Visning av landskapsbilder på en stor kurvet skjerm

– Visningsbetingelsenes effekt på evalueringene

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Vitenskapelig bedømt (refereed) artikkel

Caroline M. Hägerhäll og Ramzi Hassan: Displaying landscape photos on a large curved screen – The impact of viewing condition on evaluations.

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Photographic representations are commonly used as substitutes for on-site experience of landscapes in research on human evaluations of landscape. However, there is an ongoing discussion about the validity of such representations. In this study we explore how screen size affects evaluations. We also present an approach in which 2D static photographs are used in combination with a digital 3D environment, combining the advantages of a photorealistic representation of vegetation and a digital model. Forty-two respondents, divided into two equal groups, evaluated forests with three different degrees of biodiversity viewed either on a 17 inch computer screen or on a 7m x 3m curved display. Groups evaluated the forests using the Basic Emotional Qualities scale, where subjects are asked to judge how they would feel after having spent a period of time in the environment presented. Although the overall landscape evaluation was not statistically significant under the different screen conditions, interesting differences in evaluation of the different forests were found that suggest that the evaluations were affected by viewing conditions.

Key words: landscape experience, emotion, biodiversity, forest, curved display, landscape modelling techniques, virtual reality theater

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Introduction

Field experiments are costly and time consuming and limit the number of environments that can be tested. Photographic representations are therefore commonly used as a substitute for on-site experience of landscapes in research on human evaluations of landscapes. Furthermore, photo based studies provide experimental control and allow the study of future landscapes using simulation techniques. The validity of photo based studies is currently under discussion.

Studies have been carried out on various types of representations, such as normal photographs, panoramic photographs and videos. The results concerning validity are inconsistent and point to a complex relationship between stimuli and evaluations (Daniel T. C. & Meitner M.M. 2001; Hull R.B. & Stewart W.P.1992; Kellomaki S. & Savolainen R. 1984; Shuttleworth S. 1980; Stamps A.E. 1990; Oh K. 1994). One important difference between an on-site experience and viewing a photographic representation is in the sense of presence, that is, the difference between being in or looking at the landscape. Apart from on-site factors that could affect other senses than vision, the extent of the visual environment differs greatly if, for example, a person is looking at a small size photo or is surrounded by the environment in the field. (IJsselsteijn W. & Riva G. 2003; Lombard M. & Ditton T. 1997; Flach J.M. & Holden J.G. 1998; Slater M. 2009).

The majority of landscape preference and landscape experience tests are performed using a standard computer screen or projector. The aim of this study is to investigate possibilities for combining the control of a laboratory setting and photographic representations with a larger degree of presence achieved by showing static photos on a large curved display and using Virtual Reality technology. The hypothesis is that the experience of environments in this setting would differ from the experience when viewing the same environments on a small normal computer screen. We hypothesize that responses will be stronger and that there will be a larger degree of presence.

Commercially available 3D software is available which could create 3D representations of vegetation and ecosystems. However, 3D digital models of a forest, for example, would not be as realistic as photographs of a real forest. Creating digital 3D models is also time consuming. Photographs, on the other hand, represent real cases and could be produced in a relatively shorter time. In this study we introduce a method using 3D immersion using 2D photo based material. The strong 2D illustrative characteristic of a photograph is combined with a 3D environment in order to enhance the feeling of presence in the environments. This creates a new experience that differs from the experience of a digital 3D model. In this study we investigate how Virtual Reality technology can enhance the use of 2D photo presentation.

Method

Participants

Forty-two respondents participated in the study, equally divided between the two setups: small computer screen and large curved display. All were students at the Norwegian University of Life Sciences. Most of the participants were from the Department of Landscape Architecture and Spatial Planning but a few came from The Department of Ecology and Natural Resource Management. The sample for the small computer screen consisted of 5 males from 22–29 years old (mean 25.6), and 16 females from 19–25 years old (mean 21.8).The sample for the large curved display consisted of 9 males 22–34 years old (mean 26.4) and 12 females 22–32 years old (mean 25.25).

Environments

The environments in this study are forests with differing degrees of biodiversity, categorized as low, middle or high diversity based on the visible degree of layering of vegetation and the ground cover vegetation. Sites were selected in collaboration with local authorities and a landscape ecologist at the Department of Landscape Architecture and Spatial Planning. Local landscapes were used in order to allow the subjects to return to the sites for future studies, and to provide sites that were familiar to the test subjects.

