

Simulating the driving effects of planning policies or future variables on LUCC with the PLUS model



Team: High-performance Spatial Computational Intelligence Lab @ CUG

Contact: Dr. Xun Liang (liangxun@cug.edu.cn)

Supervised by: Prof. Qingfeng Guan (guanqf@cug.edu.cn)

China University of Geosciences

School of Geography and Information Engineering

National Engineering Research Center of GIS

CONTENT

- 1. Methodology**
- 2. Consider the driving effects of planning transport infrastructure on LUCC**
- 3. Consider the driving effects of development zone on LUCC**

Note that these functions are only integrated into PLUS v1.3.5 and later versions. Please learn tutorial A before reading this tutorial. The planning data in this tutorial is the dummy data for the model test. Please don't regard them as the real planning data.

01

Methodology

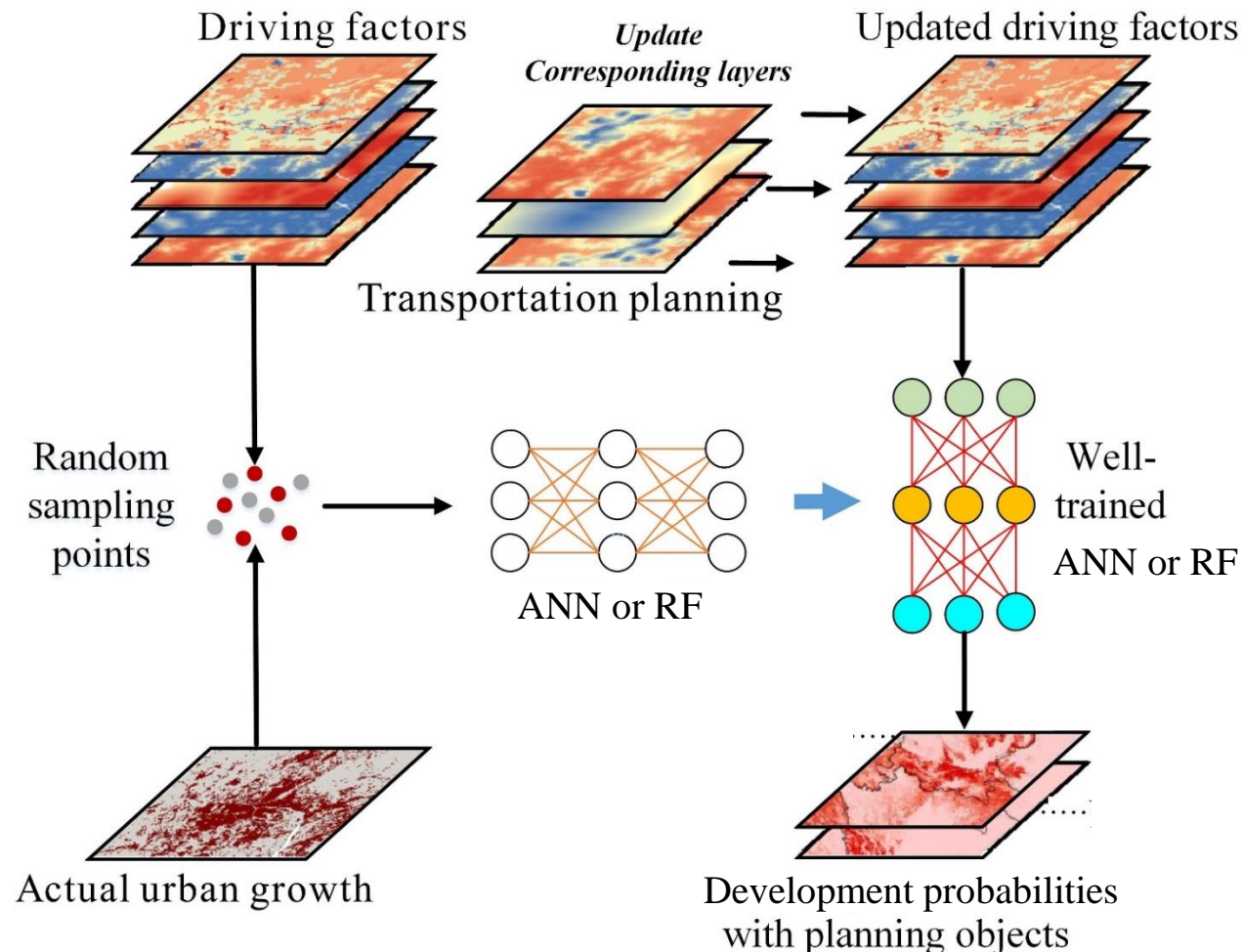
We used an updated mechanism of planning transport infrastructure based on random forest (RF) and a random seeding mechanism based on planning development zone, which can consider the driving effects of planning policies or future variables on LUCC into the simulation.

