Geostatistics in the SPRING
Exercise 6

Course: Master of Science on Geospatial Technologies
Professor: Carlos A. Felgueiras

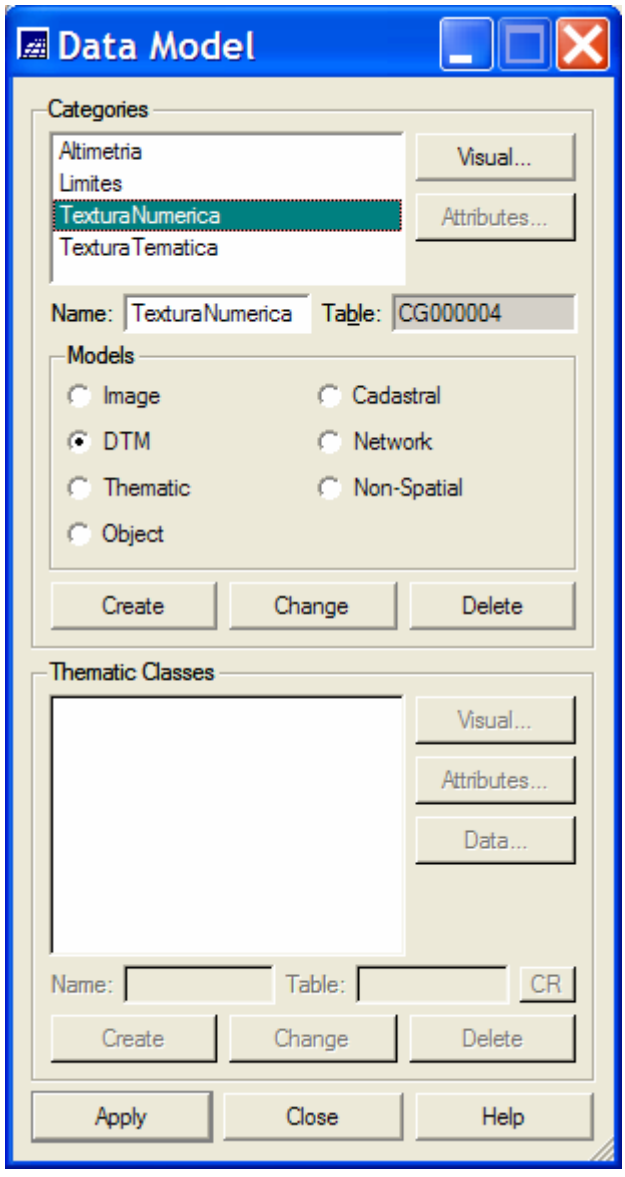
Contents

6.1 Importing and displaying the soil texture sample data

- Activate (Apply) SaoCarlos database
- Activate (Load) Canchim project

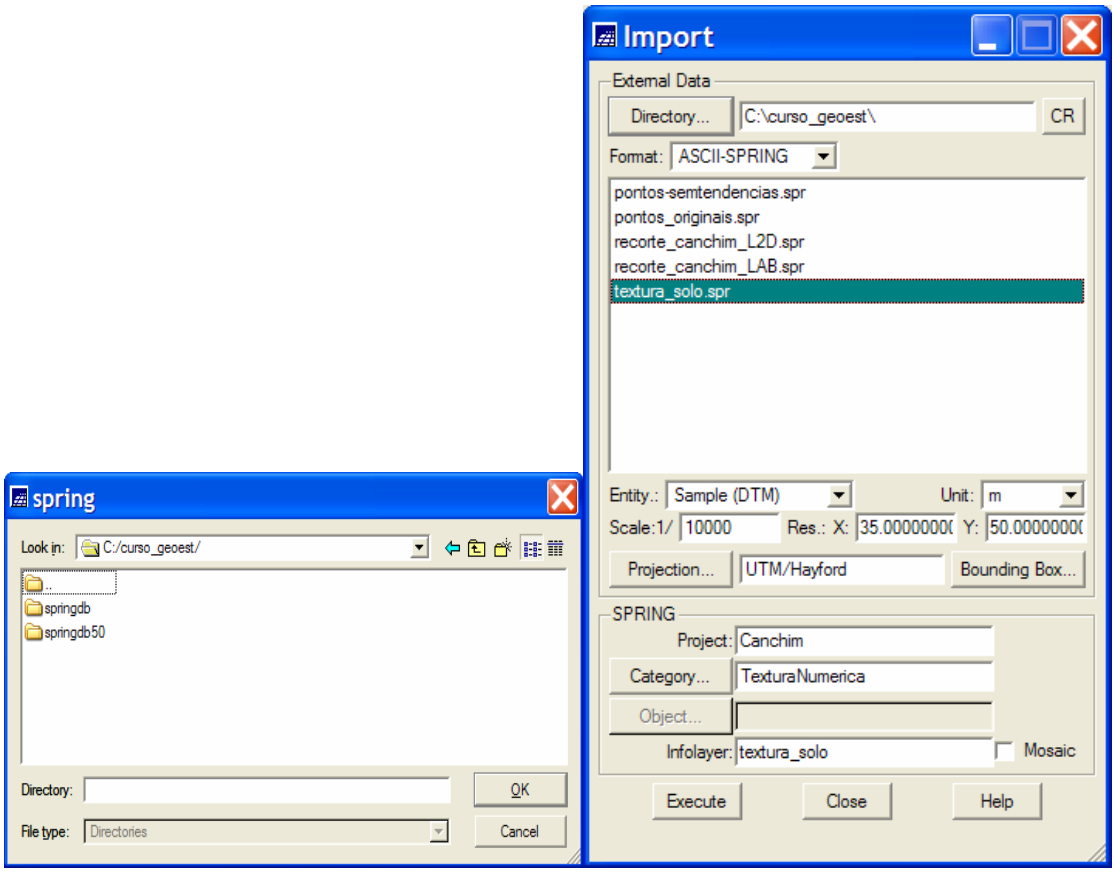
- Creating a category of a DTM model

  o Select the **Data Model… option** from the **File menu** of the SPRING
  o In the Data Model window
    - o Fill out the **Name field** with: *TexturaMnt*
    - o Choose from options of **Models** : *DTM*



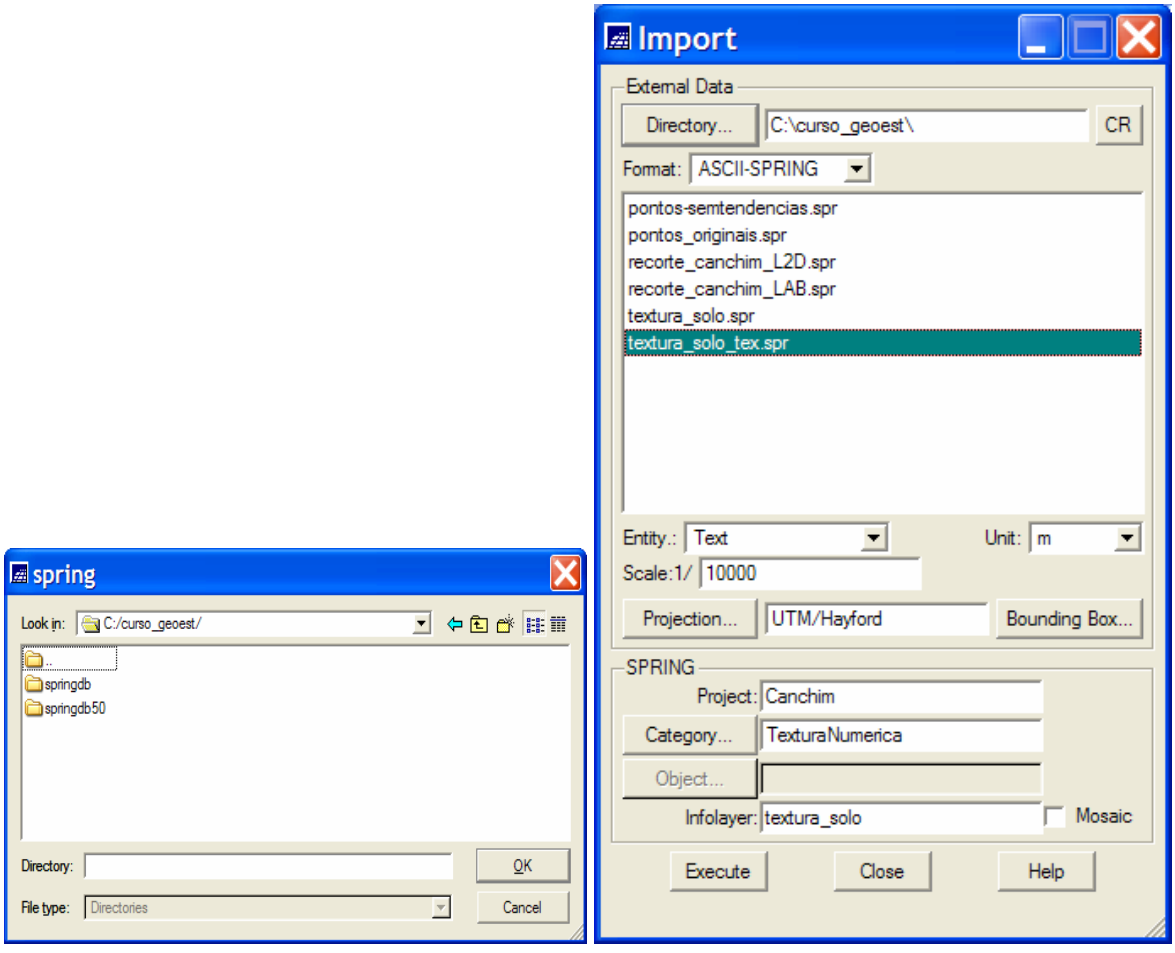
  - o Click on the **Create button** to create the category
  - o Click on the **Apply button**
  - o Click on the **Close button** to quit the Data Models window

- Importing the data of soil texture of the Canchim region
    - o Select **option Import...** from the **File menu** of the SPRING,
    - o Click on the **Directory… button**
    - • In the *Directory window*
        - o Select as **Directory**: c:*curso_geoest* e click on the **OK button**
        - o Select as **Format**: *ASCII-SPRING*
        - o Select as **File:** *textura_solo.spr*
        - o Select as **Entity**: *Sample(DTM)*
        - o Select as **Unity***: m* (meters)
        - o Define for the **Scale** value: *10000*
        - o Define the values **Res. X:** *35* and **Res. Y:** *50*
        - o Keep current values for **Projection** and **Bounding Box** of the project.
        - o Keep the current **Project Name** (Canchim)
        - o Click on **Categories... button**
        - o In the *Category window*
            - o Choose **Category** *TexturaNumerica*
            - o Click on the **Apply button**
        - o Fill out the **field IF**(Info Layer) with the name: *textura_solo*
        - o Click on the **Apply button**



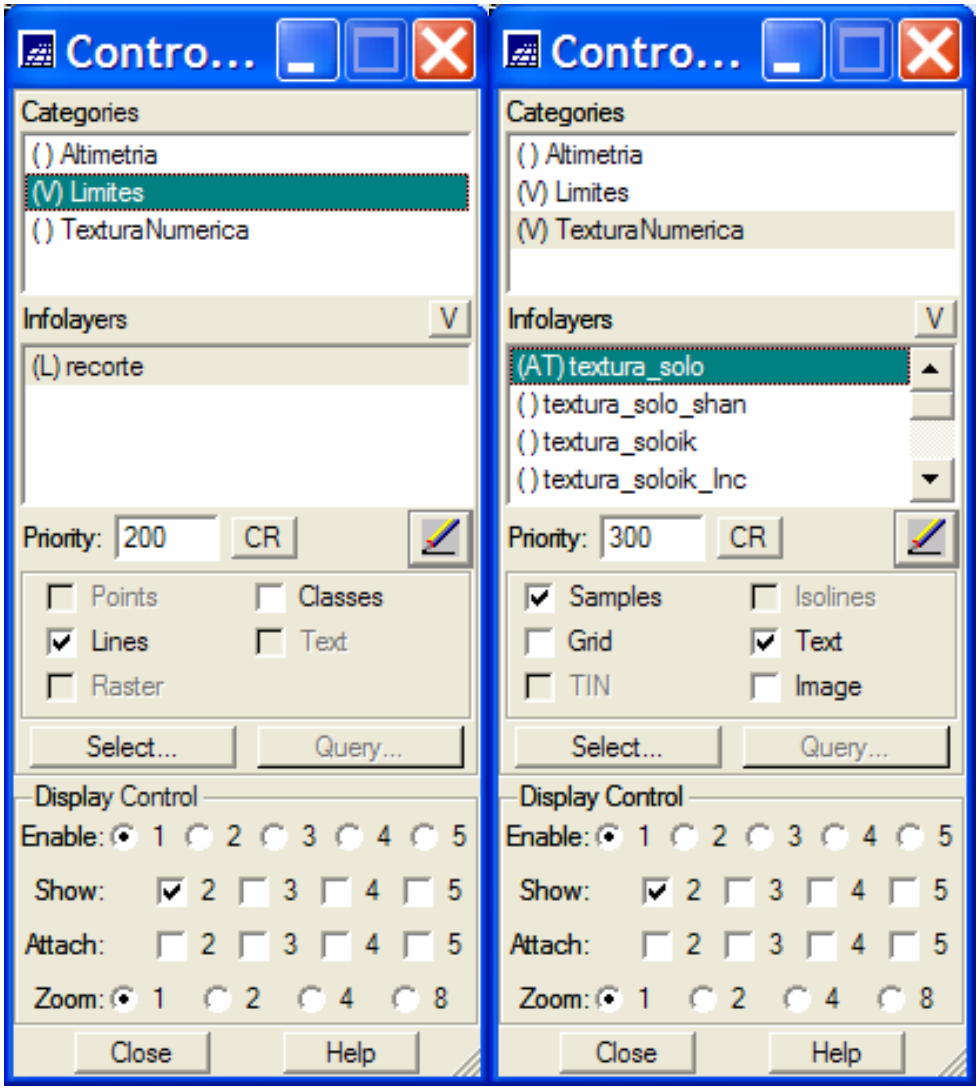
- o Quit the import window clicking on the **Close button**

