CoVCA v1.0.0:"Land-population-economy" urban space collaborative simulation platform based on vector-based cellular automata model

Instruction Manual

UrbanComp

https://www.urbancomp.net/

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Contents

1. Product Description

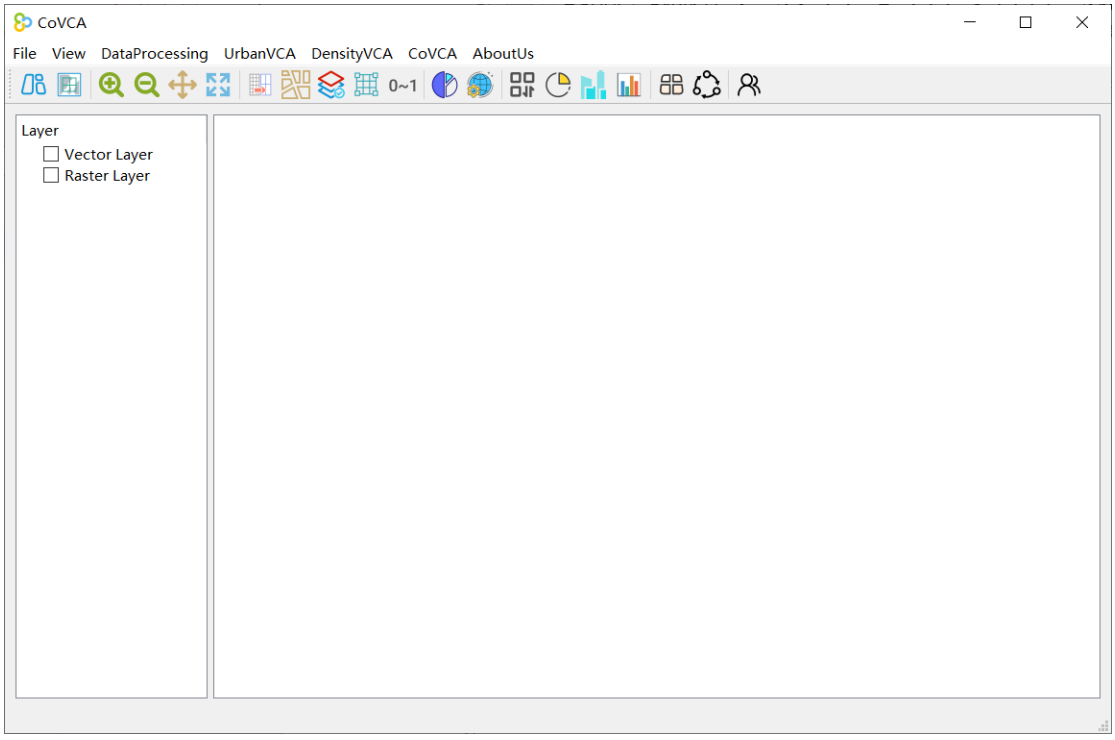
1.1. Objects to use

CoVCA v1.0.0, the "land-population-economy" urban space collaborative simulation platform based on vector cellular automata model, integrates the density cellular automata and vector cellular automata models, and adopts the strategy of "hierarchical progressive" step-by-step dynamic driver update to conduct the "land-population-economy" multi-element space collaborative simulation. To provide help for practitioners and scientific research workers related to geographic information and urban planning.

1.2. Installation method

Click setup.exe or CoVCA_Setup.msi to install (the path cannot have Chinese characters and Spaces).

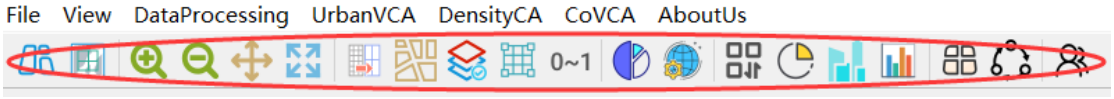
1.3. Interface display effect



1.4. Software control description

1.4.1. Menu bar

It consists of "File", "View", "DataProcessing", "UrbanVCA", "DensityCA", "CoVCA" and "AboutUs".

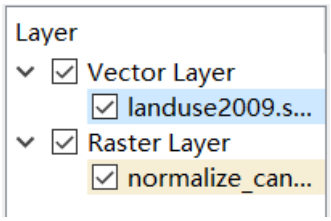


1.4.2. Toolbars

By "Open Vector File", "Open raster file", "Zoom in", "Zoom out", "Pan", "FullExtent", "Raster resample", "DLPS split", "Match land use data", "Vector to raster", "Normalize", "Calculate Pg", "UrbanVCA", "Initation Density State of Urban Development","Calculate Overall Development Probability (Density)", "Continuity-based Mechanism CA", "Density Accuracy Evaluate", "Step-wise Synergetic Simulation VCA", "Step-wise Synergetic Simulation VCA (Multi-factor)" and "About us" several parts.

1.4.3. Data management module

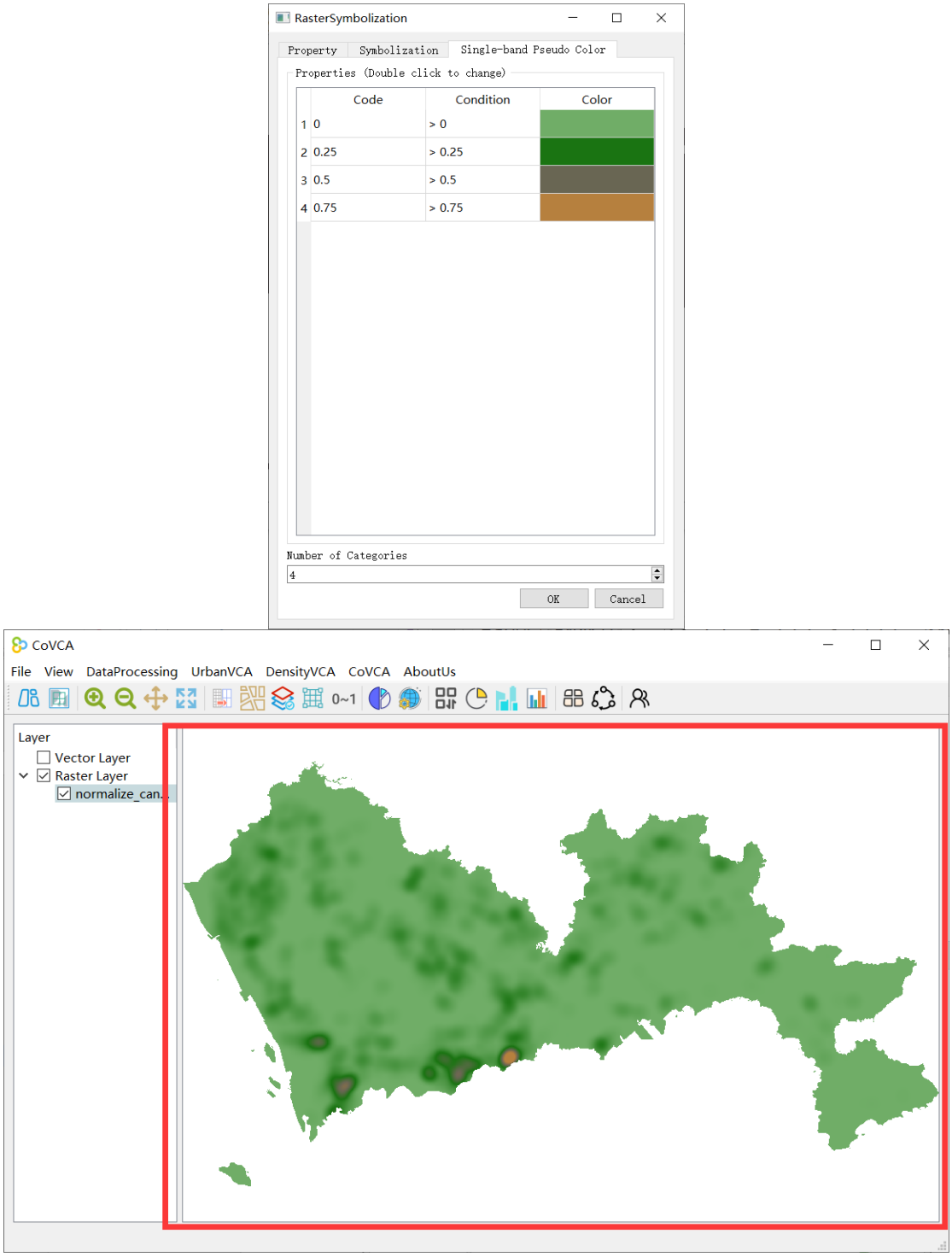
This area is used to display the open data and perform some basic functions of GIS, in which the data is composed of "vector data" and "raster data", and the data that has been imported into the system is displayed under each module.



Right click on the data to be processed can open the basic GIS function module menu bar. Vector data includes four parts: "Scaling to layer", "Opening Property sheet", "Symbolization" and "Layer removal". Raster data includes three parts: "Scale to Layer", "Raster Symbolization" and "Layer Removal".

1.4.4. Data Visualization Area

This area is used to display vector files and raster files imported into the system, and also supports data display after operations such as classification. Here the raster image is symbolized to display.

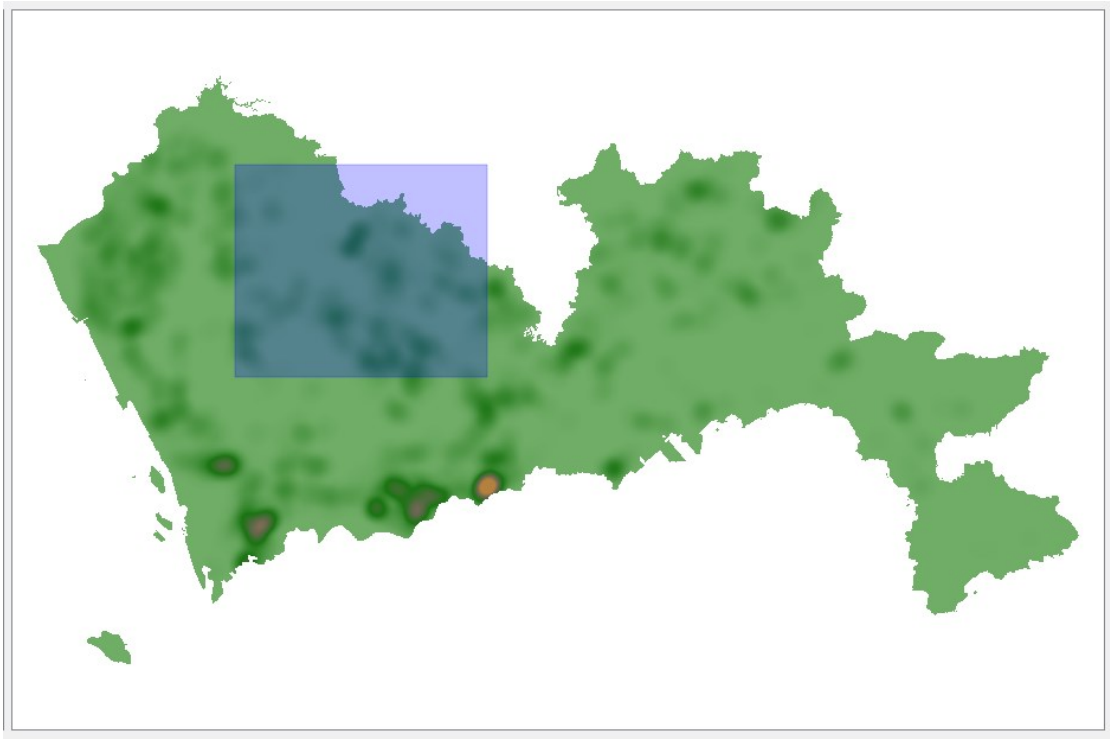


1.4.5. Layer view

Select the four function keys at the top of the toolbar, "Zoom in", "Zoom out", "Move", "Zoom to current layer" to get a closer look at the current layer.

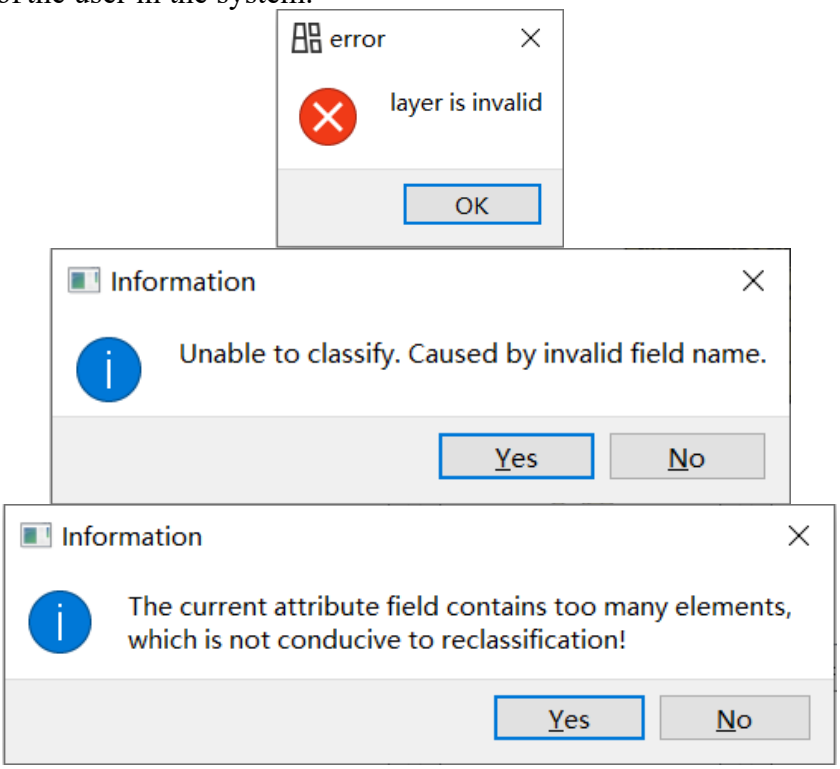
Take "Zoom" button as an example. After clicking this button, the mouse pointer will turn into "Zoom" button. At this time, after clicking a certain position of the

image, hold down the left mouse button to drag and drop, you can select a certain rectangular area to zoom in, so as to observe more specific features of the area.



1.4.6. Exception prompt dialog box

This dialog box is used to prompt the status and cause of the current abnormal operation of the user in the system.

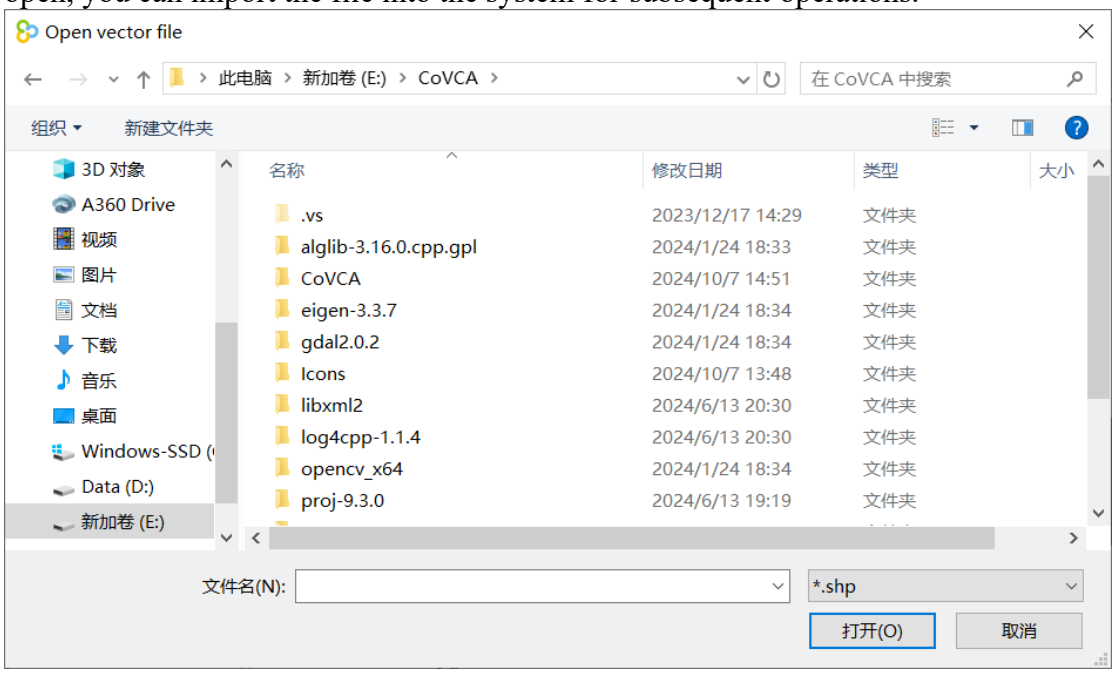


2. Data display function

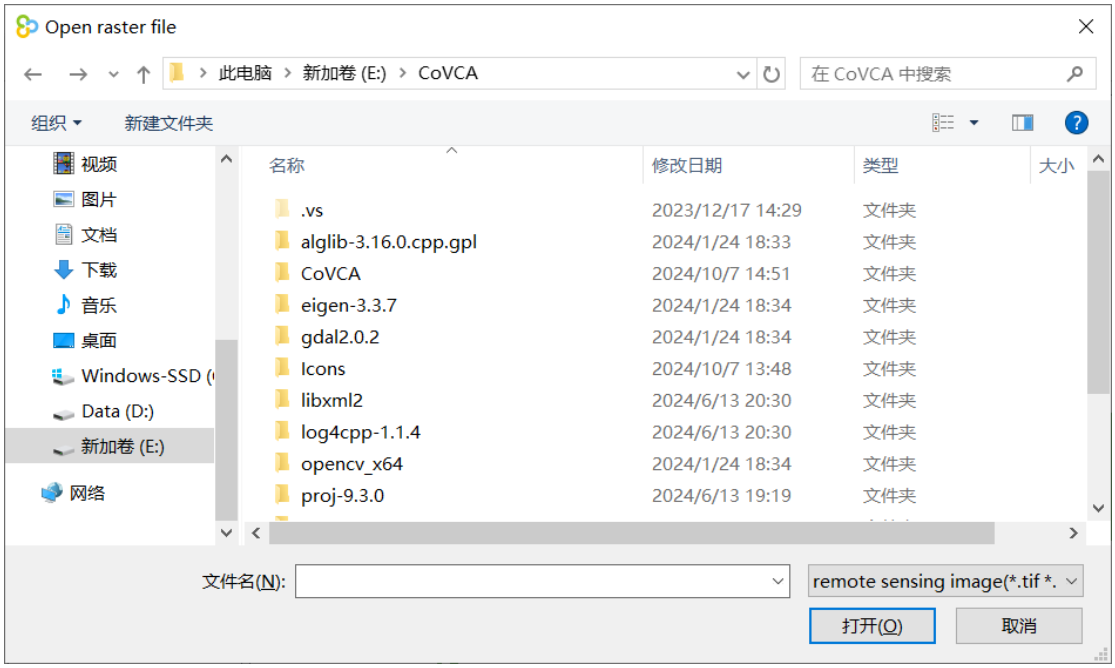
2.1. Basic functions

2.1.1. Data file Import

Click Open Vector File in the File directory or the icon in the menu bar to open the Select vector file dialog box, the user can select the desired vector file to be added to the main interface for visualization. By selecting the vector file you want to open, you can import the file into the system for subsequent operations.



Click the Open Raster File in the File directory or the icon in the menu bar to open the dialog box of selecting raster file, and the user can select the required raster file to be added to the main interface for visualization. By selecting the raster file that needs to be opened, the file can be imported into the system for subsequent operations.



2.1.2. Vector data basic GIS function selection

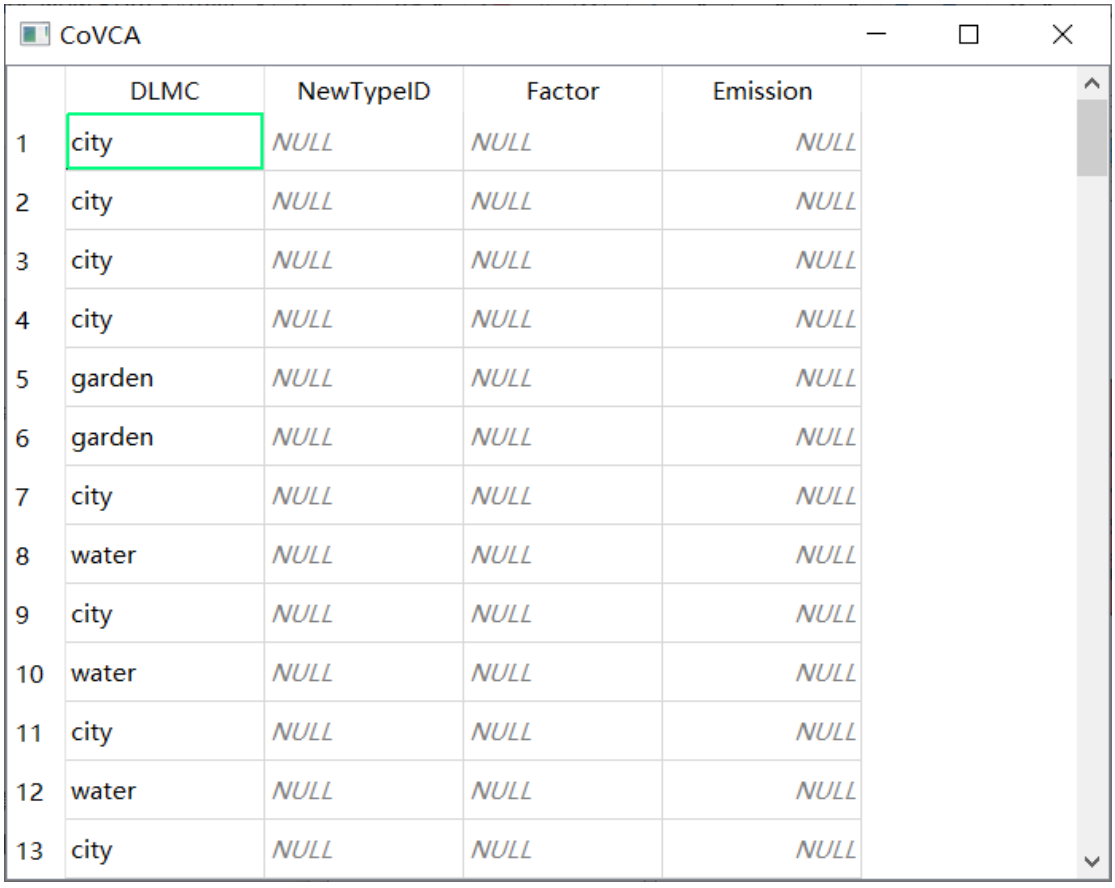
Right click on the vector data layer that needs to be operated, after the right click, the menu interface will appear, including "Scale to layer", "Open property sheet", "Symbolization", "Remove layer" four functions.

2.1.2.1.Zoom to Layer

Click the "Scale to layer" option to display the current vector data layer as the layer range within the data visualization area.

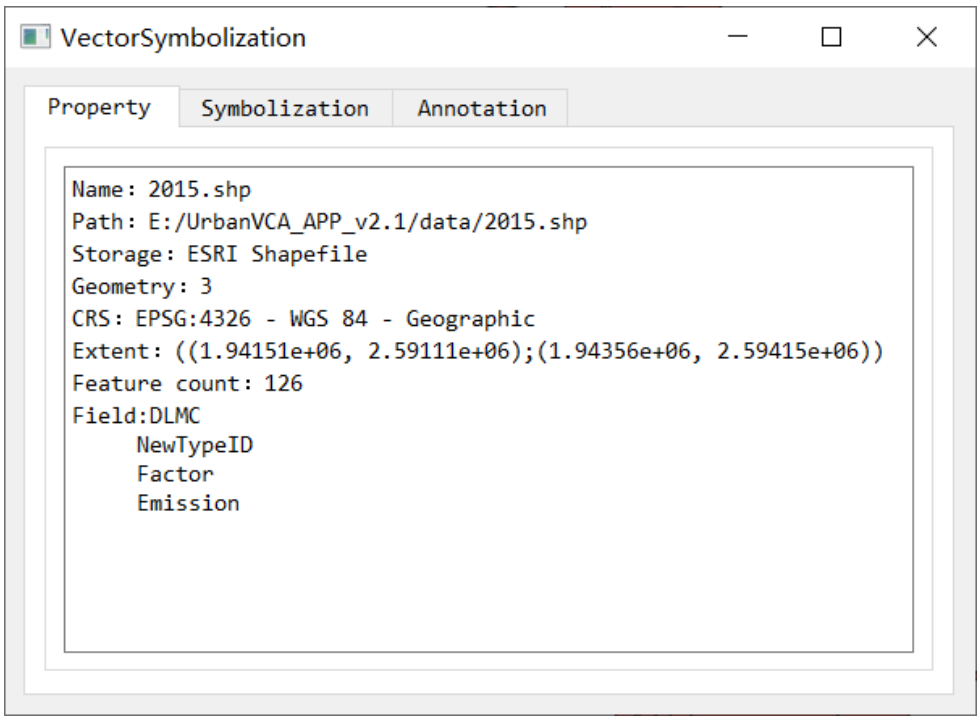
2.1.2.2.Open the Properties sheet

Click "Open property sheet" option, you can jump to the property sheet interface, and the property sheet of the selected data will be displayed, and we can edit the property sheet of the data by clicking. As shown in the following picture:

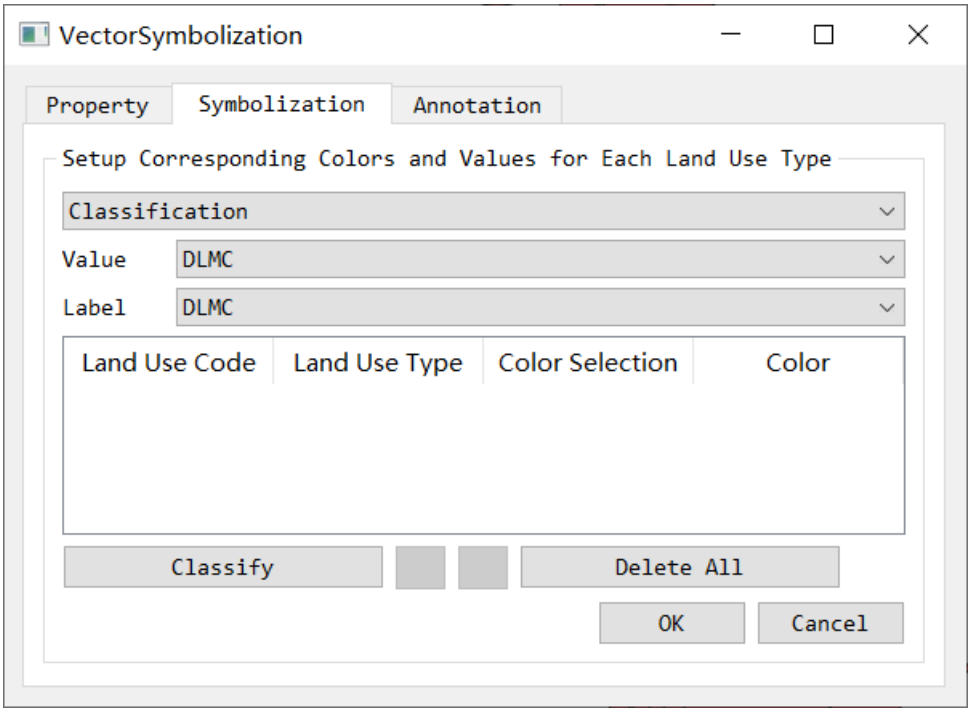


2.1.2.3.symbolization

If the data of the current operation layer is vector data, click the "Edit vector symbol" option to open the vector layer symbol interface.



