Improving usability on GIS modeling with two new tools in Dinamica EGO

Rômulo Fernandes Machado Leitão, Bruno Morais Ferreira, Hermann Oliveira Rodrigues, Britaldo Silveira Soares Filho

Universidade Federal de Minas Gerais - Centro de Sensoriamento Remoto
Av. Antônio Carlos, 6627 - IGC, Sala 206, Pampulha, 31270-010 - Belo Horizonte - MG, Brasil
{romulo, bruno, hermann, britaldo}@csr.ufmg.br

Abstract. GIS modeling has always been and still is a very complex and big task. Usually, these models range from small to very big projects with one to many modelers. We present two techniques that made GIS modeling simpler and quicker, through the use of the Dinamica EGO application. Targeting production and easier user parameter calibration, we developed an interface called "Dinamica Wizard" that guides the user through a series of screens allowing him to choose parameters and better understand the scenario he is about to run as a model. For result verification purposes, a second application (that ships with Dinamica EGO) called Dinamica Map Viewer was created, making possible for users to verify map cell values as well as previewing calculations in a quick and easy way. These tools improved the accessibility and user interaction of Dinamica EGO by breaking the initial barrier of complexity from GIS modeling.

Keywords: remote sensing, dinamica ego, map viewer, wizard

1. Introduction

Simulating space-time phenomena can be a tough challenge. It is necessary to handle a great amount of data, develop a model with many operations and in the end present the results in a clear way. Since the task of constructing the simulation model is handled by a selected group of individuals (usually a team of scientists), every information contained within the model represents an extra layer of complexity for those who are unfamiliar with it. As this situation is pretty common (data domain is very specific) a solution to decrease the complexity of the models or at least make them more manageable was required. Dinamica EGO propose a series of interface improvements to make models user friendly, uncomplicated and easier to deploy everywhere, mainly home computers.

Dinamica EGO (Soares, 2002) is a freeware software that allows scientists to create simulation models in an easy way (Soares, 2009). Thanks to its rich component library, and low level core, Dinamica EGO is able to offer usability combined with flexibility and high performance. The application allow users to create, modify and run simulation models through a rich and yet simple graphical interface. Not only models can be constructed from the graphical interface but internally those are converted to the software internal scripting language (EGO). Applications of Dinamica EGO include assessment of biodiversity loss (Vega, 2012), carbon emissions and deforestation (Carlson, 2012), emission reduction (REDD) (Hajek, 2011), urbanization and climate change (Huong, 2011), urban growth (Thapa, 2011) and others (Nepstad, 2009, Soares, 2006).

Since version 1.8 Dinamica EGO provides two new tools that improve the user experience while developing their models. The first one is the Dinamica Wizard, a tool for presenting models created with the software using formatted text, images and other graphical features (much like a webpage). The second one is the Dinamica Map Viewer, a complete standalone application (shipped with Dinamica EGO and accessible from both externally and within Dinamica GUI) to visualize and manipulate raster images. With the Map Viewer it is possible to overlay map layers, set different palettes, create animations with the maps and several other features. In this paper we present these new tools and how the user can benefit from it.

2. Improving usability with two new tools

Dinamica EGO is seen as a Geomodeling Domain Specific Language (DSL) (Beven, 2002), well optimized (Ferreira, 2012) and with great ease of use to help non-programmers to extract information from maps, blend and modify this information in a flexible way, and infer knowledge from this processing. This DSL is developed in C++ and Java, providing a 64-bit native version with multithreading. Both new tools were implemented on the top of this environment directly in its source code.

