

# **User's Guide**

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**Digital Terrain Model (DTM) Plugin**



INPE / FUNCATE

# **TerraAmazon 4.6.3**

## **Digital Terrain Model(DTM) Plugin User´s Guide**

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The information in this document is subject to change without notice.

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## Preface

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### Welcome to TerraAmazon

TerraAmazon is a GIS tool designed to be a multi-user editor of geographic vectorial data stored in a TerraLib model database. It engages land use and land cover classification tools as well as spatial operations between vector data, allowing transitions analysis among other applications. TerraAmazon keeps work time records for project control. It's functionalities are extensible through plugins, such as the already existing TerraImage (PDI) and TerraPrint (plotting).

TerraAmazon was first developed by INPE and FUNCATE in early 2005. It was initially applied to SISPRODES project and quickly conquered space in other projects, such as DETER and DETEX, among others, due to it's multi-user characteristic. Until late 2009 TerraAmazon was used only within FUNCATE, being widely applied to many of its projects. With the creation of CRA, INPE's Amazon Regional Center, located in Belém, TerraAmazon reached international space, having regular trainings being held in CRA's facilities for both national and international specialists.

Nowadays, TerraAmazon is constantly being updated and having tools and system enhancements, pursuing national and international approval.

TerraAmazon is part of Brazil's attempt to become an international reference on forest monitoring programmes.

TerraAmazon is free and open source provided under GPL license as published by Free Software Foundation at [www.gnu.org](http://www.gnu.org).

TerraAmazon is available for download at [www.terraamazon.org](http://www.terraamazon.org).

## Involved Institutions

The following institutions are involved in TerraAmazon's development process.

**INPE**, Brazil's *National Institute for Space Research*, founded in 1961. It is engaged on many research fronts in various areas of space science and their applications. INPE is involved with TerraAmazon in the political sphere and settling agreements between countries and institutions.

[www.inpe.br](http://www.inpe.br)

**INPE Amazon (CRA, Amazon Regional Center)** is an INPE unit settled in Belém, State of Para, and east of the Brazilian Amazon. Founded in 2007 to support researches and fieldwork in the Amazonian region, this unit became fully operational in 2009 and since 2010 implemented the *International Course on Tropical Forests Monitoring*. This capacity building activity is based on the knowledge of the TerraAmazon System, for which documentation and training tutorials were developed enabling participants from Latin America, Africa and Asia countries to monitor their forests, as Brazil has been doing for more than 20 years.

[www.inpe.br/cra](http://www.inpe.br/cra)

**FUNCATE**, *Foundation for Space Science, Technology and Applications*, is a non-profit private organization founded in 1982. It is engaged on national projects involving land use and land cover classification, estimating GHG emissions due to land use as well as many others. It has technical agreements with Brazilian research partners, such as INPE, CTA (Aerospatial Technical Center, Brazilian Air Force) and others. FUNCATE is involved with TerraAmazon by programming the software, developing and enhancing tools, testing, writing user's guides such as this one, developing and maintaining the website as well as other related activities.

[www.funcate.org.br](http://www.funcate.org.br)

## TerraAmazon Documentation

TerraAmazon has the following documentation available for download at [www.terraamazon.org](http://www.terraamazon.org):

*User's Guide Administrator:* defines the administrator roles and presents the use of each interface related to administration procedures.

*User's Guide Operator:* defines the operator roles and presents each procedure for working on multi-user environment and the use of each vectorial edition tools.

*Edition Plugin User's Guide:* presents each procedure for image edition.

*Digital Image Processing (DIP) Plugin User's Guide:* presents each procedure to process digital image.

*Digital Terrain Model (DTM) Plugin User's Guide:* presents each procedure to model digitally terrain surfaces.

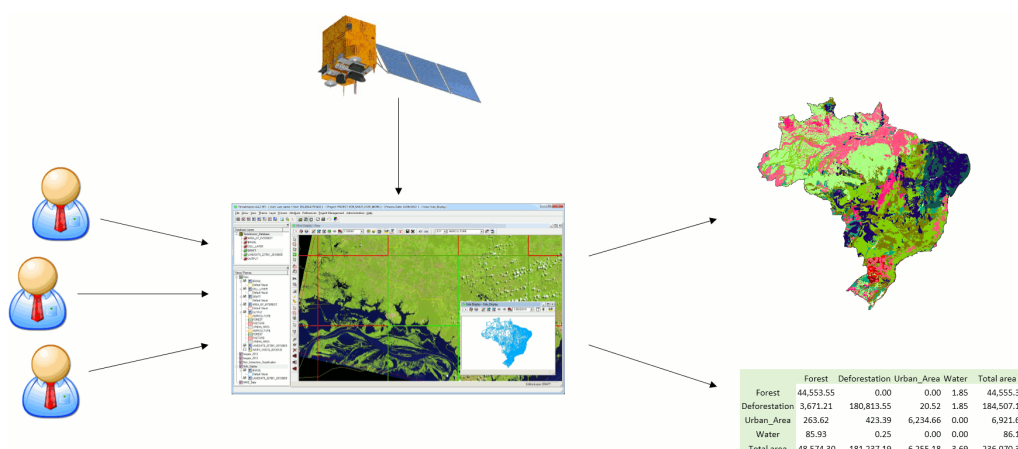
# 1 Introduction to TerraAmazon

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## What is TerraAmazon

TerraAmazon is a GIS tool designed to be a multi-user editor of geographic vectorial data.

It was developed to improve the corporate production of geographic data in order to provide an accurate measurement of deforestation, forest degradation, land use and land cover change and similar applications.



In TerraAmazon, several users can work simultaneously in the same data following a methodology fixed by Administrator Users. This reduces the time of project execution and ensures that the final data is entirely produced under the same methodology.

The spatial operations between vector data allow transitions analysis among other applications.

The system has a built-in structure to allow experienced users to audit the data produced. It also provides reports so Project Managers can follow and analyze the evolution of the work.

The data is stored in a TerraLib model database ([www.terralib.org](http://www.terralib.org)) and is worked within a client-server environment.

### Database

A TerraAmazon database encloses the whole set of data, either raster or vector data.

### Layer

Vector or raster data. Every vector or raster data stored in the database is presented to the user as a layer in the Layers Tree (see the main interface on pg 3).

Vector data can have three types of representation: polygons, lines or points.

Layers are visible to all users.

## **Theme**

A theme is a structure that defines which data from one particular layer will be visualized and how will it be displayed on the screen. Themes are user-related, that is, if a user creates a certain theme, he will be the only one able to see it, change it or remove it.

No user can see other user's themes, not even having administrator privileges.

## **View**

A view is a structure that defines the data that will be visualized and manipulated simultaneously. That is, if the user needs to visualize a satellite image and a vectorial data at the same time, both these data must be added to the same view. Views are user-related, that is, if a user creates a certain view, he will be the only one able to see it, change it or remove it.

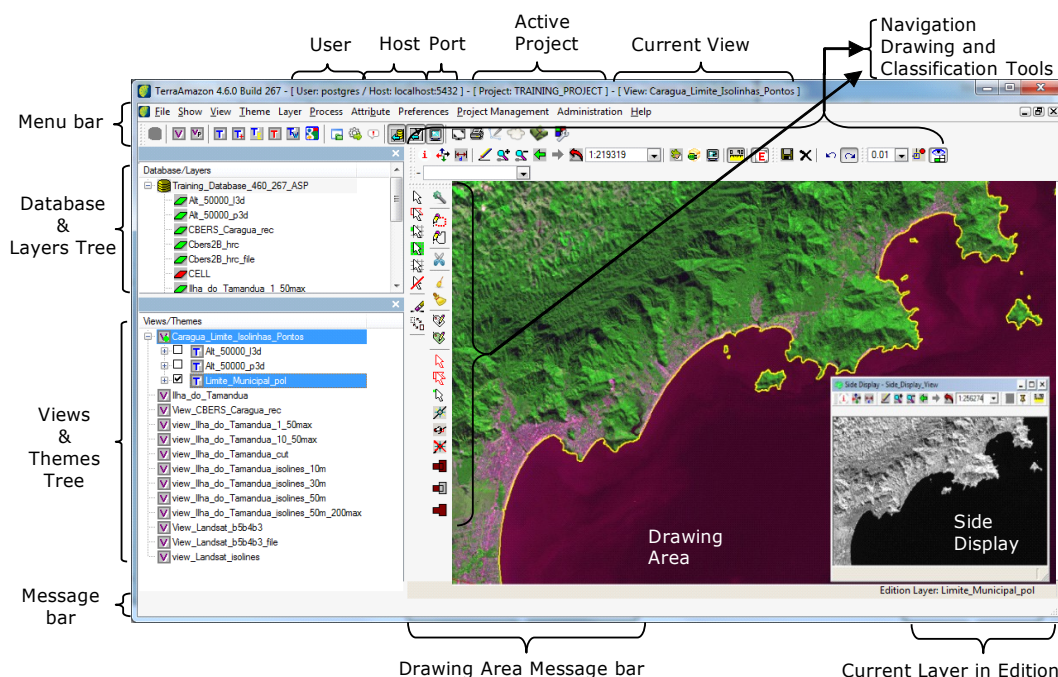
No user can see other user's views, not even having administrator privileges.







## Presenting the Main Interface

The following figure presents the main interface. It has three main areas:

- Database & Layers Tree
- Views & Themes Tree
- Drawing Area.



In the *Database & Layers Tree*, the icon  identifies the currently connected Database, while the icon  identifies the layers. This tree is shown the same way for every user since it contains every single layer in the database.

In the *Views & Themes Tree*, the icon  identifies the views, while the icon  identifies the themes. This tree is different for each user since both views and themes are user custom.

