Case Study: Visual Access for Landscape Event Based Temporal Data

M. Sheelagh T. Carpendale*, Andrew Fall*†, David J. Cowperthwaite*, Joseph Fall† , F. David Fracchia*

School of Computing Science, Simon Fraser University

Abstract

We explore the application of our visual access distortion technique to a block of temporal data created from a sequence of landscape event based information. This type of access extends the possibilities of visual exploration for temporal and spatial interrelations in a data set.

Keywords: Distortion viewing, 3D interaction, information visualization, temporal data

INTRODUCTION

As ecological awareness increases there has been a shift towards more integrated forest management. Accurate modeling of future states of forested landscapes will allow better planning for safeguarding our forest resource for future generations. We present an initial exploration into providing visual access to information generated by SELES [3] (spatially explicit landscape event simulator). SELES integrates known aspects of landscape change to create models that demonstrate how different events interrelate. By providing visual access, the output models of SELES will be available for both qualitative and quantitative inspection. This is critical for validating landscape models, exploring the repercussions of changes in ecological theory or management policy in the model, and following changes in landscape structure over time. A limitation SELES currently shares with many complex models is the lack of user accessibility to the output results. This limitation manifests itself in at least two ways: (i) input landscape maps may be large - it may not be possible to see the entire map while retaining the capability to see detail in relevant parts, and (ii) the sequence of maps output from a simulation may be large, and we need tools to assist in selection, animation and navigation.

This paper focuses on the second of these two points, particularly with respect to the relationship between temporal and spatial data. Currently the options for viewing temporal data include the examination of sequences of separate images, and combining these images into an animation that allows for control of direction and speed. We are applying our 3D visual access distortion method [2] to expand the possibilities for exploring this type of data.

SELES

This section briefly describes SELES; for a more complete description see Fall and Fall [3]. SELES is a tool for building models of landscape dynamics, such as the role of disturbance in creating and maintaining landscape structure. Models built with SELES are raster-based, stochastic, whole landscape models [1] in which all forms of change are described using the abstract notion of a *landscape event*. The overall behaviour of a model, and the resulting landscape patterns, emerge from the behaviours of individual cells. Creating a model involves the specification of one or more landscape events (such as fire disturbance and succession), which are characterized by a set of expressions that control how often an event occurs, how a cell state is affected by the event, and how the event spreads between cells. These expressions are dependent on one or more cell state variables (e.g. vegetation cover, soil type, elevation), and may be accessed from a GIS. SELES also provides modules for creating and using artificial data or *neutral models* [4]. These may vary along gradients of neutrality, from extremely simple models that are neutral to all ecological processes responsible for landscape pattern, to models that include constraints such as average patch size, fractal dimension or vegetation responses to elevation.

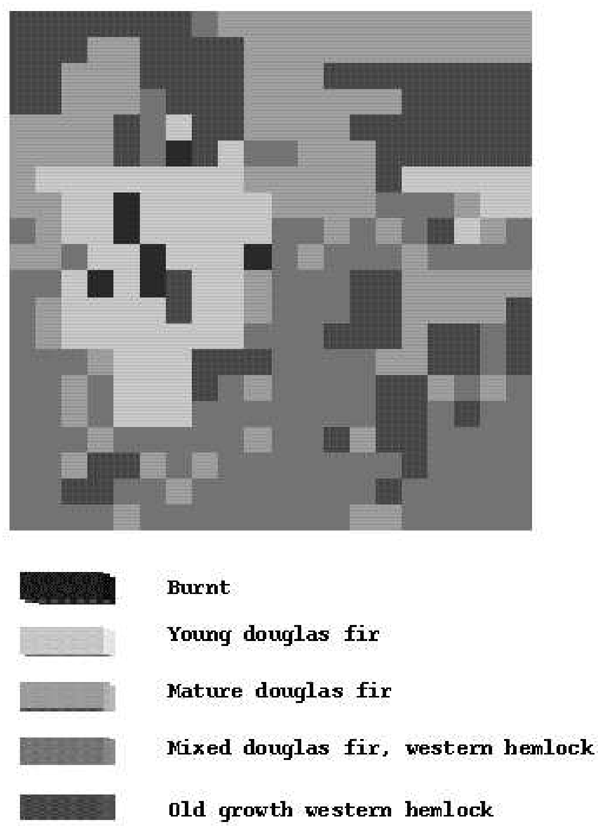

Figure 1: Land coverage image and legend

*School of Computing Science, Simon Fraser University, Burnaby, B.C. V5A 1S6 CANADA. email: carpenda@cs.sfu.ca

*School of Resource Management, Simon Fraser University, Burnaby, B.C. V5A 1S6 CANADA

