method developed through this project enables mapping of a cultural landscape across a larger spatial scale than typically addressed by cultural resource managers (Karle & Carman, 2020). This methodology can be applied by cultural resource managers working on other heritage projects, including Historic American Landscapes Survey (HALS) reports, cultural landscape reports, historic landscape studies related to Section 106 and 110 review, and preliminary archeological surveys.

The creation of a digital archive itself expands the questions that landscape architects practicing in the fields of both historic preservation and forestry can ask when evaluating this large-scale cultural landscape. Questions on how to maintain historical integrity while trying to renovate shelterbelts with new, better adapted plant species are some of the topics that can be assessed through the archival platform. The examples of archival metadata entry illustrate how large-scale digital methods can also connect geography to people, providing a deeper understanding of place and creating opportunities for additional cultural landscape research.

In addition to historical documentation and assessment, the digital archive can also serve as a conversation starter with landowners. Turnover in farm ownership in the region has disconnected familial history from these multi-generational shelterbelts, and the archive offers a mechanism to reestablish connections with this landscape heritage. This dialogue can open the door to discussing current windbreak issues and needs as well as the preservation and renovation of existing PSFP shelterbelts. The USDA National Agroforestry Center’s work around the adoption and retention of windbreaks is informed by the archive, as cultural connections to the PSFP shelterbelts may both indicate the retention of current windbreaks and inform the adoption of future windbreaks (Smith et al., 2021).

From a landscape planning perspective, the PSFP represents one of the largest and most focused landscape interventions by the U.S. government to address an environmental problem and is considered by some as a potential model for an effective climate change strategy (Sauer, 2010). Viewed by modern standards, the project was conceived, designed, and implemented in a short period of time and incorporated effective top-down and bottom-up management styles. The digital archive provides a platform and a systematic framework for understanding the strengths and limitations of the PSFP that can help guide future landscape interventions.

Documenting and evaluating historical landscapes helps us understand and wrestle with complex questions and dilemmas by examining how landscapes were shaped (and continue to be shaped) by people and the environment. The digital humanities can provide us with tools to help analyze patterns that might otherwise be invisible and provide crucial insight for understanding and solving current and future problems.

5 REFERENCES


EPHEMERAL LANDSCAPES: MAKING THE INVISIBLE VISIBLE

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1  ABSTRACT
Under normal circumstances, observation of our surroundings is often lost in the hustle and bustle of work and play, commuting and getting to the gym. Spring of 2020 was far from normal, however; suddenly time slowed, with one day blending into the next, and many of us found ourselves with more time to look around and notice the ephemeral of the surrounding landscape. This heightened observation falls within the broader philosophical theory of phenomenology – the study of how different people experience or think about things in different ways. How individual people experience the world around them can be specifically dictated by artists and designers. Two artists, Christo (with Jeanne-Claude) and Richard Long, and one landscape architect, Georges Descombes, use wrapping, walking and recovering, respectively, to highlight a site’s systems and reveal the its ephemeral nature; thereby contributing to phenomenology at a more specific level. Through detailed project analysis and exploration of relevant landscape theory, this paper will reveal the strategies and means these artists have applied to the realization of their art. These three artists help to draw attention to elements in the landscape that might otherwise go unnoticed. Wrapping an object is one technique to make the often-invisible visible. A simple walk recorded by listing sounds experienced along the way brings the invisible into sight. What we take for granted and walk by without seeing, again and again, when wrapped or organized or recovered, becomes a visual void that makes us take notice and question its meaning.

1.1 Keywords:
Observation, ephemeral, landscape, transience, invisible
2 INTRODUCTION

Under normal circumstances, observation of our surroundings is often lost in the hustle and bustle of work and play, commuting and getting to the gym. The moon goes through its stages without notice, spring bulbs pop up, birds build nests, trees leaf out. Spring of 2020 was far from normal, however; suddenly time slowed, with one day blending into the next, and many of found ourselves with more time to look around and notice the ephemeral qualities of the landscape that surrounds us. Two artists, Christo (and his wife Jeanne-Claude) and Richard Long, and one landscape architect, Georges Descombes, use wrapping, walking and recovering, respectively, to highlight a site’s layers (physical and natural) and reveal the ephemeral nature of its setting. Through detailed project analysis and exploration of relevant landscape theory, this paper will reveal the strategies and means these artists have applied to the realization of their art.

This ephemerality of the landscape is a characteristic that requires the notice of the viewer in order to wield its true power. In *Space and Place*, Yi-Fu Tuan notes: “A scene may be of a place but the scene itself is not a place. It lacks stability: it is in the nature of a scene to shift with every change of perspective…” (Tuan (1977): 236) In this way, the landscape assumes the role of background stage set to our daily performances and it is the constant flux of this stage set that lends richness and meaning to our everyday lives.

Landscape artists have been harnessing this ephemeral quality of the landscape for decades. This transience is what lends seasonality and timeliness to our environment. As Anne Spirn notes, Landscape symphonies evolve continually in time… responding to process and to human purpose, and, in landscape symphonies, all dwellers are composers and players.” (Spirn (1998): 22) These three artists: Christo, Long, and Descombes, help to draw attention to these symphonies in the landscape that might otherwise go unnoticed. What we take for granted and walk by without seeing, again and again, when wrapped or organized or recovered, becomes a visual void that makes us take notice and question its meaning.

2.1 The Artists

The selection of Christo, Richard Long and Georges Descombes is significant because of their minimal approach to their work and the effort that each artist takes to let their projects “disappear” over time. Through the seemingly simple acts of wrapping, walking and recovering, these three artists allow the landscape to become the central player in their work and to dictate the end result, whether aesthetic or functional. Wrapping an object is one technique to make the often-invisible visible. This seemingly simple act of covering an object draws one’s attention to its absence, and therefore its presence, in the landscape. Michael Kimmelman wrote about Christo for the New York Times,

> "With his interest in intangibles and process, Christo was like many other conceptual artists of the ’60s and ’70s. That his approach involved wrapping things in order to reveal them was itself a familiar conceptualist concept. What set him apart was the fact that his work attracted such large masses of people…and generated no small measure of happiness and awe.” (Kimmelman, 2020)

Christo and Jeanne-Claude wished to be credited as equal collaborators on all of their projects, and they worked in a style of abstraction whose meanings remained open-ended and up for debate. Instead of creating art projects that were meant to last for ages, typical of the Marxist regime of his homeland, their works are temporary, meant to last a certain amount of time – to be taken down either by the same hands that put them up, or earlier by forces of nature that cannot be controlled by the artist. And thus the impact on viewers is strong but ephemeral, leaving a fleeting imprint on the eyes, but an indelible impact on ones memory. When asked about his process that included paperwork, the workers, the politics, the negotiations, the construction difficulties, the dealings with hundreds of people, Christo added that his and Jeanne-Claude’s projects “exist in their time, impossible to repeat. That is their power, because they cannot be bought, they cannot be possessed.” (Kimmelman, 2020)

One of Christo’s most well-loved and revered projects was the wrapping of the Pont Neuf in Paris. (Figure 1) The project, which was completed in 1985 after being stalled for years due to French bureaucracy, covered an integral part of the city’s historic infrastructure in a saffron nylon fabric. Parisians cross this bridge that spans the Seine at the western tip of the île de la Cité by foot and by car. A variety of
boats float under it, including Bateaux Mouches (excursion boats), barges, and fishing boats. And cars can pass under it on the north side of the river only. I would argue, however, that very few people ever gave much thought to the bridge beyond being a way to get from the Rive Droit to the Rive Gauche on their daily commute until it was wrapped in its yellow glory. William Grimes described the wrapping in Christo’s obituary in the New York Times, noting “The honey-colored fabric... blended harmoniously with Paris’s urban palette, and the bridge's artful draping was deemed worthy of a couture house.” (Grimes, 2020)

After the installation, John Russell wrote in the New York Times of the of the public’s love affair with the wrapped bridge. “If it was fundamentally vacuous, nobody complained. It was something to look at, something to walk on and something to think about.” (Russell, 1985) This urban element, an integral part of the landscape of the city of Paris, was brought into the public consciousness and given a new facade. People stopped and looked and noticed, and talked, and considered a part of their city that had before been a mere means of convenience. Russell went further describing,

“What could not have been foreseen was the sheer elegance, the perfection of French craftsmanship that had gone into the wrapping.... The color is amazing, and so is the texture. As color, it cannot be defined. It is by turns blond, bronze, gold, bamboo.... It changes hour by hour, minute by minute, from dawn till dusk. Furthermore, it is never obtrusive. Not only are the hallowed original forms of the ancient bridge protected and respected, but here and there they make themselves felt in a teasing, delicately erotic way that is truly Parisian.” (Russell, 1985)

By wrapping the Pont Neuf in this blond, gold covering, Christo reintroduced his audience to the underlying beauty of the bridge, and as an extension, the beauty of its context. Its sinuous structure and its prominent position within the city were reflected in the watery mirror of the Seine flowing below and for a short time the Pont Neuf made people slow down and take time to reacquaint themselves with their city. The Philosopher John Dewey wrote that “The closer man is brought to the physical world, the clearer it becomes that his impulsions and ideas are enacted by nature within him. …The sense of relation between nature and man in some form has always been the actuating spirit of art.” (Dewey (1929): 338) Christo's
act of wrapping things, whether buildings, objects, landscapes, brings man closer to the physical world by startling him out of a state of complacency and providing a vehicle through which to come a little closer to his natural surroundings. Even if for just a moment in time.

In a similar fashion the British artist, Richard Long, brings the invisible into sight through the art of his walks. Entering the public consciousness in 1972 with his ground-breaking work, *A Line Made from Walking*, (Figure 2) a seemingly simple black and white photograph of a straight line etched into the ground, Long draws his mark on the surface of the earth.

![Figure 2. (A Line Made from Walking, www.richardlong.org January 6, 2021)](image)

What does this single line reveal to the viewer? A number of modest elements of the landscape that could easily go unnoticed: the evenly flat terrain, the layers making up the surface of the ground (packed soil uncovered by his steps, the low grass with spring ephemerals that have been effectively erased by his steps), the dark, dense boundary of the field where the line seems to end. This directness of the line underscores the perspectival space of the field as it recedes into the distance. Recognizing the temporary nature of these drawings, whether in the form of a line, circle, or collection of objects found along his route, Long records his walk through the media of photography and written text. Long is interested in exploring concepts of time, space, and surface, and the evolving nature of these concepts. In fact, he hints at the importance of these ideas of ephemerality on his own homepage with the following text-work:

> "In the nature of things:  
> Art about mobility, lightness and freedom.  
> Simple creative acts of walking and marking  
> about place, locality, time, distance and measurement.  
> Works using raw materials and my human scale  
> in the reality of landscapes." (www.richardlong.org)

With this simple statement, Long relinquishes any lengthy discussion of his method; instead, these lines serve as a condensed list of artistic principles centered around his measured movements through time in the landscape. (Dapena-Tretter, p.106)
Born in Bristol, England, Long was raised in the tradition of long walks through the British countryside. These walks, these “measured movements,” allow Long to bring to light the subtleties of the landscape and to reveal the details found upon and within it. Antonia Dapena-Tretter writes in her article, “Richard Long’s Passage as Line: Measuring Toward the Horizon”,

The performance of the walk, a ritual wandering, is only later documented through a photograph, marked map, or text work. Though the art object is created as a permanent remembrance of the walk, the traces are always ephemeral, sometimes drawn in the snow, or sometimes signified by upturned stones, and will disappear through the passing of time and exposure to the elements.” (Dapena-Tretter, p.103)

The physical act of walking, of foot meeting ground, is a crucial element of Long’s art; it is through the touching of sole to surface of the land that the story is told. James Corner describes the importance of this physical touch with the land: “Landscape is best understood not as scenery, object or thing, as if external to the human body, but more as a deeply visceral milieu within which the body is fully and completely immersed.” (Mind Landscapes (2020): 62) As with Christo’s wrappings, Long’s walks are intended as temporary installations that are meant to reveal elements of the site or the landscape that might otherwise go unnoticed. Richard Long’s art takes a number of forms, from simple straight walks through dust, leaves, snow, to circles cleared in the sand (negative void in the field) and circles made from found objects (positive two-dimensional object in the field); from lists of sounds heard along a route to recordings of how much time he spends with his own shadow on a walk. All of these are subject to disappearing with time, in essence fleeting reflections of the artistic performance.

One work of Long’s that I find particularly revealing and successful in this act of making the invisible visible is “Five Stones, Iceland, 1974” in which Long rolled five stones down a hill and documented their paths with a photograph. (Figure 3) Each stone makes its own individual mark on the terrain and the resulting five lines reveal the sloping topography of the land and all of the objects the stones encountered along the way that diverted and chartered their course. In a different photograph, with no stones, the landscape would appear flat and the viewer would have no sense of the undulating ground form. Again, words by James Corner seem to describe the resulting revelation aptly: “Hence, we see both the topology of topography and place (topos) intersecting with the measured topology of spatial geometry and structural relationship.” (Mind Landscapes (2020): 63)

In addition to photographs, Long often uses maps and written text to document his walks. These methods reveal the measured and spatial qualities of his works in a more suggestive way – requiring additional investment from his audience in the way of imagination and trust. No longer handed to us as two-dimensional pictures that can be easily analyzed, these works rely on words and topographic maps to tell the story of his walk. This added effort asked of the individual viewer to uncover meaning in the walk and reveal the nature of his experience lends the works a more personal vibe. One of these text works, Spring Walk, documenting a walk taken through Avon in 1991, is essentially a list of twelve objects or experiences Long encountered along his route. (Figure 4) The encounters are listed in chronological order and each experience is accompanied by the mileage marker. This blend of simple descriptive (Ladybirds, A Butterfly, etc.) and geographic / spatial measurement (29 Miles, 85 Miles, etc.) gives the list both visual and temporal rhythm. While the list is specific and set, every reader will imagine the walk in a slightly different way, bringing their own visual to the number of squirrels and color of daffodils Long chanced upon along his way.
Figure 3. (*Five Stones, Iceland*, 1974 www.richardlong.org January 6, 2021)

**SPRING WALK**

- Primroses at 3 miles
- Frogspawn at 18 miles
- A crow nest-building at 29 miles
- A farmer sowing at 34 miles
- Ladybirds at 38 miles
- Squirrels at 57 miles
- Lambs at 62 miles
- Sticky buds at 67 miles
- A tree planted at 70 miles
- A butterfly at 85 miles
- Blossom at 104 miles
- Daffodils at 112 miles

Avon England 1991

Figure 4. (*Spring Walk*, www.richardlong.org January 7, 2020)
While the creative works described above are attributed to artists, a third, Georges Descombes, is a landscape architect whose designs on the land seek to recover a site’s natural systems and the depth of its past. This interest in recovering the site’s past is another way of revealing elements of a site that might otherwise go unnoticed. Descombes is a renowned Swiss landscape architect who approaches each project by studying the existing conditions of the site and considering how with minimal interventions those conditions can be highlighted and celebrated. (https://www.oroeeditions.com/product/doing-almost-nothing/)

One project that illustrates this attention to a site’s past and how it can inform the future is a section of The Swiss Way.

The Swiss Way is a conception composed of sections of a path that link up to form a continuous pathway around Lake Uri. Approximately 35 kilometers long, the Way was conceived to commemorate the 700th year of the Confederation of Switzerland in 1991. The project was intended as the ecological counterpoint to the more grandiose projects celebrating the same anniversary. Each of Switzerland’s twenty-six cantons was given a section of the path, and Georges Descombes was invited by the canton of Geneva to design a 2 kilometer section of the pathway. (Figure 5) Descombes’s work tends to the extremely minimal, to the point that some criticize him for doing too little, but he views his approach differently. “I hope that my work acts as a device for the revealing of forces that are (or have become) imperceptible… creating a source of different attention, a different vision, a different emotion.” (Recovering Landscape (1999): 79)

Figure 5. (Sketch Plan of the Swiss Way, Georges Descombes, [drawing], pencil on paper. From Recovering Landscape (pg. 80), by James Corner et al., 1999, New York: Princeton Architectural Press)

A collaborative effort with artists Richard Long, Carmen Perrin, and Max Neuhaus, Descombes sought inspiration from the site for the design of the path. As he writes in “Shifting Sites,” an essay describing the creation of The Swiss Way, “We saw the path as a way of researching the landscape, of experimenting with alternately big and little things with the often overlooked and neglected – blades of grass, flowers, stones, tree roots, small streams, and so on.” (Recovering Landscape (1999): 81) Recognizing that the landscape is a palimpsest, a multilayered surface of stories and occurrences, the design team sought to reveal this accumulation and to build on the history of the site. Effectively making the previously invisible on the site more apparent through their intervention. Descombes walked the section of the path over and over just looking.

He “tried to look out for things that we normally do not see, such as flowers and mice, and anything else that moves around covertly with the wish to remain undisturbed. At the same time, I wanted to leave a mark of our own time, to overlay an unequivocal trace of our activity.” (Recovering Landscape (1999): 82)

This strong belief in the importance of connecting the past, present, and future layers of a site gave the team a strategy – the selective subtraction of anything that did not contribute to the natural essence of
the landscape. James Corner describes this connection between placemaking and temporality in his words: “the visceral sense of nature in landscape architecture and placemaking offers a profound connection to elemental natural phenomena and to the passage of time.” (Mind Landscapes (2020): 62)

This changing of the game, subtracting from the site rather than adding to as is the typical architectural process, gives The Swiss Way its elemental character. Descombes, Long, Perrin and Neuhaus worked to make the passing of time visible on the site and at the same time to recognize its future potential. Descombes writes,

“My attitude toward intervening in the landscape circles around paying attention to that which one would like to be present where no one expects it any more. Thus, for me, to recover something – a site, a place, a history, or an idea – entails a shift in expectation and point of view.” (Recovering Landscape (1999): 79)

They took away all things that detracted from the sense of the place, and only added elements that brought clarity to the site and drew “attention to the magic of the everyday.” (Recovering Landscape (1999): 83) One such addition, the belvedere (or Chanzel), perches on a cliff looking out over the lake and, amplifying what already existed, highlights its features.

This recovered landscape along the Geneva section of The Swiss Way assumes a new look for the future based on the memory of its terrain. “To design for sites with this principle in mind is to perform an action that allows for reflection on totally ordinary matters…. Perhaps the matters that are not noticed are those that are essential.” (Recovering Landscape (1999): 85) By bringing to light these seemingly ordinary and inconsequential elements of the site, the design team has recovered the site’s temporal qualities and has brought the previously hidden and invisible to the surface for all to experience.

3 CONCLUSIONS

It cannot be denied that the landscape is a continually evolving stage, a collection of systems both natural and manmade that are in a constant state of flux. But it is not only the terrain that changes over time, it is also the way that people perceive it. Life gets busy, our days become a blend of work, play, errands, and obligations. So much so that many can lose sight of the simple beauty of their surroundings, the changes in season, the subtleties of the natural world – even if the setting is more urban than rural. These three artists: Christo, Richard Long, and Georges Descombes, each employ strategies to slow the eye, to enhance perception, and to make the previously invisible more visible to the passerby. Christo’s wrapping of objects and draping of valleys and hillsides brought new (and colorful) life to settings both manmade and natural. By covering buildings, bridges, monuments, and voids between landforms, Christo created new shimmering objects that made people stop and take a new look at something they had seen many times before but never really understood. Similarly, Richard Long’s walks reveal the particularities of the landscape he is within and record the subtle nuances that make the site so unique. Etching a line through the sand, drawing a line with found stones by standing them on end, clearing a circle in the snow, recording his walk with words and sounds, all of these methods are personal documentation of a singular experience in the landscape. By sharing these recordings with his audience, Long makes this experience available to others and provides a new lens through which to view the ephemerality of the landscape. Although a landscape architect, Georges Descombes approaches his work through a similar sensitivity to the site as Christo and Long. While Christo wrapped, and Long walks, Descombes recovers the traces on a site that have gone unnoticed, bringing back to the surface the complex stories of the place and the forces that have become imperceptible. Studying the processes that continually reshape the land: weather, seasons, light, growth, erosion, Descombes harnesses these traces of the past as he designs for the future, emphasizing the inherent qualities of the landscape and revealing ones that had been hidden for too long.

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HISTORY AND ECOLOGY IN REDESIGNED FOREST EDGES OF THE BALTIMORE-WASHINGTON PARKWAY

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1 ABSTRACT

This paper presents a proposal for forest edges along the Baltimore-Washington Parkway. It derives from a Cultural Landscape Report for the parkway and draws upon historical precedents as a means of addressing issues of traffic safety and forest vulnerability to colonization by invasive plant species. The Baltimore-Washington Parkway is historically significant for its role in regional forest conservation with forests comprising the dominant vegetation of the parkway landscape and shaping the experience of driving through it. In order to increase driver safety, the National Park Service is cutting forest edges back farther from the roadway, increasing sunlight into the forest interior and inviting competition from invasive species. But it also offers appealing views into the forest interior for passing drivers. This results in an intriguing challenge: is it possible to protect the forest from colonization by invasive species while maintaining the more engaging spatial experience created by the cleared edge? The parkway was studied using historic documents and present-day imagery combined with field observation and investigative design. The proposed design draws the forest edge back from the front line of trees, creating a new zone of seasonally mowed grasses where ample sunshine would favor invasive species. Behind this zone, where shade predominates, a new line of shade tolerant forest species is proposed where they can compete more effectively against the invasive plants. This composite edge is more spatially diverse and consistent with the picturesque traditions of the region’s parkways.

1.1 Keywords:
Baltimore-Washington Parkway, highway landscapes, cultural landscapes, historic preservation, forest edge management
2 INTRODUCTION

Forests form a continuous backdrop for drivers on the Baltimore-Washington Parkway, a nineteen-mile roadway that extends northeast from Washington, DC toward Baltimore, MD. Traveling through a forested corridor, most drivers are probably unaware of the significance of the adjoining forest in regional conservation or even give much thought to the design and management decisions that have cultivated this forested drive. Yet the forests are key to the parkway’s historical significance as well as its form and character as a cultural landscape.

Like many forests along highways, these are threatened by the establishment and spread of invasive plant species and more immediately by highway safety regulations that mandate a thirty-foot setback from the edge of the roadway. For a parkway characterized in very large part by the close presence of maturing forests, such a mandate poses an existential threat to the character of the landscape.

This paper presents a conceptual design proposal for managing the forest edge of the Baltimore-Washington Parkway in the wake of clearing for this thirty-foot setback. Truly, this is ‘a modest proposal’, one that aspires to create a more spatially intricate edge, grounded in the history of this landscape and of other parkways in the Washington, DC region. It seeks to control invasiveness through seasonal mowing and innovative planting to create a new kind of forest edge for the parkway that will be historically grounded, easier to maintain, and more beautiful for drivers of the parkway.

The proposal is a small part of a much larger Cultural Landscape Report (CLR)(Kelsch, 2021) for the National Park Service that documents the history and current conditions of the parkway and proposes design and management changes to mitigate specific highway safety concerns. The closeness of the forest to the edge of the roadway was but one of those safety concerns, and this proposal arose out of the historical documentation and interpretation at the core of the CLR. This proposal for the forest edges is intuitive, based in history and also in design imagination. Similarly, the threat from invasive plant species is based in general knowledge of the problem and observation of the parkway’s vegetation. The proposal itself is somewhat generic, more of a management recommendation than a specific design proposal, and it would need site-specific and more scientific examination of the vegetation before implementation along the parkway. The purpose of this paper is to show an example of how historical information and design imagination can help address ecological problems in cultural landscapes.

To understand the goals and projected impacts of the proposal, this paper presents the historical significance of the parkway’s design, its role in the history of regional forest planning, our mapping methodology to document forest conditions, and the role of the forest in shaping the sequential experience of driving the parkway. It then presents the actual proposal in the form of an imagined perspective drawing and a more detailed section showing the proposed edge condition. Finally, the paper presents historic precedents for the proposal that show it to be an historically relevant design for the parkway.

3 SIGNIFICANCE OF THE DESIGN

The Baltimore-Washington Parkway is listed on the National Register of Historic Places as part of a set of parkways radiating from Washington, DC out into the surrounding region. (National Park Service, 1991) The others include the George Washington Memorial Parkway, Rock Creek & Potomac Parkway, the Clara Barton Parkway, and Suitland Parkway. Though treated as a set, each was designed and built separately with different intentions. The Baltimore-Washington Parkway was the last to be designed, and it is often referred to as being transitional in style, more modern than its earlier siblings but not as modern as later interstate highways. (HAER, MD-129).

As its name implies, the Baltimore-Washington Parkway links the cities of Baltimore and Washington and was completed in 1954 as an alternative to U.S. Route 1, the traditional link between the two cities that had become overly-congested by the 1940s and 50s. Although the roadway extends the full distance between the cities, only the southern two-thirds (nineteen miles) were built by the Bureau of Public Roads as the Baltimore-Washington Parkway and are included today within the National Park system. The rest of the route to Baltimore continues as MD 295, which is similar in alignment but different in character.

The difference in character between the Baltimore-Washington Parkway and MD 295 is part of the parkway’s historical significance. Despite their similar alignments, the two roadways differ in key characteristics that distinguish the Baltimore-Washington Parkway as a modern parkway whereas MD 295 is a conventional modern highway. Comparable images of the two roads illustrate the differences between them. (Figure 1.) The parkway is distinguished by its narrower roadway, mountable curbs, guard walls, and
spatial variation derived from the juxtaposition of grass medians and planted trees against the continuous backdrop of maturing forests. In contrast, MD 295’s wider roadway, ordinary steel guardrails, overhead signs, and homogenous spatial corridor give it a conventional highway character. Part of the parkway’s significance as a designed landscape is that it shows that an ordinary highway can instead be designed as a parkway with careful attention to conditions such as the width of the roadbed, the integrity of the enclosing landscape, the character of construction details, and thoughtful variation of the sequential experience.

Figure 1. Comparison of the Baltimore-Washington Parkway (left) and MD 295 (right) showing differences between their respective characters. (Google Maps street view, April 2018)

4 HISTORICAL BACKGROUND

The Baltimore-Washington Parkway had a surprisingly long gestation period given that it is the most modern of Washington’s parkways. Significantly, its earliest conception is directly tied to regional forest conservation. Over time, the proposed parkway would gain additional purposes, but the importance of forests remained fundamental to its conception and design.

The parkway was originally conceived as part of architect William C. Ellicott’s plan to create a capital area national forest on lands northeast of Washington in 1910. (Ellicott, 1910) In a revised 1920 version of the proposal, Ellicott included a memorial avenue commemorating those who died in WWI, and this is the first vision of what would become the Baltimore-Washington Parkway. (Ellicott, 1920) The national forest proposal ultimately failed in the 1930s, but numerous federal properties were developed on the lands Ellicott had proposed for the forest. These included the U.S. Army’s Fort Meade, the Department of Agriculture’s Beltsville Agricultural Research Station, the U.S. Fish and Wildlife Service’s Patuxent Research Refuge and the National Park Service’s Greenbelt Park. Collectively these properties conserve much of Ellicott’s proposed national forest lands. Parkway planners expanded the purpose of the roadway to include access to these federal properties, especially Fort Meade in the event of a national emergency. The ability to have safe and fast access to the fort was a critical argument for construction of the parkway during the early years of the Cold War. Parkway planners also stressed the importance of having a ‘dignified’ entrance into the city akin to those provided by the George Washington Memorial Parkway and the Rock Creek and Potomac Parkway.

Traffic congestion and frequent accidents on U.S Route 1 led to further impetus to develop a faster and safer inter-city route between Baltimore and Washington. (HAER, undated. Kelsch, 2021) This emphasis on inter-city travel led to ambiguity about whether the parkway was to be truly a parkway, with an emphasis on scenic driving and important destinations, or a regional highway that emphasized efficient transportation. The National Park Service portion of the roadway was built as a scenic parkway restricted to passenger vehicles and leading to the various federal properties. The State of Maryland, however, built the twelve-mile extension to Baltimore as an efficient highway that can carry larger trucks and commercial vehicles. These discrepancies have led to calls for the parkway to be transferred to Maryland, but state officials only want it if the Park Service upgrades it to carry commercial traffic. The cost of that upgrade has prevented the transfer of ownership. (HAER, undated. Kelsch, 2021)
Regardless of ownership, the original design of the parkway had become quite dangerous with increasing traffic loads, and the parkway was significantly rehabilitated in the 1990s to make it safer. Among the changes, longer exit lanes and wider bridges were constructed to allow drivers to exit the roadway more quickly and prevent dangerous back-ups at interchanges. New shoulders with mountable curbs were added so drivers could pull off onto the grass in an emergency, and concrete guard walls that mimic the original stonework of the bridges replaced aging guardrails. In addition, a planting design was developed and implemented for the first time along the full-length of the parkway. The planting design emphasized the interchanges, composing the vegetation at these junctures to be transitions between the adjoining vernacular landscape of the surrounding suburbs and the forested corridor of the parkway. The plans also included reforestation in places and plantings to thicken the forest edge and adorn it with ornamental species. Almost all species planted were indigenous to the forests of the mid-Atlantic piedmont and coastal plain, the forests that line the parkway. (HAER, undated. Kelsch, 2021)

5 MAPPING THE PARKWAY’S FORESTS

As indicated above, the conditions of the forest were documented as part of a cultural landscape report (CLR) for the parkway contracted with the National Park Service. (Kelsch, 2021) The goal of a CLR is to document the history and current conditions and assess historical integrity of the landscape, and then use that historical information as a basis for proposing solutions to specific problems. In the case of this CLR for the Baltimore-Washington Parkway, most of the problems related to highway safety. Despite the rehabilitation of the parkway in the 1990s, there continue to be safety concerns. (Eastern Federal Lands Highway Division, 2007) For example, the mountable curbs that allow cars to pull off in emergencies, do not allow park police to pull over buses or other commercial vehicles, so the police literally are unable to enforce the ban on commercial traffic. Simply adding emergency pull-offs would facilitate that need, but it would interrupt the clear edge provided by the mountable curbs, one of the design details that characterize the parkway. Design decisions like this distinguish the Baltimore-Washington Parkway from ordinary highways, so it is critical that proposals be grounded in the specific history and character of this landscape, and that is the goal of the CLR.

In order to understand better the importance of the forests, graduate students Amanda Cortez, Jake Fettig and Alexandra Schiavoni and I mapped the parkway at three scales. Forests figure prominently at each scale. (Kelsch, 2021)

Maps at 1” = 10,000’ show the full parkway in regional context. In Figure 1A, the parkway corridor (in red) is mapped in relationship to the 1911 proposed national forest lands (in yellow), current forests (in green), and federal properties (with light gray overlay). The importance of the parkway as a forest corridor is clearly visible in this geographical and historical context, connecting the federal properties to one another and to the Anacostia River in Washington.

Maps at 1” = 2000’ show the parkway in three segments of about six miles each, and these maps reveal pattern and structure of the landscape. In figure 1B, upland and lowland deciduous forests (green), scrubland (orange) and mowed grass (yellow) create a rhythm of grassy openings and forested medians in the southern third of the parkway as the roadway undulates over ridges and spans small streams in the swales. Clues to forest histories are visible in the orange patches of early successional shrub vegetation and also in the dark-textured, successional forests. Many of the successional forests are growing in places that had been completely disturbed during initial construction, and they are younger than the forests that were undisturbed at that time. Early successional shrubland is due to cessation of mowing or to disturbance from more recent construction.