The Property page displays the basic parameters of the selected layer, including the layer name, path, storage mode, geographic element type, reference system, coordinate range, element number, and all property field names.

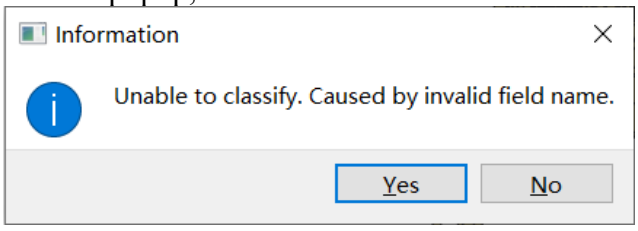


The Symbolization page classifies and renders a vector layer's elements. The "Category" drop-down box 

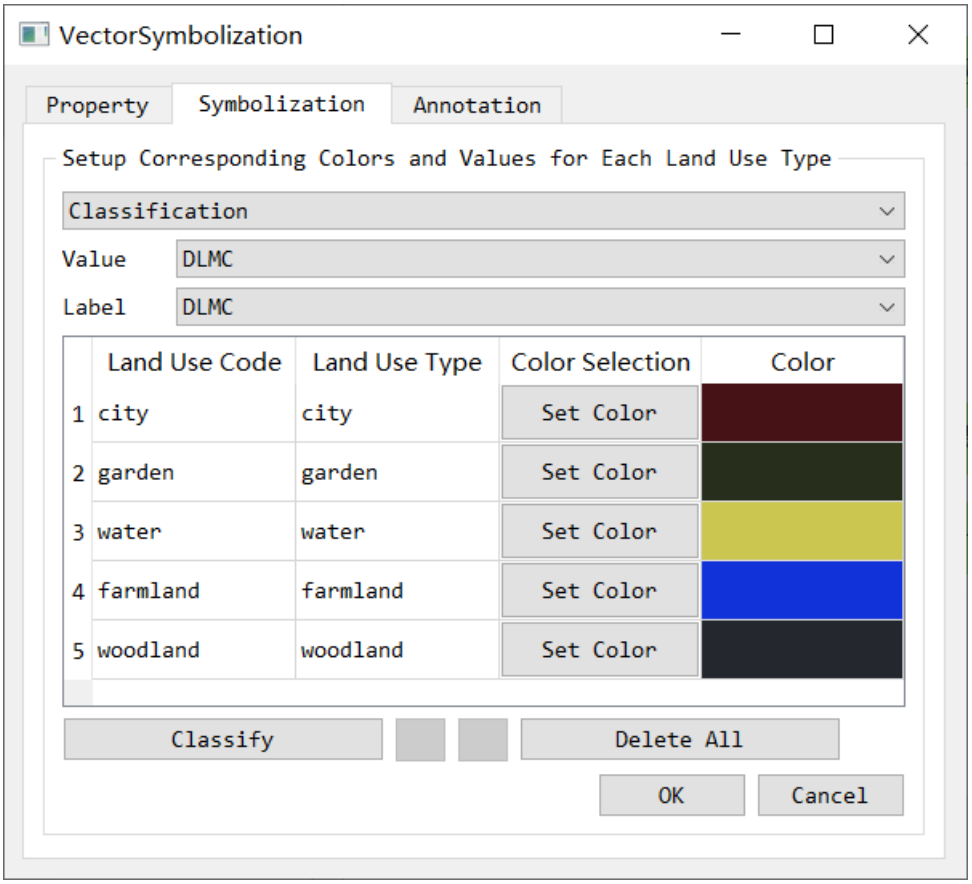
can select the method that the current operation data needs to be symbolized, and the "Field value" drop-down box can select the field name that the current layer needs to be classified: 

The "Label" drop-down box can select the field that the current layer needs to be labeled:

If the "field value" drop-down box selects anon-numeric field, the following error pop-up window will popup, and ask the user tore-select the field value:

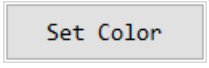


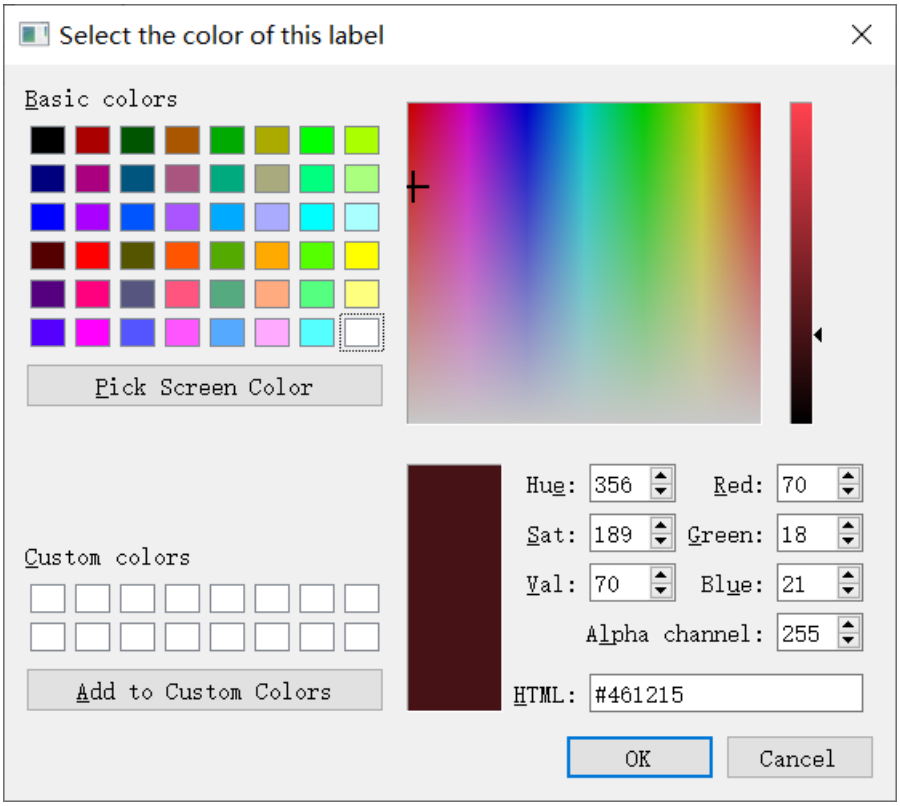
After adjusting the parameters, click the "classification" button, you cansymbolize the classification based on the current parameters. The classification results are shown in the picture below:



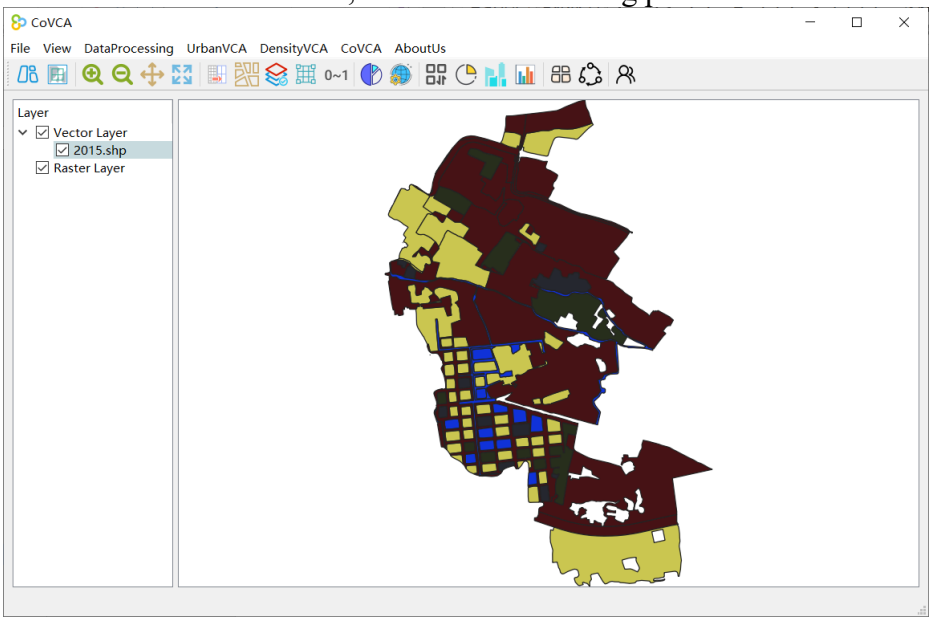
Click the "Delete all Classes" button to delete all the current classification effects and automatically empty the table content. 

However, if the user has been classified through the drop-down box to adjust the value of the category and label value, click the "category" button will re-initialize, complete thereclassification parameters setting.

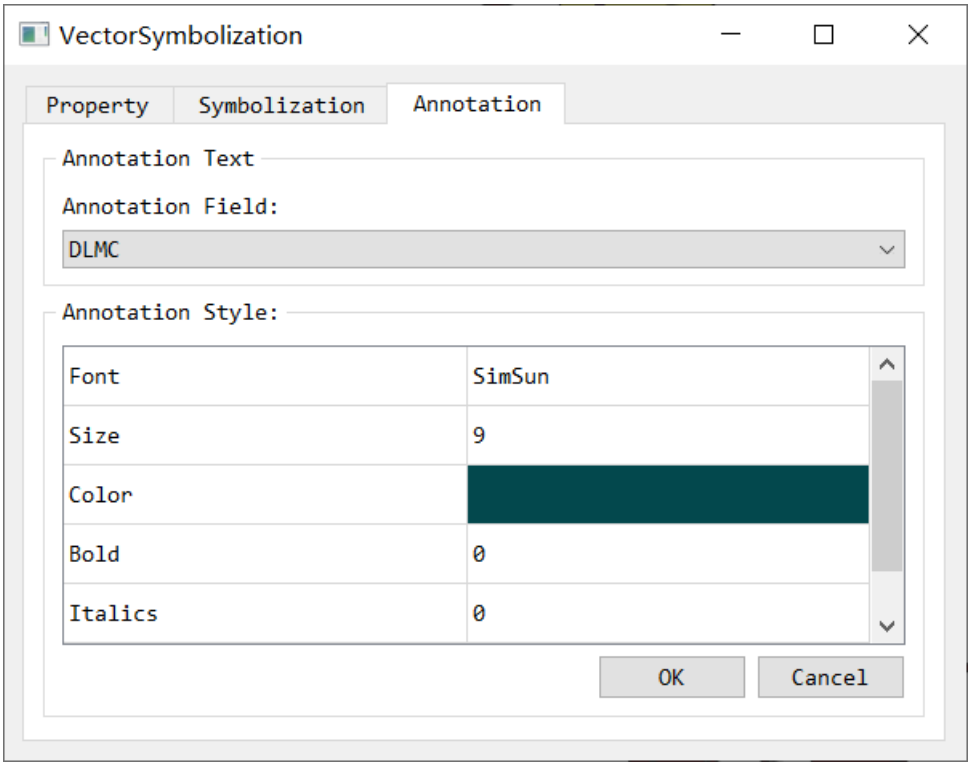
After the classification, click the "Select color" property of each category, you can jump to the interface as shown in the following figure to modify the color of the category according to user needs: 



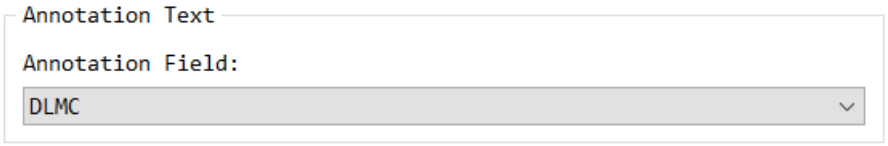
After setting the relevant parameters, click the "OK" button to exit the "Layer Properties" interface, and the original layer style after symbolic rendering will be displayed in the visualization area, such as the following picture:



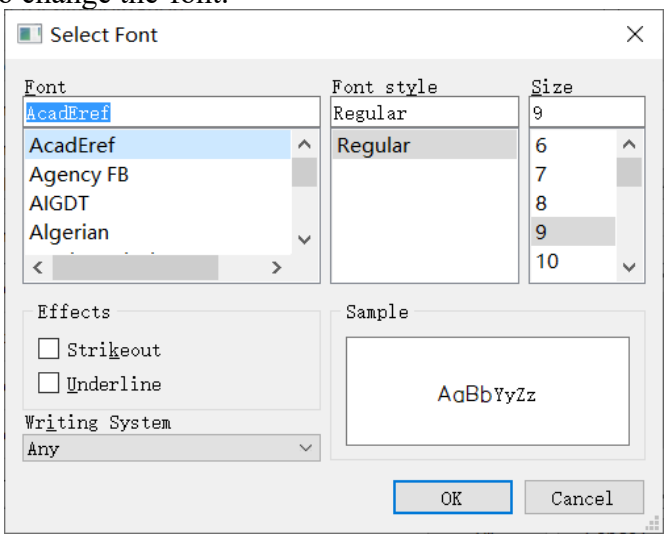
The Annotation page can display the corresponding fields on the elements.



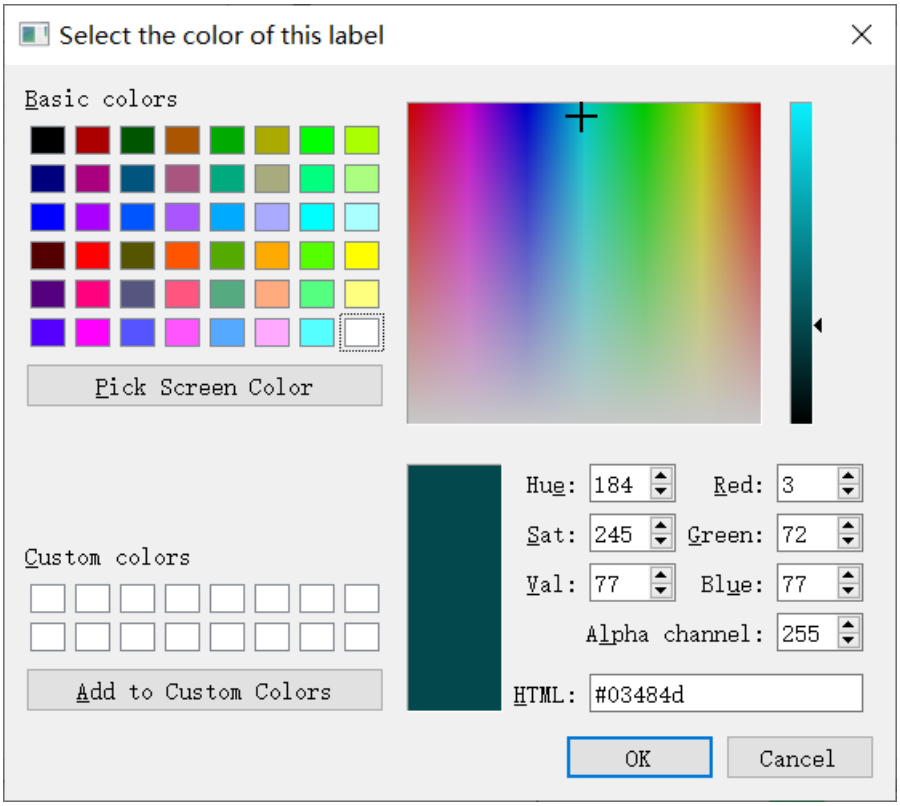
Among them, the annotation field is used to select the field that needs to be displayed.



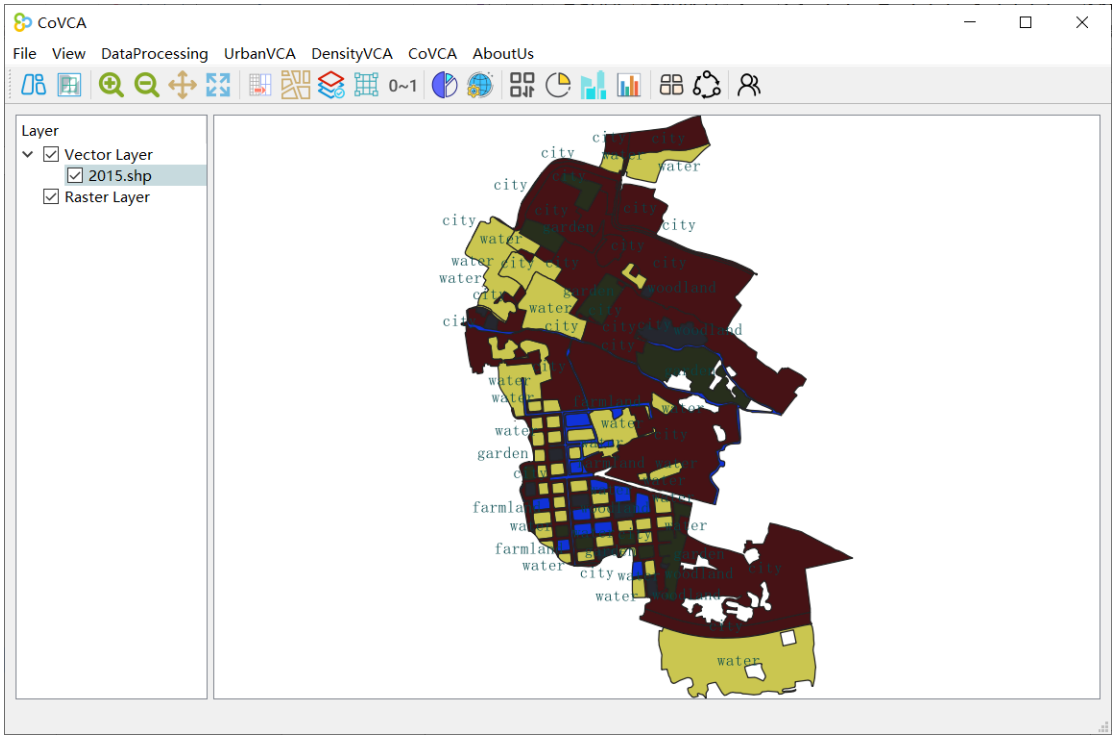
Click Font to change the font.



Click Color to change the font color.



The effect is shown below:



2.1.2.4.Remove layer

Click the "Remove Layer" option to remove the selected vector data.

2.1.3. Raster data basic GIS function selection

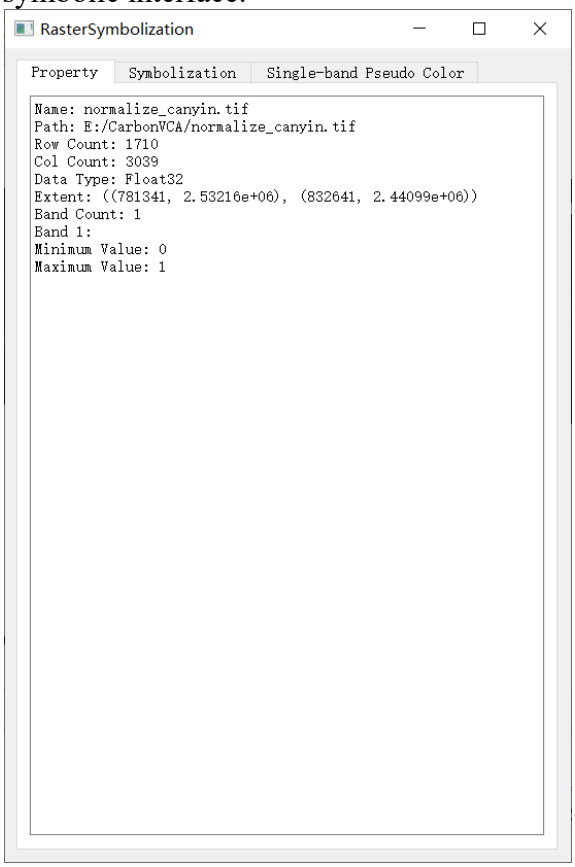
Right click on the raster data layer that needs to be operated, after the right click, the menu interface will appear, including "Scale to layer", "symbolization", "Remove layer" three functions.

2.1.3.1.Zoom to Layer

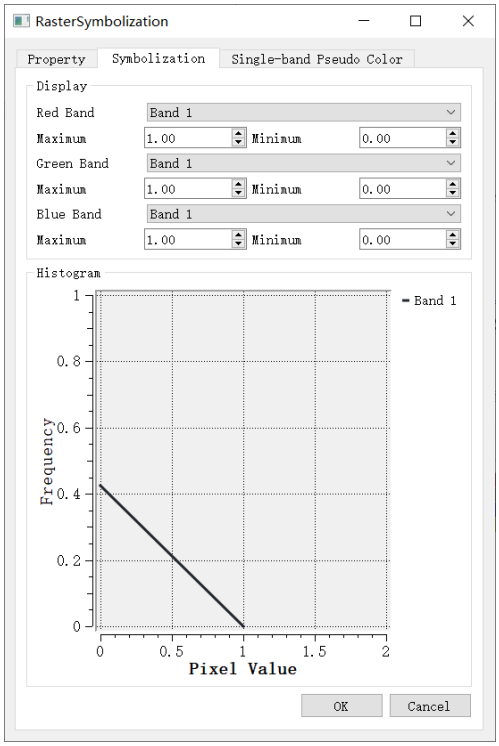
Click the "Scale to layer" option to display the selected raster data layer in its full form in the data visualization area.

2.1.3.2.Symbolize

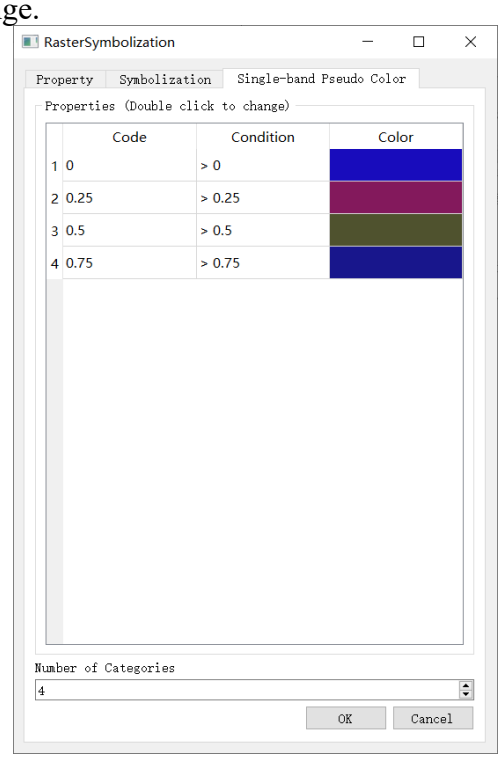
If the current layer data is raster data, click the "Edit raster symbol" option to open the raster layer symbolic interface.



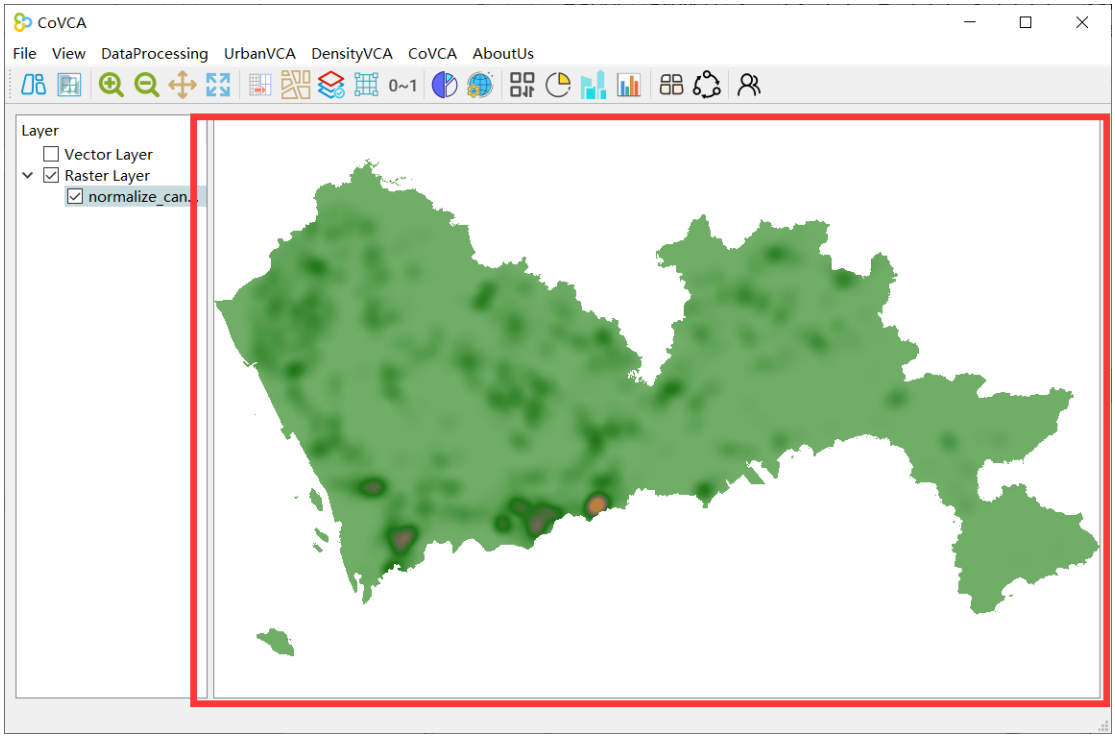
The Property page displays the basic parameters of the selected layer, including the layer name, path, resolution, data storage type, range, number of bands, and the maximum and minimum values of pixels for each band.



The Symbolization page can count the frequencies of different bands within the user-specified pixel range.



The single-band Pseudo Color page allows a pseudo-color display of a Single band. The user can set the Number of Categories in the Number of categories and click Color to change the color. The effect is as follows:



2.1.3.3.Remove layer

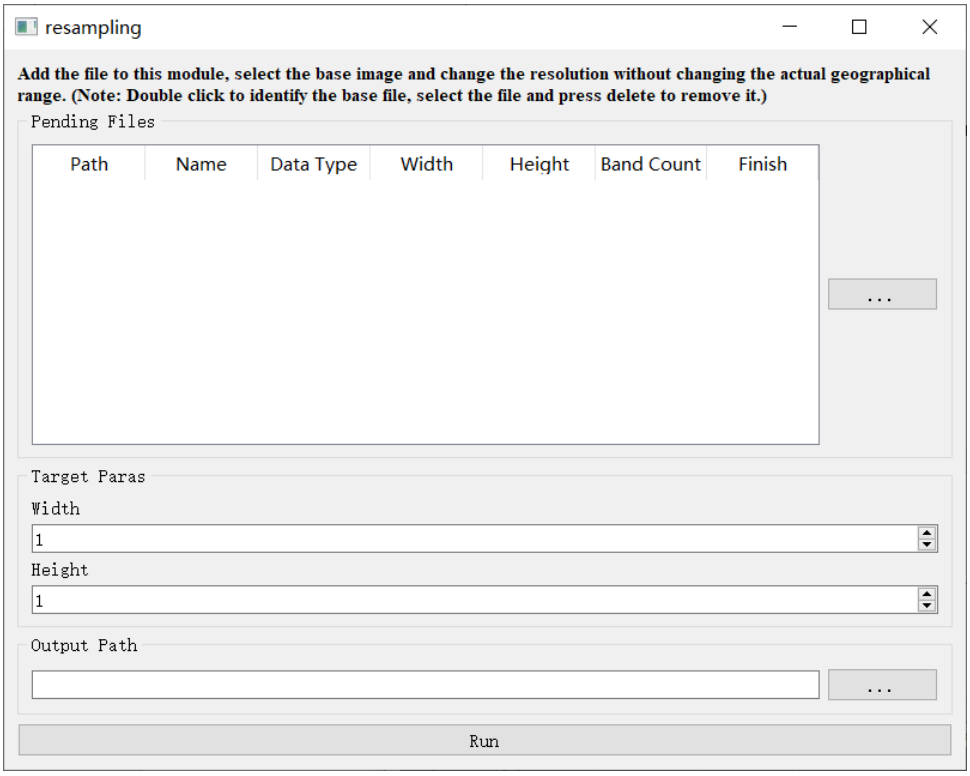
Click the "Remove Layer" option to remove the selected raster data.

