UrbanVCA：Urban Land-use Change Simulation and Prediction System based on Real Land-parcels

Version 1.0

December, 2020

HPSCIL

DIRECTORY

1. Product Introduction

1.1. UrbanVCA Product

UrbanVCA is a GeoAI-based software for the simulation and prediction of urban development and land-use change process by using vector-based cellular automata. UrbanVCA supports the simulation and prediction of both land-use interchange and urban land-use expansion processes within the city (Yao et al. 2017, Zhai et al. 2020).

1.2. Target Users

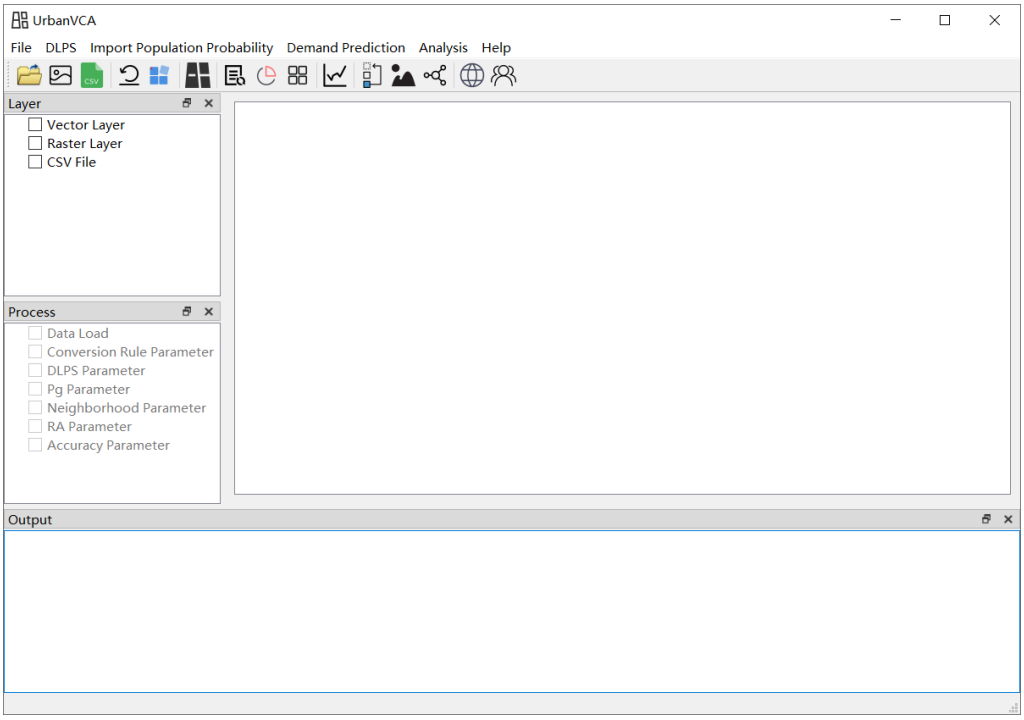
Researchers and urban planners in the field of urban planning.

1.3. Installation

Please ***unzip*** the software package to the full English file path. ***Double-click*** “setup.exe” and follow the prompts to install the software. After the installation is co mplete, you will get the following folder.

Double-click “UrbanVCA.exe” to open the UrbanVCA program.

1.4. User Interface

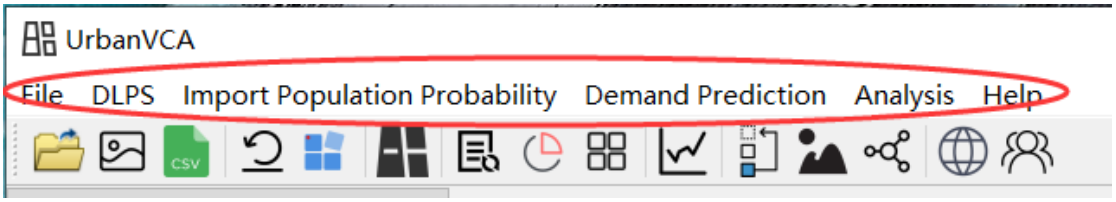


1.5. Software Control Panel Description

1.5.1. Menu Bar

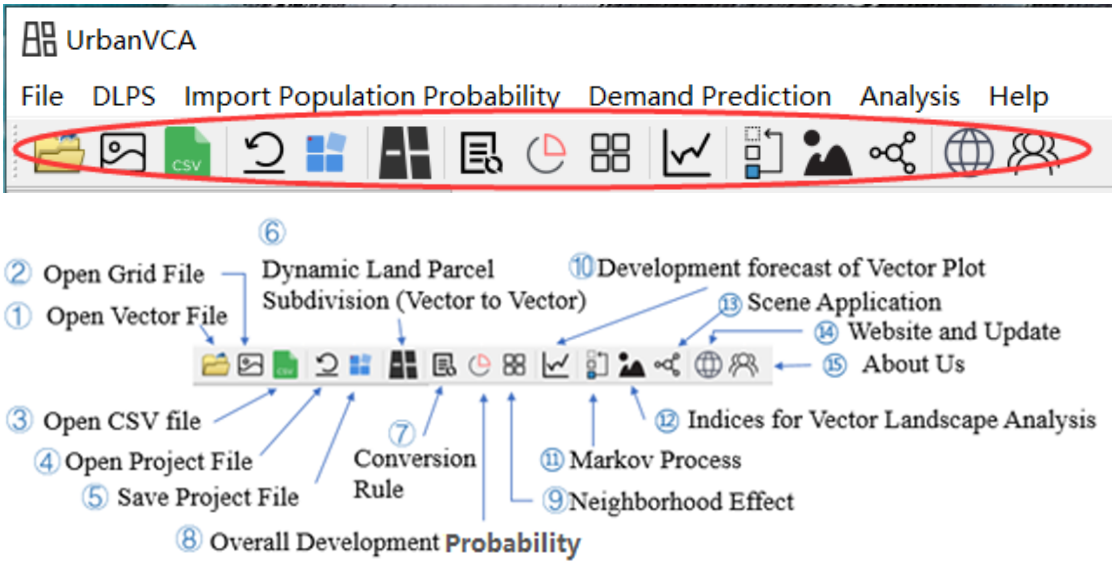
The menu bar of UrbanVCA includes six parts:

"File", "DLPS", "Import Population Probability", "Demand Prediction", "Analysis" and "Help".



1.5.2. Tool Bar

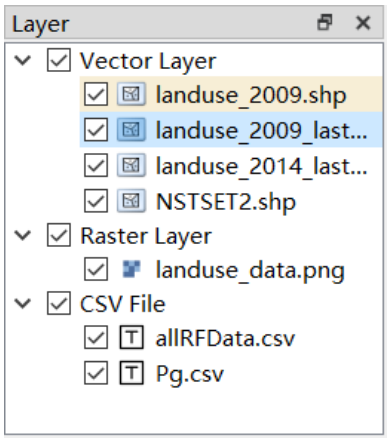
The tool bar of UrbanVCA includes 15 parts:



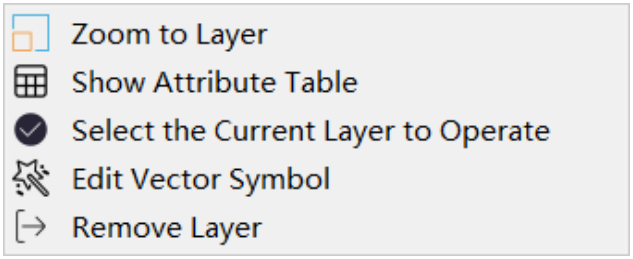
1.5.3. Data Management Panel

A brand-new IO, operational and roaming interface for operating the spatial data (raster and vector data) is designed. Basic functions of GIS such as attribute edit, layer symbolization, zoom in and out operation, etc. are included.

Data imported into UrbanVCA will be displayed and grouped by "vector layer", "raster layer" and " CSV file" layer according to its file format.

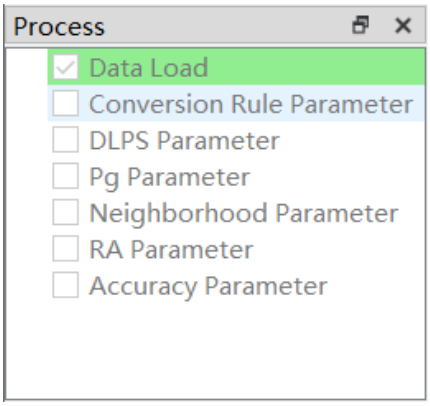


To determine a specific GIS operation, ***Right-Click*** the selected data and a GIS operation widget will pop up on hand. Available GIS operations include “Zoom to Layer”, “Show Attribute Table”, “Select the Current Layer to Operate”, “Edit Vector Symbol”, and “Remove Layer”.



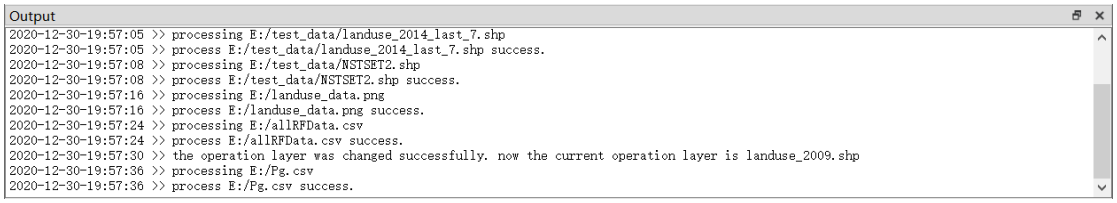
1.5.4. Progress Indicator Panel

The panel marks the current progress in the entire workflow. The completed step will be checked with √ and highlighted by a light-green shadow. The entire workflow of UrbanVCA includes “Data Load”, “Conversion Rule Parameter”, “DLPS parameter”, “Pg Parameter”, “Neighborhood Parameter”, “RA Parameter”, and “Accuracy Parameter”.



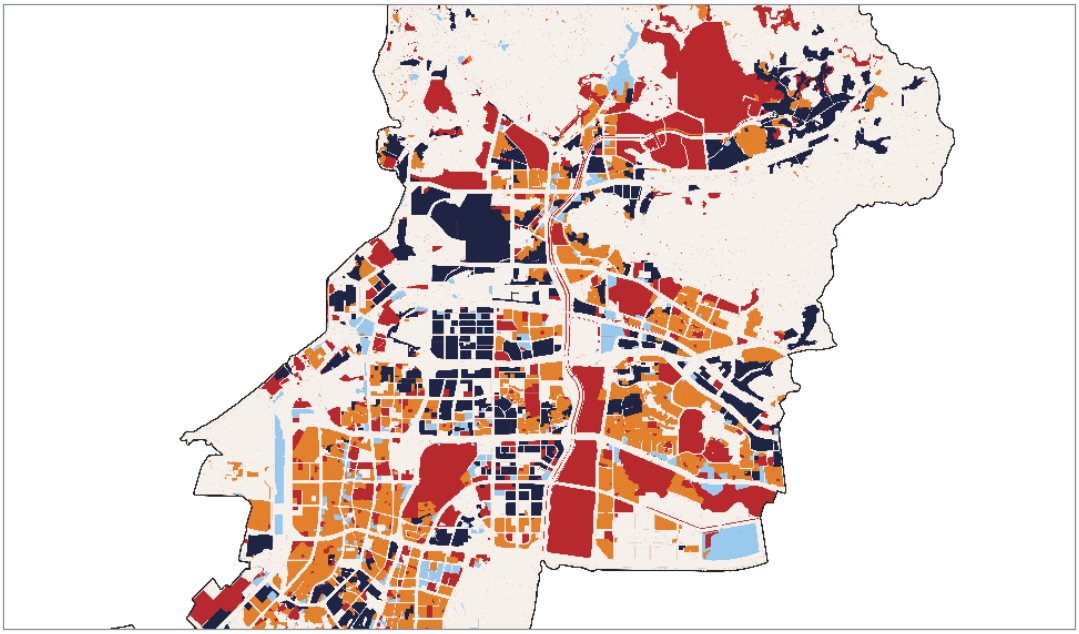
1.5.5. Log Output Panel

The panel outputs and displays the log when the model is executed.



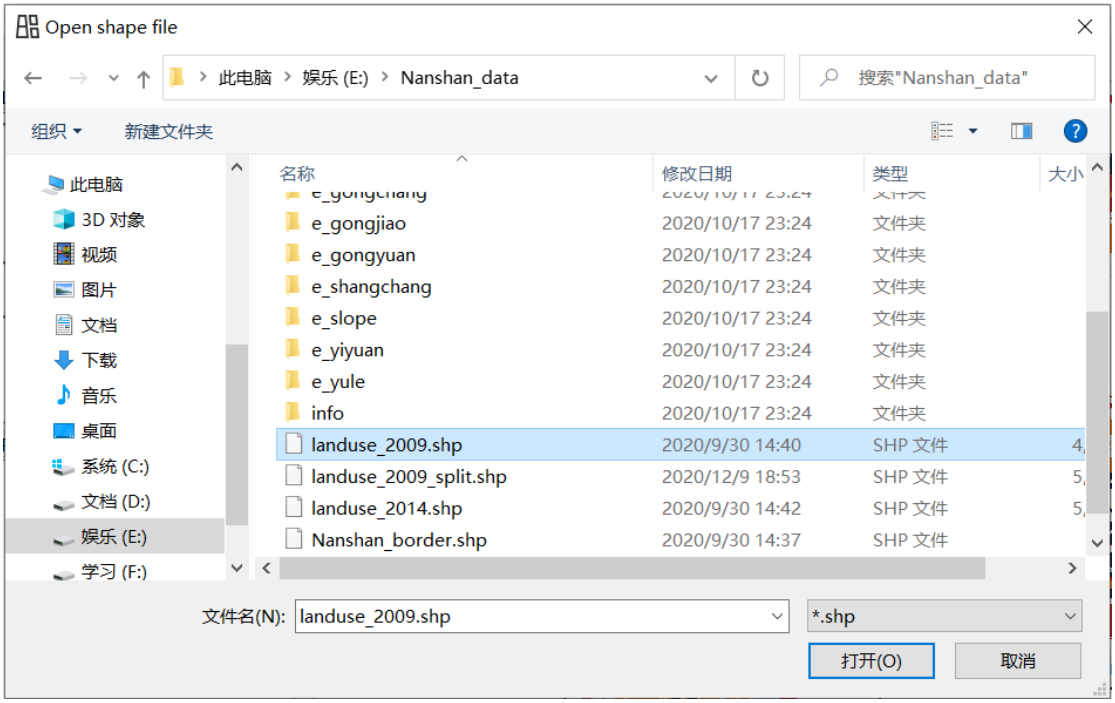
1.5.6. Data Visualization Panel

The panel supports roaming and display for vector and raster files imported into the system.



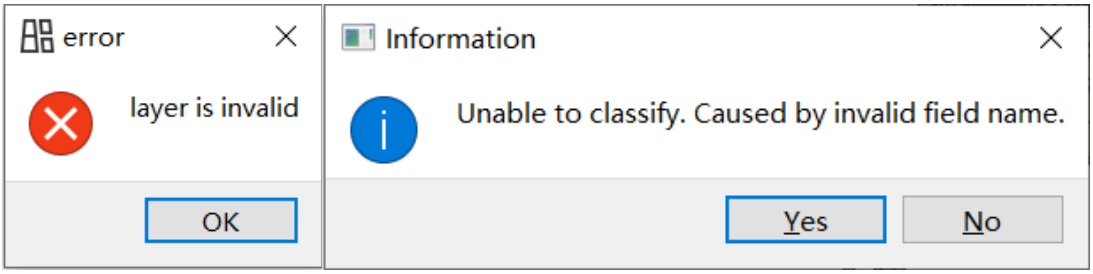
1.5.7. Directory Selection Dialog Box

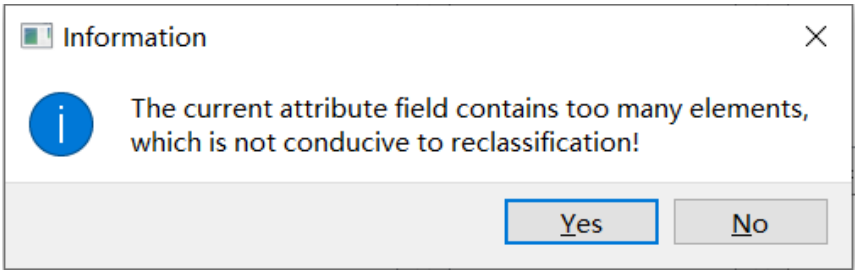
This module provides a UI for directory and file selection.



1.5.8. Exception Prompt Dialog Box

This dialog box prompts the error and provides the necessary information to debug.



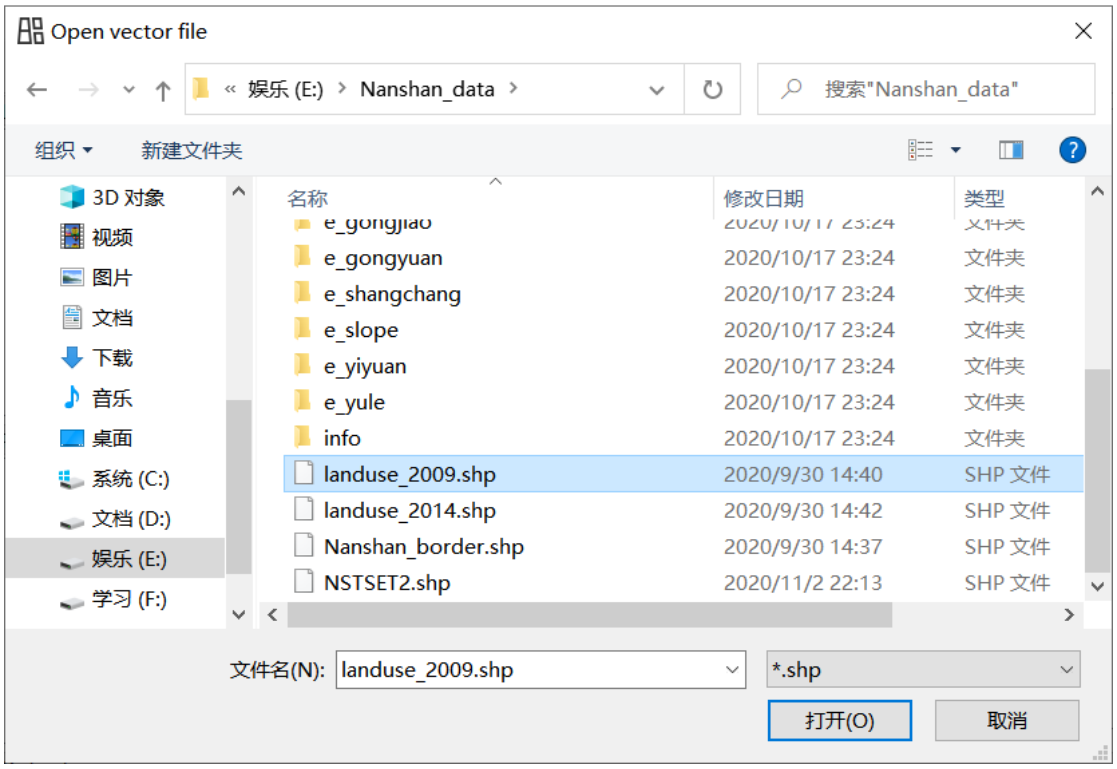


2. Data Display Function

2.1. Basic Function

2.1.1. Import Files

Click the “Open Vector File” button  in the toolbar, it will automatically jump to the Directory Selection Dialog Box for vector file selection.