Maps at 1” = 700’ divide the parkway into nine segments of two-miles each and reveal specific conditions in more detail. In Figure 1C, a map of the second segment from the southern end shows the 1993 planting design developed as part of the 1990s rehabilitation of the parkway. The map shows composed plantings at the interchanges with specimen oaks and maples (in green), flowering trees (in pink), and native grass meadows (in pale green) creating a more intricate and spatially articulated landscape as a transition onto or off the parkway. Between the interchanges, edge plantings (dashed outlines) cultivate a more robust forest edge along most of the length of the parkway. These areas show that parkway designers were concerned about the character of the full forest edge and not just the interchanges.
Figure 2. Baltimore-Washington Parkway mapped at varying scales. b: 1:10,000, B: 1:2000, C: 1:700

6 SECTIONAL ANALYSIS

The various maps at these three scales reveal and document much about the parkway, but they are unable to represent the experience of driving it. For this, we used thirty-eight repetitive sections, drawn at half-mile increments along the nineteen miles of the parkway. The individual sections document the topography, vegetation, road alignment, and open space at each section cut, and collectively they depict the changes in spatial conditions as one drives through the landscape. The sections correspond with the 1:700 maps such that five consecutive sections document the spatial sequence of each two-mile segment. Sections E – I (Figure 3) represent the spatial sequence of the segment shown in Figure 2C. Viewing the sections sequentially and guided with descriptive text, one can ‘read’ the experience of the parkway while imaginatively traveling from bottom to top, south to north.

After passing under the bridge at Annapolis Road, Section E, the roadways diverge and reduce to two lanes in each direction, creating an open median with planted specimen trees at Section F. The significance of this change of scenery is underscored by a National Park Service sign identifying this as the Baltimore Washington Parkway (for northbound travelers) even though the parkway actually begins two miles to the south. The roadways diverge further at Section G, separated by a wide swath of mature forest, and consequently drivers are unaware of the opposite lane of traffic. Travelers experience continuous forest
in this segment, usually with a mowed edge along the roadway. At Section H, the roadways are near enough to each other to have another open median with planted specimen trees, and then they diverge again at Section I, where the median is forested once again with wider mowed grass strips along the edge of the roadway. (Kelsch, 2021)

Figure 3. Sectional analysis showing prominence of forests in the driving experience

The text in this description was not written to specifically highlight the forest, but the prominence of references to the forest are indicative of its importance in shaping the experience of the parkway. This is especially true when the median is wide, and the northbound and southbound lanes are enclosed by rich, mature forest on each side of the roadway.

Alexandra Schiavoni developed the thirty-eight sections needed to cover the full length of the parkway. Each is a combination of site-specific and modular drawing. (Figure 3.) She first drew topographically accurate profile lines at each of the section cuts and then added graphic modules that represented a typology of vegetation along the parkway: mature forest, successional forest, forest with cleared understory (often for the safety setback), open-grown specimen trees, shrubland, and mowed grass. She added red hatching to indicate invasive vegetation and blue view cones to show the extent of views from passing cars. Automobiles show the locations of traffic lanes, and bridges, signs and overhead wires depict individual characteristics of each section.

Because of the length of the roadway and the breadth of the CLR, invasive vegetation was identified only through driving surveys. Hence our ecological assessment is general in nature. Easily recognizable and common invasive species (Ailanthus, Bradford pear) and tangled masses of vines and perennial forbs were assumed to indicate the presence of significant numbers of invasive plants. This was not intended as an accurate ecological assessment. Its goal was to look for patterns and repetitive conditions. For example, Ailanthus has established behind guardwalls built in the 1990s, and Bradford pear is common in areas recently released from mowing. As stated earlier, more thorough documentation of the forest edges is needed, hopefully before further clearing is done.

Sections G, H and I illustrate the issues related to the management of the forest edges. In each of the three sections, the successional forest on the outer edges has no understory because the forest has been cut back to make a larger setback from the lanes of traffic. Light blue view cones extend into the forest in these places because of the lack of a developed forest edge. Although the views into the woods are more alluring, the clearing allows more sunshine to extend into the forest, and this is likely to promote the
establishment of invasive plant species better adapted to the disturbed, sunny environment. In Section G, invasive species are already established along the median edges, so they are poised for rapid seed dispersal and colonization.

7 A NEW FOREST EDGE

As stated earlier, the goal of this CLR is to address specific safety concerns within the historical context of the parkway. The proximity of the forest to the edge of the road as seen in the distant left of Figure 1 and present along most of the parkway poses a threat to drivers who veer off the road. Park managers are charged to create and maintain a thirty-foot setback for the forest, except where guard walls prevent drivers from hitting trees and where topography affords extra safety. (Eastern Federal Lands Highway Division, 2007)

Our analysis documented the historical and ecological importance of the forests lining the parkway. Much of the forest edge has already been cleared, leaving it vulnerable to establishment and spread of fast-growing, shade intolerant species, many of which are invasive in this context. Currently, park maintenance staff are mowing the cleared areas once per year, which prevents woody species from establishing but allows thick growth of perennial plants, many of which are invasive. The thick, new plant growth also eclipses the new view into the forest for motorists. It may not be a stable edge, but it provides a more interesting experience for drivers and passengers.

Given that forests line both sides of the parkway for nearly all of its nineteen miles and often in the median, too, changes to the edge of the forest would have huge impact on the character of the parkway. The combination of the threat of invasive species and the appeal of more intriguing views into the forest, provoked a desire to design a more sustainable and safer edge for the forest that is also more beautiful and consistent with the parkway’s careful design.

In many places where the edge has not been cleared, the existing forest is well-developed with layered understory and denser vegetation along the sunnier edges. When mature forest lines both sides of the roadway and the gap in the canopy is narrow, drivers can often peer into the woods even when leaves are on the trees, because the edge isn’t not opaque with foliage. This is especially true in the long stretches through the Beltsville Agriculture Research Center and the Patuxent Wildlife Refuge where mature forest extends far beyond the boundaries of the parkway. In these and other stretches, the lack of recent disturbance has limited the establishment of invasive species.

As an alternative edge, I have proposed mowing the cleared land frequently enough to keep it in long grasses and to prevent shrubs and forbs from dominating the vegetation. (Figure 4.) Mowing would extend under the canopy of the first several trees, because this is the sunniest zone where fast-growing, disturbance species most likely would outcompete native shrubs and forbs. Behind these vanguard canopy trees, a thick edge of understory trees and shrubs of the mid-Atlantic piedmont and coastal plain would be planted to define a line of greater shade where they could more effectively compete with the sunnier species. Recommended species were derived from the plant palettes from historical planting plans for the parkway. All are indigenous to the piedmont and coastal plain forests.
This would create a quite different edge, spatially. Individual tree trunks would stand out from the forest, carrying the canopy out over the mowed grasses, and then a denser understory edge would form in the shadier recesses. Individual specimen flowering trees could be planted among the free-standing trunks to further ornament the edge.

8 HISTORICAL PRECEDENTS

Are there precedents for this proposed redesign of the forest? Given the goal of the CLR to ground proposals in historic precedence, is there justification for this proposal? I have identified three precedents that offer support for this redesign of the edge.

The first is the early history of the parkway itself. Historic photographs from the 1950s show a very different landscape from the present-day condition. (Figure 5A.) Areas that had been cleared during construction were mowed and kept as grasslands in contrast to the forest. In the foreground, the forest is expanding through the establishment of young trees, and the edge is similarly intricate to that in my proposal. In time, almost all the grasslands were allowed to succeed into the forests that line the parkway today, but it is clear in this photo that in its early years the parkway had greater diversity of vegetation than the current, continuous forests. Thus, there is historical precedent for greater variety in the vegetation.

A second precedent is from a paper by Douglas C. Bayliss, “Planning Our National Park Roads and Our National Parkways”, written shortly after the Baltimore-Washington Parkway opened. (Bayliss, 1957) Bayliss illustrates different strategies for maintaining vegetation along an imagined segment of a parkway. (Figure 5B.) In his diagram, he distinguishes between open grass (yellow), open shrubland (blue), woods cleared of undergrowth (green), natural forest (uncolored), and areas cleared for views (blue gradation). His article does not anticipate the current needs of the forest edges of the Baltimore-Washington Parkway, but it shows that treating the grasses, shrubs and trees as distinct layers is a long-standing maintenance practice in parkway management, and it can create a more diverse vegetative and spatial edge.

A third precedent is from the Mount Vernon Memorial Highway, the parkway that inspired the rest of Washington, DC’s parkways. (Figure 5C.) The southern portion of the Mount Vernon Memorial Highway was built along the edge of existing forest, and Wilbur Simonsen, the landscape architect who developed the planting design, called for extensive plantings of ornamental trees and shrubs to cultivate a lush and picturesque edge to the forest. As with the Baltimore-Washington Parkway, the vegetation grew into mature forest over time, but at least in the beginning, Simonsen’s plantings for the parkway were more intricate and stylized than a natural forest edge. They set a precedent for a different kind of forest edge within the Washington parkways.

9 CONCLUSION

Forests shape the experience of driving the Baltimore-Washington Parkway and are critical to its historical significance as a regional corridor among other large forested properties. The need to clear more of the edge for driver safety poses an existential threat to the landscape. It is not unreasonable to imagine that the nineteen miles of forested parkway could become a corridor of invasive species like ailanthus and Bradford pear which have already established in certain locations. This proposal for a redesigned forest edge seeks to cultivate a different kind of edge that would be historically grounded, maintainable through
mowing, and beautiful for drivers on the parkway. Its spatially intricate edge would be different from the more natural edges of the current parkway, many of which are strikingly beautiful today. In time this new edge might mature and return to a more natural forest edge as mowing regimes become more lax and forest vegetation spreads. The edge is likely to become more like those that exist today, but in the interim, it would resemble forest edges that existed earlier along this parkway and on the Mount Vernon Memorial Highway.

10 REFERENCES


LANDSCAPE ARCHITECTURE FOR HEALTH

Edited by Shan Jiang, & Sungmin Lee
INVESTIGATING SMART NEIGHBORHOOD DESIGN FOR PHYSICAL ACTIVITIES; A CASE STUDY OF SOUTH ATLANTA NEIGHBORHOOD, GEORGIA

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1. ABSTRACT

Despite an increased awareness of the importance of physical activity (PA) and its associated health benefits, minority neighborhoods of color fare poorly in access to outdoor spaces conducive to a healthy lifestyle. Literature shows that residents in such neighborhoods are amongst the most predisposed to most chronic diseases (Wang et al., 2008). Few research studies pointed out correlations between smart growth principles and health benefits, economic development, and sustainable living (Daniels, 2001). This research investigates the condition of South Atlanta neighborhood and its impact on residents’ level of PA. Specifically, the research examines habits and patterns of PA of the residents, as well as their preference of designed outdoor spaces that align with smart growth principles (SGP). Neighborhood observation and behavioral mapping were conducted in February 2020. Using quantitative and qualitative questions, an online survey was posted to the neighborhood Facebook page requesting residents’ responses. The survey was sent several times for one week in April 2020 to elicit more participation. According to 21 respondents who participated in the study, more people are willing to lead physically active lives if their neighborhood design encourages it. Additionally, safety and social destinations were identified as primary factors determining how residents engage in PA in the outdoor space. In summary, the study shows clear possible physical and mental health benefits for South Atlanta neighborhood residents by being more physically active and that SGP offers possible benefits for improved quality of life.

1.1 Keywords:
Smart, neighborhood, design, physical activity
2 INTRODUCTION

Lack of physical activity accounts for as much as 23% of all US deaths from major chronic diseases (Warburton, Darren, Nicol & Bredin, 2006). In 2008, a study by Dr. Youfa Wang and his team at Johns Hopkins school of public health concluded that “most adults in the United States will be overweight or obese by 2030, with related health care spending projected to be as much as $956.9 billion” (Wang, Beydoun, Liang, Caballero & Kumanyika, 2008). Consequently, a lack of PA will place an enormous burden on healthcare costs for people and the government. This issue highlights the relevance of an active lifestyle as low levels of PA threaten health both directly and indirectly while active living prolongs life expectancy (Lee & Paffenbarger, 2000). Studies have identified the built environment as having a great deal of impact on our attitudes towards PA (Lawrence, Peter & Thomas, 2003), with the built environment demonstrating a capacity to influence patterns of behaviors that promote health outcomes in the long term. The vast majority of low and middle-income neighborhoods lack basic amenities including sidewalk, bike lane, and open space that stimulate PA such as walking, biking, and running (Day, 2006). Factors such as safety concerns (Boslaugh, Luke, Brownson, Naleid & Kreuter, 2004; Bennett et. al., 2007) and lack of social destinations (McCormack, Giles-Corti & Bulsara, 2008) discourage residents’ engagements in PA. This is evident as most US cities are challenged with a crux of diminishing health exacerbated by their immediate environment especially for minority neighborhoods of color, (Wang et. al., 2008). The primary cause of physical inactivity that relates to the built environment design can be attributed to the consequences of urban sprawl since the twentieth century. Nonetheless, the World Health Organization attributes some other factors: violence, air pollution, high-density traffic, and lack of streetscape facilities such as parks, sidewalks, and recreational facilities as causes of physical inactivity (World Health Organization [WHO], n.d.).

Several studies have identified walking as the most common form of PA. Other cultural and physical factors influence people's decisions to select walking as their mode of movement (Rapoport, 1987; Desyllas, Duxbury, Ward & Smith, 2003). Frank et al., 2006 and Leslie et al., 2007 examined the association between walking and built environment features such as mixed land uses, street connectivity, net residential density (dwelling density), and retail floor-area ratio. Their study concludes that single land-use, low-density land development, and disconnected streets are positively associated with auto dependence and negatively associated with walking which is the most common form of PA. Healthy living and total well-being require a physically active lifestyle that is naturally incorporated in multifaceted daily activities including traveling to work, shopping, recreation, etc. Modern advancements in technology have contributed to a rather sedentary way of life (Ng & Popkin, 2012); urban sprawl causes long commute time and extended periods of inactivity (Ewing, Schmid, Killingsworth, Zlot & Raudenbush, 2003). Transit services including trains, buses, and subways could be a suitable means of PA if incorporated into daily commute. Fragmentation of urban streetscapes hardly creates a walking experience, affecting street walkability and engagement in PA (Frank & Engelke, 2005). Previous studies from other low-income urban neighborhoods located within major cities like Los Angeles (Cohen et al., 2007; Han et al., 2018) and Newark (Echeverria et al., 2014) found that crime and concern for safety pose as an impediment to residents’ PA within the neighborhood. Other studies found that, generally, low-income communities lack the basic amenities for improved PA, which calls for changes in their design and planning (Gustat et al., 2012). A more recent study conducted in low-income communities of New York concludes that children and younger adults tend to be active in neighborhoods with park facilities, bike paths, and mixed land use (Huang et al., 2020). Environmental design experts now argue that planning and design for an active living must primarily address low-income communities, where obesity and related health risks are greatest, and resources are least available (Day, 2006; Wang et al., 2008). This research identifies problems in neighborhood design and investigates ways the built environment can contribute to a more healthy, efficient, and active neighborhood design that promotes various forms of PA. The study employs six principles of smart growth as parameters that promote PA in a neighborhood context by studying the connection between various design components and how they adversely affect PA levels of residents. These smart growth principles were selected as they identify relationships between neighborhood design, aesthetic qualities and social environment. Moreover, they take into account the preservation of existing neighborhood characteristics while accommodating changes that can contribute to improved levels of PA (Dill, 2004).

What is smart growth (SG)? Smart growth is an approach to development that encourages a mix of building types and uses, diverse housing and transportation options, development within existing
neighborhoods, and community engagement (Smart Growth America [SGA], 2017). The model of Smart Growth Principles (SGP) was introduced to improve environmental sustainability and economic growth (Grant, 2009). More studies claim that applying SGP to new developments or redevelopments will address most built environment issues (Daniels, 2001). Previous studies culminate that SGP positively impacts increased PA levels, this study aims to further investigate a diametrical connection between SGP and PA by exploring six of the SGP comprehensively to understand how its application can impact levels of PA for neighborhoods. The six SGP examined in this study are; multimodal transport system, integrated land use, increased street walkability, public open spaces, community identity and safety, efficient pedestrian circulation, and connectivity. Applied to South Atlanta neighborhood, this study explores the relationship between SGP and improved PA at a neighborhood scale. This research sought to investigate the urban condition of South Atlanta neighborhood and its impact on residents’ level of PA. Specifically, the research examines the habits and patterns of PA of the residents, as well as their preference for designed outdoor spaces that align with SGP.

2.1 Study Area
South Atlanta neighborhood (previously known as Brownsville) is located about two miles south of downtown Atlanta along two important railroads which contributed to the growth of the area during the reconstruction period (1863-1877). Historic South Atlanta has a rich history of higher education, performing arts, and community development stemming from the creation of Clark University in 1869, with the aim to educate freed slaves. The college attracted development through common interests and kindred relationships of some of the most influential families in the city of Atlanta for a period of more than half a century. During the segregation period, South Atlanta blossomed into an elite middle-class African American community with over 700 privately owned homes. The community experienced rapid development until 1941 when the university relocated causing a decline in the neighborhood population and development. During this period, Browns Avenue, which ran west to east of the site, served as a historical diving line between the city of Atlanta and Fulton county. The dividing line caused a separation in areas where public development was proposed consequently causing a decline in community development of the southern parts of the neighborhood. Additionally, the neighborhood became notorious as a result of the activities of its African American residents during the Atlanta riot which caused more residents to flee the neighborhood resulting in a steady decline until the early 1940s (see figure 1).

![Figure 1. South Atlanta Source- Google Earth Pro image (2020). Image by the authors](image-url)
March 17-19, 2021

South Atlanta neighborhood was selected for the purpose of this study for several reasons. Primarily, its geographic location within Atlanta metropolitan area, and its proximity to downtown Atlanta, and Hartsfield Jackson Atlanta International Airport; the busiest airport in the world makes it a suitable site for a study that focuses on the effect of the built environment on residents’ engagement in PA. The neighborhood consists of 520 residential parcels and a population of approximately 1200 residents. It is a low to middle income neighborhood comprised mainly of minority African American population making up 91% of the population. The average household income in South Atlanta neighborhood is $23,166, and 35% of the residents make less than $15,000 annually. A combination of these factors which correlates with literature concerning low to middle socioeconomic status and residents’ associated levels of PA (Wang et al., 2008), presented South Atlanta neighborhood as a suitable site for this research investigation.

3 METHODS

3.1 Data Collection
The study derived data from two primary methods: the first method consists of behavioral mapping using correlation research methods which involve mapping and natural observation, and the second method used survey questions to collect data from South Atlanta neighborhood residents.

3.2 Behavioral Mapping
This part of the research sought to understand place-based behavior and activities of South Atlanta neighborhood residents. As per literature review, factors including land use, transit amenities, active nodes, accident rate, neighborhood connectivity, and crime rate were of prime importance to the study. To understand how these factors affected residents’ PA in South Atlanta neighborhood, the research employed the use of interactive mapping tools to independently analyze the various factors. Applications used in this step of behavioral mapping included ArcGIS, Google Earth Pro, Lexis Nexis Community Crime Map, and Georgia Department of Transportation (GDOT) crash data map.

ArcGIS
ArcGIS is a cloud-based mapping tool used in generating and analyzing maps for planning or design purposes. To explore the land use and zoning plan of South Atlanta neighborhood, the study used ArcGIS to generate several map layers describing the neighborhood’s current land uses including housing typologies, open space, commercial and industrial spaces, churches, and public schools. Additional layers were created to identify property boundaries and determine public and private land ownerships. ArcGIS maps aided in the analytical understanding of the neighborhood land use make up which was predominantly residential with few public land uses including schools and churches.

3.2.1 Google Earth Pro
The Google Earth Pro application is commonly used for wayfinding and location purposes by the general public. It is easily accessible on smartphone devices which made it ideal to use in this research. The researchers used Google Earth Pro to examine the existing physical conditions of roads and their accessibility to the different modes of transportations including private vehicles, public transit, bicycles, and motorcycles. Additionally, the application was used to generate 3D street views which provided a clearer understanding of the physical context of road conditions and places in the neighborhood. Street view pictures generated using Google Earth Pro further aided in classifying the road condition into three categories: standard, sub-standard, and poor. The categories are shown in table 1.

3.2.2 LexisNexis Community Crime Map
LexisNexis Community Crime Map is an online interactive mapping system with basic dashboards and analytics used by law enforcement to share specific crime data with the public. It is easily accessible by the public and contains information and geolocation of recent crime activity. The study used LexisNexis Community Crime application to find the current crime rate in South Atlanta neighborhood, and understand the level of safety in the neighborhood through reported crime frequency and location of occurrence.

3.2.3 GDOT Crash Data Dashboard
Georgia Department of Transportation (GDOT) Crash Data Dashboard is an online platform that offers data on crash reports for Atlanta metropolitan Area. For this study, this report was a part of the analysis that focused on investigating the accident rate in the neighborhood to understand how safe the neighborhood is for improved PA.

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3.2.4 Natural Observation

Ground truthing of the multiple mapping layers was achieved through natural observation of South Atlanta neighborhood. This was deemed relevant to ensure that current physical conditions matched data collected from the different online mapping tools and websites. The researchers observed the site closely during two site visits, spending two and a half hours in the first visit conducted in early February 2020 and two hours in the second visit later the same month. The first site observation visit took place on a Saturday morning between 9:00 am and 12:00 pm, and the second observation took place on a late Wednesday afternoon between 4:25 pm and 6:00 pm. During these visits, the researchers used Google map Global Positioning System (GPS) to correlate mapped data with physical neighborhood conditions. The investigation was more specific at some locations where intent observations and study of natural occurrences were needed. Some of those locations included Jonesboro Road (see Fig 4), Benjamin Weldon’s Bickers Drive, Lakewood Avenue (figure 3), and McDonough Boulevard. The researchers took photographs and hand sketches at various places to augment the mapping information gathered.

3.3 Survey

The study used a survey tool to gather data on residents’ behavioral habits, opinions, and attitudes aimed to understand variable patterns that affect PA in the neighborhood. Utilizing quantitative and qualitative questions, an online survey was posted to the neighborhood Facebook page requesting residents’ responses. The survey was posted several times for one week in April 2020 to elicit more participation and asking residents questions about their PA levels and how the design and condition of their neighborhood has encouraged or discouraged engagement in PA. (figure 5B). The survey consisted of four sections; the first section focused on soliciting data from neighborhood residents regarding their daily activities, and types and frequency of engagement in PA. Residents were asked to identify their most common daily destinations and their associated modes of commuting. Furthermore, this section asked residents if their neighborhood conditions encourage, discourage, or have no effect on their type and frequency of PA. The second section aimed to collect data about the residents’ perception of South Atlanta neighborhood. Specifically, in open-ended questions, residents were asked to identify three or more factors that encourage more engagement in PA levels and three or more factors that are currently prohibiting their willingness to be physically active. The third section focused primarily on Smart Growth Principles and solicited residents’ preference of incorporating them in their neighborhood design. The final survey section collected residents’ demographic data including age, gender, marital status, income, education, and employment.

4 RESULTS

4.1 Behavioral Mapping

This study comprises results from the two data collection methods employed, first behavioral mapping and second survey. The researchers used interactive mapping tools and natural observation to classify neighborhood streets into three conditions based on the existing street features. Table one shows the categories of the street conditions.

<table>
<thead>
<tr>
<th>Features</th>
<th>Standard Street Condition</th>
<th>Sub-Standard Condition</th>
<th>Street Poor Street Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Good street connectivity</td>
<td>- Sidewalk present on one side of the street</td>
<td>- Sidewalk completely absent</td>
<td></td>
</tr>
<tr>
<td>- Presence of paved sidewalks</td>
<td>- Unpaved sidewalk</td>
<td>- Deteriorated sidewalk</td>
<td></td>
</tr>
<tr>
<td>- Presence of bike lane</td>
<td>- Unmaintained sidewalk</td>
<td>- Narrow street</td>
<td></td>
</tr>
<tr>
<td>- Presence of trees</td>
<td>- Disconnected sidewalk</td>
<td>- No clarity between private and public boundary</td>
<td></td>
</tr>
<tr>
<td>- Sidewalk stepped up from the street plane</td>
<td>- Sidewalk separated from street with marking.</td>
<td>- No space for sidewalk</td>
<td></td>
</tr>
<tr>
<td>- Visible private and public boundary</td>
<td>- Available space for sidewalk but no sidewalk.</td>
<td>- No bike lane</td>
<td></td>
</tr>
<tr>
<td>- Accessible sidewalks</td>
<td>- No bike lane</td>
<td>- Cars parked on the street for extended time.</td>
<td></td>
</tr>
</tbody>
</table>
Based on the information derived from the behavioral mapping, the study further classified the street connectivity according to their physical and visual connectivity level. These classifications are based on natural observation and mapping of the neighborhood. For physical connectivity, streets were rated from low to high, considering the presence and adequacy of sidewalks, bike paths, street connections, links, and pedestrian shed. For visual connectivity, neighborhood streets were rated from low to high, considering the presence and adequacy of landmarks, destinations, experience, accessibility, and safety. Google Earth Pro maps aided in the analytical understanding of the neighborhood street connectivity identifying three major streets (Benjamin Weldon’s Bickers Drive, Jonesboro Road, and Lakewood Avenue) as very well physically and visually connected, having high physical connectivity and medium visual connectivity. Other streets such as McDonough boulevard, Thirkield Avenue, Margaret Street, and Dorothy Street were rated medium in physical connectivity and high visual connectivity. Out of the twenty-one (21) street segments investigated, eleven (11) were classified as low physically and visually, which means they lacked the basic amenities that encourage PA. Seven streets were classified medium and high physically and visually, while three neighborhood streets had low to medium connectivity (see figure 2). The study found the most connected streets with high physical connectivity and medium visual connectivity, followed by the streets with medium physical connectivity and high visual connectivity. Researchers could further study to examine which of these connectivity types has a positive relationship with increased PA levels.

![Google Earth map of street connectivity analysis (2020). Diagram by the authors.](image)

Studies explored in the literature show that crime and safety concerns discourage residents of low-income communities from engaging in PA within their neighborhood environment (Cohen et al., 2007; Han et al., 2018; Echeverria et al., 2014). To explore this further in the context of South Atlanta neighborhood, the study accessed LexisNexis Community Crime Map in late April 2020 to search reported crimes for the previous six months (November 2019-April 2020). Maps generated from the search showed that the most commonly reported crimes in the area are burglary from motor vehicles, theft, and aggravated assault. It further highlighted that majority of the theft cases were reported on Jonesboro Road (figure 4), while a majority of burglaries from motor vehicle cases were reported within the single-family residential zone. Generally, the frequently reported crime cases in the neighborhood were non-violent crimes. Other violent crimes, such as aggravated assault, robbery, rape, and homicide, were less common in the area. The study highlights that most of the inner neighborhood streets had low to medium connectivity and poor-substandard streets that may be related to the increased crime rate. The study further concludes that
residents can freely engage in PA within their neighborhood with very low reports of violent crimes without fear for their safety.

Safety-related factors are further explored using the GDOT crash data dashboard, accessed from the GDOT website in March 2020. The study found that the neighborhood of South Atlanta had 15 car crashes in the last year, with 53.3% of the crashes occurring on Jonesboro Road (figure 4). After adjusting the dates to show crash reports over the previous five years (March 2015-2020). The results showed 141 car crashes in five years, with 31% (44) occurring on Jonesboro Road. With the information derived from the GDOT crash report, the study deduced that the accident rate within the neighborhood is relatively low, with most occurrences happening on significant arterials like Jonesboro Road, Lakewood Avenue (figure 3), and Lansing Street, respectively. During the natural observation, the study identified inconsistencies in sidewalks and bike lanes, with the only complete street being Benjamin Weldon Bickers Avenue on the western boundary of the site. Other significant arterials such as McDonough Avenue, Lakewood Avenue, and Jonesboro Road (figure 1) had inconsistent bike lanes and sidewalks. The inner neighborhood streets were narrow, with trucks parked on both sides of the street, causing pedestrian and vehicular obstruction. Also, the inner neighborhood streets had numerous clutters. Most street lanes were shared as vehicles parked on the road for extended periods causing other moving vehicles to share one lane. There was no clear boundary between public and private properties, especially in the inner neighborhood. About 30% of the streets had bike lanes, and about 45% had a functioning sidewalk. In both visits, the researchers observed few pedestrians using the streets, most of whom walked on the vehicular right of way due to lack of sidewalks or obstructions. Inner neighborhood houses were also in obsolete conditions, while some looked relatively new. The site observation affirmed that South Atlanta neighborhood lacks basic safety amenities, including sidewalks and bike lanes that connect the neighborhood to local destinations such as schools, churches, and grocery stores vital to the community's daily activities.

4.2 Survey
A total of 21 respondents participated in the survey. Results show that 95.2% of the respondents engage in different forms of PA (figure 5A), while 76.2% agree that the current conditions of their neighborhood discourage PA (figure 5B). The most common PA reported include walking, running, and biking. 42.8% of the respondents indicated that they engage in such activities at least three times a week. Primary destinations within South Atlanta Neighborhood were identified by residents as workplaces, schools, churches, and grocery stores. 57% of the respondents reported that their primary destinations are more than three miles walking distance from their home which has contributed to 47.6% of the respondents driving for commute (figure 5C and 5D). 66.7% of respondents indicated their willingness to walk or bike to their primary destination contingent on the presence of safe sidewalks and bike lanes and within walking and biking distance. 10% of the respondents indicated a lack of interest in walking or biking despite having their primary locations within walkable distance due to safety concerns (figure 5E). 23.8% of the respondents identified as non-drivers who primarily commute by transit and a mix of other forms of commute (walking and biking), another 28.5% drive and use other means of commute (figure 5).

In answering the open-ended questions, respondents provided detailed descriptions of factors and amenities they believe are missing in their neighborhood. 85.7% of respondents highlighted the need for a
safe neighborhood. 19% specifically mentioned the immediate need to lessen the crime rate within the neighborhood and increase police patrols. Of neighborhood respondents concerned about safety, 28.6% pointed out high-speed vehicles and lack of signs to slow traffic in residential streets. Social public spaces including parks and children's play areas were indicated by 23.8% of respondents as essential to promoting more PA. 14.2% mentioned streetlights as lacking. Additionally, 48% of the respondents identified the absence of “good sidewalks” or “paved sidewalks” as their prime concern. The study noted that except for safety concerns, less than 50% listed the same amenities either directly or using different words. Other issues that respondents more sparsely identified as impeding physical activities included “street obstructions”, “trash” and “overall cleanliness”.

4.3 Using Smart Growth Principles as a framework for data analysis

Data collected from behavioral mapping, natural observation, and a survey questionnaire, allowed the researchers to use Smart Growth Principles as a framework to further investigate its diametrical relationship to residents’ physical activity in South Atlanta neighborhood. As such, multi-modal transit system, integrated land use, increased street walkability, public open spaces, neighborhood identity and safety, and efficient pedestrian connectivity were the six SGP utilized in data analysis.

4.3.1 Multi-modal transit system

Using ArcGIS mapping to investigate the current transit system of the site, the study found two main bus transit routes serving South Atlanta neighborhood: Route 55 operating North to South from Five Points Station (downtown Atlanta) to Forest Parkway in Clayton. This bus service runs through McDonough Boulevard and Jonesboro Road with ten stops in South Atlanta for each trip. On both weekdays and weekends days, the bus starts its service as early as 4:00 am until past midnight every fifteen-minute. The second route serving the western end of the neighborhood is Route 42 operating North to South between Lakewood Avenue and Five Points Station. This route is accessible to South Atlanta neighborhood from Benjamin Weldon Bickers Drive and Moury Avenue. Similar to Route 55, this bus route provides service all week. South Atlanta neighborhood is well connected by bus transit to downtown Atlanta and other popular parts of the metropolitan areas such as Decatur, Roswell, Johns Creek, and Hartsfield-Jackson Atlanta International airport. While public transit seems to be readily available, 47.6% of the respondents indicate that they prefer driving to work and other destinations. Only 14.2% of the respondents indicated that they use transit exclusively as their primary means of transportation. However, 23.8% of those who responded reported that they alternate between driving and taking transit depending on the location and distance of their destination.
When asked to offer reasons for choosing driving as opposed to other modes of transportation, respondents indicated problems and challenges with bus transit in the neighborhood. 5% of the respondents preferred to see “more bus stops” that are “closer to home”. 9.7% of the respondents mentioned that the bus schedule “does not fit their work hours”, and 4.8% said their commute requires “taking multiple transit lines” and consequently takes longer to reach their destinations. Although South Atlanta neighborhood seems to offer adequate options for public transit, more residents use private vehicles for commute compared to those who choose public transit. However, options of increasing number of transit routes, destinations, route connectivity, and the number of bus stops, would certainly increase the number of residents opting to use public transit on daily basis.