This study only considers planning policies in space, not macro-scale policies, including 1) planning traffic lines or sites and 2) planning development zone. Moreover, predicted variables exported by other models can also be imported to the PLUS model in the same way, for example, the future population, GDP, temperature, precipitation, etc.

References: Liang, X., Liu, X., Li, D., Zhao, H., Chen, G., 2018, Urban growth simulation by incorporating planning policies into a CA-based future land-use simulation model, International Journal of Geographical Information Science, 32(11): 2294-2316. (ESI highly cited paper)

Liang X., Guan Q.*, Clarke KC, Liu S., Wang B., Yao Y., 2021. Understanding the drivers of sustainable land expansion using a patch-generating simulation (PLUS) model: A case study in Wuhan, China, Computers, Environment and Urban Systems, 85:101569

Flowchart



- First, sampled land-use map data and historical driving force data are employed to train the RF.
- The driving factors that will be updated are specified in this step (only driving factors with both historical and planning schemes (or future variables) can be updated).
- In the RF prediction process, the historical driving forces in the specified layers are replaced with data that include both historical and future driving forces and output the development probabilities.

Flow chart

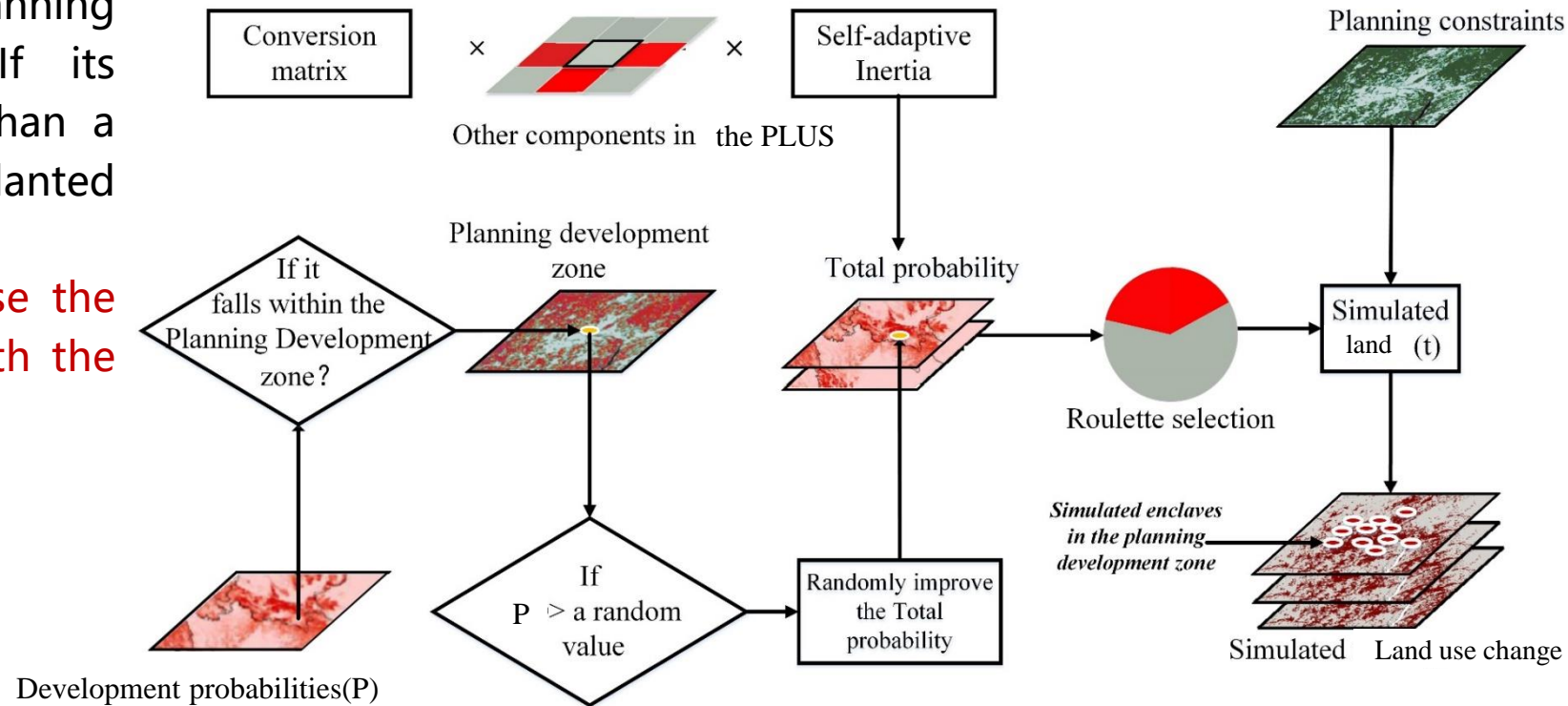
- A cell that is located in the planning development zones is selected. If its development probability is greater than a random value within [0, 1], a seed is planted in the cell.
- A planted seed will randomly increase the total probability of an urban area with the following rule:

$$TP_k = \begin{cases} (r + TP_k) \times w & \text{if } r + TP_k \leq 1 \\ 1 \times w & \text{if } r + TP_k > 1 \end{cases}$$

TP_k - denotes the total probability of specific land k

r - a random value within [0, 1]

w - the weight of the strength of planning development zones



02

**Consider the driving effects of
planning transport
infrastructure on LUCC**



Link : https://github.com/HPSCIL/Patch-generating_Land_Use_Simulation_Model

master 1 branch 0 tags

Go to file **Code**

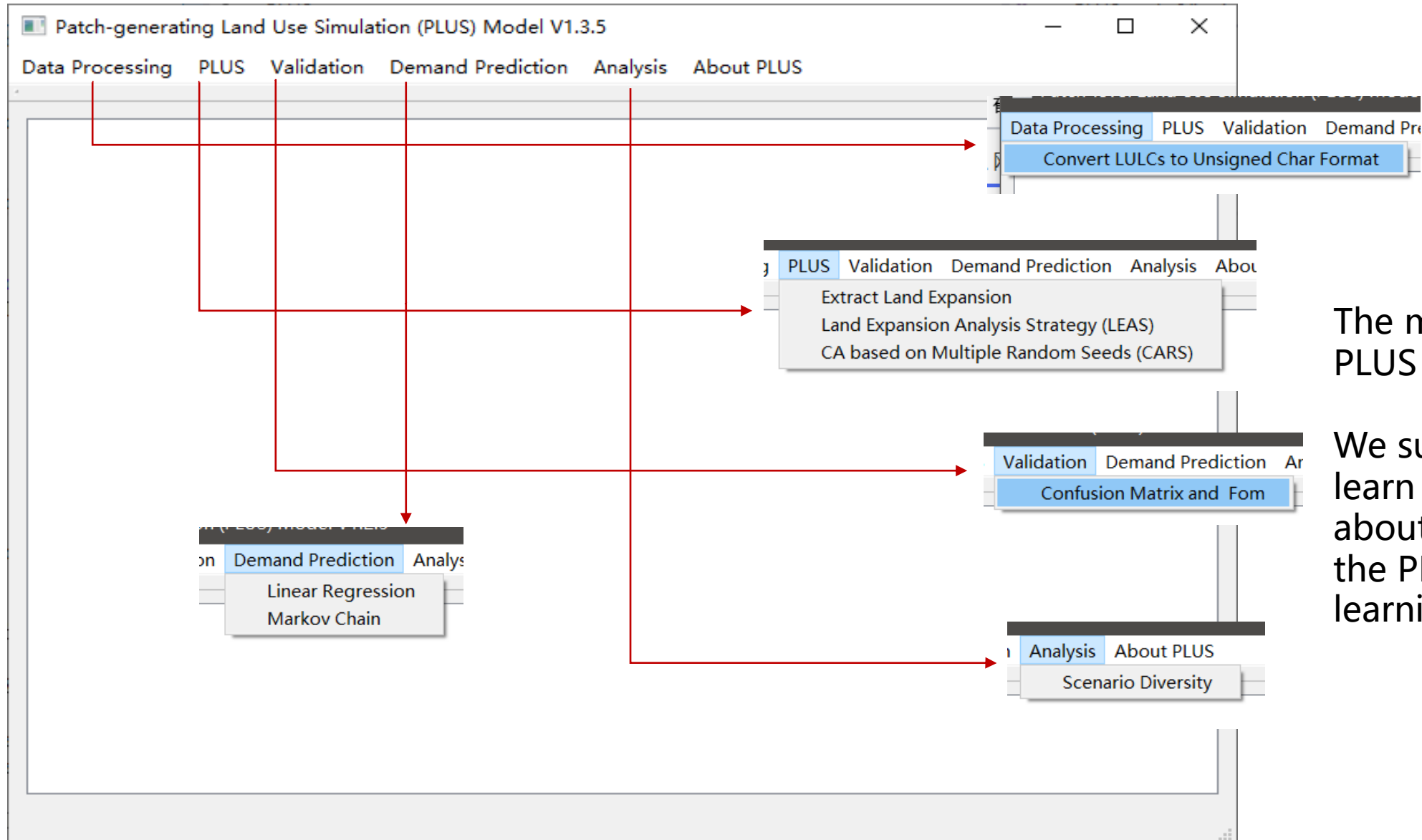
Xun2018 update 5499384 13 days ago 87 commits		
iconengines	update	2 years ago
imageformats	update	2 years ago
platforms	update	2 years ago
styles	update	2 years ago
translations	update	2 years ago
PLUS v1.3.0.exe	update	13 days ago
PLUS_test_data.rar	update	9 months ago
README.md	Update README.md	8 months ago
User Manual PLUS -20210425-Eng.pdf	update	3 months ago
pic1.png	update	9 months ago
pic2.png	update	15 months ago
plus模型原理和软件介绍-v6.5.pdf	update	3 months ago

