Future Delta
Motivating Climate Change Action Grounded in Place

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Abstract

In this paper we discuss the Future Delta game, as a time-forward 3-D visualization and simulation tool that aims to motivate actions and behavioral changes and to educate players about climate change mitigation and adaptations solutions and challenges. The game simulation is situated in a recognizable community locale: the flood-prone neighborhood of Delta, BC. Combining climate change modeling, socioeconomic scenario analysis and 3D modeling of real places with engaging soundscapes and imagery, our game is designed to make climate change science and solutions more salient and understandable to the layperson. The project comprises a game simulation and dynamic 3D visualizations of future local climate change scenarios to provide an environment for experiential learning tied to place attachment. The project builds on a foundation rich in research, experimentation, and production in the topic of climate change in Delta, but extends previous work into a new representational platform of virtual game. An initial testing of the game shows that engaging with the game strengthened the user's belief that action can be taken to mitigate climate change and increased their support for more transformative social changes to achieve climate mitigation and adaptation.

Keywords

Serious Games, Climate Change, Experience Design, Immersion, Interactivity, Landscape Visualization, Behavioral Change, Attitudes.

1 Introduction

Global climate change is one of the most urgent and far-reaching environmental issues ever to have affected society: what we decide to do today determines which world future generations will inhabit. Scientists from the Intergovernmental Panel of Climate Change (IPCC) estimate that we have 10-15 years in which to implement drastic reductions in greenhouse gas emissions if we are to avoid "dangerous" climate change and severe impacts such as destructive floods, droughts, forest fires, wind storms, and massive socioeconomic disruption [1]. However, despite two decades of science from the IPCC and others, we are still struggling to turn the trends around: a serious gap remains between the information available on climate change and societal understanding of and engagement in its implications and available options for mitigation and adaptation [2]. The aim of the Future Delta game is to help close the knowledge/engagement gap and motivate action by bringing together climate change scenario modeling and 3D game simulation, with interaction and communication design, in order to build and test an innovative tool for exploration and simulation of climate change challenges and solutions. This approach may bring the communication of climate change science to a new level, reinforcing a sense of urgency about the changing climate, accelerating awareness while building capacity and a sense of agency for future change.

The Future Delta game is situated within a recognisable locale and situation: the flood-prone community of Delta, BC. The project depicts a section of Beach Grove Road in Delta, BC, which encapsulates many climate change challenges, projected adaptation, technology and policy options, and provides choices and influences on a neighborhood scale. This theme is used to orient users by giving them an interactive experience of how the community within this locale could mitigate causes and adapt to local impacts of climate change. With this project, we have achieved a detailed neighborhood visualization and animation in an interactive virtual environment setting, as an initial proof-of-concept on a very limited site (www.futuredelta.ok.ubc.ca).

2 Literature Review

Landscape visualization represents actual places and on-the-ground conditions in 3D perspective views, often with fairly high realism [3]. Stock et al. [4] have developed a landscape-planning tool with a game-engine called SIEVE (Spatial Information and Visualisation Environment), which allows users to explore scenarios in a real-time 3D environment, with an automated landscape model-building capability. In the field of scientific visualization, virtual reality can act as a tool for data presentation, exploration and analysis, drawing on a wealth of artistic representation methods and perceptual psychology for inspiration in design and realization [5]. Visual stimuli can trigger innate and instant reflexes and feelings, which can be persistent even in the face of new information [6]. Nicholson-Cole [7] describe the promise of landscape visualization for conveying strong messages quickly, condensing complex information, engaging people in issues of environmental change, and motivating personal action. Engaging experiences embed narratives as a dramatic structure for interaction [8], where users have an active role, exploring things that are both attractive and unknown [9].

Scientific knowledge, stakeholder interests, political powers and public opinion all play an important role in improving policy-making that motivates action and change [10]. In practice, the complexity of climate science provides an obstacle for clear communication that is a critical barrier for social change, policy making and implementation. These underlying communication problems might be resolved through game play situated through local political frameworks and stakeholder input. Game simulations can enable a safe environment for experiential learning, rewarding engagement with local climate challenges and adaptation solutions as well as policy testing. Further, 3D game simulation enables the ability to dynamically visualize real places and complex multi modeling that can provide meaningful linkage across local and global climate change scales. Games and simulations provide situated cognition and give individuals the opportunity to play and replay situations, see the projected outcome of their choices, test out different strategies that are often impossible in real life. In simulations, learners aren't just active, they are actors. In game simulations the concept of place plays an important role in creating emotional attachment. An emotional engagement with a space results in experience of place identity [11] where an aspect of our understanding of self develops in relation to a physical space. An effective learning experience can be linked to the degree of presence felt by the game player. A high degree of presence can be created by using an environment familiar to game users to get them emotionally involved in the game [12].