The drawing area displays the data from the selected themes in the current view.

The other items in the interface are shown only in specific conditions. The *Drawing and Classification Tools*, as well as the *Current Layer in Edition*, only show when the user opens the edition mode. The *Navigation Tools* are shown all the time. The number of the connection Port is shown only when informed by the user at the moment of the database connection.


## 2 Accessing the Database

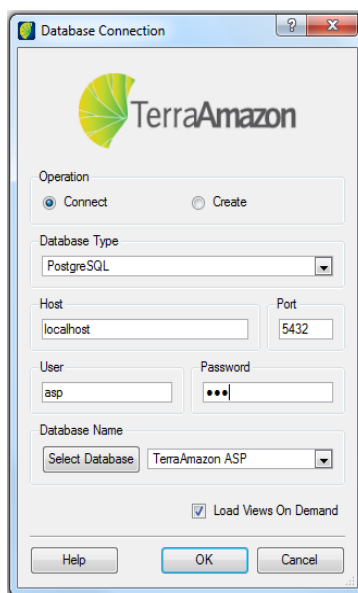
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Procedures to perform the connection with an already existing database, previously configured by an Administrator User.

Operator Users cannot create new databases. Contact an Administrator user if needed.

### Connecting to a Database

To connect to an existing database, that is, to start a working session in TerraAmazon, click on the icon  or go to the menu FILE → OPEN DATABASE.



The *Connect* operation must be selected.

Contact an Administrator User to inform the options to be chosen or typed on the fields *Database Type*, *Host* and *Port*.

Type your user name and password. For your first connection, an Administrator User must create both user name and password for you. Once you connect, it is advised to change your password and keep it safe (refer to Changing Password, on pg 7)

Next, click on the **Select Database** button and choose the database you need to connect to.

The option *Load Views On Demand* determines if the contents of the views owned by the user will be loaded at the time of connection:

- If selected, then only the list of views on the Views Tree will be loaded and the connection will be faster. In this case, the user must click on each desired view in order for it's themes to be loaded and enabled for visualization and work.

- If unselected, every theme from every view owned by the user will be loaded during connection. This will increase time demanded for the connection if the user has many views and each one having many themes. It is advised not to uncheck this box when working on the corporate environment.

## Changing Password

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Operator users may change their own password at any time by going to the menu FILE → CHANGE PASSWORD after connecting to the database.

Inform the old password and type the new password on their respective fields. Repeat the new password on the field *Repeat*.

Click on the **Save** button to apply the password change.



If the user has forgotten his password, contact an Administrator User to have a new password set up.

# 3 Digital Terrain Model

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## Digital Terrain Model

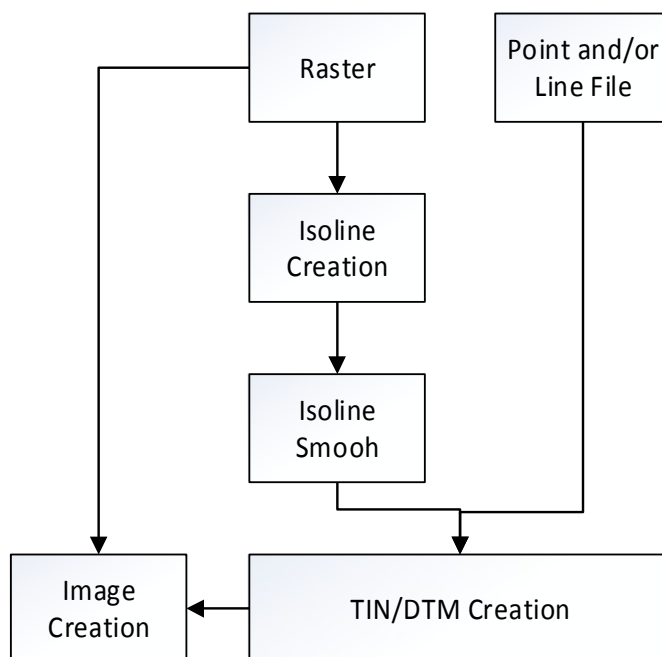
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DTM is a mathematical representation of a spatial distribution of a certain characteristic related to a real surface. The surface is, in general, continuous and the phenomena it represents can be diverse.

To represent a real surface in a computer it is essential elaborate and create a digital model that can be represented by analytical equations or a point grid in a way to transmit to user the spatial characteristics of a terrain.

The creation of a numeric model corresponds to a new manner to focus in the problem of project elaboration and implementation. From models (grids) it can be calculated directly: volume, areas, profiles and transversal sections, generate shadowed images or in gray levels, generate slope and aspect maps, generate slicing in desired intervals.

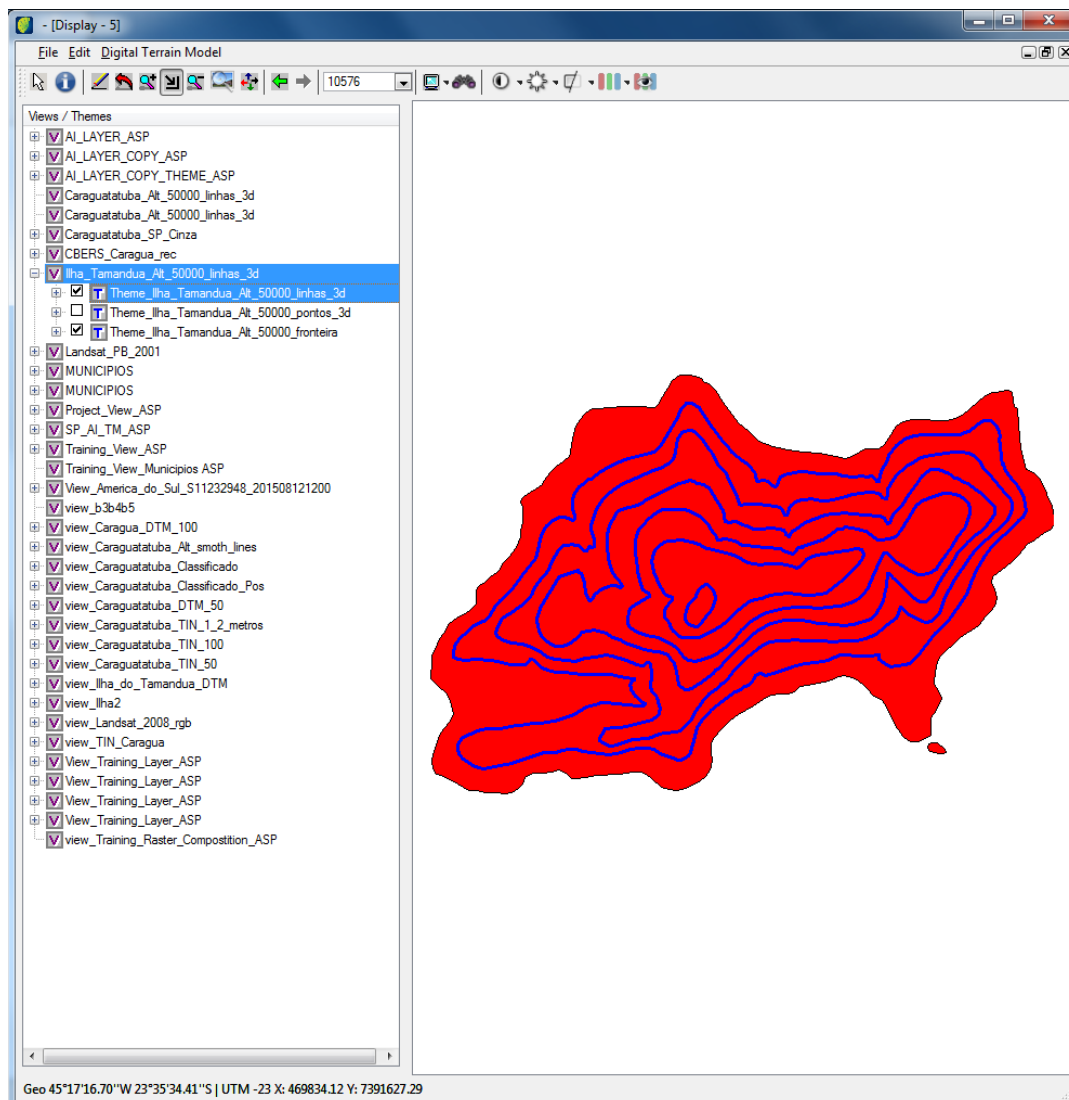
The picture below show regular flows to create TIN and DTM.



## Opening Digital Terrain Model Plugin

To start DTM click on the icon for DTM plugin  in TerraAmazon main menu.

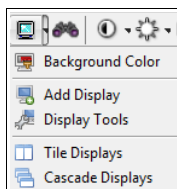
The plugin opens another window with DTM main menu. Description of icons in the main menu can be found in chapter Tools.



## Display Handling

The display tool allows adding and organizing new displays on the drawing area in order to view them simultaneously.

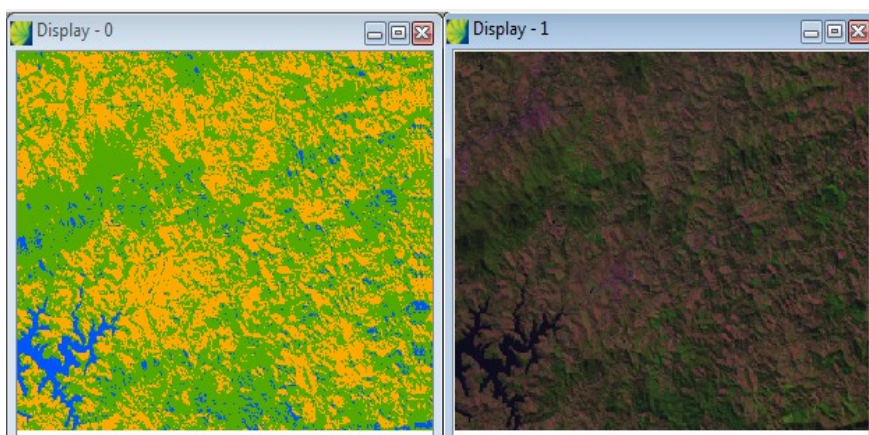
Click on the display icon and select the proper tool.