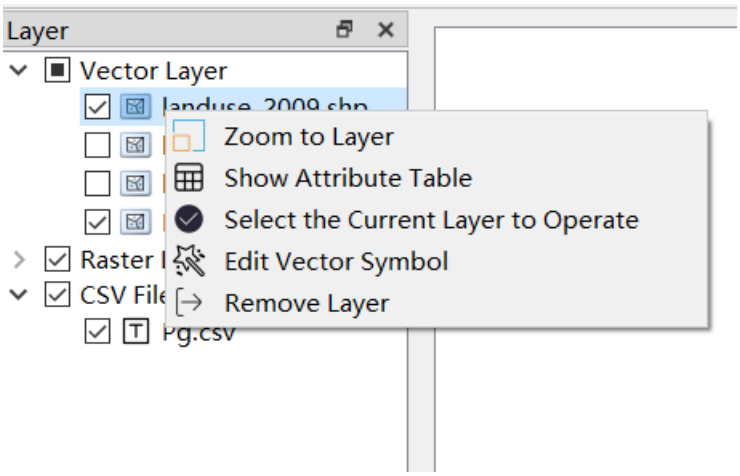


Click the “Open Raster File” button  in the toolbar, it will automatically jump to the Directory Selection Dialog Box for raster file selection.

Click the “Open CSV File” button  in the toolbar, it will automatically jump to the Directory Selection Dialog Box for CSV file selection.

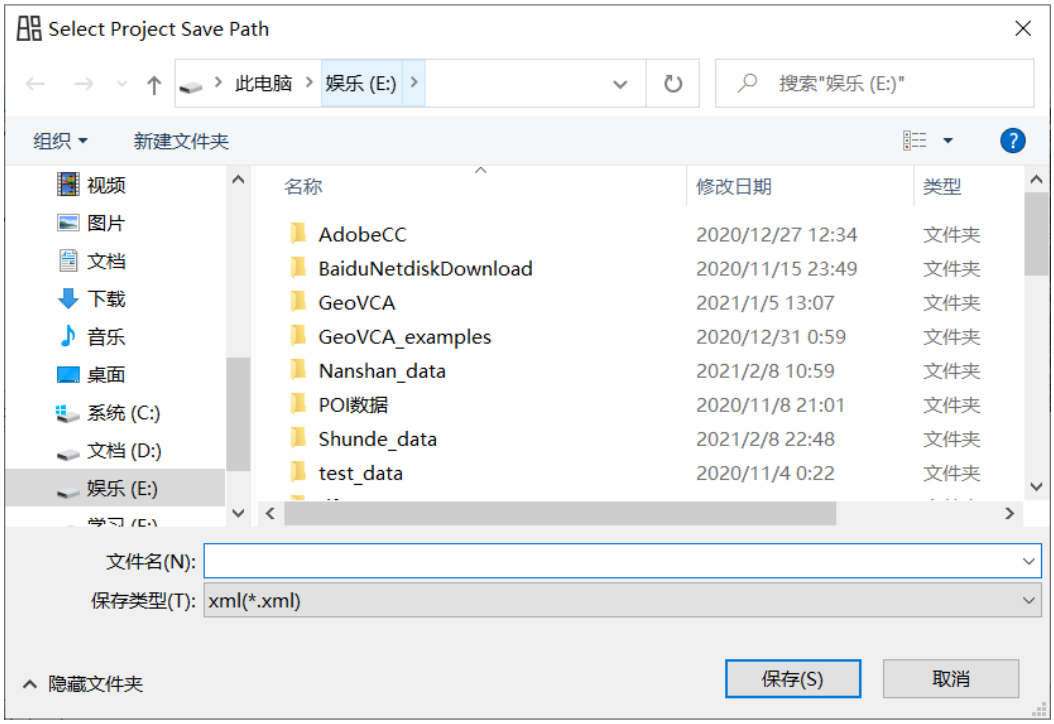
2.1.2. Basic GIS Operations

Right-click the selected data layer, it will pop up a GIS operation widget, as shown in the figure below:



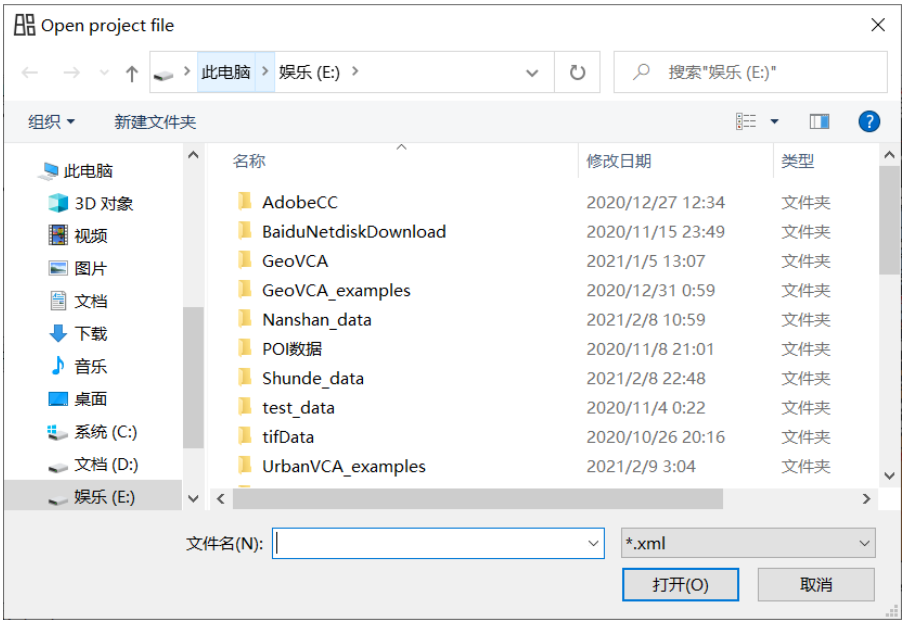
2.1.3. Save Project File (.xml)

First-Click the "File" in the menu bar and ***choose*** the "Save Project File" option, it will automatically jump to the Directory Selection Dialog Box to save the currently operating project in user's specified directory path. ***Click*** the toolbar's  button would work in the same way.



2.1.4. Open Project File (.xml)

First-Click the “File” in the menu bar and ***choose*** the “Open Project File”, it will automatically jump to the Directory Selection Dialog Box for opening an existing project. ***Click*** the toolbar’s  button would work in the same way.



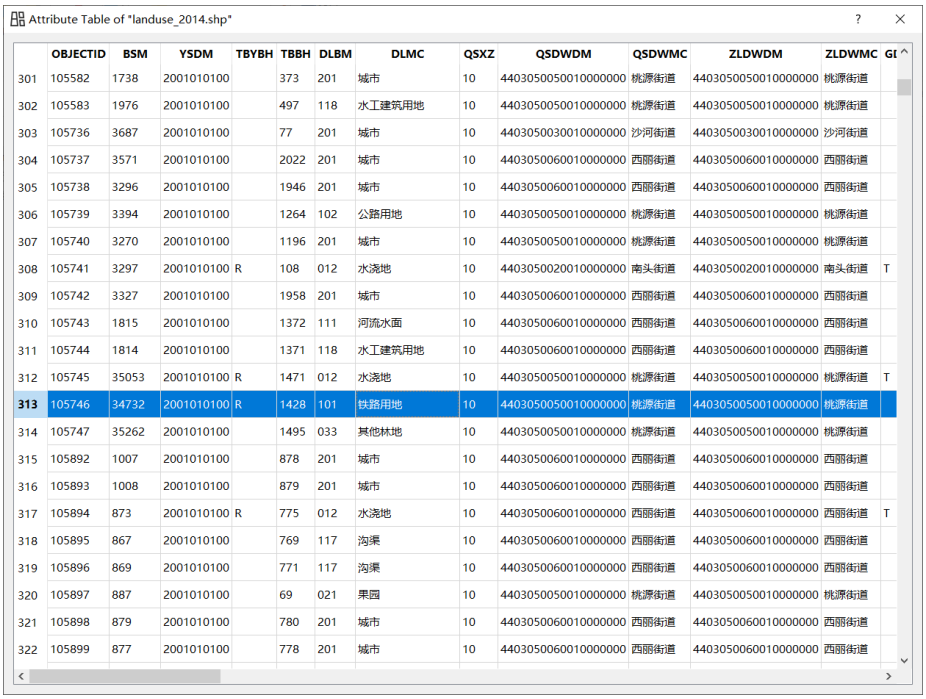
2.1.5. Zoom to Layer

Click the “Zoom to Layer” button to display the data layer in a full view for either a vector or raster data layer.

2.1.6. Show Attribute Table

Click the “Open Attribute Table” button to show the attribute table of a selected CSV file.

Attribute ***edit*** is allowed for each entry, as shown in the figure below:


Attribute Table of "landuse_2014.shp"

	OBJECTID	BSM	YSDM	TBYBH	TBBH	DLBM	DLMC	QSXZ	QSDWDM	QSDWMC	ZLDWDM	ZLDWMC	GI
301	105582	1738	2001010100		373	201	城市	10	440305005001000000	桃源街道	440305005001000000	桃源街道	
302	105583	1976	2001010100		497	118	水工建筑用地	10	440305005001000000	桃源街道	440305005001000000	桃源街道	
303	105736	3687	2001010100		77	201	城市	10	440305003001000000	沙河街道	440305003001000000	沙河街道	
304	105737	3571	2001010100		2022	201	城市	10	440305006001000000	西丽街道	440305006001000000	西丽街道	
305	105738	3296	2001010100		1946	201	城市	10	440305006001000000	西丽街道	440305006001000000	西丽街道	
306	105739	3394	2001010100		1264	102	公路用地	10	440305005001000000	桃源街道	440305005001000000	桃源街道	
307	105740	3270	2001010100		1196	201	城市	10	440305005001000000	桃源街道	440305005001000000	桃源街道	
308	105741	3297	2001010100	R	108	012	水浇地	10	440305002001000000	南头街道	440305002001000000	南头街道	T
309	105742	3327	2001010100		1958	201	城市	10	440305006001000000	西丽街道	440305006001000000	西丽街道	
310	105743	1815	2001010100		1372	111	河流水面	10	440305006001000000	西丽街道	440305006001000000	西丽街道	
311	105744	1814	2001010100		1371	118	水工建筑用地	10	440305006001000000	西丽街道	440305006001000000	西丽街道	
312	105745	35053	2001010100	R	1471	012	水浇地	10	440305005001000000	桃源街道	440305005001000000	桃源街道	T
313	105746	34732	2001010100	R	1428	101	铁路用地	10	440305005001000000	桃源街道	440305005001000000	桃源街道	
314	105747	35262	2001010100		1495	033	其他林地	10	440305005001000000	桃源街道	440305005001000000	桃源街道	
315	105892	1007	2001010100		878	201	城市	10	440305006001000000	西丽街道	440305006001000000	西丽街道	
316	105893	1008	2001010100		879	201	城市	10	440305006001000000	西丽街道	440305006001000000	西丽街道	
317	105894	873	2001010100	R	775	012	水浇地	10	440305006001000000	西丽街道	440305006001000000	西丽街道	T
318	105895	867	2001010100		769	117	沟渠	10	440305006001000000	西丽街道	440305006001000000	西丽街道	
319	105896	869	2001010100		771	117	沟渠	10	440305006001000000	西丽街道	440305006001000000	西丽街道	
320	105897	887	2001010100		69	021	果园	10	440305005001000000	桃源街道	440305005001000000	桃源街道	
321	105898	879	2001010100		780	201	城市	10	440305006001000000	西丽街道	440305006001000000	西丽街道	
322	105899	877	2001010100		778	201	城市	10	440305006001000000	西丽街道	440305006001000000	西丽街道	

2.1.7. Select the Current Layer to Operate

Click the “Select the Current Layer to Operate” button, it will enable the selected layer for the vector symbolization function and the DLPS setting function.

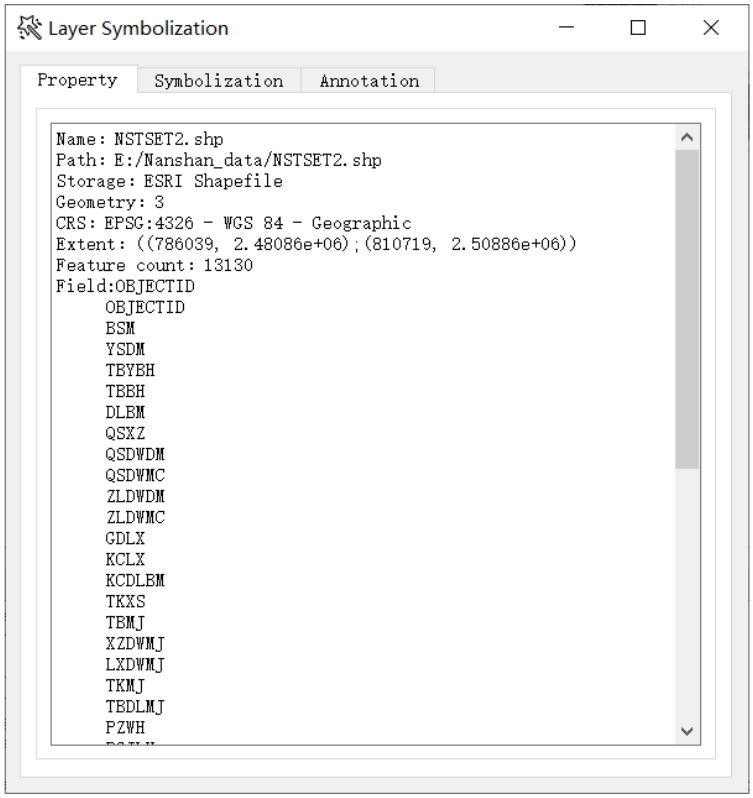
2.1.8. Edit Vector Symbol

Click the “Edit Vector Symbol” button to enable the file property option, symbolization option and Annotation option.

Note: this button will not be valid for non-vector layers.

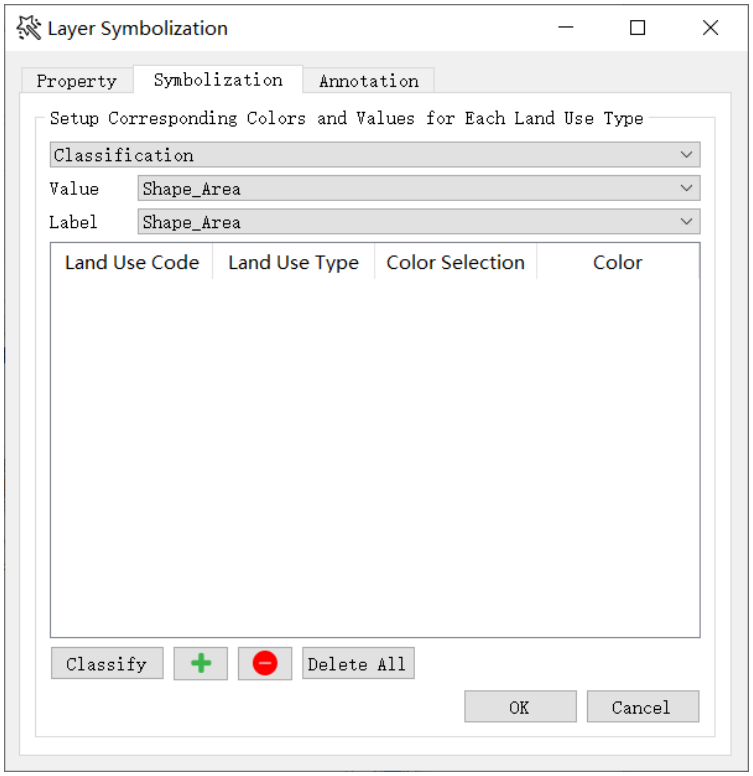
2.1.8.1. Property

Select “property” to view the property information for the current open vector file:



2.1.8.2. Symbolization

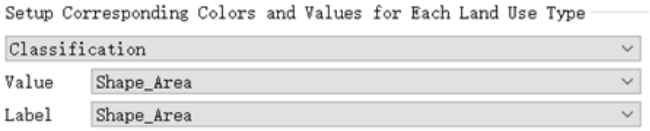
Select “Symbolization” to carry out symbolization operation. Users can ***set*** a classified display for different attribute fields:



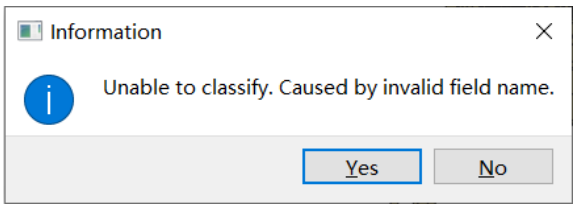
For the “classification” drop-down box, users can ***select*** a specific Symbolization Method for the currently operating data layer.

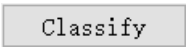
For the “Value” drop-down box, users can ***select*** a specific field name that needs classification.

For the “Label” drop-down box, users can ***select*** a specific field name that labels the category.



Note: if a non-numeric field is selected in the “Value” drop-down box, Exception Prompt Dialog Box will pop up and ask the user to ***re-select*** a valid field:



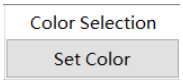
Click the “Classify”  button to conduct Vector Symbolization and initialize classification automatically. A sample of classification result is shown as follows:

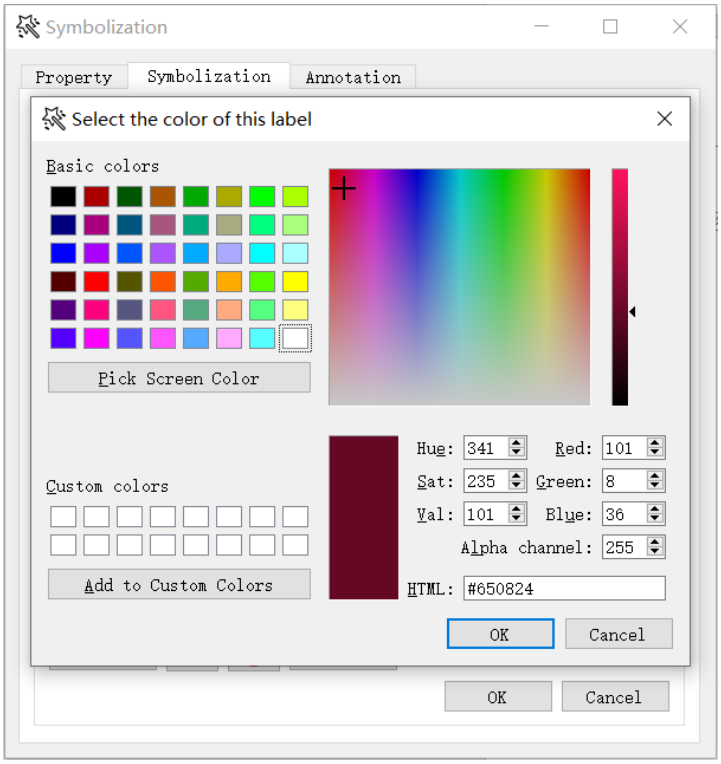
Click the "add a class"  button, it will automatically add a new category, as shown below:

Click the "delete a class"  button, it will delete the current selected category, as shown below:

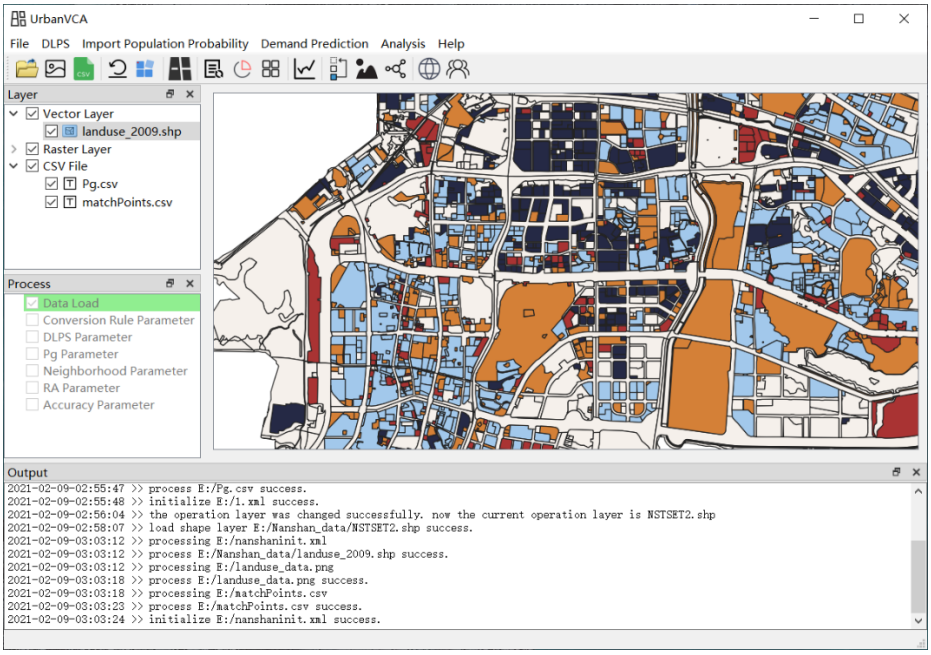
Click the "delete all classes"  button, it will automatically clear the current contents.