Major research goal of the study is to explore multiple aspects of perception, motivation, understanding, and change of behavior through learning with regard to climate change issues communicated through an educational game:

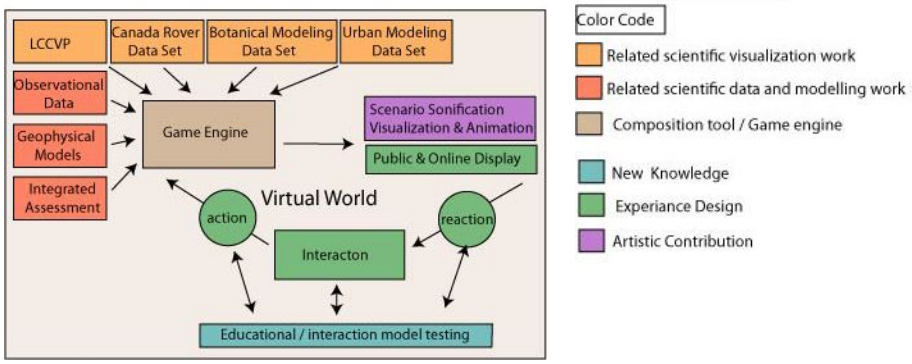
- Does the immersive, interactive virtual environment facilitate a change of people's attitudes, understanding, or behavior regarding climate change impacts, mitigation or adaptation?

3 Methods

3.1 Game Design

The Future Delta project builds on the scenarios that resulted from a Local Climate Change Visioning Process (LCCVP) in Delta in south-western BC. The LCCVP is a process for envisioning local futures with a goal to localize, and visualize climate change effects at a neighborhood and community level, based on regional climate modeling, scientific advice, and local stakeholder involvement [3]. Four alternative future scenarios were developed where local conditions match global climate change scenarios projecting out to 2100. These scenario worlds projected alternative emissions scenarios, differences in climate change impacts, and the alternative responses that a particular community can take to adapt to and mitigate global climate change. The Future Delta game builds on the LCCVP, but extends it into a new representational framework fostered by the communicative power of interactive multimedia within a virtual landscape design. The static 3D visualizations of the LCCVP became the developmental sketches for the alternative storypaths of an interactive 3D game simulation repository focused on a section of Beach Grove road in Delta, BC.

Figure 1. Future Delta Game Engine Diagram



The hyper-realistic modeling of Beach Grove Road is based on observational data, such as terrain data, maps, etc, while the simulation models are based on geophysical and integrated assessment models. The repository of 3D models consists of comprehensive selection of tools, technologies and policies for adaptation and mitigation. The animations and behaviour repository consist of the people and animals, and present and projected future natural cycles, such as flooding and storms animations. The focus of Future Delta was placed on building an engaging and realistic interactive virtual environment and 3D modeling that encompasses solutions to carbon footprint reduction and flood management. With this project we achieved a detailed neighborhood visualization and animation in an interactive virtual environment setting.

3.2 User Test Methods

The exploratory study consists of a quantitative and a qualitative part: First, 26 students were asked to fill in quantitative pre-/post-questionnaires before and after using a prototype of the game in a 90 minute testing session. Second, in-depth qualitative interviews were conducted with 10 local and non-local experts from the fields of architecture, biology, geography, education, the game industry, climate science, and local government. In the quantitative pre-/post-questionnaires, participants were asked to rate their levels of concern, urgency, attitudes and understanding with regard to climate change impacts and actions; responsibility and

willingness to change their individual behavior before and after playing the game. Results from the pre- and post-questionnaires were compared through the Wilcoxon test as non-parametric version of a paired samples t-test, performed in SPSS 14. The qualitative expert interviews followed a script that ensured that all participants had a comparable experience of the game (30 minutes). While exploring the game, they were asked to "think-aloud" about their interaction with the game environment and their comments were audio-taped. After exploring the game, participants were interviewed for about 20 minutes with regard to a qualitative interview script. Questions referred to the usability, representation style (quality of representation and interactivity) and motivation, understanding and learning about local climate change issues.

4 Results

4.1 Interaction with Future Delta Environment

The core objective of the game simulation is to communicate climate change mitigation and adaptation challenges and solutions specific to the flooding risks and low-carbon/energy needs of neighborhoods in the municipality of Delta, BC. The Future Delta environment enables a player to explore a section of Beach Grove Road, Delta BC from a first person perspective. The player can implement measures to mitigate and adapt to climate change over the period of 100 years, from year 2010 to 2110 in Delta, BC. There are ten turns in the game, each one marking the ten-year period. The mitigation and adaptation options are categorized in three areas: individual, governmental and industrial. Each option that can be implemented belongs to one of these three areas and affects the resources (money, water and food), adaptation measures and carbon footprint. The user interface includes bars that indicate how many resources are available, whether the carbon footprint targets are met and whether the community is protected with adaptation measures. Through these bars, the player is able to determine how many resources they can allocate to improvements as well as holistically check their progress in the game.