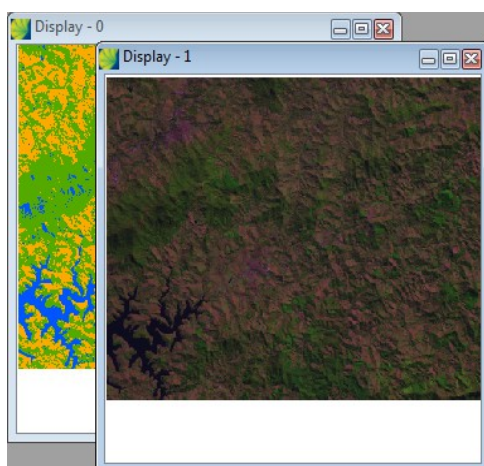
*Background Color*: this tool changes the color of the background.

*Add Display*: this tool adds a new drawing area. Once you click in this option a new window opens and user can select the theme and draw it.

*Tile Displays*: this tool organizes displays on visualization area so they are visible and aligned, tiling two or more images.

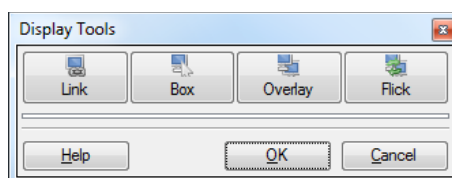


*Cascade Displays*: this tool organizes images on the visualization area cascading them.

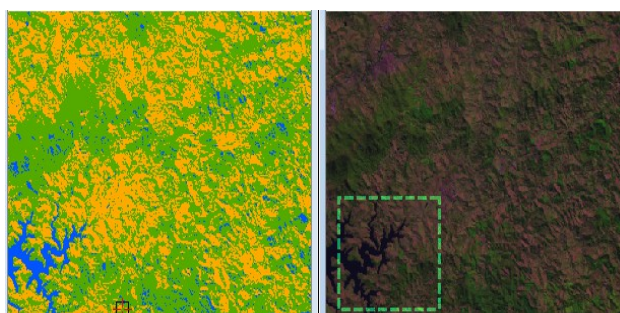
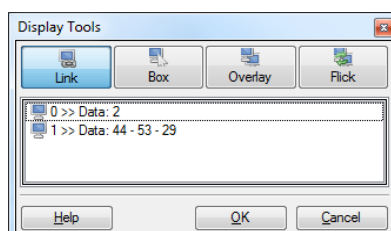


*Display tools*: this tool activate or deactivates the display toolbar.

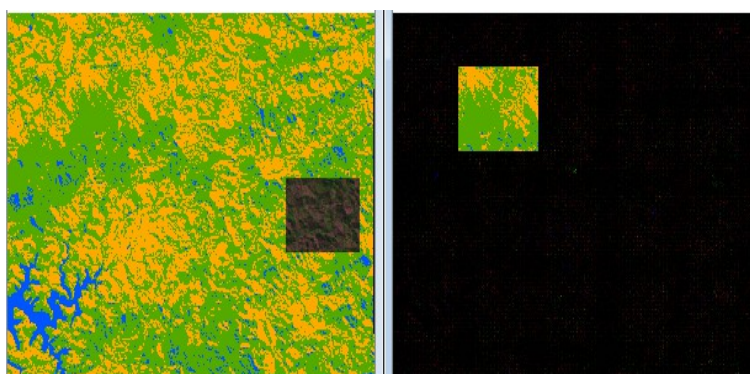
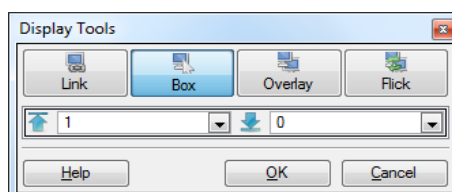




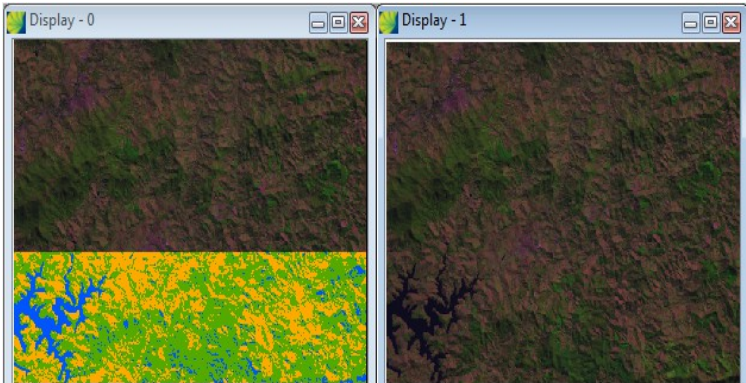
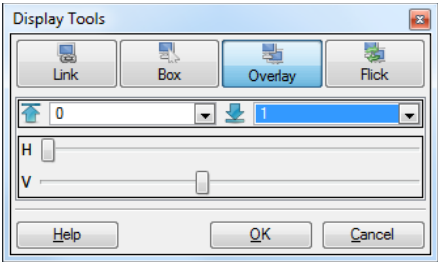
*Link Display*: this tool links two displays and action executed in one display is repeated in the other. Click on the **Link** button and click on the **OK** button. Move to visualization area and operation executed in one will be repeated in the other.



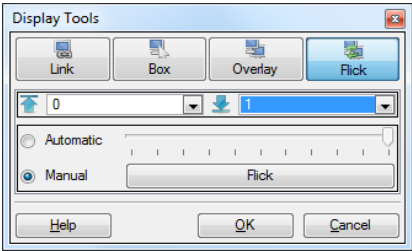
*Box*: this tool allows a definition of a box size using the mouse and drag it over the image showing the equivalent image of the other. Click on **Box** button and choose the number of each display involved in the operation. Click on the **OK** button.



*Overlay*: this tool overlays data of two different displays. Click on the **Overlay** button and choose the number of each display involved in the operation. Click on the **OK** button. Adjust on the slide buttons to overlay one display on another.



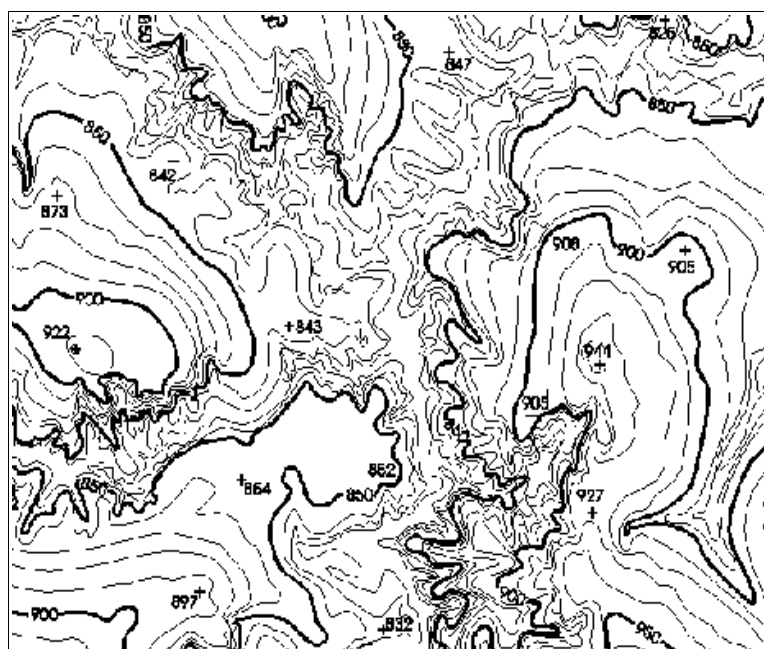
*Flick*: this tool shows alternately the data of two different displays. Click on **Flick** button, choose the number of each display involved in the operation. Click on the **OK** button. It can be set to flick manually and changing image by clicking on the lower **Flick** button, or automatically and user sets the flicking speed on the slide button beside this option.



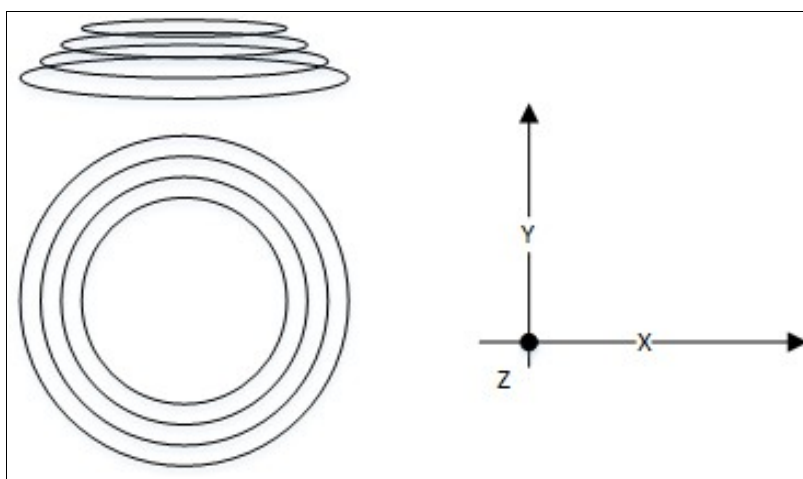
## Creating Isolines

Isolines are curves that unite surface points having same quota value.