- Importing the data texts of soil texture of the Canchim region
    - Select **option Import...** from the **File menu** of the SPRING,
    - Click on the **Directory… button**
    - In the *Directory window*
        - Select as **Directory**: c:*curso_geoest* e click on the **OK button**
        - Select as **Format**: *ASCII-SPRING*
        - Select as **File:** *textura_solo_tex.spr*
        - Select as **Entity**: *Text*
        - Select as **Unity***: m* (meters)
        - Define for the **Scale** value: *10000*
        - Define the values **Res. X:** *35* and **Res. Y:** *50*
        - Keep current values for **Projection** and **Bounding Box** of the project.
        - Keep the current **Project Name** (*Canchim*)
        - Click on **Categories... button**
        - In the *Category window*
            - Choose **Category** *TexturaNumerica*
            - Click on the **Apply button**
        - Fill out the **field IF**(Info Layer) with the name: *textura_solo*
        - Click on the **Apply button**



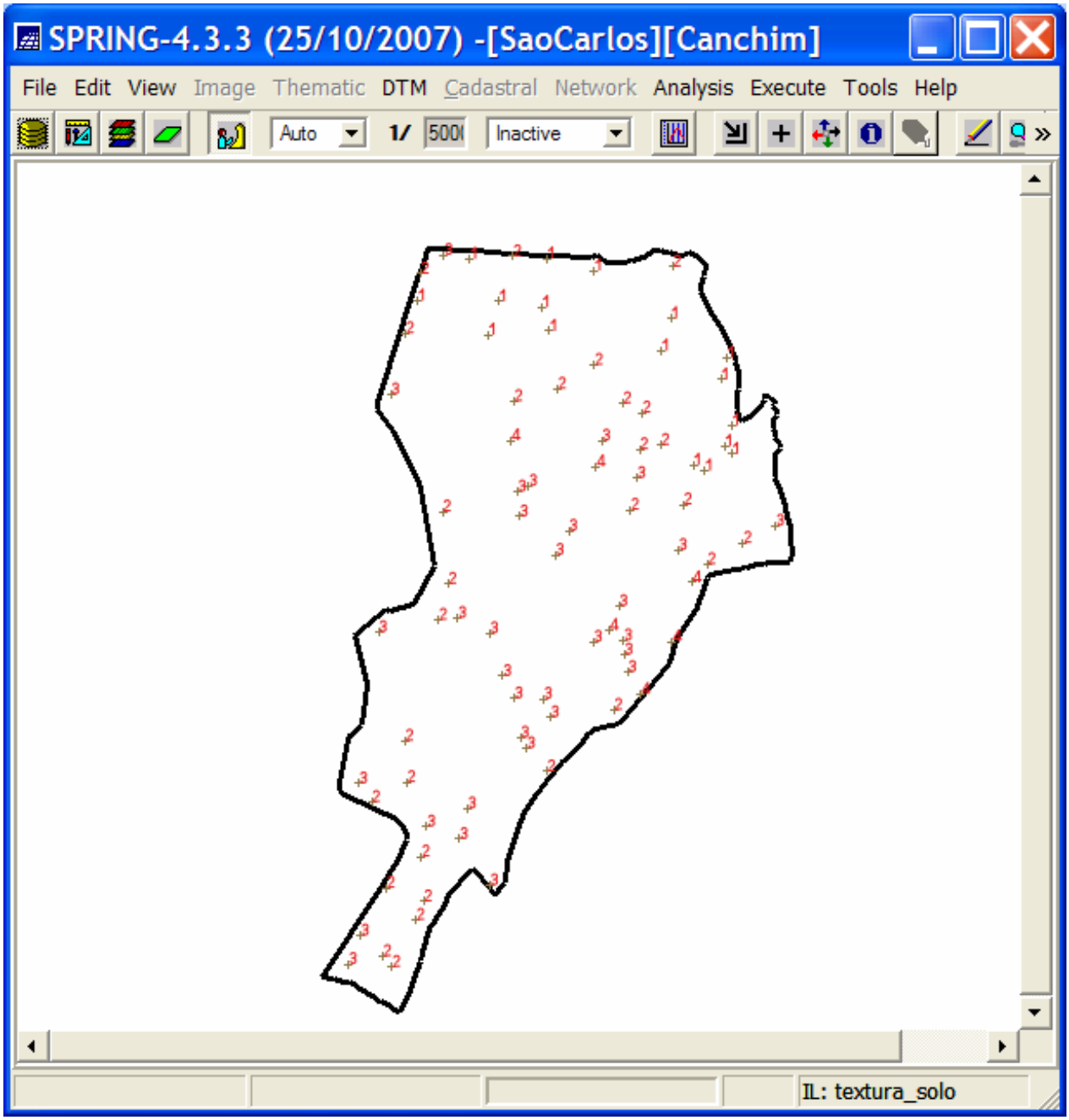
    - Quit the import window clicking on the **Close button**

- Visualizing the data and texts of soil texture of the Canchim region
    - In the Control Panel
        - Activate the Display 1
        - Select in the **Category list***:* *Limites*
        - Select in the **InfoLayer list**: *recorte*
        - Select as representation *Lines*
        - Select in the **Category list***:* *TexturaNumerica*
        - Select in the **InfoLayer list**: *textura_solo*
        - Select as representations: *Samples* and *Text*

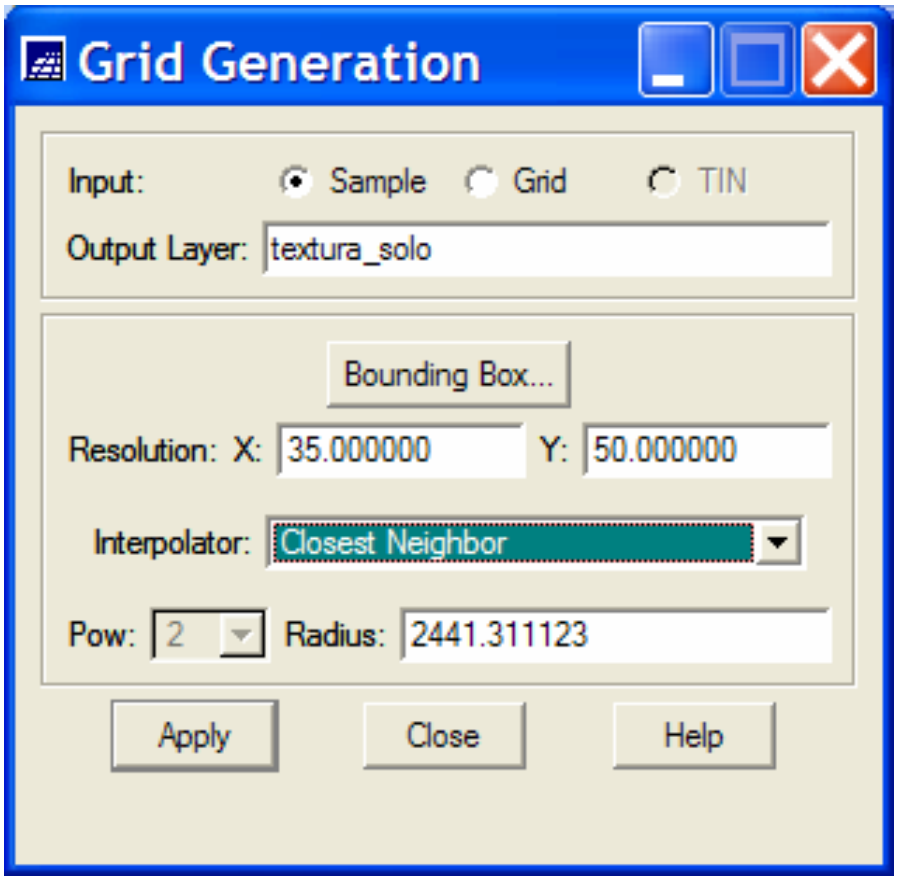


- Click on the **Draw Icon**  **of the Control Panel or of the SPRING tool bar**

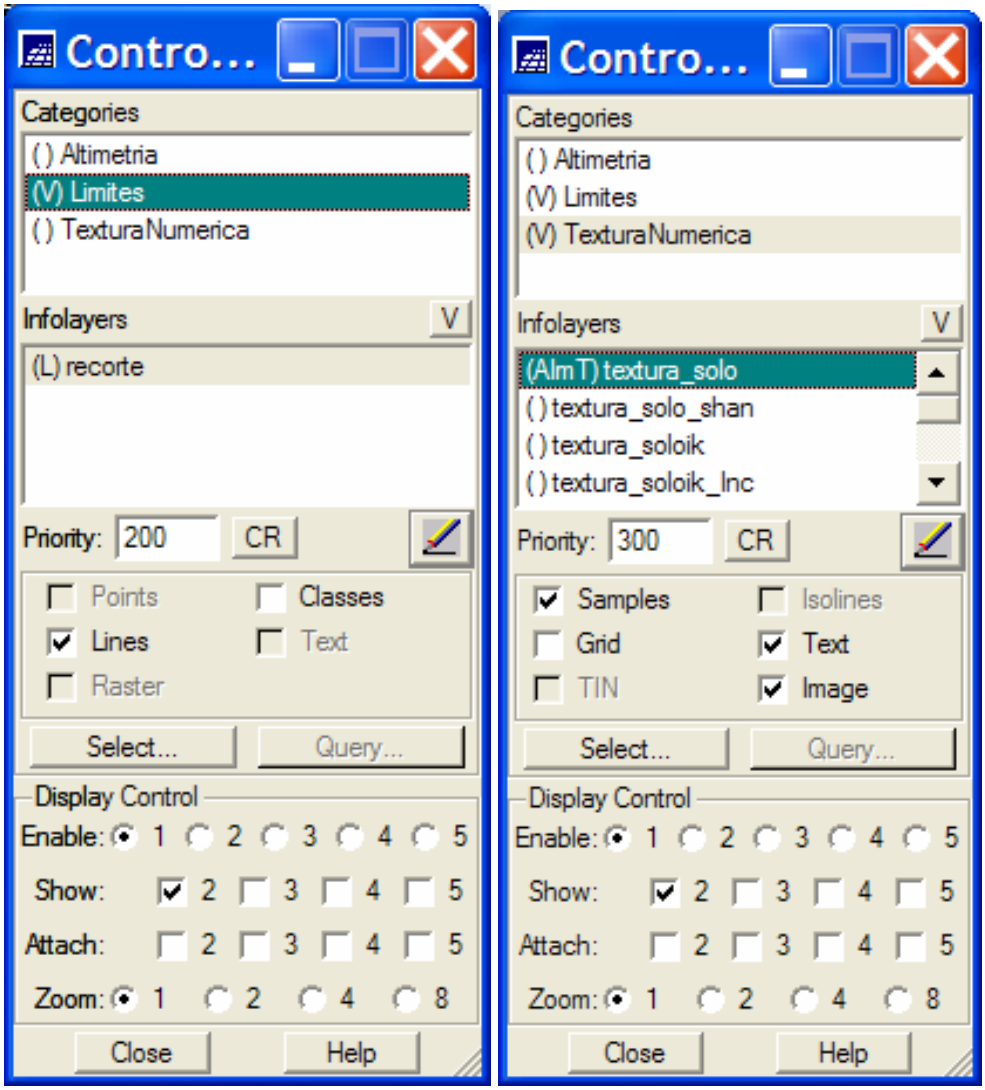
• The Figure below illustrates the results of the visualization operations above done



- Applying the nearest neighbor interpolation to the soil texture data
  - o Select the InfoLayer *textura_solo* in the Control Panel of the SPRING
  - o Select **option Rectangular Gri d Generation...** from the **DTM** option of the SPRING menu.
  - • In the *Grid Generation* window
    - o Select as **Input**: *Sample*
    - o Keep as **Output**: *textura_solo*
    - o Keep the values **Resolution** X: *35* and Y: *50*
    - o Select as **Interpolator**: *Closest Neighbor*
    - o Keep as **Radius:** *2441.31*
    - o Click on the *Apply* **button** to run the Grid Generation function