The idea behind the implementation of these tools in the Dinamica EGO platform is to improve usability for its users. Two main points of view were considered in the development: Model Makers and Model Users. Both are users of the platform, but with different actions performed when using the software. Model Makers, usually researchers or scientists, have the view of the internal properties of the model. They model the rules to simulate a land use, climatic, economic or any other type of phenomenon and implement it with the operators available in the Dinamica EGO Functor Library. In the other hand, Model Users that can be decision makers, other scientists or modelers, see a model as a black box. They manipulate the input data, run the simulation and retrieve the results from the model output. They are aware of how the simulation works, but do not need to know about its implementation details.
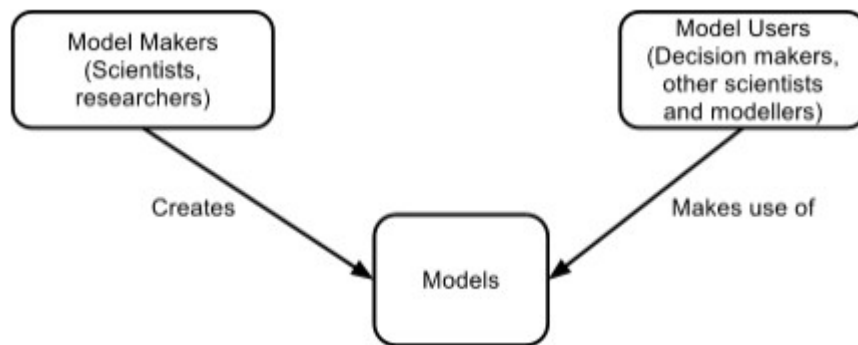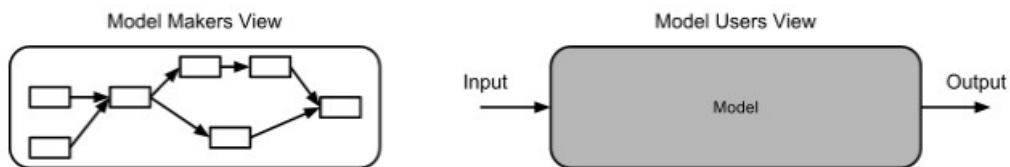
Figure 1: Model Makers and Model Users.

Figure 2: Different points of view of Dinamica EGO users.

Dinamica EGO allows its users to process given raster images improving their visual perception through the use of components from the DSL. One of the goals of image processing is to change the nature of an image in order to improve its pictorial information for human interpretation (Alasdair, 2004). Considering this scenario, values from any range would not be mapped to colors since visual perception will be broken by smooth value transitions. Dinamica Map Viewer (by using Dinamica EGO internally) uses histogram transformations to remap values (in original range) to the visible range (number of possible palette colors). Original discrete values are read from the input raster and then processed through a function (Equation 1):

$$y = f(x) \qquad (1)$$

using the histogram transformation curve. This curve represents a custom user function over the original values domain (limits) and the resulting y domain lies in the numerical integer [0, 255] range. The graphical interface provided by Dinamica Map Viewer remove the separation between Model makers and Model users by presenting information in a succinct, grouped and easy way while addressing common usability issues.

The Dinamica Wizard is a tool to present information about about a model and fill its data inputs right before its execution. This presentation, usually with a piece of information about the model and may have an area to edit some inputs of the model created by the modeler itself, is composed by a series of pages. Each page have an area with a piece of information about the model and may have an area to edit some inputs of the model.
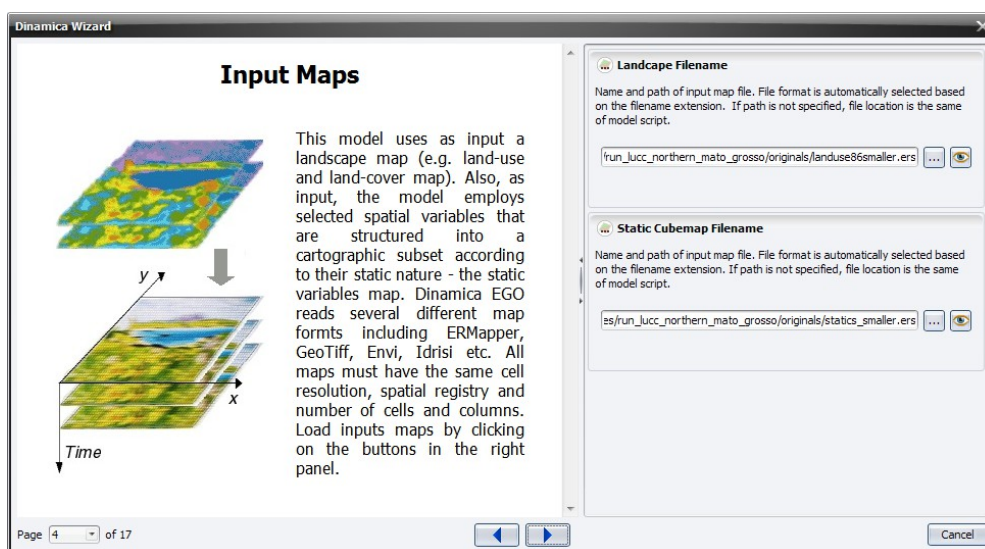
Figure 3: A Wizard page with text, image and input editors.