Quota value meaning depends on surface physical magnitude intended to model. Thus a surface that represents temperature it is obtained isothermal; to atmospheric forecast, isobaric; terrain height, level curves, etc.



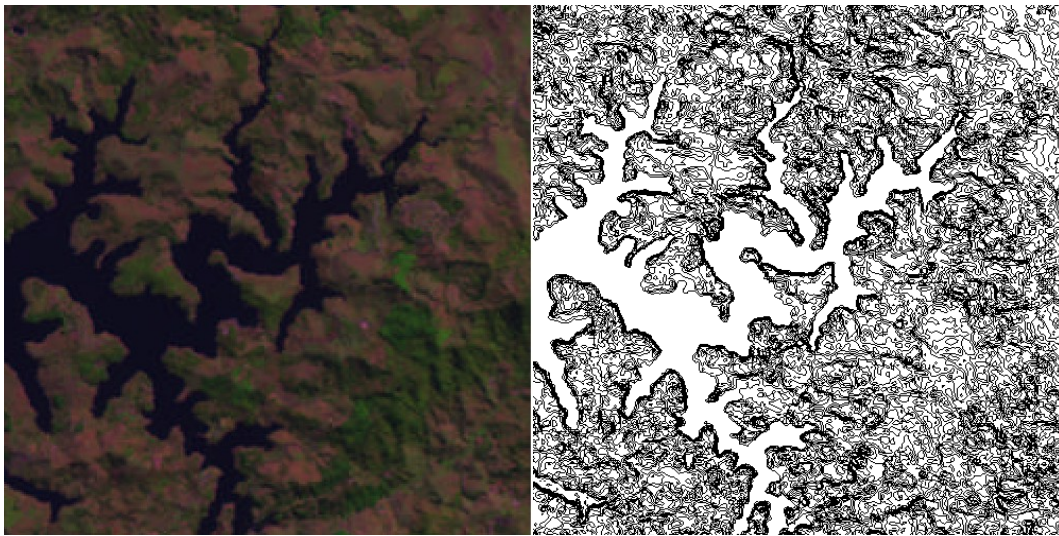
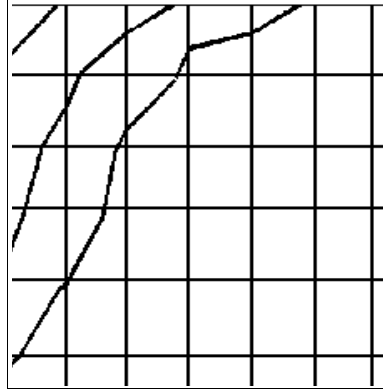
Isolines can be viewed like a plane projection (x,y) of intersections between the surface and equidistant horizontal planes.



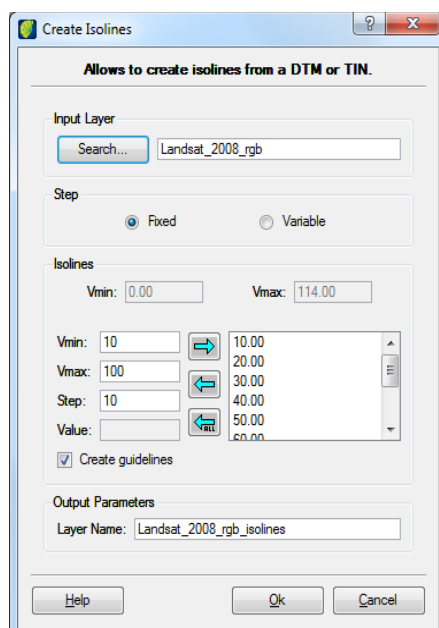
The isovalue curves have some important properties among them: all are closed unless they intercept map definition border, and never cross each other.

TerraAmazon generates isoline or isovalue curves from the terrain numeric model in a rectangle and triangle grid format using a cell method.

In this method, for each cell is generated all isovalue curves that intercept this cell. The line segments are stored, in a final phase, to be linked making an isovalue closed curve (in case they do not touch the interest region border).



Select DIGITAL TERRAIN MODEL → CREATE ISOLINE in the main menu.



*Input Layer:* click on the **Search** button and select a layer that will be used to generate isolines. Be sure that there is a rectangle grid (Grid) or a triangle grid (TIN) representation

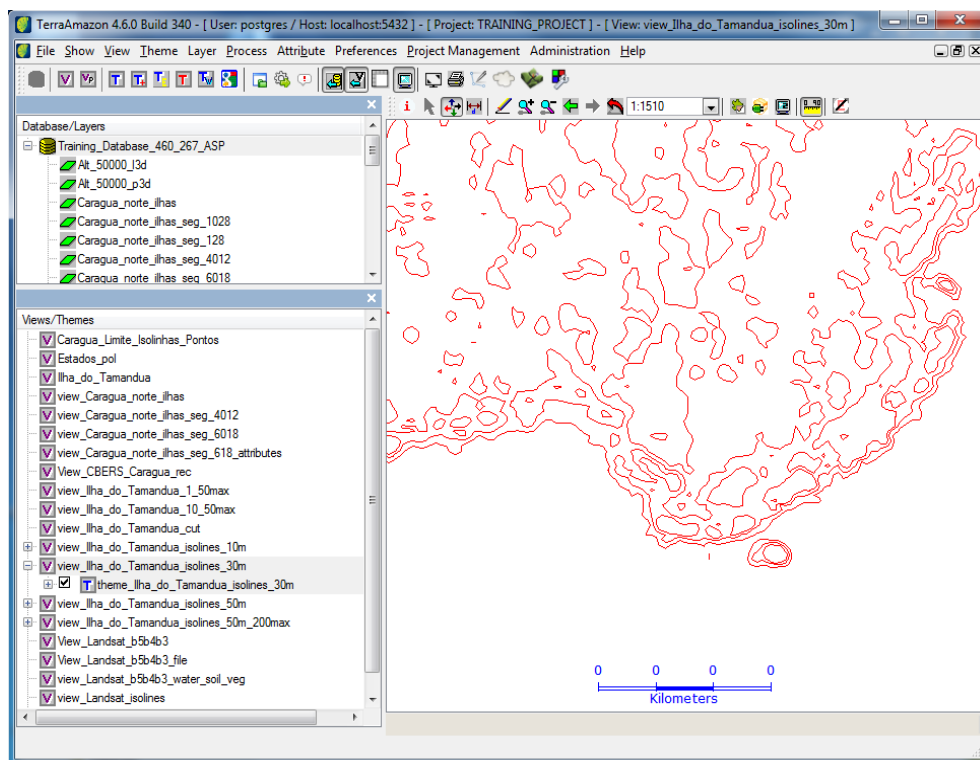
*Step:* check *Fixed* option if isolines will be distributed equally in equal quote intervals. Change the Vmin and Vmax values if wanted. Initially, these fields have default values. Also, enter a step value between isolines.

If *Variable* option is selected enter the wanted quote value for isoline. Click on the right arrow to insert in the value list. Repeat the procedure until insert all the quote values. To remove a value, click on it and on the left arrow. To remove all click on “all” left arrow.

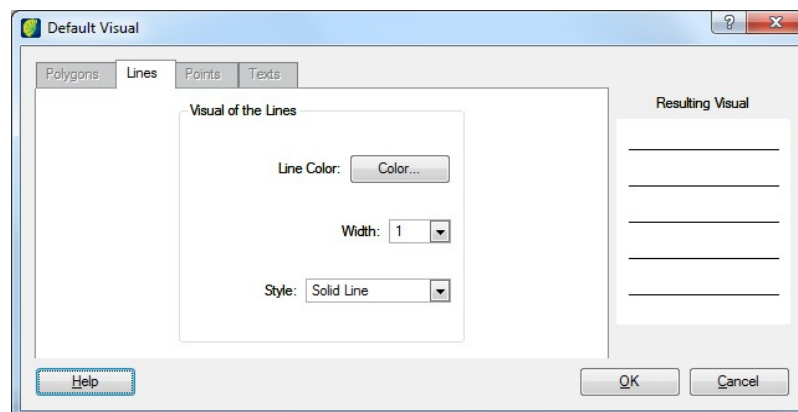
*Create guidelines:* when fixed step is selected, each line in five steps interval will be considered and created as a guideline. It will not be showed in a different line style or width in the picture but indicated only in line attributes.

*Layer Name:* enter a name for the output layer.