Click here to download

- iconengines
- imageformats
- Parameterfile
- platforms
- styles
- translations
- Tutorials_Eng
- 教程 (中文)
- pic1.png
- pic2.png
- PLUS v1.3.5.exe
- PLUS_test_data.rar
- README.md

Click here to start

PLUS can run in the environment of Windows Vista/7/8/X64 without install process and the support of other software.



The main interface of the PLUS software.

We suggest the users learn tutorial A to know about all the modules of the PLUS model before learning this tutorial.

Add in the planning traffic data



LEAS

Input Raster

Land expansion map 1 C:/Users/HP/Downloads/PLUS/PLUS_test_data/change03_13_landuse_1to2.tif

T1→T2

Folder of driving factors C:/Users/HP/Downloads/PLUS/PLUS_test_data/drivingfactor/

File list in the folder

1	C:/Users/HP/Downloads/PLUS/PLUS_test_data/drivingfactor/Dis to TertiaryHistory2.tif	Corresponding future variable(optional)
2	C:/Users/HP/Downloads/PLUS/PLUS_test_data/drivingfactor/wh Pop.tif	Corresponding future variable(optional)
3	C:/Users/HP/Downloads/PLUS/PLUS_test_data/drivingfactor/wh df dem.tif	Corresponding future variable(optional)
4	C:/Users/HP/Downloads/PLUS/PLUS_test_data/drivingfactor/wh df pre.tif	Corresponding future variable(optional)
5	C:/Users/HP/Downloads/PLUS/PLUS_test_data/drivingfactor/wh df slope.tif	Corresponding future variable(optional)
6	C:/Users/HP/Downloads/PLUS/PLUS_test_data/drivingfactor/wh df tem.tif	Corresponding future variable(optional)
7	C:/Users/HP/Downloads/PLUS/PLUS_test_data/drivingfactor/wh dist gov.tif	Corresponding future variable(optional)
8	C:/Users/HP/Downloads/PLUS/PLUS_test_data/drivingfactor/wh dist highspdstation.tif	Corresponding future variable(optional)

☐ Uniform sampling

Random Forest Regression (RFR)

Number of regression tree 20 Sampling rate 0.01 mTry 16

Output Raster

Development potential C:/Users/HP/Downloads/PLUS/PLUS_test_data/result/DevProb.tif

Operating Parameters

Thread 4

Start

Input&Output

- ✓ Land expansion map (see tutorial A to know how to obtain this file)
- ✓ Driving factors of LUCC
- ✓ **Import the planning policies or future variables (optional)**
- ✓ Output path

Other parameters

- ✓ See tutorial A

Multi-thread to reduce running time

Add in the planning traffic data



LEAS

Input Raster

Land expansion map 1 C:/Users/HP/Downloads/PLUS/PLUS_test_data/change03_13_landuse_1to2.tif