Users can ***adjust*** the filed in either "Value" or "Label" drop-down box. ***Click*** the "Classify"  button to ***redo*** the classification initialization process.

Click the "Set Color"  button, it will automatically jump to a color selection widget to select the color of this label, as shown below:

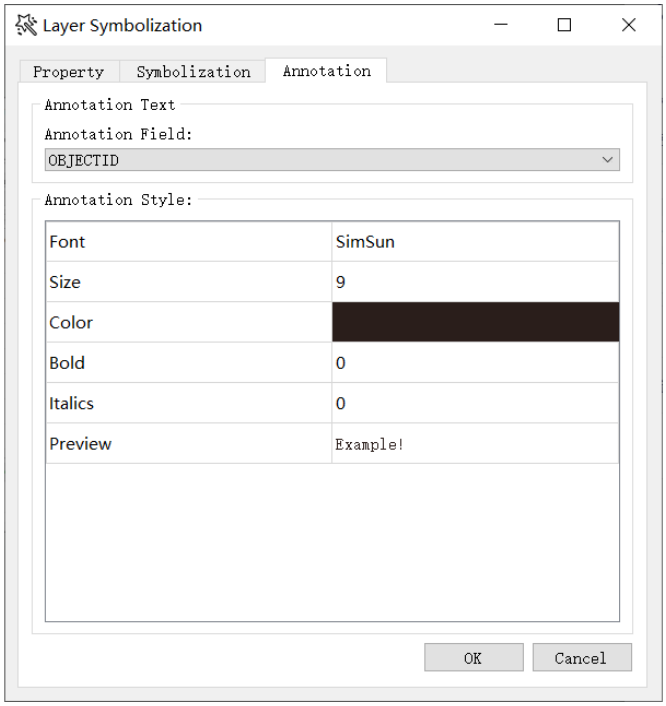


Click the "OK"  button to exit the "Layer Symbolization" interface after all parameter settings are done. It will refresh the display interface and change the layer style based on user's layer symbolization settings. A sample rendering result is shown as below:



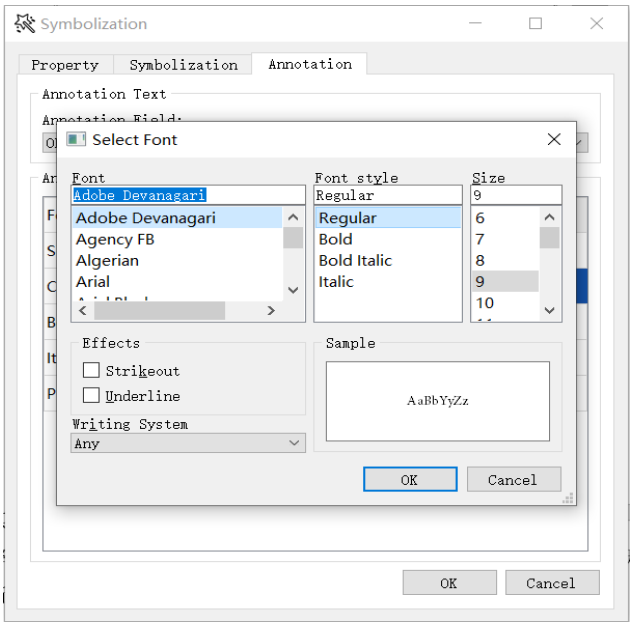
2.1.8.3. Annotation

Select "Annotation" to conduct annotation configuration:

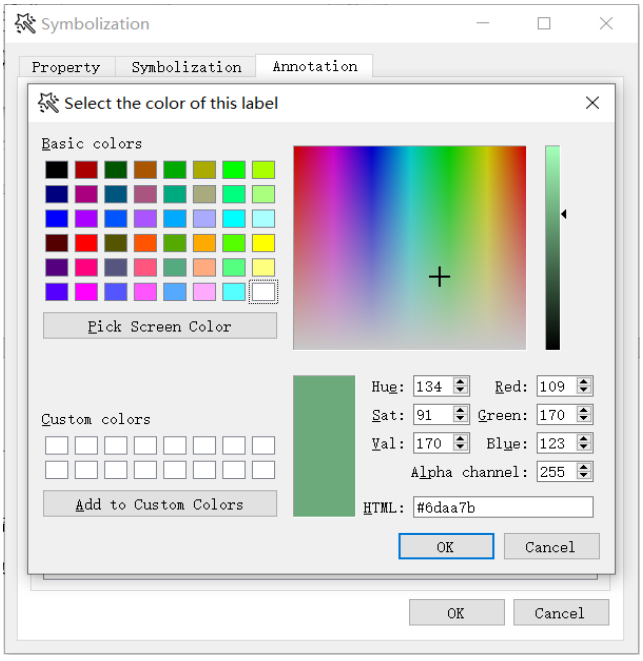


For the “Annotation Field” drop-down box, users can ***select*** a specific attribute which needs annotation setting.

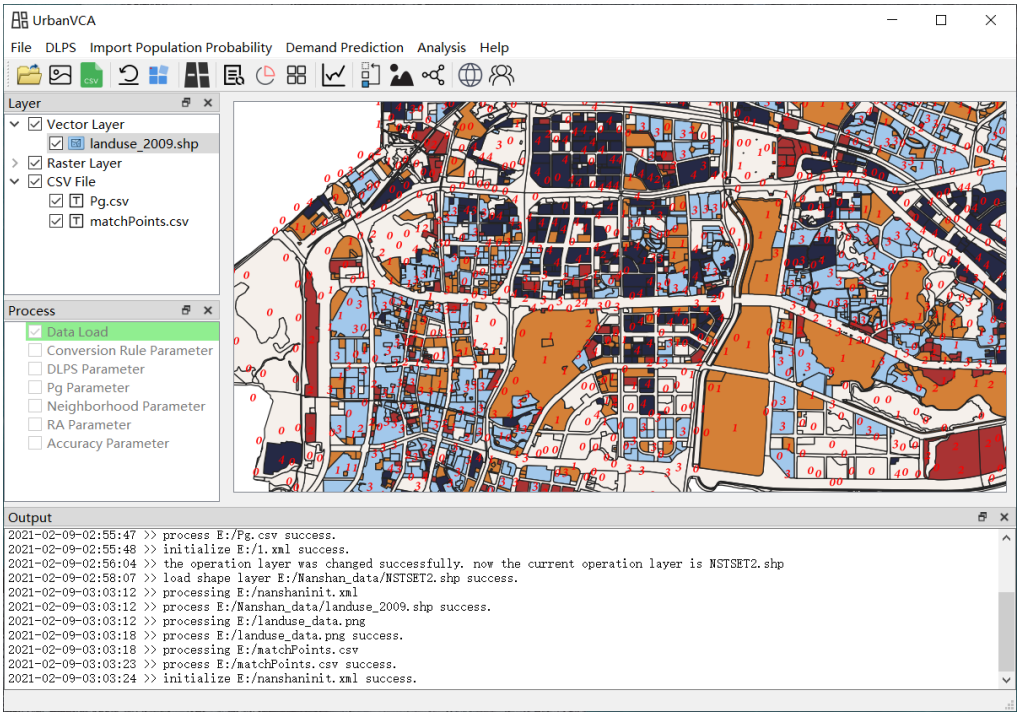
Users can ***configure*** annotation styles including Font, Size, Color, Bold, Italics and Preview as provided by UrbanVCA:



Likewise, a color selection widget is provided for selecting the annotation color, as shown below:：



Click the “OK”  button to exit the “Layer Symbolization” interface after all parameter settings are done. It will refresh the display interface and change the layer style based on user’s layer symbolization settings. A sample rendering result is shown as below:



2.1.9. Remove Layer

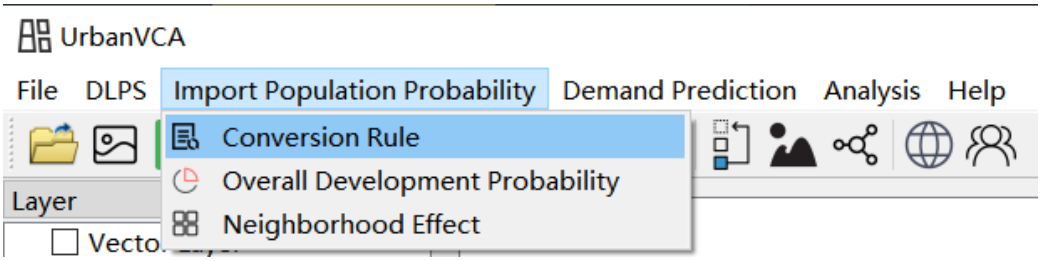
Click the “Remove Layer” button in the GIS operation widget, the selected layer will be removed immediately from the current project.

3. Urban Land-use Change Simulation Function

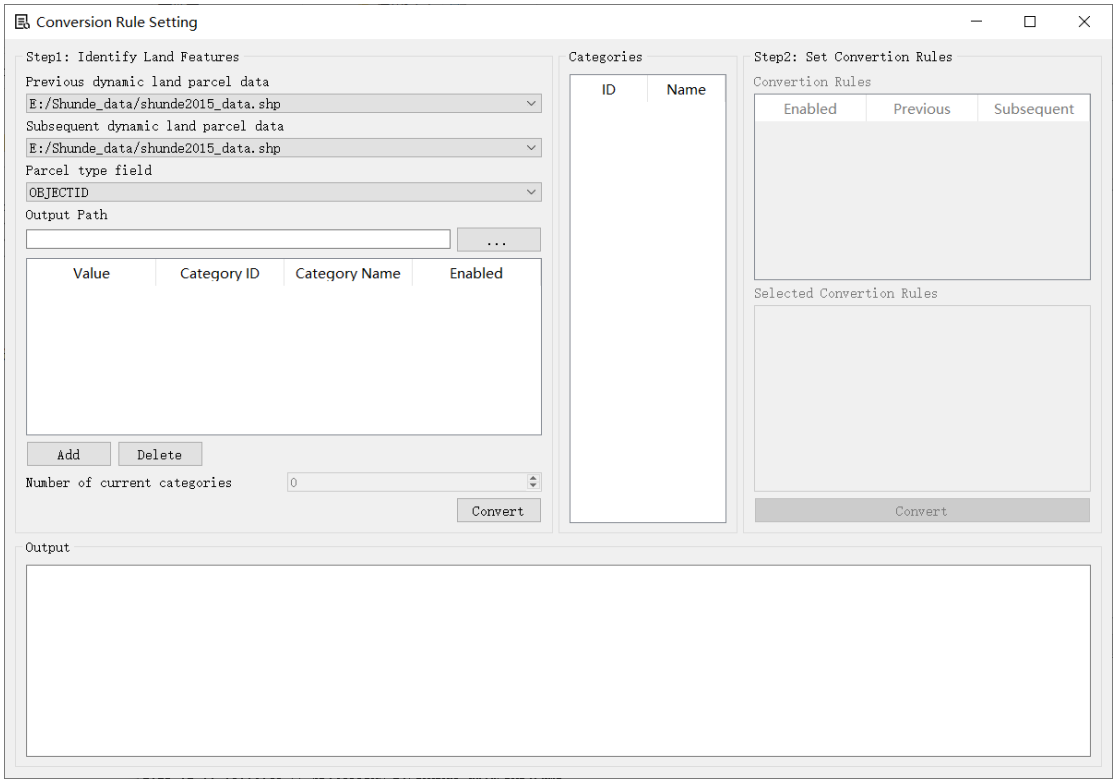
3.1. Conversion Rule

3.1.1. Features

First-Click the “Import Population Probability” in the menu bar and ***choose*** the “Conversion Rule”, it will automatically jump to the Conversion Rule Setting Module.



Click the toolbar’s  button would work in the same way：

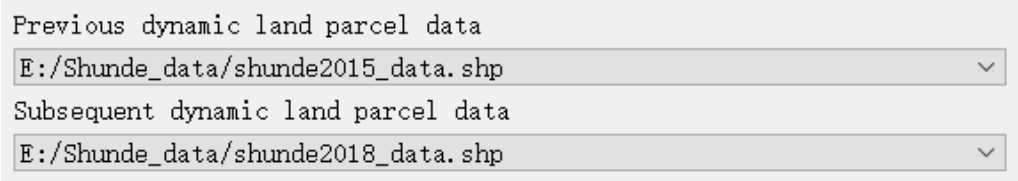


Note: this module will not be valid until vector files are imported.

3.1.2. Field Reclassification

This module is used to unify the category format by category reclassification.

First we need to choose the vector files for processing. Specifically, “Previous dynamic land-parcel data” corresponds to the vector file before conversion, while “Subsequent dynamic land-parcel data” corresponds to the conversed vector file. Vector file selection drop-down box as shown as below:

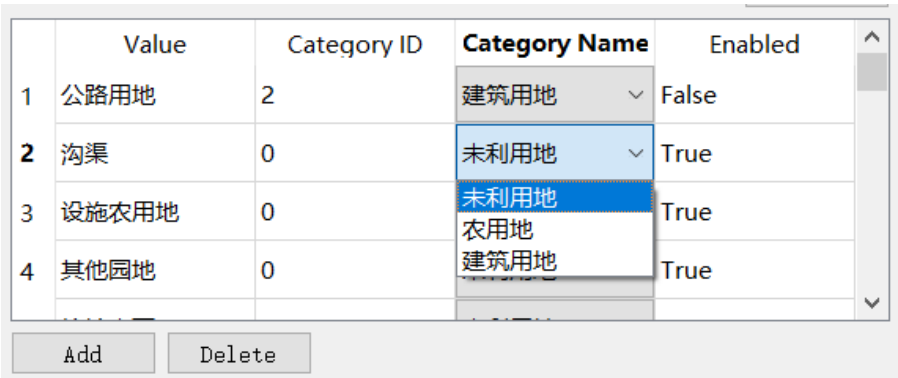


After successfully importing both “previous” and “subsequent” vector files, this module will automatically identify their common fields. Users can use the "Parcel type field" drop-down box to ***select*** a specific field that needs field reclassification operation. The “Parcel type field” drop-down box is shown as below:

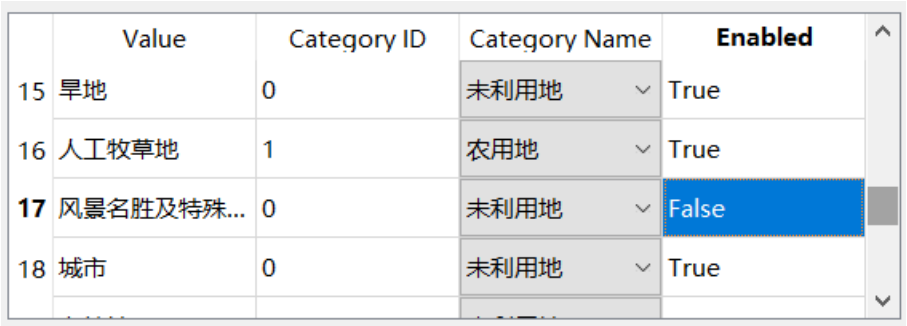
After the “Parcel type field” box is set up, this module will automatically analyze the attribute values of the two selected vector files and display them in a table panel.

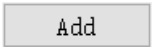
The first column “Value” shows unique attribute values of the selected field, the second column “Category ID” shows the category number that aligns with the first column, the third column “Category Name” provides a drop-down box to determine its reclassified category, and the fourth column “Enable” signs whether subdivision is enabled for the selected category.

Users can ***reclassify*** the category to a new one by selections in the drop-down box of “Category Name” column, as shown in the figure below:

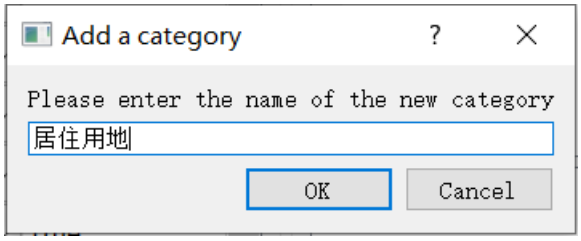


Double-click the True/False cell in the "Enabled" column to change its subdivision status (either True of False), as shown in the figure below:



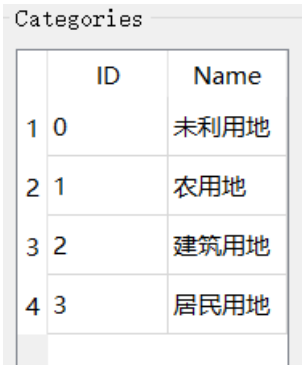
Click the "Add a category" 

button, a new custom category will be added through the dialog box:

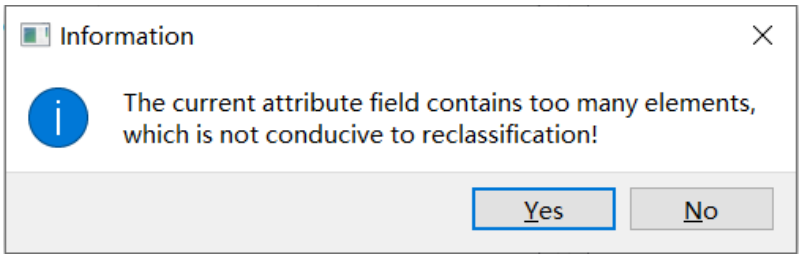


Enter a desired category (for example, water body) in the dialog box and ***click*** the "OK" 

button, a new category can be added. The system will automatically display the categories that have been added successfully, as shown in the figure below:



Noted that if too many categories are added, the system will raise prompts as follow：



Click the "Delete" button Delete to delete the selected category entry. When reclassification of all categories is set up properly, users should ***click*** the "Convert" Convert button to carry out the I/O operation that writes a new vector data with new category names, new category IDs, and a new attribute field that signs whether this category supports subdivision.