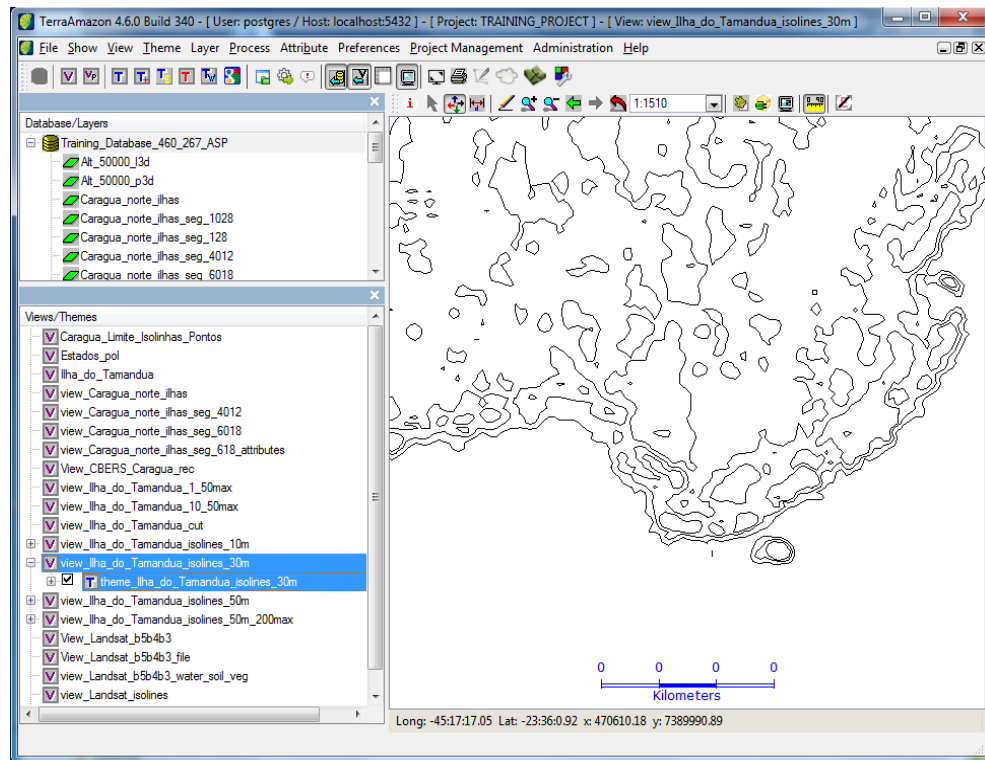
Click on the **OK** button.



To change color of isolines right-click in generated view and select VISUAL → DEFAULT.  
Click on **Color** button and choose a new color. Click on the **OK** button.





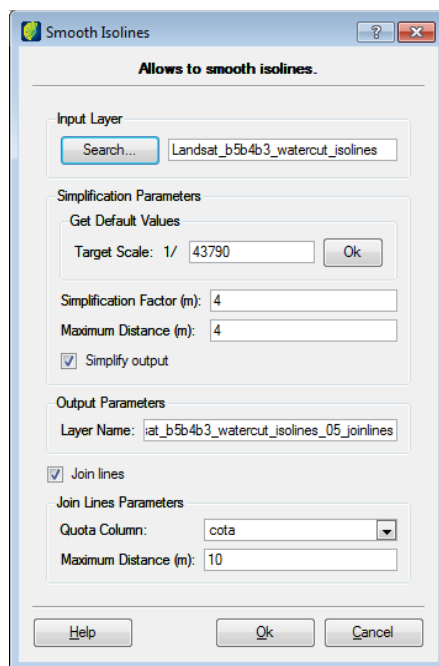


## Smooth Isolines

A generated isoline map in traditional analogical methods produces isolines with visual smooth properties. When isolines are obtained in digital systems from regular rectangle grids or irregular triangle grids, it is observed sharp corners. A smooth isoline method creates curve format to that data.

Catmull-Rom Spline was selected to smooth isolines due to its control point interpolation properties and calculation simplicity.

Select DIGITAL TERRAIN MODEL → SMOOTH ISOLINE in the main menu.



*Input layer:* click on the **Search** button and select the layer.

### Simplification Parameters:

*Target Scale:* enter the scale value and click on the **OK** button beside the field.

*Simplification Factor:* this value will be used to do an input line filtering. Enter the wanted value in meters.

*Maximum Distance:* this value will define distance among simplified line points. Enter the value in meters.

*Simplify output:* click on this box if after lines being smoothed they will pass through Douglas\_Peuckher simplification method using tolerance for simplification.

*Output Parameters:* enter the name of generated image.

*Join lines:* click on this box if input layer has fragmented lines to be joined automatically.

*Quota Column:* Select the option for quota.

*Maximum Distance:* enter the number for maximum distance in meters between lines to be joined.



Click on the **OK** button.



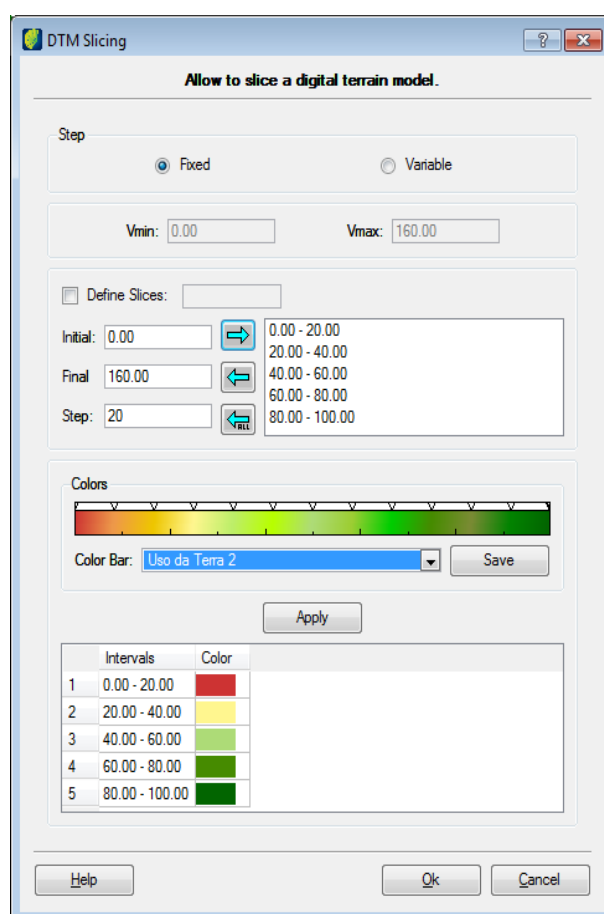
## Slicing in DTM

Slicing is to generate a thematic image from the rectangle image. The resulting image themes correspond to quota value intervals, called slices by TerraAmazon. Thus, the layer will generate a thematic category layer representing a particular aspect of terrain numeric model, consequently each slice must be associated to a thematic class previously defined.

Interval definition of quotas or slices will depend on grid value variation to highlight. A thematic image resulting from grid slicing provides a model pictorial view.

To define quota intervals, TerraAmazon can edit them in two modes: fixed or variable. In the fixed mode user define manually the wanted quota interval, while, in the variable mode, the quota value intervals are automatic distributed equally according to provided step.

Select DIGITAL TERRAIN MODEL → DTM SLICING in main menu.



**Note:** Be sure that a rectangle grid was generated to the layer in the wanted numeric category.

*Step:* select fixed or variable mode:

If fixed, enter the initial, final and step values and click on the right arrow to insert values in the right list.

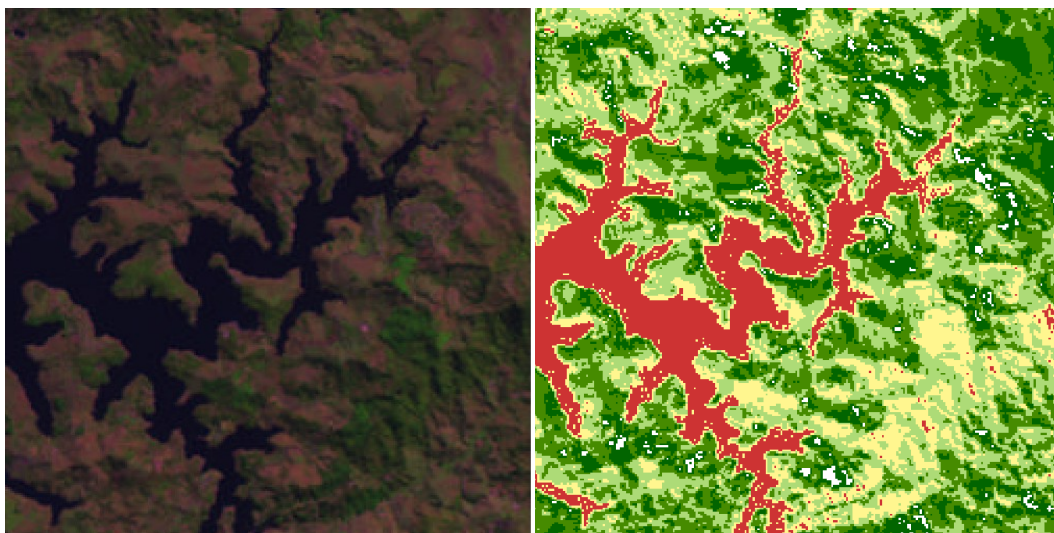
If variable, enter initial and final values and click on right arrow to insert values in right list.

*Colors:* double click over the color bar to open a selection window.

*Color bar*: select color bar configuration from the list.. Click on the **Save** button to insert a name and save it.

Click on the **Apply** button and the color list will appear below. Also, the image will be colored in visualization window.

Click on the **OK** button.



## Slope

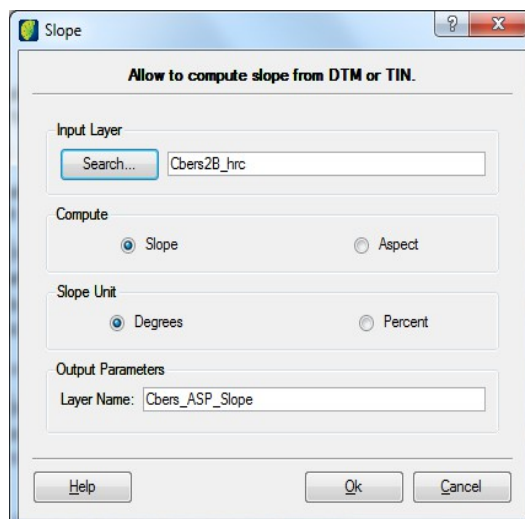
The slope is the terrain surface inclination in relation to the horizontal plane. Considering a terrain numeric model (TNM) with height data fetched from a topographic chart and plotting a tangent plane to this surface in a determined point (P), the slope in P will correspond to the inclination of this plan in relation to the horizontal plan.