T1→T2

Folder of driving factors C:/Users/HP/Downloads/PLUS/PLUS_test_data/drinfactor/

File list in the folder

1	C:/Users/HP/Downloads/PLUS/PLUS_test_data/drinfactor/Dis to TertiaryHistory2.tif	C:/Dis_to_TertiaryDummyPlanning2.tif
2	C:/Users/HP/Downloads/PLUS/PLUS_test_data/drinfactor/wh Pop.tif	Corresponding future variable(optional)
3	C:/Users/HP/Downloads/PLUS/PLUS_test_data/drinfactor/wh df dem.tif	Corresponding future variable(optional)
4	C:/Users/HP/Downloads/PLUS/PLUS_test_data/drinfactor/wh df pre.tif	Corresponding future variable(optional)
5	C:/Users/HP/Downloads/PLUS/PLUS_test_data/drinfactor/wh df slope.tif	Corresponding future variable(optional)
6	C:/Users/HP/Downloads/PLUS/PLUS_test_data/drinfactor/wh df tem.tif	Corresponding future variable(optional)
7	C:/Users/HP/Downloads/PLUS/PLUS_test_data/drinfactor/wh dist gov.tif	Corresponding future variable(optional)
8	C:/Users/HP/Downloads/PLUS/PLUS_test_data/drinfactor/wh dist highspdstation.tif	Corresponding future variable(optional)

☐ Uniform sampling

Random Forest Regression (RFR)

Number of regression tree 20 Sampling rate 0.01 mTry 16

Output Raster

Development potential C:/Users/HP/Downloads/PLUS/PLUS_test_data/result/devprob.tif

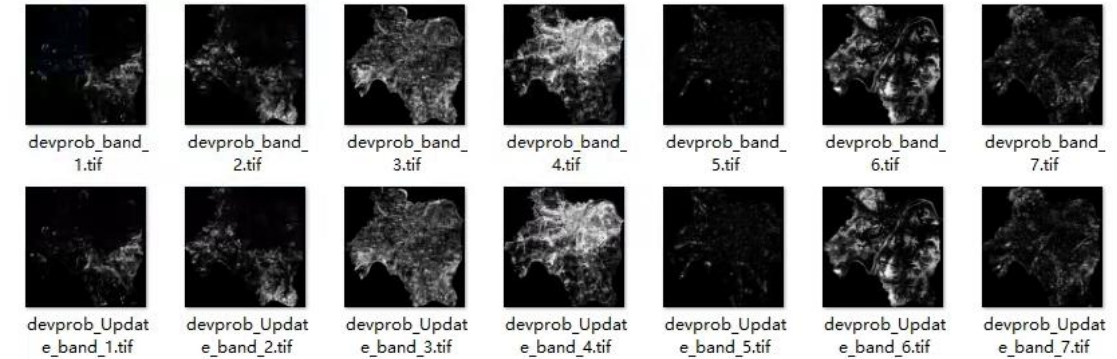
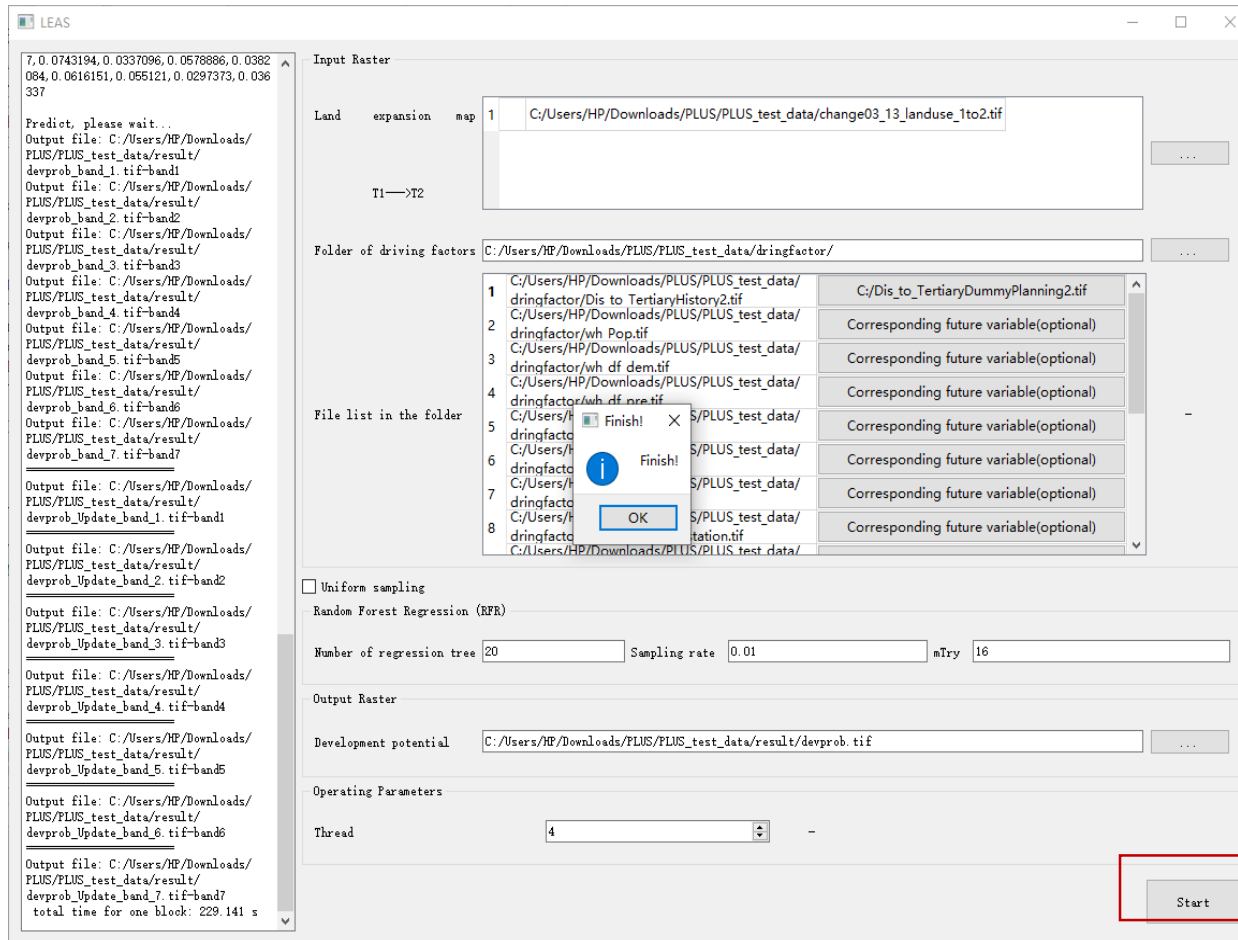
Operating Parameters