3. Data Preprocessing

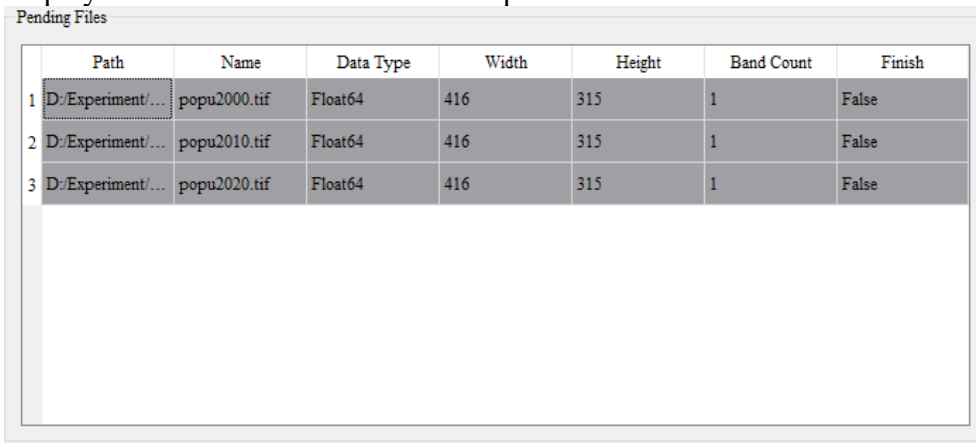
3.1. Data regularization - resampling

This function mainly resamples raster data to change the spatial resolution of the data. It should be noted that the data used by the model should maintain a uniform resolution.

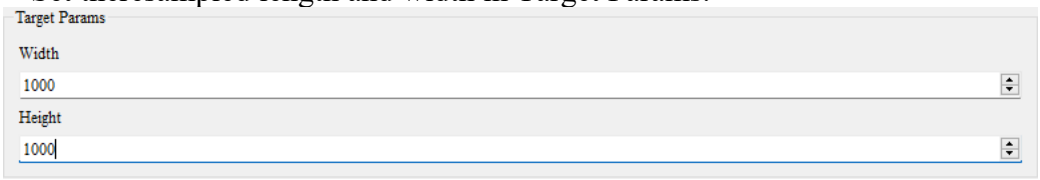
Click the "data regularization-normalization" option to open the corresponding interface. The user adds the file to this interface and selects the base image for resampling to change the resolution.



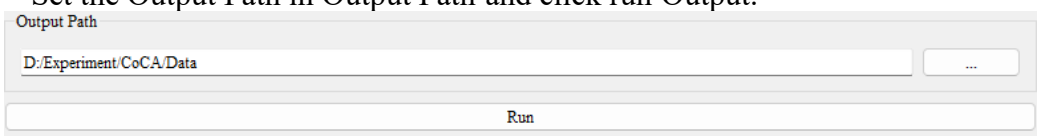
The user clicks on the Insert raster file of Pending Files, and the table in Pending Files displays basic information about the input data. 



Set theresampled length and width in Target Params.



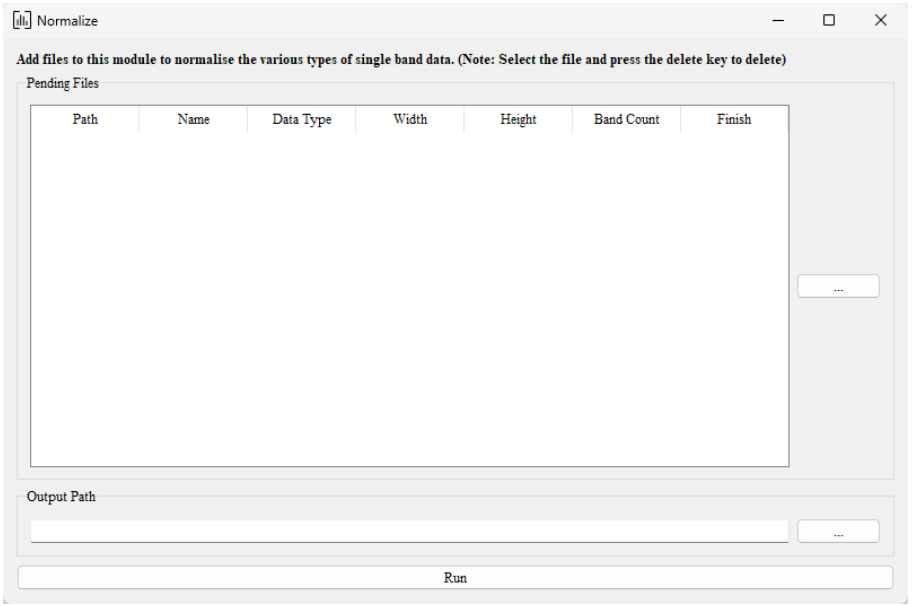
Set the Output Path in Output Path and click run Output.



3.2. Data regularization - normalization

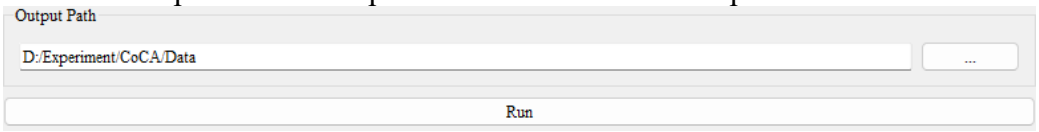
This function is mainly to normalize the spatially driven data set to form the raster data with the range value of 0~1, which is convenient for the subsequent calculation of the overall development probability.

Click the "data regularization-normalization" option to open the corresponding interface. The user adds the single band raster data to this interface to normalize it.



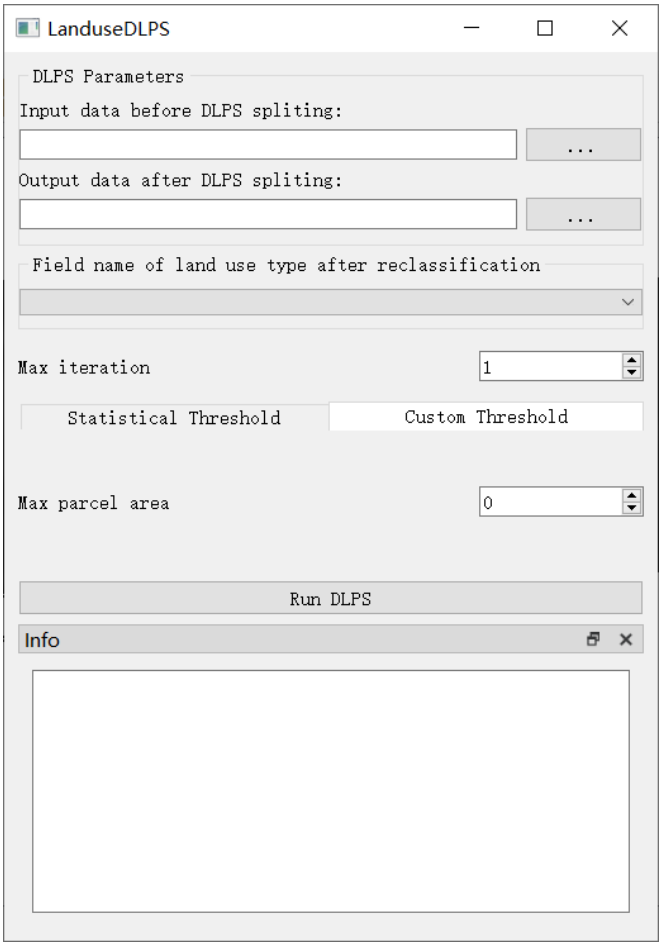
The user clicks on the Insert raster file in Pending Files, and the table in Pending Files displays basic information about the input data. 

Set the Output Path in Output Path and click run to output.

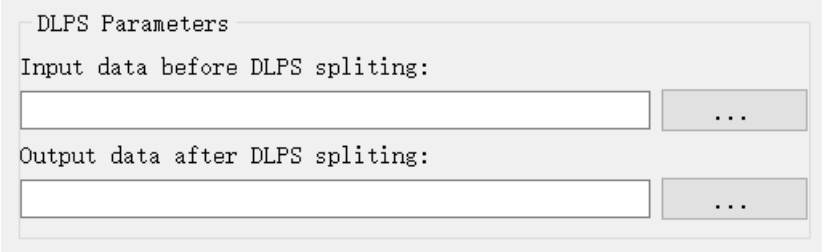


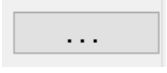
3.3. Vector plot handling - Dynamic plot splitting

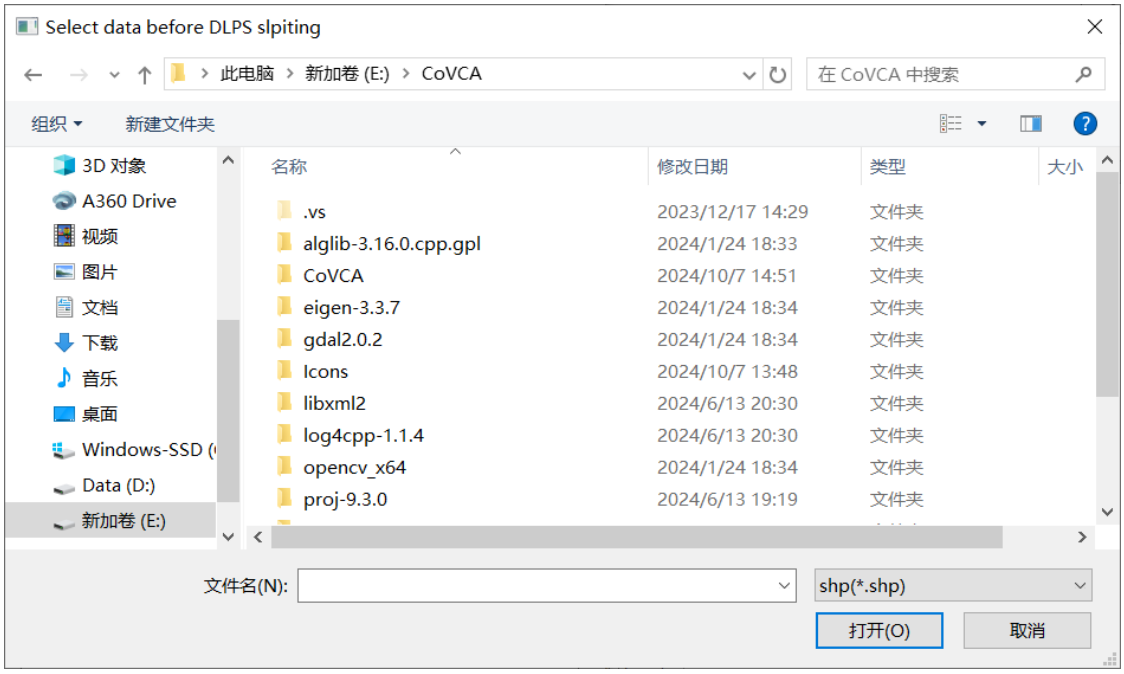
This function is mainly used to subdivide vector plots again, for dividing large plots. Click on "DLPS split" to turn this feature on.



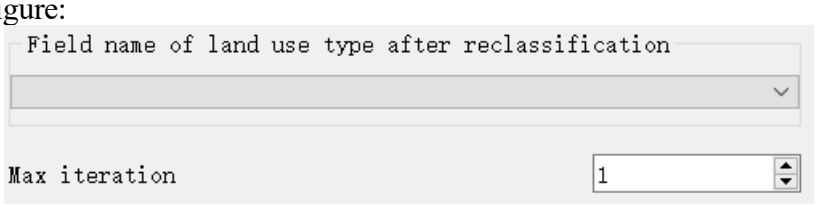
First, we need to select the vector land use file path to be split, and the vector land use data saving path after splitting



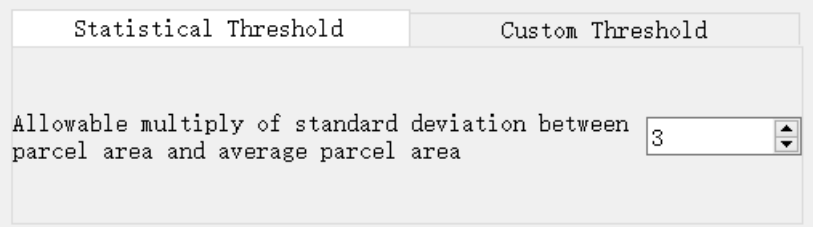
Through the "Input fileselection" button, we can select the vector file through the vector fileselection dialog box, as shown in the picture below: 



Then, the user needs to set the land splitting parameters, including the number of land splitting iterations, the maximum land volume threshold, and the field name of the land use type after reclassification. Among them, the maximum land area threshold function is: if the land area exceeds the threshold value, it will split. If it is set to "0",the system will automatically set the threshold value to the average land area according to the current data. The setting interface of dynamic plot splitting parameters is shown in the following figure:



In addition, when the maximum plot area threshold is 0, the system will split the plots whose area is greater than "average plot area +*n**dStd".Allowable product parameter *(n)* of standard deviation of area and standard deviation of mean area. Set as follows (default is 3):



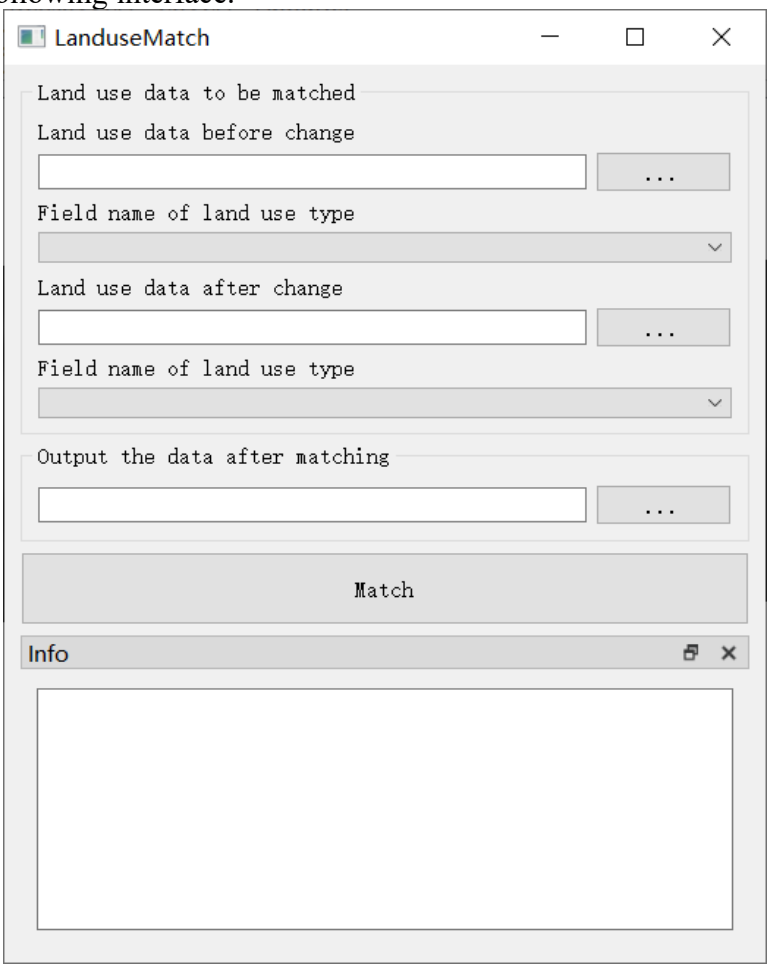
After the above parameters are set, the user clicks the "Run DLPS" button to split.

In addition, the user can observe the function running in the log status bar.

3.4. Vector plot processing - Plot matching

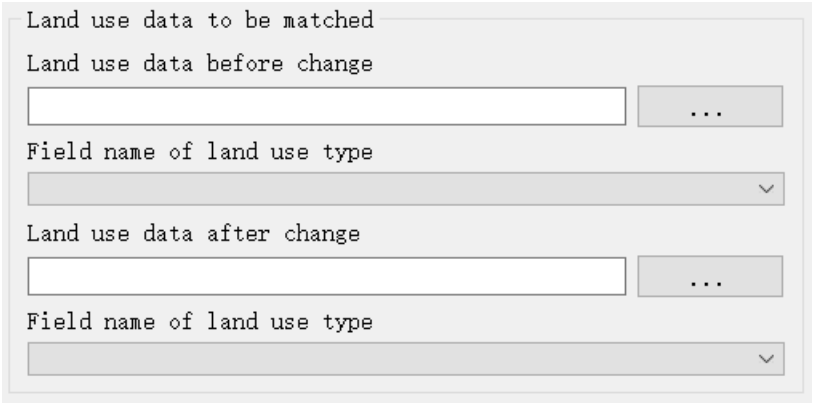
This function is used to match the vector plot data of two years, so as to merge them into the same vector data, which is convenient for the subsequent urban vector plot simulation operation.

Click on "Land use data Matching" in "Data Preprocessing" in the menu bar. You will get the following interface.

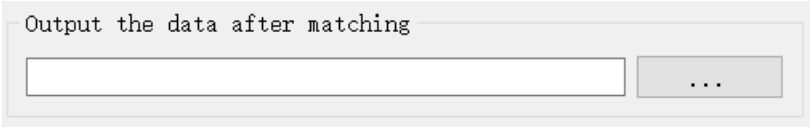


First, the user needs to enter the land use data before and after the land use change, and the field name containing the numeric code of the land use type. By clicking the button, the user can select the land use data in the pop-up dialog box, and the system will automatically identify all the field names of the property list of the current data. 

The user can select the field name with the numeric code of land use type from the drop-down list.



Once this is done, the user needs to set the path to save the matched land use data.



Click the "Match" button again, and the system will automatically run the land use data matching function.

The exported land use data will automatically generate fields: ID, before, simulated, after, Pr, area, centerX, centerY, Pg0, Pg1... Pgn, N0, N1... Nn. Their respective stands for: Plot ID Serial number, land use type before land use change, land use type after land use change simulation, land use type after land use change, limiting factor, land area, land centroid coordinate X, land centroid coordinate Y, the overall development probability of land development into type 0 land use type, the overall development probability of land use type 1 land use type... The overall development probability of the plot developing into the NTH land use type, the plot subject to the neighborhood effect of the 0th land use type, the plot subject to the

neighborhood effect of the 1st land use type... The land parcel is subject to the neighborhood effect of the NTH land type. The data automatically generates a list of properties, as shown below:

	ID	before	simulated	after	Pr	area	centerX	centerY	Pq0	N0
1	0	0	-1	-1	1	320	1941906	2593809	0	0
2	0	0	-1	0	1	2370	1942066	2593915	0	0
3	1	0	-1	-1	1	165	1941806	2593585	0	0
4	1	0	-1	-1	1	584	1941728	2593597	0	0
5	2	0	-1	-1	1	8	1941548	2593469	0	0
6	2	0	-1	-1	1	3	1941637.	2593598	0	0
7	2	0	-1	0	1	46	1941601.	2593573	0	0
8	3	0	-1	-1	1	417	1941864.	2593748	0	0

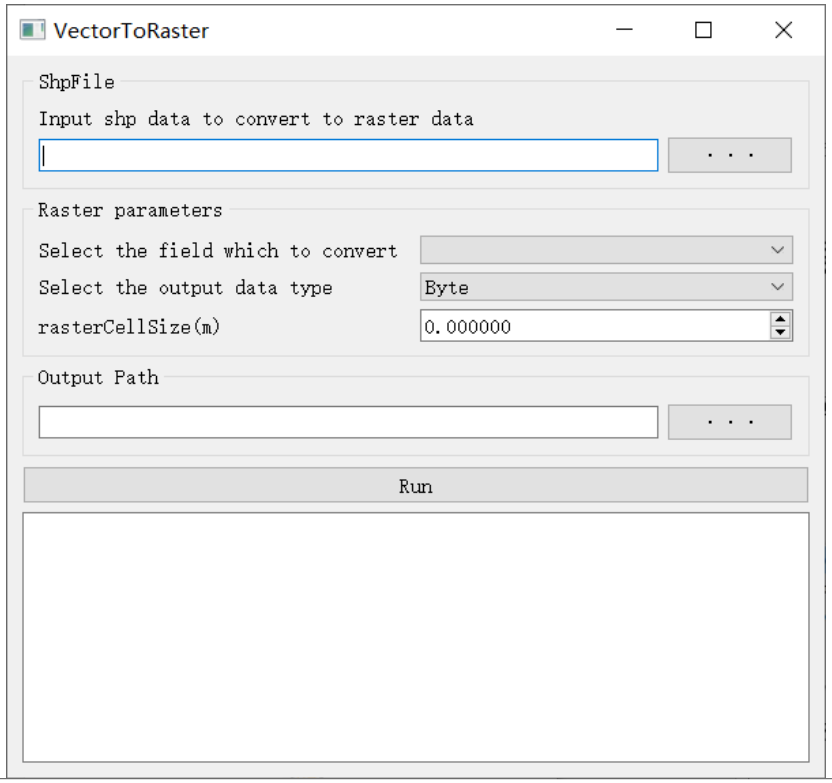
(Image courtesy QGIS)

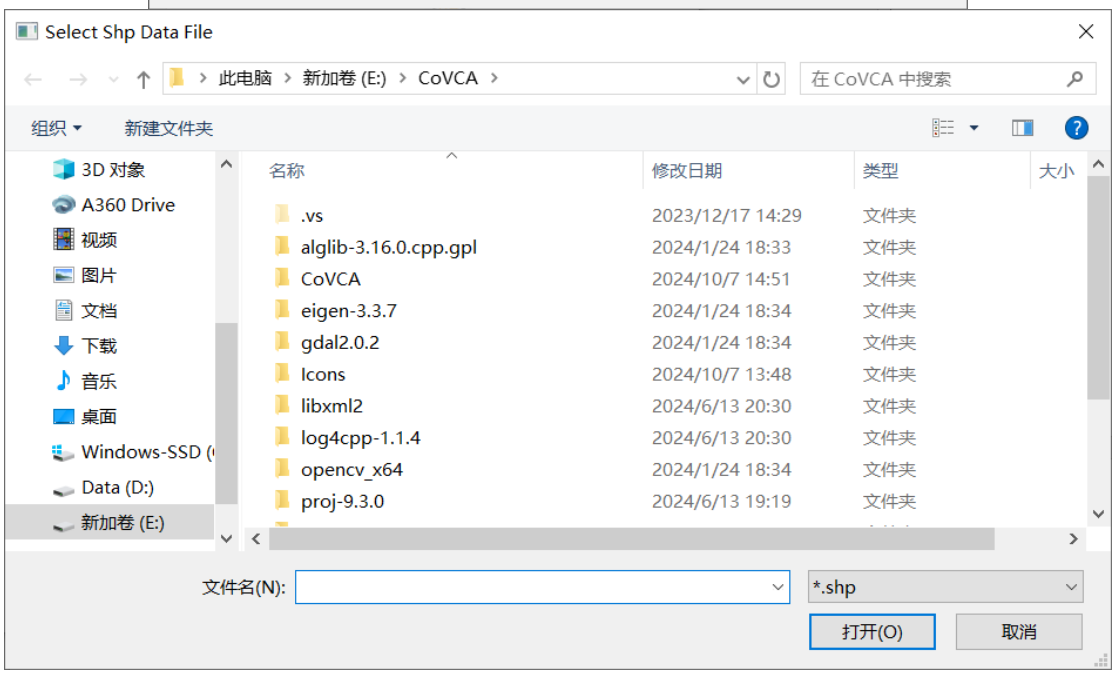
In addition, users can observe the status of the function running in the log status bar.

3.5. Vector block processing - Vector data to raster

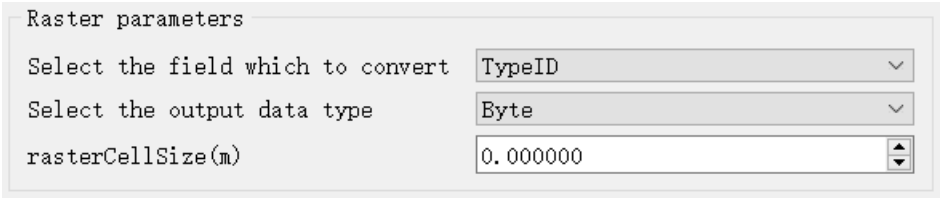
This function is mainly used to convert vector plots to raster processing, which is convenient for subsequent collaborative simulation operations.

Click "Vector to raster" in "Data Preprocessing" to open the function, as shown:





Subsequently, select "Field", "Data Type (float, etc.)", and "raster Size" for which you want to turn the raster.



Click the "run" button to perform the vector-to-raster operation.

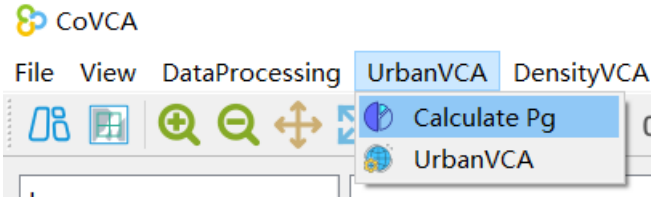
In the blank status bar below, you can see the corresponding operation and running status.

4.Vector plot simulation function based on UrbanVCA

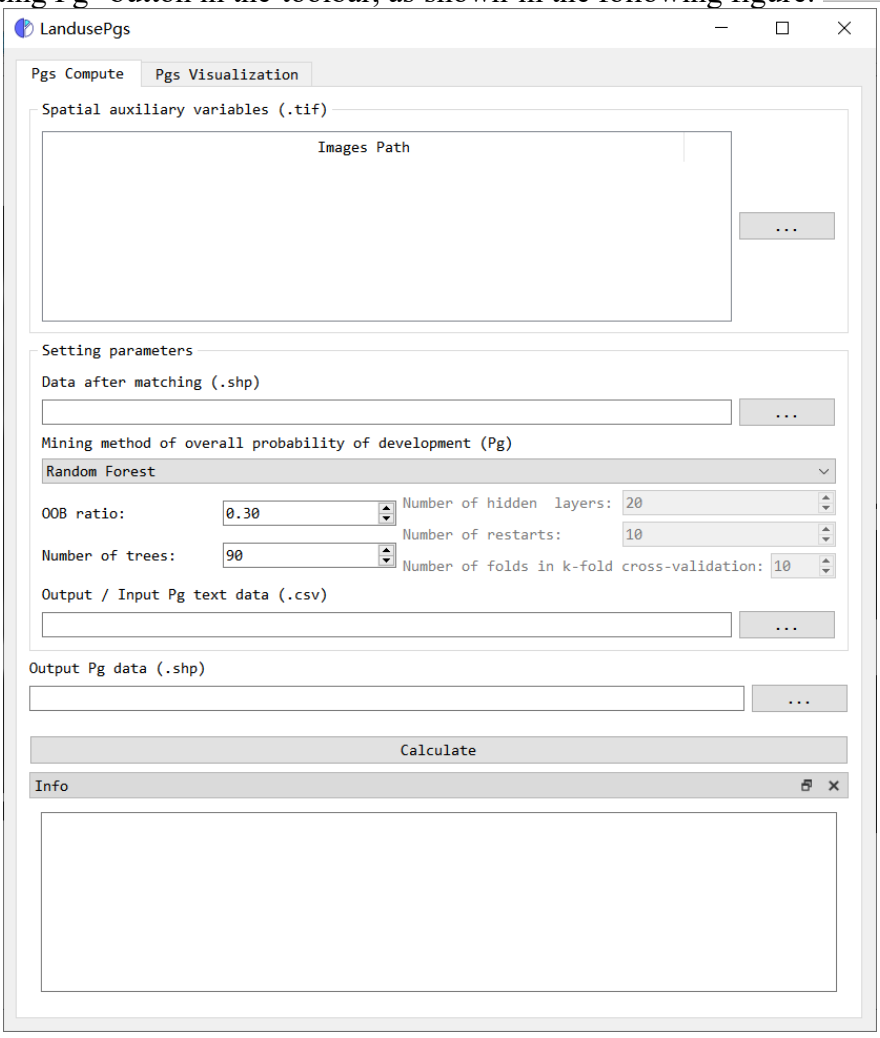
4.1. Overall development probability calculation module

4.1.1. Function selection

Click on the menu bar "UrbanVCA" and select "Calculating Pg" from the menu that pops up.