4.3.2 Integrated Land use

The study used Google Earth Pro, ArcGIS, and natural observation to investigate the current land use of South Atlanta neighborhood. The study also explored future land use and zoning plans from previous development studies conducted by the local and state government (Lakewood Community Initiative; LCI, Strategic Community Investment Report; SCI). Currently, the site is comprised of 70% single-family use, 20% general residential (including schools), and 15% commercial and industrial. This current plan has no mixed land use which provides social and commercial destinations. Consequently, residents travel for most of their social and commercial needs. Current redevelopment plans for the neighborhood aim to increase integrated land uses by 30% especially along major arterials like Lakewood Avenue, Jonesboro Road, and McDonough Boulevard (figure 1). The study explored the respondents’ perceptions of the current land use and how it affects their PA levels as well as their preference for integrated land uses within the neighborhood. 71.4% indicated the need for more commercial destinations with various types of stores and restaurants within walkable distance. Overall, residents’ response to this factor indicates that more integrated land use development may increase walkability for leisure activities and destinations within the neighborhood. Consequently, likely future plans to integrate land use development would positively impact the levels of PA.

4.3.3 Increased street walkability

The study classified sidewalks in South Atlanta neighborhood into three categories: Standard, sub-standard, and poor. Data showed that 75% of the sidewalks in the neighborhood are either sub-standard or in poor condition. The researchers found most streets to be not safely walkable due to various factors such as incomplete sidewalks, absence of bike lanes, trash on streets, and narrow streets. Based on comprehensive mapping and natural observation of the site, the study deduced that the most streets in the neighborhood lack basic qualities for safe walking and other types of PA.

The study shows that 66.7% of the respondents are willing to walk if their primary destinations could be reached safely, while 33.3% indicated an unwillingness to walk, citing different reasons. 14.2% of the respondents will not walk due to extreme heat in the summer months. 23.8% mentioned reasons related to safety concerns, including lack of sidewalks, aggressive stray dogs, or fear of getting hit by cars due to the absence of sidewalks. In the open-ended component of the survey, respondents provided detailed descriptions of the street conditions in South Atlanta neighborhood. 57.5% indicated the need for more “connected sidewalks.” 31% reported that the absence of sidewalks discourages their PA. 33.3% of the respondents indicated that adding standard sidewalks is of prime importance, expressing concern about children walking to school. Although a majority of South Atlanta residents indicated that they walk either to reach destinations or as a form of PA, the neighborhood condition does not seem to support safe walkability. Plans for improving conditions and connectivity of sidewalks in the neighborhood will likely increase residents’ willingness to walk.

4.3.4 Public open spaces

According to the UK Design Council, “Access to good-quality, well-maintained public spaces can help to improve our physical and mental health by encouraging us to walk more and play sport” (Design Council, n.d.). The study investigated public open spaces (POS) in South Atlanta neighborhood using ArcGIS mapping tool. The study identified six different types of POS within the study area. Those include schoolyards, green spaces, playgrounds, public seating areas, vacant lots, and plazas. Lucius D. Simon Memorial Park is considered the largest open green space serving as the schoolyard for Carver High School. Kimpson Park and playground are located on Thirkield Avenue, and a large vacant lot on Bisbee Avenue seems to serve as church parking on weekends and a recreation sports area for youth on
weekdays. The Ron Clark Academy schoolyard on Jonesboro road is publicly accessible and fairly utilized by the neighborhood resident on weekends.

Based on the natural observation conducted in South Atlanta Neighborhood in April 2020, researchers recorded that residents were fairly using POS in the neighborhood. Also, groups of youth were engaged in catch ball at Ron Clark Academy school field, and a few older adults were exercising around the sports field. During the second visit in late April that occurred between 4:25 pm and 6:00 pm, researchers noted a much higher level of PA in all public open spaces. The study identified that five of the six public open spaces serve as adequate space for PA. In addition, most POS in the neighborhood seems to be in fairly good conditions and accessible, except for Lucius D. Simon Park, which residents have reported to be inaccessible. According to the survey, 76% of the respondents used the POS within the neighborhood at various times, while 42.8% use it at least three times a week. Also, 57.1% of the respondents prefer access to additional spaces such as Lucius D. Simon Memorial Park. 9.5% notably reported the need for more open spaces added to the community, and 19% expressed interest in trails that connects the neighborhood with the Atlanta Beltline. Overall, South Atlanta neighborhood offers an adequate number of public open spaces accessible to the community members. Although most of those spaces are in fairly useable conditions, community members indicated that additional spaces, sports fields, and playground equipment would invite more presence and PA outdoors.

4.3.5 Neighborhood identity and safety

Smart Growth Principles (SGP) encourage the creation of high-quality communities with architectural and natural elements that reflect the interests of all residents. Additionally, SGP promotes safety and the importance of creating a vibrant community for those who live there (Smart Growth America [SGA], 2017). This study focused on identity and safety as primary components that create a sense of place and vibrant neighborhood, thereby promoting PA. Exploring the history of South Atlanta neighborhood, it can be stated that the neighborhood's sense of identity and safety was adversely affected during the decline that started in 1940. However, data shows that respondents have a strong sense of community identity frequently expressed through engagement in community events and gatherings. 23.8% of respondents highlighted the need for communal spaces within the neighborhood, which are currently lacking. 14.2% indicated the need for sports facilities such as basketball courts, soccer, and football fields, citing the importance of engaging youths in recreational sports. Another 9.5% mentioned an interest in having open food courts in the neighborhood. Considering the current neighborhoods' lack of such spaces where residents can engage in community events that enhance neighborhood identity, future integration of such desired spaces can contribute to an enhanced sense of community vibrancy and create opportunities for PA.

Furthermore, the study investigated safety as a factor determining how people use their immediate environment, including crime rate and accidents within the neighborhood. According to LexisNexis Community Crime Map, the most commonly reported crimes in the area are burglary from motor vehicles, theft, and aggravated assault, with most of the theft cases reported on Jonesboro Road. In contrast, a majority of burglaries from motor vehicle cases were reported within the single-family residential zone. Using GDOT crash report, the study found that most crash occurrences happened on major arterials like Jonesboro Road, Lakewood Avenue, and Lansing Street respectively. Therefore, those streets were found to be unsafe due to traffic-related concerns such as high speed and traffic accidents. Evidence from mapping and survey results shows a direct correlation between safety and PA levels. While 76.2% of the respondents report that their neighborhood discourages PA, 85.7% of those respondents highlighted safety concerns as the main reason. Specifically, 28.6% described traffic safety as a significant concern, 30% expressed concern about crime, and 25% mentioned that they feel unsafe outdoors at odd hours. While South Atlanta neighborhood seems to enjoy a strong sense of identity and community vibrancy, it is clear that the majority of residents do not feel safe in the neighborhood, which certainly impedes their levels of PA. Future development of additional social and recreational spaces and the introduction of crime and traffic safety measures could undoubtedly enhance a sense of neighborhood identity and safety, allowing residents to engage in more events and activities freely.

4.3.6 Efficient pedestrian connectivity

Investigating the current street conditions of the neighborhood to understand pedestrian connectivity, the study examined two types of connectivity: visual and physical. The use of Google Earth data shows that only six streets were well connected ranking high and medium for visual and physical
connectivity (see figure 2). None of the existing streets ranked high in both visual and physical connectivity. Although fairly close to downtown Atlanta, the neighborhood lacks elements that enhance pedestrian experience, including visual elements such as landmarks, destinations, experience, accessibility, and safety; and physical elements such as sidewalk, bike path, street connection, links and pedestrian sheds.

Asking residents about visual and physical connectivity criteria, the study found that respondents approached connectivity at a micro-scale, analyzing connectivity from their doorsteps to the sidewalk and maintaining consistency within different neighborhood destinations. Visual connectivity criteria including safety, destinations, and accessibility were reported to be of primary importance for PA and outdoor use. Respondents less identified other criteria of visual connectivity such as landmarks and experience as necessary for PA and outdoor use. In terms of criteria for physical connectivity, respondents mentioned the need for incorporating all five elements of physical connectivity in the neighborhood. According to responses from the open-ended questions, more respondents were interested in seeing both visual and physical connectivity elements within their neighborhood.

5 CONCLUSION

South Atlanta neighborhood is a low to middle-income community of minorities, mostly African Americans, within two miles proximity of downtown Atlanta. The neighborhood has been identified by Focused Community Strategies (FCS) and the city of Atlanta as facing a period of transition through urban redevelopment plans. Initial research plan was impacted due to the events Covid-19 pandemic resulting in less than anticipated number of participants. Based on research findings, residents of South Atlanta neighborhood are fairly physically active and are willing to be more active through engagement in various outdoor activities. Smart Growth Principles offered a valuable framework to investigate the current conditions of the neighborhood and the residents’ levels of PA. Data analysis from behavioral mapping, natural observation, and survey questionnaire found that current neighborhood existing conditions are not optimal in supporting a physically active lifestyle. Using the six principles of smart growth; transit system, integrated land use, street walkability, public open spaces, neighborhood identity and safety, and pedestrian connectivity, the study found that they vary in their level of support of PA in the neighborhood. For example, while the neighborhood offers access to adequate lines of bus transit, the study shows that there is a need for more transit routes, destinations, route connectivity, and number of stops. Offering better transit access, the study indicates, will increase the number of residents opting to use public transit on daily basis. Consistent with the literature suggesting that integrated land use encourages compact development and lowers automobile dependency, majority of South Atlanta neighborhood residents indicated the need for a mixed-use development including stores, restaurants, recreational facilities. With the current future redevelopment plans of increasing integrated land use by 30%, walkability for work, leisure activities, and other destinations will likely increase as well.

Considering that walking is the most common form of PA in general and was the highest reported by South Atlanta neighborhood residents, the research shows the existing street conditions to be unsafe and of major concern. Improving the conditions and connectivity of sidewalks in the neighborhood will have a positive impact on the number of residents willing to walk. Access to good quality public open spaces is vital for both physical and mental health of a community as per the literature. South Atlanta neighborhood comprehensively offers an adequate number of public open spaces that are accessible to the community members. However, the neighborhood could certainly benefit from the improved quality of its existing POS and the addition of recreational and sports fields. In addition, sense of safety shows as South Atlanta neighborhood’s most prime concern. Traffic-related accidents, burglary, and theft were the most commonly reported in the data, as well as residents’ overall unsafe feeling in the outdoors. Prioritizing this factor, the research suggests that introduction of crime and traffic safety measures could certainly enhance a sense of safety allowing residents to freely engage in more events and activities.

Although the research utilized the smart growth principles as separate components in examining data, the study found that each of the six SGP discussed tend to address multiple factors of concern towards improving levels of engagement in PA for South Atlanta neighborhood. Findings illustrate that more people are willing to lead physically active lives if their neighborhood design supports it. Consequently, a smart growth integrated approach of development and improvement of the neighborhood design is important to encourage a more physically active community. In summary, the study shows clear possible physical and mental health benefits for South Atlanta neighborhood residents by being more physically active, and that smart growth principles offer possible benefits for improved quality of life. Future research could focus on...
additional neighborhoods in Atlanta as well as other cities and provide valuable perspective on the benefits of SGP and designed outdoor spaces on PA.

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THE IMPORTANCE OF BOTH: COMPETING FACTORS THAT IMPACT ATTENTION LEVEL RESTORATION AND MENTAL HEALTH

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1 ABSTRACT
Attention Restoration Theory (ART) puts forward that being in nature has a restorative impact on direct attention level (Kaplan, 2001). Some researchers have tried to measure the perceptual implications of the four characteristics suggested by ART of a restorative environment (Korpela et al., 2010), and others have attempted to measure the cognitive consequences of immersion in a natural environment (Ohly et al., 2016). What has been examined far less is the interrelationship of perception and cognition and how they indicate the restorative impact. This research aimed to measure both perceptual and cognitive impacts of an immersive visual interaction with natural green elements. One hundred and eighty-two participants were randomly assigned to physically walk through, via VR goggles, one of two versions of a building's lobby modeled as a 3D virtual reality (VR) environment. One version was with, and the other was without natural green elements consisting of three types of indoor plants. To measure the two environments' perceptual impact, participants filled out a Perceived Restorative Scale (PRS) questionnaire (Hartig et al., 1997) after experiencing the environment. To assess possible improvement in attention level through cognitive processes, participants completed, before and after experiencing the environment, a Sustained Attention to Response Task (SART) (Jung et al., 2017). The results of this research seem to indicate that measuring one influencing factor may not be sufficient to evaluate the impact of an environment on attention level and may lead to misleading conclusions.

1.1 Keywords:
Attention Restoration, restorative environments, virtual reality (VR), direct attention, natural green elements/ vegetation, residential high-rise lobby
2 INTRODUCTION

Presence in nature (Kaplan & Kaplan 1989; Pilotti et al., 2015; Jenkin et al., 2018; Pascoe et al., 2017) or viewing a natural scene (Berto, 2005; Berman, Jonides, & Kaplan, 2008) for a few minutes to hours (Bratman, Hamilton, & Daily, 2012) has proven to have a positive physical and psychological impact. Numerous studies have focused particularly on possible improvements in individuals' attention level (Hartig, Evans, Jamner, Davis, & Garling, 2003; Lee, Park, Tsunetsugu, Kagawa, & Miyazaki, 2009). Different theories have tried to explain the process that helps the improvement in people's attention level to occur. One of those theories is the Attention Restoration Theory (ART), introduced by Rachel and Stephen Kaplan in 1989.

The Kaplans, in their book “The experience of nature: a psychological perspective,” explained how interaction with nature could influence attention restoration (Kaplan & Kaplan, 1989). Their theory suggests four characteristics of environments with restorative capabilities. According to ART, natural environments are typically fascinating for individuals without being exhausting (Fascination). Those environments can also accommodate a broader range of activities and are more compatible with people's needs (Compatibility). Natural environments empower individuals to distance themselves from their daily routines and regular thoughts (Being Away). Finally, natural environments are extensive enough and enriched with different activities and content that allow people's minds to get involved with them for an extended period without noticing the environment's boundaries (Extent) (Kaplan, 1995; Kaplan & Kaplan, 1989).

ART has been extensively used in evaluating an environment's impact on people's attention level (Kaplan, 2001; Perkins et al., 2011; Raanaas et al. 2011, Wells & Phalen, 2018), a few points need to be discussed that have been addressed less in those studies. First, ART uses individuals' self-reported perception of an environment's four restorative characteristics to evaluate the environment's impact on attention levels. This theory proposes that the higher the perception of the restorative characteristic of an environment, the higher the level of restoration in peoples' attention level. ART puts forward that the restorative impact that an environment has on individuals is directly correlated with their perception of the four restorative qualities of the space. Individuals' understanding/perception of those qualities can vary from one person to another and can be impacted by their life experience and personal background (CDM Group, 2014); therefore, perceptions are subjective.

However, an individual's encounter with different environments triggers around the same time cognitive processes and functions in the brain (Maclean et al., 2010). Neuroimaging research has demonstrated that different cognitive functions activate separate networks in the brain, such as the networks involved in maintaining attention towards specific tasks (Sturm & Willmes, 2001) and the networks associated with processing external distractors (Maclean et al., 2009). Cognitive functions are exhausting efforts that consume underlying mental resources (Maclean et al., 2010). Areas in the brain, including brain networks, which are associated with controlling attention become less active after executing demanding cognitive tasks (Linn et al., 2010). One of the main indicators of the decrease in brain activities in the areas related to attention control is restricted blood flow in those areas promptly before lapses in attention (Weissman, Roberts, Visscher, & Woldorff, 2006). The consequences of this physiological response can be measured through different cognitive tests. These tests objectively measure the impact of interaction with nature on individuals' attention levels.

Therefore, cognitive function impacts an individual's attention level and studies that measure the restorative quality of an environment need to take individuals' perceptual understanding (subjective measures) and cognitive performance (objective measures) into account simultaneously.

Finally, most of the studies focused on the individual's physical presence or visual access to nature. There is mounting evidence to show that vegetation used in designing parks and urban green spaces also has restorative benefits (Hartig et al., 2014). However, recent studies revealed that those who live in high-density urban areas spend most of their time at home, at work, and commuting between those two locations. Similar studies also demonstrated that per capita encounter with urban green spaces and parks for those individuals is less than thirty minutes daily (U.S. Bureau of Labor Statistics, 2017). Therefore, people living in high-rise buildings in dense urban areas may have restricted physical access or views of nature. Nevertheless, those people may have access to other forms of vegetation, such as indoor greenery, in the design of the interior spaces. Thus, it is essential to see if those natural green elements, which in this research are interchangeably referred to as vegetation, can compensate, to some degree, for a lack of access to nature.
This paper expands on the former studies by exploring the impacts that micro-interaction with natural green elements have on people’s attention level when utilized in interior design, in this case, a high-rise residential building lobby. Micro-interactions in this research are defined as spontaneous and informal encounters with natural green elements throughout the day that last less than a minute. This research employed methods and tests used in neuroscience to measure changes in individuals' cognitive performance as an indicator of attention restoration (Ohly et al., 2016). Researchers aim to answer the question: Does micro-interaction with natural green elements utilized in the high-rise residential building lobby’s design enhance the participants' attention level?

2.1 Attention restoration and high-density urban areas

Large cities are filled with different types of information, both necessary and unnecessary. Those who live or work in urban areas encounter that information, from a small traffic sign to a huge LED billboard, daily. These encounters with a massive volume of data consume mental resources involved in controlling attention (Herzog, Black, Fountaine, & Knotts, 1997). Mental resources depletion occurs when individuals try to direct their voluntary attention towards a task and at the same time ignore surrounding distractions that may interfere with executing that task (Kaplan, 1995). ART suggests that interaction with nature engages non-voluntary attention and allows depleted mental resources that enhance voluntary attention to replenish (Berman et al., 2008; Kaplan, 1995).

Growing population and increased demand for housing forced cities to expand and add higher-density housing to accommodate peoples’ needs. In this way, traditional views of nature in urban areas such as trees on the streets and small community and local parks (van den Berg, Jorgensen, & Wilson, 2014) have become less accessible. However, other forms of vegetation, such as the natural green elements used in designing buildings’ interior spaces, may provide similar restorative benefits to the city dwellers. Visual access to a limited amount of vegetation has similar attention restoring advantages as nature (Kaplan, 1993; Ulrich, 1986; Herzog, 1989). Therefore, it is likely that the utilization of natural green elements in designing indoor spaces can play a role in restoring peoples’ attention. Hence, this paper examines the extent to which less than a minute walking through a lobby that uses vegetation in its design, as opposed to a lobby with no vegetation utilized in its design, can improve attention.

2.2 Attention restoration and cognition

Sustained attention is defined as the capability to maintain control of attention throughout a task (Maclean et al., 2010), an underlying element of attention involved in memory and learning (Cowan, 1995; Sarter et al., 2001). Controlling attention consumes mental resources; therefore, it is difficult to sustain attention for a long time (Maclean et al., 2010). Even further, trying to sustain attention for an extended duration may cause mental health and productivity impairments (Sonnentag, Binnewies, & Mojza, 2010).

Two separate processes are involved in sustaining attention. Each process occurs in a separate network in the brain. Focusing on performing a specific task is processed cortically through the dorsal attention network (Sturm & Willmes, 2001) while surrounding distractors are processed sub-cortically via ventral attention network (Warm et al., 2008; Corbetta & Shulman, 2002). Studies have revealed that just before failures in attention occur, blood flow restricts the brain’s area associated with attention control (Hitchcock et al., 1999; Weissman et al., 2006). The same area of the brain becomes significantly less active after operating an attentional resource depleting task, denoting that the depletion is imminent (Lim et al., 2010).

Drawing on ART, this paper suggests that walking in a lobby with vegetation utilized in its design could provide individuals with a restorative experience to help them replenish their mental resources exhausted from maintaining attention control. Similar to previous study outcomes (Kaplan, 1993; Kaplan, 2001), researchers expected to observe visual micro-interactions with vegetation in the residential building lobby, enhancing attention. The possible enhancement can be measured via the Sustained Attention to Response Task (SART). Performing SART activates both brain networks associated with maintaining sustained attention. Homogenous variability in response time performing the SART task demonstrates participants’ ability to sustain their attention while avoiding distractions and momentary arousals (Manly et al., 2003; Barkley, 1997; Bellgrove, Hester, & Garavan, 2004).

Two different response time variabilities can occur in performing SART. One mirrors the quick alternation in the response time over the course of the task, referred to as the “Fast Frequency Variability
"The other shows the gradual changes in the response time variability during the task’s operation and is called the "Slow Frequency Variability (SFV)." Different studies suggest that shifts in FFV indicate changes in cortical attention control. Those studies also argue that alternations in SFV demonstrate changes in sub-cortical arousal (Johnson et al., 2007; Johnson, Kelly, et al., 2008). Using these two measures allows researchers to evaluate possible changes in individuals’ sustained attention more accurately as they reflect how both processes involved in sustaining attention get affected over the experiment set up by the researchers.

Using this method helps to assess both processes of attention restoration. Voluntary attention is processed cortically, and FFV indicates changes in cortical attention control. In the same way, non-voluntary attention is processed sub-cortically, and SFV illustrates sub-cortical arousal. Drawing on ART, researchers speculated that the lobby with vegetation would improve cortical attention control. They also expected to observe the sub-cortical arousal simulation. These results would be reflected in less FFV and SFV and fewer errors performing the SART.

3 RESEARCH OBJECTIVES

An objective of this research was to compare the accuracy of self-reported evaluations of the perception of the restorative impact of green environments against other less subjective, and more recently developed, cognitive measures of attention restoration. In other words, some studies have recorded and examined what subjects have said about an environment’s restorative impact while other studies have measured changes in the performance of cognitive tasks as a measure of restorative impact. Several previous research efforts have relied solely on the measurement of perception, or impacts on cognition, to measure the restorative quality of an environment. Few studies have used both cognitive and perceptual measurement approaches. This study compares the outcomes of a measurement of perception, using the Perceived Restorative Scale (PRS) questionnaire, with an established cognitive measurement instrument, the Sustained Attention to Response Task (SART). The goal was to shed light on how the findings of these different approaches to measuring the impact of an environment on an individual’s health and well-being conform and or differ.

An additional research objective was to explore to what extent a micro exposure to green environments, in this case exposure of less than sixty seconds, can have a measurable positive impact on an individual’s well-being. The intent was to increase our understanding regarding the value of the greening of environments that individuals experience for only a short time each day. As we understand better the potential impact of micro exposures, we may be able to identify cost effective measures that have a maximum benefit. Finally, this research also tested the potential of using immersive VR to create an experience of an environment that can produce perceptual or cognitive impacts.

4 METHODS

This quasi-experimental exploratory research measures how visual interaction with vegetation in the residential building lobby affects participants' perception of space and cognitive performance. Researchers used quantitative data obtained from a cognitive test and a perceptual questionnaire. Experiments often draw a causal relationship between dependent variables and independent variables (Thyer, 2012). In this research, the presence of vegetation is the independent variable. This study's two dependent variables are the participants' perception of the lobby's restorative quality and their sustained attention level. Researchers used a virtual environment to keep the experiment condition consistent for all participants. However, there were still some intervening variables that researchers had limited control over. Factors such as the higher workload, lack of sleep, or family problems could impact participants' cognitive performance. Participants' background and former experience with vegetation and other design characteristics of the lobby, such as color, height, and materials, could also affect their perception of the lobby's restorative quality. Therefore, researchers could not establish a causal relationship between the dependent and independent variables and used correlational analysis to interpret the data.
4.1 Study Context
This experiment's study context was two versions of a residential building complex's lobby modeled in virtual reality. As rendered in Figure 1, one version contained some vegetation, and the other one had no vegetation utilized in its design. The two versions were modeled in Autodesk Revit 2020, and vegetation was then added to the model using Lumion for Revit. The Unity Game Engine was the platform used in this experiment to allow participants to immerse themselves in one of the two virtual environments. Participants controlled their movement through the lobby by physically walking while wearing a VR headset to accomplish the task.

Virtual reality is an emerging tool that has been used in recent years in landscape architecture research (Saedi et al., 2020). Researchers have used screen based (Berto, 2005; Ohly et al., 2016) and semi-immersive (Chung et al., 2018; Moreno et al., 2018) VR environments, that would allow participants to experience the VR environment through head movements in contrast to physically walking, to measure the impact of physical and visual interaction with nature. Moreover, those studies are mostly focused on the participants' perception of the restorative quality of an environment and not their cognitive performance after experiencing an environment. The number of studies that have utilized fully immersive VR environments, that allow participants to explore the VR environment while physically walking during the experiment, for that purpose is limited compared to the other two versions (Lee et al., 2015; Saedi et al., 2020).

The use of virtual reality allowed the researchers to more easily modify the study site and overcome any access problems that may be associated with the use of a physical space (Saedi & Rice, 2019). In addition, research has shown that a virtual reality environment can generate a restorative impact similar to a real physical environment. The primary difference being that the restorative impact resulting from a virtual reality experience may be less than the impact of a physical space. For these reasons it was felt that using VR was both more manageable format and possibility a more rigorous test.

![Figure 1. Snapshots of the two versions of the residential building lobby as the study sites. Toward the building entrance (Top) - Toward the building elevators (Bottom)](image)

4.2 Participants
One hundred and eighty-two residents of a high-rise residential building voluntarily agreed to participate in the entire experiment as reflected in Figure 2. including the pre-test and the post-test. Each
participant experienced only one of the two versions of the study context. The participants were 63% male and 37% female with a mean age of thirty-five. One hundred and seventy-one out of one hundred and eighty-two participants carried out the pre and post SART test correctly. Seven of the participants did not respond to more than half of the PRS questions; thus, their data was not used for the final analysis. Therefore, the data obtained from one hundred and sixty-four participants was ultimately analyzed.

4.3 Measures

Researchers used two measures in this study. The first measure was the Sustained Attention to Response Task (SART) used to gauge the participants’ cognitive performance. The second measure was the Perceived Restorative Scale (PRS), which was employed to determine how the participants perceived the two lobbies.

The Sustained Attention to Response Task measures participants’ sustained attention level. The study used SART to record any significant changes in participants’ sustained attention level (Johnson et al., 2007). Using E-prime Software, participants were given a series of numbers on an iPad Air 2. They were asked to respond to any number, except the number ’7’ by touching an arrow on the bottom of the screen when the response cue in the form of “⊗” appeared on the screen. Researchers used the response cue to control the response speed between participants and to minimize the trade-off between pace and accuracy (Lee et al., 2015). The same number order consisting of two-hundred and twenty numbers were issued to all participants. One hundred and ten numbers before virtually walking through the assigned lobby, to establish the baseline of their attention level, and one hundred and ten after experiencing the lobby to detect any changes.

The Perceived Restorative Scale is a questionnaire designed to analyze individuals’ impressions of the four aspects considered by Attention Restoration Theory for environments with restorative capabilities, namely: Extent, Being Away, Fascination, and Compatibility. The Perceived Restorative Scale (Hartig et al., 1997) was regarded as the basis for assessing the participants’ perception of the lobby’s ability to restore their attention. Researchers omitted a few questions from the original twenty-six PRS questionnaire (Hartig et al., 1997) as they applied to outdoor spaces, while this study took place in an indoor environment. The result was that a questionnaire consisting of eleven questions with Cronbach’s α of 0.82. Researchers evaluated participants’ responses on a 6-point Likert Scale with number one indicating “Not at all” and number six representing “Very much so”.

4.4 Experiment Procedures

![Figure 2. The process that participants had to go through to successfully participate in the experiment](image)

Daily routines and responsibilities consume attentional resources and increase the chance people get mentally fatigued (Austria, 2014). Therefore, the 55 seconds long VR experience took place at the end of weekdays to help detect significant changes in the participants’ cognitive functioning as an indicator of attention restoration (Ohly et al., 2016). Each participant after arriving in the residential complex was invited to move to a separate space to take the pre-immersion SART tests. The room had no natural ventilation or doors to the outside areas, just artificial lights, and the air-conditioning that was kept the same for all participants. Those consistencies helped researchers take out some of the intervening variables, such as various room temperatures and daylighting, out of the equation so they could not change the participants’ cognitive performance. Figure 2 summarizes the experiment’s procedure and dedicated timeframe for each step of the process that all participants who went through the study completed.
When the pre-test was completed, participants under researchers' supervision, first practiced using the VR Headset and VR controllers. Following the practice, researchers randomly assigned each participant to walk through one of the two 3D virtual reality versions of the building lobby, as illustrated in Section 4.1. To complete this task participants were taken to the building’s 12x8 meter conference room as illustrated in Figure 3. All the furniture inside the room was removed. Only 12 chairs were kept in two sides of the room for the participants to take a rest in case they felt VR sickness and its symptoms such as nausea (LaViola, 2000). The 10x5 meter cleared space was marked down on the ground to define the area available to participants during the VR experience. Four SteamVR (SV) base stations were used to detect the participants’ movements. The participants put on the VR Headsets and physically walked through the experiment’s VR context. As the participants physically moved in the room their virtual location also changed relative to their starting point as recorded by the GPS embedded in the VR headset.

Modeling the lobby in the VR settings, rather than changing the real lobby, made it easier for researchers to try various prototypes to create the desired version more rapidly and at a lower cost (Saedi & Boone, 2018). The HTC VIVE Pro-Eye has been used for this study. Participants began the immersive experience of the VR world by clicking one of the keys on the VR controllers. They had to push the same button again when they got to the elevator to finish and register their encounter. The participants were required to walk across the lobby from the building entrance to the elevators at their normal walking speed, not rushing or pausing during the experience, without interacting with the vegetation or the lobby itself.

![Figure 3. The layout of the building’s conference room, the cleared space, and the four SteamVRs (SV) base stations](image)

5 RESULTS

The standard deviation of each participant's response time and the average response time for all participants of the two groups was calculated. Using the fast Fourier transform, fast frequency variability was the variability for one SART cycle. The components of the SART test included one hundred and ten numbers in groups of ten. The slow frequency variability included all variabilities in SART cycles (Johnson et al., 2007)
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Figure 4. Boxplot of the median and variance of fast frequency response variability (reported as power). Participants experienced the lobby without natural/green elements (gray boxes) or with natural/green elements (white boxes). Data shown for the 1st and 2nd half of the pre-test, and the 1st and 2nd half of the post-test. The asterisk indicates a significant difference between participants exploring the lobby with and without natural/green elements (p= 0.014). The hash sign indicates a significant increase in variability for participants experiencing the lobby with no natural/green elements in the 2nd half of the SART task from pre-test to post-test (p= 0.041).

The SART response times were converted into time-series data, trended, and divided into seven segments according to the method used by Johnson and her colleagues in 2007 to calculate the fast frequency variability for each participant. Every segment consisted of seventy-five data points with fifty points overlapping. These data points were then hamming-windowed and zero-padded for a cumulative length of four hundred and fifty points to assess possible improvements in the individuals’ sustained attention level. Researchers analyzed the standard deviation to response time and the fast frequency variability for the two halves of the pre-test and the two halves of the post-test. The slow frequency variability results were not divided into two halves and were analyzed for the entire pre-test and the entire post-test sections. The results obtained from the Sustained Attention to Response Task were different. The fast frequency and slow frequency variability data had non-normal distribution. Hence, the Mann-Whitney U-test was used to measure differences between fast and slow frequency variability for the two groups. Also, researchers employed Friedman’s analysis of variance to measure differences in performance among the same group’s participants. The mean response time and the standard deviation to response time were analyzed by analysis of variance and the pairwise adjusted Bonferroni comparison, as the data obtained from the experiment had a normal distribution.

The mean response time comparison among the two groups suggested that there was not a significant difference. This result confirmed that members of one group were not inherently quicker in reacting to numbers when they appeared on the screen [F (1,164) = 0.10, p = 0.759]; therefore, it made it possible to compare the results obtained from the participants in the two groups (Johnson et al., 2007).