Stimuli

The study was conducted in mid-October and over a short time span, since the visual environment changes rapidly at that time of the year. Sampling was done under similar weather conditions to minimize effects of weather on the responses. Numerous pictures were taken at each locations to provide a good variety from which to choose, and four images were finally selected for use in the test. One image was selected from each of the three diversities, and the fourth was a low diversity forest with more apparent human influence, Figure 1-4.

The technical preparation of the stimuli is of particular importance and can be described as follows. All pictures were taken with a Canon EOS 30D digital single-lens reflex camera mounted with a wide angle lens, Canon EFS 10–22 mm. A tripod was used to avoid blurred photos and to ensure that all pictures were taken from the exact same position at each viewpoint. The pictures were taken in Canon RAW file format (CR2) for maximum resolution. The large curved display (curving 160 degrees with 7m width x 3m height) is part of a virtual reality theater used for visualizing and interacting with three-dimensional models. The projection display has a resolution of 3840x1805 pixels. To adapt the format to match these dimensions we needed to take several pictures, side by side, at every location, which we then merged together digitally. By manually locking the shutter speed, aperture, focus point and focus length we achieved the same lighting conditions and viewing area in concurrent pictures for each location. Using designated software, we stitched the photos together to create the correct size and view. Several programs were used to process the pictures. First, the RAW-format file was converted to high quality jpeg file format with Canon Digital Photo Professional. Then we stitched two or three pictures together with Canon PhotoStitch. Finally, the pictures were altered and adjusted with Adobe Photoshop and Google Picasa.

One problem that arose during the preparation process was the distortion of perspective that occurs when using a wide angle lens. We were photographing in relatively cramped areas, in forests and amongst obstructive landforms, and we needed to use a wide angle lens to capture the whole scene from a short distance, without losing the ground or sky from view. The wide angle lens tends to distort the perspective as it approaches the 180 degree view, making it difficult to merge them without mismatching. We overcame this problem by adjusting the results manually in Photoshop to fix the mismatching.

Figure 01: Forest with low diversity. The ground vegetation has few species, and there is almost no vegetation in the middle layer. The main vegetation is trees of one species.

Figure 02: Forest with middle diversity. The ground cover still has low diversity but the middle layer is richer and several tree species are present.

Figure 03: Forest with high biodiversity. All layers contain many species.

Figure 04: Forest of low diversity, but containing stands with both planted (on the right) and natural (on the left) structure.

Preparing images for the large curved display

As stated earlier, the photos were to be shown in two settings: a traditional computer screen and a large curved screen. The small screen setting in the computer lab presented no problems. It was easy to show 2D picture on a 17 inch screen with display resolution:1280X1024 pixels.

Concerning the test using the large curved screen, special procedures needed to be developed. The main issue was how to project the photos which were prepared previously onto the curved screen with some kind of 3D immersion.

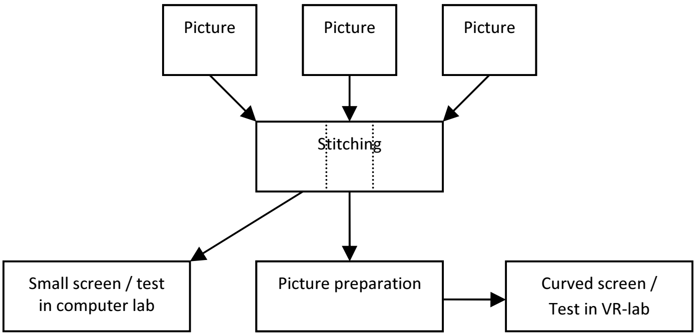

Figure 05: Process of preparing photos, for both tests.