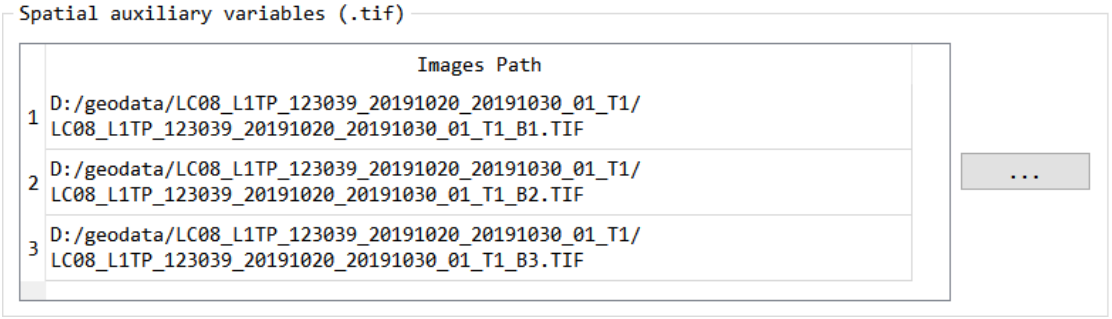


We can also Calculating the total development probability by calculating the "Calculating Pg" button in the toolbar, as shown in the following figure: 



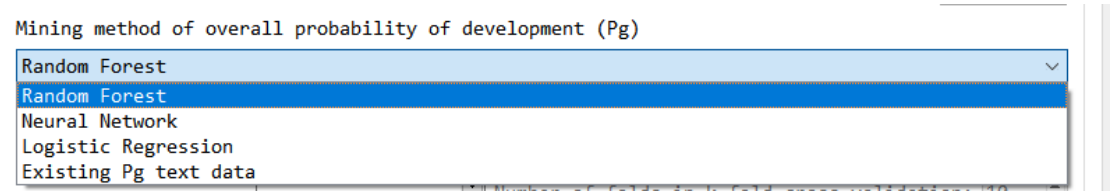
4.1.2. Calculating the total development probability

First of all, the spatial auxiliary variables in Tiff format need to be imported. Users can select multiple spatial auxiliary variables in the pop-up dialog box by clicking the button, as shown in the following figure: 

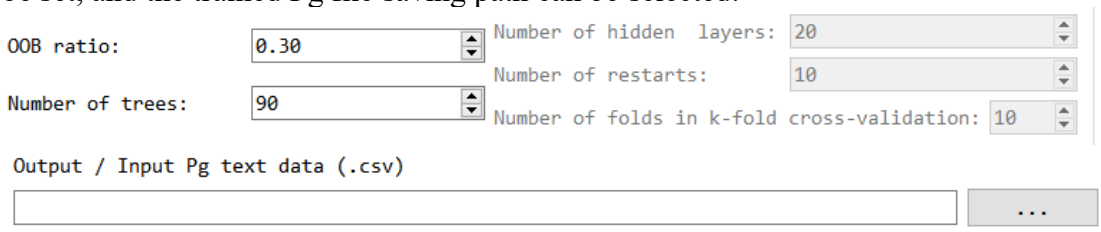


Then, the user needs to import the land use data matching data file (see 3.4 for details), as shown below:

Then, users can choose random forest, neural network, logistic regression and other machine learning models according to their needs, or directly import Pg files from outside:

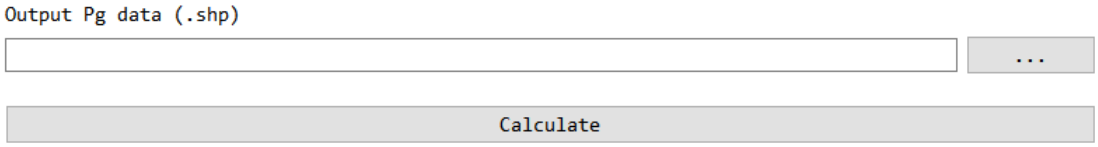


If the user chooses the machine learning model, the parameters of the model can be set, and the trained Pg file saving path can be selected:

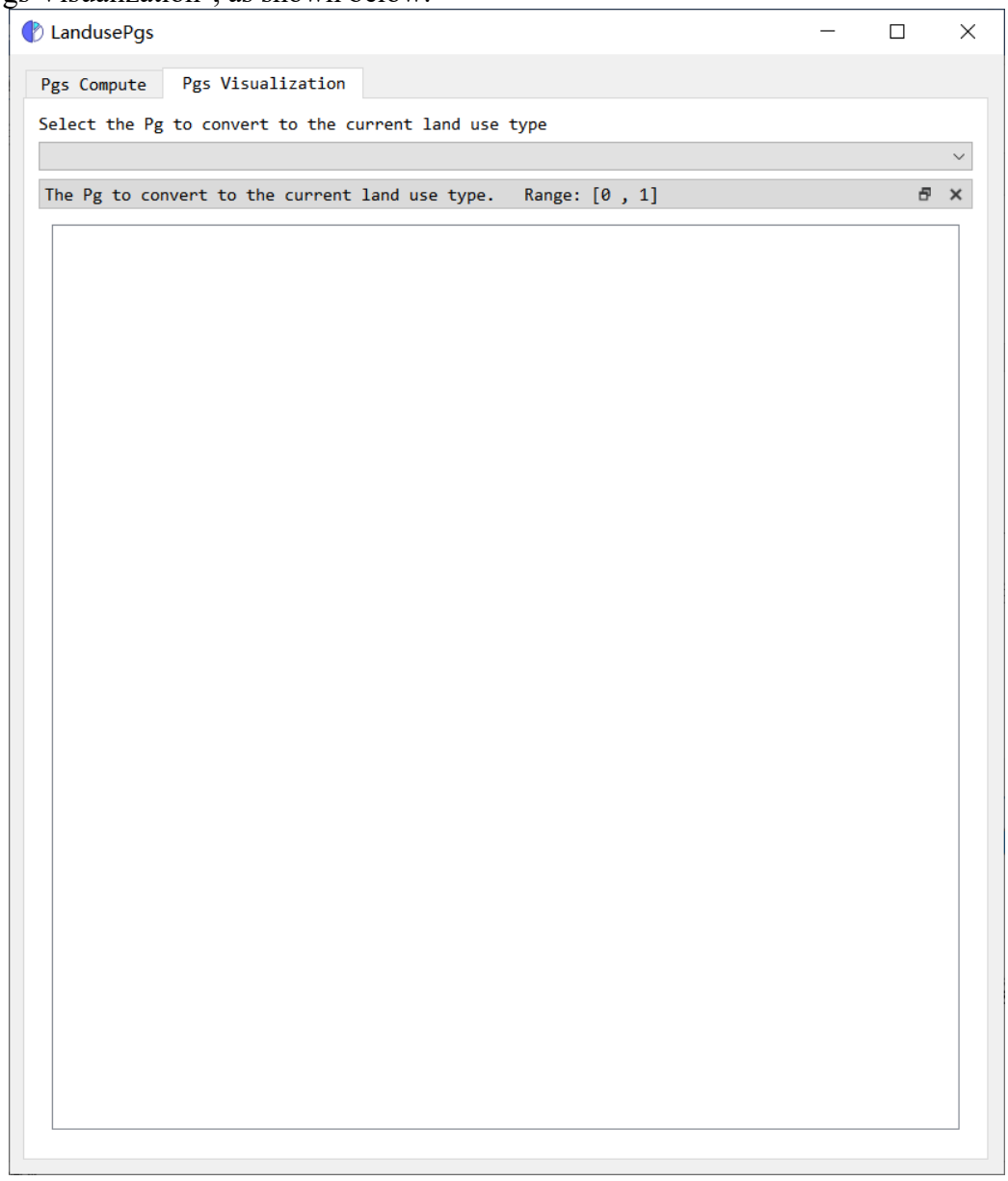


If the user chooses to import the Pg file directly, there is no need to import the spatial auxiliary variables. Note that Pg is in.csv format and each line is formatted as: "Pg0,Pg1... Pgn,ID ", where the ID of each plot is the value corresponding to the "ID" field in the generated attribute list of the land use data (the format can be referred to the trained Pg file above). Users need to import the path where the Pg file is located in the following figure:

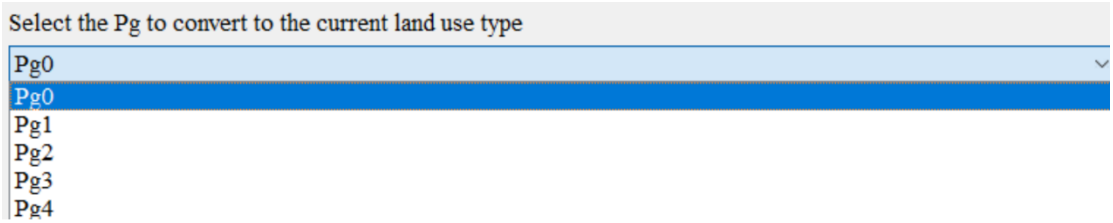
After the above Settings, set the storage path of the total development probability data file, and then click the "Calculation" button, as shown in the following picture:



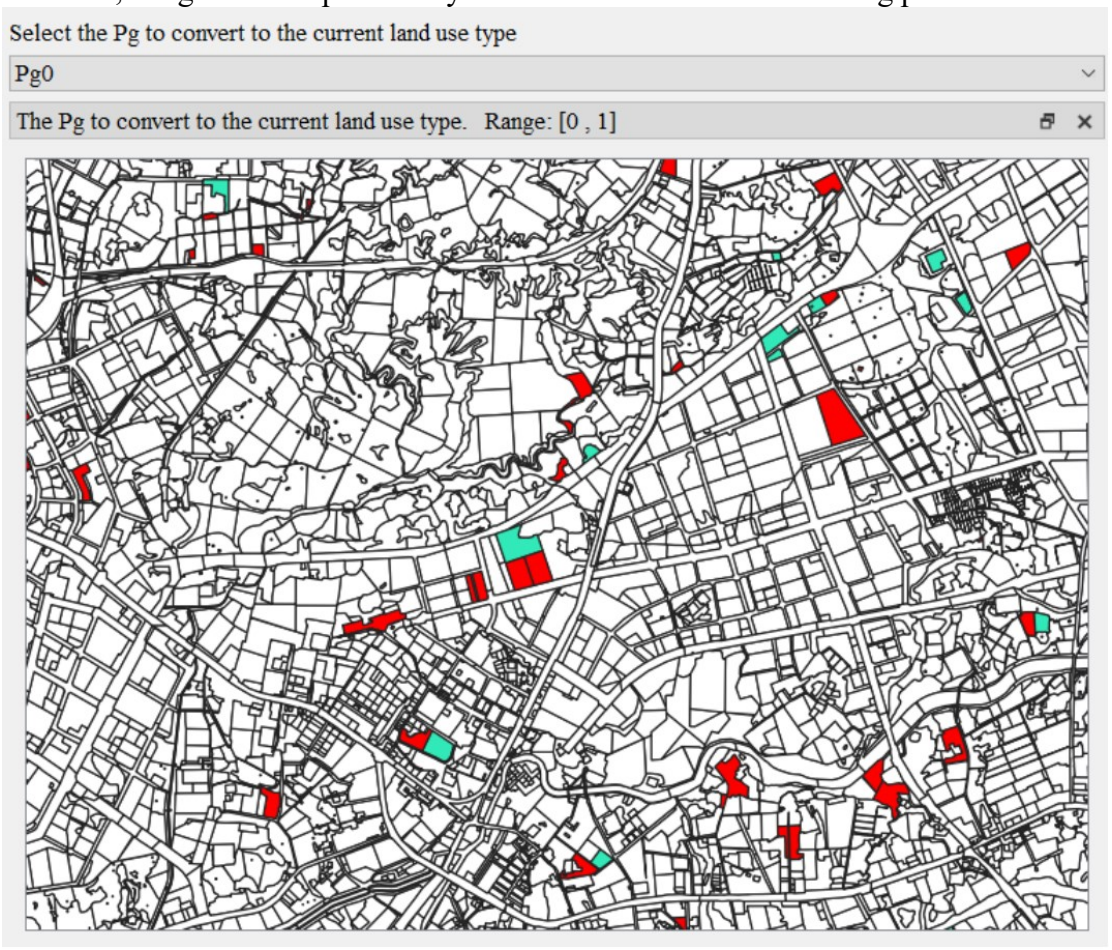
The software also provides the overall development probability visualization function. After the calculation is complete, the user can make the observation in the "Pgs Visualization", as shown below:



Select the overall probability of developing into land Type i in the drop-down list box as follows:



Then, the software will automatically display the visual dynamic effect diagram of the overall development probability on the right side of the interface, and the redder the color, the greater the probability value. As shown in the following picture:



Users can also observe the function running in the log status bar.

Of course, users can skip this module and directly modify the Pg field in the property list of land use data after matching.

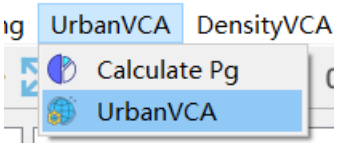
Pg0	Pg1	Pg2	Pg3	Pg4
0.08889	0.27778	0.13333	0.12222	0.18889
0.13333	0.07778	0.11111	0.34444	0.27778
0.14444	0.15556	0.22222	0.40000	0.23333
0.14444	NULL	0.21111	0.17778	0.11111
0.02222	0.12222	0.08889	0.41111	0.17778
0.08889	0.27778	0.06667	0.38889	0.08889
0.07778	0.20000	0.07778	0.43333	0.16667
0.42222	0.12222	0.13333	0.33333	0.22222
0.06667	0.15556	0.35556	0.07778	0.30000

(Photo courtesy of QGIS)

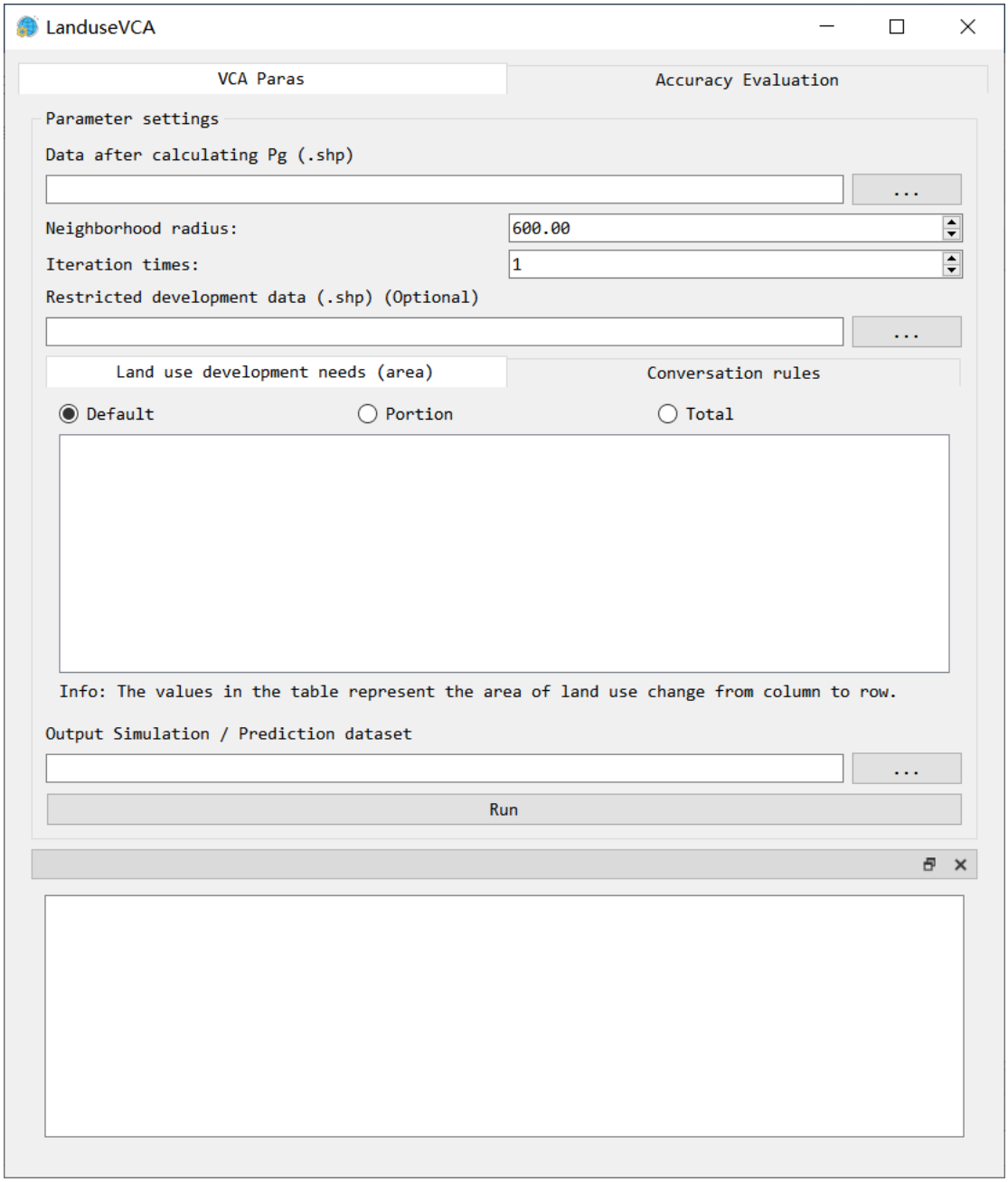
4.2. UrbanVCA analog module

4.2.1. Feature selection

Click on the menu bar "UrbanVCA" and select "UrbanVCA" from the menu that pops up.

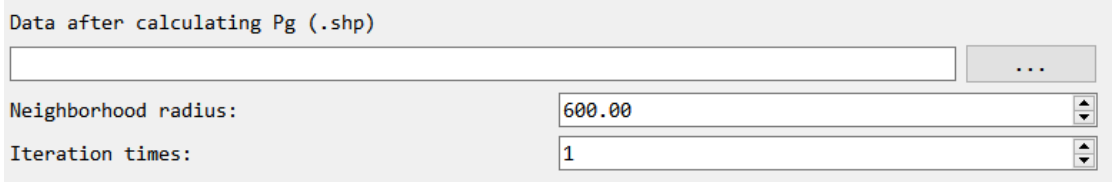


We can also open the UrbanVCA model simulation function by clicking "UrbanVCA" button in the toolbar, as shown in the following picture: 

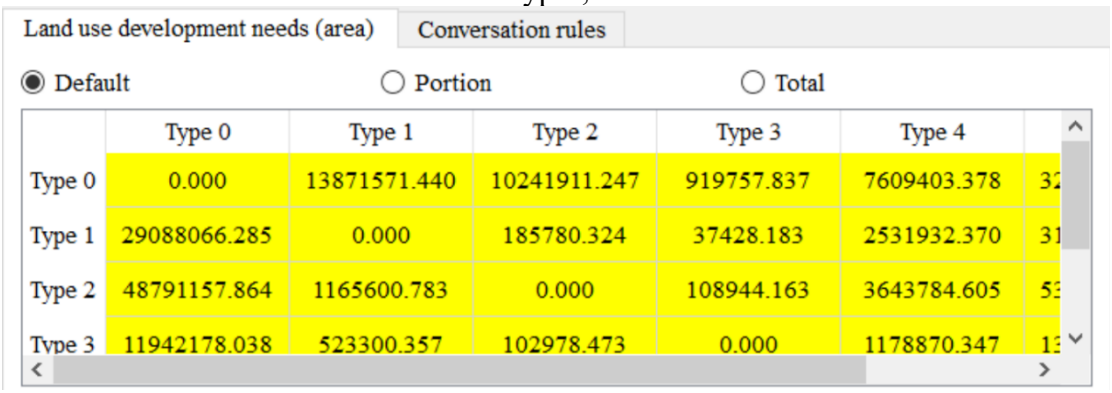


4.2.2. UrbanVCA model simulation

First, the user needs to import the total development probability calculation file (see 4.1.2 for details) and set the neighborhood radius value and the number of iterations as follows:



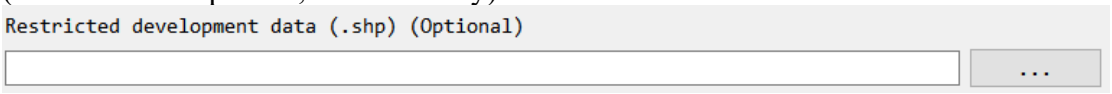
After completion, the system will automatically count and display the area size of conversion between various land use types, as shown below:



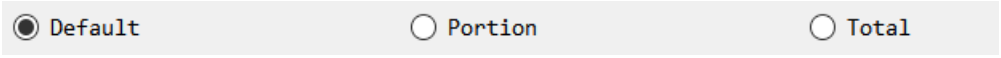
	Type 0	Type 1	Type 2	Type 3	Type 4	
Type 0	0.000	13871571.440	10241911.247	919757.837	7609403.378	32
Type 1	29088066.285	0.000	185780.324	37428.183	2531932.370	31
Type 2	48791157.864	1165600.783	0.000	108944.163	3643784.605	53
Type 3	11942178.038	523300.357	102978.473	0.000	1178870.347	13

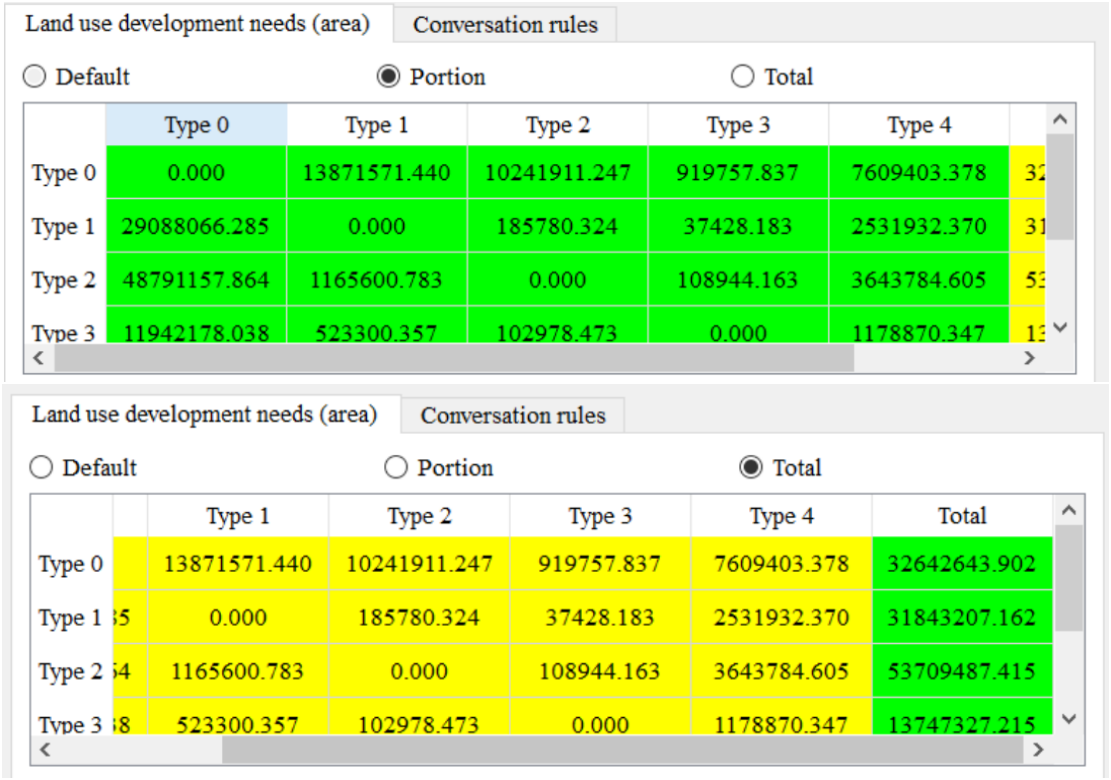
Each value of the table in the figure represents the area of the land use type corresponding to that column to the land use type corresponding to that row, regardless of the fact that the land use type has not changed.

The user can then set the restricted development area as needed, and by importing the. SHP file of the restricted area in the figure below, the system will automatically prohibit the development of the block located within the restricted area (this feature is optional, not necessary).

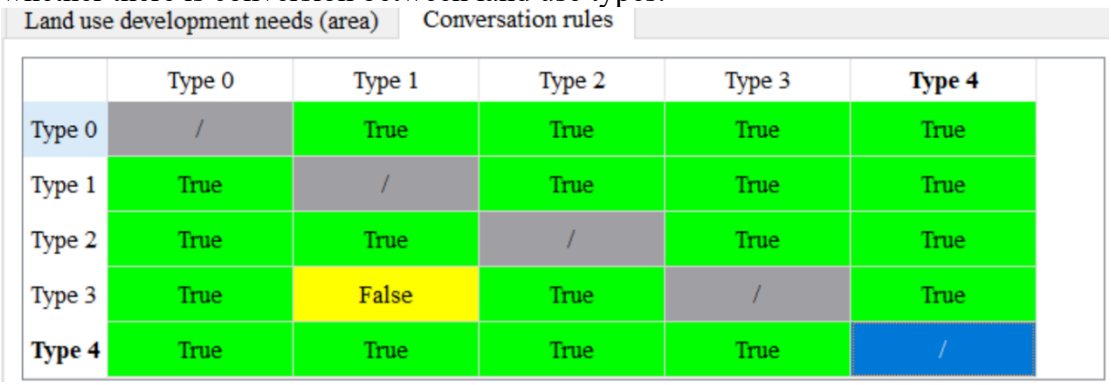


The user can then set the land use change area as shown in the image. If "Default" is selected, it means that the system adopts the statistical result of the imported overall development probability calculation file; If "Portion" is selected, it means that the conversion area between various types of land use can be modified artificially, and the system adopts the modified value; If "Total" is selected, it means that the development area of various land use types can be artificially modified, and the system adopts the artificially modified value.



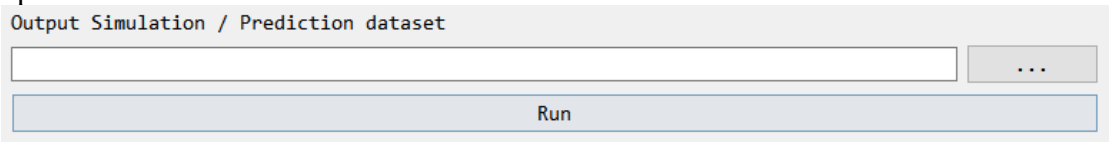


At the sametime, users can click "Conversation rules" to set the land use conversion rules. By double-clicking the median value of the table, they can set whether there is conversion between land use types.