Figure 2. Present Day Beach Grove Road, Delta (left) and Flooding risk in Delta (right).

With the central goal of creating a sustainable environment resistant to climate change in mind, the player can explore the environment in search of information. Specific objects within the environment glow if they have research information for the player to view. The player approaches the object and clicks on it with the mouse. A full-screen panel appears with the information, which consists of an upgrade that the player can implement. When the improvement is built, there is a visual marker of the user's stamp on the environment. The effects of each improvement are also visualized for the user in information windows and indicator bars. There are additional environmental effects such as storm surges, heat waves and flooding that increase in frequency and intensity and are directly linked to the carbon footprint. The player can interact with non-player characters that wander about the neighborhood and enquire about their opinions concerning the changes the player has made to the community. If

the player is doing a particularly good job at climate change mitigation and adaptation, the characters are very friendly and compliment the player on specific achievements he or she has accomplished. If, however, the player is not doing such a good job — for example, he or she has exhausted a critical resource like food and water — the characters are visibly upset. The purpose is to help the user gain a fuller understanding of the different options available at the different levels of society, individual action, industry and government.

4.2 User Tests Results

The sample (n=26) of the quantitative survey consisted of 2 professionals and 24 students younger than 39 years, 13 male and 13 female, with a self-assessment of their computer game experience above average (mean = 3.43 on a scale from 1 to 5) and a minimum education level of high school diploma; two students had a community college degree, five an undergraduate and one a postgraduate degree. The concern about climate change in the overall sample was rated as 3.54 on a scale of 1 (no concern) to 5 (high concern) with two students believing that climate was not a threat at all. The average thought that climate change will start to have serious impacts some time in between 20 to 50 years from now. In the pre-questionnaire, the majority of students agreed with the statements that a) the federal government (80.8%), b) corporations/industry (88.5%), c) environmental organizations (76.9%) were "responsible for doing something about climate change". Smaller portions thought that also scientists (69.2%), local/municipal authorities (57.7%), community organizations (65.4%), their own friends and families (69.2%) and they, themselves (69.2%) could do something about climate change.

According to the Wilcoxon test, the game simulation did not change levels of concern or urgency about climate change nor did the respondents report an increase in their understanding of climate change impacts. However, a significant change of attitudes (α=0.046) took place towards supporting more radical statements such as a) "our society must be gradually changed by reforms (such as policy change and technology incentives)" to the statement that b) "our society must be radically transformed such as changing our energy needs, how we build, how we get around, etc." Other options were c) no action at all or d) only actions that will not impact individual lifestyles. In the pre-questionnaire 57.7% supported the modest change option a) and 30.8% option b), whereas 34.6% supported option a) and 42.3% option b) radical transformative change in the post-questionnaire. The other key finding was that a significant increase of respondents rated the responsibility of local authorities higher than before playing the game. This finding is very promising because the game focused on the experience of opportunities for climate change mitigation and adaptation on the local level. There was also the tendency that people's self-reported feelings changed from feeling disempowered to being more optimistic and a higher percentage of respondents started believing that actions against climate change could be taken. However, those trends were just not clear enough to be significant (α=0.059 for a change of feelings and α=0.070 for the belief that actions could be taken). In contrast, there is no trend for more people planning individual changes of behavior.

The qualitative interviews provided suggestions about the prototype's strengths (visual representation of buildings and vegetation) and weaknesses (storyline and feedback mechanisms) and how the game prototype could further be developed by clarifying the role of the player and his goals, giving more consistent feedback and balancing the reward system. The suggestions guided the debugging and finishing phases of the game development.

5 Conclusion

The Future Delta project unites several disciplines including game design, artistic expression, climate science, scenario modeling and visualising technologies. Through dramatic multimedia

expression and virtual reality game play, the project goal was to move towards a deeper awareness, wider community engagement and sense of urgency, reaching people that climate science often fails to reach, and providing clear choices for feasible local actions. Players can explore future scenarios, trade-offs and uncertainties on the path to a sustainable local future. Players experience landscape change over time through a form of virtual time-travel to illustrate different climate change consequences through high realism, dynamic animation and soundscape design, in an expressive translation of the science of climate change in a poetically charged space. The analysis of the pre-/post-questionnaires shows that the game does not change concern or understanding of climate change, but the experience of mitigation and adaptation options did strengthen the user's belief that action can be taken and increased their support for more transformative changes of society to prevent climate change. In the pre-questionnaire, a large portion had felt disempowered by the rather abstract global threat of climate change whereas the post questionnaire seems to show that the localized proactive approach of the game made people feel more empowered and optimistic. The lessons of Future Delta informed a follow-up proposal for an educational game about energy consumption and renewable energies on the local level.

6 References

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