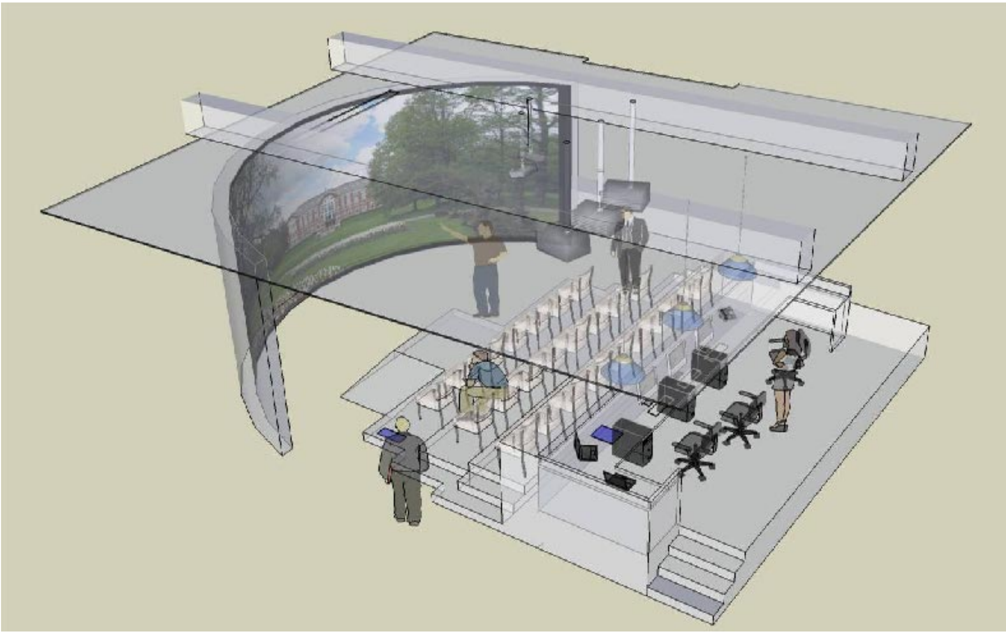

Figure 06: 3D illustration showing the setup of the VR-Lab with the curved screen.

The curved display is located in a virtual reality laboratory (Figure 6). This VR-Lab consist of a 3D visualization system of three Christie Digital Mirage S+2K front projectors with 1400x1050 native resolution and 3000 ANSI lumens brightness per projector. A warping and blending module for projection onto cylindrical surface is integrated inside each projector and is optimized for 3D projection. The projectors project a stereoscopic image to a screen curving 160 degrees (7m width x 3m height) around an audience of maximum 24 people. The 3D visualization systems are powered by a cluster of three workstations (3.8 GHZ with 4GB RAM), each of which has Nvidia FX 4500G PCI graphic card with 512 MB graphic memory.. Eon Reality Concave system us used as the main operating system to run the VR-Lab. The display technology used for testing is based on active stereo technology combined with LCD shutter glasses, see Figure 7. Active stereo display technology fits in here since it represents a bright and homogeneous picture in full pixel resolution. Due to the high separation of the individual stereoscopic pictures, perception of depth is not impaired by double contours. Furthermore, no compromises are required between the stereoscopic mode and resolution.

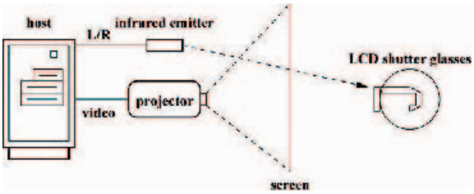

Figure 07: Concept sketch of Active stereo system (Belleman R.G. et al 2005)

We developed a solution based on the principle of creating a 3D model of the field of view for each forest scenario. The field of view is basically the representation of the projected view on the curved display. After studying the properties of the field of view on the curved screen, we made a 3D model from the data using 3D modelling software (Google SketchUp). We then took the forest image and draped it (paint) over the 3D model screen. The whole process involved is shown in Figures 8, 9, 10 and 11. The process was carried out for each forest scenario.

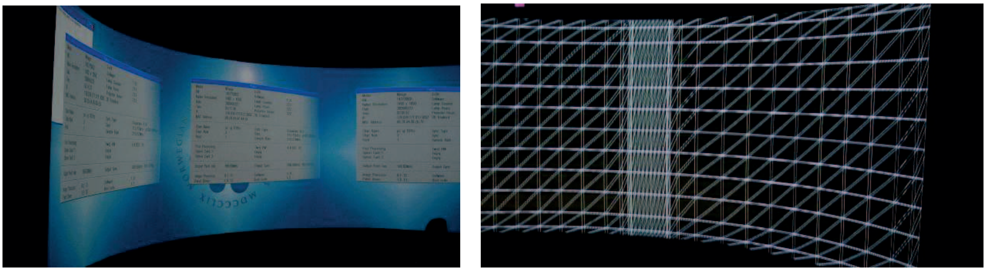

Figure 08: Studying the field of view by projecting a grid over the curved screen.

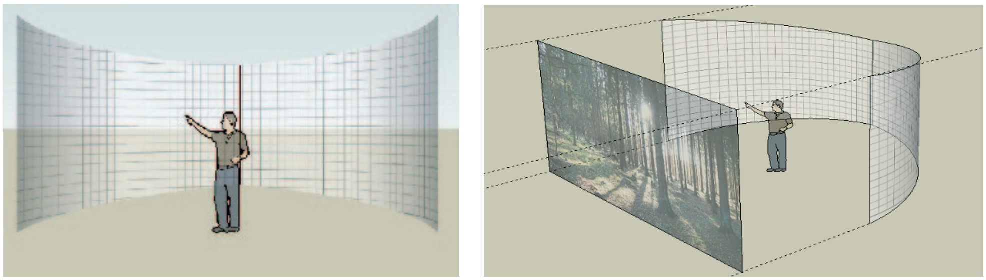

Figure 09: Creating a 3D representation of the field of view in the 3D modelling software SketchUp.