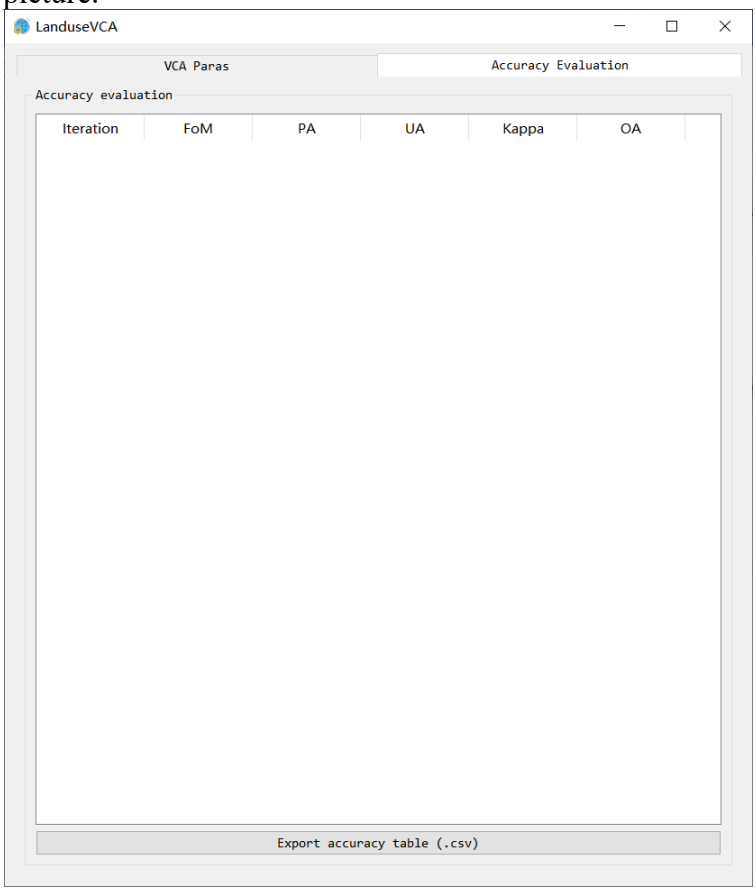
Each value of the table in the figure represents the change of the land use type corresponding to the column to the land use type corresponding to the row, regardless of the unchanged land use type.

After setting the above parameters, the user selects the path of the folder where the simulation results are saved and exported, and clicks the "Run" button to start the operation.



Note: The result file contains the land use simulation data (.shp) and corresponding accuracy evaluation (.txt). For the land use simulation data, the simulated field can be viewed after the user opens the attribute list, which represents the simulated land use type of each land plot (see 3.4 for the meanings of the fields in the attribute list). In addition, the user can observe the operation of the function in the log status bar.

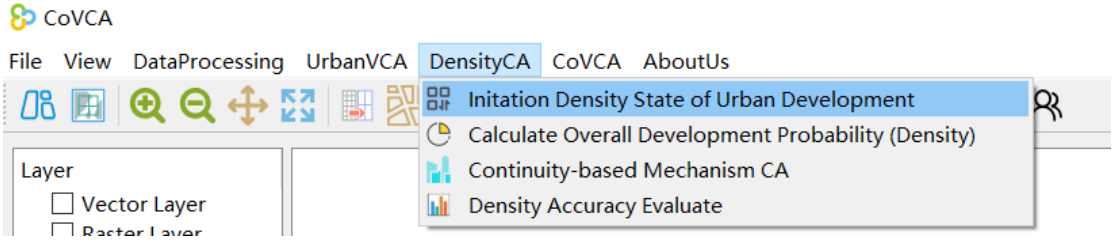
After the model simulation is completed, the Accuracy Evaluation results of each iteration will be displayed in the "accuracy evaluation" table. Users can also click "Export accuracy table" button to export the accuracy evaluation results. As shown in the following picture:



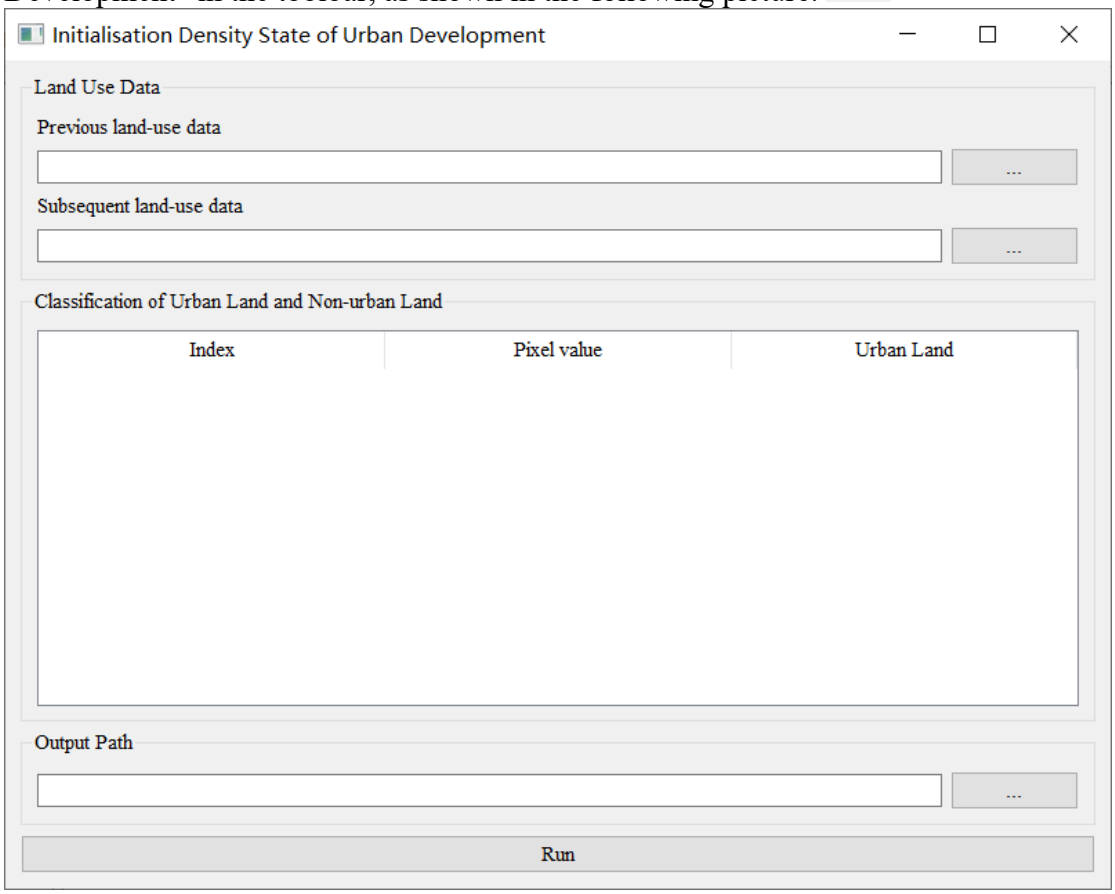
5. Simulate the continuous change of urban elements based on DensityCA model

5.1. Calculate the initial density state of urban development

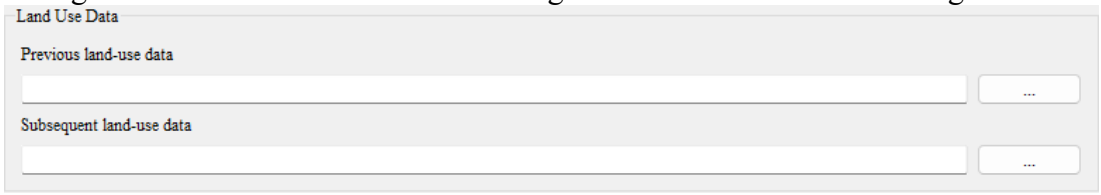
Click on the menu bar "DensityCA" and select "Initialization Density State of Urban Development" from the menu that pops up.



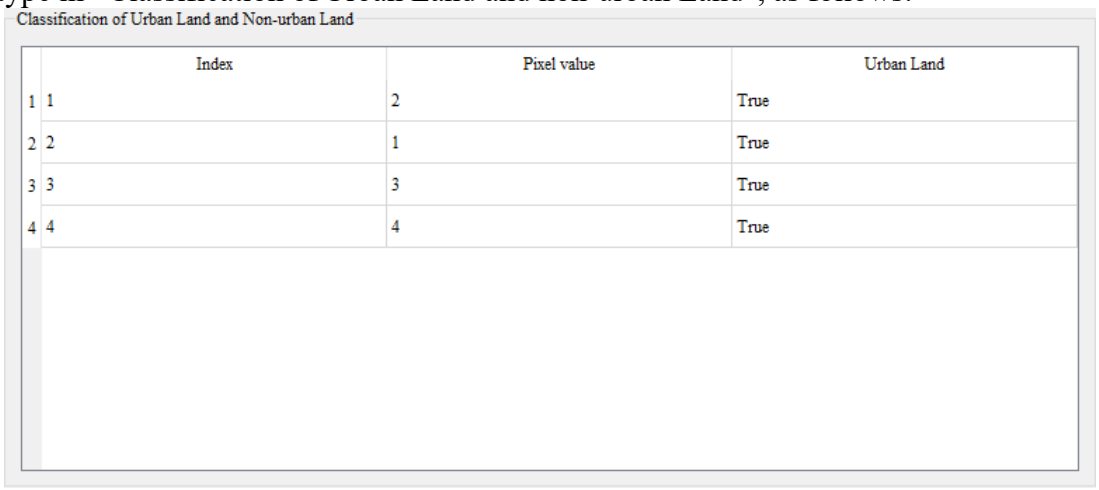
We can also open the function module of calculating the initial Density State of Urban Development by clicking the button of "Initialization Density State of Urban Development" in the toolbar, as shown in the following picture: 



First, click on the right buttons of Previous land-use data and Subsequent land-use data respectively. In the subsequent folder selection dialog box, select the path for storing Land data before and after the change. ... The following is shown:



In order to divide the original data into "Urban - Non-urban" Land, you can set whether it is urban Land by double-clicking "Urban Land" corresponding to the land type in "Classification of Urban Land and non-urban Land", as follows:



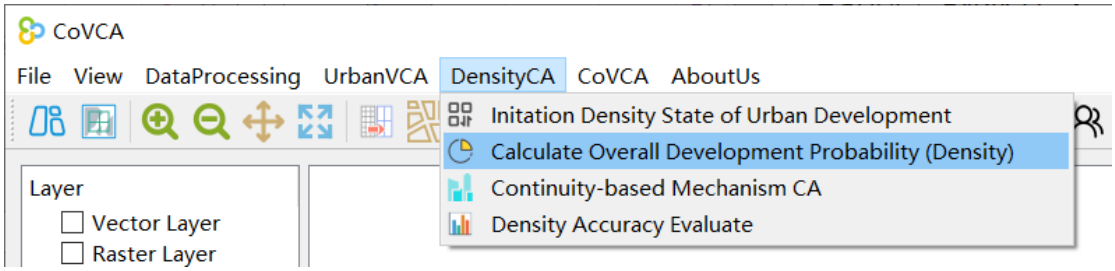
	Index	Pixel value	Urban Land
1	1	2	True
2	2	1	True
3	3	3	True
4	4	4	True

Finally, click the button in "Output Path", select the result saving path in the pop-up dialog box, and the result will be. ... Output in Tif format.

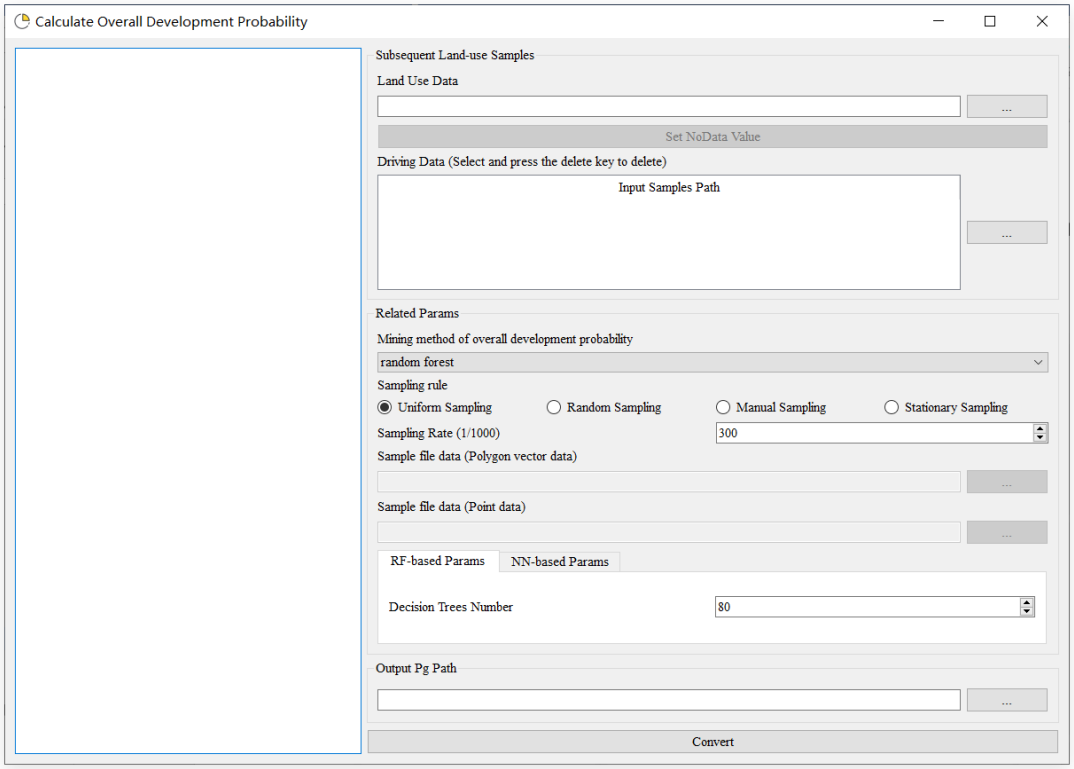
Click the "Run" button to start performing the city Development Initial density status calculation function.

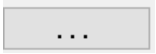
5.2. Calculate the overall density development probability of the city

Click on the menu bar "Density CA" and select "Calculate Overall Development Probability (Density)" from the menu that pops up.

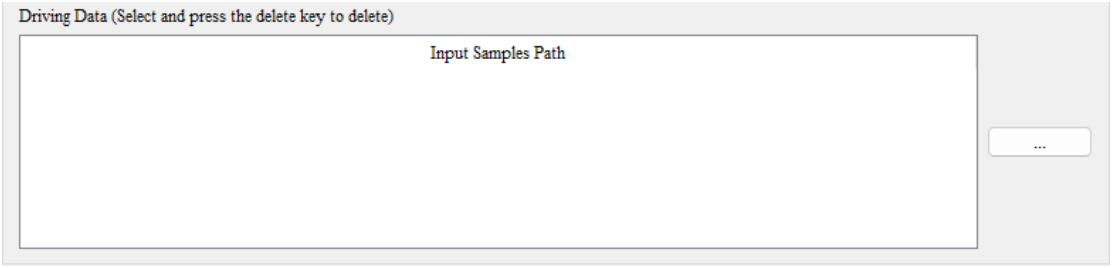


We can also open the function module of calculating Overall Development Probability (Density) by clicking the button of "Calculate Overall Development Probability (Density)" in the toolbar, as shown in the following figure: 

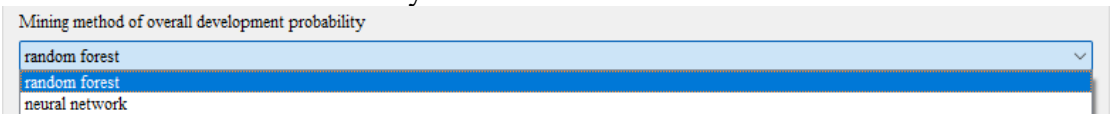


First of all, click the button in "Land Use Data", the system will automatically popup a dialog box, the user needs to select the initial density state data of urban development obtained in the previous step. 

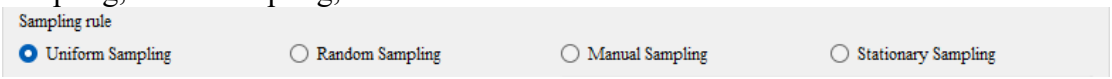
Then, after clicking the button in "Driving Data", the system will automatically popup a dialog box, in which the user needs to select the data set of driving factors to be trained. 



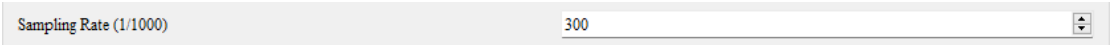
After completion, select the Mining method of overall development probability from the drop-down box of "Mining Method of overall development probability", which is random forest model by default. It looks like this:



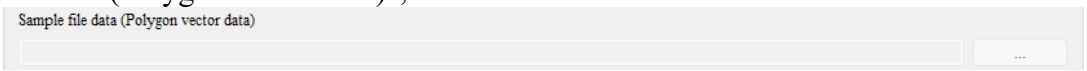
Then, in "Sampling rule" select regular sampling, random sampling, manual sampling, Static sampling, as follows:



If Sampling is random, set the Sampling Rate size by "Sampling Rate", as follows:

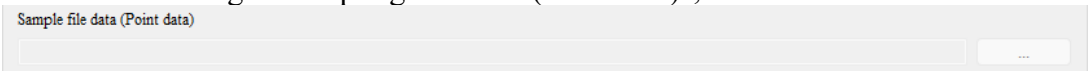


If Sampling is manual, import the specified sampling area.shp File via "Sampling File data (Polygon vector data)", as shown below:

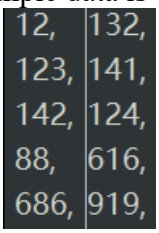


Where, the data format of the specified sampling area.shp file is polygon surface data under the same projection area range.

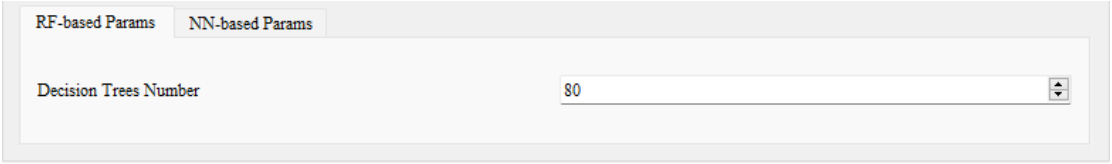
If the Sampling is static, it is necessary to import the specified sampling pixel location File through "Sampling File data (Point data)", as shown below:



Where, the data format of the specified sampling pixel location file is: "row number, column number," and the sample data is shown as follows:



Then, according to the mining method of overall development probability selected above, model parameters are set in "RF-based Params" or "NN-based Params", as follows:

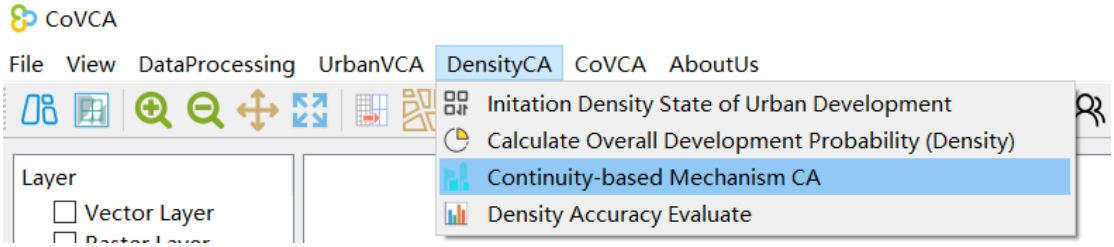


Finally, click the button  in "Output Pg Path" and select the storage location of the overall development probability file in the pop-up dialog box, as shown below:

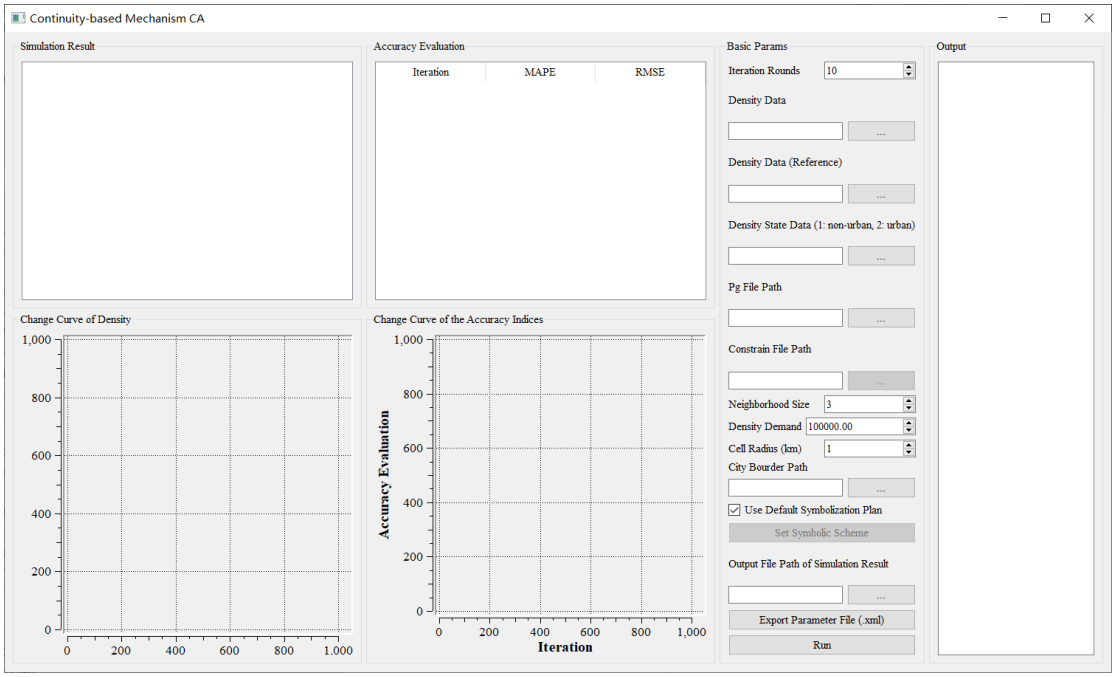
Click "OK", the system will start mining the overall development probability Pg, and display the function execution status in the left Log.

5.3. Simulate the continuous change of urban elements

Click on the menu bar "Density CA" and select "Continuity based Mechanism CA" from the menu that pops up.



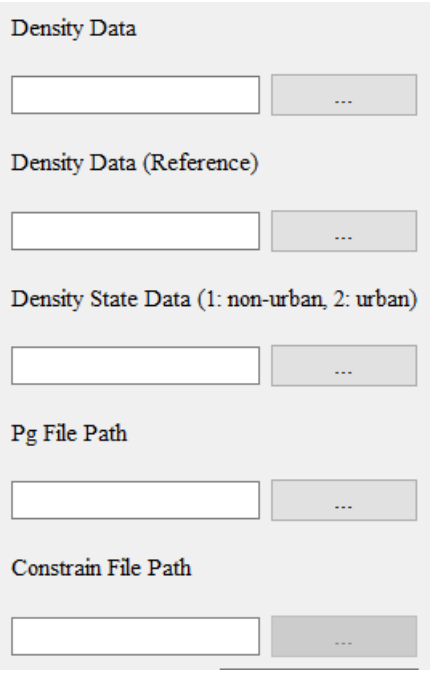
We can also open the simulation module of urban element Continuity change through the button of "Continuity-based Mechanism CA" in the toolbar, as shown in the following figure: 



First, we need to set the number of iteration rounds of this simulation through the input box of iteration rounds, which represents the number of iterations of this simulation 

Then, click the right button of "Density Data", "Density Data (Reference)", "Density State Data", "Pg File Path" and "Constrain File Path" successively. 

In the pop-up dialog box for folder selection, select the path for storing the real density data before the change, the path for storing thereal land data after the change, the path for storing the initial density data before the city change, the path for storing the Pg file and the path for storing the restricted development file in turn. The following is shown:



The "Constrain File Path" function restricts the development of a specific area, and the path can be empty. If necessary, it should be noted that the data format must be: only GByte raster data of 0 and 1 is contained in the same projection range. 0 indicates no development land, 1 indicates development land.

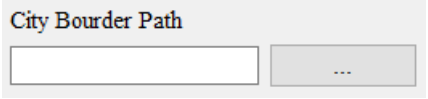
Then we need to choose the relevant parameters needed for the model simulation. Set the Neighborhood Size to the right of "Neighborhood Size";

Set the Density Demand on the right of "density demand".

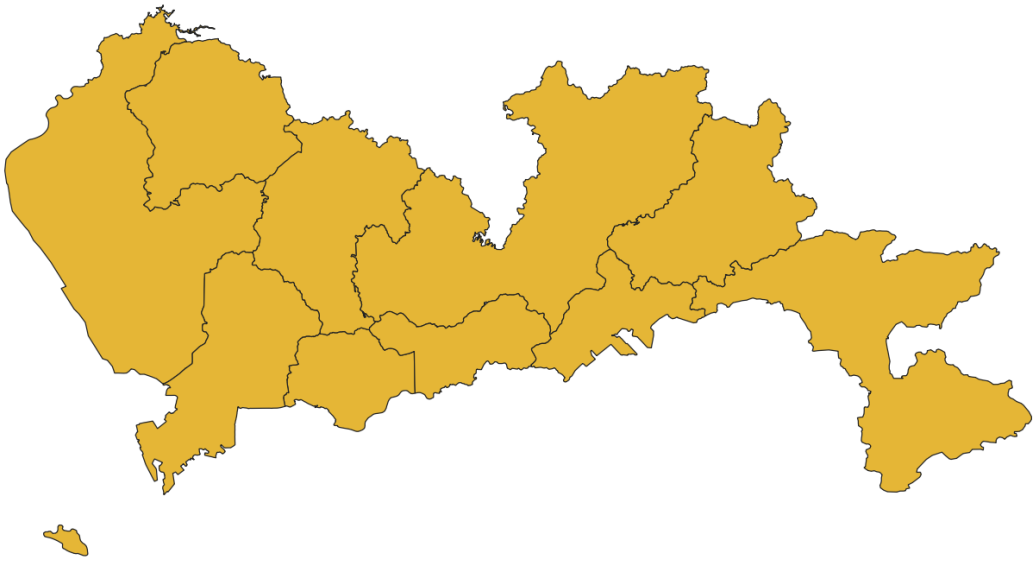
In the simulation experiment, the model will automatically calculate the total demand according to the density data put in, and the relevant value should be manually modified if the experiment is to predict the future year.

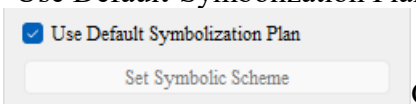
Set the Cell Radius on the right side of "Cell Radius".

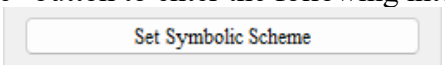
The user clicks the button to the right of "City Bourder Path" and selects the vector boundary data of the experimental research area in the pop-up dialog box (it is better to have the data divided by the boundaries of districts and counties). It is shown below:

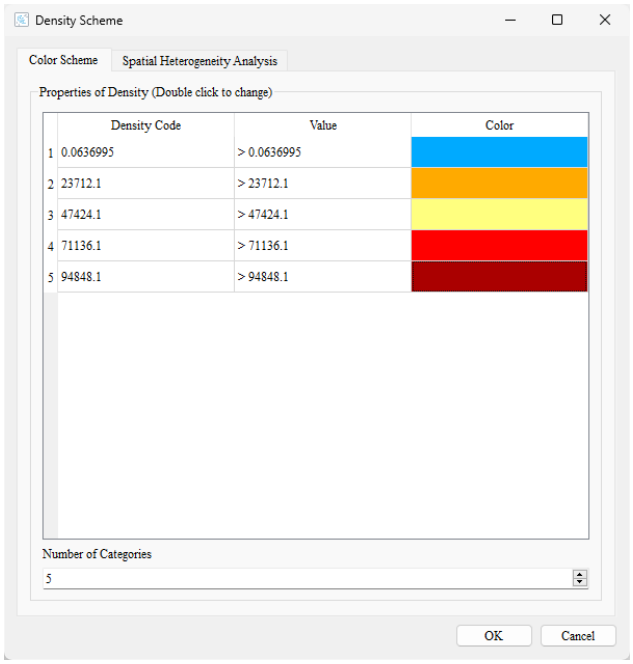


An example of boundary data is as follows:



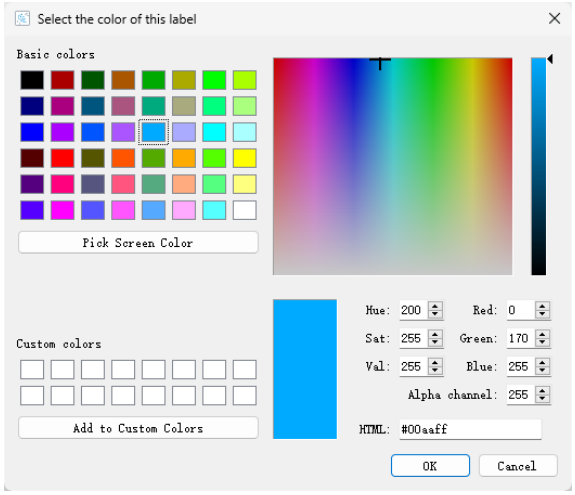
After the above parameters are set, if you need to customize the display symbols of different plots, you can click the "Use Default Symbolization Plan" check box to use the custom symbolization plan. 