3.1.3. Customize the Conversion Rules

After the field reclassification is completed, users should manually ***set*** the conversion rules of the land-parcel (for example, restricting some non-convertible land-parcel categories from land-use change). The conversion rules can be set through the “Conversion Rule” table, as shown below:

Convertion Rules

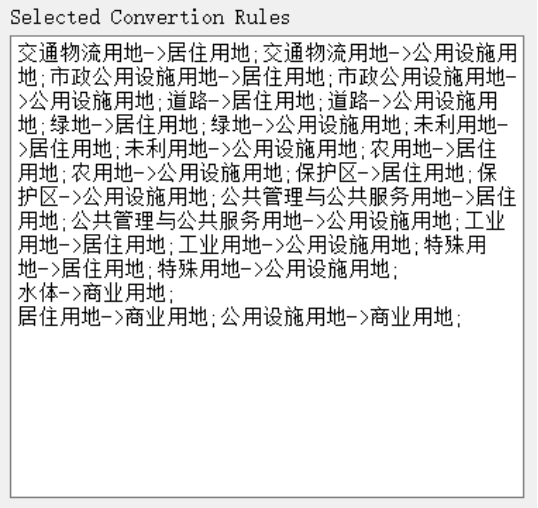
	Enabled	Previous	Subsequent
9	False	水体	未利用地
10	False	水体	商业用地
11	False	水体	水体
12	False	水体	居住用地
13	False	居住用地	未利用地
14	True	居住用地	商业用地
15	False	居住用地	水体
16	False	居住用地	居住用地

The first column “Enabled” indicates whether the specific conversion rule is allowed. By ***double-clicking*** the first cell of each entry, users can change the True/False status and thus specify the availability of each land-use conversion rule.

Take the 14th entry as example, the conversion from 居住用地 (residential land)

of the “Previous” column to 商业用地(commercial land) of the “Subsequent” column is allowed as its “Enabled” column is specified as True.

The system will display the selected conversion rules (by its original field name) in the following box, which is shown as below:



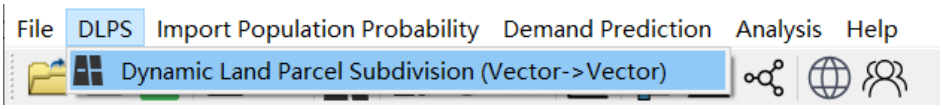
By ***clicking*** the “Convert” 

button, the custom conversion rules will be confirmed and a corresponding text file would be generated and imported. UrbanVCA determines the land conversion rules according to this generated text file.

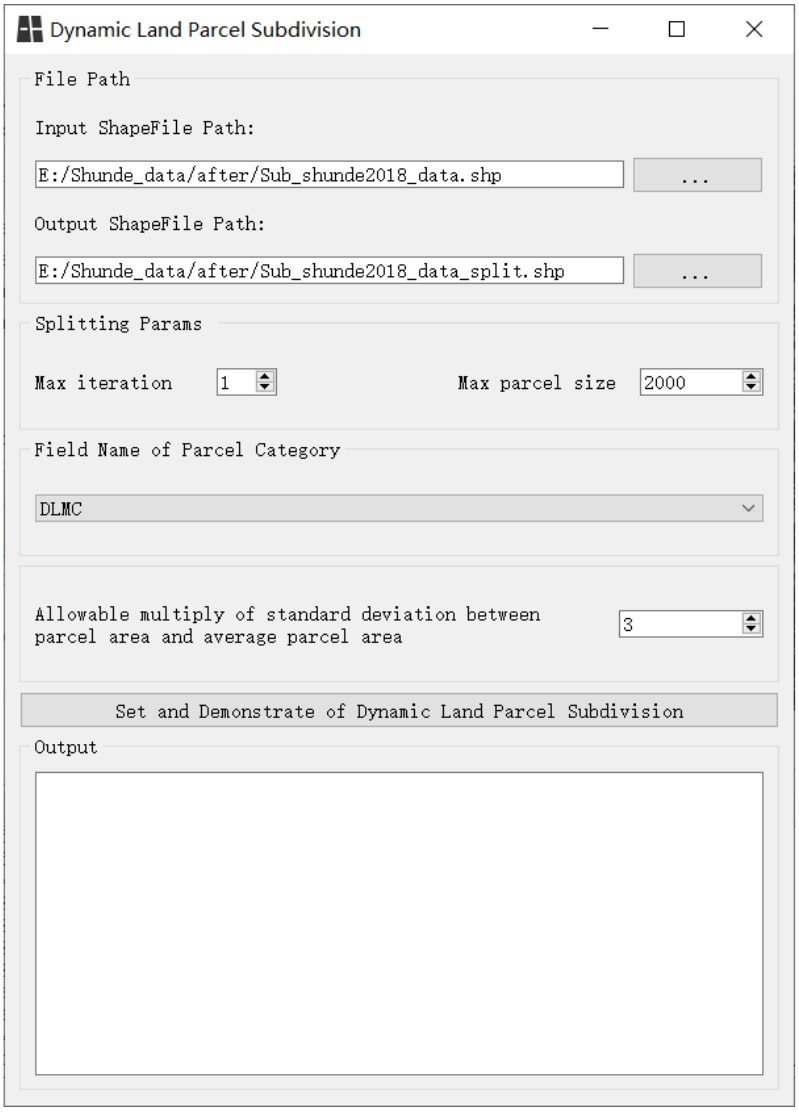
3.2. Vector Land-parcel Subdivision Parameter Setting

3.2.1. Features

First-Click the “DLPS” in the menu bar and ***choose*** the “Dynamic Land-parcel Subdivision (Vector -> Vector)”, it will automatically jump to the Dynamic Land-parcel Subdivision Module.



Click the toolbar’s  button would work in the same way：

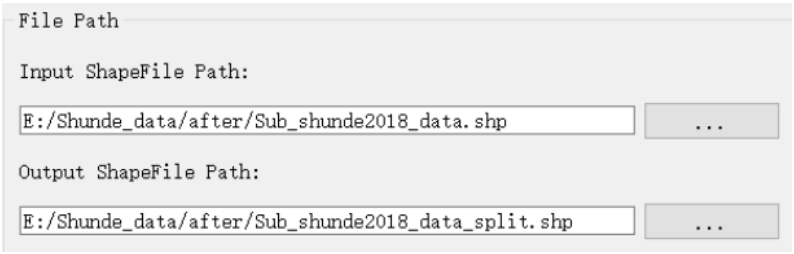


Note: this module will not be valid until vector files are imported.

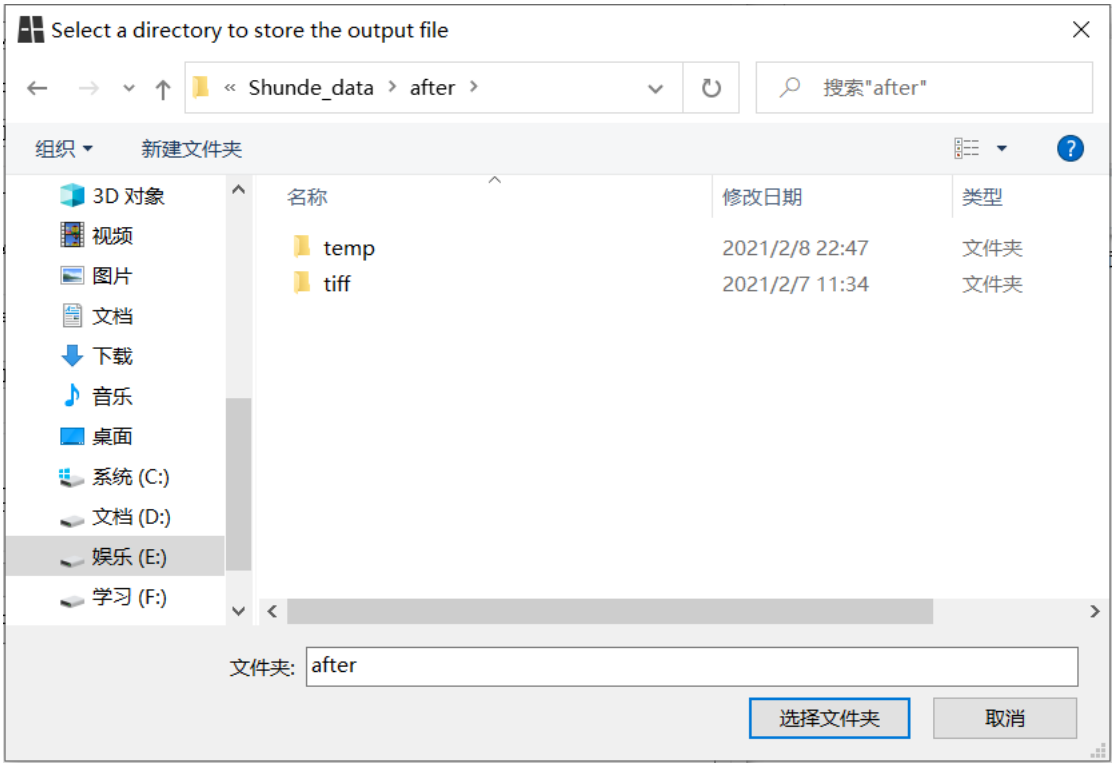
3.2.2. Dynamic Land-parcel Subdivision (DLPS)

Users should ***select*** the file path first before DLPS. By default, the system will specify vector file that was already imported as the input file.

Users can ***specify*** other vector files as input by ***clicking*** ... button to open the Directory Selection Dialog Box. The directory to which the input vector file belongs would be set as the output path, and the output file would be automatically named after the original file with a suffix "_spilt". A sample case is shown as below:



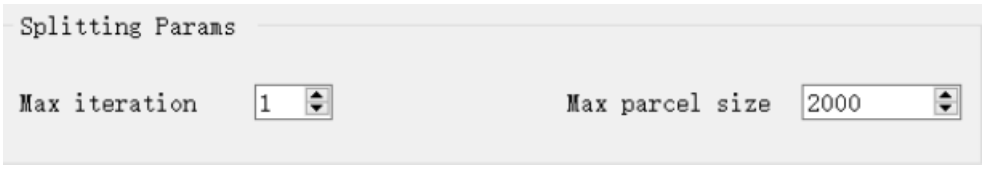
Users are allowed to ***specify*** other locations as output directory by ***clicking***  button to open the Directory Selection Dialog Box. The new output directory would take place the default setting and the output file would be automatically named after the original file with a suffix "_spilt".



Users should ***set*** the Splitting Params for DLPS, including the maximum iteration loops and the maximum parcel size.

The value of Max parcel size is a threshold to determine whether or not to further split a land-parcel. For example, if this value is set to 2000, land-parcels that are smaller than 2000 would not be processed by the subdivision program any more.

The interface for setting these parameters is shown as below:

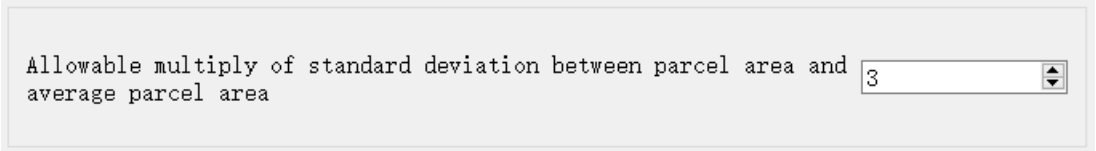


Users should ***select*** a field for DLPS through the "Field Name of Parcel Category" drop-down box. If a non-numeric field is selected, the module will raise an error in the LOG output box. The drop-down box interface of “Field Name of Parcel Category” is shown as follows:

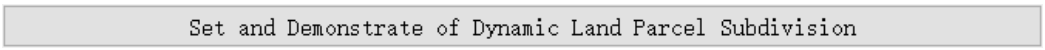
In UrbanVCA, the splitting of land-parcel is controlled by the following rule: 1). Split_flag field in the attribute table needs to be 1 and 2). Land-parcel’s area is greater than dMeanArea + 3 * dStD.

UrbanVCA’s recommended setting for Allowable Multiply of Standard Deviation (dStD) between Parcel Area and Average Parcel Area (dMeanArea) is 3.

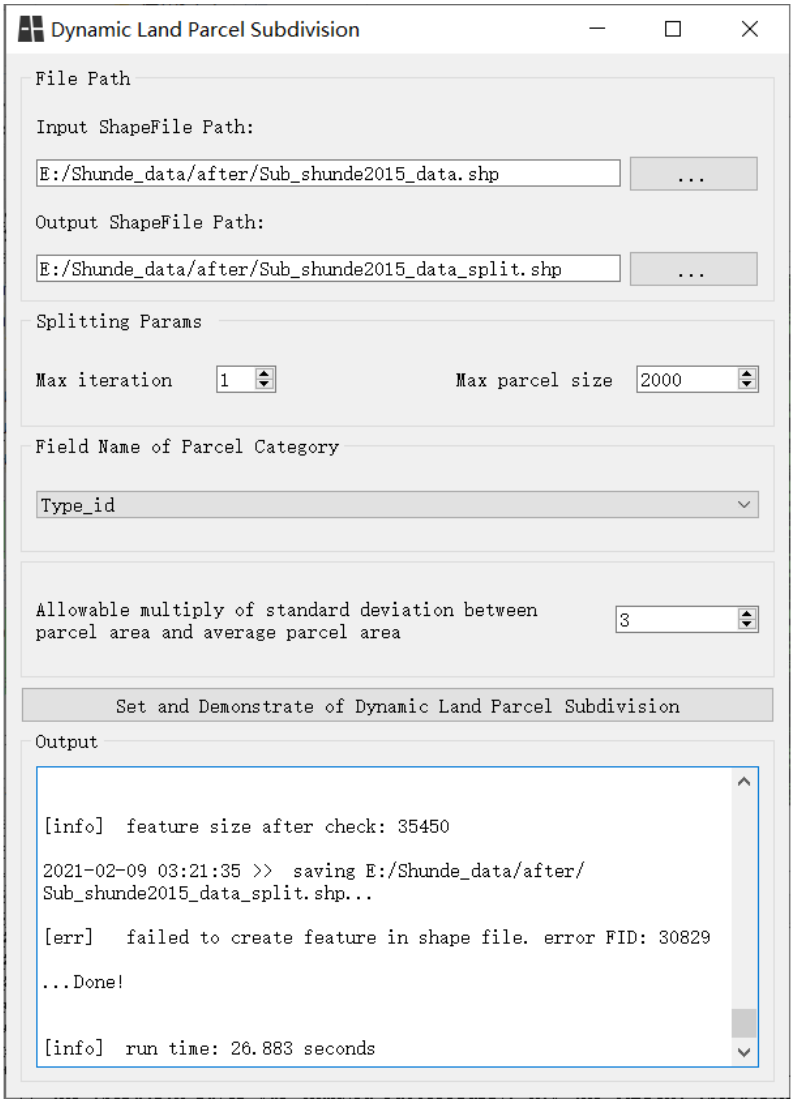
Users can ***adjust*** this parameter to accommodate various research purposes through the interface below:



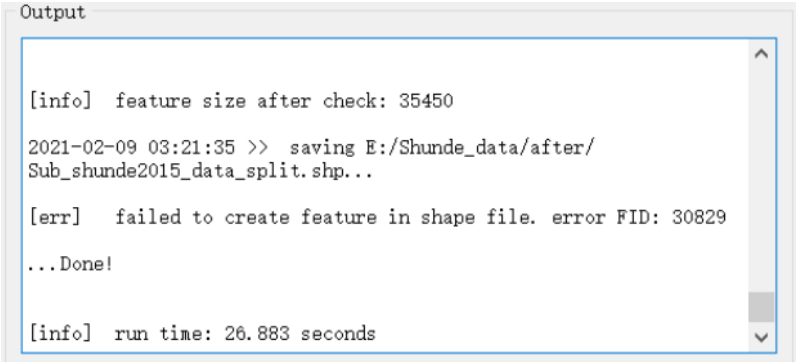
UrbanVCA provides a demonstration program to fine-tune the splitting params. To test the DLPS performance under current settings, users should ***click*** "Set and Demonstrate of Dynamic Land-parcel" button to run the demonstration program.



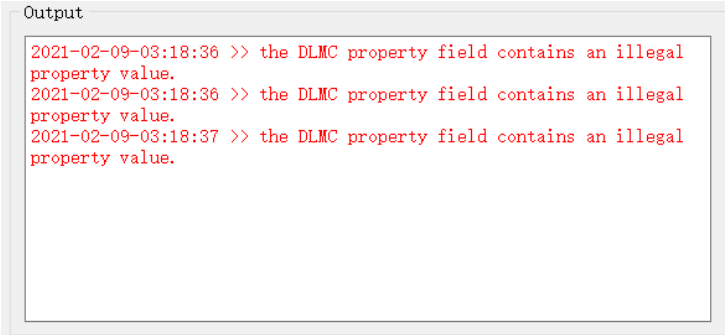
Results will show up in the display module immediately after the end of demonstration program. Users can ***check*** the splitting effect visually through zoom in and out of the content. The DLPS module will be temporarily locked while demonstration program is running. A running sample is shown as below:



Users can ***re-select*** files and ***re-set*** parameters for the next round of DLPS demonstration. The parameters from previously completed demonstrations would be automatically uploaded to the system for subsequent processing. A LOG output interface is provided to check the output info, which is shown as below:



Exceptions will throw out to notify the cause of failure.

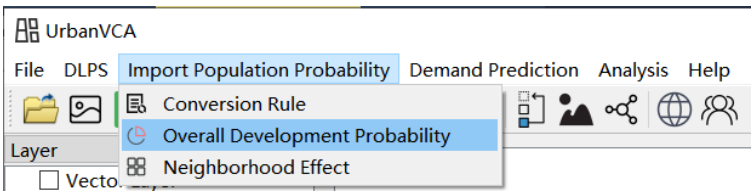


3.3. Overall Development Probability Mining Function

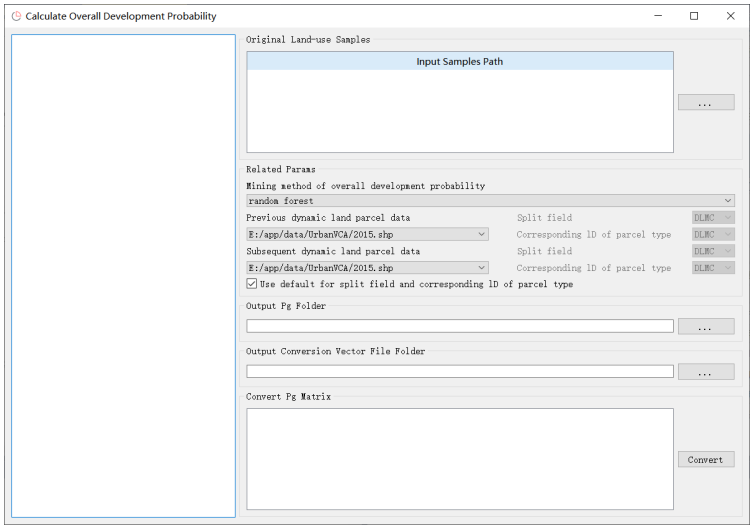
Two modes are supported for retrieving the overall development probability: 1). Compute the overall development probability by following UrbanVCA's workflow step by step; 2). Import the existing overall development probability file.

3.3.1. Features

First-Click the "Import Population Probability" in the menu bar and ***choose*** the "Overall Development Probability", it will automatically jump to the Calculate Overall Development Probability Module.