Thread 1

Start

✓ Click the button that corresponding to the proximity to the historical tertiary road "Dis_toTertiaryHistory2.tif" to import the planning tertiary road data "Dis_to_TertiaryDummyPlanning.tif" (All the test data can be found in the zip file PLUS_test_data.rar)

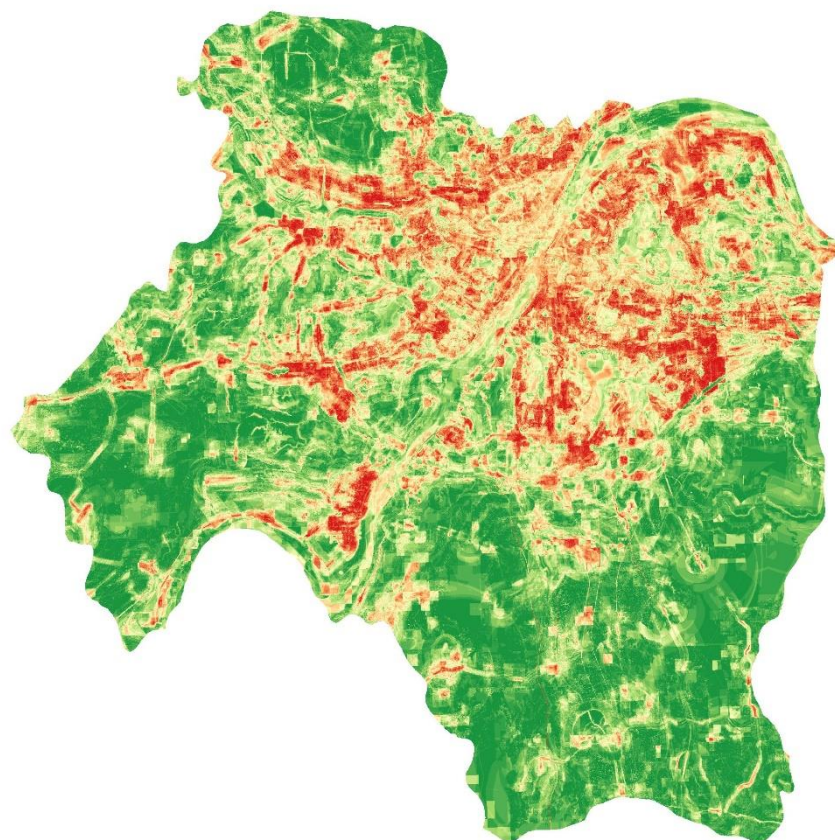
- ✓ Click the “Start” button and wait for the output files.