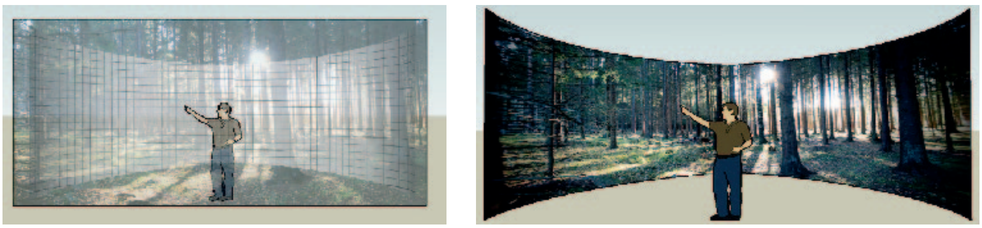

Figure 10: Adjusting the image and the centre view, then draping the image over the 3D model of the field of view, which represents the model of the curved screen.

Figure 11: Projecting the 3D model (with the forest image scenario) on the curved screen at the VR-Lab.

The central viewpoint was placed at eye height (1,8 meters above the bottom of the model) and 3 meters out from the middle of the concave curve. We could now place the model into the VR-Lab as a 3D model. When showing the pictures in this way, we could simulate a walking movement in the model. This was done by moving the control joystick forwards and looking sideways. When moving forward we were actually walking towards the model, and looking left or right turned the virtual person. Using this technique we could move around in the picture in a fluent way, giving the feeling of moving around in the landscape. To enhance the level of immersion we used the 3D active stereoscopic projection in combination with 3D LCD shutter glasses.

Test form

Our emotional state can influence how we perceive an environment. In this study we used the Basic Emotional Qualities index. This instrument is based on the Human–Environment Interaction model (HEI) developed by Küller (Küller 1991, 2004; Johansson and Laike 2007). The HEI model takes a neuropsychological perspective on emotions and describes a basic emotional process that involve the four components activation (e.g. alert/sleepy), orientation (e.g. interested/bored), evaluation (e.g. happy/sad) and control (e.g. confident/hesitant).The specific emotions we experience are combinations of different levels of these components.

The Basic Emotional Qualities index form was first translated from the original Swedish version to Norwegian before the test. The respondents are instructed to look at each picture and asked to rate how they would feel if they had spent an hour in the depicted environment. Their response is based on 12 adjectives (for example rested, safe, interested, angry, efficient, sleepy, happy) representing different emotions and four levels for each adjective. The respondents are asked to mark the level they think corresponds to how they would feel. For example: very tired, quite tired, quite rested and much rested.

Test procedure

Before both tests, the participants were given a short presentation of the goals of the study and the test procedure. The respondents were told it was a test comparing the viewing of images on different screens, but not what the environments depicted or that the environments differed in biodiversity. In the VR–lab the images were shown to the whole group of participants at the same time, as shown in Figure 12. Every forest was shown for approximately 5 minutes, starting with some panning and zooming by the system administrator. The image was shown for as long as necessary, to allow everyone to complete the test form.

Figure 12: Photo from the test sessions at the VR-lab with the curved screen.

The procedure for the test in the computer lab differed in some ways from the VR-lab test. It was carried out in three different computer labs at the same time. One folder for the test was placed on the server available on all the computers. This folder contained four more folders, one for each of the forests. Every participant had his or her own screen and computer and could decide for themselves how much time they needed to complete the form.

The order of presentation was the same in both tests; high diversity, low diversity, middle diversity, and the alternative low diversity environment (Figure 4). The order was ensured by the systems administrator in the VR-lab test and by the numbering of folders in the computer lab test.

Analyses

An average emotional index, based on all the ratings on the adjectives, was computed for each test participant for every forest. An average emotional index, based on all the ratings on the adjectives, was computed for each test participant for every forest. The index was then used in the further statistical analyses in SPSS and STATISTICA. To analyze the effects of the screens and the forest diversity conditions, a Repeated Measures ANOVA was used, with diversity as the within-subjects factor and the screen as the between-subjects factor[1]. Significance level was set to 0.05.