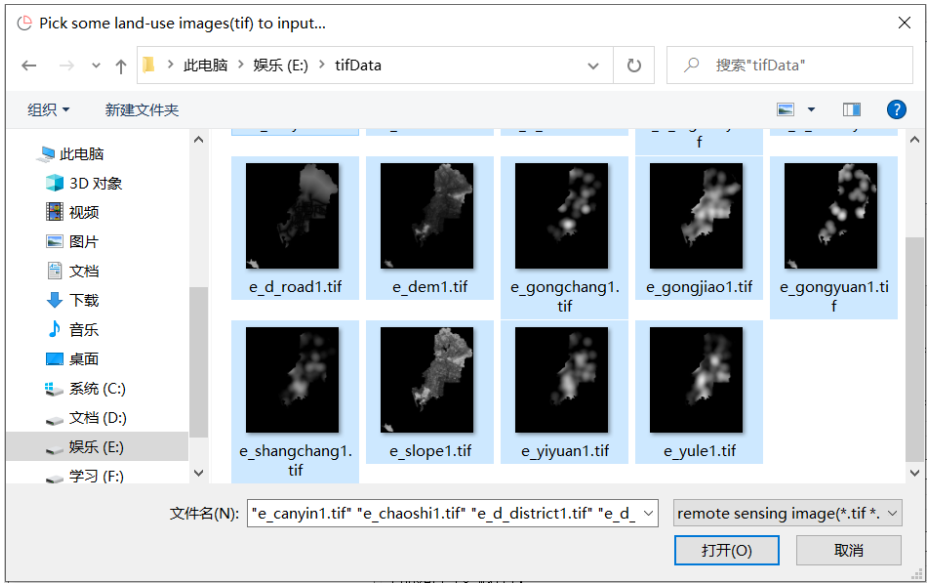


Click the toolbar's  button would work in the same way：

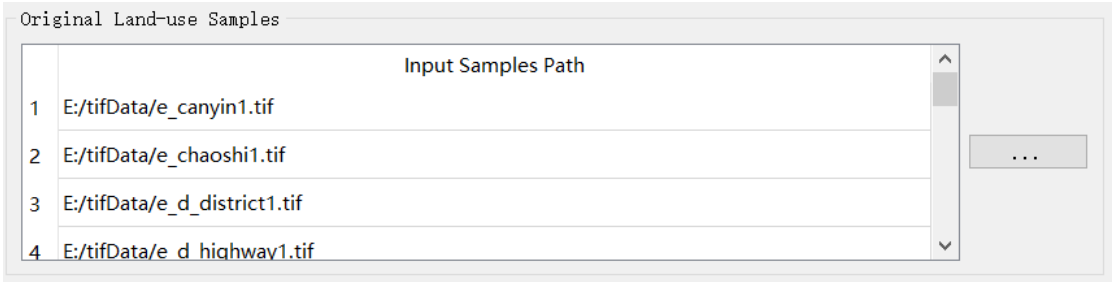


3.3.2. Compute the Overall Development Probability

Users can compute the overall development probability by following UrbanVCA's default workflow. Users are asked to ***import*** auxiliary geographic data (auxiliary TIFF files such as catering, supermarket, highway, railway and factory TIFFs). To import the data, Users should ***click*** "Auxiliary Geographic Data Import" button ... to import auxiliary data by the Directory Selection Dialog Box:



The module will automatically list the paths of auxiliary data as shown in the figure below:

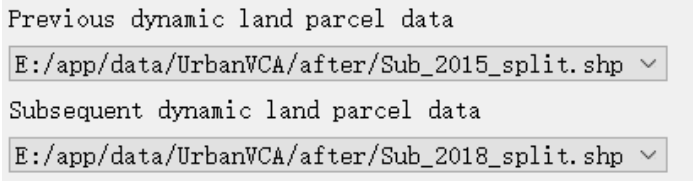


Users can ***delete*** the undesired files by pressing keyboard's delete button for selected rows.

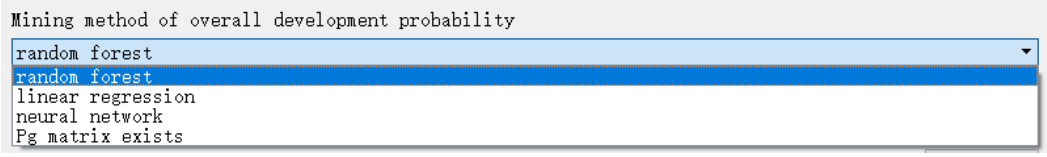
Users are asked to ***set*** necessary parameters for overall development probability computation. Parameters include: 1). Mining method of overall development

probability; 2). Previous dynamic land-parcel data and its attribute fields that denote the corresponding ID of parcel type and split field respectively; 3) Subsequent dynamic land-parcel data and its attribute fields that denote the corresponding ID of parcel type and split field respectively.

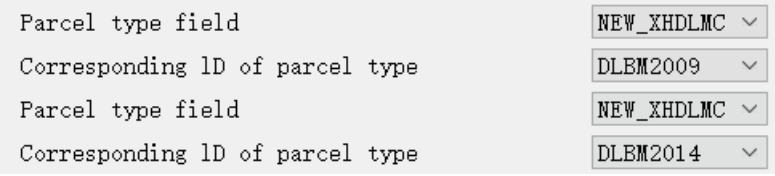
Noted that “Previous dynamic land-parcel data” represents vector files before the land-use conversion, and “Subsequent dynamic land-parcel data” represents vector files after the land-use conversion. The imported vector files is shown as below:



By ***clicking*** the “Mining method of overall development probability” drop-down box, users can ***select*** algorithms from random forest, linear regression and neural network. It is worth noting that users should ignore the “Pg matrix exists” option here as no imported overall development probability file is available in 3.3.2 chapter.



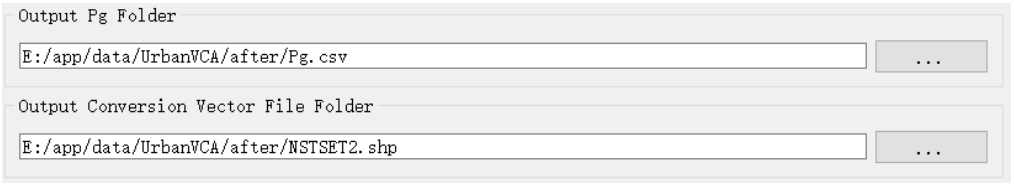
Users should ***select*** the corresponding field names through “Parcel type field” drop-down box and “Corresponding ID of parcel type” drop-down box. The primary reason for this operation is the potential inconsistency in field names (mainly introduced by vector data not generated via UrbanVCA). Users should manually ***set*** these parameters as shown below:

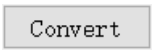


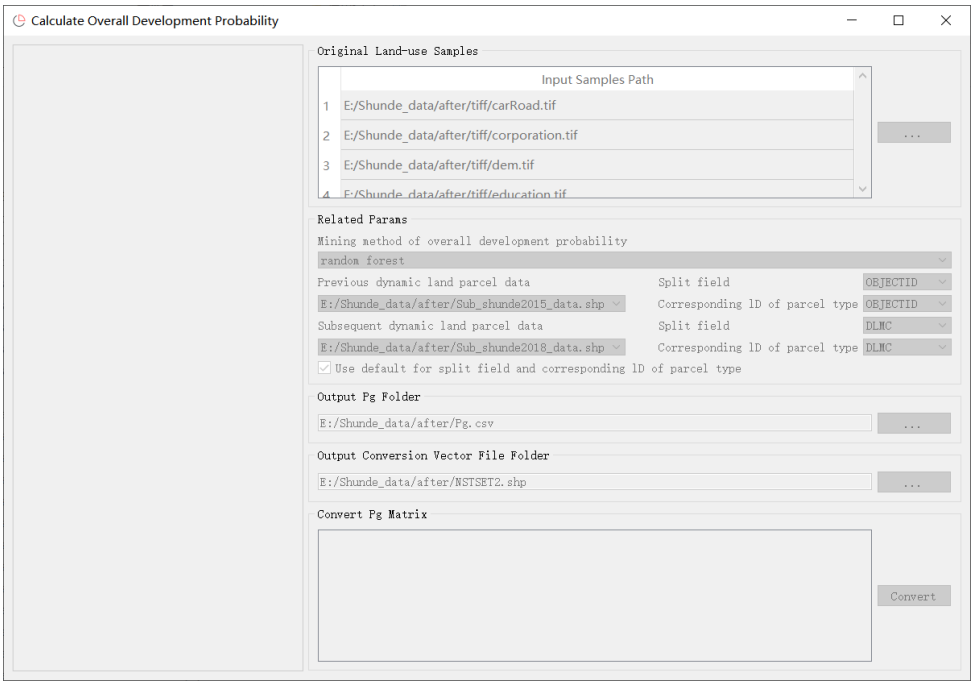
Noted that vector data generated via UrbanVCA’s customized conversion rules module (introduced in 3.1.3) should also follow this procedure.

Users should ***specify*** the output paths explicitly for both the overall development probability file and the generated conversion vector file by clicking 

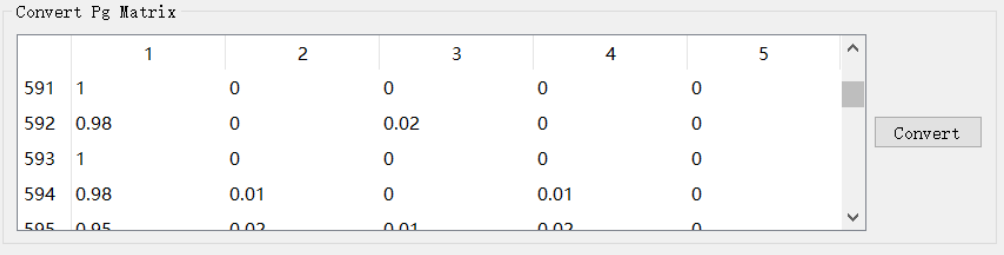
buttons respectively. Users can determine file's output path through Directory Selection Dialog Box. The parameter setting interface is shown as below:



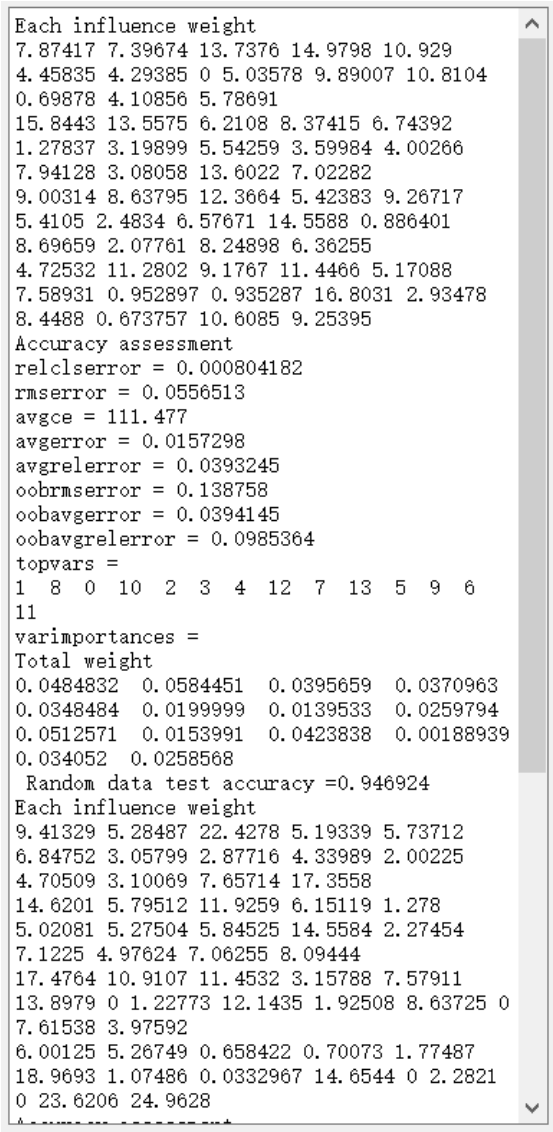
Click the "Convert"  button to run the overall development probability mining module with the above parameter setting. By default, the generated overall development probability file will be named "Pg.csv" and the conversion vector file will be named "NSTSET2.shp". The mining module will be temporarily locked while the program is running. A running sample is shown as below:



The system will immediately import the generated overall development probability file and conversion vector file after the module ends. The derived Pg matrix will simultaneously show up in the display module. A sample of Pg Matrix is shown as below:

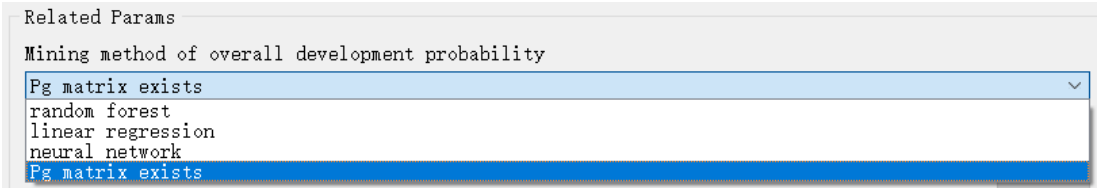


UrbanVCA provides a LOG output interface to ***check*** the accuracy of overall development probability mining. Noted that different algorithms have different accuracy evaluation indices. Users can therefore fine-tine the parameters according to the LOG output results. The Log output interface of the overall development probability mining module is shown as below:

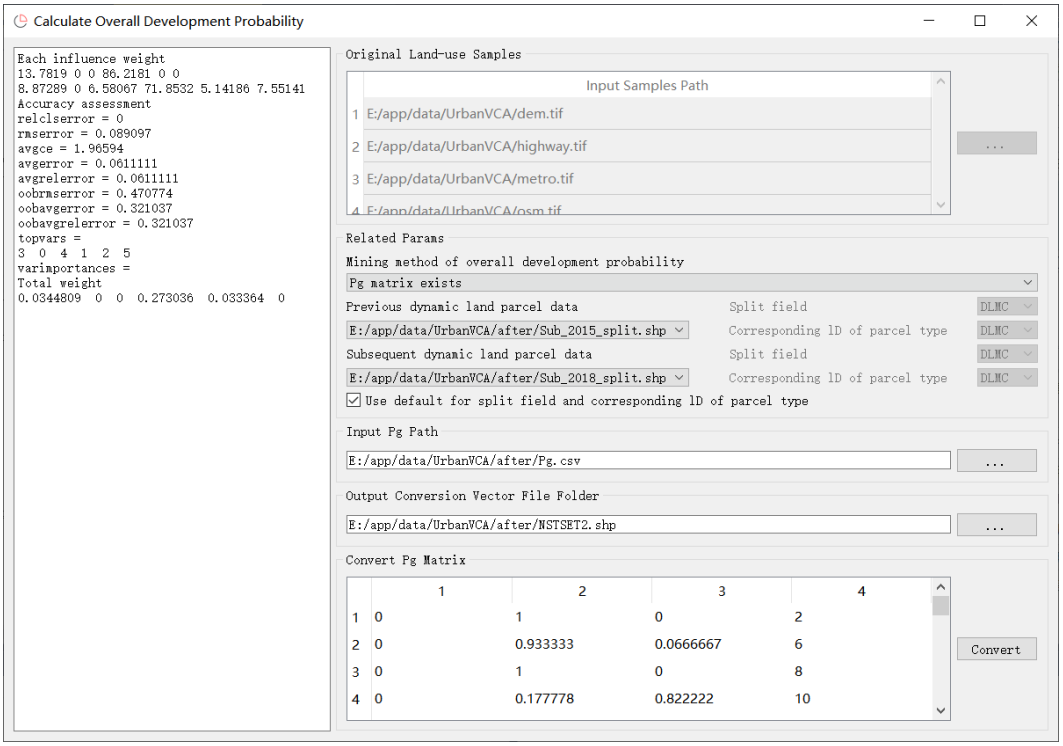


3.3.3. Import the Existing Overall Development Probability

Instead of computing Pg directly, users are allowed to ***import*** the existing overall development probability file to retrieve Pg parameter. Users can select the “Pg matrix exists” option through the “Mining method of overall development probability” drop-down box:



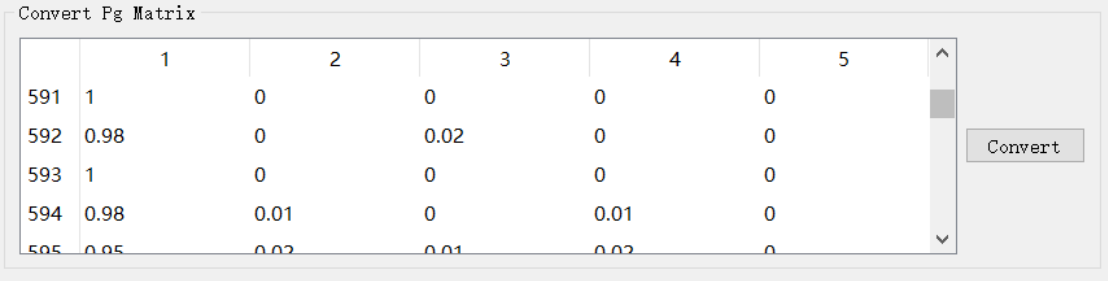
User interface will therefore change to accommodate the File Imported mode. Users should import a probability file pre-trained outside UrbanVCA through the "Select the existing probability file" drop-down box:



Users should ***specify*** the output paths explicitly for the generated vector file by clicking ... buttons.