To build the Wizard it is available the Wizard Editor inside Dinamica EGO's graphical interface. This editor has a "what you see is what you get" like interface, very intuitive and easy to use. With this editor it is possible to format text changing fonts, sizes and colors and even edit the HTML source code of the page. It is also possible to import the page text from an external HTML file.

Each page may provide a set of data input editors to the final user. In the page editor it is possible to add a specific description for each of these inputs describing its effects in the simulation. This way is better than directly edit the model internal operators that have a generic description for all functors of the same type.

Dinamica Map Viewer is a standalone application that ships with Dinamica EGO. Map Viewer was designed to be an application for viewing, displaying and verifying values on raster images. Thanks to the under sampled loaded raster image, Map Viewer is able to execute calculations of image expressions very fast and present results in real time.

Dinamica Map Viewer has an easy graphical interface tailored towards usability. Icons on the toolbar provide access directly, without using context information. Stack map properties are displayed individually for each map making information localized. There are no menus. As the date of this writing we support multiple loaded datasets (map stack), layer blending through transparency, saving and loading map algorithm's (we call them viewer states), screenshots, legend and categories visualizations, multiple editable color palettes, map algebra

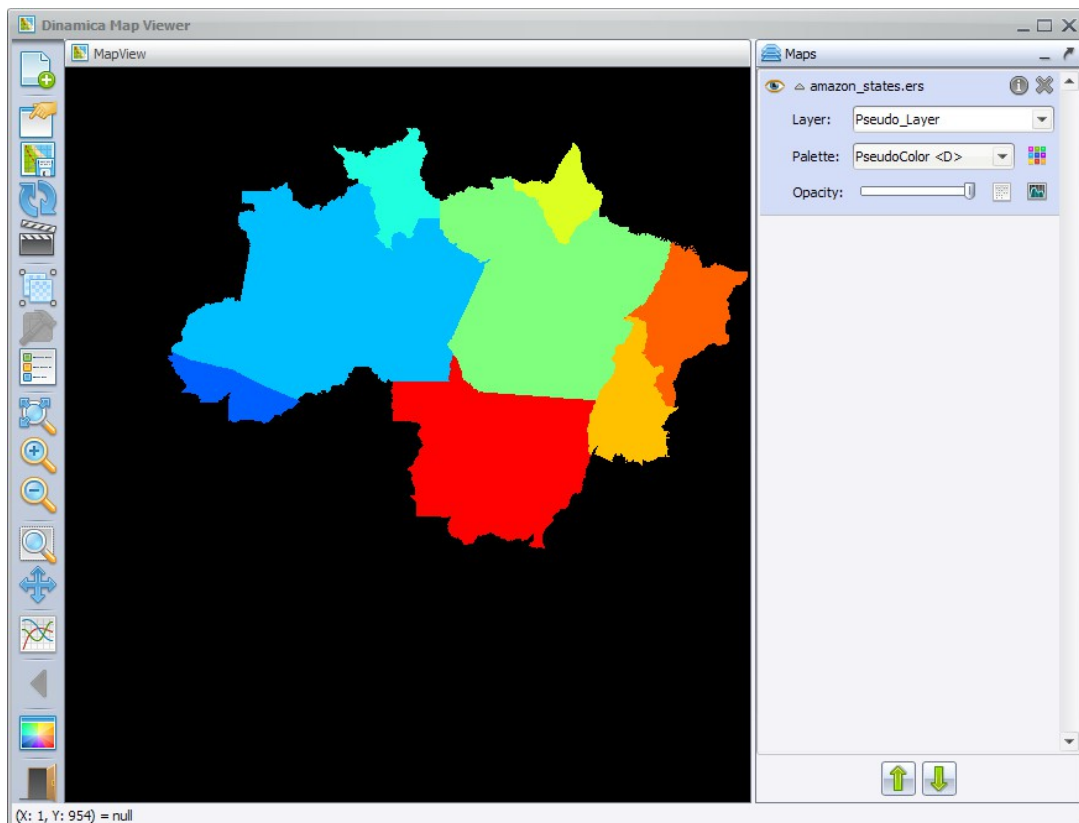Figure 4: Wizard page editor.