The results of the experiment revealed that overall, all participants responded faster in the post-test as compared to the pre-test [F = (1, 164) = 5.33, p = 0.021, r = 0.19]. They also responded faster in the second half of the pre-test and second half of the post-test in comparison with the first half of the pre-test and the first half of the post-test, respectively [F = (1,164) = 14.88, p<0.001, r = 0.35] (Lee et al., 2015, p. 182-189). This response speed difference can be associated with the experience the participants had from the pre-test (Lee et al., 2015).

The results of this experiment demonstrated that the fast frequency variability declined over the course of the experiment. Researchers observed this decline solely among those who walked through the
lobby with no vegetation [Lobby with no vegetation, $x^2(3)= 29.05$, $p< 0.001$; Lobby with vegetation, $x^2(3)= 2.11$, $p= 0.533$]. The results also, as illustrated in Figure 4., revealed have more significant fast frequency variability between the two halves of the post-test in comparison with the two halves of the pre-test [$z= -1.75$, $p= 0.034$, $r= -0.14$]. Moreover, there was neither a significant difference between the members of the two groups’ fast frequency variability for the two halves of the pre-test [1st half, $U= 2450$, $p= 0.376$, $r= -0.03$, 2nd half, $U= 2322$, $p= 0.165$, $r= -0.08$] nor the first half of the post-test. On the contrary, there was a significant fast frequency variability difference in the second half of the post-test between the members of the two groups, as it is marked by the asterisk in Figure 4. Results indicated that after the VR experience in the lobby without vegetation, participants’ attention control was significantly less than that of participants in the other group [$U= 1989$, $p= 0.013$, $r= 0.18$].

Results from the sustained attention to response task verified no significant difference between the members of the two groups’ attention level prior to walking through one of the two lobbies [$U= 2231$, $p= 0.148$, $r= -0.12$]. After physically walking through the VR lobby the participants who encountered the vegetation during the experience demonstrated significantly lower slow frequency variability compared to those who experienced the lobby with no vegetation [$U= 1971$, $p= 0.008$, $r= -0.21$]. Also, no significant changes were observed in the slow frequency variability among the participants of each group [Lobby with vegetation, $z= -1.37$, $p= 0.090$, $r= -0.09$, Lobby without vegetation, $z= -0.74$, $p= 0.232$, $r= -0.05$].

An analysis of the standard deviation revealed a more consistent response time pattern from, individuals who experience the lobby with natural green elements, see Table 1. The results indicated that a higher level of sustained attention was maintained by the individuals in that group $F (1, 164) = 12.56$, $p < .001$. Data also recorded no significant difference in the baseline for individuals in two groups $F (1, 164) = 0.00$, $p= 0.939$, $r= 0.00$.

There was a significant difference in the performance of individuals after experiencing different lobby versions $F (1, 164)= 5.44$, $p= 0.031$, $r= 0.18$. As reflected in Figure 5. Individuals who experienced the lobby with vegetation demonstrated less variability in response time $F (1, 164) = 5.00$, $p= 0.023$, $r= 0.18$. A significant response time variability increase was seen with participants in the group that experienced the lobby with no vegetation $F (1, 164) = 7.59$, $p= 0.007$, $r= 0.27$. The response time variabilities measured for both halves of the pre-test and both half of the post-test demonstrated that both groups’ response time variability was lower on the first half of the pre-test as compared to the second half of the pre-test. Similar interpretation was valid for the first half of the post-test compared to the second half of the post-test $F (1,164) = 4.57$, $p= 0.041$.

![Figure 5. Boxplot of the median and variance of slow frequency changes in response variability.](image)

Results for performance at pre-test and post-test obtained from participants who experienced the lobby without natural/green elements (black boxes) and the lobby with natural/green elements (white boxes). The asterisk indicates a significant difference between participants who walked through the lobby with natural/green elements compared to those who experienced the lobby with no natural/green elements at post-test ($p= 0.008$). No meaningful difference was observed at pre-test ($p= 0.143$).
Table 1. The Mean (M) ± Standard Error (SE) for Response Time and Standard Deviation of Response Time provided in Seconds. Median (M.E.) and Interquartile Range (IQR) are Presented for the fast frequency and slow frequency variability on the sustained attention to response task SART test in power.

<table>
<thead>
<tr>
<th></th>
<th>Pre-Test</th>
<th>Post-Test</th>
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<tbody>
<tr>
<td></td>
<td>1st Half</td>
<td>2nd Half</td>
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<tr>
<td></td>
<td>M.E.</td>
<td>IQR</td>
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<tr>
<td>Lobby with Natural Elements</td>
<td>95.20</td>
<td>4.33</td>
</tr>
<tr>
<td>Lobby without Natural Elements</td>
<td>92.48</td>
<td>3.76</td>
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<tr>
<td>Fast frequency variability</td>
<td></td>
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<tr>
<td>Lobby with Natural Elements</td>
<td>127,886</td>
<td>121,693</td>
</tr>
<tr>
<td>Lobby without Natural Elements</td>
<td>131,684</td>
<td>124,522</td>
</tr>
<tr>
<td>Slow frequency variability</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lobby with Natural Elements</td>
<td>137,116</td>
<td>168,14</td>
</tr>
<tr>
<td>Lobby without Natural Elements</td>
<td>151,11</td>
<td>262,2</td>
</tr>
</tbody>
</table>

The data collected from the PRS had a standard distribution and did not include any outliers (≥2.85SD). The t-test was used to compare the PRS scale findings between the two groups. The PRS Data demonstrated no significant difference in the perception of the two groups' participants of the two different lobbies’ restorative quality introduced by Kaplan and Kaplan in 1989. According to ART, researchers expected to observe that participants who walked through the lobby with vegetation find that lobby significantly more restorative compared to the participants in the other group. The lobby with natural green elements (M=3.46, S.E.=0.10) and the lobby with no natural green elements (M= 3.13, S.E.= 0.12) were not perceived significantly different among participants in terms of their restorative quality (t (164)= -3.48, p= 0.061).

6 CONCLUSIONS

It has been revealed through the data that micro visual interaction with natural green elements in a residential building has the potential to have a significant positive impact on the sustained-attention level of those who walk through that lobby.

Many studies have used perceptual impacts to evaluate the effect of interacting with natural green elements on people’s attention levels. Other studies have utilized cognitive tasks to measure that effect. Both methods are widely used in research related to attention restoration. Despite the abundant usage of the two methods, what seems to be neglected is that encounters with an environment impact peoples’ perception and cognition simultaneously. So, measuring one impact without measuring the other may not provide a comprehensive perspective on the consequences and eliminates the benefits gained from triangulation of results.

The outcomes of this research demonstrated that physically walking through a VR representation of the lobby with vegetation had no significant impact on the participants’ perception of the lobby's restorative characteristics, as measured by the (PSR) questionnaire. On the other hand, participants’ cognitive performance significantly improved after experiencing the lobby with vegetation. These unparalleled results reinforce the idea that different criteria, perception of the restorative quality of the space and the cognitive performance after experiencing the space, that researchers utilize to measure an environment's impact on peoples' attention restoration do not necessarily support each other. Therefore, these two measures should be considered competing factors and how restorative quality of an environment is measured may need to be reevaluated.

These results also underscore the necessity of a more holistic approach that brings together all the factors that influence an environment's restorative effect on individuals' attention level and reinforces the Importance of using multiple measurement methods that then allow for triangulation.
7 DISCUSSION

The outcomes of this experiment can be divided into two contradictory findings. The first finding demonstrated that walking through a lobby that utilized vegetation in its design significantly impacted a participant’s cognitive performance, as measured by the Sustained Attention to Response Task. Those who experience the lobby with vegetation had significantly lower fast frequency and slow frequency response time variability than those who experienced the lobby with no vegetation. These results were in line with the previous studies that suggest that spending time in nature has a positive effect on an individual’s attention level (Berto, 2005; Kaplan & Kaplan, 1989).

The second finding revealed that walking through the lobby with vegetation evoked no meaningful increase in participants positive perception of the space regarding the four aspects considered by Attention Restoration Theory for environments with restorative capabilities. These outcomes contradicted the outcomes of the former studies that suggest visual interaction with nature has positive impacts on peoples’ perception as measured by these four restorative characteristics of the space (Abbott et al., 2016, Warm et al., 2008, Kaplan & Kaplan, 1989).

Previous studies on attention restoration demonstrated that visual access to nature for a minimum of a few minutes to hours and days could significantly enhance an individual’s attention level (Berto, 2005, Bratman et al., 2015). This study expands on previous studies by suggesting that the positive effects that occur through visual interaction with complex natural environments can also occur through interaction with a limited amount of vegetation for less than a minute.

The researchers utilized a virtual reality environment to help minimize the impact that mediating variables such as noise, room temperature, lighting, and more could have on the results (Saedi & Rice, 2021). VR environments have been demonstrated to produce physiological and psychological responses similar to those produced by actual environments. Moreover, it is expected that under the same conditions the impact of interaction with vegetations in physical environments are more pronounced than interaction with vegetation in VR environments (Bailenson, 2018; Banfi et al., 2018). One concern was that VR environments, though they can produce similar responses, tend to have less of an impact on participant and therefore may not reveal significant differences. However, the VR research environment was able to produce significant differences in cognitive function. It can be argued that, if this research was to take place in a physical environment the recorded differences could be even more prominent.

Although this research did not focus on the characteristic of the virtual experience, the outcomes of this research expanded the tools used to explore the impact on attention restoration from still images (Laumann et al., 2003), videos (Wang et al., 2016; Pilotti et al., 2015), and 360-degree images (Chung et al., 2018; Moreno et al., 2018) to the interactive virtual reality domain.

There are a few aspects that this research did not probe deeply that are worth exploring in the future. First, this research focused on exploring the possible impact on an individuals’ attention level when visually interacting with vegetation in an indoor setting. What this research did not explore was how long a significant effect remains with the participants.

Second, vegetation has different characteristics, such as color and height. Each of these characteristics might impact an individual’s attention. In this study, researchers did not focus on a specific type of vegetation or its characteristics but used the rendering software options. Now that the significant impact of interaction with vegetations on attention level has been detected subsequent studies can explore the role of vegetation and its design characteristics in the restoration process. These proposed studies may more directly contribute to design and planning suggestions.

Finally, this research measured the perceptual and cognitive impact of interaction with vegetation in an indoor setting on participants’ attention level. There might be other psychological processes that need to be considered in evaluating the ultimate impact.

8 REFERENCES


LANDSCAPE PERFORMANCE

Edited by Taner R. Özdil, & Jessica Canfield
THE EMERGENCE OF THE SITES RATING SYSTEM FOR ENHANCING PUBLIC PLACES

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1 ABSTRACT
This paper addresses the results of the Sustainable SITES Initiative, which created the SITES rating system and its emergence as a tool for landscape governance. The method used is reflective analysis from two individuals intimately involved in the design of a distinctive rating system specifically geared toward landscapes and other outdoor spaces. The purpose is to create more understanding of the process of developing the SITES system to demonstrate its interdisciplinary nature and extensive research. A key finding is that the SITES rating system is proving valuable for landscape governance. SITES’ contribution to landscape governance is important because it empowers landscape and site design in the development decision-making process, ensuring that essential ecosystem services are protected and restored in our communities. This paper first reviews the history of the design of the SITES rating system. Several examples of how it is being used by federal, state, and local agencies and entities follow, including the U.S General Services Administration, Arizona State University, and the Atlanta BeltLine in Georgia. The paper concludes with prospects about the future applications of SITES in ensuring development projects strive to protect and restore ecosystem services, foster resilience and improve the overall quality of life. SITES elevates the value of sustainable landscapes in development projects (with or without buildings) and in concert, also highlights the importance of landscape architecture in such work.

1.1 Keywords:
Sustainable sites, ecosystem services, site design, landscape governance, resilience

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2 INTRODUCTION

A landscape is a synthesis of the cultural and natural processes of a place. What we build on the land profoundly affects ecological systems as well as the health, safety, and welfare of human communities (Lady Bird Johnson Wildflower Center et al., 2014a). Any landscape can hold the possibility to both improve and regenerate the natural benefits and services of ecosystems. As such, landscapes provide a suitable framework for governance that promotes sustainability, resilience, health, and equity.

The SITES program at GBCI describes sustainable landscapes as appreciating in value, in contrast to buildings that typically depreciate over time, by continuing to provide many benefits, such as stormwater management, carbon sequestration, less energy use, air and water pollution reduction, habitat protection, and improvements to human health and well-being (GBCI, 2021a). Whether the site is a city park, a university campus, an urban plaza, a cemetery, a schoolyard, or a corporate office, landscapes can be ecologically resilient places that are better equipped to withstand and recover from episodic floods, hurricanes, wildfires, droughts, and other catastrophic events, thus protecting property and people. Landscapes can also be designed to reduce long-term maintenance costs and improve the overall quality of life.

In the early 2000s, several well-established sustainable design interest groups with overlapping agendas were engaged in parallel discussions. The U.S. Green Building Council’s (USGBC) Leadership in Energy and Environmental Design (LEED) rating system was measurably changing the building industry in being accountable to specific criteria and metrics that defined sustainable building design and construction. Environmental and landscape-oriented organizations were impressed but felt something was missing and undervalued. This was strongly supported in the 2009 report – The Case for Sustainable Landscapes: “The impetus for creating the guidelines came from the recognition that although buildings have national standards for ‘green’ construction, little existed for the space beyond the building skin. Modeled after the LEED® Green Building Rating System™ of the USGBC, the Initiative’s rating system gives credits for the sustainable use of water, the conservation of soils, wise choices of vegetation and materials, and design that supports human health and well-being” (ASLA et al., 2009a, p.5). LEED was wonderfully sophisticated about inside-the-building systems metrics but less so outside the building envelope. For building sites, early LEED suggested the use of native plants and the conservation of water, for example—both worthy objectives but not as thoroughly developed as the building standards.

The American Society of Landscape Architects (ASLA) and the Lady Bird Johnson Wildflower Center (LBJWC) were engaged in these discussions. In 2004, they convened a gathering in Austin, Texas, to explore creating a LEED-like rating system for the landscapes (Steiner, 2011; ASLA et al., 2009b). The event attracted several allied organizations, including the U.S. General Services Administration (GSA), the U.S. Environmental Protection Agency (EPA), and USGBC. The participants committed to developing a new site-scale rating system in cooperation with USGBC, which could be integrated into LEED or used in tandem with it and could also function to assess sustainability for places without buildings.

The Sustainable SITES Initiative was launched soon afterward in 2006, with the U.S. Botanic Garden (USBG) joining the LBJWC and ASLA in leading the effort. Over the subsequent eight years, this core team, with many collaborators, developed the SITES rating system. In 2015, the LBJWC and ASLA transferred the ownership of SITES to GBCI, which oversees LEED and other environmental rating systems. Since then, agencies and entities have adopted SITES in the United States at the federal, state, and local levels. While the use of SITES by private and non-profit groups is certainly important, the adoption of SITES by public entities and agencies at various levels is noteworthy as an indicator of the system’s utility and promise.

SITES was established on the understanding that landscapes are an integral part of the built environment and can be designed and maintained to avoid, mitigate, and even reverse the frequently deleterious impacts of development (Lady Bird Johnson Wildflower Center et al., 2014b; Calkins, 2012; Venhaus, 2012; Pieranunzi et al., 2017). Its adoption by private and public entities in North America and beyond indicates the appeal and need for the rating system and the growing understanding that outdoor spaces can profoundly impact our communities and the environment, in addition to buildings. However, SITES is still relatively new in the market. Additionally, as it is designed for projects undergoing new construction or major renovation, further research is needed to assess how and to what extent more sustainably designed landscapes contribute to providing ecosystem services for the development project and the surrounding community.
This paper first traces the evolution of the Sustainable SITES Initiative that resulted in the SITES rating system. Second, it highlights how SITES is being adopted and employed by agencies and entities at the local, state, and federal levels in the United States.

3 A REFLECTIVE HISTORY OF THE SUSTAINABLE SITES INITIATIVE

The Sustainable SITES Initiative began in 2006 to create a rating system for landscapes like the USGBC’s highly successful LEED system for buildings. Although begun in the United States, LEED has also had broad international appeal and use. In its early days, LEED paid relatively little attention to the site beyond the building envelope. While LEED promoted water conservation and use of native plants, for example, it did not place restrictions that would protect healthy, functional systems like floodplains, wetlands and habitat, pay attention to proper soil protection and restoration, or in creating quality outdoor spaces that improve human health and wellbeing. However, its attention to building systems was much more effective than conventional methods. The SITES effort began with the LBJWC of the University of Texas at Austin, the ASLA, and the USBG, which is administered by the Architect of the Capitol. The joint effort fostered close ties with other organizations and government agencies such as USGBC, the EPA, and the GSA. The SITES program was interdisciplinary, involving landscape architects, civil engineers, policymakers, ecologists, botanists, soil scientists, planners, and other environmental and social scientists.

In comparison to other rating systems grounded in industry best practices, SITES from its origins was rooted in science. The ecosystem services concept was used to guide the development of a LEED-like rating system for the outdoors (Windhager et al., 2010; Steiner, 2011). The Wildflower Center staff was the glue that held the initiative together, managing day-to-day operations for the SITES program. The Wildflower Center’s leadership was essential as some interested parties pushed back against using ecosystem services as going “too far” and advocating a lower bar of best practices instead. Meanwhile, ASLA reached a wider landscape architecture community and included leading landscape architects from Mithun, Andropogon, OLIN, and other firms to develop the tool. At the same time, USBG provided steady and essential support to keep SITES moving forward.

Beginning in 2006, a SITES steering committee was formed to guide the development of the program and the rating system. In addition to the founding organizations (LBJWC, USBG, ASLA), the committee included a diverse group of interested parties, including the EPA, the National Recreation and Park Association, the American Society of Civil Engineers, leading national landscape architecture firms, USGBC, and others. Drawing from the success of the LEED program and other green development tools, the committee adopted a similarly rigorous approach in creating performance-based benchmarks. Technical subcommittees were then established that included a committed group of more than 60 recognized experts from across the country (academics, scientists, design practitioners, and policymakers) in five critical areas: soil, vegetation, water, materials, and human health and well-being. The subcommittees were charged with examining and synthesizing the best available science and practices to establish rigorous and comprehensive guidelines and metrics for site planning, design, construction, operations, and maintenance practices.

The SITES Rating System was designed to create clear and practical benchmarks for landscape performance to advance professional practice and transform the market. Rather than simply rewarding projects for compliance with certain prescriptive measures or incorporating a list of desirable features, the system emphasizes measurable performance outcomes and the conservation and enhancement of ecological services and natural functions. Early on, its designers realized that measures and systems for soils, plants, hydrology, and materials vary widely from place to place, so relevant credits focus on regional or local references. In particular, SITES highlights the importance of soil in development projects. It serves as the foundation for robust vegetation, helping to filter pollutants and prevent excess runoff, erosion, sedimentation, and flooding. In SITES, healthy soil and proper topsoil management is a design element and construction priority. The system also pays attention to how outdoor spaces are designed and built for a healthy human habitat — to improve mental and physical wellbeing, strengthen social cohesion, and support social equity. Green infrastructure is promoted throughout the rating system, while resilience and regenerative design are also inherent in SITES credits. Many credits also address how the project can reduce carbon emissions and increase the project’s carbon sequestration potential. The rating system is vast, covering various strategies and criteria to ensure a site-specific, high-performance landscape. SITES sought feedback from the general public throughout the development process that was received informally
and systematically and through three formal public comment periods. Transparency was critical to ensuring the system received diverse input from a wider audience.

Drawing from a rich history of design and environmental theory, in 2007, the SITES committee adopted the following principles to guide the development of the program and clarify the elements of creating a sustainable project.

### 3.1 SITES Guiding Principles

The following SITES Guiding Principles were developed by the original founding partners and associated technical committees. These principles informed the development of specific and measurable criteria for site sustainability, and can also be applied to the land design and development process (GBCI, 2021).

1. **Do no harm.**
   Make no changes to the site that will degrade the surrounding environment. Promote projects on sites where previous disturbance or development presents an opportunity to regenerate ecosystem services through sustainable design.

2. **Adopt the precautionary principle.**
   Be cautious in making decisions that could create risk to human and environmental health. Some actions can cause irreversible damage. Examine a full range of alternatives—including no action—by being open to contributions from all potentially affected parties.

3. **Design with nature and culture.**
   Create and implement designs that are responsive to economic, environmental, and cultural conditions with respect to the local, regional, and global context.

4. **Use a decision-making hierarchy of preservation, conservation, and regeneration.**
   Maximize and mimic the benefits of ecosystem services by preserving existing environmental features, conserving resources in a sustainable manner, and regenerating lost or damage ecosystem services.

5. **Provide regenerative systems as intergenerational equity.**
   Provide future generations with a sustainable environment supported by regenerative systems and endowed with regenerative resources.

6. **Support a living process.**
   Continuously re-evaluate assumptions and values and adapt to demographic and environmental change.

7. **Use a systems thinking approach.**
   Understand and value the relationships in an ecosystem and use an approach that reflects and sustains ecosystem services and re-establishes the integral and essential relationship between natural processes and human activity.

8. **Use a collaborative and ethical approach.**
   Encourage direct and open communication among colleagues, clients, manufacturers, and users to link long-term sustainability with ethical responsibility.

9. **Maintain integrity in leadership and research.**
   Implement transparent and participatory leadership, developing research with technical rigor, and communicate new findings in a clear, consistent, and timely manner.

10. **Foster environmental stewardship.**
    In all aspects of land development and management, foster an ethic of environmental stewardship—an understanding that responsible management of healthy ecosystems improves the quality of life for present and future generations.
3.2 Credits to Protect and Restore Ecosystem Services

Typical development processes often attach minimal importance to landscape design issues and consider them only at the end of project planning and even development. In contrast, SITES moves these critical considerations to the forefront of decision-making and project planning to facilitate integrated building and landscape design. The integrative design process (a SITES prerequisite) is the foundation needed for a team to optimize site performance—by identifying and executing synergistic opportunities across different disciplines throughout all phases of design and construction. As stated in the SITES v2 Rating System, innovative solutions are more likely to emerge when experts from several disciplines pool their talents and expertise (Lady Bird Johnson Wildflower Center et al., 2014a). Sustainable goals and practices are easier and often less expensive to achieve when different perspectives are brought to bear on common goals. Thus, in order to change the outcome or performance of a project, the process for getting there must also change. In other words, SITES is not solely a certification system; it is a mechanism for advocacy and education to the public and professional practice. It is a means to elevate the awareness and value of landscapes (and ecosystem services) in our society and design accordingly. The central message of SITES is that any development project—commercial sites, parks, residential landscapes, public gardens, academic campuses, roadsides, cemeteries, and more—has the capacity to protect and regenerate ecosystem services.

Ecologist Gretchen Daily, professor of environmental science at Stanford University and author of Nature’s Services: Societal Dependence on Natural Ecosystems (Island Press, 1997), provided this definition: “Ecosystem services are the conditions and processes through which natural ecosystems, and the species that make them up, sustain and fulfill human life. They maintain biodiversity and the production of ecosystem goods, such as seafood, forage, timber, biomass fuels, natural fiber, and many pharmaceuticals, industrial products, and their precursors” (Daily, 1997, p. 3). The conception of ecosystem services and the implementation of the concept have advanced in the early 21st Century and by scholars and practitioners alike around the world (BenDor et al., 2017; Woodruff and BenDor, 2016; Xiang, 2017; La Rosa, 2019; Hagemann et al., 2020). Daily’s original definition has been expanded to include the ecosystem services of designed landscapes in addition to built ones. Employing an ecosystem services framework, the SITES rating system offers an alternative and more effective approach to conventional site-design practices (Pieranunzi et al., 2017).

Resource economists have adopted the term ecosystem services to describe those benefits that the natural environment provides to humans for free. Humans would have to find ways to replace them if the natural environment ceased to provide them. These services, essential for our daily life, include but are not limited to filtering air pollutants; controlling erosion; maintaining fishable, swimmable, and drinkable water; regulating climate; cycling nutrients and waste; and supporting tourism and recreation. In 2011, the value of global ecosystem services was estimated to be approximately $125 trillion/year, about three times the global gross domestic product (Constanza et al., 2014). An in-depth 2017 analysis assessing urban tree cover and its impact on residential building energy use in the contiguous United States estimates a reduction of 38.8 million MWh or $4.7 billion in electricity use and 246 MMBtus or $3.9 billion in heating use annually. The estimated collective reduction in national residential energy use attributable to trees is 7.2% (Nowak et al., 2017).

An accurate assessment of the cost and value of a significant project should include a full accounting of the project’s diminishment or enhancement of ecosystem services. Planned landscapes and green infrastructure can protect and even regenerate natural systems. Measuring or estimating the value of ecosystem services and natural capital provided on a project site before and after construction can inform a more thorough understanding and estimate of a project’s value and its impacts on associated communities, economies, and natural systems in the short and long term. For example, when wetlands are lost to development, new and costly levees, pipes, and pollution-control technology must often be constructed to perform the functions those wetlands previously provided naturally. Such functions may include storm surge protection, flooding control, and water filtration and provide additional benefits such as wildlife habitat, which may also contribute to recreation and tourism. In contrast, front-end planning and design that protects or enhances these natural functions can benefit the environment, property owners, and local and regional communities and economies by reducing the real costs of maintaining and replacing them.

At the launch of the 2009 rating system, the National Recreation Park Association’s former chief public policy officer and SITES Steering Committee member Rich Dolesh announced: “The new system
has potential to make a large impact on local and regional parks throughout the country. Many park planners, landscape architects and park administrators have told us that they’ve always felt there is a lack of an equivalent system for landscapes to the LEED (Leadership in Energy and Environmental Design) rating system, the international standard for green building, and thus there was no way to receive credit for exemplary practices” (NARRP, 2010).

The initial 2009 rating system (i.e., SITES “v1”) was used by practitioners in 162 pilot projects (from the over 300 who expressed an interest) to assess the effectiveness of the system and to refine it. Most of these projects were in the United States, but projects in Canada, Spain, and Iceland participated too, an indicator of international interest which continues. Field testing the draft rating system was essential to understanding how it worked on the ground with various project types, sizes and contexts, and where refinement was needed in the rating system. That work resulted in a second iteration of the rating system, called SITES v2 (Lady Bird Johnson Wildflower Center et al., 2014a).

3.3 Launching the SITES v2 Rating System

The SITES v2 Rating System is directed toward new construction or major renovation of existing sites, as with the previous version. The rating system is designed for any site, whether urban, suburban, or rural, which will be protected and developed for public or private purposes. Although SITES is available for use by greenfield, greyfield, and brownfield sites, it strongly encourages the redevelopment of degraded sites through its credit system to restore ecosystem services where they have been lost or degraded.

The organization of the rating system generally corresponds to the typical project design and development phases. The SITES v2 certification levels (Certified, Silver, Gold, and Platinum) mirror LEED certification nomenclature and replace the one to four-star recognition used in the pilot program. The entry point for certification (meeting the prerequisites) and the four certification levels were re-evaluated and refined in SITES v2 to encourage broad participation while at the same time raising the bar for site sustainability. The rating system includes 10 sections that cover various stages of the design and development process. SITES v2 assigns value to each of the 48 credits based on a credit’s relative impact on improving sustainability and protecting and restoring ecosystem services. Projects receive SITES certification by fulfilling minimum requirements (i.e., prerequisites) as well as achieving specified numbers of points for different levels of performance. Bonus points are awarded for innovative and exemplary performance outside the 200-point system. The value or number of points assigned to each credit is based on its potential effectiveness in meeting the four goals outlined below.

SITES Goals

1. Create regenerative systems and foster resiliency
   - Protect and restore natural resources such as soil, water, and vegetation.
   - Protect and restore biodiversity.
   - Enhance landscapes to provide multiple ecosystem services such as cleaning air and water, providing habitat, and storing carbon.
   - Mitigate for evolving hazards and natural disasters.
   - Plan for monitoring and adaptive management.

2. Ensure future resource supply and mitigate climate change
   - Minimize energy consumption and encourage use of low carbon and renewable energy sources.
   - Minimize or eliminate greenhouse gas emissions, heavy metals, chemicals, and other pollutants.
   - Reduce, reuse, recycle, and upcycle materials and resources.
   - Conserve water.
   - Increase the capacity of carbon sinks through re-vegetation.

3. Transform the market through design, development, and maintenance practices
   - Foster leadership in industry and professional practice.
   - Use a systems-thinking, integrative and collaborative design approach.
   - Use lifecycle analyses to inform the design process.
   - Support local economies and sustainability policies.

4. Enhance human well-being and strengthen community
   - Reconnect humans to nature.
   - Improve human health (physical, mental, and spiritual)
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- Foster stewardship by providing education that promotes the understanding of natural systems and recognizes the value of landscapes.
- Encourage cultural integrity and promote regional identity.
- Provide opportunities for community involvement and advocacy (Lady Bird Johnson Wildflower Center et al., 2014a, 2014b).

The ecosystem services addressed in the SITES v2 Rating System are linked to specific actions outlined in the 18 prerequisites and 48 credits. They include reduction of greenhouse gas emissions, filtration of air and water pollutants, water conservation, erosion and sediment control, hazard mitigation, conservation and restoration of pollinator and other habitat functions, waste decomposition and treatment, support for food production, enhancements to human health and well-being, among others. Also fundamental to SITES is the concept of resilience, defined as the capacity for a system to survive, adapt, and flourish in the face of turbulent change (Fiksel, 2006). While healthy natural systems tend to be inherently resilient, many constructed systems are poorly designed and on "life support," needing supplemental irrigation and fertilizer to thrive and regular mowing during the maintenance phase. They are typically not designing with nature. This lack of attention to nature, in turn, creates an unhealthy landscape that serves as a carbon release rather than a carbon sink. Aside from consuming scarce resources and contributing to pollution, these landscapes are often vulnerable to natural and man-made disruptions.

The goal of promoting resilience is embedded throughout the SITES v2 Rating System; for example, it requires the conservation of critical, functioning natural features (e.g., wetland, floodplains) and rewards ecological restoration of degraded areas. SITES guides projects to create a healthy, functioning, and biodiverse system that can respond, adapt, and recover quickly to a changing climate and other disturbances. This goal was tested recently with a SITES certified project on the coast of Alabama. Gulf State Park Lodge -- a Hilton Hotel in Gulf Shores, Alabama — set out to create an international benchmark of economic and environmental sustainability, demonstrating best practices in the design and operation of facilities in the hospitality sector (The Sustainable SITES Initiative, 2019a; Sasaki, 2018). A traditional hotel landscape mostly serves as "decoration" and requires a significant amount of water, energy, and chemical pesticides and fertilizers to maintain. In contrast, the Gulf State Park Lodge landscape provides habitat for wildlife, buffers the buildings from future storm surges, and naturally filters and absorbs stormwater through wetlands and swales. In short, it was designed to optimize all those services that intact ecosystems inherently provide while also creating a beautiful vacation setting for guests.

The original Lodge at Gulf State Park was located close to the water, directly on top of the primary dunes. Unfortunately, the lodge and the dune system were wiped out by Hurricane Ivan in 2004. In 2010, the British Petroleum (B.P.) Deep Water Horizon disaster flooded the Gulf of Mexico with oil, and tar balls filled the beaches as tourists fled. On September 15, 2020, on the 16th anniversary of Hurricane Ivan’s landfall, Hurricane Sally subjected Gulf State Park to over 12 hours of category 2-3 winds, rain, and storm surge. The new resilient design of the Lodge allowed it to serve as a shelter in the storm for park employees, reporters and recovery teams and resulted in minimal damage. According to Rebecca Dunn Bryant, Principal Architect at Watershed, LLC (sustainability consultant on the project who worked closely with Sasaki Associates), “After the B.P. oil spill disaster, our region had a hard reckoning with the reality that our economy and environment are mutually dependent. People’s lives were deeply affected by the economic devastation of the oil spill, resulting from the environmental devastation. This project was funded by B.P. settlement funds, and SITES helped us to demonstrate that best practices in restoration and conservation support a healthy economy (Figure 1). People protect what they love, and this project will help more people fall in love with Alabama’s Gulf Coast” (The Sustainable SITES Initiative, 2019a).