Click the "Set Symbolic Scheme" button to enter the following interface to set the plot symbol and partition display: 

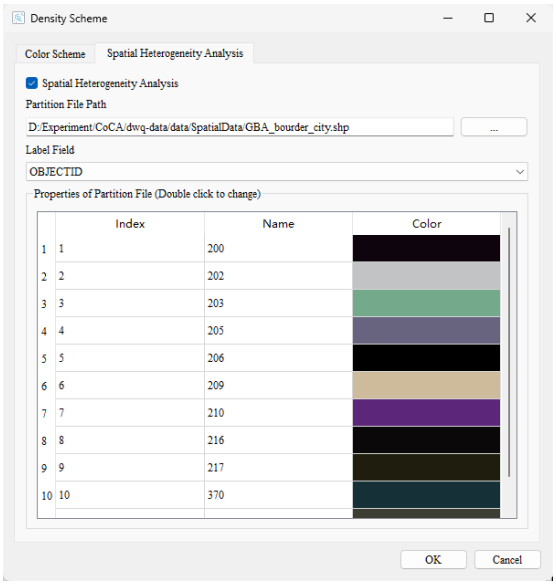


Click the color of each category, you can jump to the interface as shown in the following picture to modify the color of the category according to user needs, click the value of each category, you can switch the value of each color segment point, and

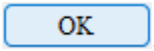
need to add or delete categories can be completed through the bottom category setting box:



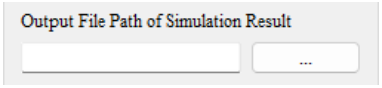
Also very important point, this model supports the display of partition data, through the "partition statistical analysis" module, including the selection of partition plane data, partition annotation fields and color Settings, the method is similar to the above.



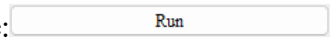
Click the "OK" button, you can complete the setting of custom symbolization.

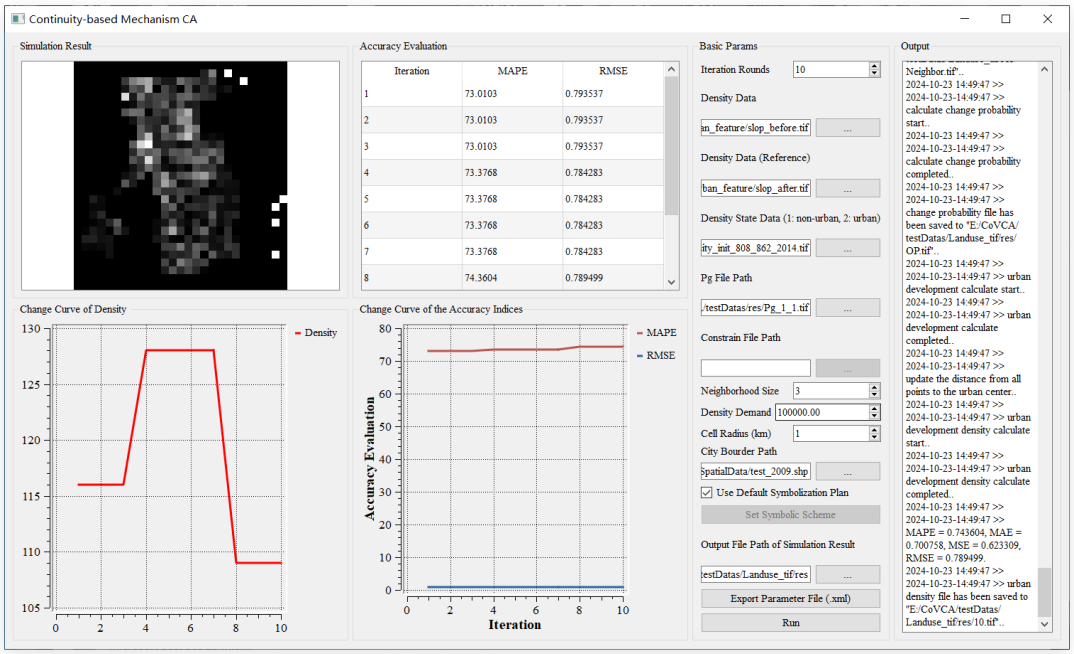


. To facilitate subsequent research, click the button in the "Output File Path of Simulation Result" function, and select the saving path of simulation results in the pop-up dialog box

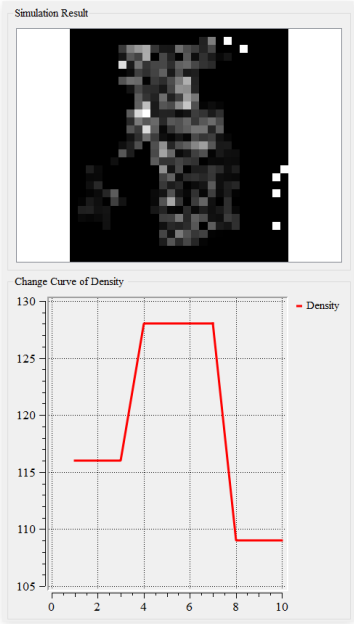


Click the button "Export Parameter File", you can save and export all parameter Settings of the current interface in XML file format 

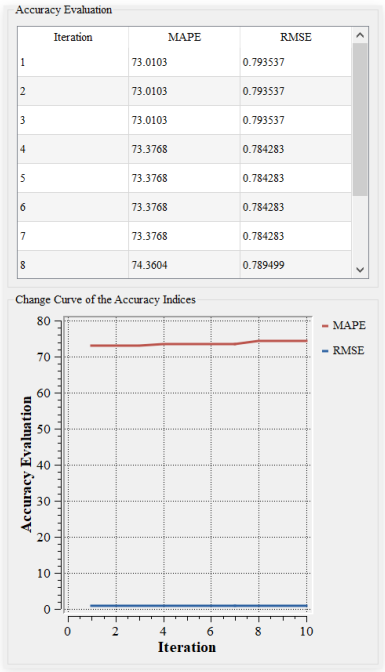
Finally, click the button "Run" in the simulation interface to simulate the continuous change of urban elements automatically, as shown in the following picture: 



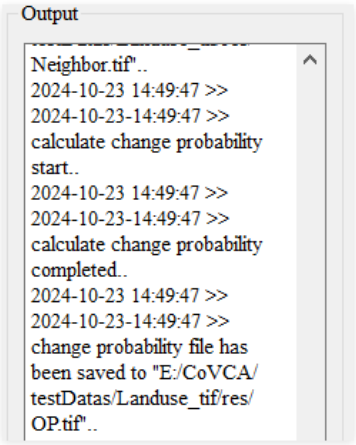
The urban element change chart module in the upper left corner can display each area through scaling, and the line chart of density change below it corresponds to the density change in the simulation process.



The accuracy evaluation index module located in the middle of the system shows the changes of each accuracy index in this simulation, and the accuracy evaluation index change line chart below corresponds to the changes of each accuracy index in this simulation (under the partition statistical setting, the calculation unit is each plane partition rather than the grid).

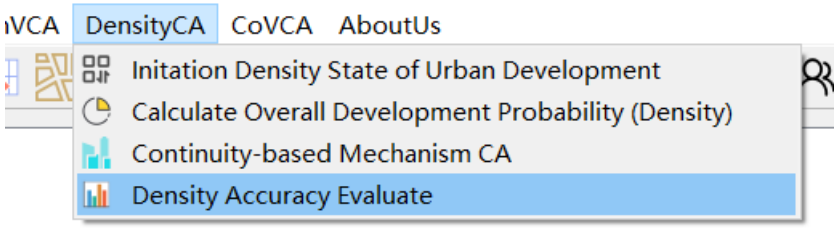


In addition, we also provide a Log output interface for checking the relevant output. The Log output interface of the urban element density change simulation module is shown in the following figure:

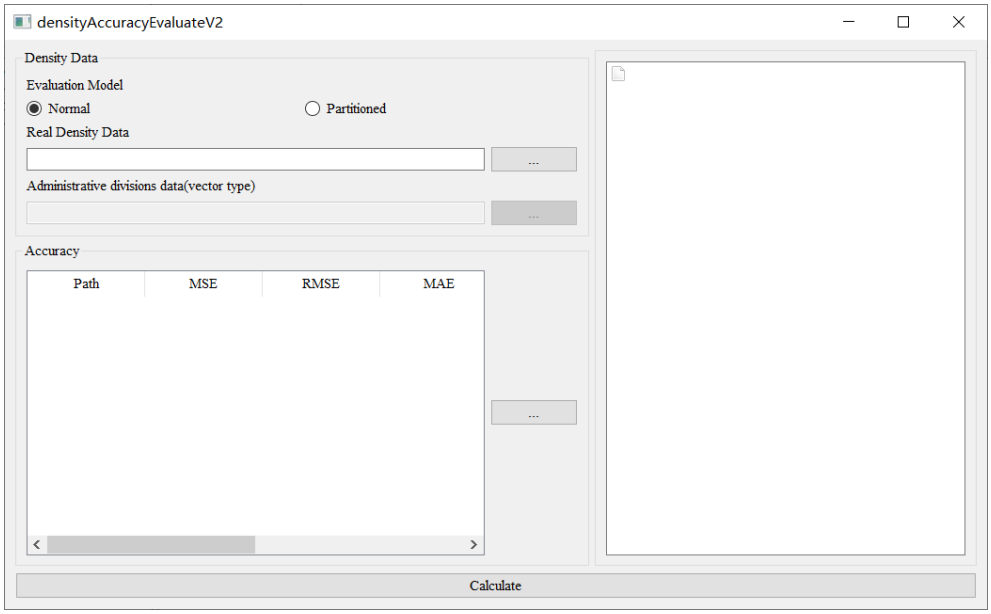


5.4. Accuracy evaluation

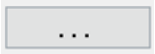
Click on the menu bar "Density CA" and select "Precision Validation (Density)" from the menu that pops up.

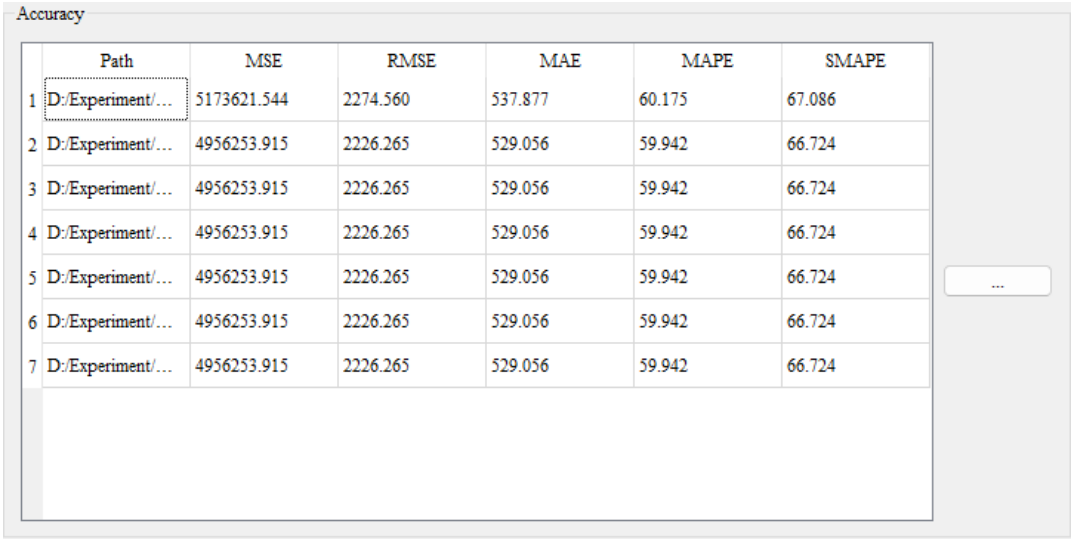


We can also open the Precision evaluation function module by clicking "Precision Validation (Density)" button  in the toolbar, as shown in the following figure:

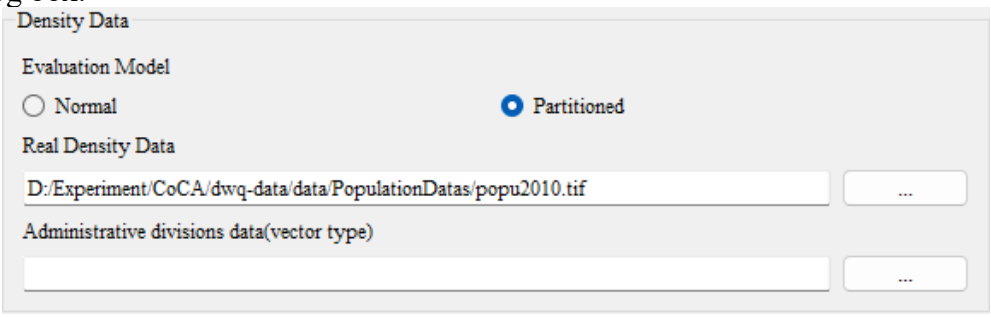


First, click the button to the right of "Real Density Data" and select the path of storing real data in the dialog box of folderselection that pops up.  It is as follows:

Then, click the button on the right of "Accuracy" to import the land data to be assessed for accuracy in the pop-up dialog box, as shown below: 



If the user needs to perform partition statistics, please select the "partition statistics" mode, and select the partition data for calculation through the select file dialog box.



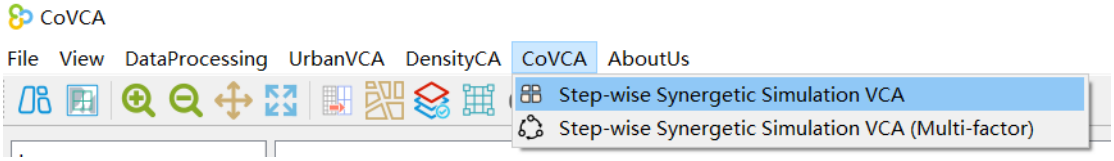
When finished, click the "Run" button to start the precision evaluation function

6. Simulate the vector land-population-economy collaborative development module based on the CoVCA model

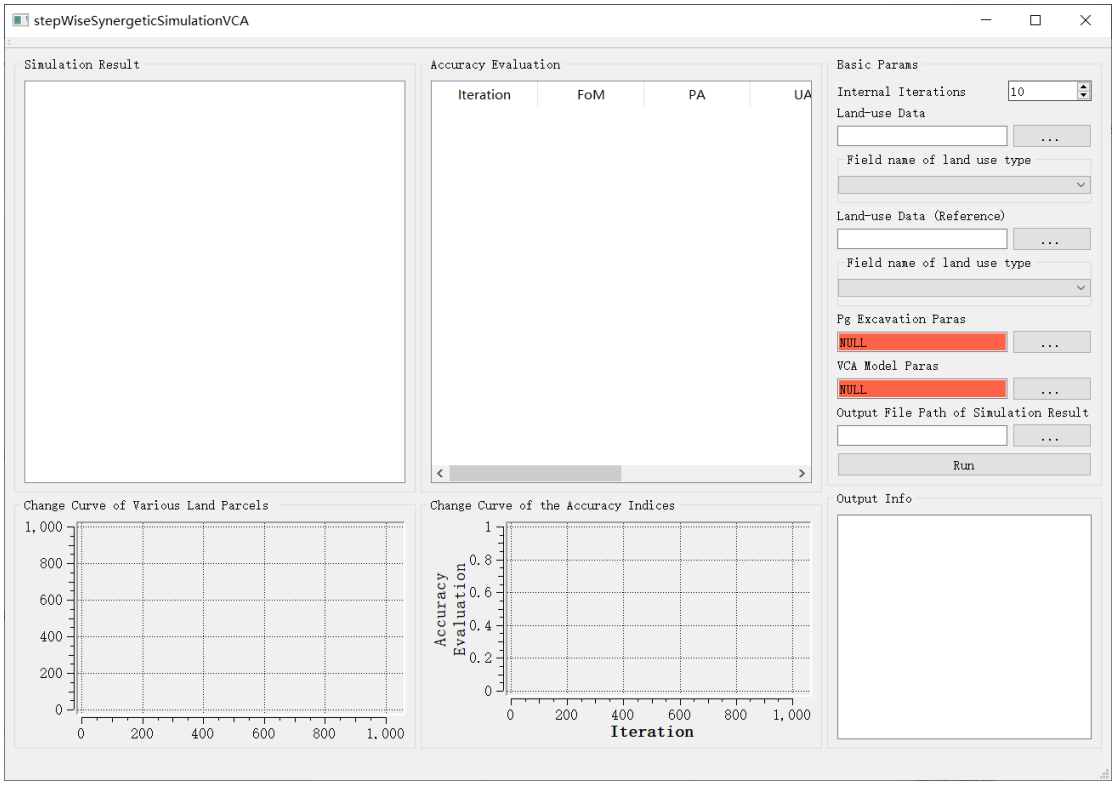
6.1. Urban single element (real vector land) simulation

This function is mainly used for the simulation of urban vector plots. This module integrates the three functions of UrbanVCA: land matching, calculating the overall development probability, and starting the cellular automata for simulation, so that it can directly complete all the basic simulation operations of UrbanVCA in this module.

Click on the menu bar "CoVCA" and select "Step-wise Synergetic Simulation VCA" from the menu that pops up.



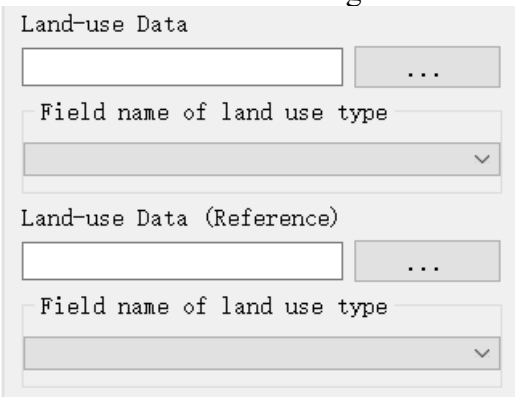
We can also open the Simulation module of urban single elements (real vector plots) by clicking the button of "Step-wise Synergetic Simulation VCA" in the toolbar, as shown in the picture below: 



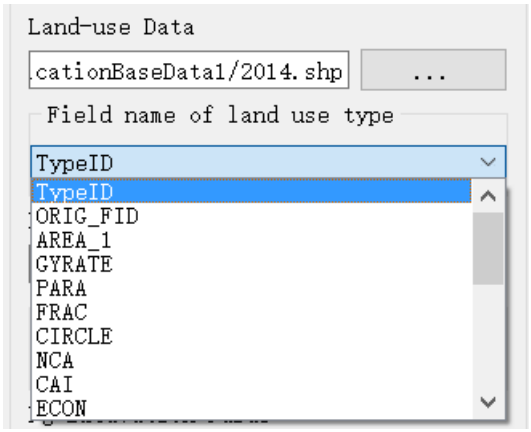
First, you need to set the number of iterations through the internal iteration number input box 

Then, click the buttons on the right of "land-use Data" and "land-use Data (Reference)" respectively. In the pop-up dialog box for folder selection, select the path for storing real Land use Data before the change and the path for storing real Land use Data after the change. 

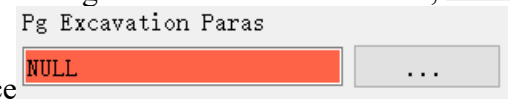
The following is shown:



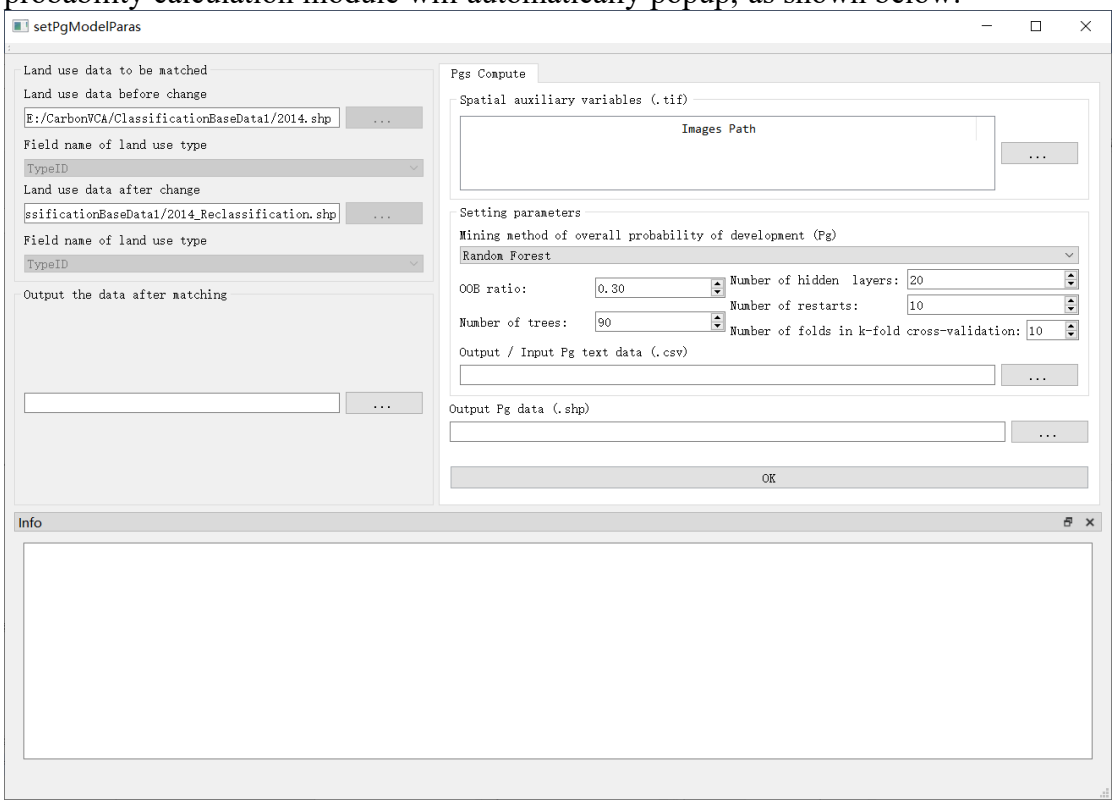
Also, select the plot field in this vector plot data (note the use of English).



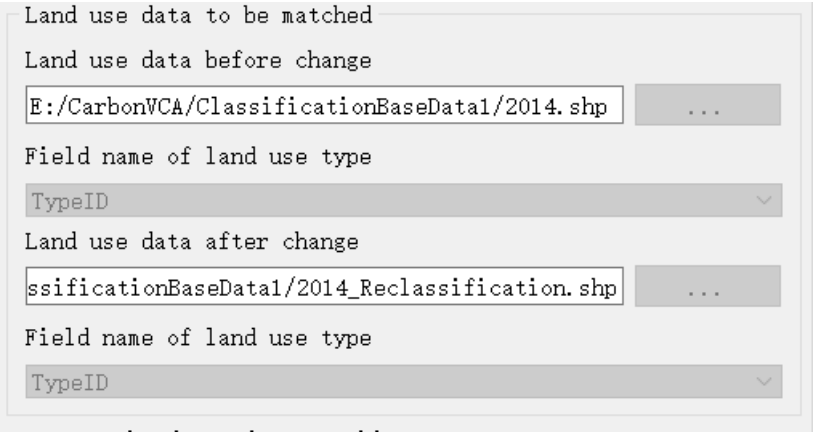
Next, we need to set the parameters of the global development probability model by clicking the "Pg Excavation Paras" button, 

and the parameter setting sub-interface 

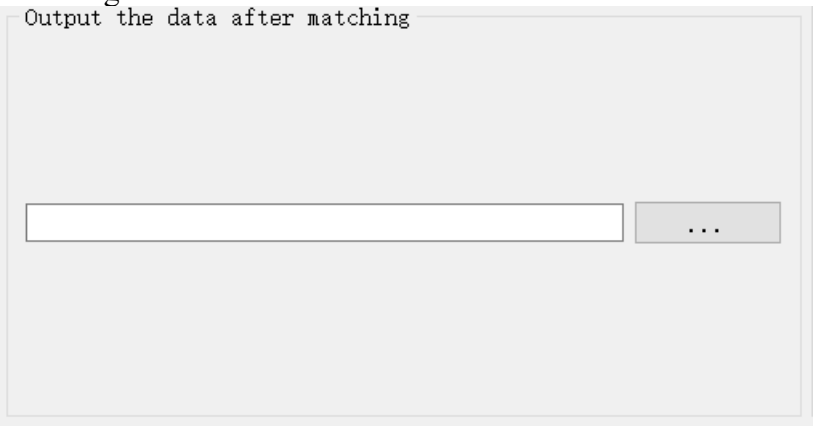
of the global development probability calculation module will automatically popup, as shown below:



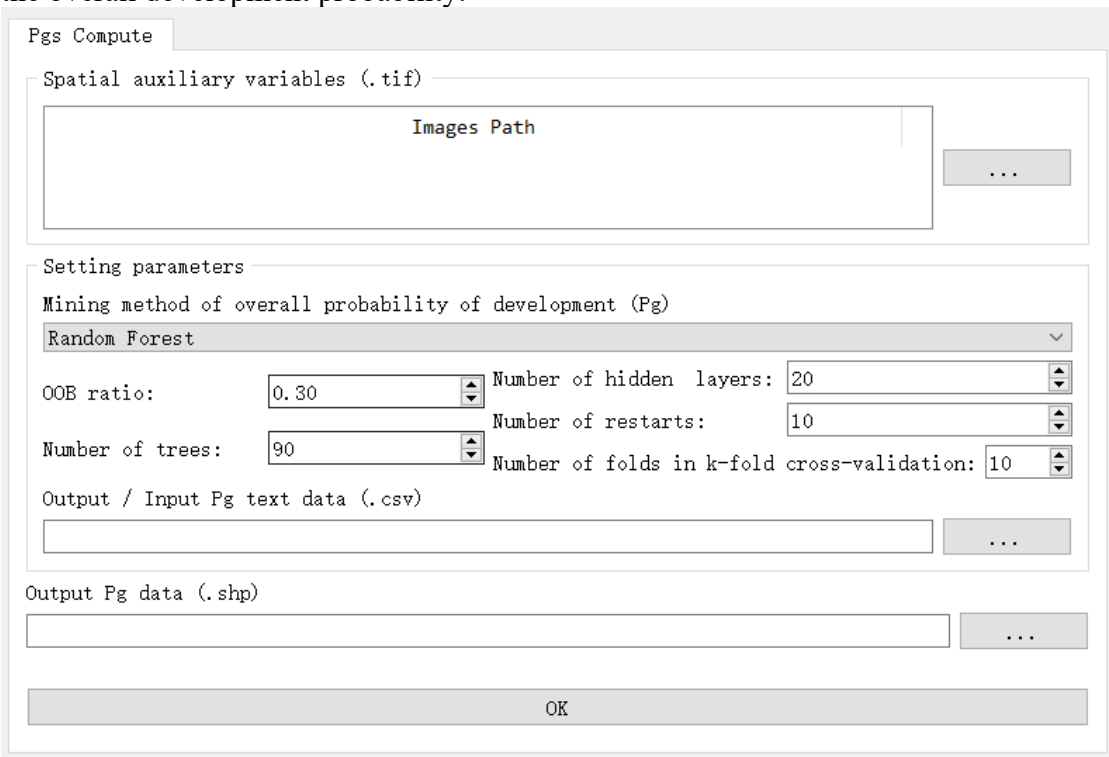
In the Pg parameter setting sub-interface, "Land use data before change", "Field name of land use type", "Land use data after change", and "Field name of land use type (after) is automatically set based on the parameters on the previous interface and cannot be modified externally. The following information is displayed:



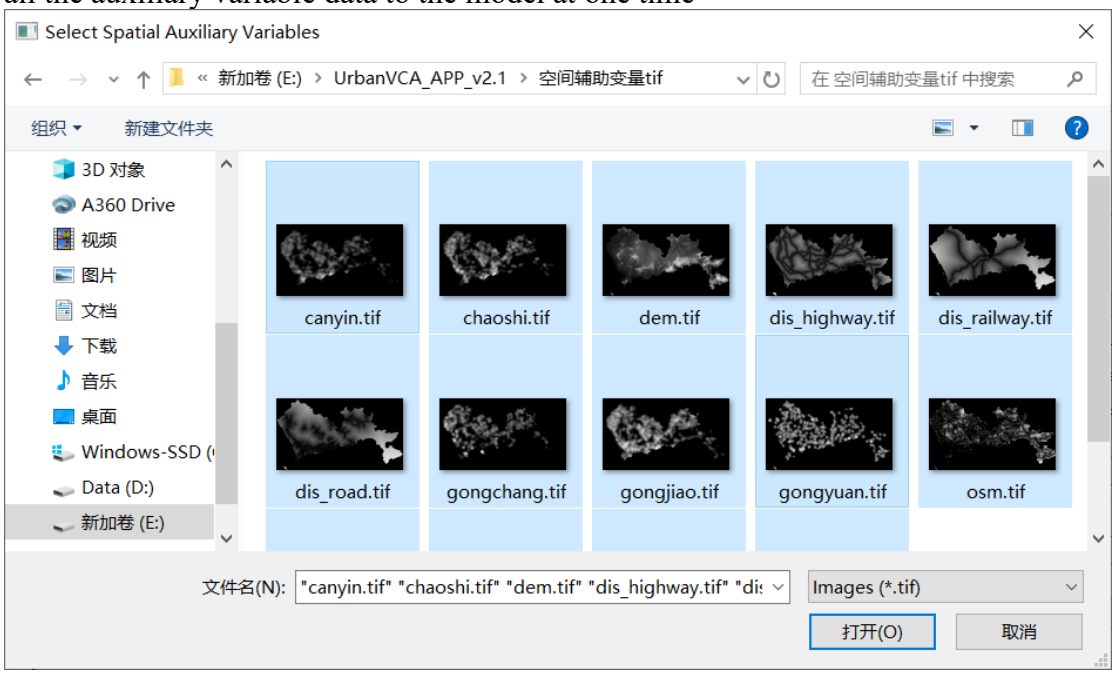
Then, in the Output the data after matching module, click the button to select the output plot matching 



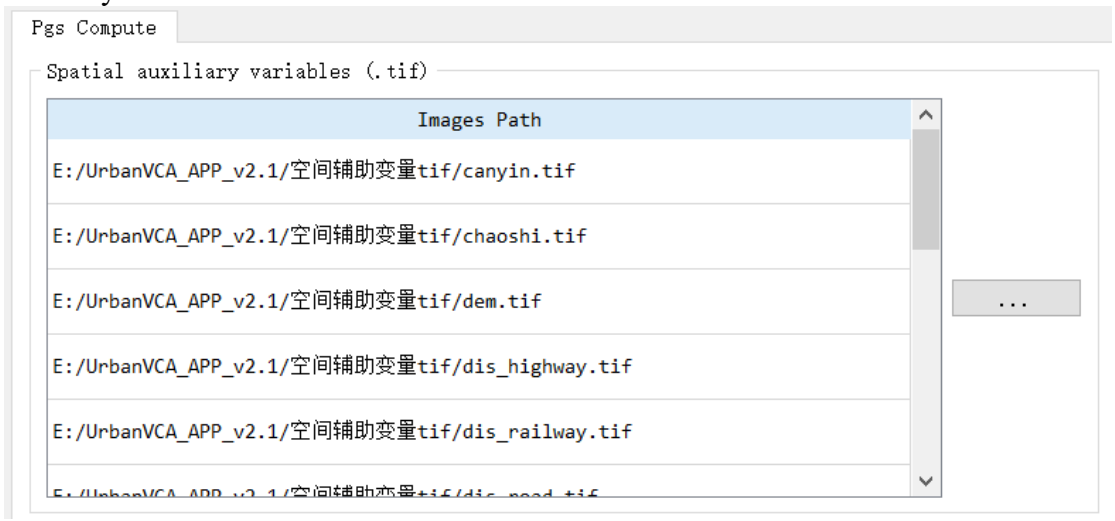
In the Pgs Compute module on the right, it is the calculation parameter setting of the overall development probability.



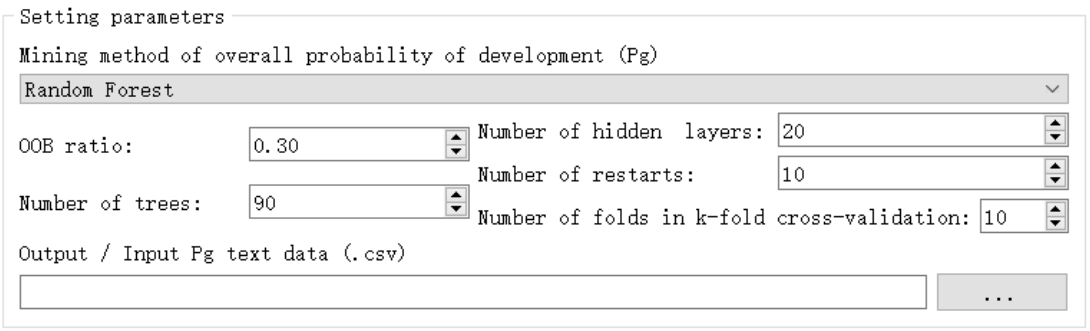
First, you need to add the spatial auxiliary variable (.tif), click the button to add all the auxiliary variable data to the model at one time 



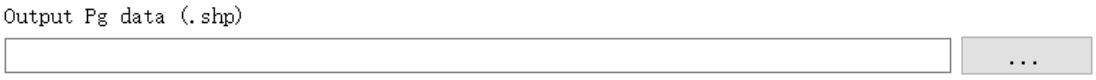
When this is done, the software can automatically recognize these spatial auxiliary variables.



Then, the algorithm, algorithm parameters, and the output of the csv file are set (see 4.1.2).

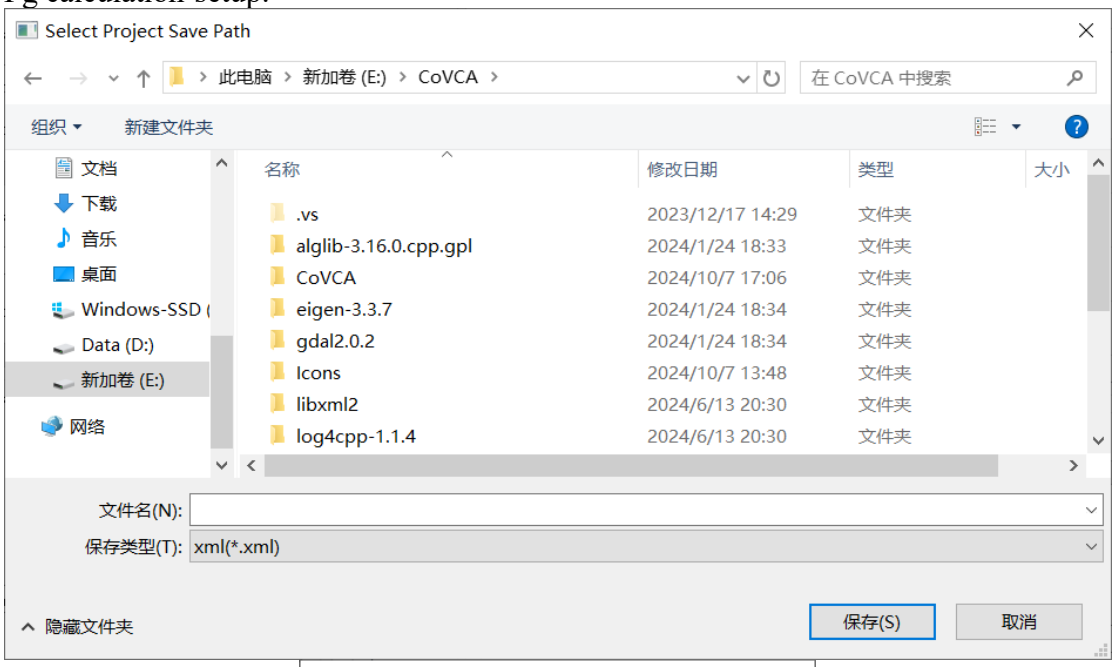


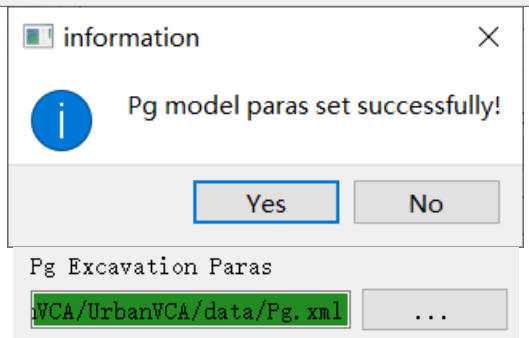
Finally, click to select the Pg file location for output.



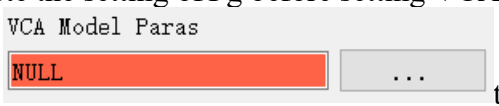
Click "OK"

"And select the location of the output".xml "model parameter file to complete the final Pg calculation setup.

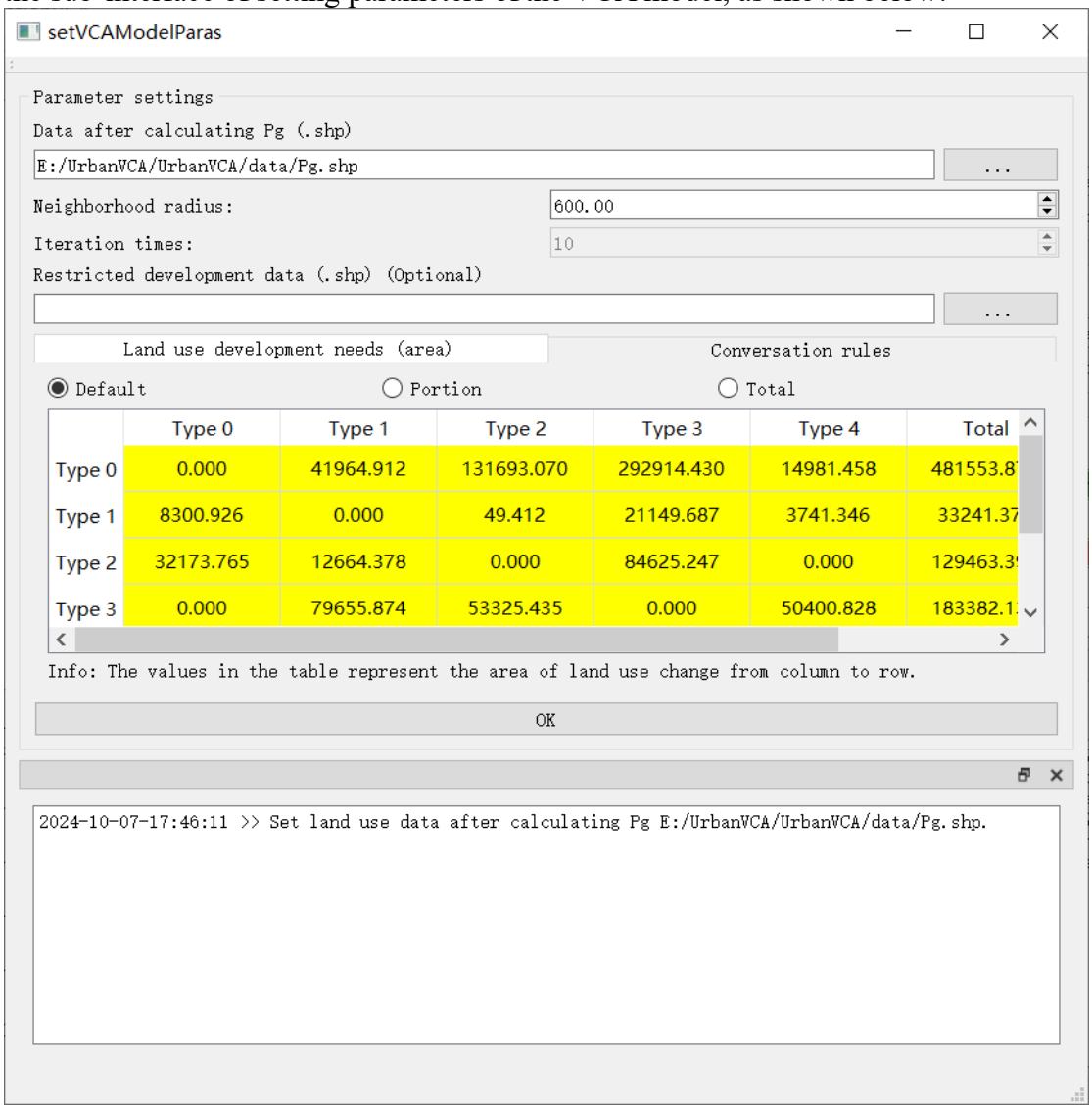




In the status bar below, you can view the status and operation of the current run.

Next, we need to set the parameters of the VCA Model, (note that it is necessary to complete the setting of Pg before setting VCA) Click the button in "VCA Model Params", 

the system will automatically popup the sub-interface of setting parameters of the VCA model, as shown below:

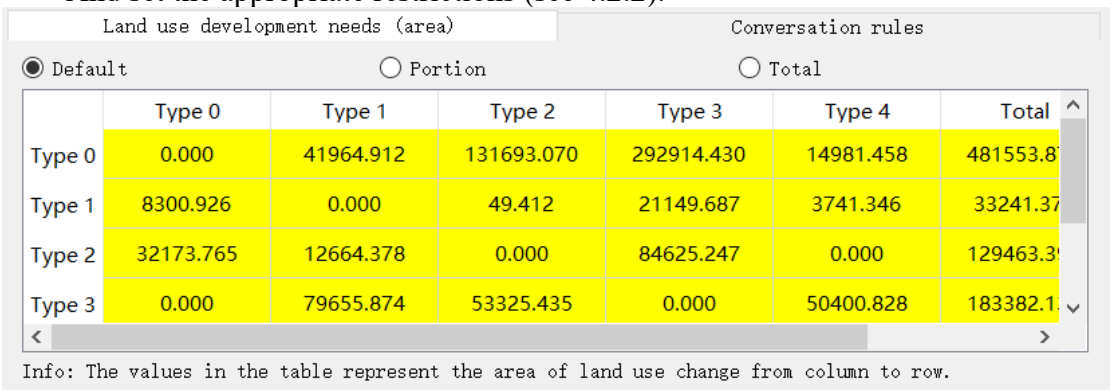


The first is to load the Pg file, where the software has automatically read the Pg file in the previous step (users do not need to add it themselves).

Subsequently, the user needs to set the field radius (see 4.2.2), and the number of iterations has been set according to the first step.

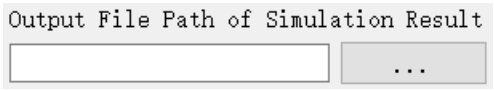
The user can set the vector data of the restricted development area below (none can be left unadded).

And set the appropriate restrictions (see 4.2.2).

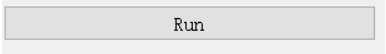


Finally, click "OK" to complete the operation.

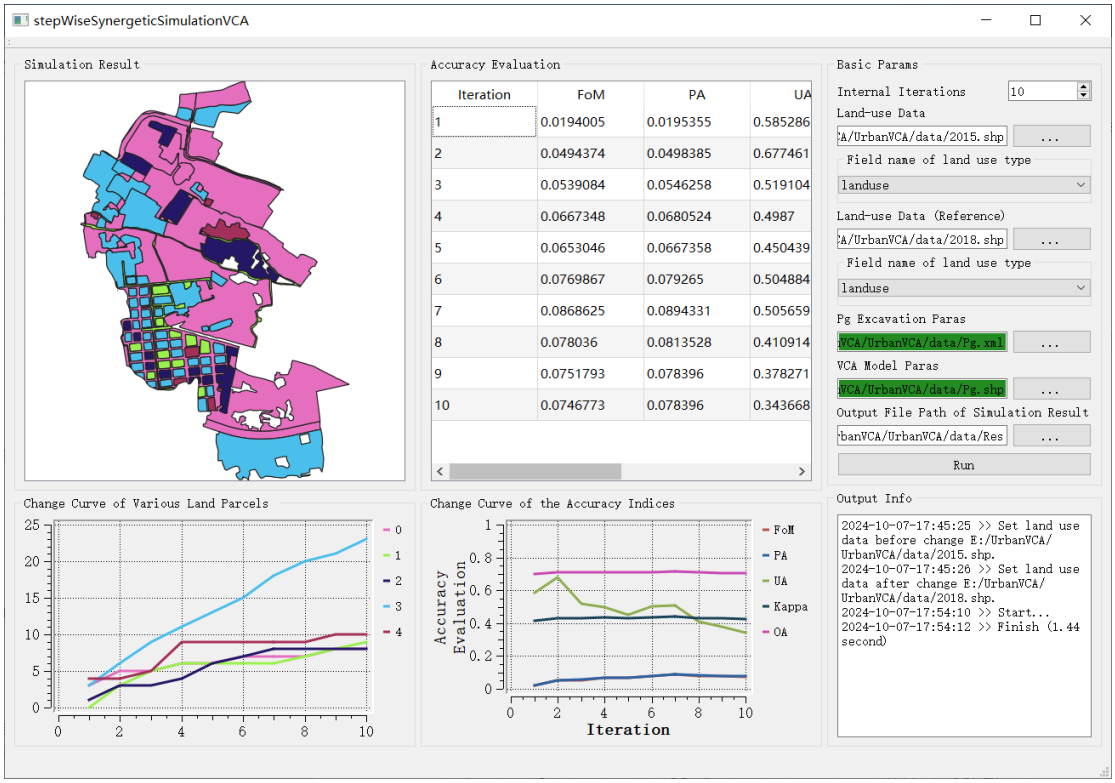
After setting up the Pg and VCA models, select the folder directory where you want to output the results.



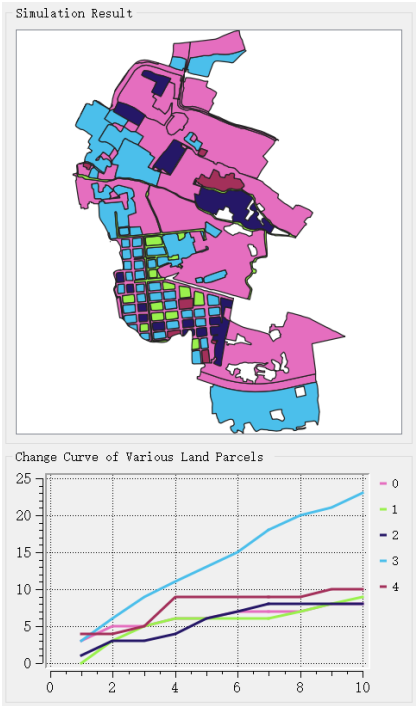
Click the "run" button to start running the module.



After the program is finished, the system will display the last land use type chart, the accuracy evaluation index of each round of iteration, the line chart of the change number of different types of land and the line chart of the change of each accuracy evaluation index, as shown in the following figure:

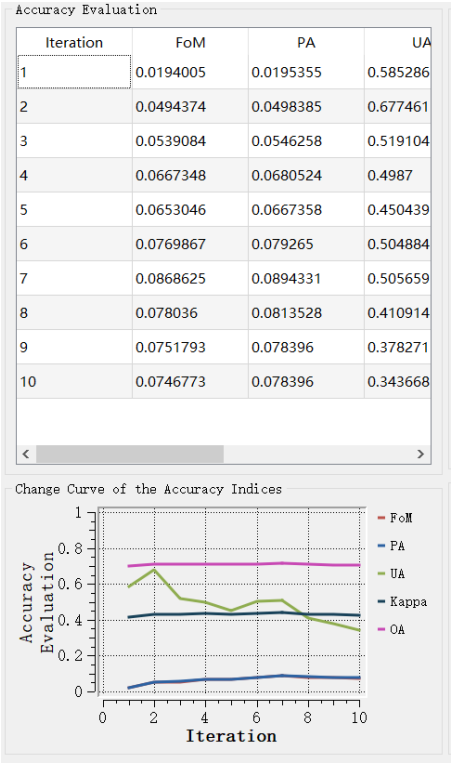


The land use type chart module in the upper left corner can display each area by scaling and traversing, and the line chart of the change number of different types of land plots below corresponds to the change situation of each type of land plots in this simulation.

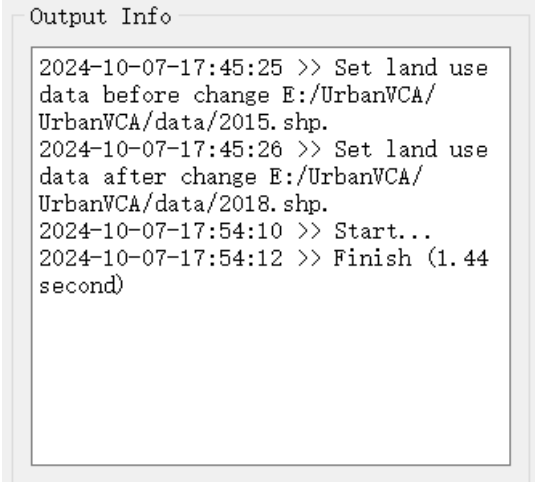


The accuracy evaluation index module located in the middle of the system shows the changes of each accuracy index in this simulation, and the accuracy evaluation

index change line chart below corresponds to the changes of each accuracy index in this simulation.

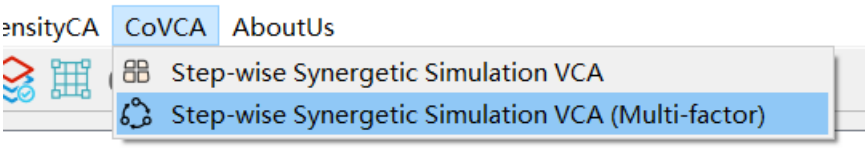


In addition, we also provide a Log output interface for checking the relevant output, as shown in the following figure:

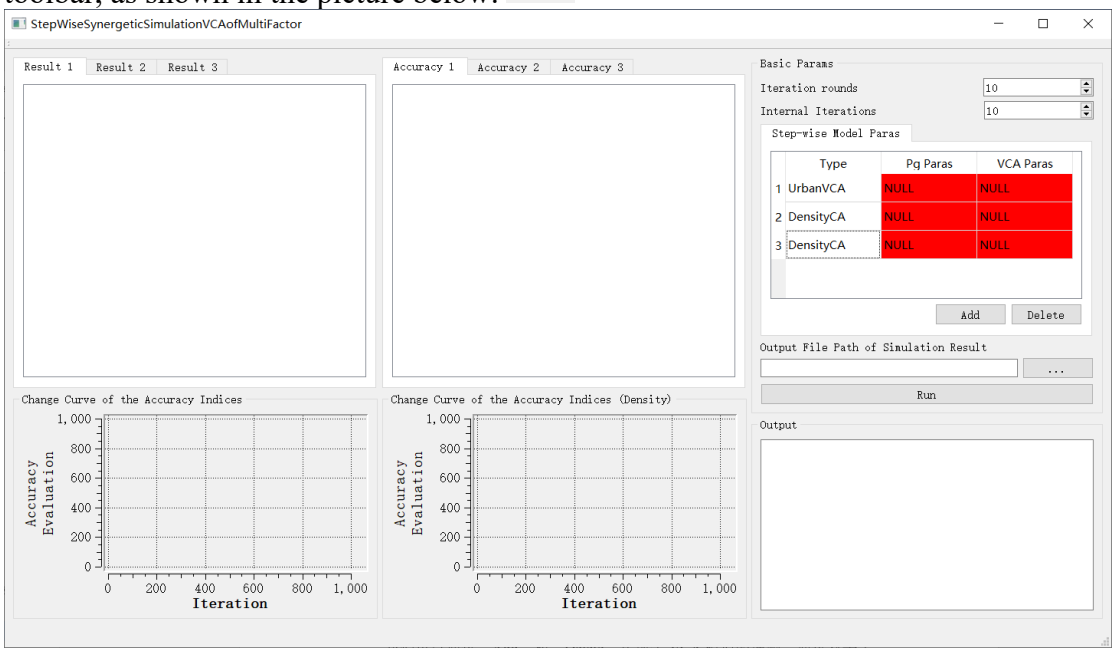


6.2. Urban multi-factor collaborative change simulation

Click on the menu bar "CoVCA" and select "Step-wise Synergetic Simulation VCA (Multi-factor)" from the menu that pops up.

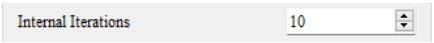


We can also open the urban Multi-factor collaborative Simulation change module by clicking the button of "Step-wise Synergetic Simulation VCA (Multi-factor)" in the toolbar, as shown in the picture below: 

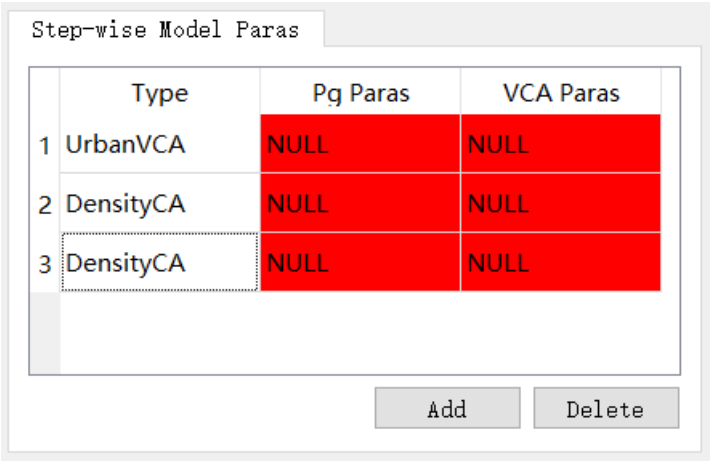


First of all, the number of iterations of each collaboration should be set through the internal iteration input box; 

Set the number of collaboration through the external collaboration number input box setting.