Figure 5: Dinamica Map Viewer - Main Window

expressions, common image transformations (zooming, panning), movie making, analysis of straight line data and histogram transformations.

Since Map Viewer uses Dinamica EGO low level core, all image formats supported by Dinamica EGO are as well supported by the Map Viewer. The comprehensive list of formats can be found on GDAL raster formats list[1]

The histogram window is responsible for displaying and updating visualizations, individually. The curve presented in this window, allows the user to assign palette transformations (through mapping of curve values) to the visualization of the active raster image. Using this tool and calibrating the curve, patterns can emerge. The histogram also offers pre calculated curves, "Linear", "Histogram Equalization" and on a nearby future, "Gaussian stretch".[1]
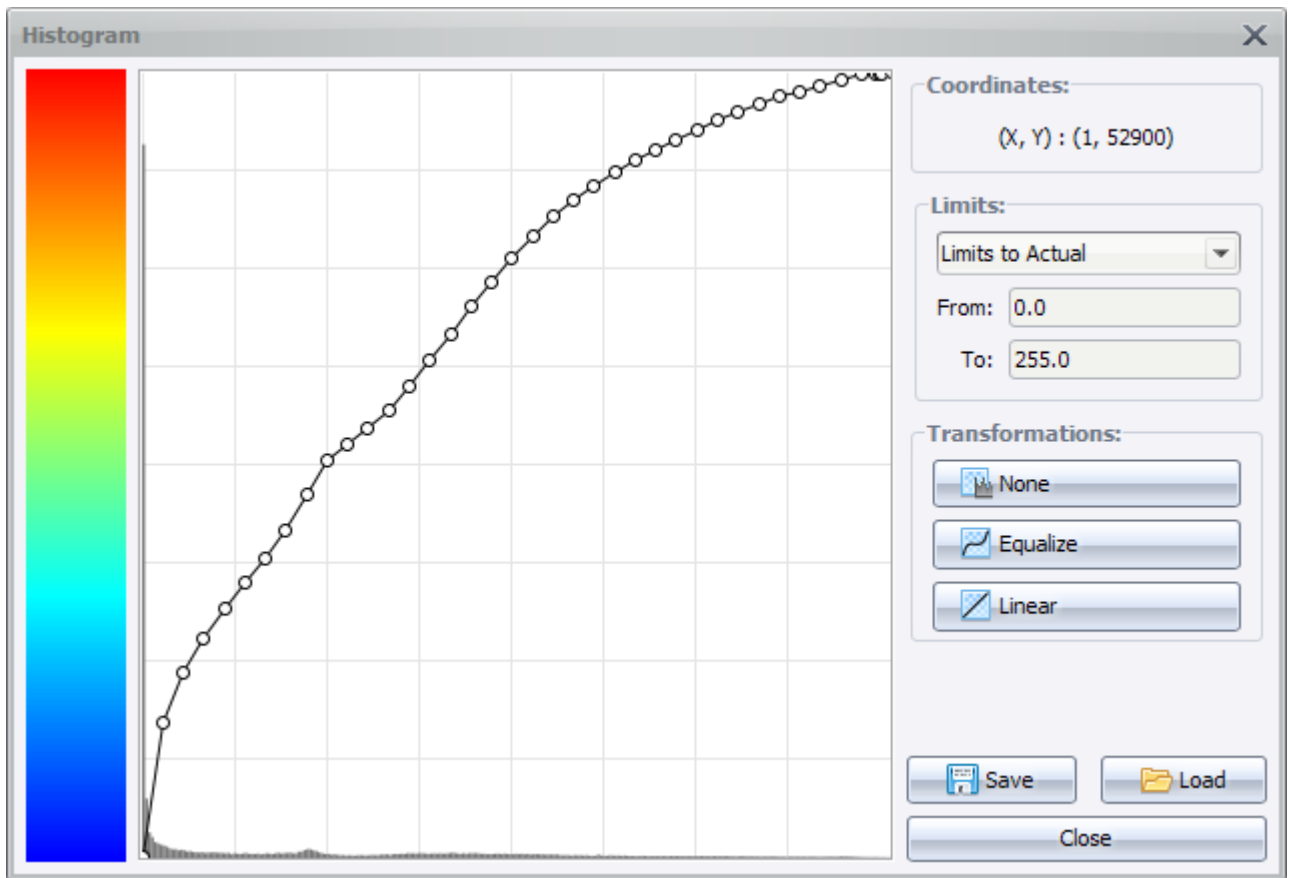