SITES projects are designed to protect and give back to nature, enhancing and creating ecosystem services that benefit site users and typically those beyond a project’s official “boundary” promoting social equity. In fact, one of SITES Guiding Principles is to “provide regenerative systems as intergenerational equity” (Lady Bird Johnson Wildflower Center et al., 2014a; GBCI, 2021b). In the SITES Rating System, this can translate into protecting any existing site features that are critical, healthy, rare, or sensitive — that provide necessary functions and important resources from floodplains to historical and cultural landscapes. For degraded sites, SITES credits promote ecological restoration and enhance community resilience and vitality. To ensure projects respect and meet community needs, SITES asks projects to engage with the site users, interested parties, and the community in a meaningful and transparent manner before the design is finalized. Subsequent credits in the rating system are in place to support the designs, amenities, and programming that meet the needs of all site users. Additionally, SITES promotes hiring and purchasing
strategies during construction, ones that provide living wages and training and support local businesses. SITES takes a long view of any development project as an investment in our communities, the environment, and our collective future. This may result in more additional project costs in the short run but yield more benefits over time. In many cases, savings are recognized upfront with the input and experience from an interdisciplinary team. “SITES makes you think through the site before you begin to design. It forces you to use a quantifiable framework that creates learning opportunities,” explains Bryan Astheimer from Revision Architecture, who has consulted on three SITES projects so far. "Challenges create growth and ultimately value...I believe that SITES will drive the industry to become more sustainable and transparent" (Green, 2016).

After the release of v2 in 2014, GBCI expressed an interest in acquiring SITES from the LBJWC and ASLA. The SITES original collaborative had worked closely with USGBC and GBCI since the beginning of the process, and elements of SITES had already been incorporated into LEED. GBCI now manages the SITES program, which includes overseeing the certification of projects, the accreditation of professionals (SITES Accredited Professionals or SITES APs) and the evolution and further development of SITES in general. As of July 2021, over 200 projects and more than 744 million gross square feet of outdoor space have registered or certified with SITES, covering 38 U.S. states and Washington, DC and 16 countries. While most of the 76 projects that have been certified as of July 2021 are in the United States, projects in Canada, China, and Japan have also achieved SITES certification, with two projects in Brazil that have achieved SITES precertification. Formally launched in early 2020, precertification recognizes and rewards projects earlier in their planning phase. As of July 2021, eleven projects have also been precertified, mostly in China and Japan. Additionally, one of the largest superfund sites in the U.S. in Butte Montana (approximately 200 acres, 81 hectares) has also achieved precertification. Expanding SITES global presence, the first SITES projects in Uruguay, Spain, Italy, and Saudi Arabia registered in 2020.

The SITES program reviewed in the following section of this paper also illustrates how practice can inform socio-ecological theory advocated by Wei-Ning Xiang (2020). As ecological theory guided the Sustainable SITES Initiative, reflective experiences with the SITES rating system will contribute to our understanding of ecosystem services. For instance, ecosystem services are viewed as those benefits that nature provides to humans at generally no cost. We do not pay for the air we breathe, for example. Instead, we take from nature, often with little thought about what we destroy or diminish in the process. Gretchen Daily and Pamela Matson stress that ecosystem services need to move from theory to implementation. They note that a radical "transformation will be required to move from conceptual frameworks and theory to practical integration of ecosystem services into decision-making, in a way that is credible, replicable, scalable, and sustainable" (Daily and Matson, 2008, p. 9456). SITES offers a tool for such transformation.

4 LANDSCAPE GOVERNANCE AND SITES

The advantages of SITES include its credibility, replicability, and scalability, and it has inspired SITES use in public projects to guide and verify design decisions toward sustainable outcomes. It also ensures government funds are spent wisely and with the goal of benefitting the community for the long term. These practical applications in landscape governance help inform socio-ecological design practice and theory.

How landscapes are governed contributes to this resiliency potential. De Graaf and colleagues explain: "Landscape governance relates to how various interests in the landscape are balanced in decision-making and how the rules stimulate the sustainable management of the landscape resources" (2017, p.1). Drawing on Kozar et al. (2014), they note that “landscape governance is inherently multi-level, multi-sector, and multi-actor in nature” (De Graaf et al., 2017, p. 5).

During and after the release of the SITES v2 Rating System, governments in the United States began to adapt and to adopt SITES. The first was the New York City Department of Parks & Recreation in 2010. The GSA followed the New York parks department in 2016 and the Atlanta BeltLine in 2018. These examples help illustrate the potential for using SITES in landscape governance and the growing relevance of such systems. Meanwhile, Chicago, Illinois, requires SITES Certification in Section 4.4 of its Sustainable Development Policy Handbook. In Austin, Texas, its Green Building Policy is updated for city council approval to require SITES Certification for projects over $2 million. In addition, the governor of Arizona issued an executive order in 2005 mandating that all state landscape projects pursue LEED Certification. As a result of the executive order, Arizona State University (ASU) adopted this mandate in its Sustainable
Design Guidelines yet expanded it to include SITES. In December 2020, the Orange Mall Green Infrastructure project became the first SITES v2 certified project at ASU, demonstrating this commitment to the University’s overall sustainability goals.

These efforts are noteworthy, in part, because they represent the three principal layers of public agencies and entities in the U.S. system: federal (national), state, and local. This paper focuses on the use of SITES in the United States because that was where the system was developed. The efforts in New York City, the GSA, Arizona, and Atlanta are summarized in more detail below (See also, Steiner, 2020.)

4.1 New York City Parks

As the SITES developers were in the pilot project stage, the New York City Department of Parks & Recreation adapted the system for its new landscape guidelines (Design Trust for Public Space and the City of New York, 2010). Under the leadership of Mayor Michael Bloomberg and Parks Commissioner Adrian Benepe, the city and the Design Trust for Public Space assembled municipal staff, park advocates, and designers to create a blueprint for designing, building, and maintaining the city’s 29,000 acres (11,736 hectares) of parks and open space. It was one measure to help implement the city’s 2007 plan, PlaNYC, and part of the mayor’s strategy to significantly expand parks and open space throughout the city. The resulting High Performance Landscape Guidelines: 21st Century Parks for NYC (Design Trust for Public Space and City of New York, 2010; Bloomberg, 2020; see also Carlisle and Pevzner, 2012) was closely aligned with SITES as it existed then. This compatibility is stated on the first page of the manual.

The 270-page manual was based on principles about design, ecology, economy, and society. For design, principles were established for engaging all users, integrating nature, and responding to the context of the site. Ecological principles addressed supporting natural functions and increasing diversity and interconnectivity. Resilience and performance were the two economic principles. For society, collaboration and participation, public health, education, and long-term thinking are the key principles. The manual authors presented comprehensive guidelines for sustainable park and open space planning, design, and construction for every new project. The goal was to improve the quality of life for New Yorkers while mitigating the city’s global environmental impact. As a result, clearly drawing on SITES, the manual describes strategies for cleaning the air, absorbing stormwater, reducing the urban heat island, addressing climate change, and providing wildlife habitat. These guidelines have subsequently been employed across the five boroughs of the city in park and open place planning. The Hunts Point Landing (Figure 2) is an example of a certified project in New York City that resulted (The Sustainable SITES Initiative (2019b).

4.2 U.S. General Services Administration Capital Construction Program

The GSA is responsible for supporting the basic functions of federal offices, including buildings and properties across the United States. As a result, the reach of the agency is broad and significant. In 2015-2016, after SITES v2 was published, and as GBCI was assuming leadership for SITES, GSA adopted SITES, with a minimum silver rating, for its capital construction program. This decision was implemented in GSA’s Facilities Standards for the Public Buildings Services (called the P100 document). GSA believed that the agency needed to address sustainability beyond the building envelope, and with SITES’ ecosystem services focus, it was the appropriate tool.

As noted by Christian Gabriel, National Design Director for Landscape Architecture, U.S. General Services Administration, "As a site-focused certification system, SITES is a very useful framework, allowing us to systematically discuss site-related design and construction aspirations and project-level decisions across subject matter experts, project stakeholders, and construction specialists. The SITES system better allows us to bring forward landscape-related project benefits in more measurable terms" (https://www.asla.org/ContentDetail.aspx?id=46393).

P100 establishes design standards and criteria for new buildings, site improvements, infrastructural projects, and historical structures for GSA’s Public Buildings Service (PBS) (U.S. General Services Administration, 2018). The P100 includes both policy and technical criteria for the programming and design of GSA buildings and facilities. PBS provides workspace for 1.1 million federal employees, primarily within courthouses, ports of entry, and federal offices. PBS acts as a proving ground for green technologies, supports sustainable design, and has over 144,000 acres (58,275 hectares) of land, making it among the largest real estate holders in the United States (U.S. General Services Administration, 2018). GSA participated in the SITES pilot program with projects for a federal office building (Florida) and a courthouse (New Mexico), both of which received certification. GSA currently has 14 SITES v2 projects, including ports
of entry, federal courthouses, and other facilities in various stages of development. One such land port of entry in Columbus, New Mexico (Figure 3), was certified in late 2020 under SITES v2 in addition to achieving LEED Platinum.

4.3 Arizona State University

In February 2005, Governor Janet Napolitano issued an executive order requiring LEED Silver Certification for all state buildings Executive Order 2005-05). The Executive Order proclaims: “The State of Arizona Governor’s Executive Order 2005-05 mandates that all new state facilities achieve LEED Silver certification. LEED Silver is the minimum standard for Arizona State University (ASU) new construction and major renovation projects with Platinum certification as the goal. Project teams are to design projects to support achievement of ASU’s Sustainability Goals and Vision (https://cfo.asu.edu/sustainability-goals-and-vision). ASU has pre-determined LEED credits it usually obtains to assist in building design efficiency, as outlined in Section 3: 01 81 13 (https://www.asu.edu/fm/documents/project_guidelines/Project-Guidelines.pdf). Compliance with certain LEED credits and sustainability specifications is required for all projects regardless of whether the project is required to achieve LEED Silver certification. All landscape projects are to pursue qualification for Sustainable SITES certification and seek certification when OUA determines it to be appropriate. All parking garages are to pursue qualification for ParkSmart certification and seek certification when OUA and Parking and Transit Services determine it to be appropriate.” Clearly, ecosystem services, such as those provided by shade and water conservation are vital for Arizona’s future.

This is reflected in the Arizona State University (ASU) sustainable guidelines (“Facilities Development and Management Project Guidelines” (https://www.asu.edu/fm/documents/project_guidelines/Project-Guidelines.pdf). “To address the negative impacts of climate change”, states ASU Project Manager Norman Yatabe, “ASU has committed to leading the world by example and has established a series of sustainability goals which, in essence, permeate all aspects of university life. To meet these goals, ASU’s approach includes advancing sustainable technology and research, converging the university’s mission with its operations, raising awareness of climate change and resource depletion, and learning from the practice of application. Since 2006, ASU has utilized LEED as the measuring stick for sustainable building design,” Yatabe states, “We really see, on the flip side, SITES as that perfect vehicle to help us elevate the significance and role of the landscape in supporting ASU’s sustainability mission” (GBCI, 2021c).

The Orange Mall Expansion (Figures 4 and 5) became the first project certified under the SITES v2 Rating System. Located in the core of ASU’s Tempe Campus, the project replaces a former section of roadway and cul-de-sac with a new pedestrian mall and multi-use plaza for programmed events and informal social gatherings by students, faculty and staff. Developed in concert with the adjacent LEED Platinum and emerging Net Zero Student Pavilion, the project utilizes low impact development (LID) techniques to create an integrated sustainable design solution for both building and site. Connected runnels transfer collected building condensate and stormwater from on-site to a series of planted bio-swales and a rain garden for infiltration and as supplemental irrigation. Excess stormwater flows to a second infiltration gallery for use as groundwater recharge. Students will be actively involved in the on-going monitoring of several site performance factors including stormwater quality and flow rates along with monitoring of space utilization and social interactions. As noted by ASU, this project has strengthened collaboration between academic and operation units of the university to promote sustainable practices in campus landscape design and using campus as a living laboratory integrating research, education, and community outreach, and provides evidence-based design for nature-based solutions applied in hot and arid climate for sustainable and resilient urban environments (https://herbergerinstitute.asu.edu/research/landscape-architecture-foundation-asu-orange-mall-green-infrastructure).

4.4 The Atlanta, Georgia, BeltLine

The Atlanta BeltLine was conceived by Ryan Gravel in his 1999 Georgia Tech thesis. He earned graduate degrees in both architecture and city planning. Gravel’s idea was to create a 22-mile (35 km) loop around the city by converting a ring of abandoned and active freight lines into a system of bike and walking trails, light-rail transit, and parks (Van Mead, 2018). Gravel’s thesis ideas have been pursued by the City of Atlanta since the early 21st Century, with additional multi-use paths extending into neighborhoods, resulting in a total of 33 miles (53 km). (Figures 6 and 7). In total, 45 neighborhoods will be linked with the endeavor
that also involves 1,300 acres (526 hectares) of new or renovated open space, 5,600 units of affordable housing, and public art (Day, 2018).

The Atlanta BeltLine Partnership and Atlanta BeltLine, Inc., which are developing the project, have aligned their goals for sustainability with those of the City of Atlanta. As a result, the BeltLine Sustainability Plan embraces SITES. Its guidelines require compliance with the rating system and, since 2018, all parks must achieve silver or gold level certification, becoming the first municipal agency in the world to require SITES (Day, 2018).

Kevin Burke, Director of Design, Atlanta BeltLine Inc., has observed, "In this day and age, we focus too often on the here and now. What Atlanta BeltLine seeks to do is, at its core, create a legacy project that will serve the residents and visitors to Atlanta for the coming decades and beyond. It is critical that we as landscape architects not lose track of that timeframe in all the decisions we make and what urban design in landscape architecture can offer. That is why we adopted SITES for the Atlanta BeltLine. SITES ensure we optimize the parks for the community, providing both short- and long-term benefits." (Schurch, 2018).

Many other municipalities in the United States are participating in SITES with small neighborhood parks to large regional parks (see Table 1). As Recreation and Park Department General Manager Phil Ginsburg explains, "SITES was invaluable in helping us transform Boeddeker Park (Figure 8) into a safe, inviting and green oasis in San Francisco’s Tenderloin—the city’s densest and poorest neighborhood that is also home to a large population of children and seniors. Nature is woven throughout the project, allowing urban residents to reap the mental and physical health benefits of time in nature.” (Wessel, 2021).

In Nashville, Tennessee, home of the SITES v2 Gold certified Centennial Park, “the principles of sustainability guide decision-making on all of our capital projects,” adds Parks and Recreation’s Tim Netsch. “For landscape projects, SITES has proven to be a useful tool to help organize our sustainability strategy, ensure that we cover the full breadth of considerations, and quantify the outcomes.” (Wessel, 2021). Additionally, more cities, like the City of Austin mentioned above, are also considering adopting SITES for parks and other spaces as they may have done with LEED for building projects. In fact, the first park project in Austin, Mary Elizabeth Branch Park (Figure 9), certified under SITES v2 in early 2021. “Applying SITES strategies to the project had a direct impact on the design and distribution of program elements,” explained Claire Hempel of Design Workshop, the team hired by Catellus to complete the park. “Branch Park has created nature where there once was none. Over 200 trees were planted on a 3.5-acre park site that was former airport runway. The introduction of trees, plants and places for people promotes physical activity, restorative experiences and social interaction.” (Kortick et al, 2021). In addition to advancing the park’s ecological goals, the park was designed with an efficient stormwater management system and as a unique, regionally appropriate civic space.

Table 1. Local Jurisdictions Using SITES in the United States

<table>
<thead>
<tr>
<th>Park</th>
<th>Location</th>
<th>Agency</th>
<th>SITES Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blue Hole Regional Park</td>
<td>Wimberley, TX</td>
<td>City of Wimberley, TX</td>
<td>Certified Pilot (v1)</td>
</tr>
<tr>
<td>Boeddeker Park</td>
<td>San Francisco, CA</td>
<td>City of San Francisco Recreation and Parks Dept</td>
<td>Certified Pilot (v1)</td>
</tr>
<tr>
<td>Evans Parkway Neighborhood Park</td>
<td>Silver Spring, MD</td>
<td>The Maryland-National Capital Park &amp; Planning Commission</td>
<td>Certified Pilot (v1)</td>
</tr>
<tr>
<td>George &quot;Doc&quot; Cavalliere Park</td>
<td>Scottsdale, AZ</td>
<td>City of Scottsdale Parks &amp; Recreation</td>
<td>Certified Pilot (v1)</td>
</tr>
<tr>
<td>Kirke Park</td>
<td>Seattle, WA</td>
<td>Seattle Parks &amp; Recreation</td>
<td>Certified Pilot (v1)</td>
</tr>
<tr>
<td>Woodland Discovery Playground</td>
<td>Memphis, TN</td>
<td>Shelby Farms Park Conservancy / Shelby County</td>
<td>Certified Pilot (v1)</td>
</tr>
<tr>
<td>Centennial Park</td>
<td>Nashville, TN</td>
<td>Nashville Metro Parks</td>
<td>Certified Gold (v2)</td>
</tr>
<tr>
<td>Grant Park Gateway Project</td>
<td>Atlanta, GA</td>
<td>City of Atlanta Parks and Recreation Department</td>
<td>Certified Gold (v2)</td>
</tr>
</tbody>
</table>
For landscapes to be effectively used in governance, at least two conditions are necessary. First, the services that landscapes provide must be understood and viewed as relevant and, second, there need to be tools to act. Ecosystem services help with the first condition and SITES with the second. The ecosystem services concept is a useful theory for practice, as illustrated by SITES, as well as related advances in the development of green infrastructure. All landscapes hold the potential to improve and regenerate the natural benefits and services provided by ecosystems. As we advance SITES practice, the experience and reflection about that experience can help advance ecological theory and landscape performance measures. For instance, we may better understand and appreciate our own ecology and how we interact with each other, other species, and our environments. We might advance Patrick Geddes’s idea that we can participate in our own evolution through design and planning (Steiner and McSherry, 2017). The SITES system helps connect people and the decisions they make to nature and society.

As noted earlier, landscapes are an interface between natural and cultural processes. As such, they are a frame to visualize, to experience, and to record ecological and social interactions. These interactions also demonstrate an economic benefit. As stated by Lady Bird Johnson, “The environment is where we all meet, where we all have a mutual interest; it is the one thing all of us share. It is not only a mirror of ourselves but a focusing lens on what we can become.”

In the spirit of Mrs. Johnson, we can watch bees pollinate flowers and note which flowers are preferred. The SITES rating system emphasizes the use of native plants, which are favored by bees and other wildlife. Additionally, SITES encourages green infrastructure to control and clean stormwater, providing several co-benefits such as reducing urban heat islands and air pollution. SITES also pays particular attention to soil conservation and restoration, which tends to be overlooked in conventional developments. Soil formation, defined as a “supporting” ecosystem service, is necessary to ensure all other ecosystem services (regulating, provisioning, and cultural) are provided. Thoughtfully designed outdoor spaces also encourage people to exercise, have mental respite, and recreate, which have many physical and mental health benefits, which is especially important as we spend up to 90% of time indoors.

Additionally, the value of such outdoor spaces and their connection to public health has been elevated during the COVID pandemic. As social scientist Mark Berman describes, “nature is not an amenity—it’s a necessity (for public health). We need to take it seriously” (Wang, 2020). The practices and benchmarks outlined in SITES provides a comprehensive framework vetted by numerous interested parties, project teams, and experts, and offers a multitude of benefits, as shown by the examples noted above and throughout this paper. This makes SITES ideal for planning, designing, and managing spaces in between our buildings or on top of them and for landscapes without buildings. The developers of SITES realized the ecosystem services concept was helpful to raise awareness and elevate the value of
landscapes, design with function in mind in addition to aesthetics, and develop performance measures to understand a site’s true impact. SITES, therefore, can be used by government officials to ensure more resilient communities — both socially and ecologically — are created.

In their call to move ecosystem services from theory to implementation, Daily and Matson note: “Around the world, leaders are increasingly recognizing ecosystems as natural capital assets that supply life-support services of tremendous value. The challenge is to turn this recognition into incentives that will guide wise investments in natural capital, on a large scale” (2008, p. 9455). Planners are just beginning to understand how to integrate ecosystem services into urban plans (Woodruff and BenDor, 2016). Scholars have reported the challenges of integrating ecosystem services into planning in Italy (La Rosa, 2019) and Sweden (Hagemann et al., 2020). SITES provides a useful tool for integrating ecosystem services into landscape governance and for demonstrating that ecosystem services are a useful theory for practice. As a result, SITES offers an opportunity and a means for governments from the local to the national to lead and to act.

6 ACKNOWLEDGMENTS

In addition to the two authors, others at the Lady Bird Johnson Wildflower Center who led the effort and helped to maintain day-to-day operations for the SITES program until the USGBC/ GBCI acquisition include, notably Susan Rieff, Steve Windhager, Heather Venhaus, and Mark Simmons, as well as J. Amy Belaire, Darcy Nuffer, Joanna Rechnitz, Lisa Storer, Jonathan Garner, and Lana Denkeler. Refer to the full list of contributors and technical advisors in the Acknowledgements for the SITES v2 Rating System: For Sustainable Land Design and Development (http://www.sustainablesites.org/resources).

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March 17-19, 2021


LANDSCAPE PLANNING AND ECOLOGY

Edited by Chingwen Cheng, & Dongying Li
CONSERVATION AND SERVICE: LANDSCAPE ARCHITECTS AS TECHNICAL SERVICE PROVIDERS IN THE AGRICULTURAL LANDSCAPE

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1. ABSTRACT
The Conservation Reserve Program (CRP) has been a positive asset to remediation and water quality in the Agrarian environment by providing farmers with incentives and cost share programs. These give farmers the means to implement a number of best management practices, which improve runoff conditions and reduce nutrient pollution in the major waterways of the United States (US). Landscape architects are rarely, if ever, involved as implementers in this program, even though they frequently address water quality issues in urban environments. In this study, we compare the best management practices (BMPs) that landscape architects frequently use to improve water quality in the urban environment with BMPs that are used to improve water quality in rural agricultural environments. In particular, we compare their effectiveness at removing nitrogen and phosphorus through the utilization of the International BMP database. Our results show that the urban stormwater strategies are at least as effective at removing nitrogen and phosphorus as most rural strategies, suggesting that landscape architects would make ideal service providers for the conservation reserve program and that more cross-disciplinary efforts are needed. We explore opportunities for landscape architects to intervene as service providers of the CRP in the state of Illinois, and discuss next steps for research and engagement in agricultural landscapes.

1.1 Keywords:
Water quality, Conservation Reserve Program, landscape design, nitrogen, phosphorus, Upper Mississippi River basin

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1 INTRODUCTION

Nitrogen and phosphorus are polluting our water systems. In the Mississippi watershed in the U.S., nutrient pollution is largely responsible for the ever-expanding hypoxic zone in the Gulf of Mexico, where it is killing wildlife and destroying the coastal fishing industry (Dale et al., 2007). The hypoxic zone is a region along the Louisiana-Texas coast where the water at the Gulf's bottom contains fewer than two parts per million of dissolved oxygen, resulting in hypoxia. In 2013, the U.S. Environmental Protection Agency named nitrogen and phosphorus pollution as “one of the costliest, most difficult environmental problems we face in the 21st Century” (EPA, 2016). One major source of nitrogen and phosphorus is farm runoff, with agriculture contributing 41 percent of nitrogen and phosphorus in our polluted waterways, compared to only 6 percent from urban areas (USGS, 2016; Carpenter et al., 1998). This pollution comes from animal manure, excess fertilizer applied to crops, and soil erosion. Unfortunately, agriculture stormwater runoff is exempt from U.S. Clean Water Act standards because these standards extend only to point source pollution, and nutrient pollutants are considered nonpoint source pollutants because they come from the disperse activities of many farmers (CWA, 1972). The EPA has proposed nutrient reduction loss strategies to reduce the contaminants draining into the Mississippi river basin, but the adoption of these strategies is completely voluntary (EPA, 2016; EPA, 2017).

To incentivize the adoption of agricultural strategies to improve water quality and decrease pollution from stormwater runoff, state and federal programs in the U.S. have created cost-share and incentive programs for farmers (Feather & Cooper, 1995). The largest of these programs is the USDA’s Conservation Reserve Program (Khanna & Ando, 2009). The CRP is a program in which enrolled farmers agree to withdraw environmentally vulnerable land from agricultural production and plant species that will improve environmental health and quality in exchange for a monthly rental payment. (USDA, 2003). The Conservation Reserve Program requires that farmers employ qualified technical service providers to implement the pollution-reducing strategies (ICREP, 2002). These technical service providers come almost entirely from within the agricultural industry.

This paper explores a novel concept: Might landscape architects be well suited to implement nutrient pollution reduction strategies in agricultural landscapes, potentially as technical service providers for the Conservation Reserve Program? Landscape architects have been addressing water quality and stormwater issues in urban environments for decades. It is unclear, however, whether the strategies landscape architects use in urban environments are adequate for meeting the water quality challenges of agricultural environments. In both urban and rural landscapes, there are a number of different water quality concerns, and we need to better understand how the strategies used in agricultural and urban landscapes compare, especially in efficiency of nitrogen and phosphorus removal, as this is the most pressing water quality concern in agricultural landscapes.

To fill this knowledge gap, we use data from the 2016 International Best Management Practices (IBMP) data set to compare the effectiveness in reducing nutrient pollution of best management practices in both urban and agricultural environments (IBMPD, 2016). In discussing the results, we consider how landscape architects’ “stacked approach” to designing landscapes might benefit agricultural landscapes in other ways as well (Christianson et al., 2017). Next, we consider opportunities where landscape architects might intervene in Illinois, a state that is 75% agricultural land. Where has the Conservation Reserve Program been implemented, and where are the opportunities for growth? Finally, we suggest future research avenues and next steps for tapping into this unexplored market in the U.S.

1.1 Background

Before addressing the involvement of landscape architects in the Conservation Reserve Program (CRP), it is important to understand the current state of water quality in the agriculture environment and the potential of the CRP to aid in this initiative. In this section we present the current goals of the EPA for the agricultural environment and briefly discuss the scope of stormwater management in both the rural and urban environments.

Within urban environments, the National Pollutant Discharge Elimination (NPDE) and the EPA are responsible for mandating and enforcing water quality levels, thus leading to more effective and efficient designs for water quality management systems (Ferguson, 1998; EPA, 2000; EPA, 2002; EPA, 2005; EPA, 2009). A majority of the nutrient pollutants come from the disperse activities of many farmers and are therefore classified as “nonpoint” source pollutants (Bianchi & Harter, 2002; Stubbs, 2016). Because the
Clean Water Act extends only to point source pollution, agriculture stormwater runoff is exempt from meeting any water quality standards (Kovalic, 1987). There are also several significant contributors to nitrogen and phosphorous runoff in the urban and residential environment, predominant from fertilizer, decomposing lawn cuttings, and other yard waste (Hobbie & Finlay et. al, 2017; Yang & Toor 2018).

In the wake of the US EPA Gulf Hypoxia Action Plan (2008), a goal of a significant 45% reduction in Nitrate-Nitrogen and Phosphorus loads was implemented by each state that drains into the Mississippi River basin (EPA, 2016). Because a majority of these contaminants are a product of the agricultural industry, the agricultural community has proposed the most significant changes as far as water quality management is concerned (Brown & Schulte 2011). The State of Illinois has produced an annual Illinois Nutrient Reduction Loss Strategy highlighting the ways in which the state’s stakeholders are currently meeting and will meet the EPA-outlined goals (IEPA & IDOA, 2017).

Although there have been some recent attempts to amend the Clean Water Act to include agriculture as a point source of pollution (Board of Water Works Trustees of City of Des Moines v. Sac County Board of Supervisors, 2017), they have not succeeded due to procedural standing technicalities (Kai, 2016; Vos, 2017). Therefore, state programs and cost share incentives attempting to control the non-point pollution and improve water quality remain the only means for regulation and management of stormwater quality in farms (Lant et. al., 2001). The principal programs include the Clean Water State Revolving Fund and the Drinking Water State Revolving Fund, both of which are loan programs to improve water quality (Robbins, 2007).

The financial incentives such as the cost-sharing and incentive payments are critical in water improvement (USGS, 2016). Without these financial support programs, the means for water quality improvement are too costly for farmers to implement (IEPA & IDOA, 2017). When these programs are utilized, farmers rely heavily on technical service providers for help with design and implementation. Technical service providers are frequently “individuals or businesses that have technical expertise in conservation planning and design for a variety of conservation activities” (ICREP, 2017).

The services of technical service providers are outsourced by the Natural Resource Conservation Service, and the providers are required to undergo a simple special training course and register (ICREP, 2017). There are 36 different strategies that technical service providers can implement within the CRP program, including but not limited to the following ones that have a strong connection to landscape planning and design:

- buffers for wildlife habitat
- wetlands buffer
- riparian buffer
- wetland restoration
- filter strips
- grass waterways
- contour grass strips
- shallow water areas for wildlife

Landscape architects are seldom involved in conversations concerning pollution from agricultural landscapes. However, we argue that landscape architects could serve the agricultural community by implementing highly designed and efficient methods for stormwater management and ecological resilience in the agricultural landscape.

As designers, landscape architects regularly deal with the water quantity and quality concerns that are now in question by the agricultural community (Echols & Pennypacker, 2008; Cettner et. al., 2013; LAF, 2017). Their expertise is not often sought due to budget concerns and general lack of interaction between the two professions of farmer and designer. However, if we can determine that landscape architects can successfully address the water quality concerns in agricultural landscapes, then landscape architects may be ideal technical service providers for the Conservation Reserve Program and may meet an important need in the agricultural community. This study examines the current best management practices to manage stormwater used by landscape architects in urban environments with those used in agricultural environments, comparing their ability to reduce nitrogen and phosphorus. Next, we explore opportunities for potential intervention by landscape architects as technical service providers in the State of Illinois.
2 METHODS

2.1 Urban and Rural BMPs

To compare urban and agriculture stormwater management practices and their ability to reduce nitrogen and phosphorus, we chose three of the most common best management practices (BMPs) for improving water quality that are implemented by landscape architects in urban environments, and three common best management practices for improving water quality and managing stormwater that are implemented by the agricultural industry in agricultural environments. Stormwater management methods used by landscape architects in the urban environment are rapidly growing. Many municipal codes are moving away from traditional stormwater management (large storms and large sites only) and encouraging more on-site stormwater management. On-site stormwater management stems from rainfall and infiltration as a natural process and can be defined as simply the management of stormwater runoff on a site (Sample & Heaney, 2006; Ferguson, 1998). This approach generally focuses on the management of rainfall runoff in an assortment of storage facilities such as on-site storage ponds, rainwater cisterns, and soil moisture drainage (Sample & Heaney, 2006). This is a direct result of the need to expand their stormwater management policies that only require a flood prevention and control method, to one that encourages more on-site infiltration and integrated site design (Kraszewska, 2017). These best management practices are often specific to the surrounding environmental and atmospheric conditions. According to the EPA, urban stormwater management falls under three categories: Point BMP (captures drainage at a specific source), Linear BMP (collects drainage along a stream or in a narrow linear area), and Area BMP (collects water runoff from a larger land based area) (EPA, 1999). For each of these three categories, we chose one commonly used practice: Bioretention (Point BMP), Wetland channel (Linear BMP), and Infiltration basin (Area BMP). These were selected because they represent the largest application of stormwater management for urban runoff and are the most widely used for each landscape category used by the EPA.