SELES INFORMATION SPACE

In SELES landscape structures, features such as vegetation cover are represented by rasters. Each grid cell indicates the dominant aspect of the area it represents. The current block of information includes British Columbia forest cover in a system that has one disturbance type, namely fire. Vegetation cover includes burned, young douglas fir, mature douglas fir, mixed douglas fir and western hemlock, and old growth western hemlock (Figure 1). SELES produces individual images sequentially according to set time intervals or triggered by events. As both spatial and temporal adjacencies are of interest we have layered the spatial images, using time as the third dimension (Figure 2). This information, represented as a solid block of discrete cells, has two spatial dimensions and one temporal dimension. Each layer represents ground cover at one time instant; each slice represents the time sequence for that strip of ground. In Figure 2 on the right hand side of the cube is a spatial layer showing a pattern of forest cover. Notice the difference in visual pattern between the spatial and temporal sides of the block. In a spatial layer it is possible for patches of varying forest cover to be interspersed. However, on the temporal side such adjacencies exist only in the spatial dimension (top to bottom). Temporal changes (moving to the front) follow a sequential succession order. For example, mature douglas fir follows young douglas fir, burned areas may be replaced by young douglas fir, and old growth western hemlock may take over areas of mixed douglas fir and western hemlock. The temporal sequences of images generated by SELES can be set to either a particular frequency or be triggered by the occurrence of an event. For instance, a rapidly spreading fire could trigger a section of information that is temporally denser.

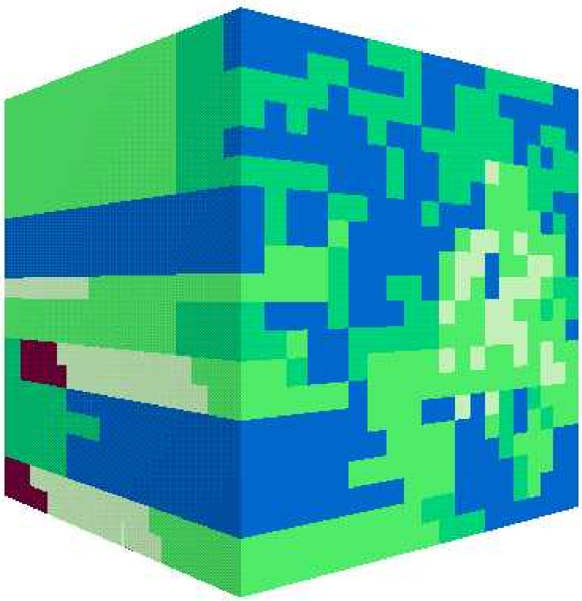

Figure 2: The temporal block of landscape coverage information

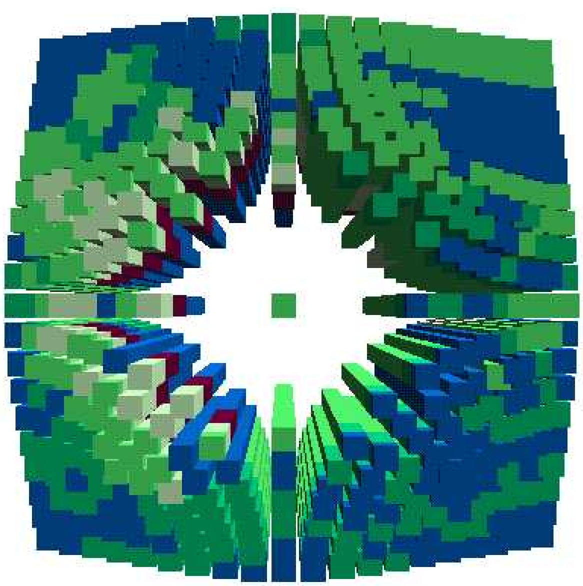

Figure 3: Peering through the temporal axis

APPLYING VISUAL ACCESS DISTORTION

Interrelations between different aspects of the data exist both spatially and temporarily. Some events such as disease and fire often primarily spread through adjacency. For instance, if one tree is burning it is quite likely that the trees next to it will catch fire. Other events, such as succession, are sequential in nature. We could separate the layers into two sequences, one spatial and one temporal. However, ideally one would like visual exploration that will preserve as much of the context as possible. To visually assess the interrelationship between temporal and spatial adjacencies we apply visual access distortion [2] to the layered 3D block.