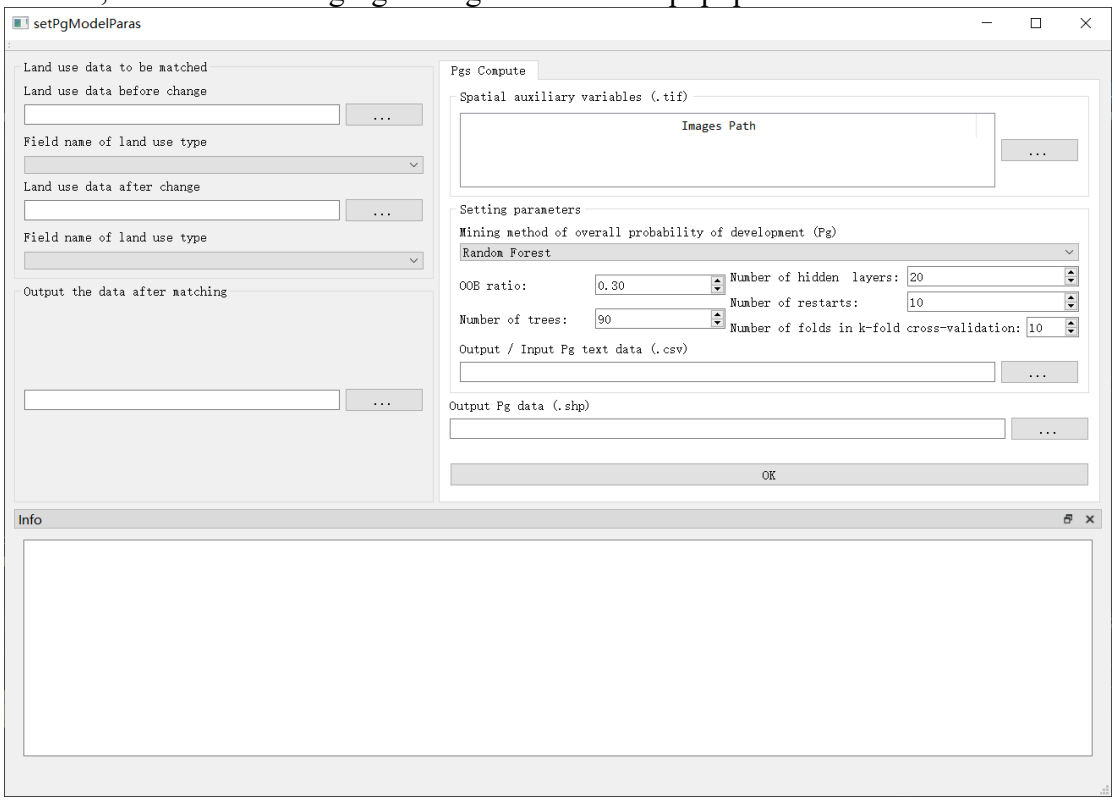
We can Add and Delete sub-VCA models by "add" and "delete". By double-clicking sub-VCAmodel parameter table, model switching, VCA parameter setting, Pg parameter setting and symbolic display can be achieved, as shown in the following figure:



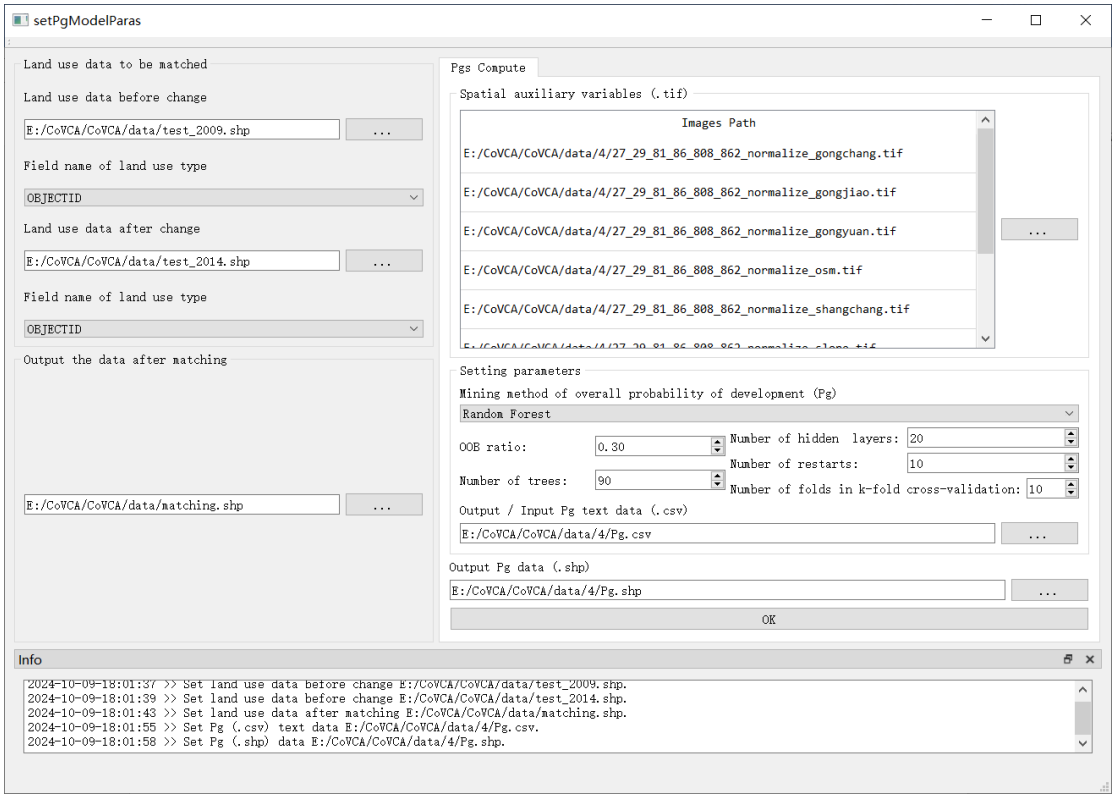
The second part is the parameter setting of each sub-VCA model, which is similar to the previous content. Next, the specific design methods of UrbanVCA and DensityCA will be introduced respectively.

UrbanVCA:

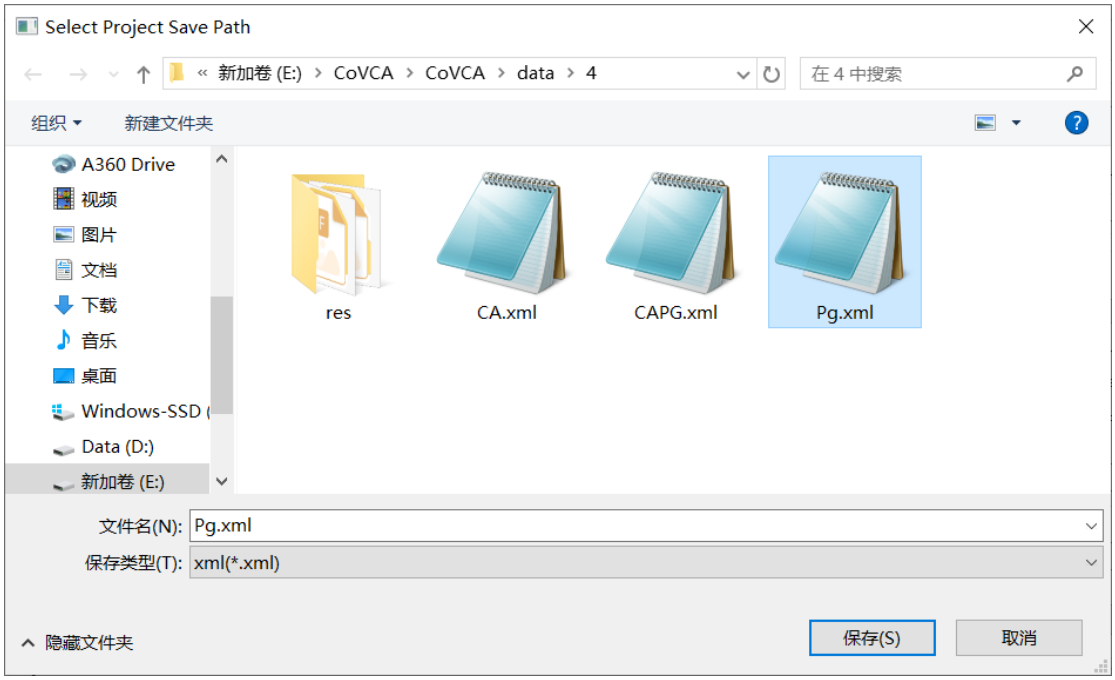
First, double-click the red NULL corresponding to UrbanVCA in the "Pg Paras" column, and the following Pg setting interface will popup.



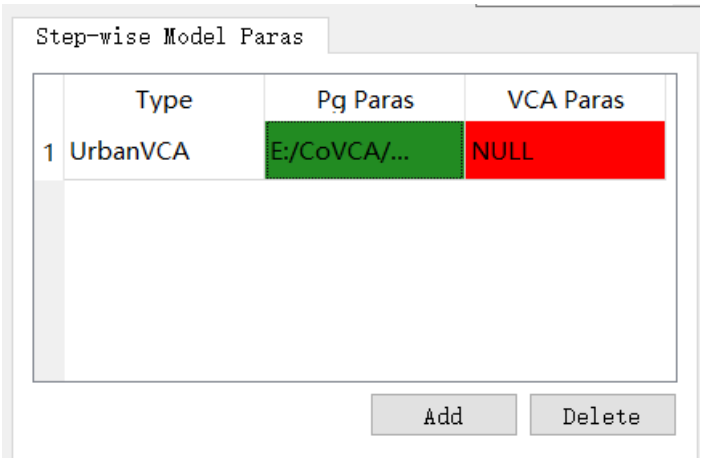
For the specific Settings of this part, see 4.1.2. Fill it in the order from left to right and from top to bottom.



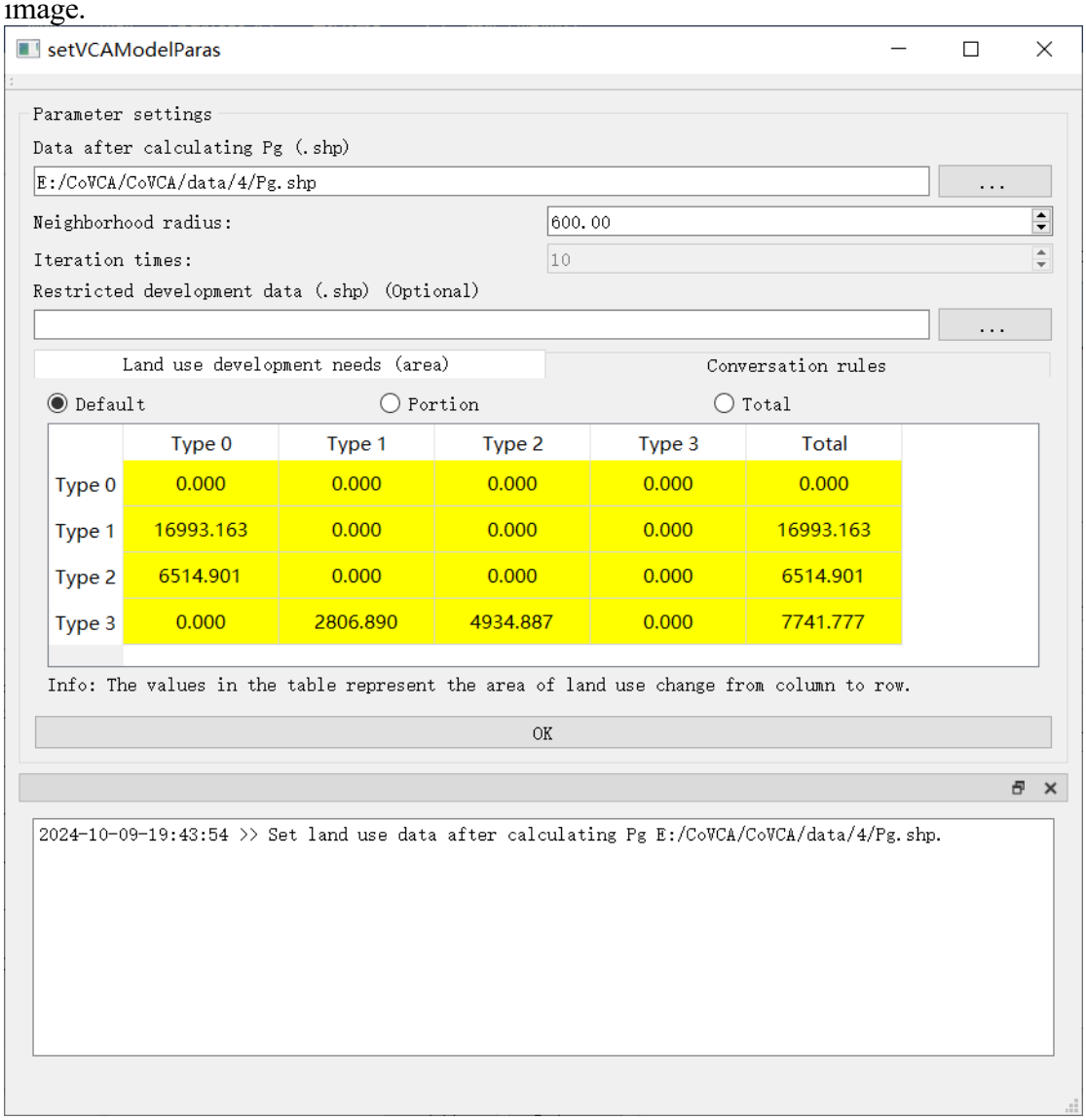
After clicking "OK", a window will popup to set the xml file, the user needs to choose the location of the file to save, click the "Save" button in the lower right corner.



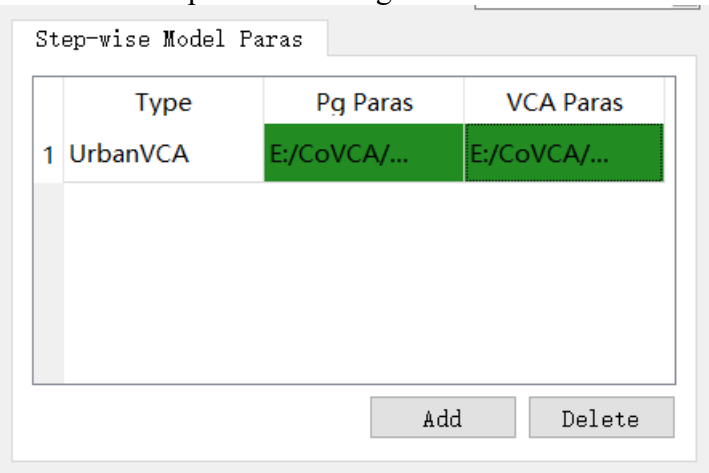
Then you can find that the "Pg Paras" section has been setup, as shown in the picture.



Double click the red "NULL" button under "VCA Paras" again, you can open the interface of setting cellular automata in the UrbanVCA section. As shown in the image.

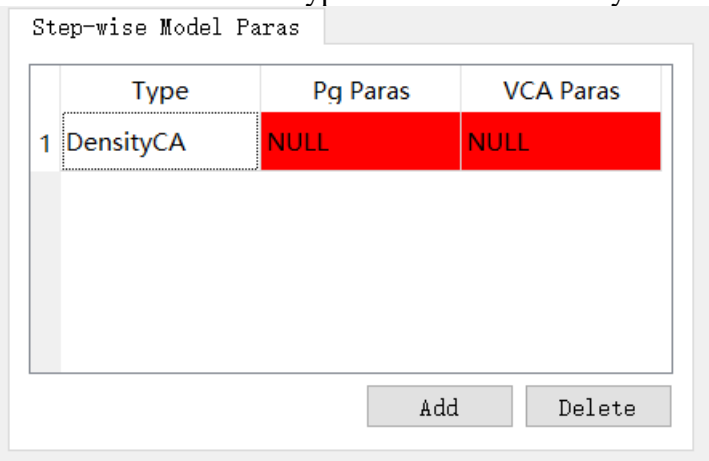


See 4.2.2 for the Settings of this section. The Pg file and the number of iterations have been set. The user only needs to set the radius of the domain and the restrictions below, and click "OK" to complete the setting of this module.

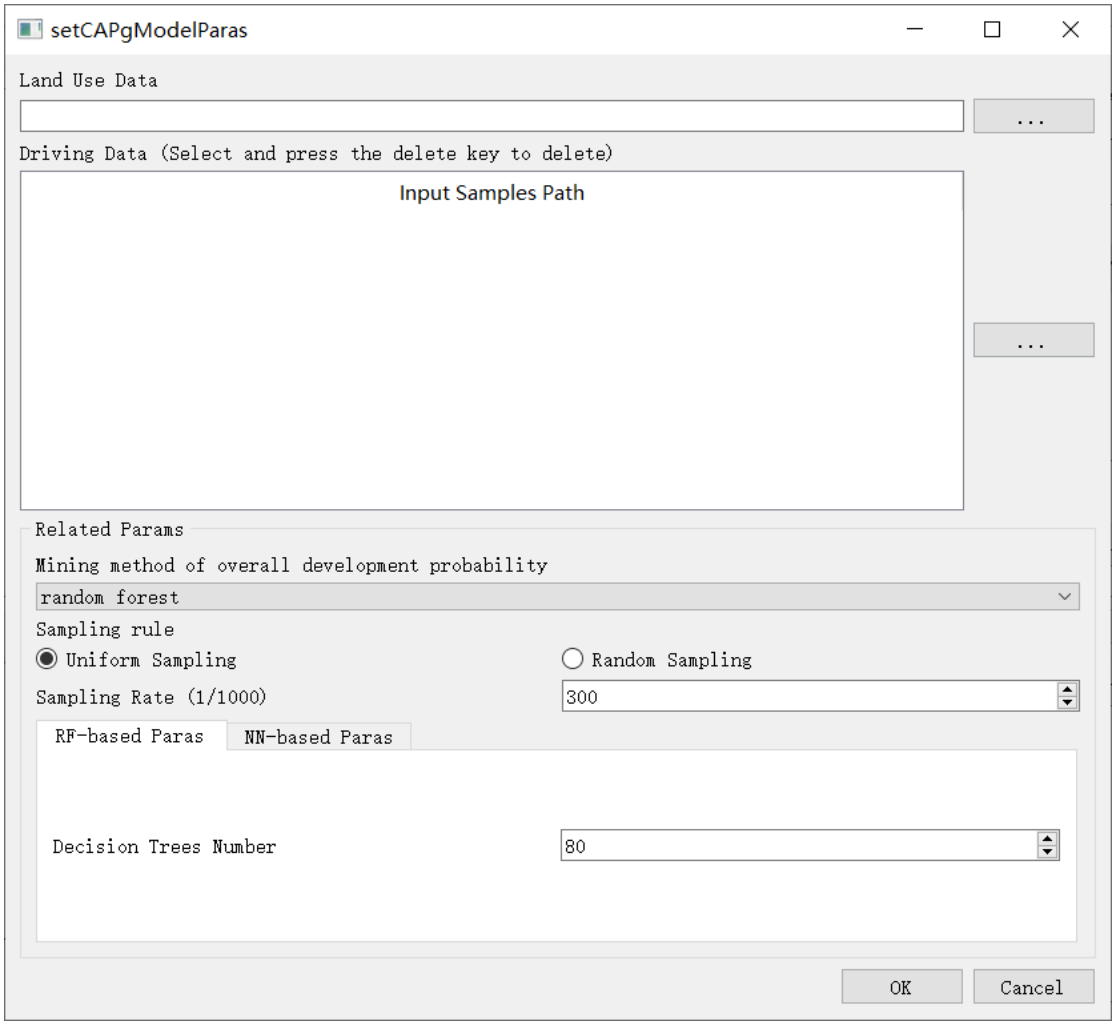


DensityCA:

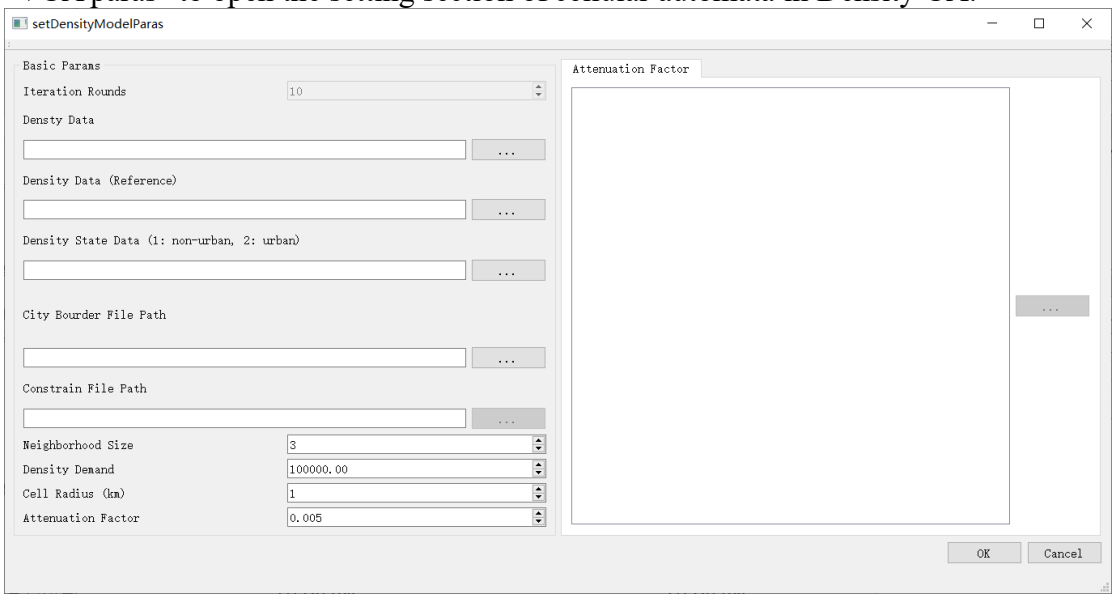
Double click UrbanVCA under "Type" to switch to DensityCA



As above, double click on the red "NULL" under "Pg Paras" to open the setting screen for the overall development probability of density CA.

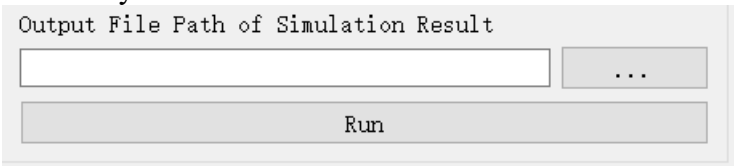


The Settings of this part are detailed in 5.1 and 5.2, which will not be repeated here. After the setting is complete, click "OK" and double click the red button under "VCA paras" to open the setting section of cellular automata in Density CA.



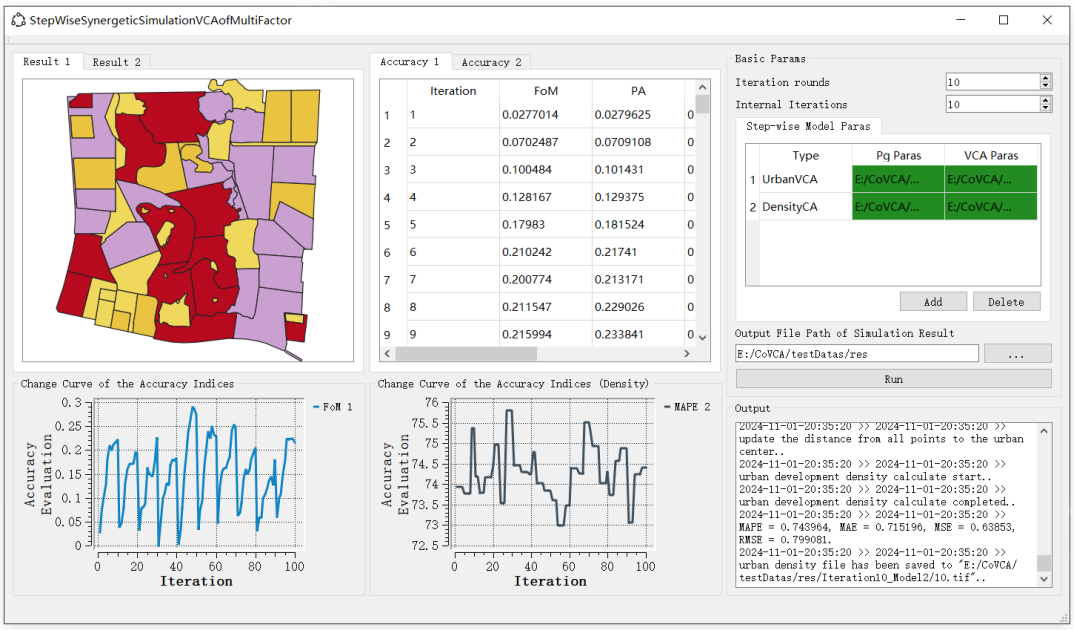
See 5.3 for the Settings of this part, and do not go into details here.

After all Settings are completed, the user needs to select the folder directory of output results and click "..." Button, select the folder directory. Click the "Run" button at the end, and it is ready to run.



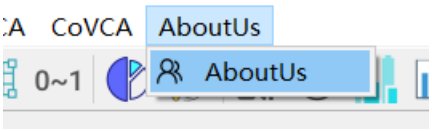
(The data used here is only for simulation, users need to prepare their own data.)

The running result is shown as follows:

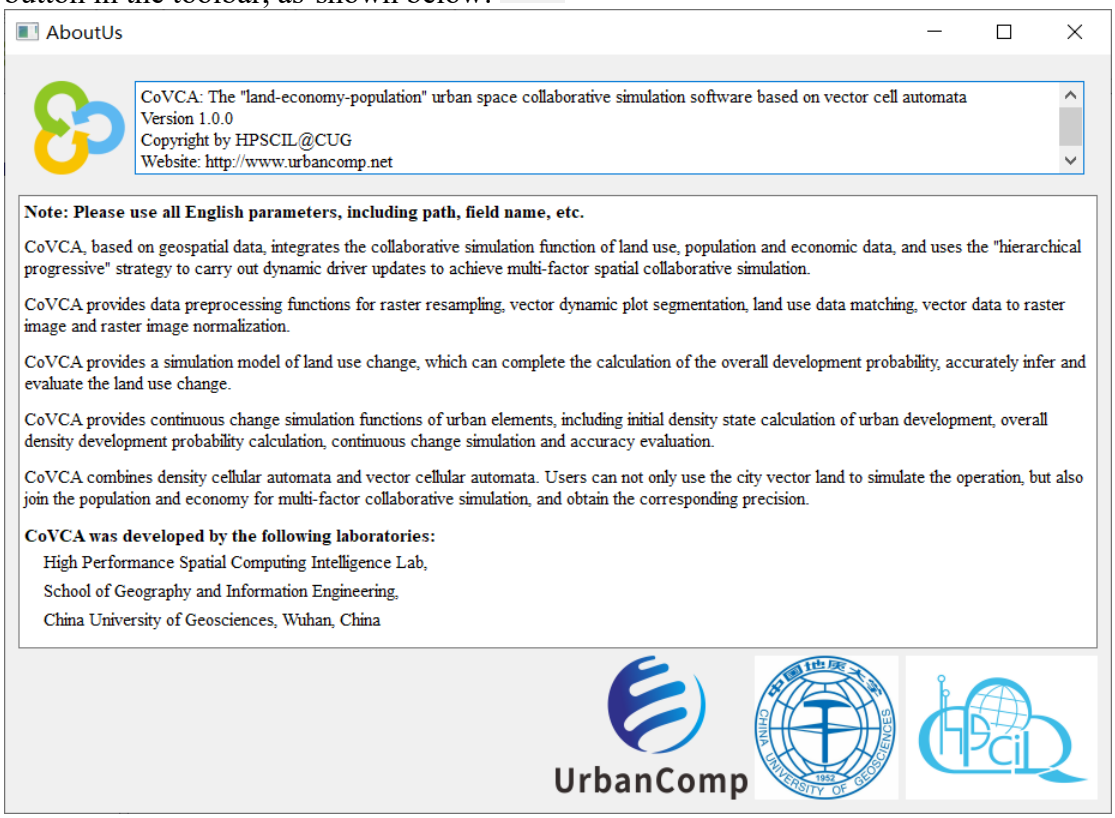


7. About Us

Click AboutUs on the menu bar, and choose AboutUs from the menu that is displayed.



We can also access information About the R&D team by clicking the "About Us" button in the toolbar, as shown below:



8. Copyright Notice

9. Acknowledgments:

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