After examining the programs utilized in the Conservation Reserve Program for water quality in the agricultural landscape (CRP, 2017), we determined that the three most common methods for agricultural stormwater management were: constructed wetland basin, grass strip buffer and riparian swale buffer. The six urban and rural stormwater management methods are described in Table 1.

The terms urban and rural are used to represent the majority of BMPs used in each respective landscape. However, it is acknowledged that each of these BMPs can and are used at a variety of sites and scales that don’t necessarily align with how they are categorized in this research. In a majority of cases, agricultural stormwater management utilizes the three rural BMPs chosen for this project. This is also true within the urban environment as the majority of designed stormwater management practices fall into the three Urban BMPs selected for this project.

Table 1. Comparison of the most commonly used BMPs for stormwater management

<table>
<thead>
<tr>
<th>BMP Method</th>
<th>Classification</th>
<th>Landscape Application Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constructed Wetland Basin</td>
<td>A uniquely designed basin that contains water, a substrate, and, most commonly, vascular plants. Within these constructed wetland basins water flows into the system in a vertical manner and holds the water for long intervals during periods of high rainfall. <strong>EPA</strong></td>
<td>Rural: used to treat stormwater runoff in predominantly large land areas such as agricultural fields, highways, and large industrial areas</td>
</tr>
<tr>
<td>Grass Strip Buffer</td>
<td>An area of permanent vegetation located within and between agricultural fields and the watercourses to which they drain and are intended to intercept and slow runoff as well as intercept shallow groundwater moving through the root zone below the buffer. <em>EPA</em></td>
<td>Rural: used to treat stormwater runoff in predominantly large land areas such as agricultural fields</td>
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<tr>
<td>Riparian Swale Buffer</td>
<td>A shallow, channeled grassed depressions through which runoff is conveyed generally from impervious surfaces that provide stable routing for stormwater runoff and a low-cost drainage option for highways, farms, industrial sites, and commercial areas. <em>EPA</em></td>
<td>Rural: used to treat stormwater runoff in predominantly large land areas such as highways, farms, industrial sites, and commercial areas</td>
</tr>
<tr>
<td>Bioretention</td>
<td>A BMP that utilizes soils and both woody and herbaceous plants to remove pollutants from stormwater runoff. Stormwater runoff is conveyed as sheet flow to the treatment area, which consists of a grass buffer strip, sand bed, ponding area, organic layer or mulch layer, planting soil, and plants. <em>EPA</em></td>
<td>Urban: used to treat stormwater runoff predominantly in areas of high density impervious surfaces</td>
</tr>
<tr>
<td>Wetland channel</td>
<td>An open conduit either naturally or artificially created which periodically or continuously contains moving water, or which forms a connecting link between two bodies of standing water <em>UDFCD</em></td>
<td>Urban: used to treat stormwater runoff predominantly in areas of high density impervious surfaces</td>
</tr>
<tr>
<td>Infiltration Basin</td>
<td>A shallow artificial pond that is designed to infiltrate stormwater through permeable soils into the groundwater aquifer and does not release water except by infiltration, evaporation or emergency overflow during flood conditions. <em>USDA</em></td>
<td>Urban: used to treat stormwater runoff predominantly in areas of high density impervious surfaces</td>
</tr>
</tbody>
</table>

### 2.2 Water Quality Parameters and Removal Efficiency

After selecting the urban and agricultural stormwater BMPs, we compared these strategies’ ability to address water quality concerns using the 2016 International Best Management Practices data set. The urban stormwater BMPs (Bioretention, Wetland channel and Infiltration basin) were measured against the agricultural stormwater BMPs (Constructed Wetland basin, Grass strip buffer and Riparian Swale buffer). In both urban and rural landscapes, there are a number of different water quality concerns. For the purpose of this study, nitrogen and phosphorus removal efficiency were given precedence, as these are the most pressing water quality issues in the rural environment. However, we also examined each method’s efficiency in removing Biological Oxygen Demand (BOD), Total Volatile Solids (TVS) and Total Suspended Solids (TSS) as these are primary concerns within the urban landscape. The water quality parameters that were considered include: Total Nitrogen, Total Nitrate, Total Nitrite, Total Phosphorus, TSS, TVS and BOD. The International Best Management Practice database is the leading resource to compare different rates of contamination reduction in each method of stormwater management. In order to give a more uniform analysis of the success of each BMP, all data is representative of all samples taken and was derived from all available sites.

The International Best Management Practices database has current data on each of the different stormwater management approaches. There are two types of water quality data: influent (mg/L), which refers to the quality of water before it enters into the BMP for treatment, and effluent (mg/L), which refers to the quality of water as it is released from the BMP. To examine the comparative success of reduction, the removal efficiency equation for mass load (see equation 1) was applied to each contaminant based off of the influent and effluent values of each water quality parameter (Gulliver et al., 2010). To measure the removal efficiency of a water quality parameter by a BMP, the median value of effluent was then divided by the influent and subtracted by a factor of one. This value was then multiplied by a factor of -100 to determine the summation of contaminant load. The final value represents the percentage removal rate of a contaminant by a BMP. This equation was applied to each of the selected methods for stormwater management against each of the contaminants being examined: Total Nitrogen, Total Nitrate, Total Nitrite, Total Phosphorus, TSS, TVS and BOD. Therefore, each type of rural stormwater management has six values that describe their efficiency in reducing contaminants, biological oxygen demand and erosion particles.
The contaminant values of the three agricultural BMPs and the three urban BMPs were categorically analyzed to determine the relative success of contaminant removal and overall water quality improvement for each (see figure 1) and specifically Nitrogen reduction (see figure 2). By determining the removal rate of Nitrogen, Phosphorus, TVS, TSS, and BOD a further assessment of the advantage and disadvantage of rural and urban stormwater methods in Illinois can be made, and a case can be made for involving Landscape Architects in the design process.

**Equation 1.** Removal Efficiency: Mass Load

\[
\text{Removal Efficiency (Summation of Load)} = \left[ 1 - \left( \frac{M_e}{M_i} \right) \right] \times -100
\]

where:

- \( M_e \) = Effluent Pollution Mass Load as listed in BMP Database
- \( M_i \) = Influent Pollutant Mass Load as listed in BMP Database


**Figure 1. Comparison of Urban and Agricultural BMPs**

1. Authors describe EMC as the amount of the Event Mean Concentration efficiency. The event mean concentration (EMC) efficiency method is used to determine the average reduction in pollutant concentration for a given stormwater treatment practice.
2. SD = Standard Deviation. *Simple substitution of one-half of the detection limit values has been used for non-detects. The percent of non-detects in a given data set provides some insight.*
into the potential bias introduced by this substitution. Other, more specific analyses conducted by the Database Team have used more advanced approaches for dealing with non-detects, which may lead to different results. A simpler method was selected for this analysis to provide a more general tool for use with a variety of data sets." –as described by IMBP

3. **Data Analysis** – According to the BMP performance analyses provided in the 2016 report, the BMP performance data in the Database as of November 2016. The analyses are based upon the distributions of influent and effluent water quality sample data for individual events by BMP category, thereby providing greater weight to those BMPs for which there are a larger number of data points reported. In other words, the performance analysis presented in this technical summary is “storm-weighted,” as opposed to “BMP weighted.” Authors derived data from the International Stormwater BMP Database (International Stormwater Best Management Practices (BMP) Database project. “2016 Summary Statistics.” Accessed June 9, 2018, http://www.bmpdatabase.org/bmpstat.html


**2.3 Spatial analysis for intervention opportunities**

Given that landscape architects are capable of designing landscapes that address these important agricultural water quality concerns, what are the opportunities for landscape architects to intervene in agricultural landscapes in the US? Since the Conservation Reserve Program is the dominant way for farmers to adopt nitrogen and phosphorus removing landscape strategies on their land, we mapped the places where the CRP has been adopted in the State of Illinois, which consists of 75% agricultural land. To identify the spatial opportunities for landscape architecture interventions, we verified the relative usage of the Conservation Reserve Program and where the agricultural water quality and stormwater management initiatives are currently in practice. We established the locations of rural BMPs that are the most relevant to agriculture nutrient loss, as well as locating the areas where they are underutilized.

Using data reported by the Conservation Reserve Program statistics as well as from the United States Department of Agriculture Farm Service Agency, a spatial analysis was created to evaluate the current usage and location of all the CRP sites within the state of Illinois (Figure 3). We then compared these locations to those that apply the most common practices of stormwater management for water quality - Constructed Wetland basins, Grass strip buffers and Riparian Swale buffers (Figure 4 and 5). After comparing the programs that utilized the CRP for water quality in the agriculture landscape, we could then ascertain the most opportune and potential locations where intervention by landscape architects could take place.

In Illinois, 321,726 total acres of land have been allotted to the Conservation Reserve Program (USDA 2018). Application of the programs seems to be heavily concentrated in certain counties, while other counties have seen very little application, as shown in Figure 3. This suggests that there is likely a peer
effect, where farmers in some counties are encouraging other farmers to participate in the program, leading to concentrations of CRP participation. Can landscape architects tap into these markets and suggest ways that the land already allotted to CRP can be used more effectively?

In counties where there is minimal use of the Conservation Reserve Program, as shown in Figure 3, landscape architects may be able to join agricultural industries to persuade farmers about the benefits of the conservation reserve program. This is an untapped opportunity.

The placement and allocation of the total CRP acres signifies a landscape-specific application to the type of BMP used. In order to implement certain CRP cost share programs, certain landscape conditions must be present in areas whose landscape conditions qualify for support but are not making use of the CRP. Future research is necessary to determine why farmers in these areas are not utilizing the CRP options available to them and, especially, what landscape architects can do to address these issues. The Wetland Basin CRP locations (figure 4) reveal less of a landscape specific application and more of the county or local precedent in BMP usage. Future research is necessary to determine why a vast majority of sites reside in only a select few counties and not evenly dispersed throughout the agricultural landscape. Similar to the wetland basin allocation, grass and riparian buffers are not necessarily applied in landscape-specific conditions. Future research is necessary to determine why these BMPs have a regional precedent for application and implementation and are not evenly distributed throughout the state as well. These areas that are underutilized by farmers and the CRP are ideal locations for interventions by landscape architects and researchers alike.

While we mapped the places where the CRP program has been implemented in Illinois, it is unclear whether the strategies adopted by the CRP program match the nutrient pollution levels at the sites. For instance, at sites where there is significant phosphorus pollution, are the strategies that are adopted effective at removing phosphorus? This is a challenging question to answer because these sites are on private property, where access to data is limited. Future research should adopt better methods for gathering data about pollution levels at various sites so that strategies can be better tailored to the unique needs at a site. Landscape architects should also work to further develop professional relationships with farmers in these programs who want to increase the efficiency and socio/ecological success of their landscapes.
3  RESULTS

Figures 1 and 2 illustrate the relative success of different urban and agricultural BMPs on nutrient reduction, TSS, TVS, and BOD. Overall, the Urban strategies performed as well or better than agricultural strategies in Nutrient Removal. The Agricultural Grass Strips Buffer performed similarly to the Wetland Channel in All Nitrate and Phosphorus Removal rates (ranging from 20-33% in all categories). The Urban Bioretention and Infiltration Basin categories outperformed all Agricultural methods in Total Nitrogen Removal Rate (36% and 45%), and Nitrite Removal Rate (39% and 50%). However, the results were mixed for Nitrate and Phosphorus Removal. The Urban Infiltration Basin performed significantly higher in phosphorus removal (46%), compared to the three Agricultural BMPs: Constructed Wetland Basin (24%), Grass Strips Buffer (27%), Riparian Swale Buffer (9%). Agriculture Constructed Wetland Basin was the highest performer in Nitrate (NO3) Removal Rate (52%), compared to Agricultural Grass Strips Buffer (23%), Riparian Swale Buffer (9%), Bioretention (34%), Wetland Channel (33%), and Infiltration Basin (20%).

Interestingly, several of the agricultural strategies performed as well or better than several of the urban BMPs in urban water quality measures: Total Volatile Solids (TVS), Total Suspended Solids (TSS), and Biological Oxygen Demand (BOD). Although the Urban Bioretention BMP had the highest ratings for TSS and TVS removal, the agricultural methods of Constructed Wetland Basin and Grass Strips Buffer outperformed the other two urban methods in TSS Removal, TVS Removal, and BOD Reduction. The agricultural Grass Strips Buffer performed significantly higher in BOD reduction than all other categories.

4  DISCUSSION

4.1.  Main contributions

These results demonstrate that most of the urban stormwater management best practices are at least as effective, and often significantly more effective, at reducing nitrogen and phosphorus pollution than agricultural methods. In particular, the Bioretention and Infiltration Basin Urban methods were significantly more effective at removing Nitrite (NO2) and total Nitrogen and Phosphorus, although the Agricultural Constructed Wetland Basin was significantly more effective at removing Nitrate (NO3). The effectiveness of bioretentions and infiltration basins at removing nutrient pollution is not surprising given their high levels of biodiversity and the amount of time contaminated water remains within the designed system. One reason they may have performed higher is that the contaminants had greater opportunity for bioremediation given the variety of plant species and subsequent bacterial communities that are often found in these systems.

For removing Biological Oxygen Demand, Total Volatile Solids, and Total Suspended Solids, two of the agricultural methods performed similarly or even better than the Urban methods, with Grass Strips Buffer achieving a score of 90%, far outperforming the Urban methods for BOD Reduction. These results are not surprising due to the vast size and scale in which grass strips typically occur in agricultural landscapes. One possible reason the agricultural strategies may have outperformed the urban strategies is that the area of land that is available to these BMPs is much greater than the typical size and scale of an Urban BMP.

These results suggest that the best management practices that landscape architects are frequently using in urban environments may be applied to agricultural environments with confidence, especially the Bioretention and the Infiltration Basin methods. Additionally, it may be worth considering agricultural best practices for removing TSS, TVS, and reducing BOD, as these strategies (particularly constructed wetland Basin and Grass Strips Buffer) performed well. In short, our research suggests an opportunity for the designers and implementers of agricultural and urban water quality and stormwater management strategies to learn from each other and consider adopting or adapting the strategies of each.

It also suggests that designers should think carefully about the specific needs of the site, as different strategies are more effective at reducing certain kinds of pollution. For instance, if phosphorus removal is the goal, then the Infiltration Basin is the strategy that outperforms all others. However, if NO3 removal is the goal, then the Agricultural Constructed Wetland Basin is the best choice. The type and location of the site will also likely impact the strategy implemented.

Choosing to adopt methods typically used in urban environments in agricultural environments may bring other benefits. Landscape architects adopt a more stacked, heavily designed approach. Landscape architects design sites that are meant to do much more than improve water quality. They attract users, build
habitats for wildlife, provide places of relaxation, restoration, and recreation, and contribute to a healthy economy. That is, a landscape architect’s approach to addressing water quality in agricultural environments is likely to bring many other benefits, as well. For example, the rail-to-trails project in Illinois provides a dynamically designed space that borders large areas of agricultural communities and could serve as potential linear water treatment facilities as well as ecological restoration corridors and outdoor recreation opportunities.

4.2. Limitations

This research has certain limitations. We were unable to collect any data for existing agricultural sites participating in the CRP due to limited access and private property restrictions. Future researchers should develop partnerships with farmers who are currently enrolled in the CRP and are willing to allow water quality testing on their sites.

In addition, this research does not address the cost of implementing a specialized designed facility by a landscape architect and the process that designers have to undergo to partner with willing farmers. Future research should develop a more detailed and integrated approach to becoming technical service providers and provide alternative design solutions that landscape architects can implement within the agricultural landscape.

4 CONCLUSIONS

This research is a preliminary attempt to measure the effectiveness of urban vs. agricultural methods for addressing water quality, to make a case for landscape architects’ involvement in agricultural nutrient pollution mitigation strategies through a review of significant literature. Within the urban environment, landscape architects often dominate the advancement of BMP strategies for improving water quality. This is evident from the overall success of improved water quality by BMPs used in the urban landscape. Because urban BMPs were seen to be at least as or more effective at reducing nutrient pollution than most of the agricultural strategies, it can be concluded that landscape architects can provide significant improvement to water quality conditions in the agricultural landscape. In addition, landscape stormwater practices take into consideration more than the singular approach of improved water quality. They provide ecological connectivity, economic stimulus, recreational opportunities, and biodiversity enhancement. Urban design strategies implemented by landscape architects are currently considered multidimensional or “stacked” in the overall implementation and application. A recent study on the current success of nutrient reduction loss strategies (Christianson et al., 2018; Erickson, 2018) calls for a more stacked approach to agricultural stormwater management, and rural BMPs designed by landscape architects are an ideal solution.

Entering the area of agricultural landscapes will present several challenges for landscape architects. Our initial work in this area has shown that there is distrust from farmers, who may feel like people in urban environments criticize or promote agricultural solutions without understanding the complexity of problems the agricultural industry faces. If landscape architects are to successfully work in the agricultural industry, they will need to listen to stakeholders and learn from them about what the current use and performance of the landscape has been and where there are areas for further water quality development. In this role, Landscape architects can also function as negotiators between national programs and private initiatives in order to promote more complex stacked approaches.

Currently, the primary avenue for landscape architects’ intervention in the agricultural environment is through individual partnerships with farmers. These partnerships are either privately funded or subsidized through cost-share programs like the Conservation Reserve Program. The Conservation Reserve Program only partners with Technical Service Providers to implement best management practices. More research needs to be done to understand the training opportunities and costs associated with becoming Technical Service Providers. It is likely that landscape architecture training programs already teach some of the skills needed. What is needed for landscape architecture programs to train landscape architects to become technical service providers, or could they advocate for an alternative approach to certification? If landscape architecture students can be trained and certified as Technical Service Providers, they may be able to better bridge the agricultural and urban design gap, and provide valuable insight into this burgeoning and essential field of water quality research.
In addition, the cost of landscape architect-managed urban stormwater strategies typically outweighs the cost of agricultural strategies implemented by Technical Service Providers, in part because landscape architects adopt more of a stacked approach, considering many other elements of the landscape and designing multi-functional landscapes that bring other benefits. Landscape architects will need to make the case that a stacked approach is beneficial in an agricultural environment to justify the added cost of working with a landscape architect. Alternatively, landscape architects may need to develop strategies to bring the cost of their work down to a level that is acceptable for the cost-share programs of the Conservation Reserve Program.

Within the agricultural community in the U.S., the number of farmers implementing nutrient reduction landscape strategies is minute compared to what is needed to effectively protect our waterways from pollution. This is primarily because their implementation is not obligatory, but incentive driven. Given the precarious and inconsistent nature of government funding, this approach to agricultural water management seems limited to the realm of temporary solutions. This presents another opportunity. Landscape architects should join others in the agricultural industry to advocate for policy reform. Future research and lobbying is needed to determine the optimal approach for addressing stormwater runoff of farms throughout the United States and globally. Landscape architects’ voices are essential in reaching this objective.

5 ACKNOWLEDGEMENTS

The authors would like to acknowledge the following individuals for information or input on this paper: William Sullivan with the Department of Landscape Architecture, University of Illinois, Lowell Gentry with the Department of Natural Resources and Environmental Sciences, University of Illinois, and Eliana Brown with the Illinois and Indiana Sea Grant and University of Illinois Extension.

5. REFERENCES


GUIDING DESIGN FOR SEA-LEVEL RISE: AN ITERATIVE METHODS FRAMEWORK

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1 ABSTRACT

Climate change poses immediate challenges for human populations worldwide. Coastal areas in particular face sea-level rise and storm surge issues. Several artificial designs, including seawalls and surge barriers, have been used to manage the effects of sea-level rise, but these options often require ongoing upkeep and fail to offer long-term solutions. Nature-based solutions offer an alternative for coastal resilience and adaptation strategies relevant to both urban areas and other coastal areas such as national parks. Identifying design procedures for nature-based design could promote successful implementation and long-term sustainability. Based on existing literature, a set of design criteria is formed to guide the implementation of nature-based design in response to projected sea-level rise in the context of East Potomac Park in Washington, D.C., but endeavors to be widely applicable to other coastal areas facing sea-level rise and storm surge. The design criteria address socio-ecological factors of landscape, planning and design for adaptation and resilience, communicating climate change, and design performance evaluation. The goal is to provide an iterative methods framework, composed of the design criteria, for climate change design projects and to connect research with practice by creating a design-science feedback loop. The framework provides a platform for innovative solutions in climate change design and furthers dialogue on nature-based design.

1.1 Keywords:  
Climate change, sea-level rise, coastal resilience, nature-based design, national parks

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2 INTRODUCTION

Designing for climate change, and specifically for sea-level rise, is one of the biggest challenges facing designers today. Fair weather flooding is now common among coastal cities and considerable resources are going into planning and design for a variety of mitigation measures. Traditional methods of shoreline protection, including seawalls and dikes, can still leave coastal areas vulnerable to sea-level rise, threatening infrastructure, local economy, and community fabrics. Research articles, agency reports and other documents identify important strategies for studying and addressing these problems, but typically focus on a narrow set of issues relevant to local problems in need of solutions. The benefit is the richness of detail and depth of consideration in each situation. The drawback is the lack of broader coordinated procedures that can bring in additional stakeholders, experts, and ideas from an increasingly comprehensive viewpoint. Overall, services to adapt and mitigate climate change effects will likely become progressively more important, but current strategies remain fragmented locally and globally.

The research presented here draws from multiple sources of published information that each encapsulate one or more parts of the design and planning process. Together, the research brings into focus a more fully developed set of actions and objectives that could improve the decision-making processes for communities affected by climate change issues such as sea-level rise. The results of the study offer a framework, supported by a diverse collection of literature that is organized by triangulation, into a set of actions and objectives for identifying and addressing issues relevant to climate change design. To manage the complexities of designing in the context of climate change, with a focus on sea-level rise, the framework provides a guide to engaging social and environmental factors critical to the long-term sustainability of climate change design projects. The framework translates widespread literature into an applied method informing and strengthening adaptation responses to coastal climate change issues that support socioecological needs.

2.1 Literature Review
2.1.1 Climate Change

Climate change poses significant challenges in human-made environments and natural systems worldwide (IPCC, 2014). More than half of the world’s population lives in urban areas and urbanization is expected to continue in the future (Revi et al., 2014). Many cities lack measures for climate change adaptation planning, while those that do not are mostly located in high-income countries (Araos et al. 2016). Moreover, growing populations of people are living less than 10 m above sea level, creating significant risks from climate change issues related to sea-level rise, including elevated tides, increased flooding, erosion and groundwater salinization (Oppenheimer et al., 2019).

Global average sea-level rise since the late 19th is around 210 mm, with a linear trend of 1.7-1.9 mm per year (Church & White, 2011), and global average sea level is likely to increase in the future, with some studies reporting a possible global sea-level rise increase of 2 m by 2100 in a high emission scenario. However, likely sea-level rise projections for global mean sea-level rise range from 0.24-0.32 m by 2050 and 0.43-0.84 m by 2100, with a 17 percent chance of 0.59-1.1 m by 2100. Moreover, sea-level rise is not uniform, and some regions could see up to 30 percent higher sea-level rise than the global average due to factors such as ocean dynamics and subsidence (Oppenheimer et al. 2019).

In the United States, the North Atlantic Coast is extremely vulnerable to sea-level rise, especially considering the region’s population density and coastal hazards such as hurricanes and severe storms. Based on climate models from the Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report (AR4), Yin, Schlesinger, & Stouffer (2009) project sea-level rise ranging .36-.51 m in New York City; .37-.52 m in Boston; and .33-.44 m in Washington, D.C. by the end of the 21st century. Moreover, the region has regularly experienced severe storms in the past. Hurricane Sandy in 2012, for instance, brought widespread economic damage, where storm surges reached 9.4-12.65 ft above normal high tides in the New York Metropolitan area. The event revealed an immediate need to address sea-level rise and storm surge issues in coastal areas (US Army Corps of Engineers New York District, 2019).

Tide gauges along the East and Gulf coasts have also been used to extrapolate on storm surge and flooding. Dahl, Fitzpatrick, & Spanger-Siegfried (2017) studied 52 locations along the U.S. East and Gulf Coasts, with projections indicating that Washington, D.C. will experience up to 337 tidal flooding events per year by 2045, the most of all the study cities. Moreover, Washington, D.C. ranked in the top 10 for number of flooding events that received a Coastal Flood Advisory in 2012-2013, with almost 70, and in the
top three for average tidal flood events between 2001-2015. The National Capital Region is susceptible to multiple flooding risks, including riverine, coastal, and interior flooding. Tidal flooding and storm surge, which can be caused by hurricanes, have the potential to produce extremely high water when occurring at high tide in the Washington, D.C. (National Capital Planning Commission, 2018). In fact, Washington, D.C. has around a 50 percent chance of experiencing a record-breaking flood by 2040. For a 100-yr flood, this would be 11 ft above the high tide line. For comparison, previous high floods were 7.9 ft in 1942 during torrential rains; 7.4 ft in 1936 due to storm water; and 7.1 ft in 2003 during Hurricane Isabel. Under the highest sea-level rise scenarios, floods exceeding these records would become annual events by 2080-2100 (Strauss et al., 2014).

Furthermore, the National Capital Region is estimated to have the highest rate of sea level change in the National Park System by 2100, with an average of 0.8 m sea-level rise. U.S. national parks are important in preserving cultural and natural resources. Yet, with more than one quarter of lands managed by the National Park Service falling on ocean coastlines, many National Parks are vulnerable to the effects of climate change, especially issues resulting from sea-level rise (Caffrey, Beavers, & Hoffman, 2018). Peek and Beavers (2015) estimate that with 1 m of sea-level rise, over $40 billion of National Park assets will be at risk. For the National Mall in Washington, D.C. the effects of sea-level rise alone may not cause significant damage, but in combination with storm surge, the area could face serious issues (Caffrey, Beavers, & Hoffman, 2018). Economic costs of 0.1 m and 5 m of sea-level rise for Washington, D.C. stand at approximately $2 billion and $24.6 billion, respectively (Ayyub, Braileanu, and Qureshi, 2012), while sea-level rise threatens $4.6 billion in property value less than 6 ft above the high tide line, with the amount increasing to $9 billion at 10 ft above high tide level (Strauss et al., 2014). The Washington, D.C. tide gauge 8594900, which is located near the Tidal Basin in the Washington Channel, has experienced an annual mean change of 3.09 mm from 1959-2008, with the area projected to experience 0.33m by 2050. (Tebaldi, Strauss, & Zervas, 2012). In 2019, the National Trust for Historic Preservation named the National Mall Tidal Basin as one of America's most endangered historic places, largely due to flooding issues. The Tidal Basin experiences regular flooding during high tide, creating accessibility issues and possibly adverse effects on the Tidal Basin Cherry Trees, which attract 1.5 million visitors during the National Cherry Bloom Festival. Similarly, in nearby Annapolis, Maryland, Hino et al. (2019) found that visitation numbers to historic downtown Annapolis are likely to drop by 37,506 visits, or approximately 24%, during high tide flooding with 1 ft of sea-level rise.

2.1.2 Nature-based Solutions

A number of protective design solutions based on natural systems have been proposed to combat the effects of sea-level rise, including seawalls, floodwalls, tide gates, levees and surge barriers. However, many of these options require ongoing upkeep, may not be cost-effective, create ecological problems, and fail to offer long-term solutions (Hirschfeld & Hill, 2017). Hinkel et al. (2014) estimate the cost of maintenance and upkeep of dikes managing coastal flooding range $12-31 billion in a low emissions scenario and $27-71 billion in a high emissions scenario by 2100. Moreover, adaptation requires directed, long-term solutions. In the Gulf of St. Lawrence in Canada, Jolicoeur and O'Carroll (2007) observed how nature based design and ecosystem-based adaptation is receiving increasing attention as a strategy for adapting to sea-level rise, storm surge, and flood risks (Oppenheimer, 2019; Bridges et al. 2018). In New York City, for instance, wetland and dune restoration have been suggested as methods of shoreline protection (Rosenzweig et al., 2011). Nature-based design incorporates natural features that improve coastal protection (Pontee et al., 2016). For instance, coral reefs and salt marshes can reduce wave height up to 70 and 72 percent, respectively (Narayan et al., 2016). Tidal wetlands can even offer a level of coastline protective capacity against storm surge during hurricanes, with larger wetlands providing increased protection from flooding damage and storm surge (Highfield, Brody, & Shepard, 2018). Related to Hurricane Sandy, wetlands were found to protect against $625 million in direct flood damages from North Carolina to Maine (Narayan et al., 2017). Coastal wetlands have been shown to provide additional benefits such as providing erosion control, sequestrating carbon, and maintaining fisheries (Barbier et al., 2011). Moreover, nature-based solutions can often be more cost-effective than traditional infrastructure solutions. Salt marshes and mangroves were shown to be 2-5 times cheaper than a submerged breakwater for waves up to 0.5 m, and the habitats become more effective than breakwaters at increasing depth (Narayan et al. 2016). In addition, Hirschfeld and Hill (2017) observed that a shift from
using walls to protect vulnerable coastlines to earthen systems reduces the cost of adaptation to coastal flooding.

2.1.3 Implementation Examples

SCAPE Landscape Architecture’s Living Breakwaters project in New York City provides an example of integrating nature-based design. The design incorporates breakwaters off of Staten Island to help absorb wave energy and reduce coastal flooding, while also making habitat for fish, oysters, and other species. In China, Turenscape’s Sanya Mangrove Park works to restore damaged habitat and the protect coastline against storm surge. And in response to flooding and projected sea-level rise, the National Mall Ideas Lab in Washington, D.C. has identified five landscape architecture firms—DLANDstudio, GGN, Hood Design Studio, James Corner Field Operations, and Reed Hilderbrand—to imagine a redesign of the threatened Tidal Basin (National Trust for Historic Preservation, 2019).

A nature-based design approach opens a route for weaving scientific experiment into the design process, complementing the “designed experiment” method proposed by Felson and Pickett (2005). With an ecological base, design can offer a route for collecting quality ecological data in urban settings. Furthermore, designed experiments encourage partnerships among urban designers, landscape architects, and architects that enables ecologists and researchers to weave experiments into the urban setting. Similarly, Ahern et al. (2014) propose an adaptive urban planning approach that includes “safe-to-fail” designs, which enable pilot testing of innovative, experimental design solutions in small spatial extents and low risk contexts. The approach offers an opportunity to further integrate design and science, and a method for incorporating ecosystem services into the planning and design process. Mutually beneficial for designers, planners, and researchers, such collaborative efforts work to integrate design into science. Nassauer and Opdam (2008) argue that design can be a vehicle used by scientists and practitioners to include scientific knowledge in the decision-making process related to landscape change, contending that through transdisciplinary collaboration, scientists and practitioners of many fields enhance landscape science and knowledge. Therefore, design can act as common ground between researchers and professionals, connecting science and society by informing the design process and bolstering the outcomes of landscape projects.

3 RESEARCH OBJECTIVES

The primary purpose of this research is to review journal articles, agency reports, and other written documents addressing design and planning concerns related to climate change, particularly sea-level rise, and identify a common set of procedures across professions. The study aims to develop an iterative methods framework based on triangulation of relevant literature sources. The goal of the framework is to pull together diverse thinking on the topic of design for sea-level rise into a comprehensive, organized reference source for designers, planners, researchers, community organizers, and stakeholders. The research-based framework informs and formulate a set of pre- and post-evaluation guidelines that provide recommendations for directing decisions throughout the design process, and later, to evaluate the success of a design.

Furthermore, the project seeks to present a process integrating science and design, and aspires to further connect research and design throughout the design process in a manner that is informative to future design projects addressing issues of climate change. Although the iterative methods framework was developed to address issues of sea-level rise in an urban land area managed by the National Park Service, the study aims to be widely applicable to other study sites by furthering dialogue on the applicability of nature-based design for climate change and by contributing to management approaches in preserving natural and cultural resources at risk from climate change issues.