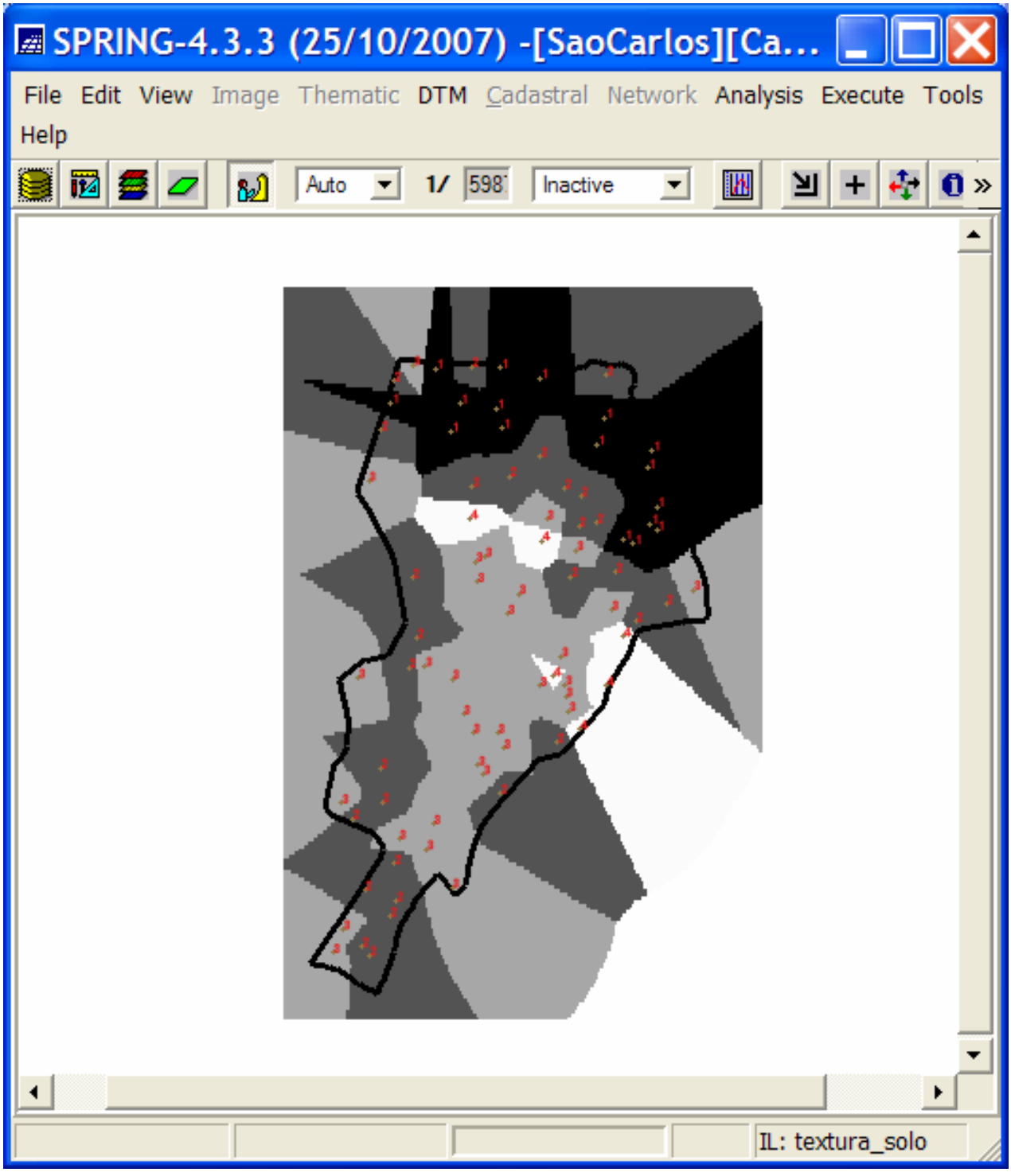


- Visualizing the data and texts of soil texture of the Canchim region
    - In the Control Panel
        - Activate the Display 1
        - Select in the **Category list***:* *Limites*
        - Select in the **InfoLayer list**: *recorte*
        - Select as representation *Lines*
        - Select in the **Category list***:* *TexturaNumerica*
        - Select in the **InfoLayer list**: *textura_solo*
        - Select as representations: *Samples, Image* and *Text*



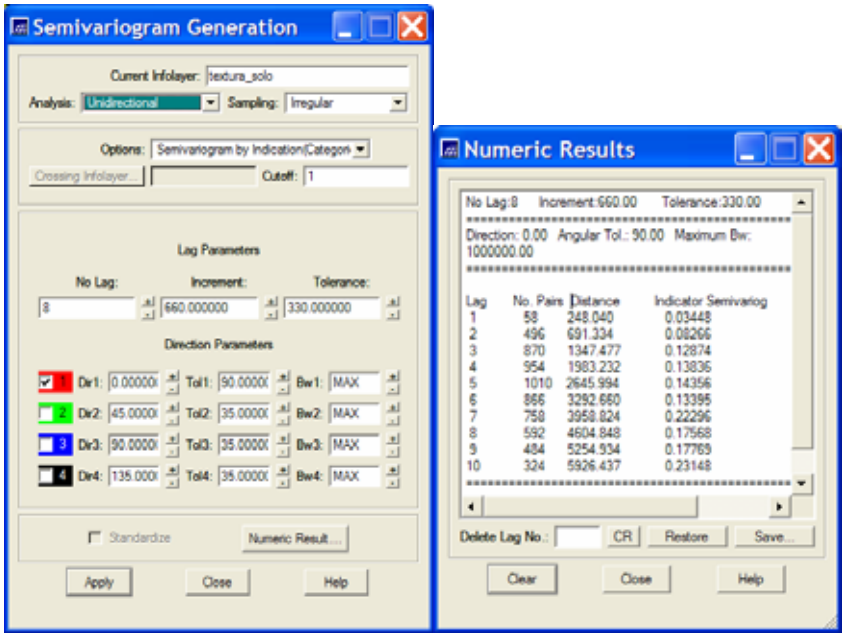
- Click on the **Draw Icon**  **of the Control Panel or of the SPRING tool bar**

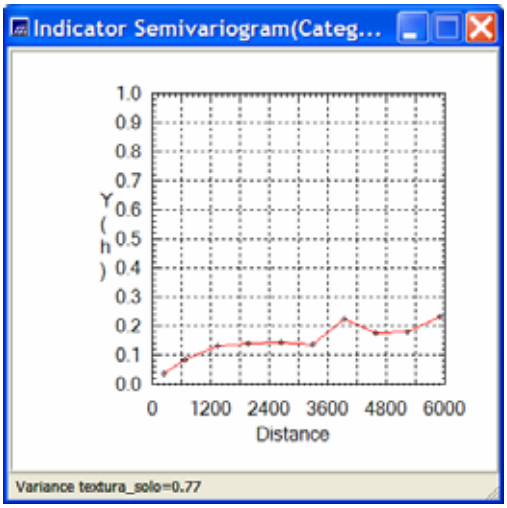
• The Figure below illustrates the results of the visualization operations above done



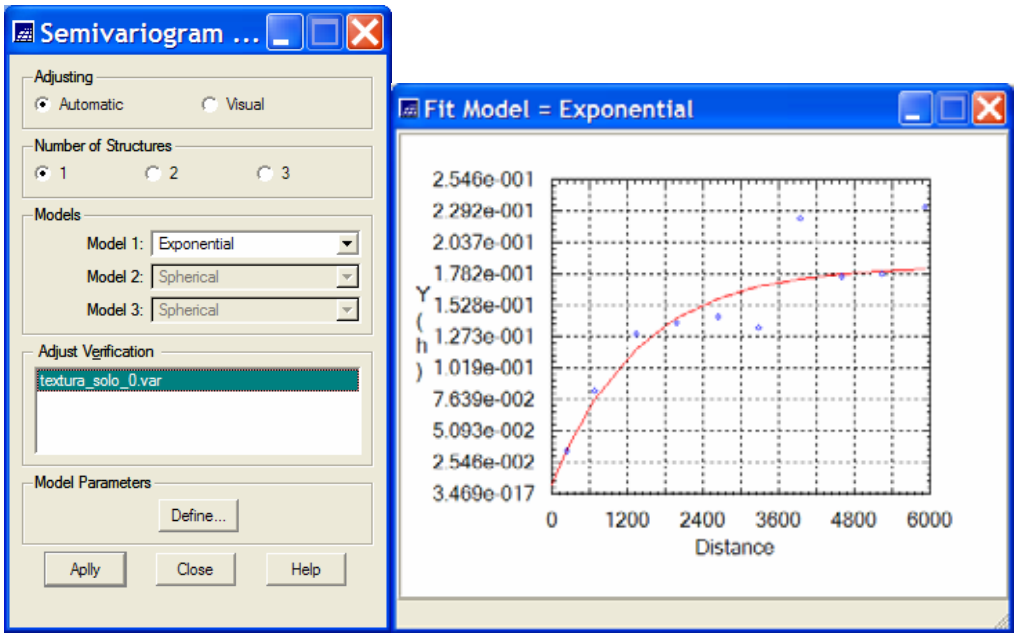
6.2 Generating and fitting variograms for the first cutoff (class 1)

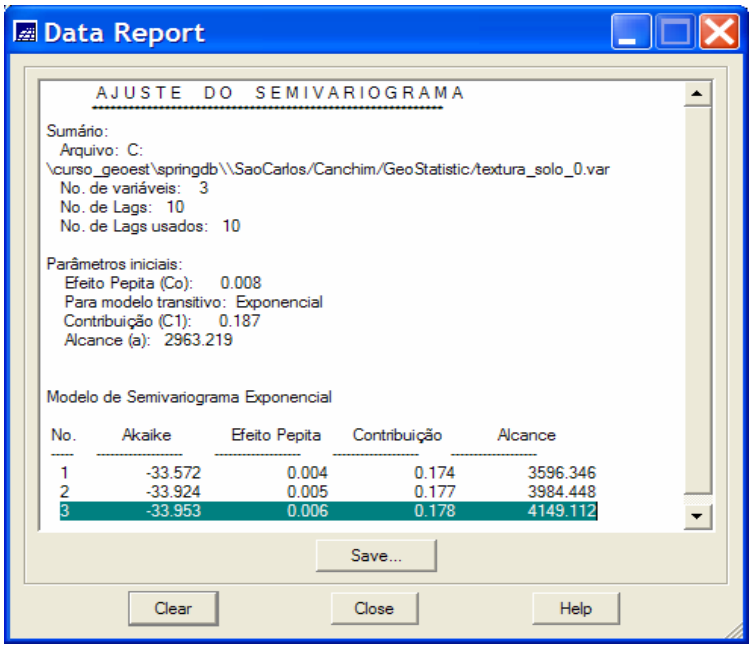
- Select the *textura_solo* InfoLayer of the *TexturaNumerica* Category
- Click on the *Semivariogram Generation* option of the Geostatistics of the Analysis SPRING menu to open the semivariograma generation window.
- In the Semivariogram Generation window
    - Select *Unidirectional* as Analysis:, *Irregular* as Sampling: and *Semivariogram by Indication (Category)* as Options:.
    - Fill out the Cutoff text field with the value equal *1.*
    - Select, as Lag Parameters, No Lag: equal *8*, Increment *660* and Tolerance *330*
    - Select as Direction Parameters the number *1* (0 degrees, omnidirectional variogram)
    - Click on the *Apply* button to display the respective experimental semivariogram
    - Click on the *Numeric Result…* button to show the Numeric Results window that contains tabular information related to the experimental semivariogram





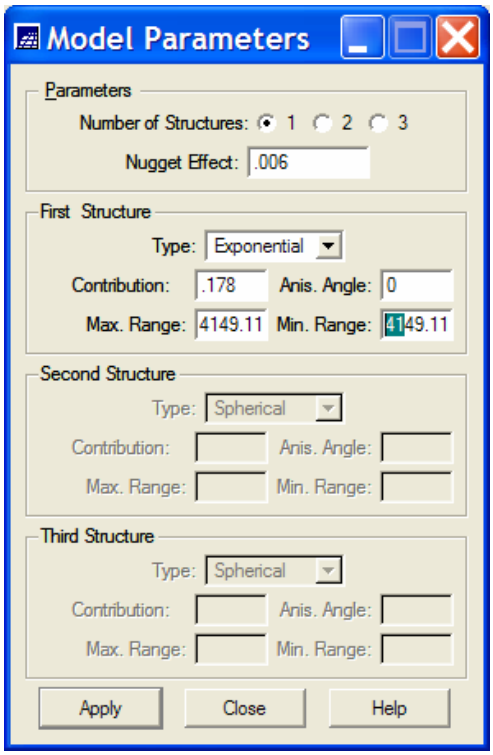
- Click on the *Semivariogram Modeling* option of the Geostatistics of the Analysis SPRING menu to open the Semivariograma Modeling window.
- In the Semivariogram Modeling window
    - Select *Automatic* as Adjusting option
    - Select *1* for the Number of Structures option
    - Select Model 1: *Exponential* as the Models option
    - Click on the *Apply* button and then click on the *textura_solo_0.var* option of the Adjust Verification list to display the Fit Model and Data Report windows.





