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Modeling, simulating and visualizing the evolution of physical landscapes

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Abstract: The paper considers contemporary physical landscape visualization and simulation models that are used for impact analysis and decision making for geographical location studies. It presents a novel generic framework for this purpose that could provide various professionals with a useful tool to facilitate their decision making processes. It argues that the main reasons for constructing a generic framework are firstly, to provide a rigorous approach to the task of studying the evolution of physical landscapes. Current methods are inadequate for obtaining a sufficient level of detail to gain an in depth understanding of the effects of any physical landscape change. This is the case for even simple environmental impact. For example, changes within a specific community, such as filter feeder changes in a coastal habitat that are due to increased sedimentation. The second main reason for constructing a generic framework is to provide sufficient appropriate data that can be used for forecasting and scenario projections using computational simulations that reflect future changes.

Furthermore, a common framework could be of significant boost to landscape planners, such as engineers, architects, and to a greater extent to policy makers, who are in urgent need of simulation models for visualizing the potential evolution scenarios of a landscape based on their current decisions made on the land use / development of a physical area. Typical contemporary examples can be drawn from what are famously referred to as "Cross-cutting issues" (Swedish Environmental Agency, www.naturvardsverket.se/en/In-English/Menu/Swedens-environmental-objectives--for-a-sustainable society/Swedens-environmental-objectives/Cross-cutting-issues/, 2008). These models could be used to determine the future scenarios, changes to the landscape of an area of interest under a given number of proposed developmental activities especially, in performing trade-off analysis studies on the options available to decision-making professionals, their potential benefits and disadvantages.

The conceptual framework presented here is based on an in-depth analysis and assessment of an example landscape tracked over time from past to present. It is developed from continuous monitoring of past and present scenarios, to portray changes that may occur on the landscape of interest in the future. On satisfactory completion of a landscape model construction process, the set of models developed are then used for the construction of visualization images to represent the entire evolutionary process of the landscape. The use of both scenario construction methods and visualization techniques for generating the images to depict the evolution of a physical landscape has many benefits; not only because they create a whole picture of the evolutionary cycle but also because they allow the models and the visualization images to provide a variety of viewpoints suitable for use by a wide range of users who need to understand the evolutionary cycle and stages relating to it. For this, the framework includes a function through which users can generate visualization models either with traditional two-dimensional maps and/or fully interactive and immersive three dimensional images generated by photographic sampling of the actual area and computer generated visualization images of GIS-based Software. Inevitably, the success of this approach depends on user input factors that may trigger changes over the subject area.

Finally, an example of visualizing the impact of climatic change on grape vineyard is presented using the generic framework to show how it could be applied to visualizing other real world scenarios.

Keywords: *Modeling, Simulation, Visualization, landscape, framework, evolution*

Abstract only