Figure 6: Histogram window displaying a "Histogram Equalization" curve.

Within the Map Viewer it is possible to manipulate data using map algebra expressions (Tomlin, 1990). Since Map Viewer load and work with images in screen resolution, when they are down sampled the process of applying map algebra expressions is very quick and results can be verified in real time. In this context, calculations are speed up by over an order of magnitude.

The movie maker tool is a tool created to generate movies from a set of datasets containing temporal changes. Movie maker allows the user to replace one raster per frame, configure video frame rate. This tool outputs movies in the famous MPEG-4 format or a series of images representing each movie frame. Every raster loaded in Map Viewer carry its own properties (Histogram, Palette, screen transformations) in Movie Maker.

The analysis tool is the newest addition to the list of features of Dinamica Map Viewer.

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1   GDAL Raster Format List: http://www.gdal.org/formats_list.html

Analysis tool allows the user to trace a line and obtain an ordered list of values following the line path. It is not only useful for viewing height information from terrain but also for verifying discrete values in an area.
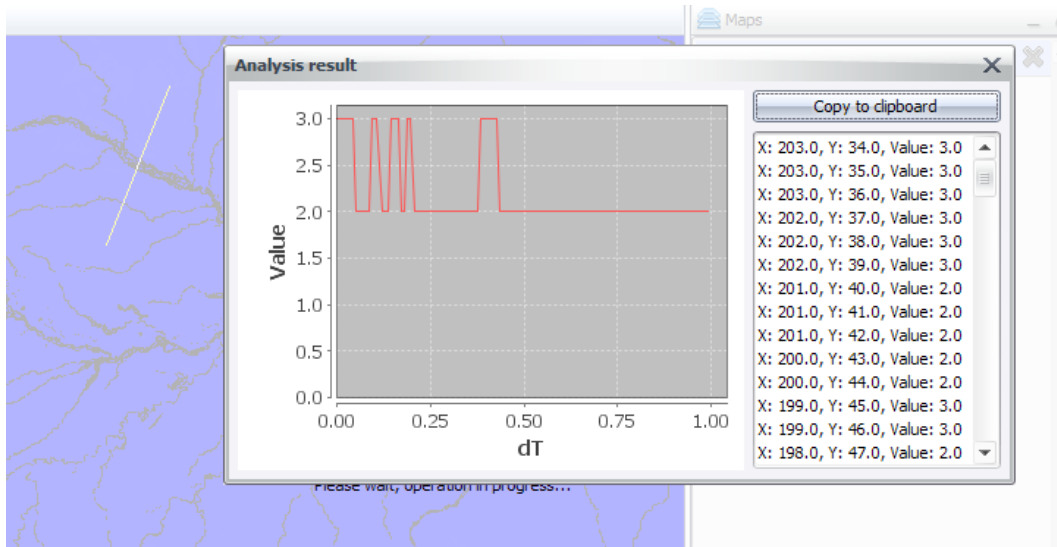