In some geological, geomorphic applications it is necessary to find regions with few obstacles or regions exposed to the sun during certain day periods. To answer those questions slope counts with two components: gradient and exposition.

Gradient is the maximum variation rate in elevation value, it can be measured in grades (0 to 90°) or in percentage (%), in TerraAmazon called slope; and exposition is the direction of this measure variation in grades (0 to 360°).

Be sure that a rectangle grid was generated to the layer in the wanted numeric category.

Select DIGITAL TERRAIN MODEL → SLOPE in the main menu.



*Input Layer:* click on the **Search** button and choose a layer.

*Compute:* choose slope or aspect

*Slope Unit:* choose between degrees or percent (only for slope option).

*Output Parameters:* Enter the name of the resulting image.

Click on the **OK** button.

**Note:** once slope grid or aspect grid is created, sloping should be done on it to obtain a thematic map that represents slope/aspect interval as desired. (See Slicing in DTM).

## Generating Image

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Analyze a triangle or rectangle grid does not give an overall idea, i.e., parameters being modeled, so it is convenient to transform the grid in a more suitable product to be analyzed

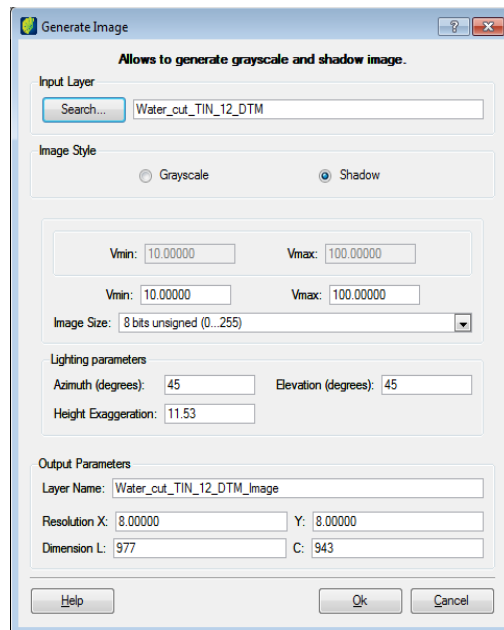
TerraAmazon allows generate gray level image from the TNM considering the interval between 0 (black) and 255 (white), i.e., grid real numbers are transformed in integer values, in gray level range, or in a shadowed image which consider the azimuth angle and the light source elevation.

Gray-level image generation to a terrain numeric model, where pixels will contain gray level, consist of distributing quota minimum and maximum values obtained from rectangle grid in gray levels from 0 to 255 using a linear equation ( $y = ax + b$ ).

The output image resolution (in meters) will have the same rectangle grid that generated it. To generate an image with a different XY resolution, it is necessary to generate another grid with the wanted resolution, and then generate the gray level image. This happens because each grid cell will correspond exactly to a pixel in output image where minimum quota values will be represented by dark pixels and the maximum values by clear pixels.

A shadowed image generated from a terrain numeric model in TerraAmazon will make possible to view terrain differences in each region. It is generated from the rectangle grid on which is applied a light model. This light model determines the reflected light intensity in a surface point considering a certain light source. The model depends on the light source that can be day light or other light source, and the surface reflexion.

Select DIGITAL TERRAIN MODEL → GENERATE IMAGE in the main menu.



*Input Layer:* click on the **Search** button and select the layer.

*Image Style:* choose gray scale or shadow.

If the gray scale was selected fill in *Vmin* and *Vmax* fields with minimum and maximum quote values respectively to be considered grid to image transformation. Value out of this range are mapped to a gray level 0 when it is lower than *Vmin*, and to 255 when it is higher than *Vmax*. *Vmin* value must be lower than *Vmax* value.

If shadow was selected enter lighting parameters.

*Azimuth:* correspondent to light source position, starting in the South (Y axis), ranging from 0° to 360°, in anti clock-wise.

*Elevation:* correspondent to the angle between of light source and the surface layer, ranging from 0° to 90°.

*Image Size:* Select one image model category.

*Height Exaggeration:* it is the added value in the surface vertical scale in relation to horizontal scale.

### **Output Parameters:**

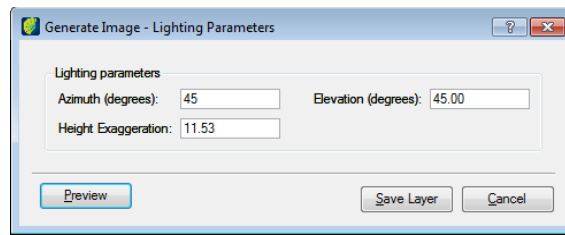
*Layer Name:* Enter the name of the resulting image.

*Resolution:* enter X and Y values.

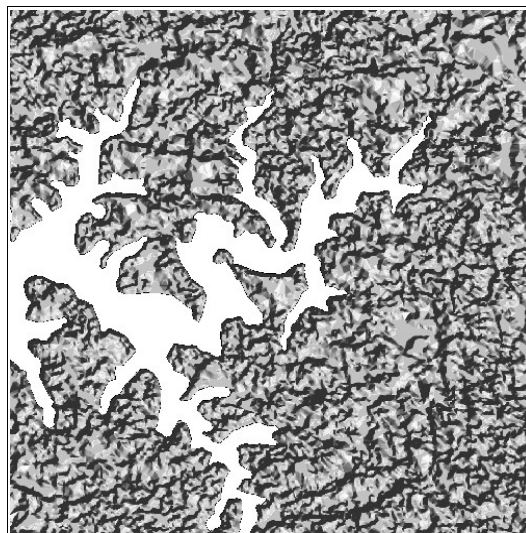
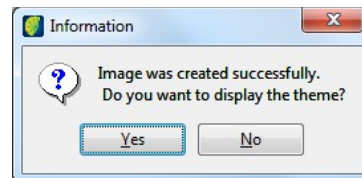
*Dimension:* enter L and C values.

Click on the **OK** button.

Before saving the new image the user can adjust azimuth, height exaggeration and elevation and check the result clicking on **Preview** button.



Once it reaches the user needs click on the **Save Layer** button.



## Profile

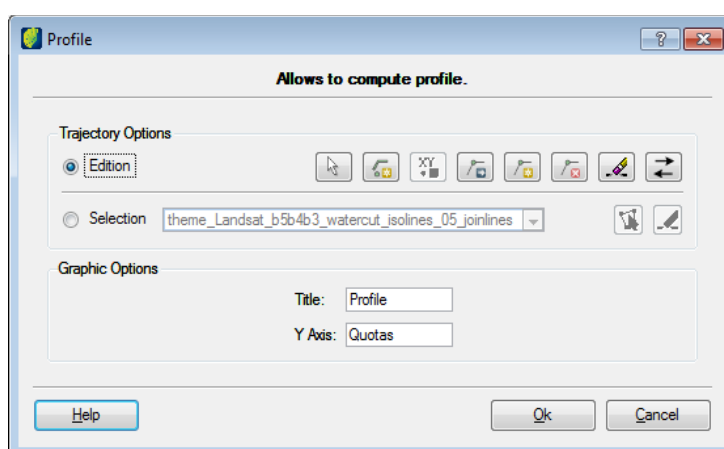
A certain type of TNM, such as a topographic surface, can be represented through profiles which describe point elevation (z value) in a line. This action is performed over numeric model data (grid or isoline) in raster format, presenting in a chart the z value equivalent to point that define the trajectory.

The profile is plotted, starting in a defined line trajectory by the user or starting in lines that have been digitalized previously and that belong to thematic, cadastral or net model data.

To consider layer line in mentioned models, it is necessary they are active in only one visualization window.

It can be selected up to five trajectories in the same layer and their profiles showed in only one chart.

Select DIGITAL TERRAIN MODEL → PROFILE in the main menu.



*Trajectory Options:* Click on Edition as trajectory option.

*Selection:* In this option user selects another theme and select information using the tools beside.



Note that beside Edition there are some specific options (icons) to this selection:



Select a trajectory.



Create trajectory by click on the path.



Add point by the coordinate in the path.



Move selected point in the trajectory.



Add a point on selected trajectory.



Delete selected point from the trajectory.



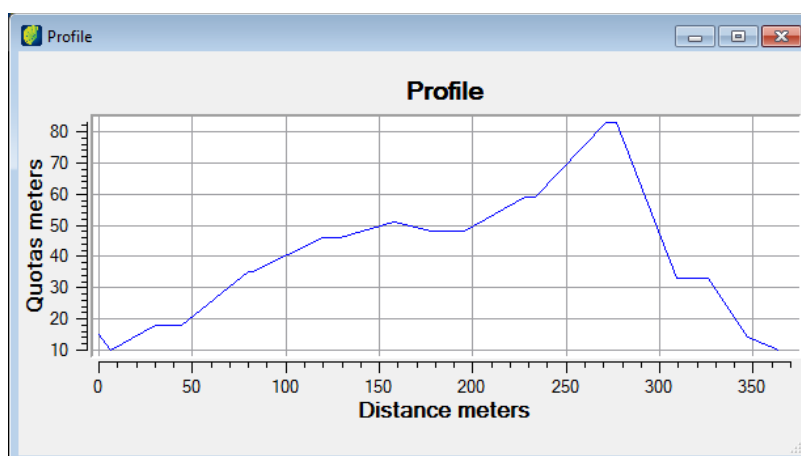
Delete selected trajectory.



Invert trajectory direction.

Use the point or trajectory option to draw the trajectory on the image.