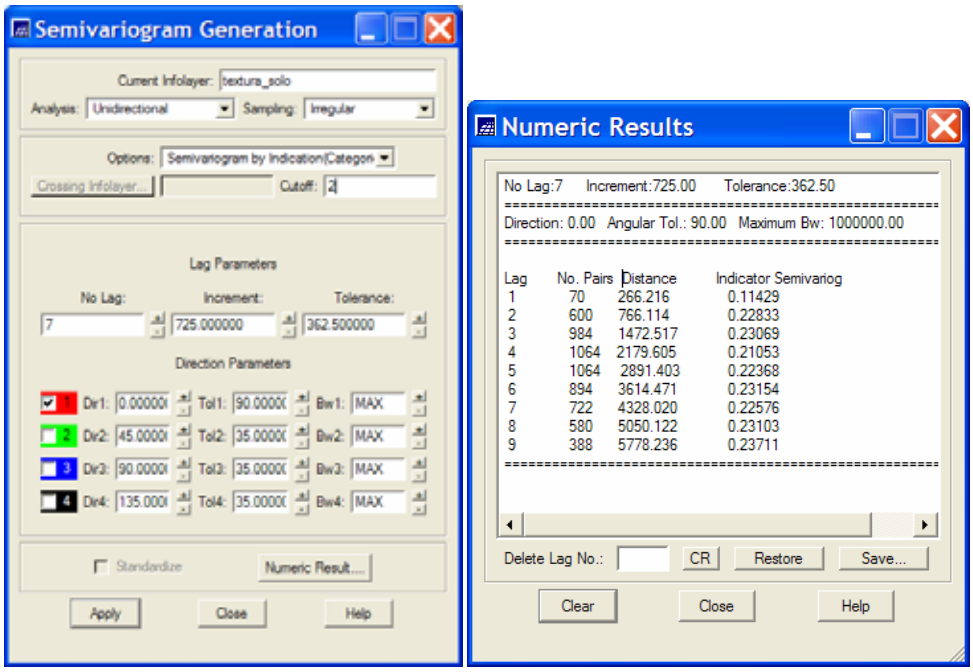
    - Click on the *Define…* button to open the model parameters window
    - In the Model Parameters window

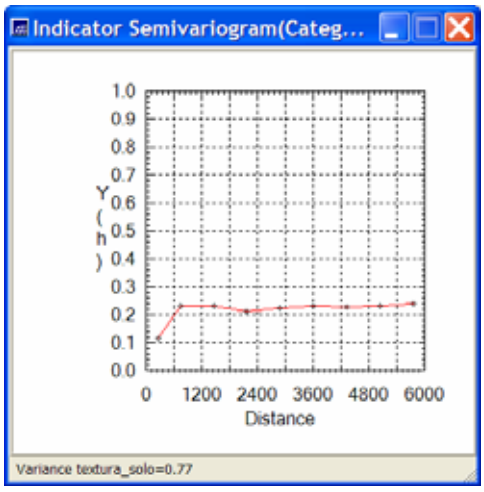
- Choose Number of Structures equal *1*
- Fill out the Nugget Effect text field with the value *.006*
- For the First Structure options
    - Choose Type: equal Exponential
    - Fill out the Contribution field with value *.178*
    - Fill out the Anis. Angle with value *0*
    - Fill out the Max. and Min. Range fields with value *4149.11*
- Click on the *Apply* button to store the above model parameters



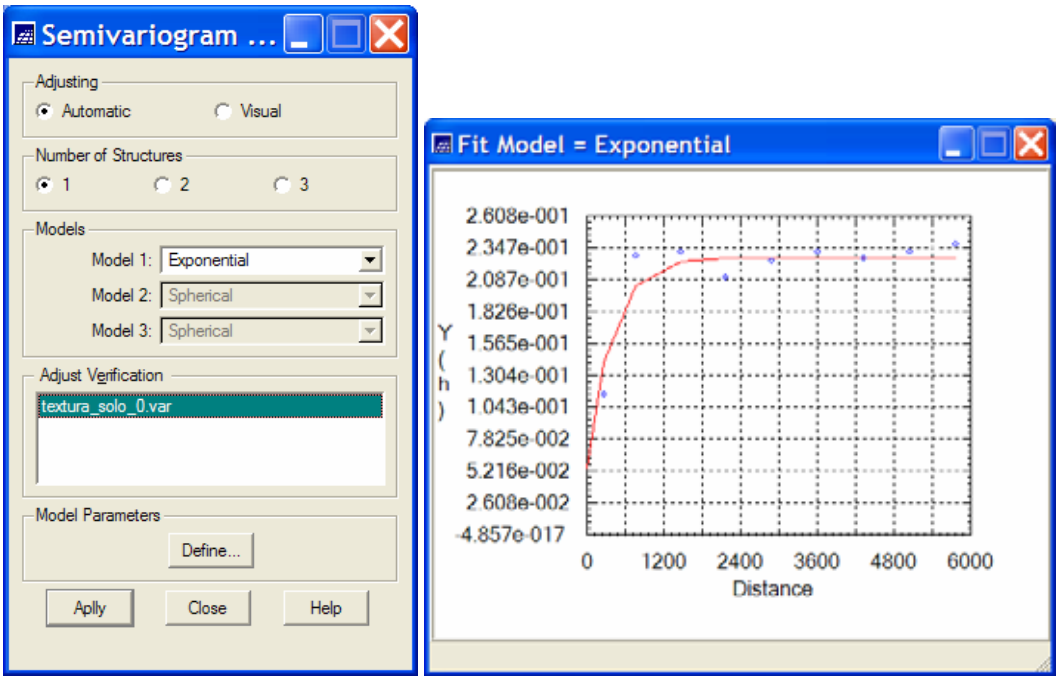
6.3 Generating and fitting variograms for the second cutoff (class equal 2)

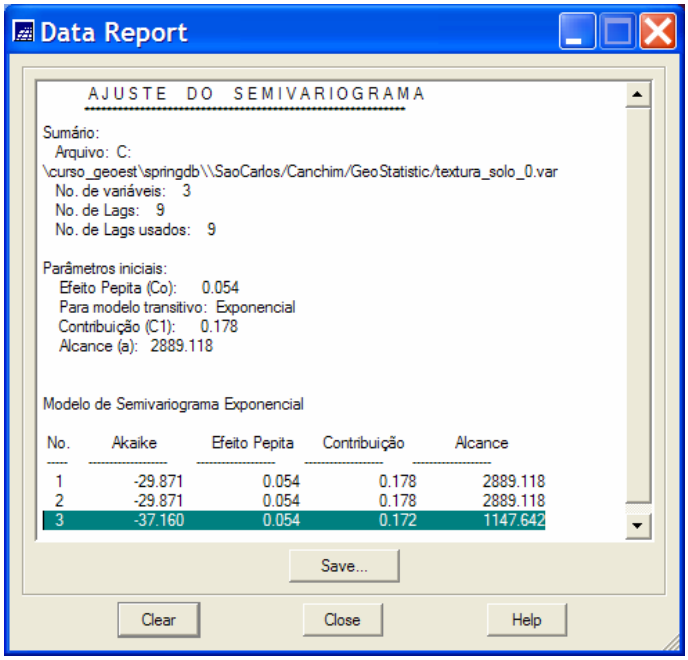
- Select the *textura_solo* InfoLayer of the *TexturaNumerica* Category
- Click on the *Semivariogram Generation* option of the Geostatistics of the Analysis SPRING menu to open the semivariograma generation window.
- In the Semivariogram Generation window
    - Select *Unidirectional* as Analysis:, *Irregular* as Sampling: and *Semivariogram by Indication (Category)* as Options:.
    - Fill out the Cutoff text field with the value equal *2*.
    - Select, as Lag Parameters, No Lag: equal *7*, Increment *725* and Tolerance *362.5*
    - Select as Direction Parameters the number *1* (0 degrees, omnidirectional variogram)
    - Click on the Apply button to display the respective experimental semivariogram
    - Click on the Numeric Result… button to show the Numeric Results window that contains tabular information related to the experimental semivariogram.



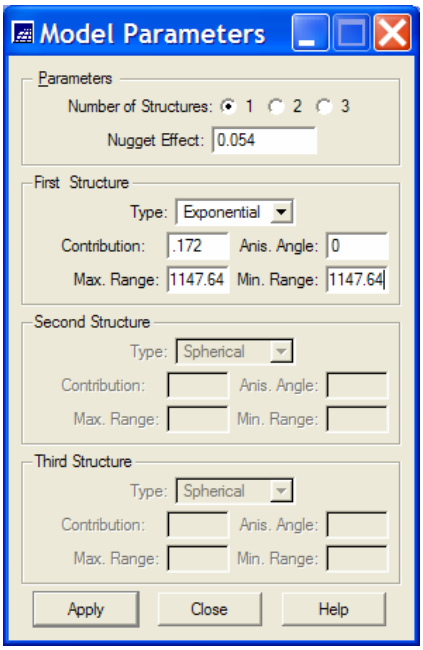


- Click on the *Semivariogram Modeling* option of the Geostatistics of the Analysis SPRING menu to open the Semivariograma Modeling window.
- In the Semivariogram Modeling window
    - Select *Automatic* as Adjusting option
    - Select *1* for the Number of Structures option
    - Select Model 1: *Exponential* as the Models option
    - Click on the *Apply* button and then click on the *textura_solo_0.var* option of the Adjust Verification list to display the Fit Model and Data Report windows.



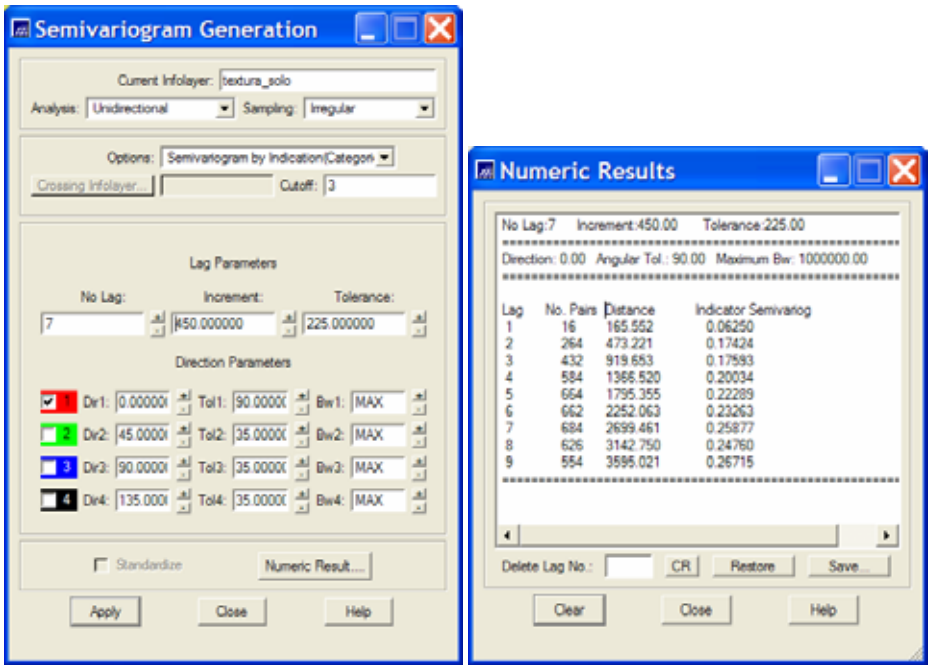


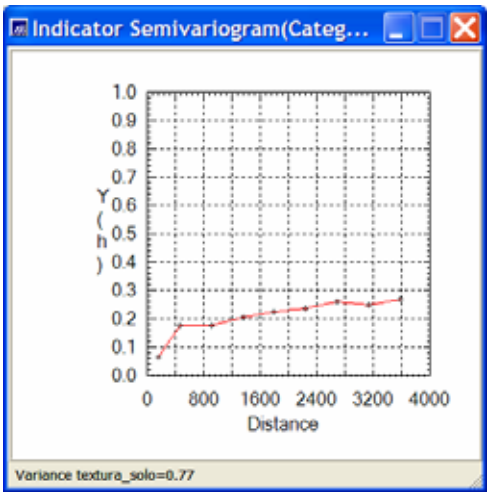
- Click on the *Define…* button to open the model parameters window
- In the Model Parameters window
  - Choose Number of Structures equal *1*
  - Fill out the Nugget Effect text field with the value *.054*
  - For the First Structure options
    - Choose Type: equal *Exponential*
    - Fill out the Contribution field with value *.172*
    - Fill out the Anis. Angle with value *0*
    - Fill out the Max. and Min. Range fields with value *1147.64*
  - Click on the Apply button to store the above model parameters