4 METHODS

To accomplish these goals, the study pulls on literature from interdisciplinary fields and studies addressing climate change to form a framework meant to guide design related to sea-level rise and storm surge. A search for journal articles, agency reports and other documentation on design for sea-level rise was conducted using large online journal databases, such as Science Direct and U.S. Department of the Interior Integrated Resource Management Applications data repository. Search terms broadly fell into topic
categories of climate change, nature and ecosystem-based design, parks and places, and communication. For instance, ‘nature-based design,’ ‘coastal resilience,’ ‘coastal planning,’ ‘sea-level rise,’ ‘storm surge,’ ‘flooding,’ and ‘national parks’ were among the search terms. Supporting literature was identified from journal articles (JA), National Park Service reports (NPS), and documents from other institutions (O) such as government or non-profit entities. These materials were organized based on the actions involved and the people engaged in the actions into the appropriate Action category of the framework. Triangulation was used to determine how strongly the literature supported the categories of action and engagement identified in the documents reviewed.

The iterative methods framework was formed in the context of addressing design for sea-level rise using nature-based design solutions in Washington, D.C., an urban area where much of the parkland is managed by the National Park Service. The content of each Action and Objective, for instance, was developed and informed by considering social and environment dimensions—e.g., human activities, bathymetric and hydrological characteristics, and topographic features—specific to the study site at East Potomac Park in Washington, D.C. (Figure 1). Thus, although the review includes global and regional (Atlantic/Gulf coast) perspectives, and is meant to be applicable to other areas, the primary strength is related to the Chesapeake Bay and Washington D.C. area.

Figure 1. Examples of studies related to sea-level rise for East Potomac Park, Washington, D.C. East Potomac Park (left) encompasses four hurricane evacuation study zones (center), while the southern point is below 6 ft of elevation (right), making it vulnerable to sea-level rise.

4.1.1 Framework Development

The framework is based on supporting literature. Triangulation identified relevant research from journal articles (JA), National Park Service reports (NPS), and documents from other institutions (O) such as government or non-profit entities. Research broadly fell into topic categories of climate change, nature and ecosystem-based design, parks and places, and communication. The framework text is based on a review of more than 40 research papers in these categories. The framework includes Action and Objective columns with text developed to reflect and summarize information from the review of the research literature. For brevity, the framework includes 15 examples from the identified literature (JA, NPS, O; Table 1). The supporting literatures that appear in the table were selected for relevance, instructiveness, and accessibility to a wide audience of academics, practitioners, and communities. The aim was to include literature approachable to more than a single audience. Although the remaining articles were critical to the development of the framework (Table 2), providing additional insight on resilience and adaption topics, the authors felt the 15 chosen best encompassed the framework content and provided the most opportunity for further instructiveness. Each Action and Objective section correspond to examples from the supporting literature, with one example from each identifier in every section, to support the directives of the proposed framework method, the main result of the study.
Table 1. The iterative methods framework identifying actions, objectives, and triangulated supporting literature (JA: journal article; NPS: National Park Service; O: Other)

<table>
<thead>
<tr>
<th>Action</th>
<th>Objective</th>
<th>Supporting Literature</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Explore</strong></td>
<td>Identify the Issue and Key Players</td>
<td>*Sources grouped for relevance to the Action, and are not linked to a single directive only</td>
</tr>
<tr>
<td>Study site history and context</td>
<td>Locate natural and cultural resources</td>
<td>High-tide flooding disrupts local economic activity</td>
</tr>
<tr>
<td></td>
<td>Connect decision-makers and information users</td>
<td>Coastal Adaptation Strategies Handbook</td>
</tr>
<tr>
<td>Determine users and community</td>
<td>Collaborate to define the issue</td>
<td></td>
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<tr>
<td>opportunity for innovative</td>
<td></td>
<td></td>
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<tr>
<td>and creative solutions</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Engage social scientists and</td>
<td>Ex: Social media postings for site use</td>
<td>Designing With Water: Creative Solutions From Around The Globe</td>
</tr>
<tr>
<td>stakeholders</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Acclimate</strong></td>
<td>Define Socioecological Factors</td>
<td></td>
</tr>
<tr>
<td>Assess vulnerability to climate</td>
<td>Identify vulnerable experiences and ecosystems</td>
<td>Nature-based solutions: Lessons from around the world</td>
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<tr>
<td>change</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Specify adaptation and resilience</td>
<td>Determine habitat type of nature-based design</td>
<td>Climate Change Response Strategy National Park Service (2010)</td>
</tr>
<tr>
<td>strategies</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Evaluate appropriate nature-based</td>
<td>Balance user needs, coastal services, and design solution</td>
<td>When Rising Seas Hit Home Spanger-Siegfried, E. et al. (2017)</td>
</tr>
<tr>
<td>designs and ecosystem services</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Engage ecosystem scientists and</td>
<td>Ex: Mapping and projections to study site</td>
<td></td>
</tr>
<tr>
<td>allied researchers</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Plan &amp; Design</strong></td>
<td>Implement Adaption, Mitigation, and Resilience</td>
<td></td>
</tr>
<tr>
<td>Integrate culture and nature</td>
<td>Design solutions that provide multiple socio-eco benefits</td>
<td>The shore is wider than the beach: Ecological planning solutions to sea level rise for the Jersey Shore, USA Burger, J. et al. (2017)</td>
</tr>
<tr>
<td>Consider time horizons and scenarios</td>
<td>Use scenario planning and phasing for uncertain futures</td>
<td>Climate change scenario planning: A tool for managing parks into uncertain futures Weeks, D. et al. (2011)</td>
</tr>
<tr>
<td>Strengthen preparedness,</td>
<td>Encourage local and regional preparedness and adaptation</td>
<td></td>
</tr>
<tr>
<td>adaptation, and resilience</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Engage planners and designers</td>
<td>Ex: Plan two alternative futures</td>
<td></td>
</tr>
</tbody>
</table>
### Communicate

- **Promote Dialogue and Idea-sharing**
  - Bring attention to place identity and meaning
  - Provide educational and engagement opportunities
  - Encourage curiosity and discussion
  - Engage communicators and end users
  - Ex: Past and present photographs for context

### Monitor

- **Study Design Outcome**
  - Research and evaluate pre-cost site performance for long-term sustainability
  - Make findings accessible and instructive
  - Connect research and practice
  - Engage all relevant parties
  - Ex: Baseline and outcome data for comparison

### Engineering with Nature

Bridges, T.S. et al. (2018)

<table>
<thead>
<tr>
<th>Communicate</th>
<th>Promote Dialogue and Idea-sharing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bring attention to place identity and meaning</td>
<td>Advance the local context and a sense of place</td>
</tr>
<tr>
<td>Provide educational and engagement opportunities</td>
<td>Use site to demonstrate climate change</td>
</tr>
<tr>
<td>Encourage curiosity and discussion</td>
<td>Develop public dialogue between science and design</td>
</tr>
<tr>
<td>Engage communicators and end users</td>
<td>Ex: Past and present photographs for context</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Monitor</th>
<th>Study Design Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Research and evaluate pre-cost site performance for long-term sustainability</td>
<td>Identify relevant metrics and indicators</td>
</tr>
<tr>
<td>Make findings accessible and instructive</td>
<td>Examine design contribution to cultural and ecological goals</td>
</tr>
<tr>
<td>Connect research and practice</td>
<td>Create a practice-science feedback loop</td>
</tr>
<tr>
<td>Engage all relevant parties</td>
<td>Ex: Baseline and outcome data for comparison</td>
</tr>
</tbody>
</table>

- Climate change impacts in Missouri State Parks: Perceptions from engaged park users
  - Groshong, L. et al. (2018)

- Using social science in National Park Service climate communications: A case study in the National Capital Region
  - Campbell, E. (2020)

- Climate Change Communication Campaign Planning: Using Audience Research to Inform Design
  - Thompson, J. et al. (2013)

- Designed experiments: new approaches to studying urban ecosystems

- Coastal Adaptation Strategies: Case Studies
  - Schupp, C.A. et al. (2015)

- Site Commissioning White Paper
  - U.S. General Services Administration (2017)
<table>
<thead>
<tr>
<th>Authors</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ahern, J. et al. (2014)</td>
<td><em>Journal Article (JA)</em> The concept of ecosystem services in adaptive urban planning and design: A framework for supporting innovation</td>
</tr>
<tr>
<td>Brown, S et al. (2014)</td>
<td>Shifting perspectives on coastal impacts and adaptation</td>
</tr>
<tr>
<td>Campbell, L. et al. (2016)</td>
<td>A social assessment of urban parkland: Analyzing park use and meaning to inform management and resilience planning</td>
</tr>
<tr>
<td>Hinkel, J. et al. (2014)</td>
<td>Coastal flood damage and adaptation costs under 21st century sea-level rise</td>
</tr>
<tr>
<td>Hino, M. et al. (2017)</td>
<td>Managed retreat as a response to natural hazard risk</td>
</tr>
<tr>
<td>Hurlimann et al. (2014)</td>
<td>Urban planning and sustainable adaptation to sea-level rise</td>
</tr>
<tr>
<td>Jarrat, D. et al. (2019)</td>
<td>Planning for climate change impacts: coastal tourism destination resilience policies</td>
</tr>
<tr>
<td>Kirsehn, P. et al. (2008)</td>
<td>Climate change and coastal flooding in Metro Boston: impacts and adaptation strategies</td>
</tr>
<tr>
<td>Le Cozannet, G. et al. (2017)</td>
<td>Sea Level Change and Coastal Climate Services: The Way Forward</td>
</tr>
<tr>
<td>Monahan, W. et al. (2014)</td>
<td>Climate Exposure of US National Parks in a New Era of Change</td>
</tr>
<tr>
<td>Molinaroli, E. et al. (2019)</td>
<td>Do the Adaptations of Venice and Miami to Sea Level Rise Offer</td>
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<tr>
<td>Nassauer, J. et al. (2008)</td>
<td>Design in science: extending the landscape ecology paradigm</td>
</tr>
<tr>
<td>Rosenzweig, C. et al. (2011)</td>
<td>Developing coastal adaptation to climate change in the New York City infrastructure-shed: process, approach, tools, and strategies</td>
</tr>
<tr>
<td>Siders, A.R. et al. (2019)</td>
<td>The case for strategic and managed climate retreat</td>
</tr>
<tr>
<td>Van Dolah, E. et al. (2020)</td>
<td>Marsh Migration, Climate Change, and Coastal Resilience: Human Dimensions Considerations for a Fair Path Forward</td>
</tr>
<tr>
<td>Van Wesenbeeck, B. et al. (2016)</td>
<td>Coastal and riverine ecosystems as adaptive flood defenses under a changing climate</td>
</tr>
<tr>
<td>Woodruff, S. et al. (2018)</td>
<td>Fighting the inevitable: infrastructure investment and coastal community adaptation to sea level rise</td>
</tr>
<tr>
<td>National Park Service (2010)</td>
<td>Inventory of Coastal Engineering Projects in Coastal National Parks</td>
</tr>
<tr>
<td>National Park Service (2014)</td>
<td>Dyke Marsh Wetland</td>
</tr>
<tr>
<td>National Park Service (2015)</td>
<td>Adapting To Climate Change in Coastal Parks</td>
</tr>
<tr>
<td>National Park Service (2018)</td>
<td>Estimating the Exposure of Park Assets to 1 m of Sea-Level Rise</td>
</tr>
<tr>
<td>National Park Service (2018)</td>
<td>Sea Level Rise and Storm Surge Projections for the National Park Service</td>
</tr>
</tbody>
</table>
5 RESULTS

An iterative methods framework (Table 1) is developed to inform and guide a design process for coastal resiliency. The framework is populated with an Action and Objective column supported by relevant literature from three different source types. The Action column is organized by the following sections: Explore, Acclimate, Plan & Design, Communicate, and Monitor (Figure 2). The process begins at Explore and follows through to Monitor. However, the process is iterative and a section can, and should, be revisited as needed at any point while using the framework.

![Figure 2. Conceptual layout of the iterative methods framework](image)

Each section contains a directive to address in achieving the related Objective. For instance, the Action “Explore” aims to achieve the Objective “Identify the issue and key players.” Recommendations of useful steps in going through the process are included in each section. Continuing the Action “Explore” example, the directive to “study site history and context” is to “locate natural and cultural resources,” while the directive to “determine users and community relationships” is to “connect decision-makers and information users,” and finally, the directive to “consider opportunity for innovative and creative solutions” is to enable “collaboration in defining the issue.” This process is repeated for each Action section. Additionally, each Action and Objective describes relevant parties to be involved at a given stage of the process and a concrete example enabling progress toward the Objective. The Action “Explore” suggests engaging social scientists and stakeholders at this stage, while using social media is listed under the Objective column as one potential route in working to achieve the Objective “Identify the issue and key players.”

A third and fourth column attaches supporting literature to the corresponding Action and Objective columns. The supporting literature informs and is directly related to the directives in the Action and Objective columns. Each section contains supporting literature from three source types: journal articles (JA), National Park Service reports (NPS), and Other (O), lending multi-source support to the directives in the Action and Objective columns. Although these literatures were situated in the Action “Explore” category, information within the literature could overlap in other Action categories. Therefore, the literature associated with each Action category should not be misinterpreted as only contributing a single directive to a single category. However, the literature identified in each category did contribute significantly to the category it is tagged within compared with the other categories. For instructive and organizational purposes, therefore, the authors grouped literature in the most relevant categories.

Using the Action “Explore” as an example, Hino et al., 2019 (JA), Beavers et al. 2016 (NPS), and Aiken et al. 2014 (O) each contain content that supports the directives in the Action “Explore” column and the Objective “Identify the issue and key players” column. The directive “study site history and context” is to “locate natural and cultural resources,” with suggestions of engaging social scientists and stakeholders and proposed example of exploring social media for site uses. The process described is followed likewise for each Action. For instance, the Action “Acclimate” aims to achieve the Objective “Define socioecological factors.” The directive “specify relevant adaptation and resilience strategies” is to “determine habitat type...”
of nature-based design,” encouraging users to engage ecosystem scientists and allied researchers and consider using mapping and projections for studying the site. Similarly, the Action “Plan & Design” aims to achieve the Objective “Implement adaptation, mitigation, and resilience measures.” The directive “strengthen preparedness, adaptation, and resilience” is to “encourage local and regional preparedness and adaptation,” with planners and designers engaged at this stage and a potential method of planning alternative futures. The Action “Communicate” aims to achieve the Objective “Promote dialogue and idea-sharing.” The directive “provide educational and engagement opportunities” is to “present the site as a demonstration of climate change.” At this stage, the Action “Communicate” suggests engaging communication professionals and end-users, and recommends using past and present photograph comparisons as one potential example in achieving the Objective “Promote dialogue and idea-sharing.” Finally, the Action “Monitor” aims to achieve the Objective “Study design outcome.” The directive “connect research and practice” is to “create a practice-science feedback loop.” Here, the Action “Monitor” suggests engaging all relevant parties and recommends comparing baseline and outcome data as one potential example in achieving the Objective “Study design outcome.”

Together, the Action, Objective and Supporting Literature columns form the iterative methods framework. The directives capture perspectives from three types of literature largely related to climate change or sea-level rise adaptation, though the JA and O articles in the Action “Monitor” were selected for their instructiveness on integrating science and design. The literature also serves to provide further reading and context for those using the iterative methods framework for climate change design related to sea-level rise.

6 CONCLUSIONS

The study presents an iterative methods framework for informing coastal resilience design and planning projects. The framework is constructed in the context of national park land in Washington, D.C., but endeavors to be widely applicable to other coastal areas facing similar issues. The text within the framework reflects interdisciplinary thinking to provide a cohesive method to work from in the design process for sea-level rise issues.

A number of studies address the design process. Many even seek to understand design and planning adaptation strategies specifically in response to or preparation for sea-level rise and coastal change (Kirshen, Knee, & Ruth, 2008; Hurlimann et al. 2014; Burger et al. 2017; Woodruff, BenDor, & Strong, 2018; Molinaroli, Guerzoni, & Suman, 2019). Given the many disciplines involved in addressing sea-level rise issues, however, a comprehensive methods framework attempting to bring together and structure relevant interdisciplinary information might promote an informed, effective, collaborative, and sustainable design and planning process to address climate change issues such as sea-level rise. The iterative methods framework proposed here aspires to differentiate itself from other similar frameworks by focusing on climate-adaptive approaches, specifically for sea-level rise. The content in each Action and Objective provides a pathway to informing and guiding design in the context of coastal resilience, offering steps of when to engage interested parties and examples of strategies useful in adaptation design and planning. Furthermore, the framework includes literature with the potential for additional instruction and inspiration for users of the framework.

Attempting to bridge the gap between science and design, the framework develops a set of Actions and Objectives across diverse disciplines and takes initiative to involve stakeholders before, during, and after design. Engaging and empowering communities is an essential and informative part of the design process, or a project might risk unsuccessful adaptation or create inequity. Therefore, collaborating with communities in the design process, as encouraged by the framework, can inform and strengthen adaptation responses to climate change that support socioecological needs. Each Action pertains to an Objective meant to contribute to strengthening resiliency and sustainability. Ultimately, the framework aspires to improve the decision-making processes for communities affected by climate change issues such as sea-level rise. The iterative methods framework could be useful as a foundational tool and case study for park managers, policy-makers, and communities concerned with sea-level rise and storm surge issues.

However, the framework is meant to act as a guide for design related to climate change, specifically sea-level rise, and it is encouraged to use the framework as a foundation rather than canon. The proposed iterative methods framework is unlikely to be applicable in every instance of climate change design. Moreover, the framework may need to be appropriately adjusted for use on a case specific basis.
Additional limitations of the study include the extent of the literature review the framework is built on. A number of other studies and works could further inform and specify the framework. Literature was selected for its relevance and topic area, but the process was somewhat subjective. The authors hope that the triangulation of multiple sources for each section of the framework alleviates some of the subjectivity involved in the development of the framework, and advocate that users of the framework adopt additional relevant literature as necessary.

Finally, future study should evaluate the effectiveness, fluidity, and transferability of the iterative methods framework in multiple contexts and timescales. Whether the framework has applicability in both urban and rural contexts, for instance, provides an interesting route of future study, as does how well the framework stands up to issues of climate change beyond sea-level rise. The framework’s ability to connect multiple nature-based design projects in a shared area into a larger functioning system that provides numerous ecosystem services presents another interesting route of study. Overall, the study is not attempting to promote a single solution for sea-level rise and storm surge issues. But what the authors do hope the iterative methods framework does achieve, is furthering dialogue on design for climate change and offering a way forward in using nature-based design to increase community and ecological resilience in the context of sea-level rise and storm surge.

7 DISCUSSION

Unlike previously in history, human centers and coastal areas of interest have not been managed or planned for in an era of rapid sea-level rise and climate change. Large urban centers are likely to be the hotspots needing adaptation and coastal resiliency plans. But other areas of human interest, such as coastal national parks, are also primed to benefit from considering adaptive strategies addressing climate change issues like sea-level rise. Nature-based design offers an innovative and exciting approach in adapting to climate change and may serve as a vehicle for exploring and reinvigorating a research-design feedback loop. Tackling the complexities of sea-level rise, for instance, transcends any single discipline, presenting an opportunity for interdisciplinary collaboration and breaking down communication barriers across disciplines.

The interdisciplinary nature of the content informing the iterative methods framework in this study has implications for coastal resiliency and adaptation efforts, and the study may be useful in designing to buffer against the effects of climate change on the coastal front. The framework provides a step in promoting dialogue on design for climate change and connecting science and design as well as serving as a tool for coastal communities enacting resilience planning measures. Although the future of coastal areas seems tenuous, never has there been such urgency in developing sustainable, resilient, and innovative paths forward to preserving—and reimagining—human connections with coastal zones.

8 REFERENCES


March 17-19, 2021


ABSTRACT:
Over the past fifty years, water management and design has embarked on a new journey of resource allocation and disparity. A new generation of designers of the built environment are seeking innovative approaches to address the growing demands on our freshwater resources. Best management practices (BMPs) are often the first solution that are employed, however, stacked BMPs are making their way into the discussion of stormwater management for the first time. Stacking BMPs refers to combining multiple BMPs within a single landscape to mirror the flexibility of nature. This review explores the preliminary means of how these ephemeral and flexible landscapes can be achieved in the built urban and suburban environment and by what means we can achieve this - either through altering our design practices or our perception of what a BMP is within a stormwater based landscape. We examine how stacked BMPs can be applied as an alternative approach to singular BMPs in landscape application in order to better evaluate the current methods and practices for stormwater design and ultimately, proposing alternative methods better suited to the coming needs of future generations. In this critical review, we explore the current literature around stacked BMPs primarily focusing on water quality, ecological benefits, and aesthetic values of a stacked BMP as a design approach. Results reveal that, even though our water management styles are evolving to envelope ecological and social considerations - designers still prefer implementing single BMP systems that are heavily engineered for site specific capacities.

Keywords: Stormwater, stacked bmp, green infrastructure, water quality, climate change, design, landscape architecture
2 INTRODUCTION

One of the most common effects of climate change has been the ever-increasing intensity and irregularity of storm events in both urban and rural landscapes. Past approaches to engineered stormwater management have shown to be successful only in so much as the extent of the storm they are designed to manage. Most BMPs serve one or two fundamental stormwater management functions, however, they are relatively limited in addressing, simultaneously, the following common water management design goals: improved water quality, ecological diversity benefits, and inclusive aesthetic design.

Over the past two decades, a more environmental approach that mimics natural on-site infiltration—commonly referred to as on-site stormwater management—has been increasingly adopted. Onsite stormwater management utilizes best management practices (BMPs) to apply this sustainable alternative to addressing unpredictable rain events. These BMPs target stormwater management on site and increase infiltration to recharge groundwater supply. This is also widely considered a type of green infrastructure that has seen a rapid growth in application over the past twenty years as well. These are typically applied as stand-alone systems with the most common being: Wetland Basins, Grass Filter Strips, Riparian Swales, Bio-retention, Wetland channels, Infiltration pond/Basins, Composite / Bio reactor, Detention Basins, Rain Gardens, Media Filters, Porous Pavement, Retention Pond /Basins, and Tree Planters (see table 1). A burgeoning approach to stormwater management is stacking a variety of BMPs in a single landscape.

This review examines the existing literature of variables that are needed to design a stacked BMP system and explores the current practices and challenges of water quality modeling, ecological benefits and aesthetic design considerations. As this is a recent and evolving conversation in water management, more research regarding the design practices and considerations of stacked BMPs is needed. This critical review aims to fill this gap in literature and address some of the strengths and weaknesses of a stacked approach to stormwater management.

2.1 Background

Today, a broad range of best management practices exist for designs to implement into landscape settings. Regardless of BMP types, the goal of incorporating stormwater management into urban or rural infrastructure remains the same—to improve water quality and regulate volume flow to prevent flooding. We know that BMPs as individual systems have the potential to greatly impact the water quality, ecological diversity as well as the aesthetic value of a landscape design. However, these systems are highly engineered to serve a single purpose (water quality improvement, flood protection, groundwater recharge, etc.) and do not allow for the frequent drastic weather changes or for the agency of ecology (Reed, 2010) to evolve independent of the design. Only recently, did BMP application consider the aesthetic values these systems add to a landscape (Echols & Pennypacker 2008) and surrounding communities. A new generation of design is emerging, that incorporates a stacked approach to BMPs into the larger green infrastructure goals (Christianson et al. 2017, Korger et al. 2015, Sith et al., 2019, Villarreal et al., 2004, Damodaram et al. 2010).

While water quality efficiencies, ecological benefits and design aesthetics of BMPs as individual systems is an ever growing body of knowledge, that include discussions from engineers, designers, planners, and stakeholders alike (Hayden et al. 2015, Korger et al. 2015, Li et al., 2019, Villarreal et al., 2004, Damodaram et al. 2010). However, the concept of stacking multiple BMPs together in a single system is a relatively novel concept. Amongst stormwater engineers, the practice of ‘Daisy-chain’ systems, or systems where multiple stormwater management areas designed for a single function connect and/or flow into each other, is a somewhat common practice, but is not to be confused with stacking BMP systems. Although the ‘daisy chain’ approach to stormwater management is efficient in terms of water volume control and increasing water quality, it is not always ideal in areas with limited space or resources. Stacking refers to multiple BMPs combined and redesigned in order to be flexible and to create a single stormwater system that is an integrated part of the landscape, rather than separately functioning unit apart. In the sections below, we examine the water quality modeling, ecological benefits, and aesthetic values of a stacked BMP design approach. Our sources, though limited on actual stacked BMP case studies, include research journals, reports from various municipalities, and design manuals. Within each section, we identify the emerging practices of integrative design in stormwater management, and then highlight the challenges and what are the future considerations.
Table 1. Summary of the predominant BMPs and their corresponding design specifications and water management capabilities.

<table>
<thead>
<tr>
<th>BMP Method</th>
<th>Classification</th>
<th>Design Considerations</th>
<th>Water Volume Accommodations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wetland Basins</td>
<td>Wetland basins are engineered systems that utilize plants, soil, and organisms to remove a range of pollutants from water.</td>
<td>The average size of wetland basins should be ≥10 acres. The average slope for wetland basins is ≤ 3:1; the average rainfall between 69-79 in (1750mm-2000mm) of rain per year.</td>
<td></td>
</tr>
<tr>
<td>Grass Filter Strip</td>
<td>An area of land maintained in permanent vegetation found primarily on agricultural land and is designed to improve water, soil and air quality.</td>
<td>The minimum recommended length of filter strip is 25 feet, with the minimum total size of the buffer strip is 0.3 acres.</td>
<td>Typical specifications ensure an estimated capacity of between 0.1 – 0.15 m/s. Filter Strip Volume Reduction = Filter Strip Areas x Infiltration Rate x Storm Duration.</td>
</tr>
<tr>
<td>Riparian Swale</td>
<td>Encompass not only the active water channel, but also the exposed bars and areas of ponded water near the channel, including floodplain surfaces above and outside the channel banks.</td>
<td>Side slopes ranges from 3:1 to 5:1. One key feature of vegetated swale design is that they can be well-integrated into the landscape character of the surrounding area.</td>
<td>They are sized to temporarily store and infiltrate during a 1-inch storm event, while providing conveyance for up to the 10-year storm event with freeboard; flows for up to the 10-year storm event.</td>
</tr>
<tr>
<td>Bioretention</td>
<td>Consist of a soil bed planted with vegetation and underdrain system where Stormwater runoff is filtered through the planting bed, infiltrating into the existing subsoil layer below, removing pollutants and conveying discharge.</td>
<td>Bioretention are best served when the grade of contributing slopes is &gt;1% and &lt;5%. The planting soil bed is recommended to consist of a mix of materials, including sand, silt, and clay, &lt;5%. The soil should contain 5-20% silt/clay and &lt;20% clay content.</td>
<td>The bioretention surface area is approximately 3-6% of the contributing drainage. These systems have an average capacity of &lt;5 ft³/s, with the underdrain piping system connecting to infrastructure of freshwater system.</td>
</tr>
<tr>
<td>Wetland channel</td>
<td>A conveyance BMP designed to both slow stormwater runoff and allow time for both biological uptake and settling of sediment through dense vegetation before the untreated stormwater enters natural, or existing wetlands.</td>
<td>The mature channel geometry, in order to pass the flow rate of ≤ 2.0 ft/s, requires a channel depth between 1.5-3.0 feet, with the bottom width being not less than 3.0 feet. Vegetation plays a crucial role in swale treatment capacity, flow attenuation, and stabilization.</td>
<td>The channel should also provide enough capacity to contain the flow during a 100-year storm event, with the bottom width of the should being increased when additional capacity is needed.</td>
</tr>
<tr>
<td>Infiltration pond/Basin</td>
<td>Acts as a recharge basin that manage stormwater runoff in order to prevent downstream erosion and are often used throughout urban landscapes, remove a variety of pollutants from stormwater.</td>
<td>The surface is generally composed of a two-inch pea gravel or river stone layer, with substrates including filter beds, filter fabric and bottom soil. Soils are recommended to contain both &lt;40% silt/clay and &lt;20% clay content and have a slope no steeper than 3:1.</td>
<td>Infiltration basins vary in size, with the general basin covering 5-50 acres.</td>
</tr>
<tr>
<td>Composite / Bioreactor</td>
<td>Consist of a buried trench, filled in with woodchips, in which farmland tile drainage water flows, before finally entering the surface water.</td>
<td>Bioreactors can be applied in agricultural landscape or large land area types for the purpose of enhancing water quality.</td>
<td>Designed to treat from 30-50 drained acres averaging in size of ~4 feet deep by ~100 feet long and ~20 feet wide.</td>
</tr>
<tr>
<td>Detention Basin</td>
<td>Facilities built adjacent to tributaries of rivers, streams, lakes, and bays.</td>
<td>Loose, well-drained loam is recommended for detention basins, with clay-based soils not being optimal. Flat basins with gently sloping sides are needed before constructing, and it should be lower than the area to be drained.</td>
<td>The overall basin area is recommended to be &gt;20 acres, with the embankment slope being ≤ 25:1.</td>
</tr>
<tr>
<td>Rain Garden</td>
<td>Small facilities that treat stormwater by pooling water on the surface, allowing filtering and settling of suspended solids and sediment at the mulch layer, prior to entering the plant/soil/microbe complex media.</td>
<td>The soil should contain 5-8% compost, and 20-95% soil with slopes ranging from 3:1, or 2:1 when space is limited. The vegetation should be chosen to evaporate/stormwater, create pathways for infiltration, while also providing habitat for animals and insects.</td>
<td>Can provide for the infiltration of relatively small volumes of stormwater runoff, often managing stormwater on a lot-by-lot basis versus the total development site.</td>
</tr>
<tr>
<td>Media Filter</td>
<td>Media filters are structures, or excavated areas, containing a layer of sand, compost, organic material, peat or other filter media.</td>
<td>In order to avoid premature clogging and increased maintenance, media filters that operate under a lower hydraulic loading rate typically include finer gradations of media that are able to remove higher volumes of pollutants.</td>
<td>Designed to convey at least a ten-year, 24-hour storm event and if there is a detention facility, the filter needs to convey the 100-year, 24-hour storm event.</td>
</tr>
</tbody>
</table>
Porous Pavement
An alternative to typical pavement types that allow stormwater to filter through the pavement itself to an underlying gravel reservoir in order to either to temporarily store or infiltrate water. Porous pavement can be used to replace traditional impervious surfaces in a variety of locations, including: low-speed roads, alleys, parking lots, driveways, sidewalks, plazas, and patios. The capacity of the underlying reservoir limits the contributing area and permeable pavement may accept runoff contributed by adjacent impervious areas, such as driving lanes or rooftops.

Retention Pond/Basin
The function of a retention basin is to capture additional stormwater surge, which cannot enter into a stormwater drainage system, thereby slowly releasing it into the surrounding waterway. Basins should include differing depths, to accommodate varying vegetation types and perennial plants ideal for aquatic habitat. Species should be selected based on overall water depth tolerance, as well as aesthetic value and/or phytoremediation performance. Retention basins are recommended to have a total area of >20 acres, with the basin slopes being no steeper than 3:1 or flatter than 20:1.

Tree Planter
A small area that is contained and vegetated with trees in order to convey, collect, filter and treat stormwater runoff. The combined effect of trees’ ability to intercept, evapotranspire rainfall, and promote infiltration of water into the soil allows reduction in both the rate and overall proportion of rainfall runoff. Street tree planters can intercept 6.5 – 66.5% of annual rainfall, compared to 10 – 46% of annual rainfall for natural forests.

3. BMP WATER MODELING FOR QUALITY AND EFFICIENCY

Water quality modeling research on BMPs are relatively well-understood, so also are the various efficiencies and modeling approaches for BMP assessment. Numerous models, such as SWAT, AGNPS, AnnAG NPS, and HSPF are available for use, yet designers and practitioners are often unaware or not educated as to the appropriateness of which models are available and apply to certain conditions. (Douglas et al., 2013, Geng et al., 2009, Tuppard et al., 2011, Xie et al., 2015). These watershed models are also often limited, due to the scale of several more structural BMPs which are commonly implemented at a field-size scope. (White & Arnold 2009). More direct, specific models have been crafted for these interventions, such as modeling software that focuses specifically on the efficiencies of filter strips and riparian buffers, allowing for a more accurate set of results (Tuppard et al., 2011). Utilizing several of the aforementioned models, the International Stormwater BMP Database (IBMP) has collected a wide range of data sets from a vast anthology of BMPs currently in use, and then determined their abilities for improved water quality in: Total suspended solids (TSS), Enterococcus, Fecal Coliform, Arsenic, Cadmium, Chromium, Copper, Iron, Lead, Nickel, Zinc, Phosphorus, and Nitrogen (table 2).