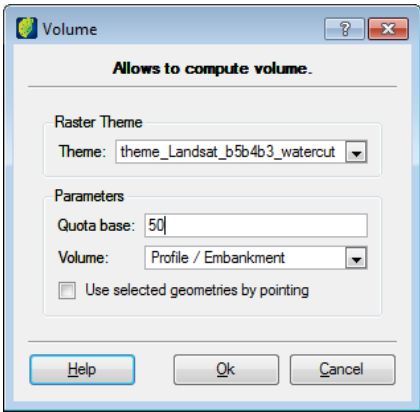
Click on the **OK** button.



## Calculating Volume

Volume calculation in TerraAmazon is done from areas, i.e., closed polygons of thematic or cadastral models and triangle or rectangular grids of the numeric model. From the grid is calculated the central value of each grid cell corresponding to height (z-axis), multiplied by available area value.

Select DIGITAL TERRAIN MODEL → VOLUME in the main menu.



**Quota base:** enter the maximum value for the quota base to calculate the volume.

**Volume:** select one of the calculation methods.

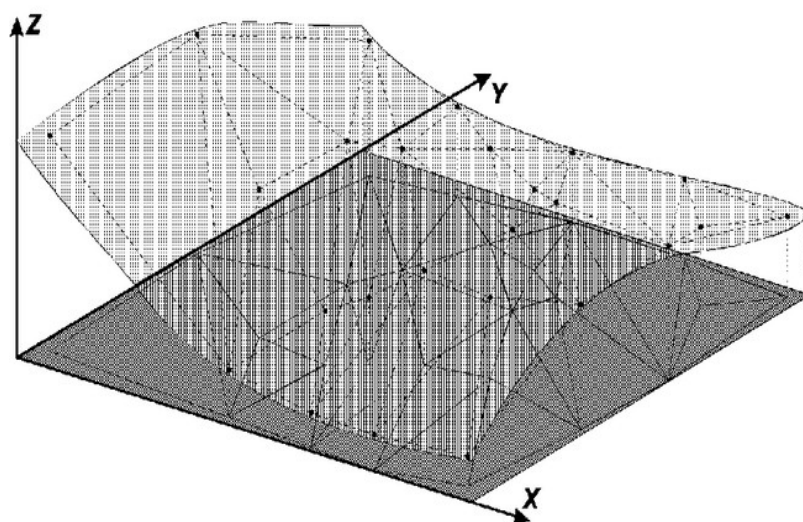
To select specific geometries in the theme click on box *Use selected geometries by pointing* and select wanted geometries on the presentation picture.

Click on the **OK** button.

	POLYGON_ID	PROFILE (m)	EMBANKMENT (m)	AREA (m)	QUOTA_IDEAL
1	25723	0.00	0.00	69.99	50.00
2	25733	0.00	0.00	314.15	50.00
3	25835	0.00	0.00	107.30	50.00
4	25842	0.00	0.00	496.32	50.00
5	25857	0.00	0.00	70.38	50.00
6	25955	0.00	0.00	127.94	50.00
7	28636	0.00	0.00	142.74	50.00
8	28642	0.00	0.00	166.55	50.00
9	28643	0.00	0.00	165.14	50.00
10	28644	0.00	0.00	619.98	50.00
11	28646	0.00	0.00	271.55	50.00
12	28647	0.00	0.00	154.34	50.00
13	28648	0.00	0.00	40.38	50.00
14	28650	0.00	0.00	188.16	50.00
15	28651	0.00	0.00	62.68	50.00
16	28652	0.00	0.00	533.05	50.00
17	28653	0.00	0.00	313.40	50.00

## Generating TIN

In surface modeling through triangle irregular grid, each polygon of a polyhedron face is a triangle. The triangle vertexes are generally surface sampled points. This modeling, considering triangle sides, allows that important morphological information such as discontinuity represented by linear shapes of tops and valleys are considered during triangle grid generation, making possible to model a terrain surface keeping surface geomorphic shapes.



The redundancy number is drastically reduced if compared to the rectangle grid, once the grid is thinner in regions of big variations and more spaced in almost plane regions. Surface discontinuities can be modeled through characteristic lines and points.

This grid has the advantage to use its own sampled points to model the surface, with no need of any type of interpolation. The disadvantage of irregular grid is the procedure to obtain data from triangle grids tend to be more complex and consequently slower than the rectangle grid.

Select DIGITAL TERRAIN MODEL → GENERATE TIN in the main menu.

### Isolines Layer Tab:

*Layer Name:* Select the layer from the list.

*Quota column:* select one of the available options.

or

### Samples Layer:

*Layer Name:* Select the layer from the list.

*Quota column:* select one of the available options.

*Target Scale:* enter the wanted scale and click on the **OK** button. It will automatically calculate and suggest values for triangulation and line simplification. If needed user can adjust those values.

### Triangulation:

*Type:* select between Delaunay or Smaller Angle.

*Minimum Edge Size:* enter the value in meters of the minimum size that will be considered in the process.

*Break Line:* select *Yes* if interpolator will use break lines. In this case, it can be possible with a layer that contains break lines; if not informed system looks for break lines in the own numeric layer that contain the samples. If the option is *Not*, the system will not consider break lines.

*Line Simplification:* data preprocessing phase values that are calculated initially from the defined scale of the layer. Parameters can be:

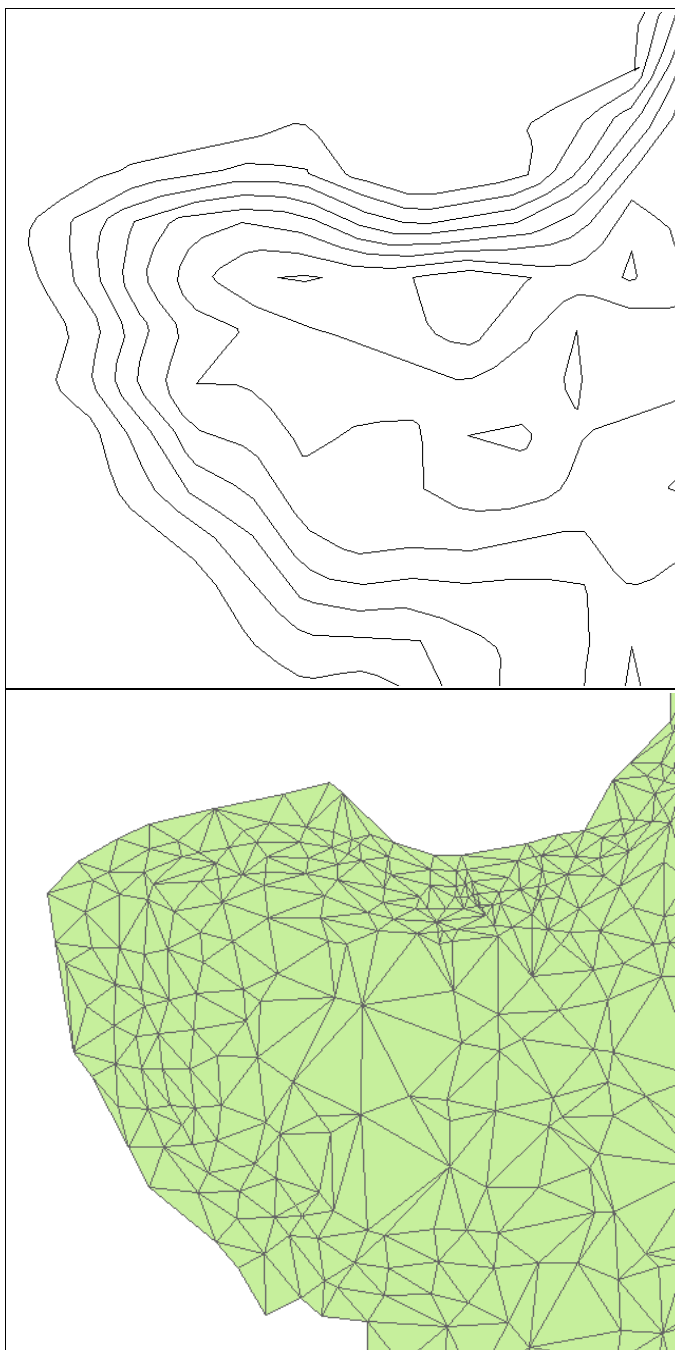
*Isoline Tolerance:* enter the value in meters.

*Distance of isolines points:* enter the value in meters.

**Output Parameters:**

*Layer Name:* enter the name of the resulting image.

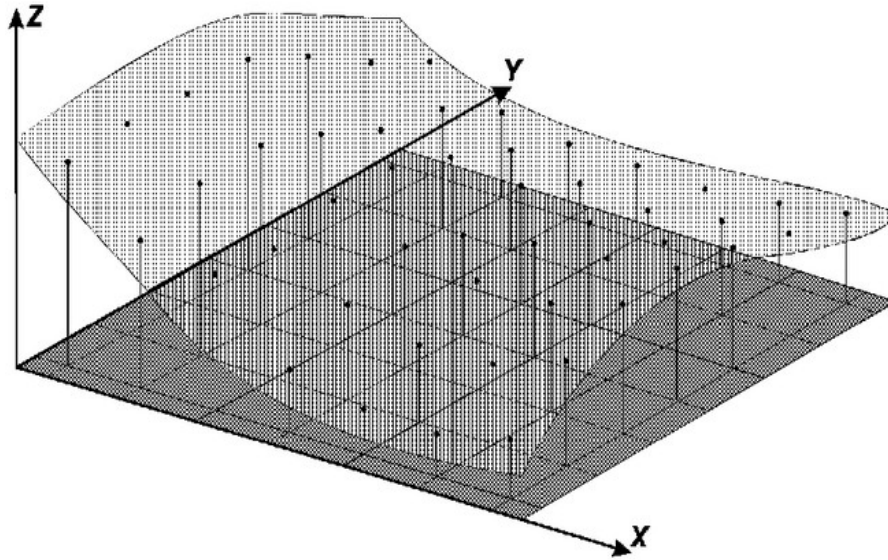
Click on the **OK** button.