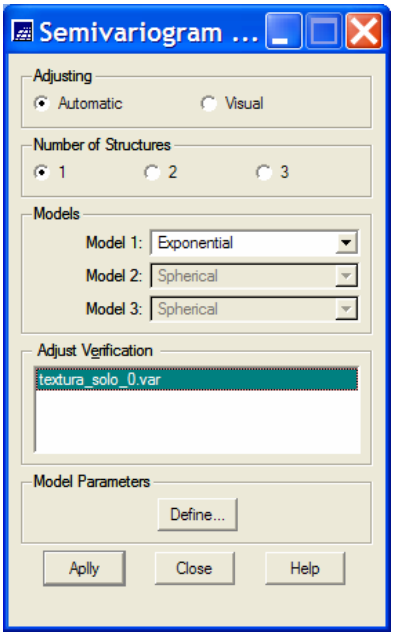
6.4 Generating and fitting variograms for the third cutoff (class equal 3)

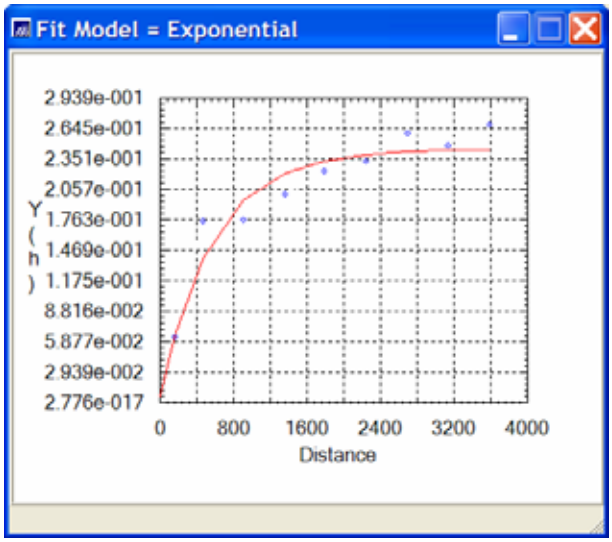
- Select the *textura_solo* InfoLayer of the *TexturaNumerica* Category
- Click on the *Semivariogram Generation* option of the Geostatistics of the Analysis SPRING menu to open the semivariograma generation window.
- In the Semivariogram Generation window
    - Select *Unidirectional* as Analysis:, *Irregular* as Sampling: and *Semivariogram by Indication (Category)* as Options:.
    - Fill out the Cutoff text field with the value equal *3.*
    - Select, as Lag Parameters, No Lag: equal *7* Increment *450* and Tolerance *225*
    - Select as Direction Parameters the number *1* (0 degrees, omnidirectional variogram)
    - Click on the *Apply* button to display the respective experimental semivariogram
    - Click on the *Numeric Result…* button to show the Numeric Results window that contains tabular information related to the experimental semivariogram.

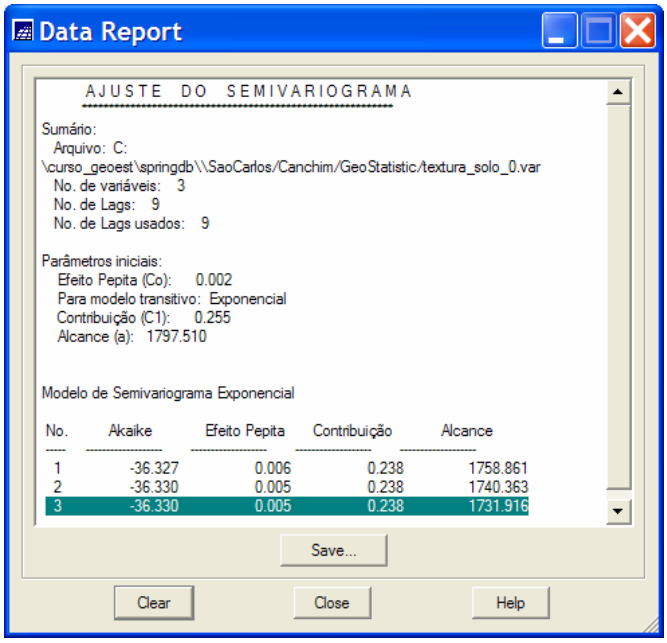




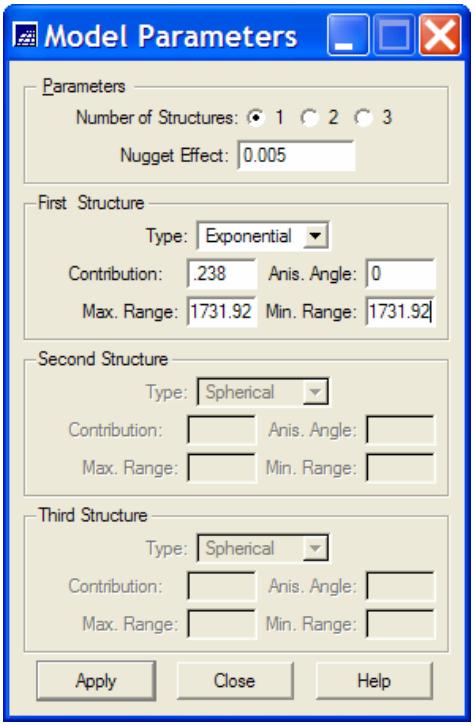
- Click on the *Semivariogram Modeling* option of the Geostatistics of the Analysis SPRING menu to open the Semivariograma Modeling window.
- In the Semivariogram Modeling window
    - Select *Automatic* as Adjusting option
    - Select *1* for the Number of Structures option
    - Select Model 1: *Exponential* as the Models option
    - Click on the *Apply* button and then click on the *textura_solo_0.var* option of the Adjust Verification list to display the Fit Model and Data Report windows.





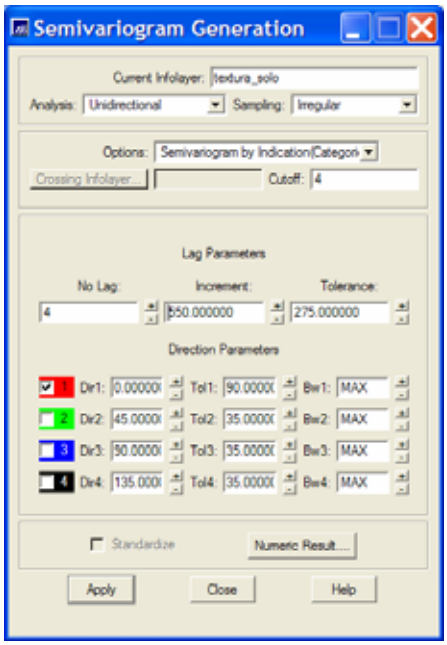


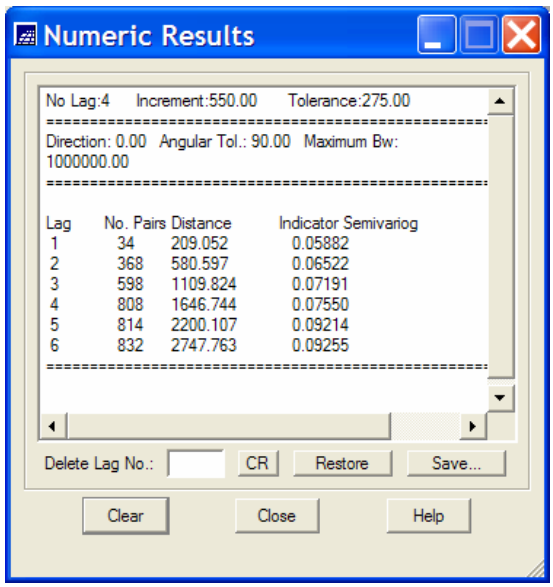
- Click on the *Define…* button to open the model parameters window
- In the Model Parameters window
  - Choose Number of Structures equal *1*
  - Fill out the Nugget Effect text field with the value *.005*
  - For the First Structure options
    - Choose Type: equal Exponential
    - Fill out the Contribution field with value *.238*
    - Fill out the Anis. Angle with value *0*
    - Fill out the Max. and Min. Range fields with value *1731.92*
  - Click on the *Apply* button to store the above model parameters

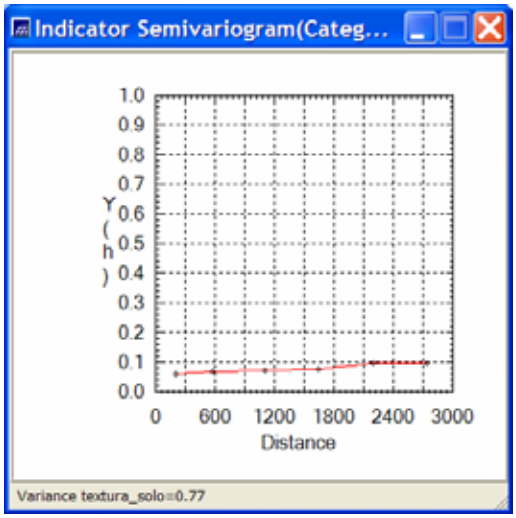


6.5 Generating and fitting variograms for the fourth cutoff (class equal 4)

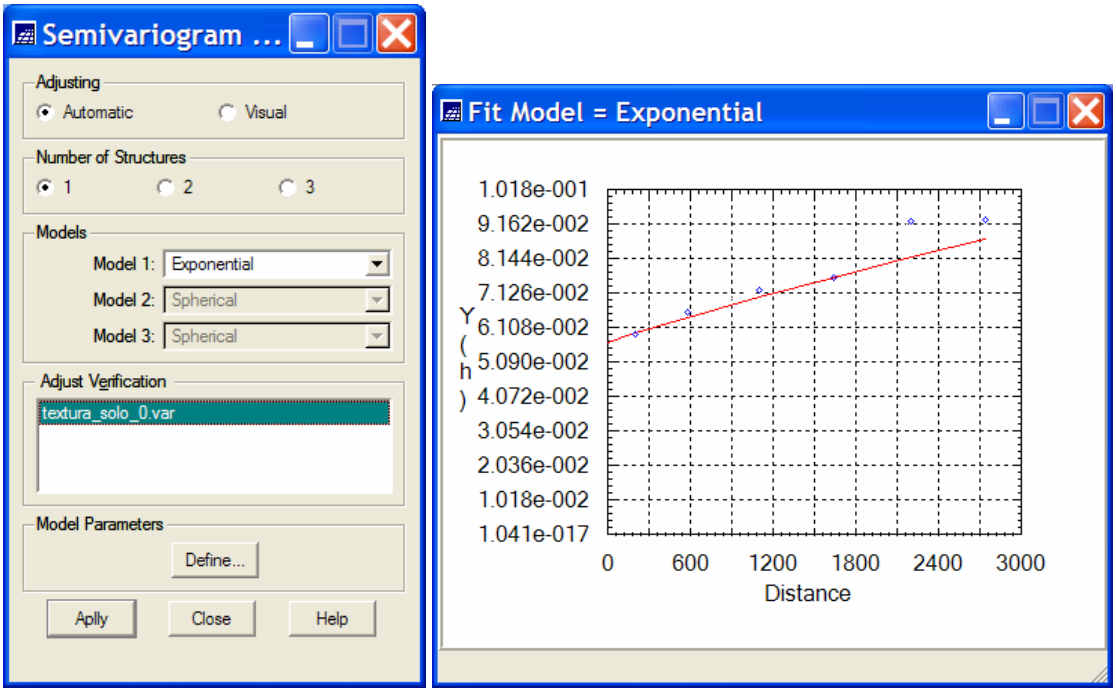
- Select the *textura_solo* InfoLayer of the *TexturaNumerica* Category
- Click on the *Semivariogram Generation* option of the Geostatistics of the Analysis SPRING menu to open the semivariograma generation window.
- In the Semivariogram Generation window
    - Select *Unidirectional* as Analysis:, *Irregular* as Sampling: and *Semivariogram by Indication (Category)* as Options:.
    - Fill out the Cutoff text field with the value equal *4.*
    - Select, as Lag Parameters, No Lag: equal *4*, Increment *550* and Tolerance *275*
    - Select as Direction Parameters the number *1* (0 degrees, omnidirectional variogram)
    - Click on the *Apply* button to display the respective experimental semivariogram
    - Click on the *Numeric Result…* button to show the Numeric Results window that contains tabular information related to the experimental semivariogram.