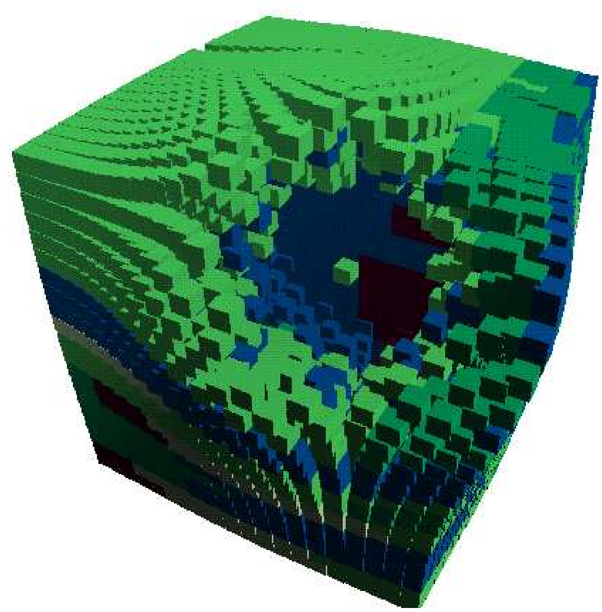

Figure 4: View with single node focus

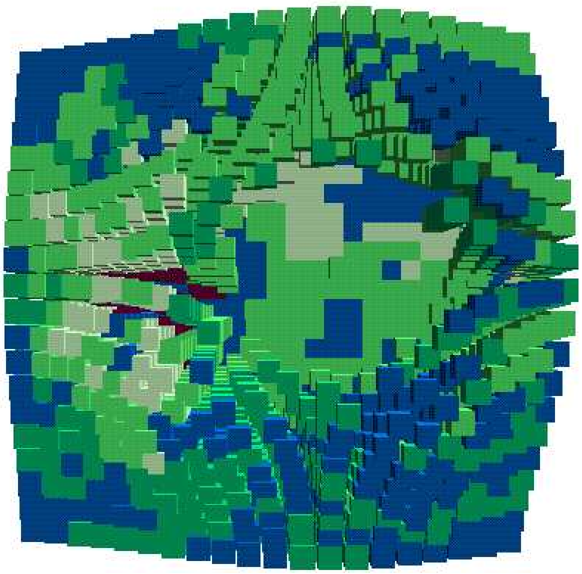

Figure 5: Browsing through temporal space to a spatial layer

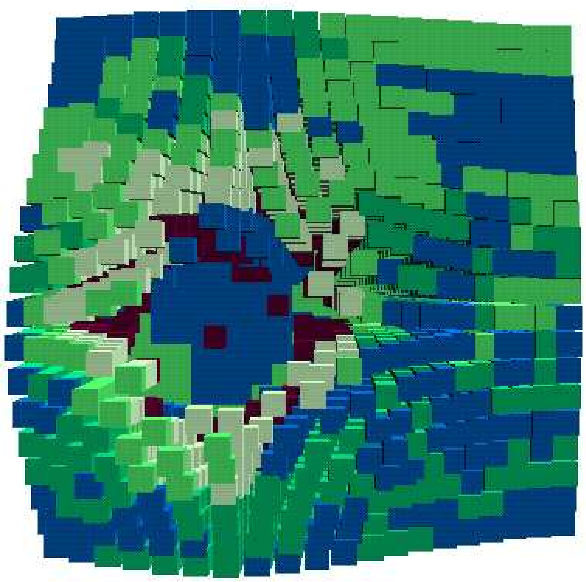

Figure 6: Continued browsing reveals fire start

Visual access distortion is a viewer aligned distortion viewing tool that allows access to internal regions of three-dimensional information. When the user selects a focal point objects are radially displaced away from the line of sight giving the user an unobstructed view of the chosen section. As this distortion is calculated from user perspective, the view of the focal section remains clear even during rotation. This gives internal visual access in three-dimensional context.

While it is possible to combine varying types of magnification with visual access distortion, with this particular data set we are initially interested in visual access only. Thus in our case, focal sections are undisturbed rather than magnified. Figure 3 looks through the information space along the temporal axis. This reveals separate columns of contiguous temporal data. Increasing the displacement of the access

