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Information Visualization in Three-Dimensional Photorealistic Environment: A Case Study of Forestry and Visual Impact Assessments

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ABSTRACT

Visual impact assessments are an integral part of forest operations often conducted by foresters to prevent excessive visual damage to the scenery. In this work, we study how visual impact assessments are conducted and explore how information visualization can complement this process. We start by deriving important tasks and design requirements from i) a review of relevant documents and ii) findings from interviews with domain experts. Then, we describe Evergreen, an information visualization system in three-dimensional photorealistic environment informed by these tasks and requirements. Finally, we report on a qualitative evaluation of Evergreen where domain experts completed the derived tasks. We found that the system can effectively assist foresters in conducting visual impact assessments, and that participants would include Evergreen into their current workflow. The results highlight directions for future research including how navigation, interactions, and visual encodings can make communicating information within a 3D environment more precise and effective.

Index Terms: Human-centered computing—Visualization—Visualization application domains—Information visualization;

1 INTRODUCTION

Visual Impact Assessment (VIA) is the analysis of the potential visual effect that proposed forest operations may have on the scenic landscape. It is often used in the planning and design phases of development projects to ensure the project does not cause excessive damage to the scenery of an area and its local communities. In this research, we focus on VIA conducted within the scope of forestry regulated by the province of British Columbia (B.C.), Canada.

The overarching research question is **How can information visualization assist foresters in conducting VIAs?** There exists several tools and systems designed for the purpose of conducting VIAs in forestry. However, these tools focus on the analysis aspect of assessments and the visualization aspect is rarely the emphasis of these tools. For example, conducting slope analysis in QGIS [1] relies on overlaying a heat map onto a 2D map. Although this approach may be suitable for simple operations, it becomes overwhelming for the user when completing complex operations, such as comparing multiple areas of the forest with similar visual criteria.

2 FORMATIVE STUDY

To understand the process of VIAs and which aspects to design for, we conducted a formative study to form domain tasks and visualization requirements. As the process is regulated by the B.C. government, we used government documents [4–6], including regulations and guidelines, published by the B.C. Ministry of Forests as

the primary data source. To gain a deeper insight to VIAs in a real world setting and to verify the data gained through the documents, we also conducted semi-structured interviews with domain experts as the secondary data source.

We identified two basic components: 1) viewpoints and 2) visual sensitivity units, or polygons. Both components are associated with multiple quantitative and qualitative parameters. We also identified the three following high-level tasks to support: 1) the user should be able to view which parts of the terrain can have additional modifications, 2) the user should be able to view parameters associated to components on the terrain, and 3) the user should be able to view the relationship between components on the terrain.

3 EVERGREEN

For the purpose of this research, we used a sample dataset from Malcolm Knapp Research Forest in B.C. to prototype and design Evergreen.

Due to the characteristics of VIAs, which simulate the visual effects of modification operations in perspective view, Evergreen is designed in a photorealistic 3D environment using Unity [2].

Visualization components are placed on top of a realistic terrain that depicts the research forest with accurate elevation and texture from high resolution satellite images. The terrain we use does not include vegetation data natively and trees were planted onto the terrain manually.

Major visualization components were designed for both viewpoints and polygons. Viewpoints are depicted using 3D models of a pinpoint whose 2D size represents viewpoint importance. Polygons are depicted as color overlays on the terrain whose color hue represents whether additional modifications can be made.

Evergreen uses the Visual Information Seeking Mantra: “Overview first, zoom and filter, then details-on-demand” [7]. Users may see additional information of specific viewpoints and polygons once they identified ones of interest. Then, bars show associated parameters of selected polygons and arcs represent their relationship with nearby viewpoints.

4 EVALUATION

To evaluate Evergreen, we conducted a qualitative evaluation with domain experts, where emphasis was placed on whether Evergreen would assist them during VIAs. Four experts were asked to complete tasks while using the think-aloud protocol [3] and to complete a short questionnaire after each task. At the end of the evaluation, they were asked to elaborate their experience with the system in a short interview.

Overall, participants were able to complete tasks and they stated Evergreen is effective at assisting foresters in completing VIAs while being easy to learn and use.

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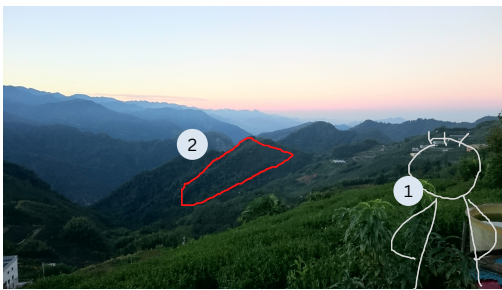
DRAFT

Our goal is to understand:

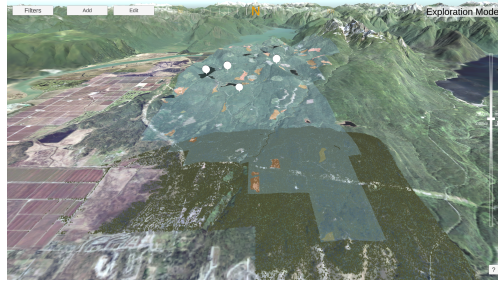
How can information visualization assist foresters in conducting visual impact assessments

Visual impact assessments consists of

1. Viewpoints
2. Visual sensitivity units (Polygons)

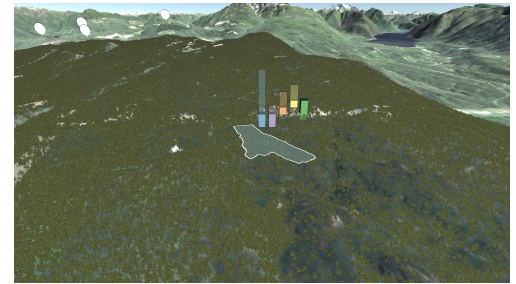


We designed **Evergreen** to solve some of the issues we discovered

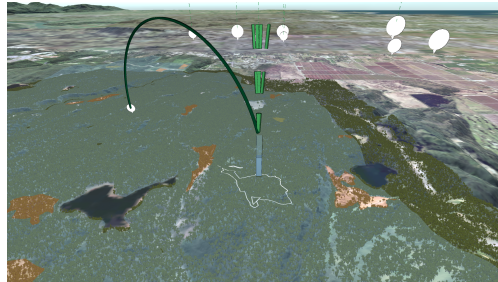


Users are able to navigate the forest in a three-dimensional photorealistic environment

Quickly determine which areas of the forest is suitable for additional modification using the color overlay

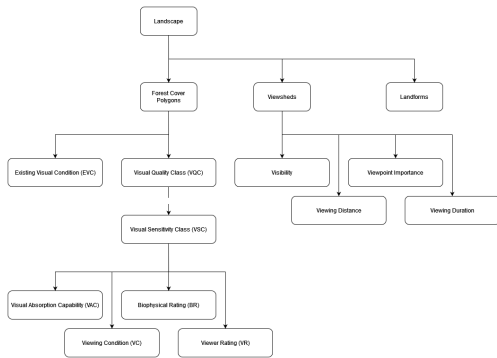


View associated parameters of both viewpoints and polygons



Explore and discover the relationship between selected viewpoints and polygons

With their individual associated parameters



Enter first person mode to view the landscape and simulate field work