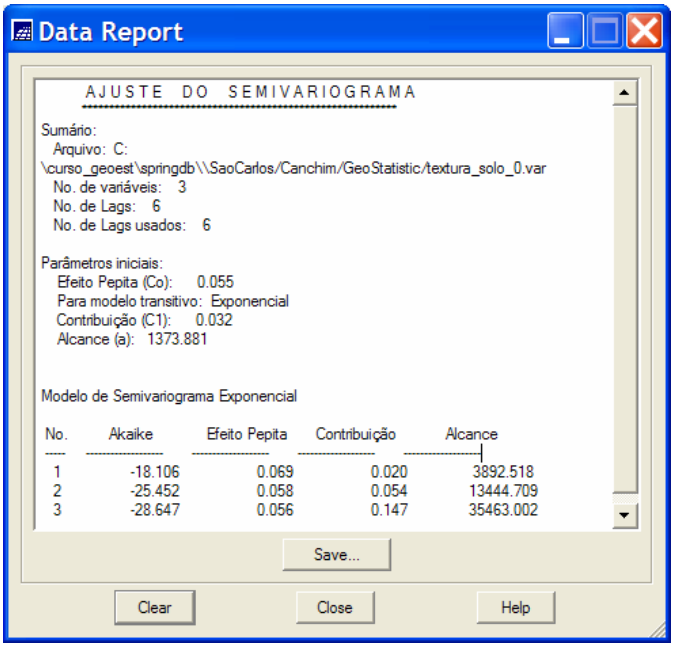




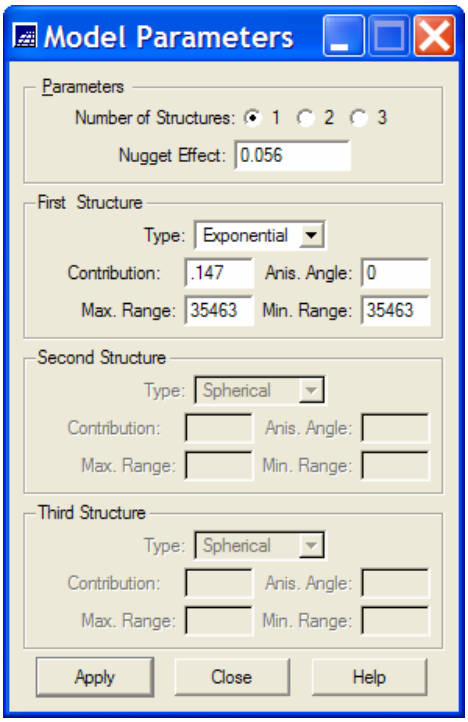


- Click on the *Semivariogram Modeling* option of the Geostatistics of the Analysis SPRING menu to open the Semivariograma Modeling window.
- In the Semivariogram Modeling window
    - Select *Automatic* as Adjusting option
    - Select *1* for the Number of Structures option
    - Select Model 1: *Exponential* as the Models option
    - Click on the *Apply* button and then click on the *textura_solo_0.var* option of the Adjust Verification list to display the Fit Model and Data Report windows.



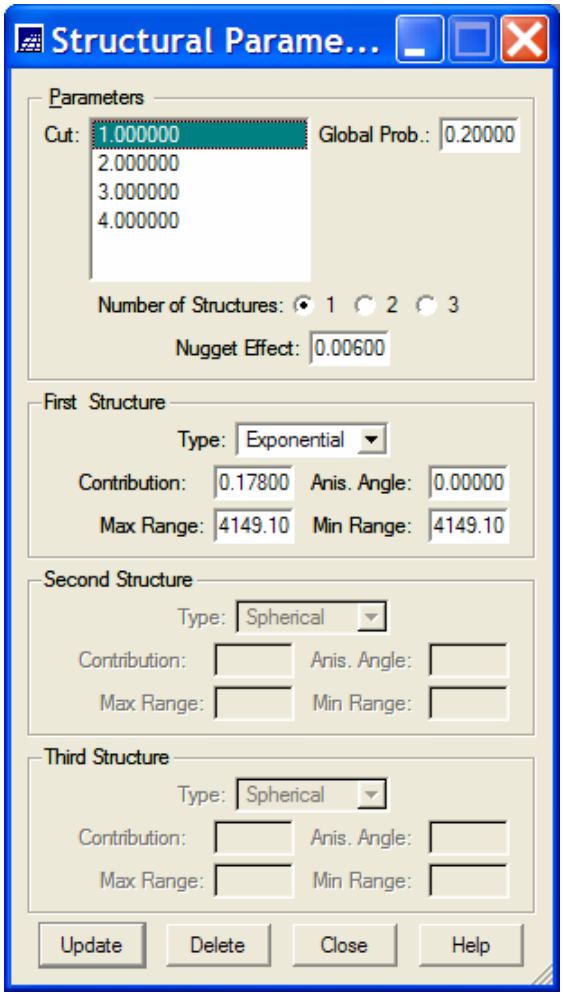


- Click on the *Define…* button to open the model parameters window
- In the Model Parameters window
  - Choose Number of Structures equal *1*
  - Fill out the Nugget Effect text field with the value *.056*
  - For the First Structure options
    - Choose Type: equal Exponential
    - Fill out the Contribution field with value *.147*
    - Fill out the Anis. Angle with value *0*
    - Fill out the Max. and Min. Range fields with value *35463*
  - Click on the *Apply* button to store the above model parameters



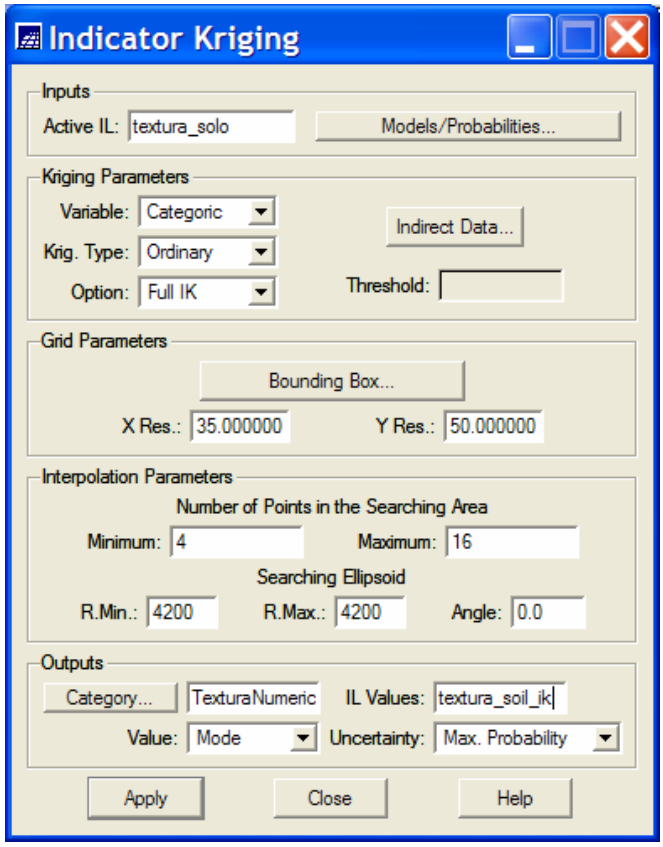
6.6 Kriging the textura_solo sample data with indicator kriging

- Select the *textura_solo* InfoLayer of the *TexturaNumerica* Category
- Click on the *Indicator Kriging* option of the Geostatistics of the Analysis SPRING menu to open the Indicator Kriging window.
- In the Indicator Kriging window
    - Click on the Model/Probabilities button to open the window of variogram structural parameters.
    - In the window of Structural Parameters:
        - Fill out the field Global Prob: for each cutoff value. The sample set has 84 samples where 17 belong class 1, 29 belong to class 2, 32 belong to class 3 and only 6 belong to class 4. So, in this case use the values .2, .35, .38 and .07 for the first, second, third and fourth cutoff values respectivelly. Click on the update button after each probability value is entered.
        - Use the window of Structural Parameters also to check and edit the entered values of variogram structural parameters.
        - Click on the Close button to exit the window of structural parameters.



- Back to the Indicator Kriging Window

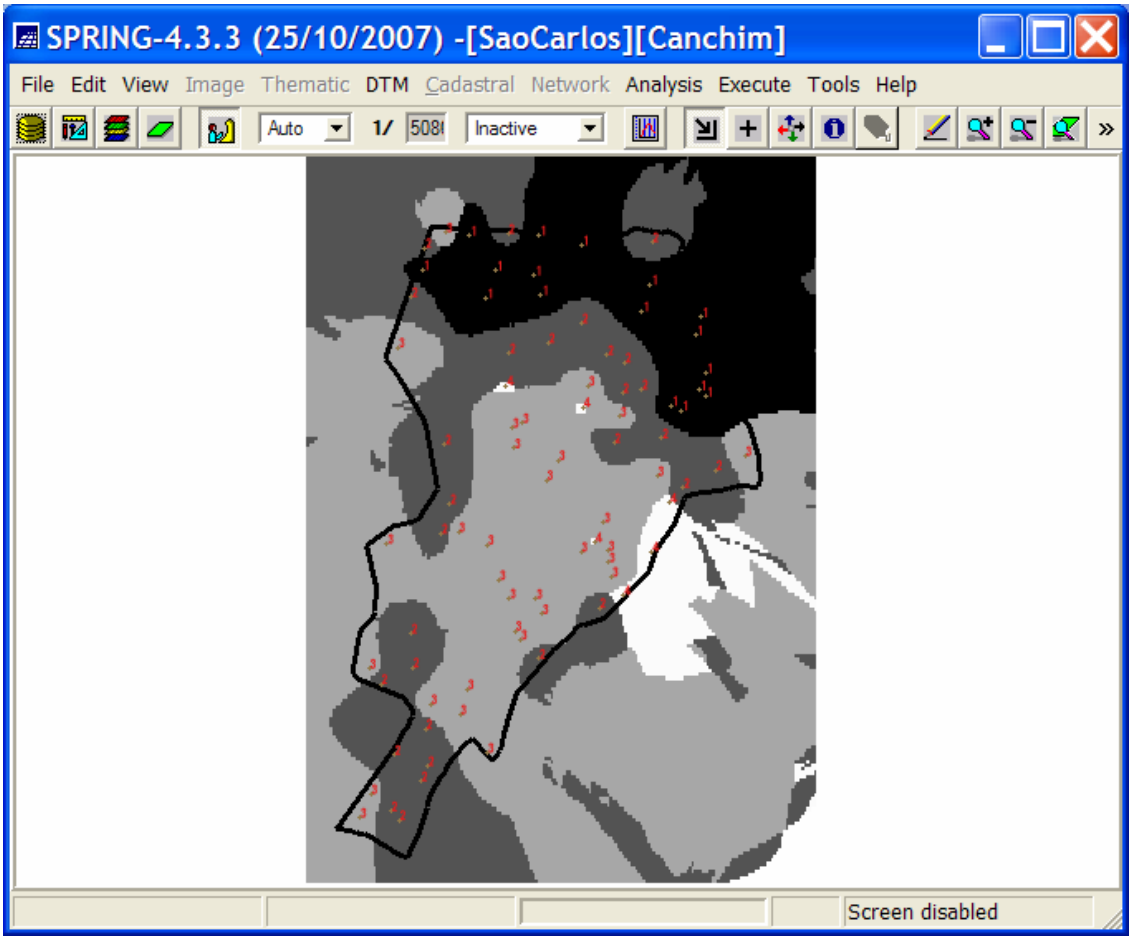
    - Select as Variable: the option *Categorical*
    - Select as Krig Type: the option *Ordinary*.
    - Select as Option: the option *Full IK*.
    - Define the grid parameters ResX: equal *35.* and ResY: equal *50.* This default values, along with the project bounding box, will generate a grid with *200* rows by *200* columns.
    - Fill out the fields related to the interpolation parameters with the following values: Minimum: equal *4,* Maximum: equal *16*, R.Min: equal *4200*, R.Max: equal *4200* and Angle: equal *0.0.*
    - Choose the output category *TexturaNumerica* clicking on the Category… button
    - Fill out the field IL Values: with the name of the infolayer to be created, *textura_soloik* in this case.
    - Choose as Value: *Mode* and *Max. Probability* as Uncertainty
    - Click on the *Apply* button to run the indicator kriging procedure



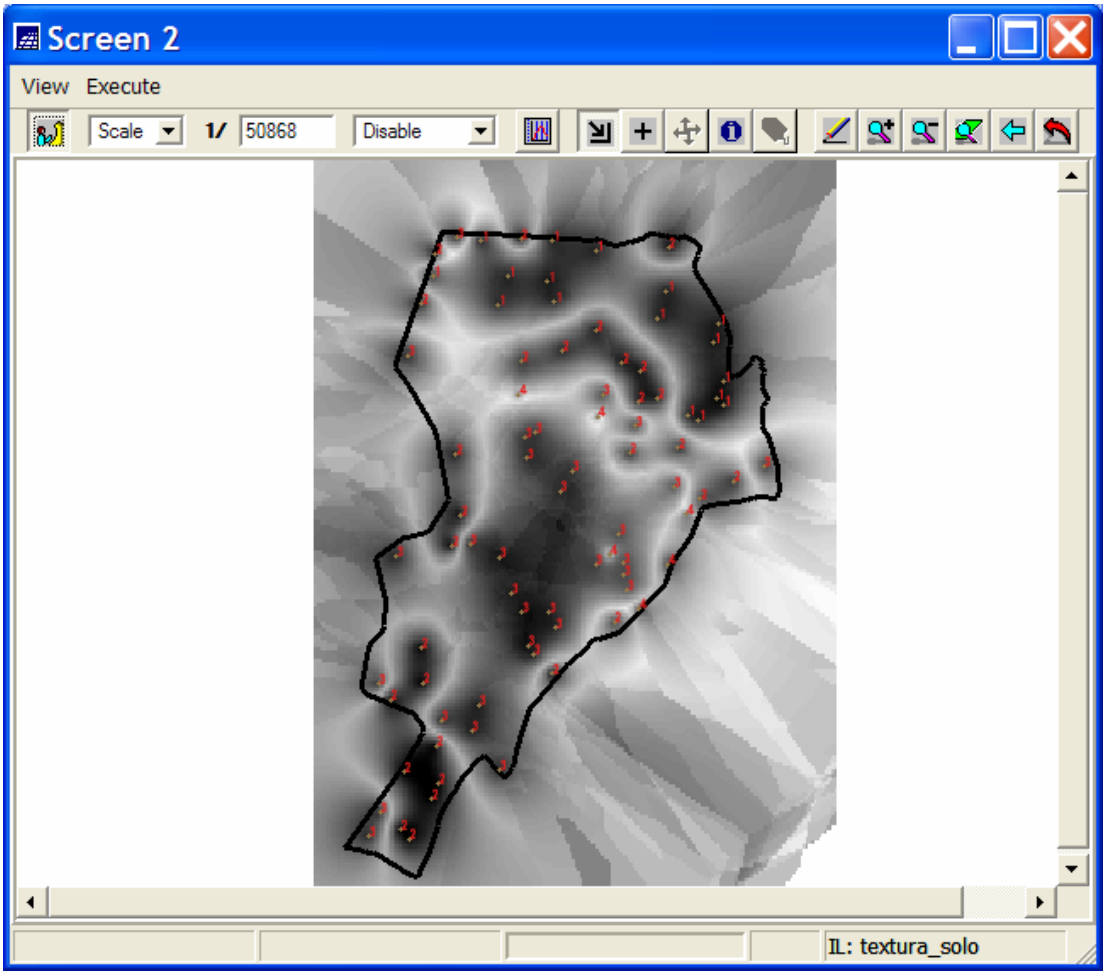
- **Repeat the three last steps above replacing the IL Values: by the name by *textura_soloik_shan* and choosing as Uncertainty: *Shannon Entropy*.**