Results

The results of the ANOVA showed that screen type did not have a significant effect on the participant's response on the emotional index. The level of diversity, in contrast, did have a significant effect on the emotional response.[2] No significant interaction between screen type and diversity was found. However, the response to different forests was affected in different ways by the screen condition. As shown in Figure 13, the emotional response to the high diversity forest was higher in the large screen condition than in the small screen condition. The response to the middle diversity forest was the same in both screen conditions. The low diversity forests had a higher response index in the

1. An important strength of a within-subjects design is that it controls for individual differences. We expected such differences to be bigger in relation to experience of biodiversity than in relation to the screen conditions.
2. ($F_{3,120} = 25.84$; $p = 0.000$)

small screen condition. This is interesting since it means that responses to the high and low biodiversity conditions are affected in opposite ways by different screens. The response to the middle diversity forest is not affected by viewing condition. Interestingly, that emotional index was highest for the low diversity forests.

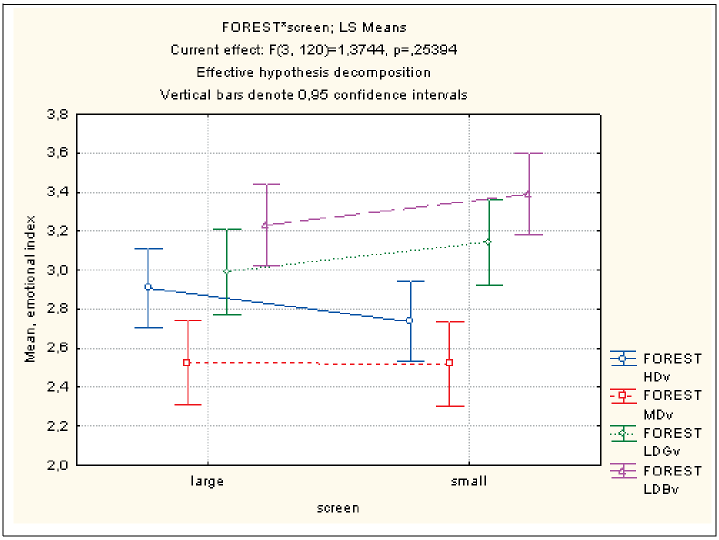

Figure 13: Mean emotional index score for the four forest images in the two screen conditions. Forest type, HDv- high diversity, MDv- middle diversity, LDGv- low diversity, LDBv low diversity alternative.

Discussion

Our results, surprisingly, show no statistically significant difference between the two presentation methods. The larger screen was expected to add more presence, but this did not have a significant effect on emotions. There are indications, however, that the effect of presentation method differs in forests of different diversities. This is very interesting and calls for further research.

Screen size affects the amount of detail the respondents can see, and both positive and negative aspects of the environment can be enhanced by increasing the size of the screen. The high diversity forest has a lot of detail, for instance from foliage. The emotional response to this forest type was higher on the large screen than the small screen, which might be due to blurring of these details on a small screen. The small screen does not give the viewer as clear an impression of this type of forest as the large screen. The amount of detail in a low diversity forest is lower. As a result, photos of a low diversity forest could be less exciting on the larger screen, as everything is clearly visible.

Another factor influencing the results could be the low position of the sun on the horizon due to the autumn season. In the more open, low diversity forests, sunlight through the trees is visibly striking and might have effected the evaluation of these images, making them more interesting. This effect could have confounded the effect of vegetation diversity. Even though we tried to make the photos as alike as possible, the sunlight is most visible in the lower diversity forests.

This could explain why the emotional index is higher in low diversity forests under both screen conditions than in any of the other forests types. It should also be noted that sound conditions in the two different lab settings could have had an effect on the results. Conditions in the VR lab setting were less comfortable due to noise from the large projectors.

A main aim of this study was to explore the usefulness of VR technology and a facility with curved screen, for presenting environments to respondents in photo based landscape experience studies. Although we did not find an effect of screen size on response to forest diversity, the development of the model and procedures for showing 2D static images on the large curves screen of the VR facility was successful and has great value for future studies. Using the VR-lab environments for landscape experience studies opens many opportunities to simulate field experience, including work with senses other than vision. Adding such effects was outside the scope of this study, which focused on effects of size of the projected image. In future studies variables such as sound, wind and maybe even smell could be included. Further work with visual aspects of the image, for instance the perception of depth, is also called for. A greater sense of depth is expected to add to the feeling of presence; this could be tested using emerging techniques that can produce stereoscopic(3D) effects in standard 2D photos.

The focus in this study was on screen size and projecting 2D static images, but the approach also allowed for some movement (forward and backward and side to side) in the model. One advantage of virtual reality environments is that real-time movement can be added. The type of motion is more interactive, and hence more natural, than what can be achieved, for example, in a film of a walk in an environment.

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