Table 2. Water quality capacity of common BMPs Data collected from the 2016 International Database for BMPs. Blank spaces indicate unavailable data (IMBMP 2016).

<table>
<thead>
<tr>
<th>Solids</th>
<th>Bacteria</th>
<th>Metals</th>
<th>Nutrients</th>
</tr>
</thead>
<tbody>
<tr>
<td>BMP</td>
<td>TS S</td>
<td>Enterococcus</td>
<td>Fecal Coliform</td>
</tr>
<tr>
<td>Wetland Basin</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Grass Filter Strip</td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Riparian Swale</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bioretention</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Wetland Channel</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Infiltration Pond/Basin</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Composite</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>
3.1 Current practices

The most frequently used BMP modeling software typically falls under the category of watershed models for pollutants and sediments. The most commonly used by researchers and practitioners are the Soil and Water Assessment Tool (SWAT). Another modeling tool that is used to evaluate the effect of management decisions impacting water, sediment and chemical loading as well as the impact of management decisions on water and watersheds as a whole is the Agricultural Non-Point Source Pollution Model (AGNPS). AnnAGNPS PL, is another modeling tool that functions as continuous-simulation for pollutant loading as a batch-processor. Vegetative Filter Strip Modeling System (VFSMOD) is an event-based model routing system that examines the incoming hydrograph and sediment graph to simulate outflow, accumulation and trapping of sediments under field conditions (Sabbagh et al., 2010). VFSMOD-W: which is a vegetative filter strip modeling system that studies the hydrology, sediment and pollutant transport, specifically through a vegetative filter strip (Fox et al., 2010). The Riparian Ecosystem Management Model, or REMM, is a simulation structure that considers typical three-buffer riparian zones (Lowrance et al., 2005). Current practices for modeling the efficiencies of BMPs (stacked or otherwise) all contain multivariate simulations of real-time flow forecasts, stream flow model velocity and rainfall and/or runoff and/or flood values (Christianson et. al 2017). Additional components include a precipitation forecast and flow forecasting of streams, rivers, lakes, and reservoirs, and estimate the rate of evaporation. These features are useful for water resources assessment in the field, however, they are limited by the current and historic water flow and weather patterns (Li et al., 2019, Xie et al. 2015) and do not address the growing irregularities cause by climate change.

3.2 Challenges and future considerations

There are several challenges that impede designers from utilizing and implementing knowledge derived from water modeling software. The first being that practitioners are often unaware of the appropriateness of models for certain conditions (Xie et al. 2015). Several structural BMPs are commonly implemented at the field scale at which the utility of watershed models is limited (White & Arnold 2009). More factors need to be considered, such as limiting climatic factors, farmer preference, costs and practicality of implementation (Ibid). It also denotes that designers cannot make a conclusive selection of the ideal BMPs without an outside expert’s decision (Geng et al. 2009). Lack of time-based estimates of BMPs efficiency is also a challenge, due to the nature of the model database and the collected data (Ibid). Future research is needed to develop modeling approaches that quantify specific variables that watershed planners can adequately consider before proposing a design solution (Douglas et al., 2013). For these widely used BMPs (e.g., filter strips, riparian buffers, and detention ponds), specific assessment models have been developed (Tuppard et al., 2011). However, there is a need more detailed information as references to improve the operation process of data access and search efficiency of a stacked BMPs database (Geng et al., 2009).

A more realistic assessment of this complex approach to water systems design and management will enable designers and municipalities to better forecast climate change events, manage water infrastructure, and identify strategic needs that can benefit society. Digital modeling tools are a unique planning tool that can, in many cases, act as a natural extension of engineering in order to improve
stormwater management. However, its conception and application is limited to those with sufficient training in the modeling software, almost always, to a singular BMP and not a stacked design.

4. ECOLOGICAL BENEFITS OF STACKING BMPS

In terms of the current literature regarding ecological benefits of stacked BMPS, some research exists, however, it merely relates to the rural environment. According to research developed by Christianson et al, stacking BMPS can enhance overall water quality, particularly within agricultural areas, as well as accomplish the following: reduce nitrogen and sediment, significantly reduce all non-point source (NPS) loads, enhance freshwater provisioning (FWP), and suppress crop disease (Christianson et al. 2017). In their research, it is recommended that layering (stacking) of multiple BMPS is more advantageous than solely one treatment. If non-point-source pollution (NPSP) cannot be solved through ecological patch-level, landscape-level interventions should be implemented through adjusting landscape patterns, namely through increasing highly heterogeneous-patched or highly-connected corridors (Ibid). An example of an ecologically oriented rural stacked BMP can be seen in figure 1.

4.1 Current practices

In practice, when implemented in isolation, individual BMPS alone may not have the capacity to make a significant improvement in water quality, especially if nutrient loads are excessively high. However, when designers have multiple BMPS stacked within a landscape (e.g., slotted pipe draining into a two-stage ditch, with low-grade weirs), this leads to enhanced water quality, and ultimately ecological resilience (Kroger et al., 2015). The stacking of BMPS application could enhance the effectiveness of reducing nitrogen and sediment compared to single application, thus increasing the quality of aquatic habitat in riparian ecologies (Maharaj et al., 2016). A combination of BMPS significantly reduces all NPS loads, and thus improves soil, plant and fauna biodiversity (Sith et al., 2019). The stacked approach to BMPS was the most efficient way to enhance Freshwater Provisioning (FWP), which is a critical ecosystem service that is highly affected by climate change variability as well as land use and land management (Li et al., 2019). By combined application of BMPS, they can effectively suppress crop disease without using fungicides (Hempfling et al., 2017). Compound use of BMPS is recommended compared to only implementing a single application (Yaowu, 2015).

In practice of designed landscapes that are multileveled and flexible to change, ecological scholar and designer Chris Reed states that “ecological systems—in their multiple forms and manifestations, as mechanisms and/or models—forms the basis for a newly charged set of design practices: flexible, responsive, and adaptable as projects evolve and accumulate over time.” (Reed, 2010).
4.2 Challenges and future considerations

Non-point source pollution (NPSP) is one of the leading causes of degradation to our freshwater aquatic ecologies, and addressing this cannot be solved by simply applying BMPs at an ecological patch level. Rather, landscape-level interventions should be implemented by adjusting landscape patterns, increasing highly-heterogeneity biodiversity and/or highly-connected corridors (Yaowu, 2015). The dynamic change of impaired aquatic habitats brought on by watersheds exceeding total maximum daily loads (TMDL), and irregularity fostered by climate change, new challenges have arisen for designers choosing BMPs; especially whether stacking BMPs provides ecological benefits in and around a specific site (Williams et al., 2017). The stacking of BMPs for ecological benefits begs further research in order to better understand the true impact that this approach to design has on the surrounding ecology, with research focusing specifically around additive, multiplicative, or cumulative functions. (Kroger et al., 2015).

5. DESIGN AESTHETICS AND SOCIAL ACCEPTANCE

In terms of the design aesthetics and social acceptance of stacked BMPs, economics are one of the only areas that have seen significant study of benefits. Another area of research on the adoption of stacked BMPs is at the residential scale, and examining homeowner preferences. The exploration of Artful rainwater design (ARD) as a means for fostering amenities that enhance a site’s attractiveness or value, is another area of stormwater management and BMP design that has seen a sudden rise within the design professions. An example of an urban stacked BMP can be seen in figure 2.

5.1 Current practices

According to a recent study conducted by Christianson et. al., a stacked approach to BMPs, when utilizing conservation dollars, may prove to be the most cost-effective options, especially when considering nutrient reduction goals (Christianson et. al 2017). However, the major obstacle in this instance is a lack of understanding of either the social trade-offs or synergies between layered practices. On a smaller scale, other research indicates that homeowners prefer an intermediate number of BMPs stacked within residential landscapes; this being preferred for both their aesthetic preference and ecological concern (Hayden et. al 2015). In order to incorporate more and varying BMPs, new aesthetic norms are waiting to be formed within these residential zones. When deciding whether or not to adopt the stacked approach to BMPs, a designer or practitioner must first consider: size (area), water volume capacity, surface and subsurface requirements, slope percentage limitations, and whether it is infiltration based or surface movement (Table 3).
Table 3. Design guidelines for individual BMPs. Blank spaces indicate unavailable data. Data collected from the International BMP Database (IMBMP 2016).

<table>
<thead>
<tr>
<th>BMP</th>
<th>Size (Area)</th>
<th>Capacity (Vol)</th>
<th>Surface</th>
<th>Subsurface</th>
<th>Slope</th>
<th>Infiltration vs Surface Movement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wetland Basin</td>
<td>≥10</td>
<td>vegetation</td>
<td>M</td>
<td></td>
<td>&lt;1/3</td>
<td>infiltration</td>
</tr>
<tr>
<td>Grass Filter Strip</td>
<td>≥0.03</td>
<td>vegetation</td>
<td>soil</td>
<td></td>
<td>&lt;1/10</td>
<td>infiltration</td>
</tr>
<tr>
<td>Riparian Swale</td>
<td></td>
<td>vegetation</td>
<td>soil</td>
<td></td>
<td>1/5-1/3</td>
<td>movement</td>
</tr>
<tr>
<td>Bioretention</td>
<td>F</td>
<td>&lt;5</td>
<td>mulch</td>
<td>M</td>
<td>1/100-5/100</td>
<td>infiltration</td>
</tr>
<tr>
<td>Wetland channel</td>
<td>15-48</td>
<td>vegetation</td>
<td>loam</td>
<td></td>
<td>&lt;15/100</td>
<td>movement</td>
</tr>
<tr>
<td>Infiltration pond/Basin</td>
<td>15-50</td>
<td>gravel</td>
<td>filter fabric</td>
<td>&lt;1/3</td>
<td>infiltration</td>
<td></td>
</tr>
<tr>
<td>Composite / Bio reactor</td>
<td></td>
<td>vegetation</td>
<td>woodchips</td>
<td></td>
<td>infiltration</td>
<td></td>
</tr>
<tr>
<td>Detention Basin</td>
<td>≥20</td>
<td>vegetation</td>
<td>subsoil, riprap</td>
<td>1/20-1/3</td>
<td>infiltration</td>
<td></td>
</tr>
<tr>
<td>Rain Garden</td>
<td>F</td>
<td>F</td>
<td>vegetation</td>
<td>soil</td>
<td>1/3-1/2</td>
<td>infiltration</td>
</tr>
<tr>
<td>Media Filter</td>
<td>F</td>
<td>0.01-0.02</td>
<td>lighter media</td>
<td>F</td>
<td>infiltration</td>
<td></td>
</tr>
<tr>
<td>Porous Pavement</td>
<td></td>
<td>F</td>
<td>F</td>
<td></td>
<td>infiltration</td>
<td></td>
</tr>
<tr>
<td>Retention Pond /Basin</td>
<td>&gt;20</td>
<td>vegetation</td>
<td>subsoil, riprap</td>
<td>1/20-1/3</td>
<td>infiltration</td>
<td></td>
</tr>
<tr>
<td>Tree Planter</td>
<td>F</td>
<td>F</td>
<td>F</td>
<td></td>
<td>infiltration</td>
<td></td>
</tr>
</tbody>
</table>

When examining stormwater best management practices as an aesthetic alone, the growing trend of artful rainwater design has been a widely adopted practice by both landscape architects and planners alike. A recent study of ARD conducted by Echols and Pennypacker (2008), demonstrated a variety of benefits within a landscape when aesthetics are incorporated into the design process. These include: increased property values, incentive for revision of current stormwater regulations, increase public education to the ecological aspects of stormwater, successful case studies for site wide stormwater management, promote the value of maintenance of stormwater management systems due to the value they bring to the site, and promote designs that creatively address stormwater management in any site, regardless of location (Echols & Pennypacker 2008).

5.2 Challenges and future considerations

One of the largest challenges that face designers and planners when considering aesthetics and social acceptance of stacked BMPs is the lack of understanding of either the trade-offs or synergies between layered practices (Christianson et. al 2017). The new aesthetic standards are often inhibited by policy and current design standards that prohibit creative stormwater design solutions being implemented into the landscape regardless residential or urban (Hayden et. al 2015). Further research needs emphasize the compatibility of BMPs within landscape aesthetics in order to better address this gap in knowledge (Warner et al., 2017). Furthermore, the compatibility of BMPs within residential landscapes must be emphasized to accommodate a greater overall adoption and acceptance.

Other challenges that have been presented by the ARD movement include: unique designs bring unique maintenance, inspection, and management expectations and requirements; aesthetic values and ideas are rarely considered and integrated in the early design phases of projects; very little information is available on the best retrofit opportunities and life cycle costs of artistic stormwater management facilities (Echols & Pennypacker 2008).

6 DISCUSSIONS

This review of a stacked approach to integrated best management practice design for stormwater demonstrates that current approaches to stormwater management as highly engineered, singular systems,
are not the only option for designers, and there is an alternative more sustainable option available in stacking them. These systems are physically and technologically complex and can be particularly well designed for strict environmental compliance; however, they are highly interdependent and will seldom work effectively in a multifaceted system that is prone to frequent change. Current BMP designs, within the larger conversation of green infrastructure, have the potential to increase water quality, provide ecological benefits and improve aesthetic conditions, however a more integrated design approach in needed in the face of current weather patterns continual change in intensity and frequency. A stacked approach has the potential to better protect the environment and the public landscape with innovation to address extreme weather events while also allowing for improved community resiliency for more effective recovery after climate events. However, more research is essential to enhance a more resilient approach to water management. This review suggests a number of important implications for designers, researchers, and policy makers alike. With several important implications for the wider design world, the following section briefly examines the implications for water sustainability.

For designers, the current body of literature presented in this study suggests that increased consideration of stormwater designs that are aesthetically strong and socially inclusive is greatly needed. We recommend that designers consider how increasing on-site stormwater retention and infiltration can improve the visual aesthetics of urban and rural areas through improved aquatic connectivity and aesthetic appeal of stormwater sources and treatments (see figures 1 & 2). This stacked approach to stormwater management design has the potential to combine ecological services found in both urban and rural landscapes as well as provide additional water quality and flood protection. Designers should also consider the relationship between improvements in visual beauty and improvements in stormwater retention with regard to urban planning as well as a realistic assessment of stacked BMPs as a means for water systems design and management. Either through education or practice, providing opportunities for designers to explore new aesthetic norms of stacked BMPs into the designed landscape will offer a greater overall adoption and acceptance of this emerging approach to stormwater management.

This review has implications for a range of interdisciplinary researchers: from scientists who study interactions between water use by ground-based observation and others, who examine water quality and ecological relationships. Given the constraints to reduce NPSP levels imposed by physical and political parameters, namely design interventions at the ecological patch level rather than the landscape-level, future research needs to focus on how to address this concern on a larger site scale. By researching interventions that are implemented by adjusting landscape patterns and increasing highly-heterogeneity biodiversity and/or highly-connected corridors, a better understating of the ecological and water quality benefits can be assessed. The technology to manufacture this information through advanced modeling software has greatly improved as well as the ability to predict and design for conditions. However, technical and legal limits have imposed further challenges on the kind of data that is able to be generated. For example, the use of satellite images of field boundaries may be limited or otherwise prohibited. This latter restriction only strengthens the need for ongoing research of remote sensing techniques for ground observations, based on modeling data, of stacked BMPs. The future design capabilities of stacked BMPs, combined together with understanding the true impact that this approach has on the surrounding ecology, is an area of research that is in ever increasing demand.

The implications for policy makers are multifaceted, but equally significant. Loss of freshwater resources for communities and urban landscapes is a problem that will only continue to grow unless direct action is taken to halt its decline. Policy makers need to take climate change into account in their municipal goals and adaptation plans with regards to stormwater management requirements. A practical, long-term program is needed that will monitor the environmental changes being caused by climate change and ensure that pollution is reduced while maintaining a healthy social and ecological environment. Policy makers should also consider the aesthetics and social acceptance of stormwater management, specifically the stacked BMP approach, as a means of financial trade-offs or synergies between these multilayered practices. The effects of municipal requirements of stormwater management on flood prone populations will only become more pronounced in the coming years if policy does not require development to plan for long-term implications of their designs, specifically their stormwater management plans.

7 CONCLUSIONS

As we continue to implement highly engineered stormwater systems for our landscapes and strive for the ideal site specific practice, a more resilient approach to green infrastructure is needed. However,
the vast majority of water management systems step further away for this goal of mirroring natural systems flexibility and overall ability to evolve to change, and rather stagnate our landscapes in single function and single use designs. There has been significant development over the past 20 years toward understanding best management practices and their impact on green infrastructure and promoting environmental fitness. Specifically with regards to ecological adaptability, designers are encouraged to construct stormwater landscapes to be more flexible, responsive, and adaptable in order to evolve to the unprecedented changes the future brings. However, these are based on single BMP units and not on the combined effect of a stacked approach. In this review, we have explored the limited literature available on the water quality abilities of a stacked approach to BMPs, their ecological benefits, and the significance of the aesthetic consideration in design. Moreover, as our knowledge of their value increases, the scientific community has yet to reach a consensus on the role of stacked BMPs in the implementation of green infrastructure. Furthermore, given that green infrastructure is an area of design that is still relatively recent in regards to successful case studies that knowledge can be drawn from, the lack of long-term lifecycle analysis of stacked BMPs creates its own challenge to accurately measure the impact this alternative design approach can have on water quality and ecosystem health. There have been a number of other challenges that have impeded an increase in the adoption of stacked BMP design. These obstacles include a lack of reachable information to designers and policy makers alike due to the overly technical nature of stormwater modeling. Also, the lack of current information in the city’s stormwater policy is a significant challenge, as many municipal codes haven’t changed or been reevaluated to reflect the growing trends as a result of climate change. Lastly, a need for significant financing for the investment in ecological and aesthetically inclusive stormwater management systems at the national level is considered essential. Both designers and researchers need to continue challenging the conventional approaches to stormwater management and BMP design and provide feasible options to our communities, in order to create more resilient and integrated stormwater management systems that can ensure access to freshwater quality for future generations.

8 REFERENCES


TRANSFORM A VEHICULAR ROAD INTO A WATERWAY: RECLAIMING A LOST WATERWAY OF DHAKA CITY THROUGH LANDSCAPE DESIGN

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1 ABSTRACT
In the intense urbanization of fast-growing cities in developing countries, preservation of surface water has consistently been neglected. Overall, rapid urbanization increases impervious surface and decreases natural land surface, resulting in ecological degradation; bringing surface water back into a city will improve its ecology. One means of restoring surface water is to reintroduce lost water bodies or waterway connections. This paper will discuss a hypothesis regarding the process of reviving a lost waterway through landscape design, namely that reviving a lost water channel through transforming a vehicular road into a waterway can bring nature back within the city. Dhaka City was chosen as the study site for this idea-based proposal. First, a physical survey was conducted and the road to be transformed was categorized into several sections based on land use, activities, and appearance on both sides of the road. The ArcGIS flow accumulation tool and watershed tool were used to determine a proposed depth for the waterway. The design proposals are particular to each road section. An overall design concept was developed, and several functions are proposed based on site surveys to support the existing transport system. In addition to restoring nature, the potential outcome of this idea-based experimental proposal may help address the growing demand for water in the urbanized area of the city of Dhaka, Bangladesh

1.1 Keywords:
Lost waterway, landscape design, ecology, Dhaka.
2 INTRODUCTION

For generations, people in developing countries had intimate connections with water; it was part of their daily rural life. In Bangladesh, it was a common scenario for every village house to have a pond that collected and stored water for daily use (Sultana & Crow, 2000). As the urban population increases, however, city residents lose the opportunity to experience the blessings of water during their daily life and work. Urbanization and the associated impervious land have altered the topographies and natural processes of our cities to such an extent that it is not easy for water, soil, vegetation, and heat systems to function naturally (Gajjar, 2017). The ecology of the city is being degraded—but water has power for both mitigation and problem-solving in terms of improving human life and site environments. To restore surface water to a city will improve its ecology. Accordingly, landscape designers and planners can take a strong step by reintroducing lost water surfaces to a city and so reclaim the lost natural system for that place.

This project is an experimental design built upon a hypothesis for bringing a lost waterway of Dhaka City back to life. The waterway in question was buried under a vehicular road and has become a box culvert; it can no longer carry water due to blockage resulting from a lack of maintenance. The road covering it, named “Panthapath,” is very important to the city because it feeds traffic to the Bashundhara City Shopping Mall, one of the largest shopping malls in Southeast Asia. The mall comprises the 19-storey corporate office of the Bashundhara Group and contains retail shops, theme parks, a fitness center, swimming pool, food court, cinema complex, and more. Every day, more than 25,000 people visit the mall (Mandal, 2019). Notably, after reopening the waterway to connect two other water bodies, Dhanmondi Lake and Hatirjeel-Begunbari Channel, a new mode of transport will be introduced for this area (Figure 2).

Reopening a lost water channel through transforming a vehicular road into a waterway can bring nature back to a city and allow residents to encounter the blessings of water in their everyday work. The transformation has social and economic value; retired couples, friendship groups, and families are the most frequent users of waterway recreational facilities (Social and Economic Benefits of Waterways, n.d.), and the restored waterway would also serve as water collector and storage for the site area. For example, the River Quaggy at Sutcliffe Park in Eltham, South East London was lost underground in a culvert for
years. During flood events, it was quite evident that a river had once flowed there. Restoring the river allowed people to access nature and wildlife and simultaneously improved flood risk management, which is beneficial for the local community (Mandal, 2019). Another great example is the Cheong Gye Cheon Restoration Project, one of the most expensive river restoration projects in the world (Lee & Jung, 2016; Yoon, 2018). In such projects, landscape design proceeds according to three principles: 1) resurrecting the history of the site, 2) urban renewal and revitalization, and 3) bringing nature into the middle of the city (Mandal, 2019). Furthermore, restoration allows for economic growth (Seoul & it, 2011), improves air and water quality, and reduces the temperature of the surrounding area by an average of 3.60 °C (Mandal, 2019). Above all, however, the most positive aspect of this work is introducing an opportunity for ground water recharge. Research shows that in Dhaka, the groundwater level is declining with a trend of 3 meters per year (Islam, et.al., 2017). Groundwater is a critical resource, as it comprises about 97% of the world’s freshwater (National Research Council 1994) and can be tapped as part of the water supply in urban areas. In the United States, about half of the population and three-fourths of public water supply systems rely on groundwater (National Research Council 1994). To prevent contamination of a waterway restored from a vehicular road, fast-growing local grasses are introduced beside it, which also serve to reduce runoff and sedimentation (Fiener & Auerswald, 2003).

In preparation for the transformation process in Dhaka, a physical survey was first conducted. After analyzing water flow throughout the whole city, a study area was selected, and the chosen road was divided into several sections based on the activities and appearance on both sides. Design proposals were suggested for each road section according to its context. An overall design concept was developed, and several functions based on the site survey are proposed here to support the existing transport system. This landscape design process can provide a prototype for similar situations in Dhaka City or any other city of Bangladesh.

**Figure 2: Location of the study area.**

### 3 RESEARCH OBJECTIVES

This study aims to develop a process for reintroducing a lost waterway through landscaping as a possible means of restoring surface water to a city. Specifically, this paper demonstrates how a vehicular road can be transformed into a waterway and bring nature back into the city. The most positive aspect of this proposal is the protection of wetlands and water bodies, in the absence of which the drainage system of any city will collapse. This process will resurrect dead waterways and restore the hydrological balance.
of the area. In addition, a continuation of this study will show how to recharge groundwater while minimizing contamination.

4 METHODS

First, a regional-level inventory and analysis was conducted using documents, historical maps, Google Earth Pro images, hydrologic analysis with arch map tools, and review of urban planning proposals to identify the study area for the present work. A stretch of vehicular road was selected for conversion that would restore a lost waterway, provide a reservoir, allow recharge of ground water, and restore the hydrological balance of the study area.

The road to be converted was divided into sections on the basis of its uses and associated activities. Important buildings were noted, and the catchment area was determined through hydrological analysis of the zone. Measures for preventing runoff contamination were incorporated, and a plant list was developed to intentionally restore nature to the city. Finally, a design concept was developed to provide guidelines and proposals for incorporating the changes.

4.1 Regional level inventory and analysis

Water flow analysis was conducted using ArcGIS tools. Notably, Bangladesh does not have public-level access to the resources needed to generate the metadata for this analysis; data must be purchased or generated by the researcher. The water flow analysis map (Figure 3) revealed that water flows from every direction in Dhaka City; even within a single water basin, it flows from several directions. Accordingly, there is no hardship in converting a road into a waterway where the streamlines support one (Figure 3).

Historical maps and resources helped reveal the city’s lost waterways (Datta & Mandal, 2017; Mandal, 2019). Where streamlines do not meet with a water body (colored black on the map) (Figure 3), the water in question is surface runoff. For the selected study area, converting the road into a waterway would reduce waterlogging of Dhaka City.

4.2 Physical survey

The study area is an important east-west secondary connecting route approximately 1.7 km in length, named “Panthapath” and located almost at the center of the western part of Dhaka City (Mandal, 2019). It connects two major roads, Mirpur Road on the west side, where it terminates at Russel Square, and Kazi Nazrul Islam Avenue on the east side, where it ends in the SAARC Fountain Circle (Mandal, 2019). A secondary road, Green Road, crosses Panthapath from north to south between those two major roads (Figure 4, existing road condition view).

In terms of hydrology, Panthapath connects Dhanmondi Lake on the west side and the Hatirjeel-Begunari water channel on the east. The Begunbari channel can carry 15% of the total runoff of Dhaka City and functions as a water reservoir for the whole area. Originally, there was a passage linking Hatirjeel-Begunbari with Dhanmondi Lake. In the late 1980s, construction began on the east-west route; it was completed in 1995.

Panthapath is among the important business areas of Dhaka City. In particular, it is home to one of the largest shopping malls in Southeast Asia, the Bashundhara City Shopping Mall, which provides spaces for numerous high-tech manufacturers, corporations, theme parks, fitness centers, and shops. Many important buildings are located at the mall, such as a hospital, banks, and mosques, and more than 25,000 people visit it every day. Besides the Bashundhara City Shopping Mall, other key landmarks include Square Hospital, Samorita Hospital, and the Unique Trade Area (Mandal, 2019). Generally, both sides of the road are lined with tall buildings (Figure 4, sectional view), specifically buildings with more than ten stories, although there are high-rise, low-rise, and one-storied buildings at points along the road. Most of the tall buildings are mixed-use, hospitals, and banks. One hospital has an overhead connecting bridge, which is for pedestrian use; there is also a second overhead bridge for general pedestrian use. There are likewise pedestrian paths in front of the buildings, which are above the level of the vehicular road. Regarding vehicular traffic, the road has two, three, or four lanes at different points. The road divider is of different widths in different sections, and where it is more than five feet wide, people use the divider area as a vendor zone (Figure 4, sectional view). Overall, the study area was divided into four sections on the basis of road size, road appearance, building heights, and associated activities (Figure 4).
Map of the water basin for Dhaka City

Figure 3: Water flow analysis of Dhaka City.

Existing road condition in the study area
4.3 Design concept

In addition to bringing nature back into the city, a second purpose of this work is to introduce waterways as a mode of transportation. Both purposes are served here through the design concept. Figure 5 shows the proposed plan, conceptual sectional view, details of the pedestrian and vehicular portions, and a view of the connecting waterways.
RESULTS

The goal of this design was to incorporate a historical water surface that has been lost and to create surrounding space that will bring nature into the city. This space is envisioned as becoming a vibrant gathering place for the community and as augmenting transport and vehicular circulation. Accordingly, the designs considered were based on the initial site survey and context analysis, taking into consideration the different types of facilities that need to be provided along the banks of the waterway to achieve the concept’s goals.
5.1 Incorporating emergency access

As the waterway will limit vehicular access, it was important to ensure the proposal provides emergency access for fire trucks and ambulances to all existing buildings. After analyzing the building typology on both sides of the area, some important buildings such as hospitals and banks were identified where emergency vehicular access needs to be provided.

5.2 Providing opportunity for street markets

Dhaka City is famous for its roadside market stalls, and residents are accustomed to doing their everyday shopping in these marketplaces; hence, a portion of the concept was dedicated as a vendor zone (Figure 5). There is provision for piers to make the area more usable for city dwellers.

5.3 Creating appropriate planting zones

Plants are very important elements of any landscape design. Here, the whole study area was divided into several distinct planting zones with consideration of local climate, sun exposure, and soil type. Native trees with edible fruit were selected to make a productive landscape and promote healthy food habits among visitors; moreover, trees were selected such that fruits can be picked and enjoyed all year round. Each planting section will get one tree to give shade and shelter. For aesthetic purposes, a variety of flowering plants were likewise chosen to provide interest in all seasons.

5.4 Phytoremediation

A number of different ground covers and local grasses were proposed for the purpose of preventing erosion. In addition, aquatic phytoremediative plants capable of absorbing waste material from water were incorporated in the bank areas to improve water quality and provide better conditions for marine life.

5.5 Maximizing walkability

The whole area was designed as a pedestrian-friendly area with provision for emergency vehicular access. After analyzing road connectivity, it was decided to propose an alternative road behind the buildings. Such a road should be implemented by the city’s urban planning department to provide services to important buildings in the study area.

5.6 Ensuring universal accessibility

To promote universal accessibility, rams and safety bars have been incorporated into the design. Textured surfaces were used for ease of navigation and for safety purposes. The pedestrian level was kept on the same plane as the building ground level, eliminating any need for steps.

5.7 Maximizing water permeability

Hard surfaces like asphalt roads and concrete pavements increase the surface runoff volume during heavy rains. By minimizing the use of impermeable materials, surface runoff can be decreased and underground aquifers can be replenished. To increase permeability, this design incorporated permeable pavement and other soakable materials. Furthermore, a bio-swale system was used to collect the water from permeable surfaces, with the remaining water directed to the lake (Figure 5). A grassy strip was incorporated to reduce erosion. As storm water percolates through the different layers of soil media and plants, dust particles and heavy elements are removed, thereby improving water quality.

5.8 Bringing nature into city life

Converting a road into an urban waterway creates a natural-looking environment. The resulting wetland fulfills the purpose of a natural drainage system and improves the overall urban environment by several means such as improving air and water quality and providing an ecological conservation area that can bring nature into the city (Figure 5).

6 CONCLUSIONS

The main emphasis of this study is to develop a landscape design process for converting a vehicular road into a waterway. One of the major problems faced by city residents is a scarcity of drinking
water. This study revealed a possible means to recharge groundwater resources from surface runoff in a natural way while reducing contamination. The most positive aspect of this study is the protection of wetlands and water bodies, which will improve the ecological environment and drainage system of the city. Another positive aspect of this study is the use of the proposed waterway for transportation, as water transport is the cheapest of all modes of transportation. All in all, this study can be a key factor in bringing dead water lines back to life throughout Bangladesh.

7 REFERENCES


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Peer-reviewed article publication on the Record starts from the abstract submittal to the CELA annual conference. The CELA executive office sends out Call for Abstracts around August each year.

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The Vice President for Research leads the track chairs in the abstract review. Double blind review is used. Each abstract is reviewed by at least two reviewers.

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Authors of accepted abstracts receive the invitation to submit a full paper in November. The deadline is in January of the following year. The papers submitted at this time are not peer reviewed but only edited to satisfy the conference standard. Papers that do not follow the template of the conference are rejected.

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Paper Review: May-June
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Review Result and Revision: July
Track chairs collect review results and make recommendations on the manuscripts. Papers that are accepted with revision requirement will be sent back to the authors in July.

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