Click the “Convert” Convert button to run the module. By default, the generated conversion vector file will be named "NSTSET2.shp". The system will

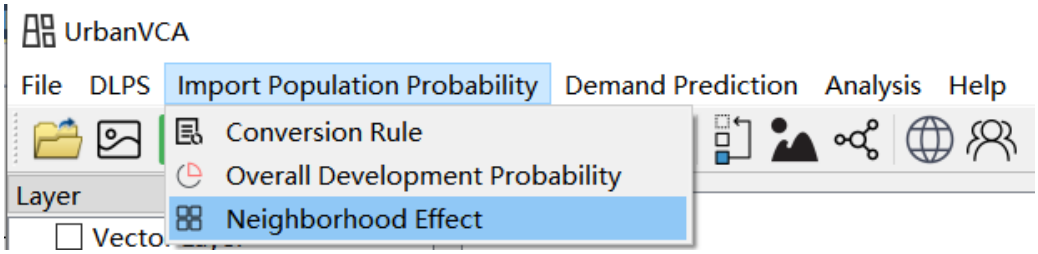
immediately import the generated overall development probability file and conversion vector file after the module ends. The derived probability matrix will simultaneously show up in the display module as shown in the figure below:



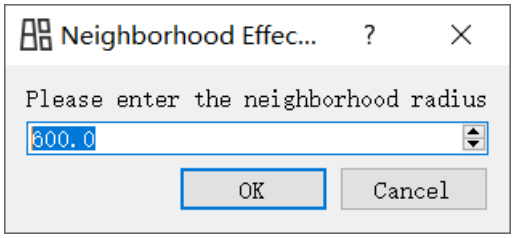
3.4. Urban Land-use Change Simulation Function

3.4.1. Neighborhood Effect Setting

First-Click the "Import Population Probability" in the menu bar and ***choose*** the "Neighborhood Effect", it will automatically jump to the Neighborhood Effect Setting Dialog Box and asks users to enter the neighborhood radius:

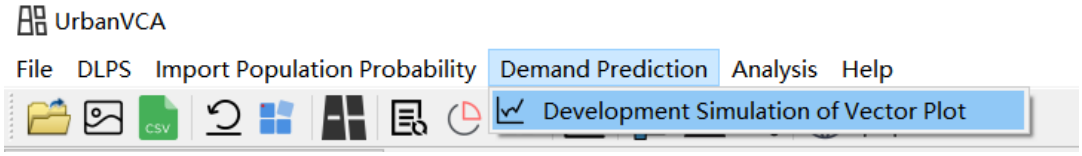


Click the toolbar's  button would work in the same way:

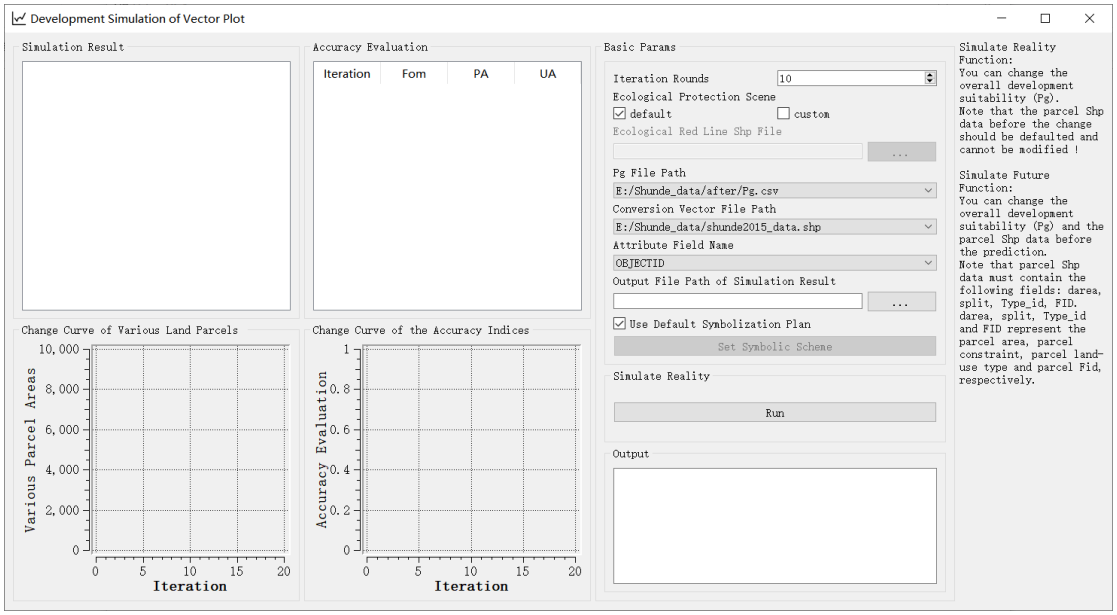


3.4.2. Urban Land-use Change Simulation

First-Click the "Demand Prediction" in the menu bar and ***choose*** the "Development Simulation of Vector Plot", it will automatically jump to the Demand Prediction Window.

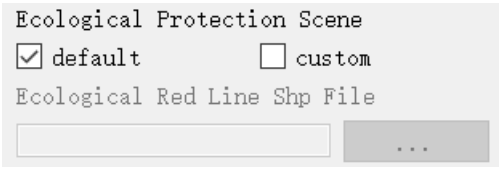


Click the toolbar's  button would work in the same way:



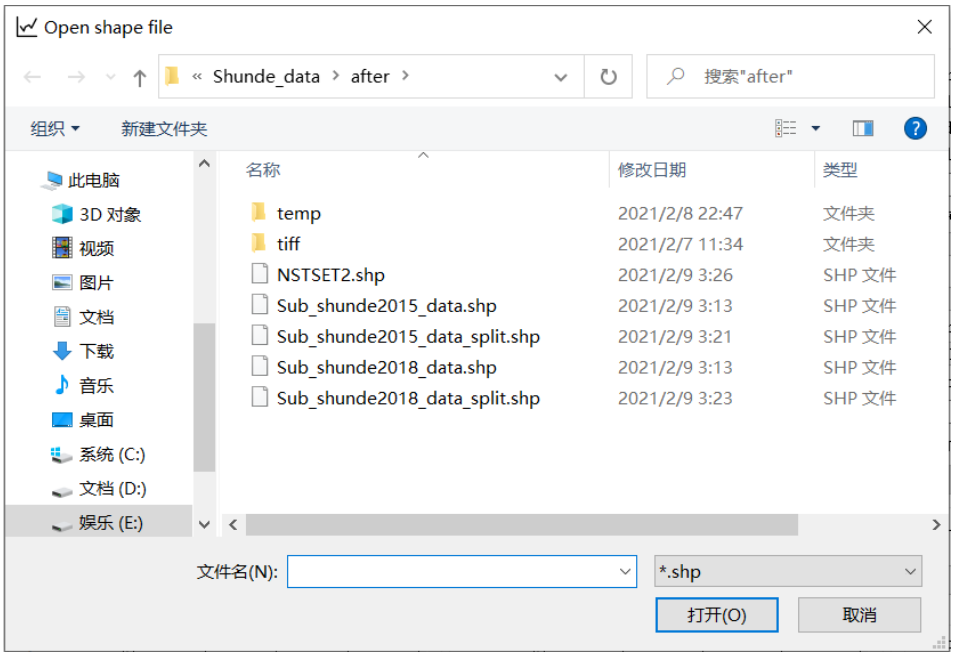
Users should ***set*** the number of iteration rounds for land-use simulation first:

Users are allowed to ***specify*** the "Ecological Protection Scene". Users can either select the default threshold recommend by UrbanVCA or customize this parameter. By default setting, the default option is check with √ and the "Ecological Red Line Shp File" box is disabled.

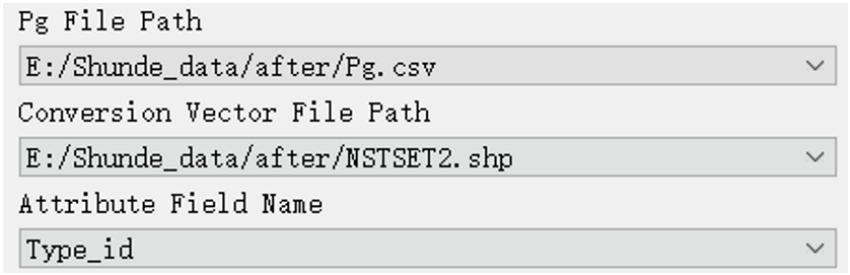


Users can ***activate*** the "Ecoloogical Red Line Shp File" box by checking the custom option with √. This mode supports the Ecological Red Line features and thus restrict developments of land-parcels within Red Line Zones.

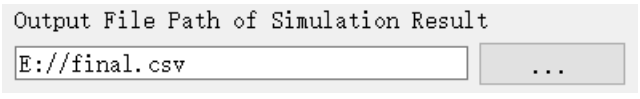
Click the  button, it will automatically jump to the Directory Selection Dialog Box and ask users to import the relevant shapefiles:



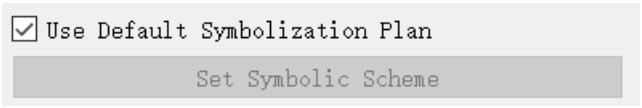
Users should ***select*** the urban land-use overall development probability file, the land-use conversion vector file, and the corresponding land-use attribute field name. The above file selection is conducted through three drop-down boxes respectively, which is shown as below:



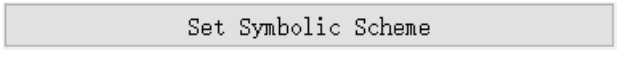
Click the  button to ***specify*** the “Output File Path of Simulation Result”, it will automatically jump to the Directory Selection Dialog Box. By default, the generated simulation result file will be named "final.csv". A sample path setting is shown as below：

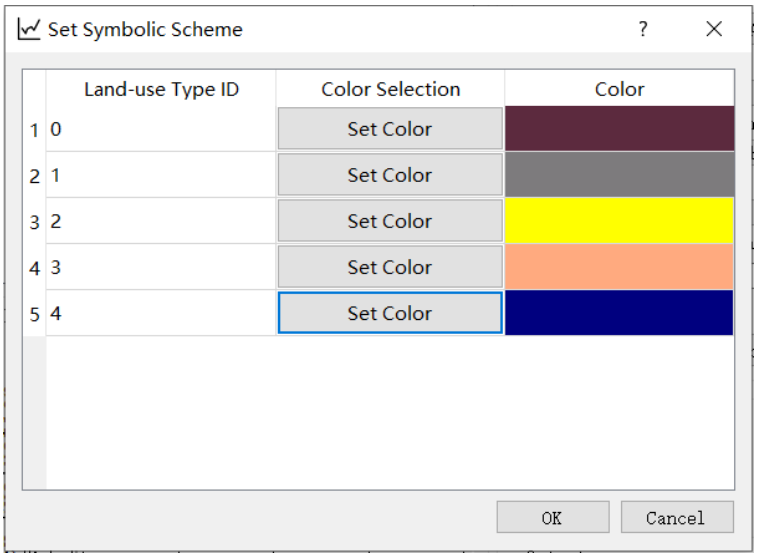


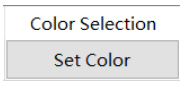
Users can ***specify*** a custom symbolization scheme for different land-use types by ***unchecking*** the “Use Default Symbolization Plan” box.

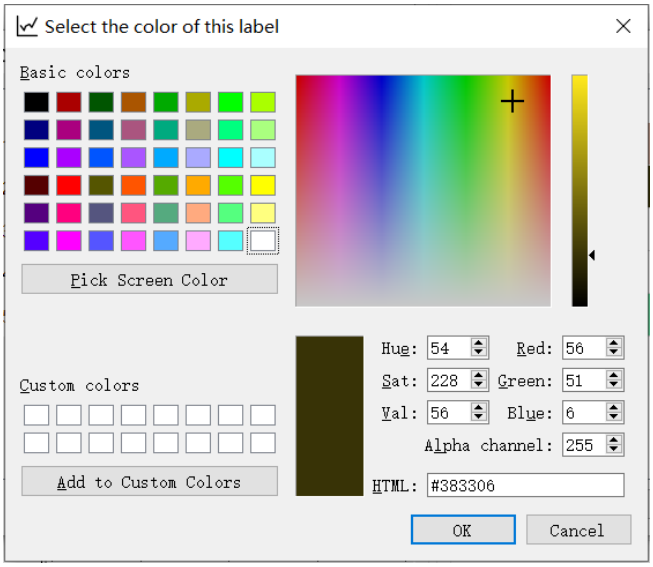


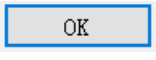
Click the "Set Symbolic Scheme" button, it will automatically jump to a symbolic scheme setting interface as shown below:





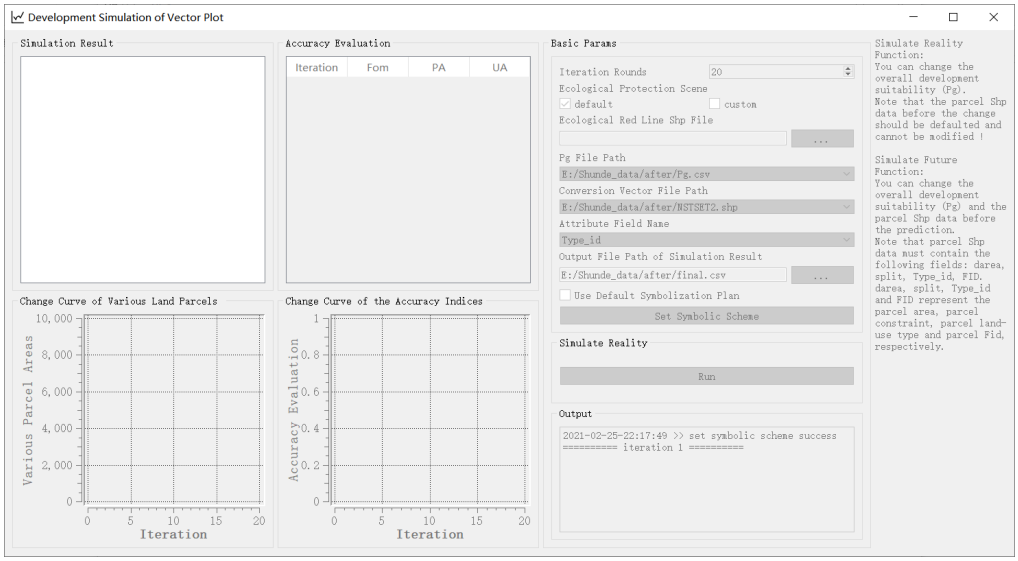
Click the "Set Color"  button, it will automatically jump to a color selection widget to select the color of this label, as shown below:



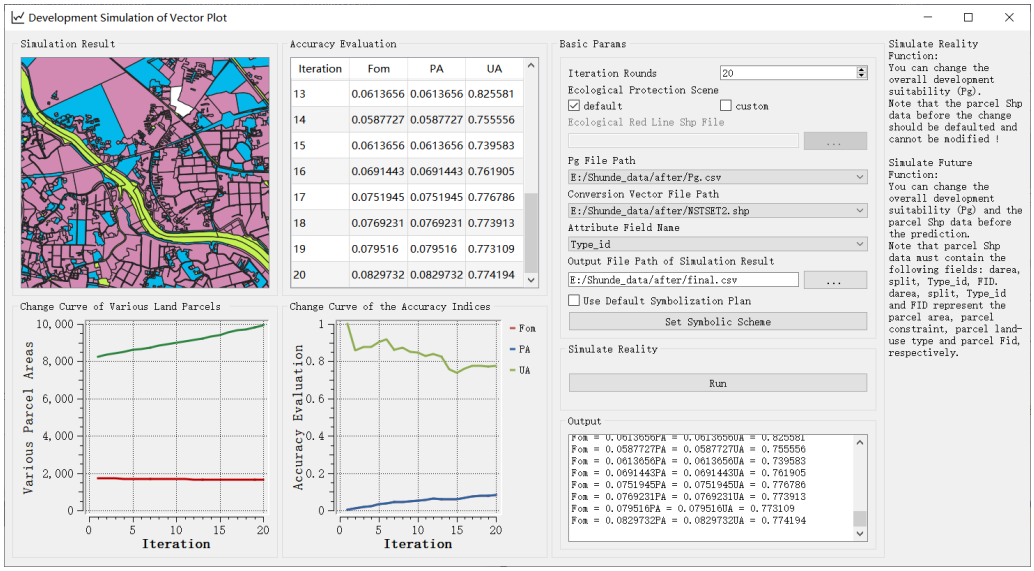
Click the "OK"  button to exit the "Layer Symbolization" interface.

Click the "Run" button to start the urban land-use simulation module after all the parameter settings are done.

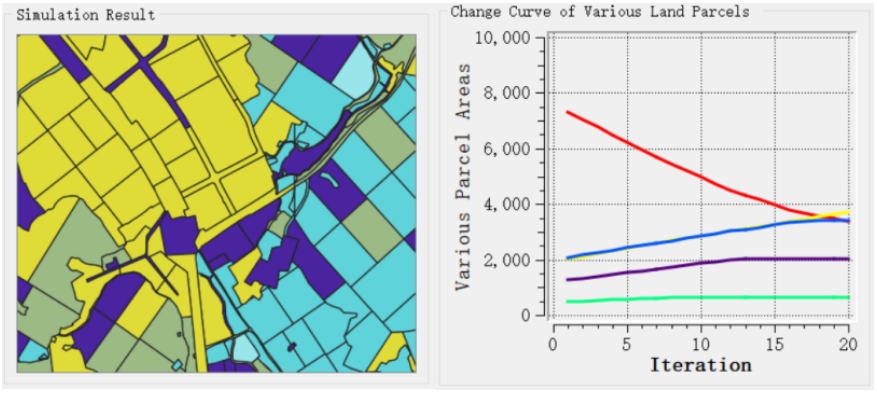
The simulation module will be temporarily locked while the program is running. A running sample is shown as below:



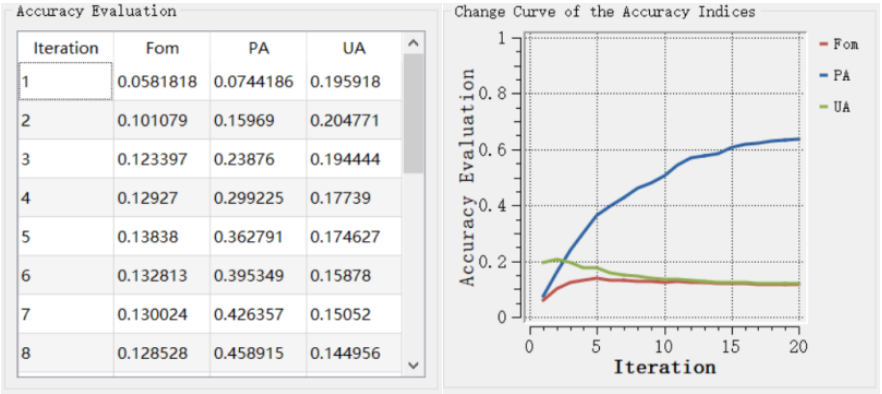
The system will display the land-use simulation map generated by the last iteration round in tandem with the accuracy evaluation indexes with each iteration at the top left corner of the panel. At the bottom left corner, the system will display the diagram that records the land-parcel area change with each iteration, as well as the simulation accuracy change with each iteration, respectively.



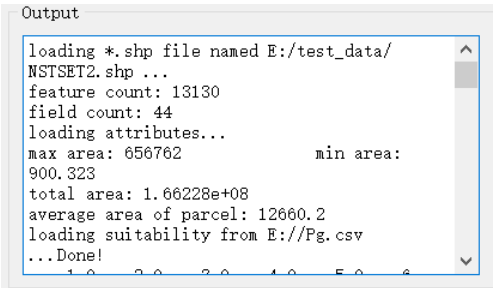
Users can ***check*** the simulation result in detail by zoom in and out. The line plot entitled “Change Curve of Various Land-parcels” reports each land-use type’s land-parcel area change in different color’s curve.



Users can ***check*** the Accuracy Evaluation by scrolling down the accuracy report table. The line plot entitled “Change Curve of the Accuracy Indices” reports simulation result’s accuracy change with each iteration by various evaluation metrics such as FoM, PA and UA.