6.7 Visualizing the results in the main graphical display of the SPRING

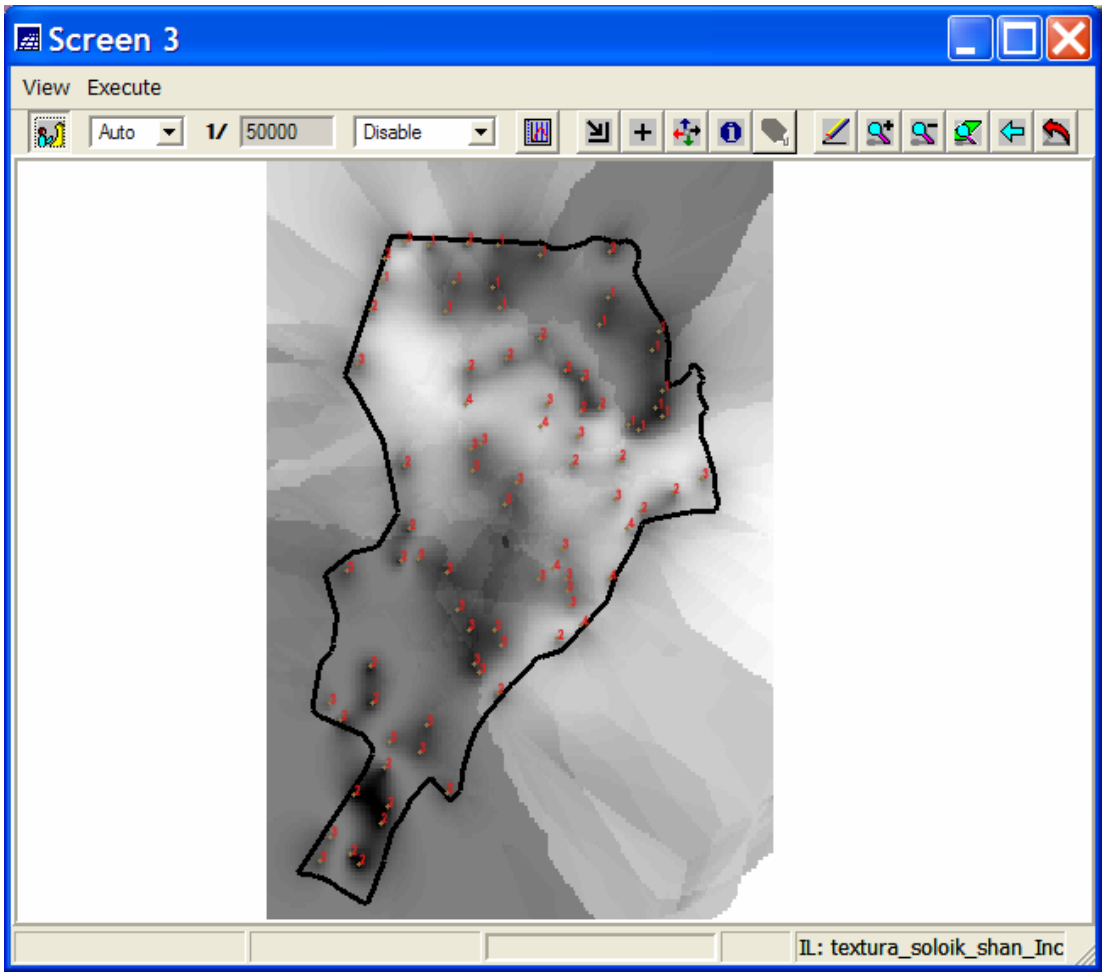
- Displaying the map of estimates of the indicator kriging
- In the Control Panel:
  - Enable the display control 1
  - Select in the list of Categories list: *TexturaNumerica*
  - Select in the list of Infolayers : *textura_soloik*
  - Select representation Image
  - Select also the lines of the *recorte* infolayer of the *Limites* Category and the samples of *textura_solo* infolayer of the *TexturaNumerica* Category
  - Click on the button Draw 
- The figure below shows the map of mode estimates obtained from the uncertainty modeling by the indicator kriging for the samples of the *textura_solo* infolayer.
-



- Displaying the map of uncertainties (Maximum Probability) of the indicator kriging
- In the Control Panel:
  - Enable the display control 2
  - Select in the list of Categories list: *TexturaNumerica*
  - Select in the list of Infolayers *: textura_soloik_Inc*
  - Select representation Image
  - Select also the lines of the recorte infolayer of the *Limites* Category and the samples of *textura_solo* infolayer of the *TexturaNumerica* Category
  - Click on the button Draw 
  -
- The figure below shows the map of uncertainty values (Maximum Probability) obtained from the uncertainty modeling by indicator kriging for the samples of the *textura_solo* infolayer.

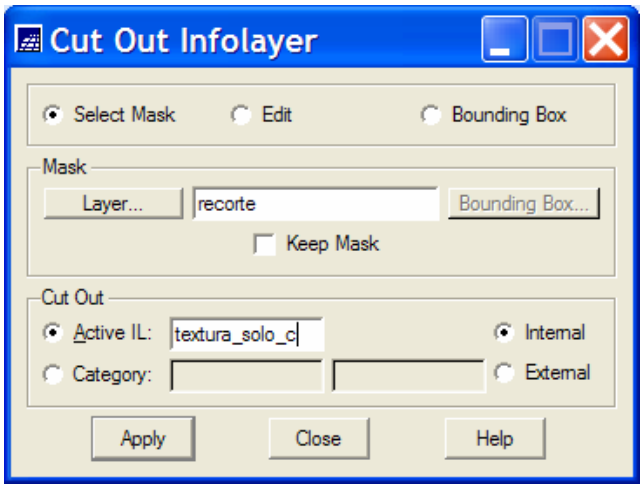


- Displaying the map of uncertainties (Shannon Entropy) of the indicator kriging
- In the Control Panel:
  - Enable the display control 3
  - Select in the list of Categories list: *TexturaNumerica*
  - Select in the list of Infolayers *: textura_soloik_shan_Inc*
  - Select representation Image
  - Select also the lines of the recorte infolayer of the *Limites* Category and the samples of *textura_solo* infolayer of the *TexturaNumerica* Category
  - Click on the button Draw 
- The figure below shows the map of uncertainty values (Shannon Entropyy) obtained from the uncertainty modeling by indicator kriging for the samples of the *textura_solo* infolayer.

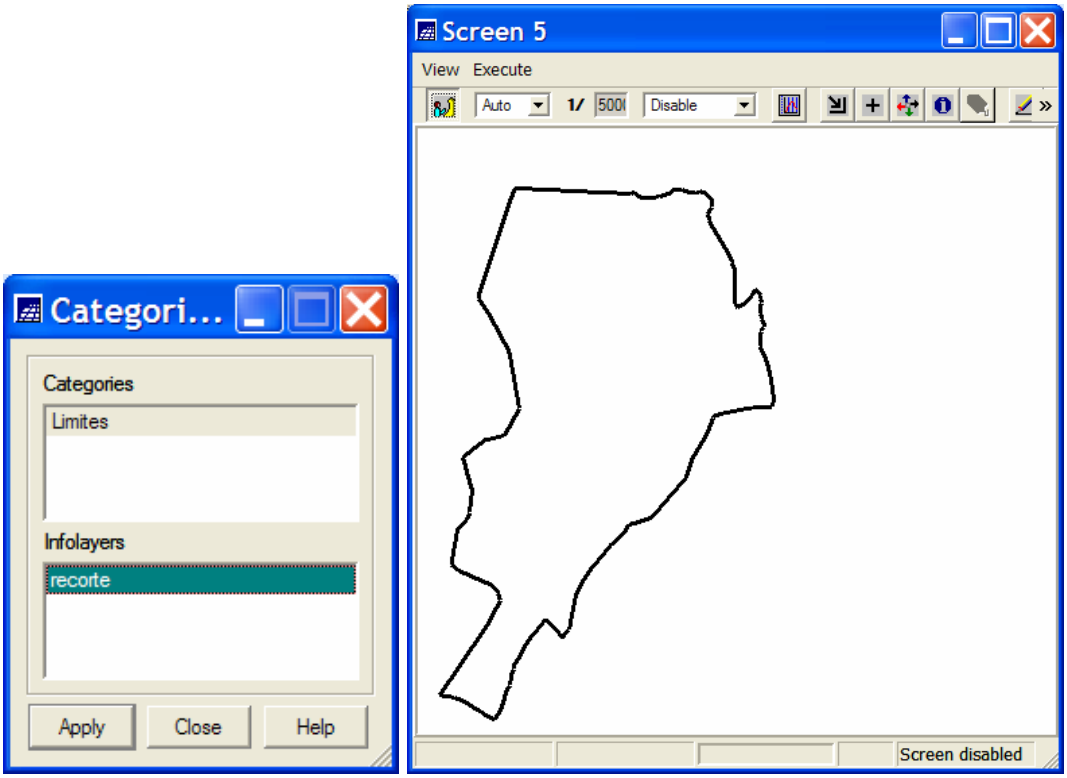


6.8 Cutting out and visualizing the indicator kriging resulting maps

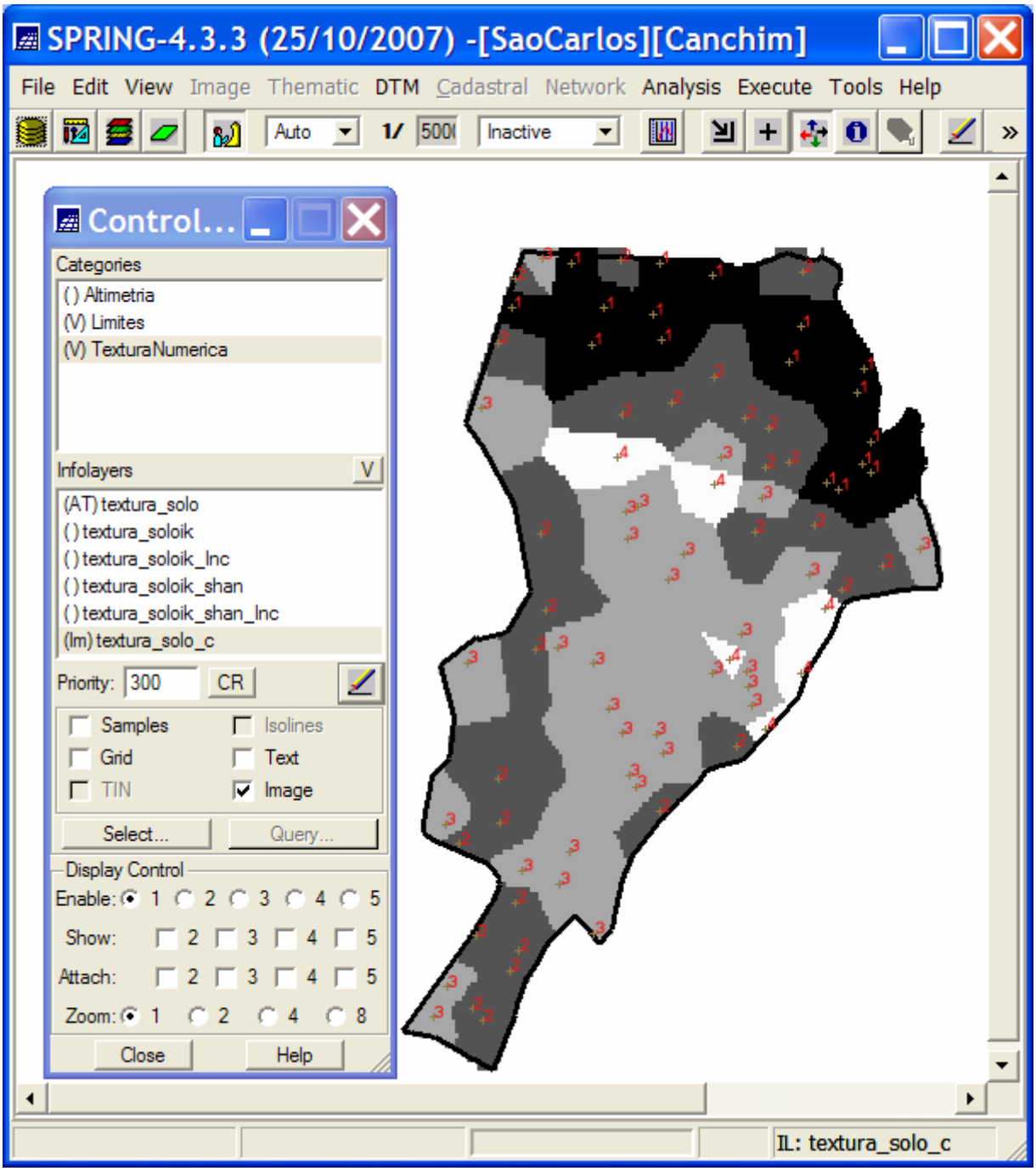
- Select the *textura_solo* infolayer in the SPRING Control Panel
- Choose *Cut out Infolayer* **option** of the SPRING *Tools* **menu** to open its window.
- In the Cut out Infolayer window:
  - Choose *Select Mask* **option**
  - Click on the *Layer…* **button** to open its window