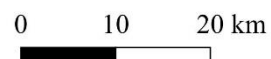
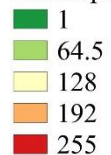
- ✓ Output two groups of development probabilities:
devprob_Update_band1-7.tif: development probabilities under the influences of planning policies, which is the input of the next step.

devprob_band1-7.tif: development probabilities without the influences of planning policies, which is used to compare with the one with the influences of planning policies.

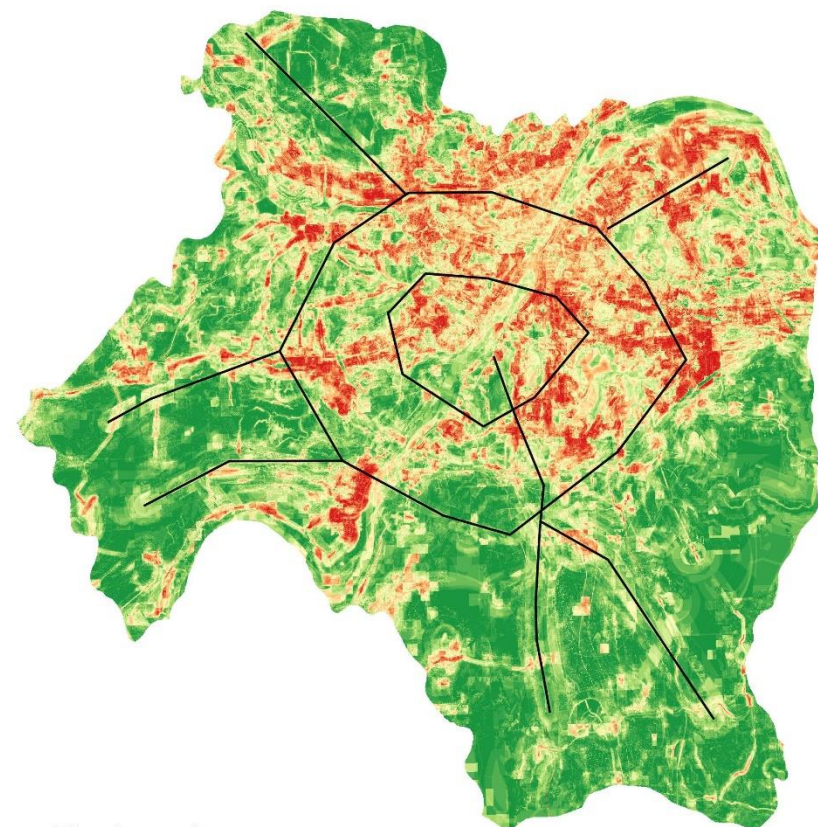
Urban development potential without the influences of planning policies



Development probability (project to 1-255)

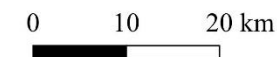
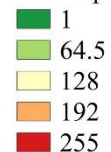


Urban development potential under the influences of planning policies



— Planning tertiary

Development probability (project to 1-255)



03

**Consider the driving effects of
development zones on LUCC**

Add in the planning development zones



CARS

Neighborhood Size Thread

Data Preparation

Land use pattern

Development potential

Conversion constraint ☐ Development Zone

Output Path

Patch generation threshold Expansion coefficient Percentage of seeds

Color ☐ Dynamic Display

Parameter Stop Run

The higher the percentage of seeds, the more dispersed for the land use pattern ✓