Figure 7: Terrain height being displayed on analysis tool

Each raster image loaded in Dinamica Map Viewer can be displayed using a palette of colors. Image input values are transformed using the histogram curve and the resulting transformed values are mapped in a [0,255] range by the corresponding palette. The resulting
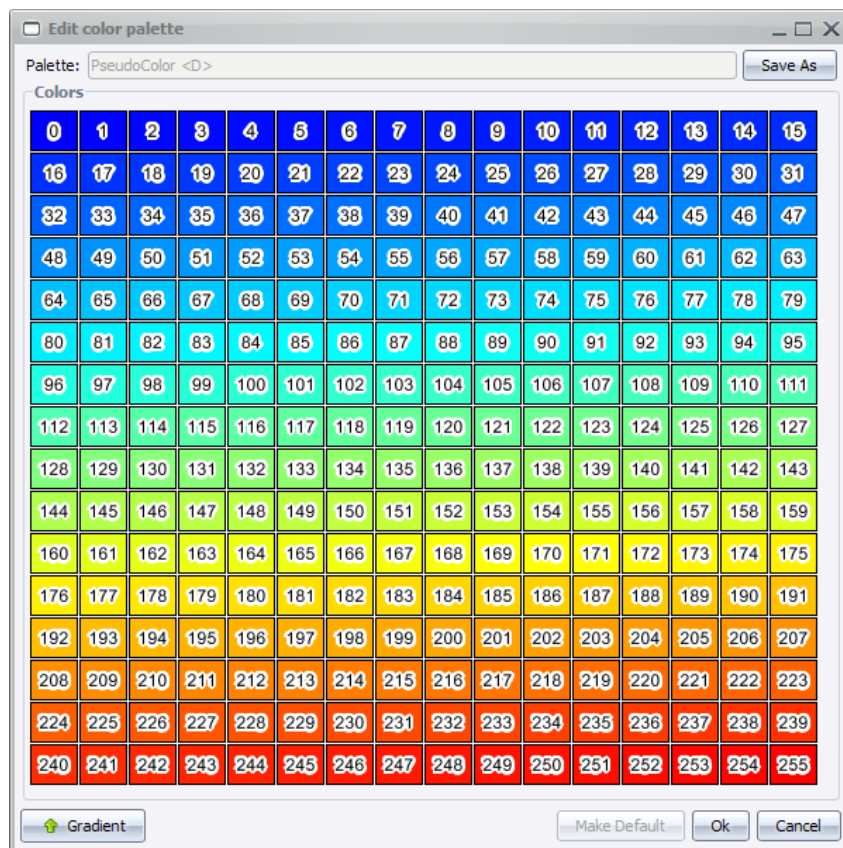

Figure 8: Color palette editing window, showing the default "PseudoColor" palette. Each value maps it's underlying color in the resulting displayed image.

color is what the user sees in the screen. The palette can be customized, saved and loaded from disk, and each mapping index can hold a different color, picked by the user.

3. Results, conclusion and future work

Thanks to the creation of Dinamica Map Viewer and Dinamica Wizard, Dinamica EGO benefits with a more user friendly interface. The tools provided aimed to break one of the barriers of GIS Modeling which is easier interactivity and proved that this task can be handled gracefully by them. With the deploy of these two new ways to work, parameter adjusting, model presentation and checking results has become easier and more practical.

Dinamica Map Viewer will become even better in the future, our goal is to introduce more features and optimize it even further. One of the ideas is to let users use it as a complete presentation application, adding graphs, text labels and pictures. A new dialog for expression edition is also on progress with better documentation, syntax highlighting and error checking. We also plan to provide geospatial information when loading datasets allowing maps from the same areas around the globe to be attached together in correct locations. Moreover, Dinamica Wizard will have more interface improvements being possible to create presentations with the simulation results.

Dinamica EGO can be download in the webpage: http://www.csr.ufmg.br/dinamica/ and tutorials about Dinamica Wizard and Dinamica Map Viewer are available at http://csr.ufmg.br/dinamica/dokuwiki/doku.php?id=tutorials .

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