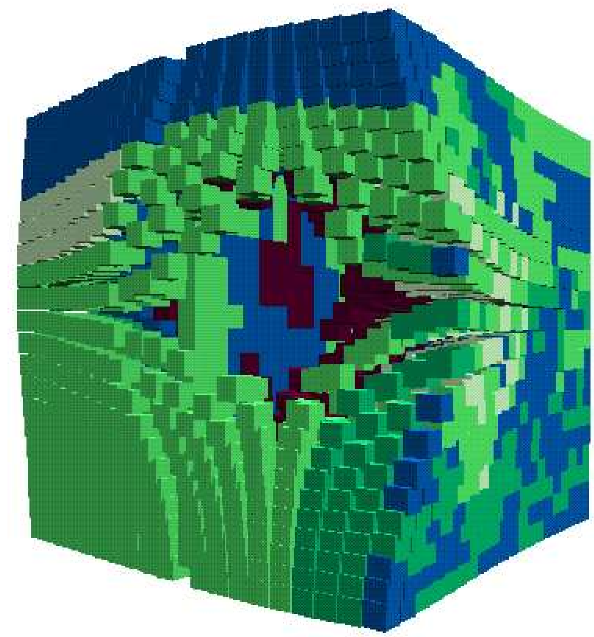

Figure 7: Viewing next spatial layer from side reveals fire spread

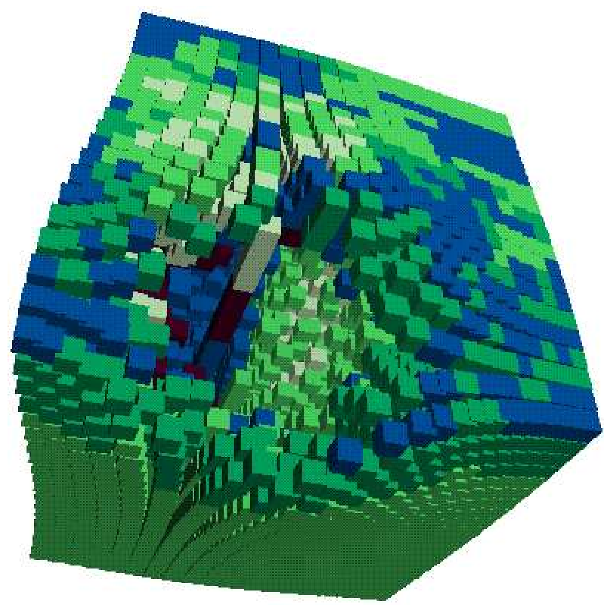

Figure 8: Preserving a temporal column

distortion can separate these columns enough to see along their full length. However, it still preserves spatial adjacencies sufficiently to be able to recognize neighbors. Figure 4 shows direct application of visual access distortion revealing a single cell focus. While this does give a view of the internal information space, a view that included interrelations would be more informative.

In Figures 5 and 6 a particular spatial layer has been chosen for exploration. The first opening in Figure 5 shows typical forest cover pattern Moving across the data Figure 6 shows the beginning of a forest fire, one red cell indicating

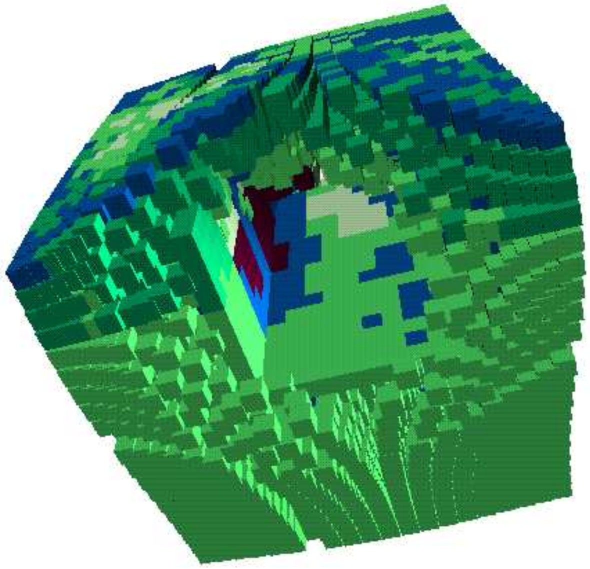

Figure 9: Preserving both a spatial layer and temporal slice

fire starting in a section of old growth. The distortion access allows one to open a 'portal' through time to the event of interest. One can browse across the space to see the initial extent of the fire and see the degree of spread to the subsequent time layers. It is also possible to rotate the model and examine up to the chosen layer, revealing the landscape conditions at the out-break of the fire. Side views expose the focal layer in context with the layers just above it (Figures 6 and 7). Similar exploration can be conducted with preservation of a temporal slice.

Other types of focal sections that are important include temporal columns. Figure 8 shows a single temporal column as a focal point. In Figure 9 both a spatial layer and a temporal slice have been preserved. Here one can see the interrelation between time and space in this model. The dark blue represents old growth, which is the most at risk from fire. The temporal slice shows fire spreading to edges of old growth section.

CONCLUSIONS

Even this initial application of visual access distortion as an exploration tool for actual three-dimensional data is revealing new ways of accessing visual information. This is still a very straight forward application to a 'three-dimensional' solid that is actually discrete pieces of information. However, each cube is controlled from its center, which causes some collision between cubes in compressed regions. We intend to explore various ways of more fully maintaining adjacent information. These include optional temporal and spatial edges, and actually representing this information as a full solid, so the access distortion would be applied at the vertices, causing sections to be stretched.

Accurate modeling of future states of forested landscapes will allow better planning for safeguarding our forest resource for future generations.

SELES is a tool which allows integration of known aspects of landscape change in the hope that more accurate modeling of future states of forested landscapes will allow better planning for safeguarding our forest resource for future generations. However, creating the models is not enough in itself, the information must be accessible if we are to learn from it. By providing visual access methods we hope to extend the usability of the information generated by SELES.

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