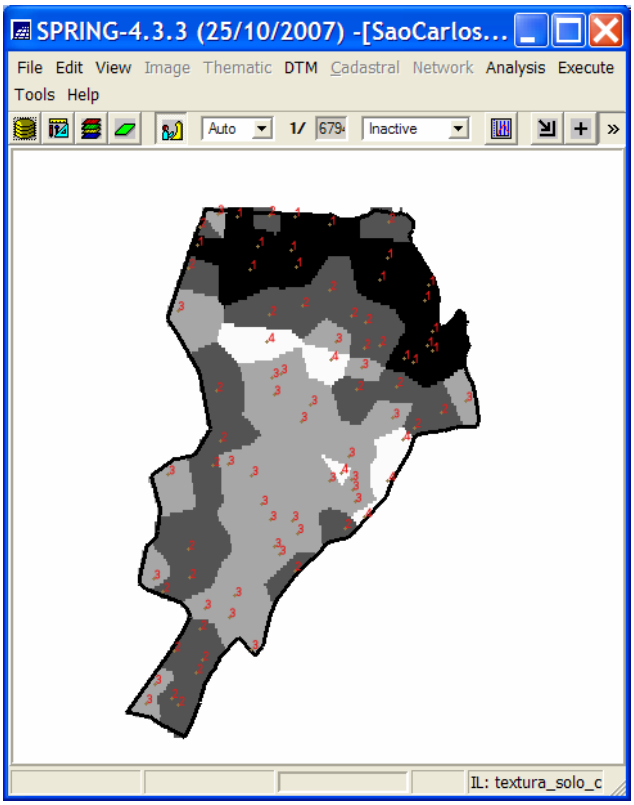
- In the window of Categories and InfoLayers
  - Select as **Category** *Limites* and as **Infolayers** *recorte*
  - Click on the *Apply* **button**
  - Click on the inside area of the recorte polygon that appears in the screen number 5 to select this polygon as the clipping area

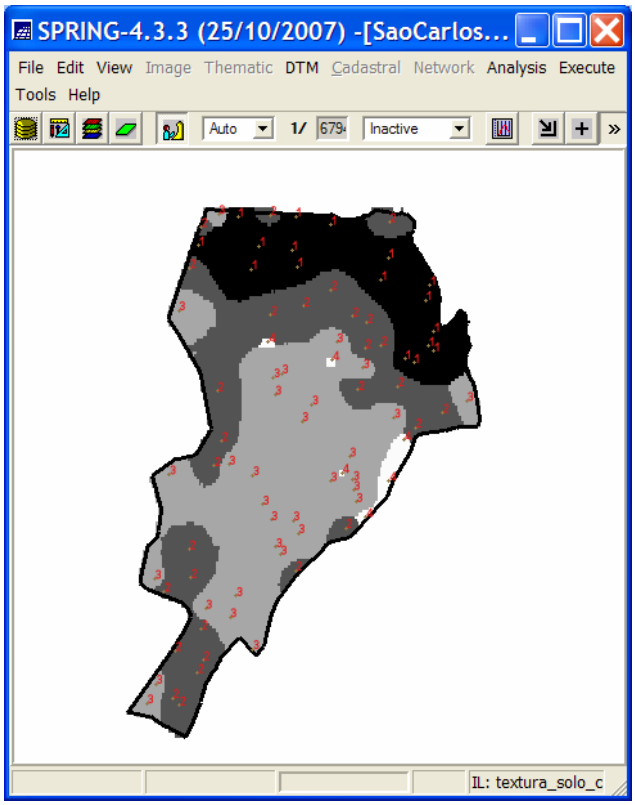


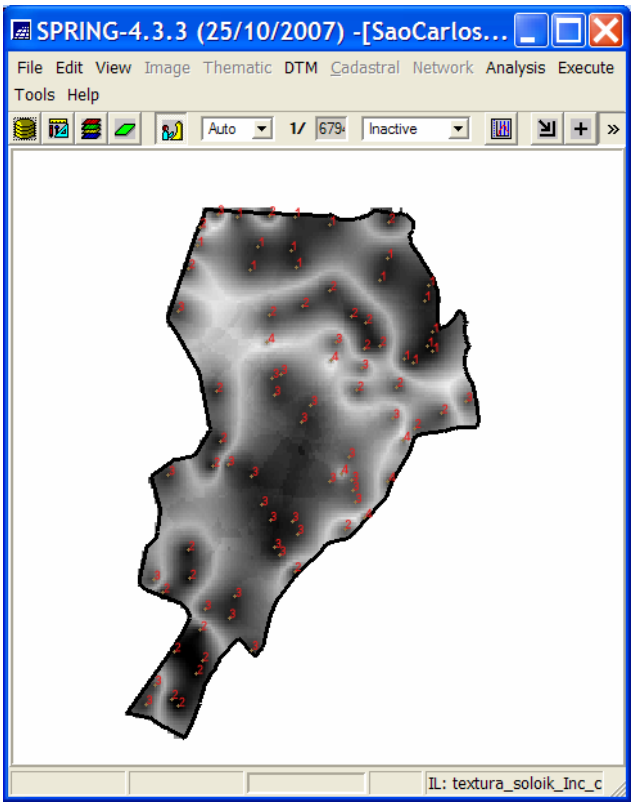
- Back into the *Cut out Infolayer* window
  - Change the name of the **Active IL:** to *textura_solo_c*
  - Keep the *Internal* **option** selected
  - Click on the *Apply* **button** to create the *textura_solo_c* Infolayer
  - Visualize the textura_solo_c Infolayer as done for the textura_solo Infolayer in the subitem “Visualizing the data and texts of soil texture of the Canchim region” of the 6.1 item.
  - The Figure below shows the resulting of the visualization

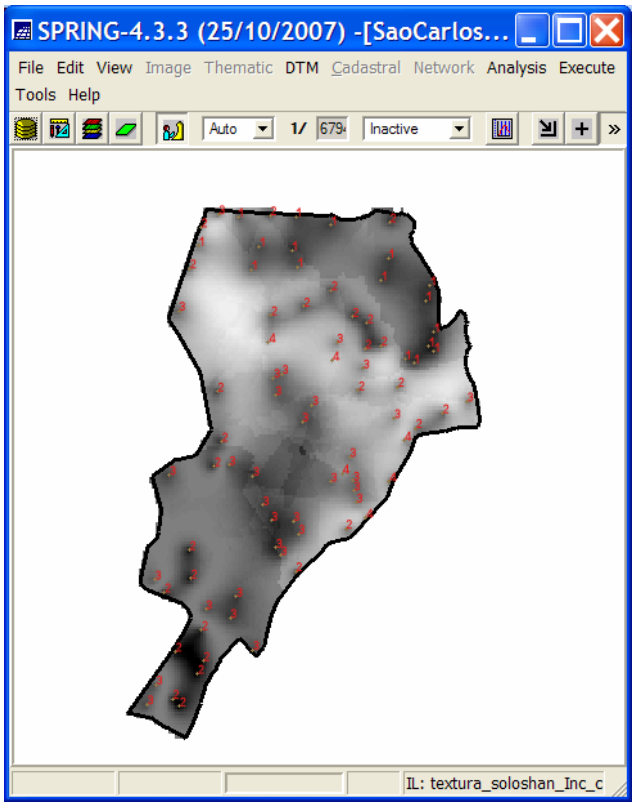


- Repeat the 6.8 item for cutting out an visualizing the infolayers: textura_soloik, textura_soloik_Inc and textura_soloshan_Inc. The resulting maps are shown below.

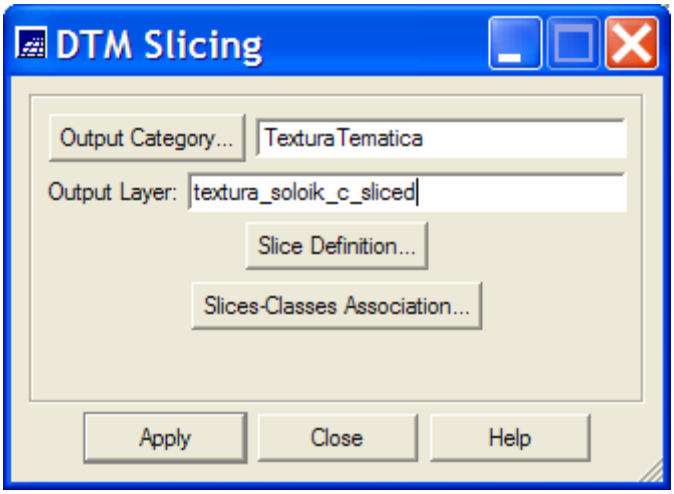


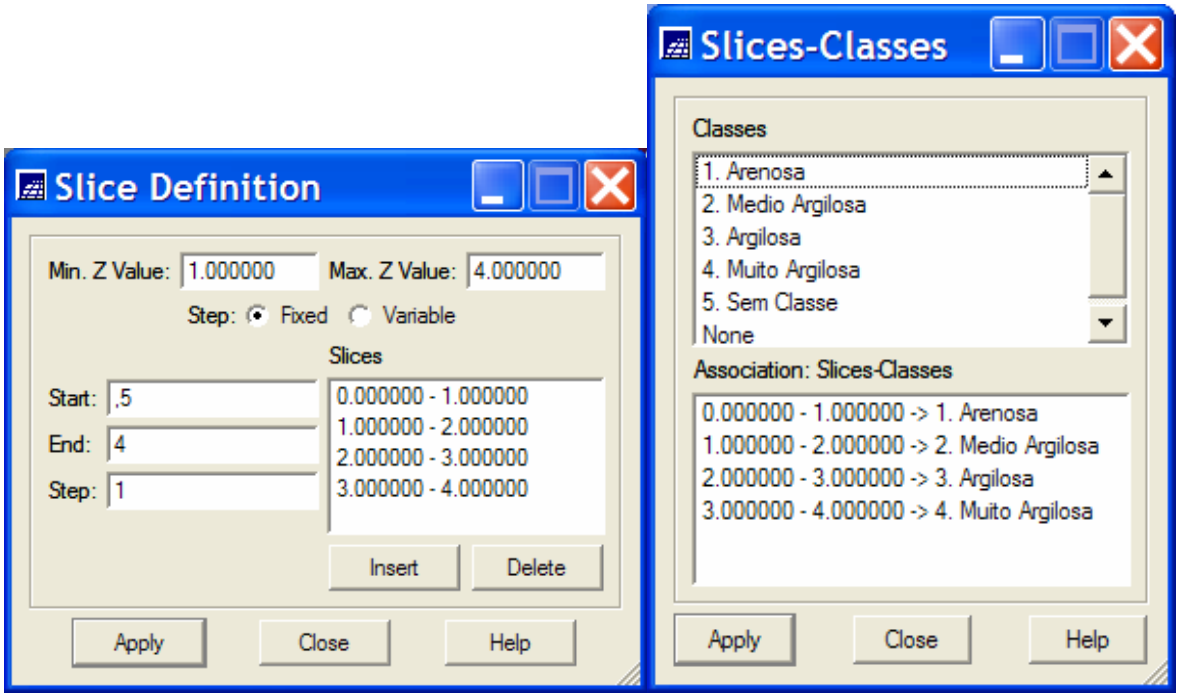






- Observation: The estimate maps can be visualized as thematic maps using different colors for the different classes. To accomplish this it is necessary to create a thematic category with 4 classes (sandy, medium clayed, clayed and too clayed). After that select the estimate infolayer (in the control panel) and run the function Slicing of the DTM option of the SPRING menu.





The resulting estimate maps (closest neighbors and indicator kriging) are shown below.