## Generating a Rectangle Grid (DTM)

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The rectangle or regular grid is a digital model that shape surfaces through rectangle face polyhedron. Vertexes of those polyhedra can be the sampled points in case they have been acquired in same XY locations that define the wanted grid.

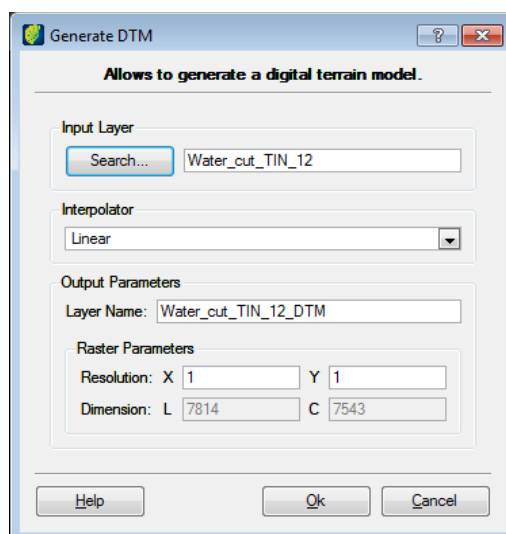


The rectangle grid generation must be done when a sampled data in the surface is not obtained with regular spacing. Thus from isoline contained information or in sampled points it is generated a grid that represent as closest as possible to the real surface. Initial values to be determined are x and y coordinate space in a way they can represent close values to the grid points in big variation regions. At same time, they should reduce redundancies in almost plane regions.

The grid space, i.e. x and y resolution, should be ideally lower or equal to the lower distance between two samples in different quotas. When generating a dense grid, with a very small distance between points, there will be a huge amount of information about the analyzed surface, but will need more time to generate. Otherwise considering big distances among points, it will be created a rough grid that could lose information. Therefore, the final grid resolution must have a commitment of data accuracy and grid generation time.

Once defined the resolution and consequently the coordinates in each grid point, it is possible to apply one of interpolation methods to calculate the elevation rounded value.

Select DIGITAL TERRAIN MODEL → GENERATE DTM in the main menu.



*Input Layer:* click on the **Search** button and choose the layer to be processed.

*Interpolator:* select a method from the list.

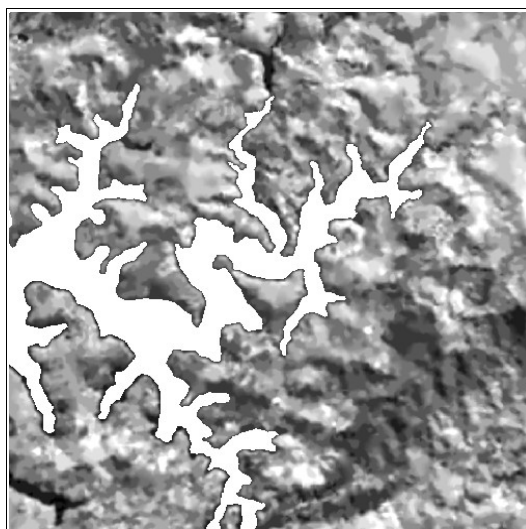
**Output Parameters:**

*Layer Name:* enter the name for the resulting image.

**Raster Parameters:**

*Resolution:* enter the value in meters. The presented resolution corresponds to the defined value during the numeric layer creation or during another interpolation process.

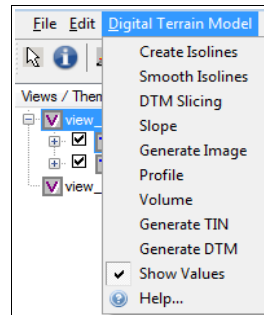
Click on the **OK** button.



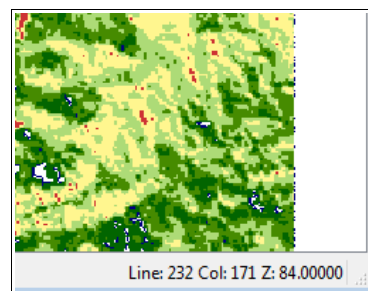
## Showing Values

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Click on DIGITAL TERRAIN MODEL → SHOW VALUES in main menu.



Then drag the mouse pointer to the desired place in the image. Position values will be shown in bottom right corner of the main window.





## 4 Tools

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### DTM PLUGIN TOOLS

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TerraAmazon DTM Plugin has one tool bar in the main interface:

## DTM Plugin Tools

Tools to display and manipulate the both vector and raster data in the drawing area. All visualization tools are effective on the drawing area only.

To use these tools, you must have a theme pointing to the data (layer) you wish to visualize or manipulate.

To visualize the data for the first time after connecting to the database, select the themes to be displayed by checking their check boxes on the Views and Themes tree.

Click on the tool  to visualize it in the drawing area.

The time required by the system to display the data on the drawing area depends on the amount of data selected to be displayed and on how complex such data is. That is so because a theme can have restrictions in order to point only to part of the data, which as a consequence makes the display process concern only the data effectively pointed by the selected themes, instead of on the total amount of data in their respective layers. Also, the time will depend on the area selected to be visualized, that is, selecting the entire theme (using the *Fit Theme* option, for example) will result in a larger amount of data to be drawn than it would be if a small area would be chosen. For the same reason, visualizing data in a scale of 1:25.000 will be much faster then doing it on 1:100.000, since more data will be visualized.



Information Cursor: queries the geometry's attributes. Select the tool and on the desired geometry. It has an effect on the geometry of the theme which is active in the Views and Themes tree.

When clicking in the intersection of two or more overlapped geometries the table will show all geometries and each one can be selected individually.



Pan cursor. Click and hold on the drawing area, move to the desired direction and release the click.



Draw tool. Triggers the data display in the visualization area. The data visualized are determined by the themes which are selected on the Views and Themes tree. That means that TerraAmazon will display only the themes whose visualization scale range is within the scale defined to be drawn. Drawing data for the first time will entirely fit all the selected themes in the drawing area. However, the following visualizations will resume the previous one, even after TerraAmazon is closed.



Zoom in. Select the tool and delimit the area to be visualized by holding a click in the visualization area and drawing a rectangle involving the desired area.



Select an area to zoom.



Zoom out. Just click anywhere in the drawing area. Multiplies the visualization scale by two.



Fits the selected theme in the drawing area.

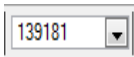


Previous and Next visualization.



Recompose. Visualization is recomposed to a box that entirely contains the selected themes. Only the themes whose visualization scale range is within the scale targeted by

the reset tool will be displayed. In case none of the selected themes are allowed to be drawn in the targeted scale, then only the empty box will be drawn.



Indicate scale of showed picture.



Find in visualization area the position indicated coordinate



Adjust an image contrast showed in the visualization window.



Adjust the image bright showed in the visualization window.



Adjust image transparency in the visualization window.



Adjust color adjust of RGB channels.



Read pixel value indicated by the pointer.



Create and organize new image views and tools to connect created views with the main one.

## Abbreviations and Acronyms

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CCD	Charge Coupled Devide
CRA	Centro Regional para Amazônica (Amazon Regional Center)
DEGRAD	Sistema de Detecção de Áreas de Degradação Florestal na Amazônia Legal Brasileira
DBMS	Database Management System
DEM	Digital Elevation Model
DESM	Dynamic Earth System Model
DETER	Sistema de Detecção do Desflorestamento da Amazônica Legal Brasileira em Tempo “Quase” Real
DETEX	Sistema de Detecção de Exploração Seletiva de Madeira na Amazônia Legal Brasileira
DIP	Digital Image Processing
DTM	Digital Terrain Model
EO	Earth Observation
ETM+	Enhanced Thematic Mapper Plus
GCP	Ground Control Point
GIS	Geographic Information System
HLS	Hue, Saturation, Lightness
HRC	High Resolution Camera
IHS	Intensity, Hue, Saturation
LUT	Look Up Table
OGC	Open Geospatial Consortium
PALSAR	Phased Array Type L-Band Synthetic Aperture Radar
PRISM	Panchromatic Remote-Sensing Instrument for Stereo Mapping
PRODES	Projeto de Monitoramento do Desmatamento na Amazônica Legal por Satélite
SWIR	Shortwave Infrared
TERRACCLASS	Projeto de Mapeamento de Uso da Terra na Amazônia Legal Brasileira
TIN	Triangle Irregular Network
TIR	Thermal Infrared
TM	Thematic Mapper
WFI	Wide Field Imager
WMS	Web Map Service

## Bibliography

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Instituto Nacional de Pesquisa Espacial - INPE. **Manual do Sistema de Processamento de Informações Georreferenciadas (SPRING)**. 53. ed. São José dos Campos: Inpe, 2012. Available in: <<http://www.dpi.inpe.br/spring/portugues/download.php>>. Accessed on: 01 set. 2015.

Instituto Nacional de Pesquisa Espacial. **TerraView User Manual**. 50. ed. São José dos Campos: In Pe, 2015. Available in: <<http://www.dpi.inpe.br/terraview/index.php>>. Accessed on: 01 set. 2015.

MANUAL do Usuário SigDesktop. 230. ed. São José dos Campos: Funcate, 2012.

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