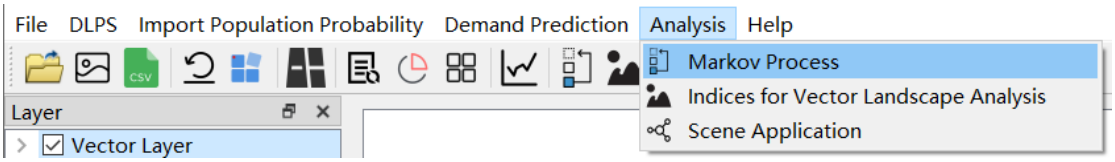


UrbanVCA provides a LOG output interface to check the status with each iteration. The Log output interface of urban land-use change simulation module is shown in the figure as below:

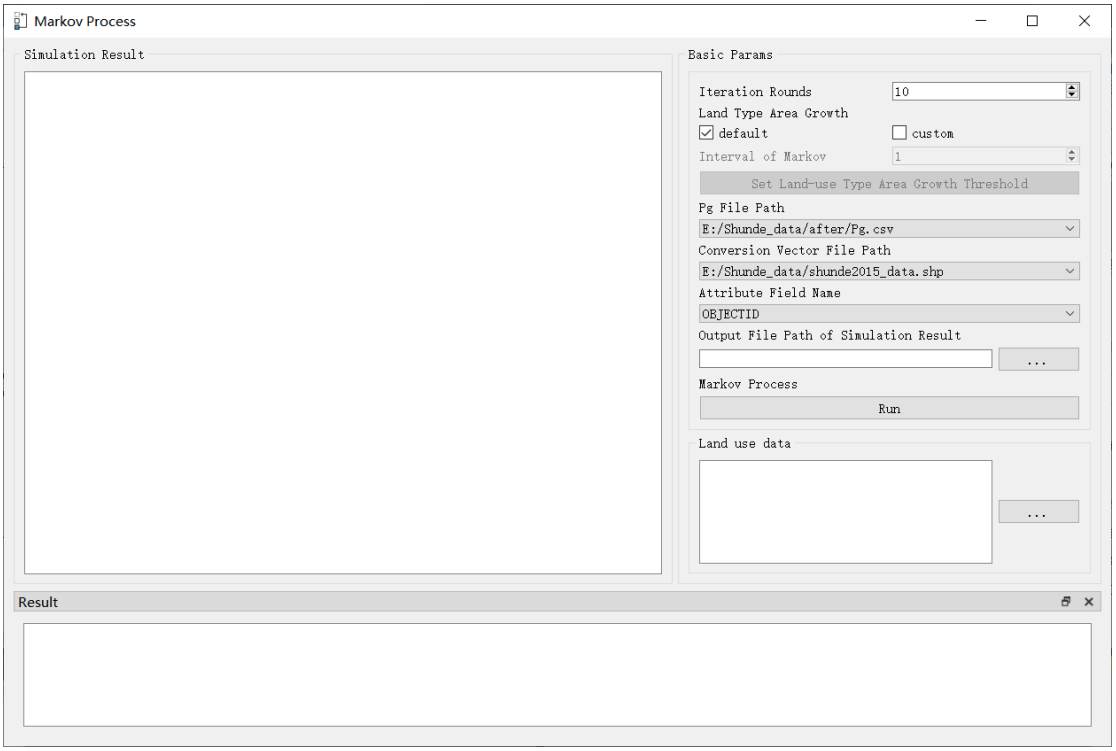


3.4.3. Urban Land-use Change Prediction

First-Click the "Analysis" in the menu bar and ***choose*** the "Markov Process", it will automatically jump to the Markov Process Window.



Click the toolbar's  button would work in the same way:



Users should ***set*** the number of iteration rounds for land-use prediction first:

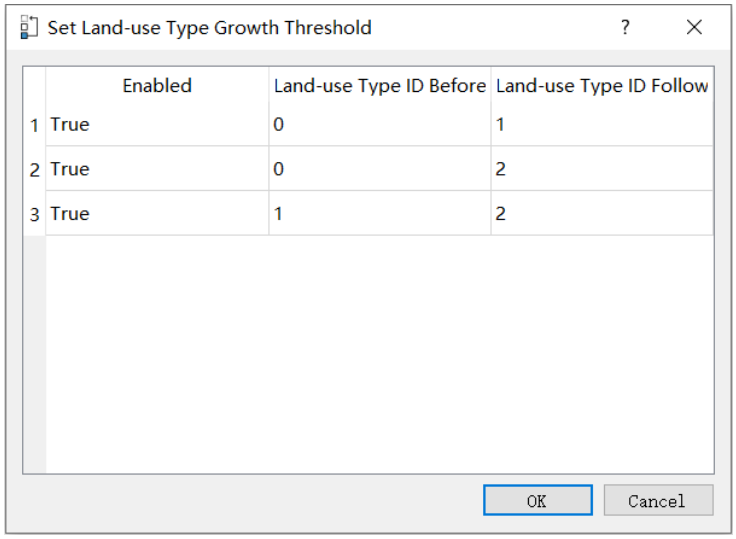
Users are allowed to ***specify*** the "Land Type Area Growth". Users can either select the default threshold recommend by UrbanVCA or customize this parameter. By default setting, the default option is check with √ and the "Set Land-use Type Area Growth Threshold" button is not enabled.

Users can ***activate*** the "Set Land-use Type Area Growth Threshold" button by

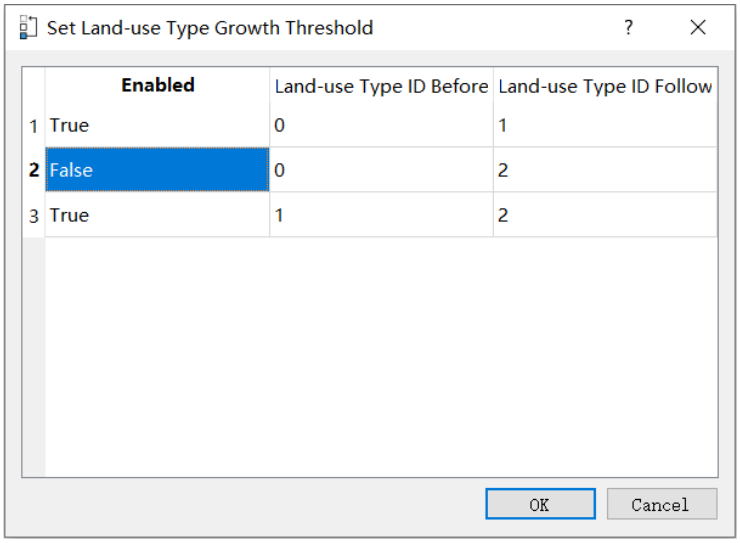
checking the custom option with √.

The custom mode supports advanced parameter setting for Markov Process: 1). Specify the explicit interval nums of each round; 2) Define Conversion Rule.

Click the "Set Land-use Type Area Growth Threshold" button, it will automatically pop up a new dialog and ask users to fill out the Conversion Rule table.



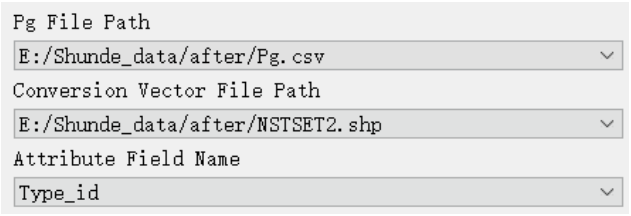
By ***double-clicking*** the True/False cell in the "Enabled" column, users can ***change*** its Conversion Rule status (either disable or enable), as shown in the figure below:



Click the "OK" 

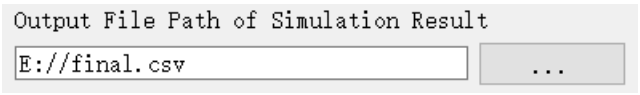
button to execute the customized Conversion Rule.

Users should ***select*** the urban land-use overall development probability file, the land-use conversion vector file, and the corresponding land-use attribute field name. The above file selection is conducted through three drop-down boxes respectively, which is shown as below:

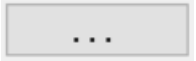


Click the 

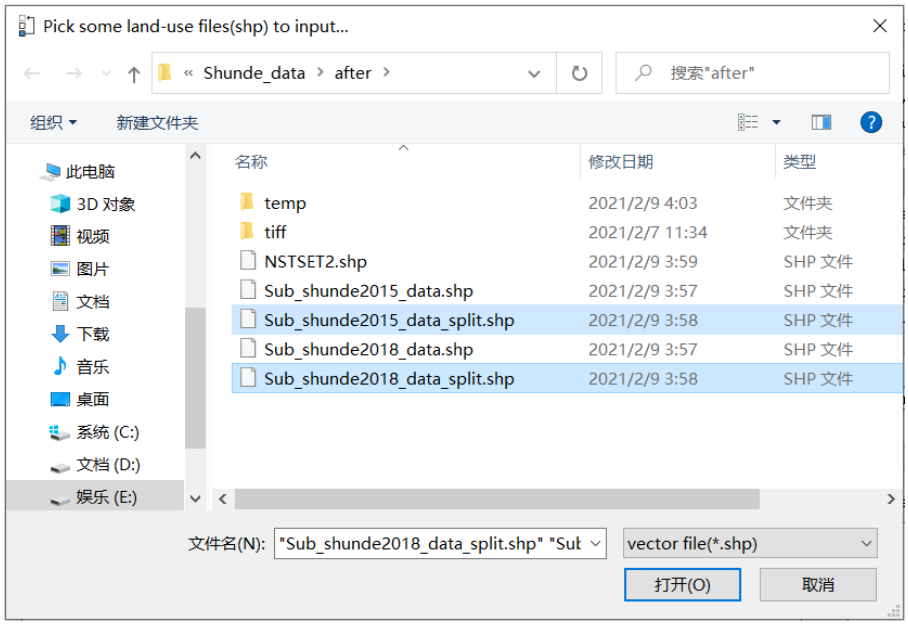
button to ***specify*** the "Output File Path of Simulation Result", it will automatically jump to the Directory Selection Dialog Box. By default, the generated simulation result file in text format will be named "final.csv". A sample output file path is shown as below：



Users should ***import*** the past years' land-use data to predict the area change of each land-use type by the Markov Process model. The import operation is processed through the following widget:

Click the 

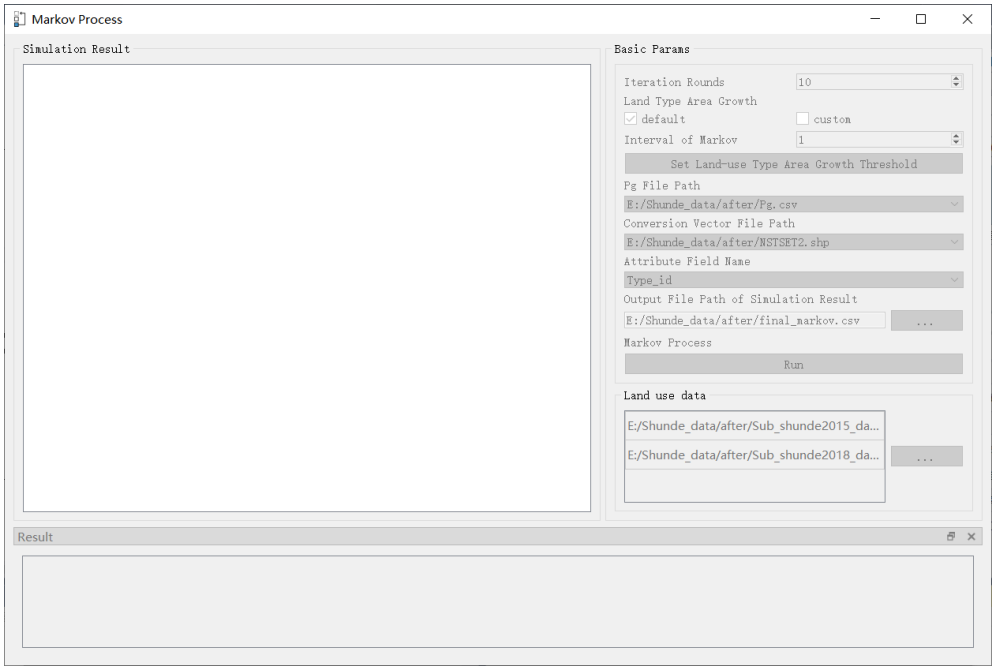
button, it will automatically jump to the Directory Selection Dialog Box for past years' land-use data selection.



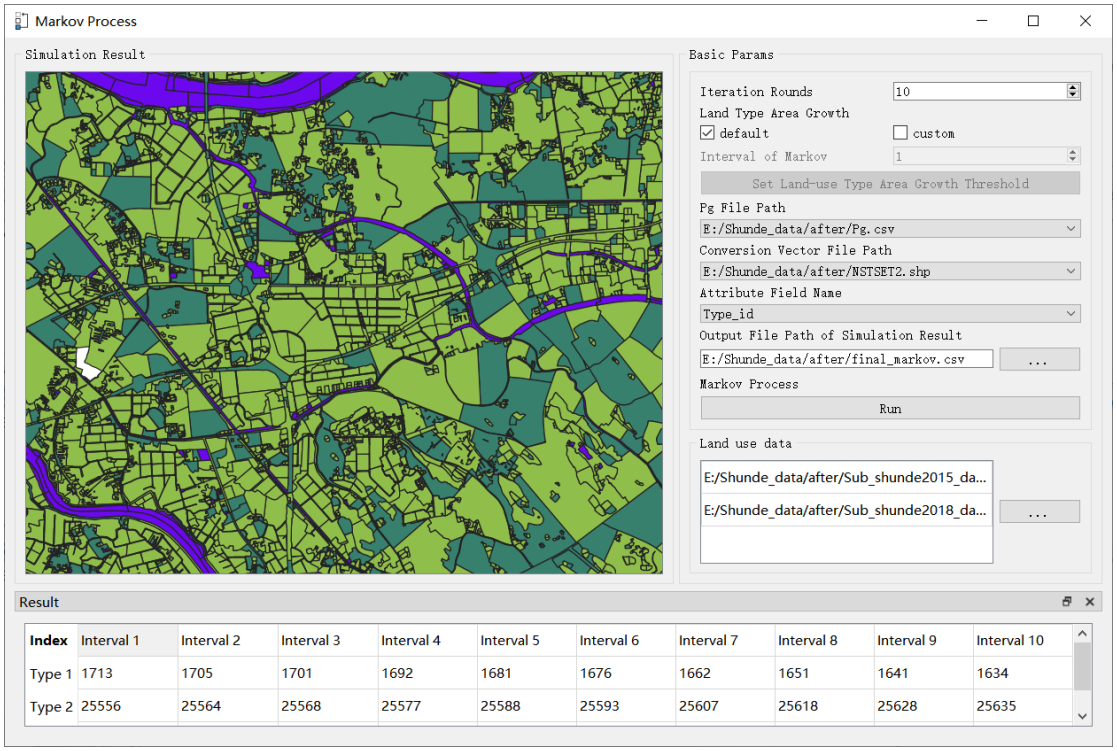
Users can ***delete*** the undesired land-use data by pressing keyboard's delete button for the selected rows.

Click the "Run"  button to start the urban land-use prediction module after all the parameter settings are done.

The prediction module will be temporarily locked while the program is running, which is shown as below:



The system will display the land-use prediction map generated by the last iteration round in tandem with land-parcel change of each land-use type with each iteration:

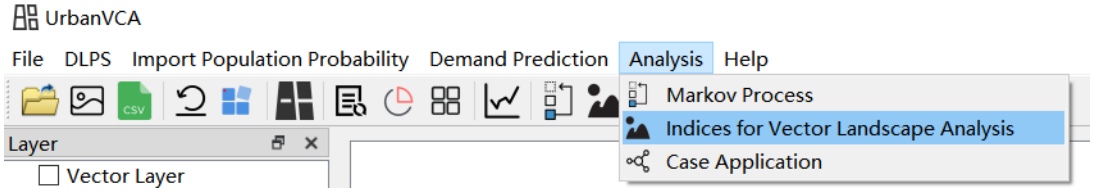


3.5. Vector-based Landscape Index Calculation

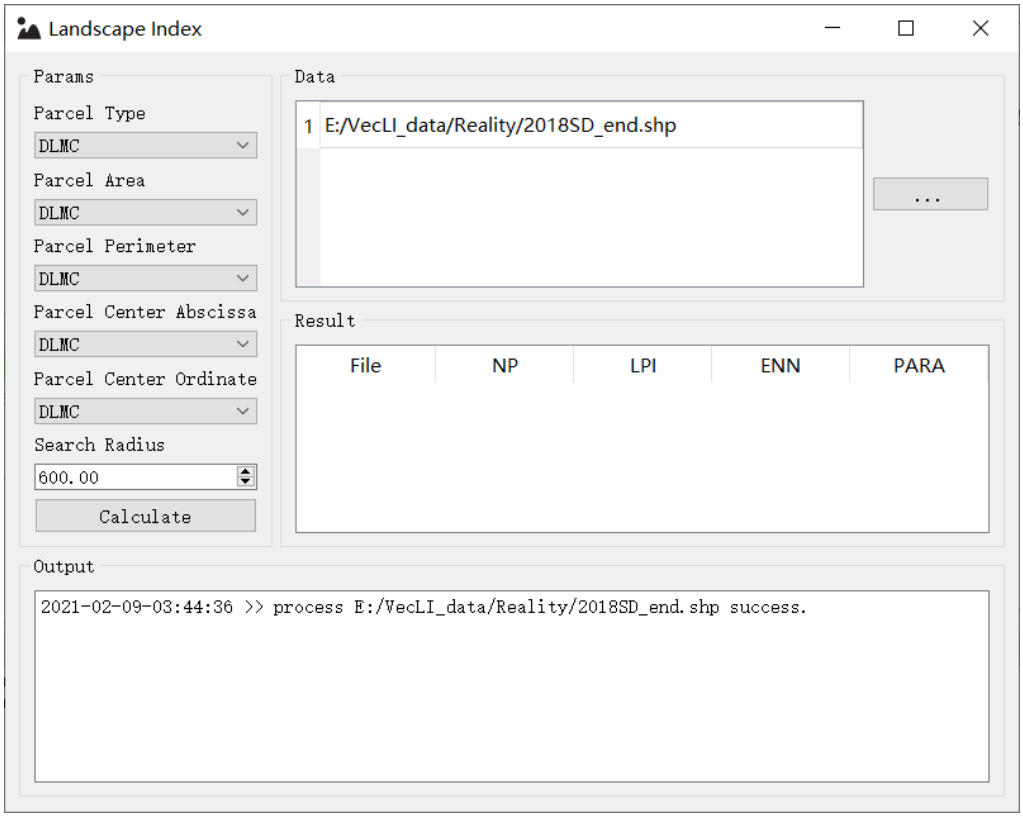
This module is designed for calculating the similarity of landscape pattern between UrbanVCA simulation results and actual data.

3.5.1. Features

First-Click the “Analysis” in the menu bar and ***choose*** the “Indices for Vector Landscape Analysis”, it will automatically jump to the Landscape Index Window.

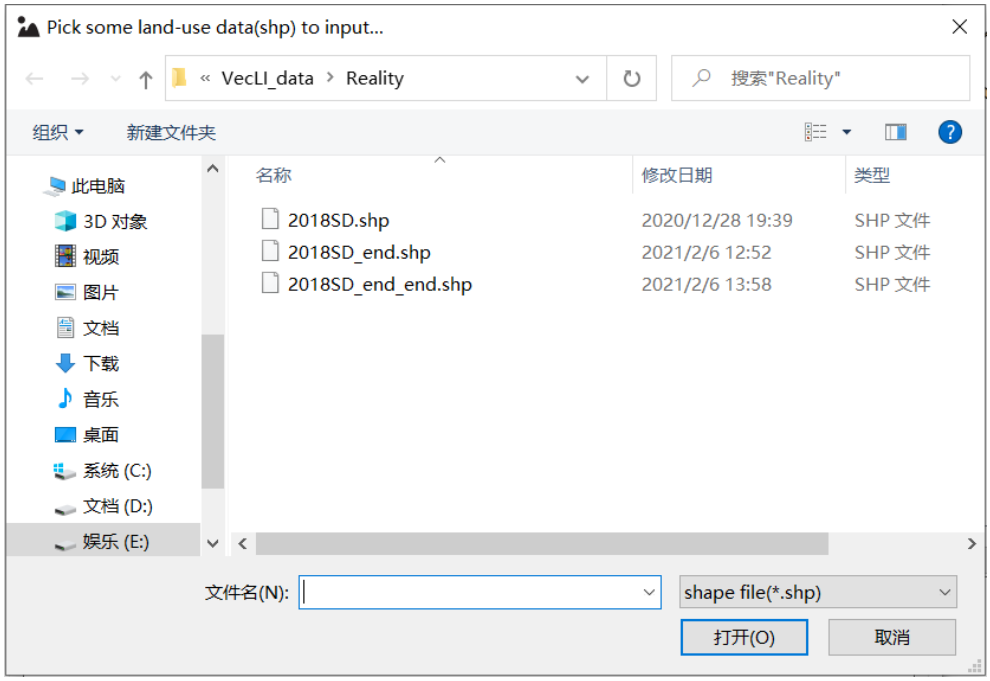


Click the toolbar’s  button would work in the same way:



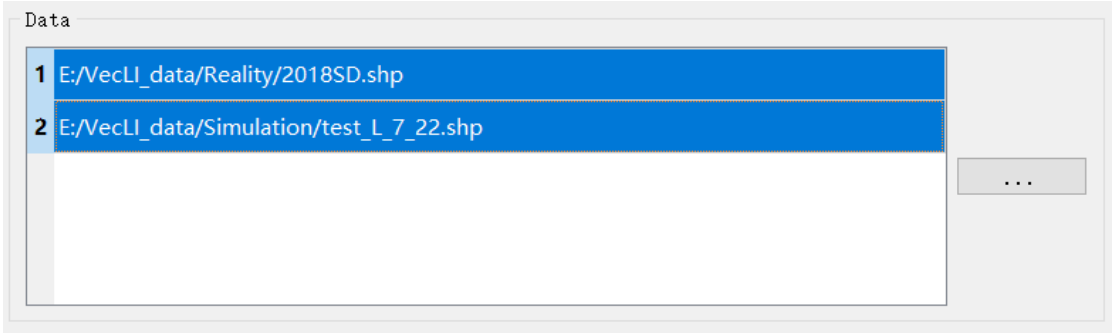
3.5.2. Import Files

Click the "Vector file Import" button  , it will automatically jump to the Directory Selection Dialog Box for vector file selection (vector-based land-parcel files from different times) :



The module will automatically list the paths of vector files after the vector files have been chosen.

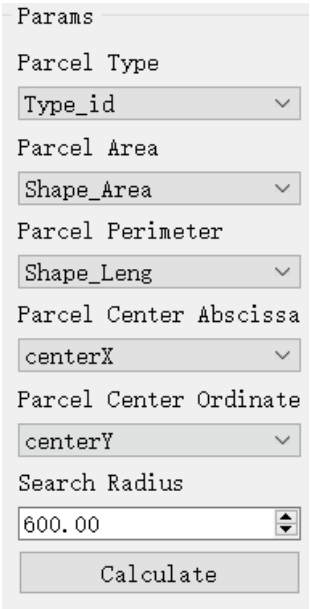
Users can ***delete*** the undesired land-use data by pressing keyboard's delete button for the selected rows:



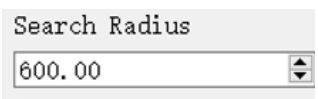
3.5.3. Parameter Settings

Users are asked to ***set*** necessary parameters for vector-based landscape index calculation. Parameters include: 1). Parcel Type; 2). Parcel Area; 3). Parcel perimeter; 4). Parcel Center Abscissa; 5). Parcel Center Ordinate; and 6).Search Radius.

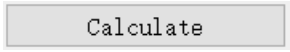
The first five parameters are ***set*** through the parameter setting drop-down box, in which the drop-down box for field selection is shown as below:



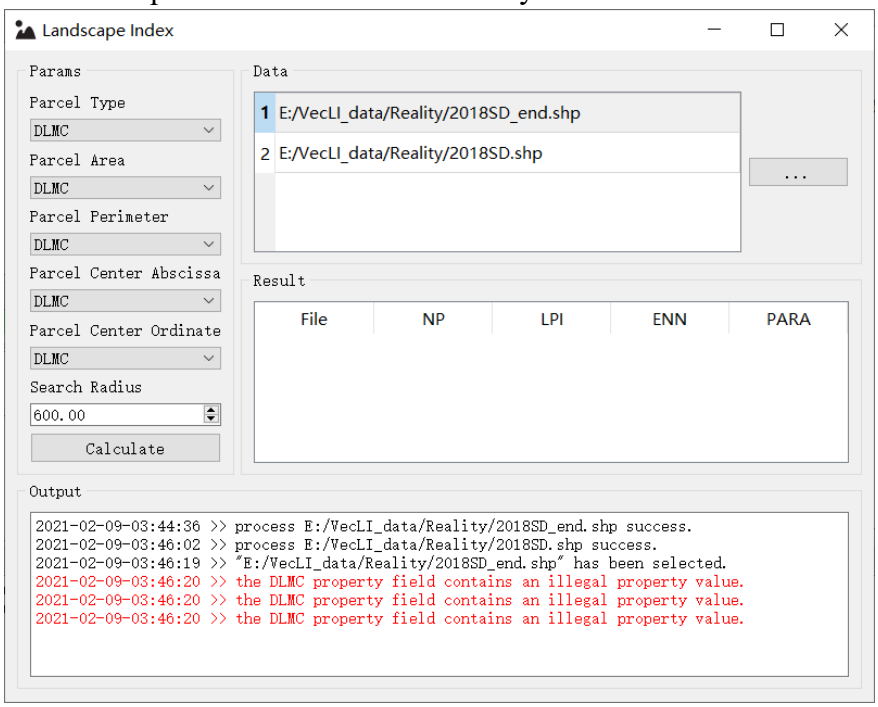
"Search Radius", the sixth parameter, should be manually ***entered*** by users:



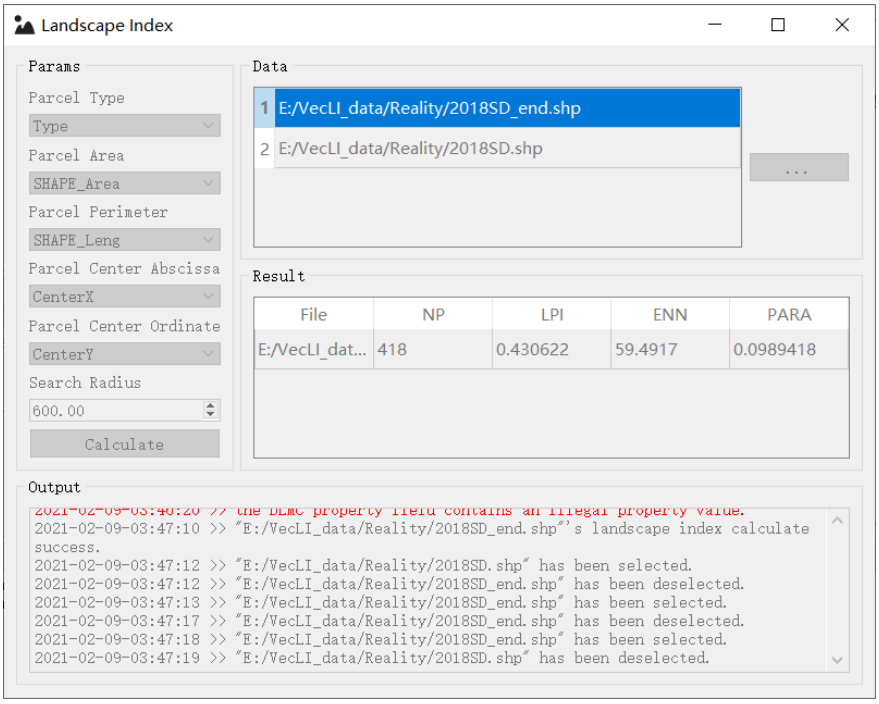
3.5.4. Vector-based Landscape Index Calculation

Click the "Calculate"  button to start the vector-based landscape index calculation after all the parameter settings are done.

Noted that exceptions will throw out to notify the cause of failure:



The vector-based landscape index calculation module will be temporarily locked while the program is running. A running sample is shown as below:



The system will immediately display the calculation result. A sample calculation result is shown as below:

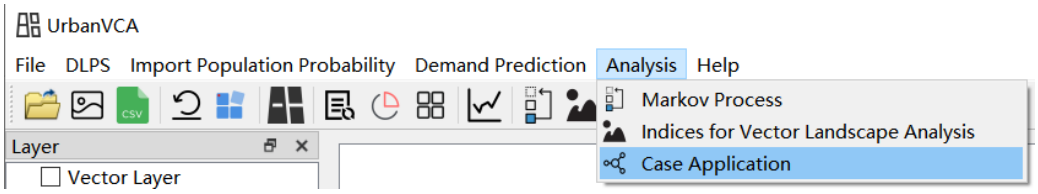
File	NP	LPI	ENN	PARA
E:/VecLI_data/Rea...	13747	0.419146	51.8826	0.111365

3.6. Automatically Mining the Optimal Search Radius

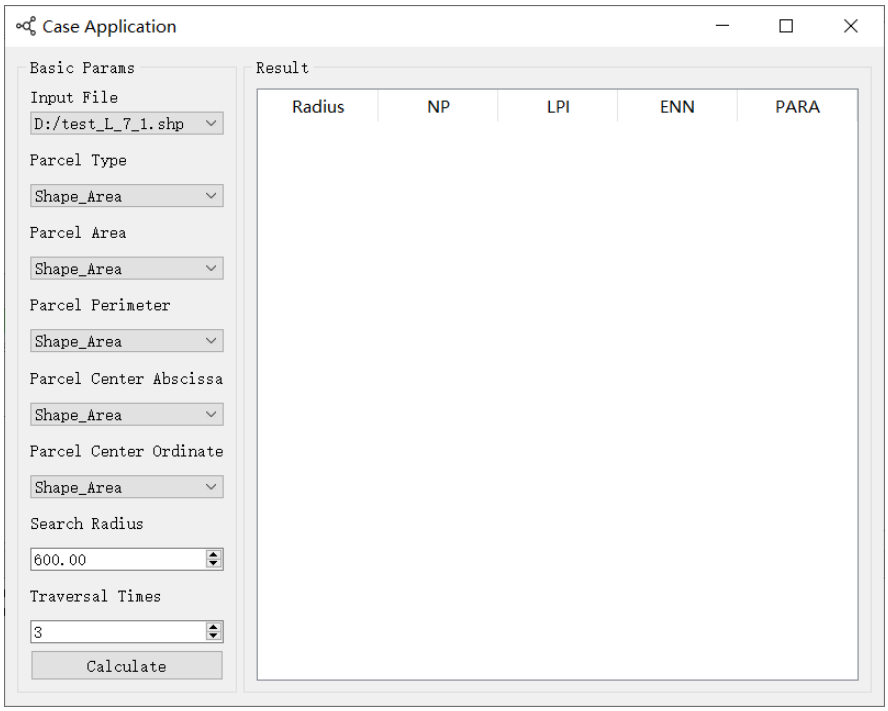
This module can automatically calculate the optimal search radius based on the imported vector files.

3.6.1. Features

First-Click the "Analysis" in the menu bar and ***choose*** the "Scene Application", it will automatically jump to the Case Application Window:

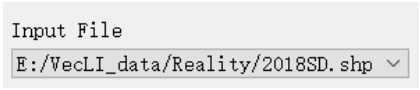


Click the toolbar's  button would work in the same way:



3.6.2. Import Files

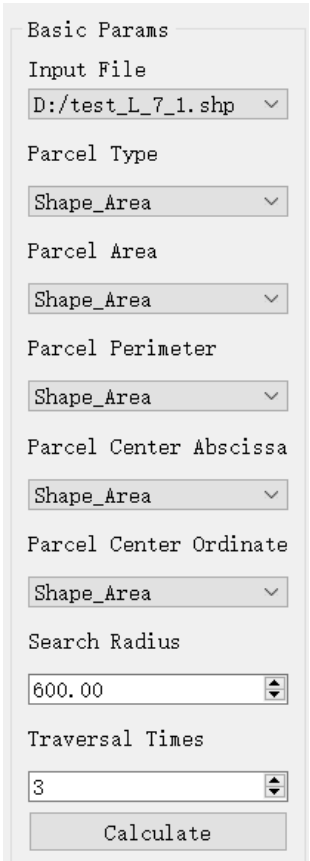
First, users should ***select*** a vector file for processing. Options in the "Input File" drop-down box include all the vector files that have been imported into the system. The drop-down box for selecting vector files is shown as below:



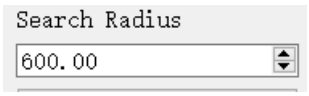
3.6.3. Parameter Settings

Users are asked to ***set*** necessary parameters for vector-based landscape index calculation. Parameters include: 1). Parcel Type; 2). Parcel Area; 3). Parcel perimeter; 4). Parcel Center Abscissa; 5). Parcel Center Ordinate; 6).Search Radius; and 7).Traversal Times

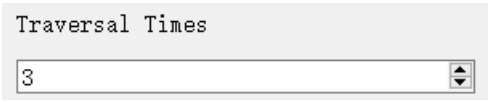
The first five parameters are ***set*** through the parameter setting drop-down box.



Search radius, the sixth parameter, sets the initial radius value for optimal search radius mining. The parameter has to be manually ***entered*** by users.



Traversal Times, the seventh parameter, is used to determine the fuzzy search range for the optimal radius mining. The parameter has to be manually ***entered*** by users.

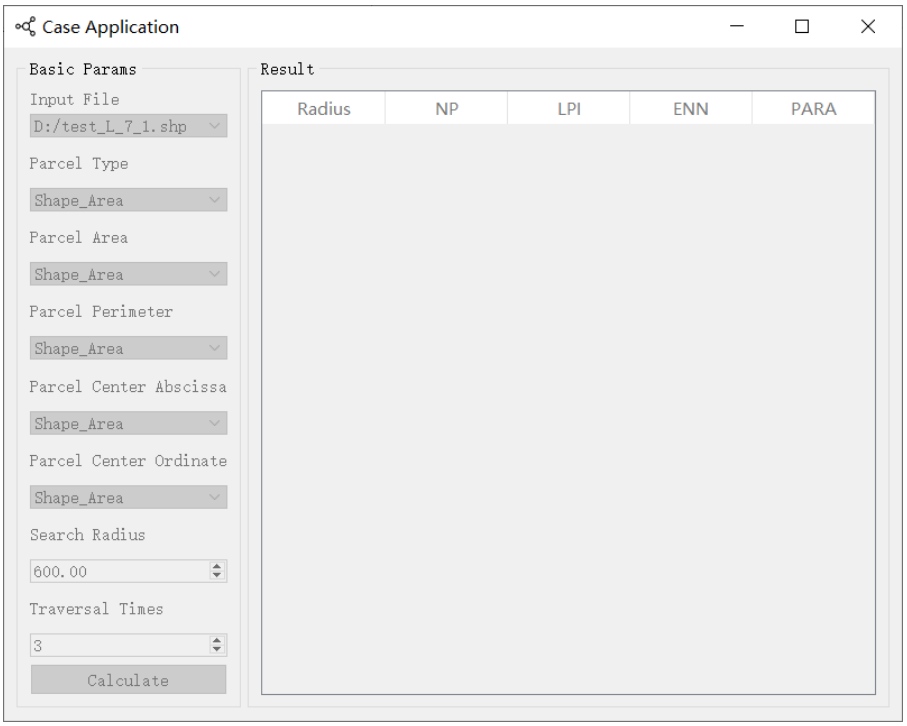


3.6.4. Optimal Search Radius Mining

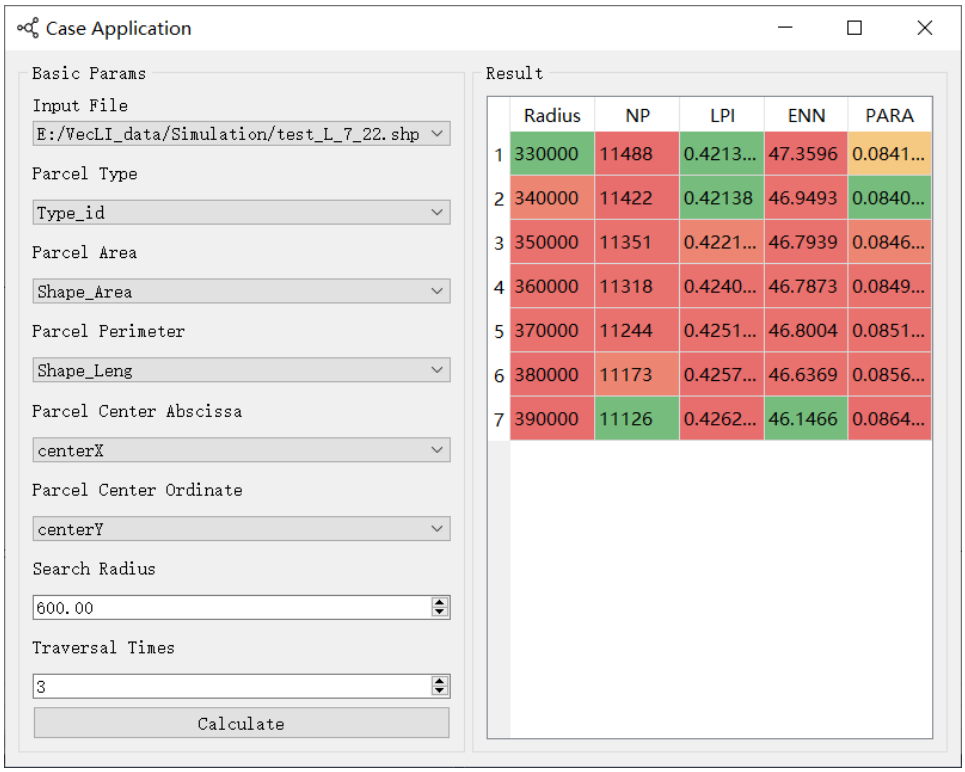
Click the "Calculate" 

button to start the optimal search radius mining after all the parameter settings are done.

The optimal search radius mining module will be temporarily locked while the program is running. A running sample is shown as below:



The system will immediately display the calculation result. A sample calculation result is shown as below:


Case Application
Basic Params
Input File
E:/VecLI_data/Simulation/test_L_7_22.shp
Parcel Type
Type_id
Parcel Area
Shape_Area
Parcel Perimeter
Shape_Leng
Parcel Center Abscissa
centerX
Parcel Center Ordinate
centerY
Search Radius
600.00
Traversal Times
3
Calculate
Result
Radius NP LPI ENN PARA
1 330000 11488 0.4213... 47.3596 0.0841...
2 340000 11422 0.42138 46.9493 0.0840...
3 350000 11351 0.4221... 46.7939 0.0846...
4 360000 11318 0.4240... 46.7873 0.0849...
5 370000 11244 0.4251... 46.8004 0.0851...
6 380000 11173 0.4257... 46.6369 0.0856...
7 390000 11126 0.4262... 46.1466 0.0864...

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UrbanVCA: Urban Land-use Simulation and Prediction System based on Real Land-parcels

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Related references:

[1] Yao, Y., Liu, X., Li, X., Liu, P., Hong, Y., Zhang, Y., & Mai, K. (2017). Simulating urban land-use changes at a large scale by integrating dynamic land parcel subdivision and vector-based cellular automata. International Journal of Geographical Information Science, 31(12), 2452-2479.

[2] Zhai, Y., Yao, Y., Guan, Q., Liang, X., Li, X., Pan, Y., ... & Zhou, J. (2020). Simulating urban land use change by integrating a convolutional neural network with vector-based cellular automata. International Journal of Geographical Information Science, 34(7), 1475-1499.