Development type ☒ Development Zone

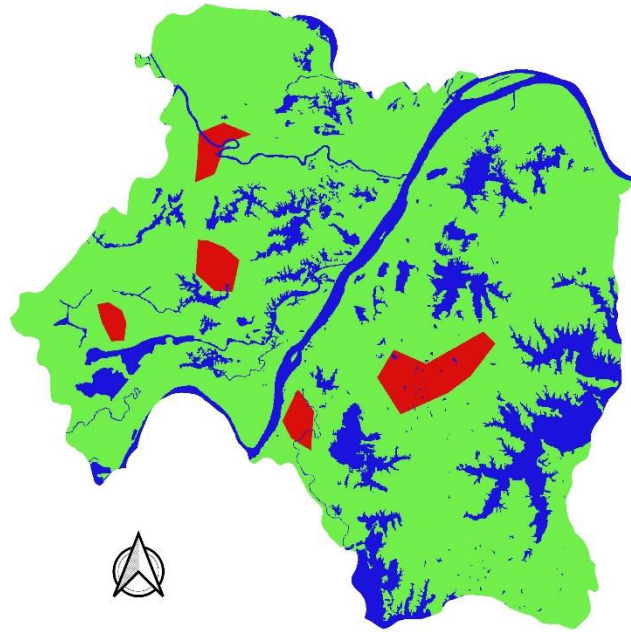
Development weight ...

ent Percentage of seeds

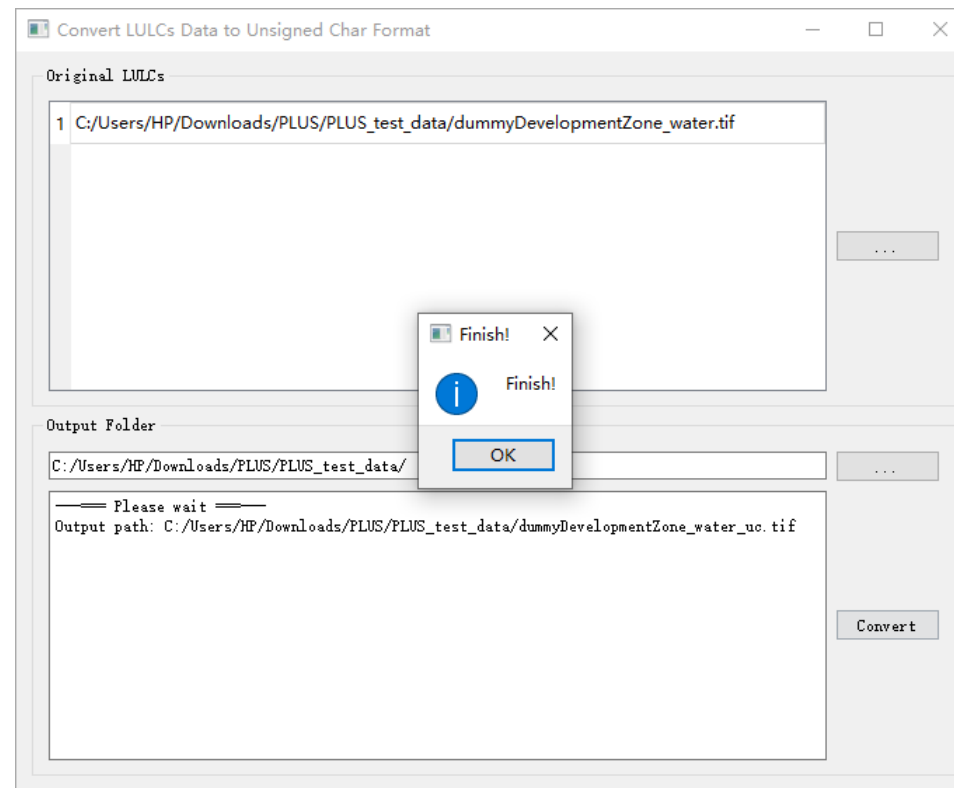
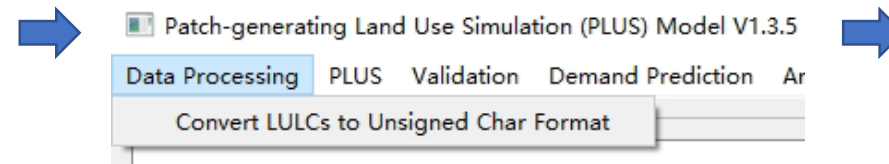
- ✓ Click the "Development Zone" checkbox to active the "Development type" and "Development weight" parameters

"Development Zone" is used to defining the land use type that is influenced by the planning policies; "Development weight" ranges from 0-1, which is used to defining the strength of the planning policies.

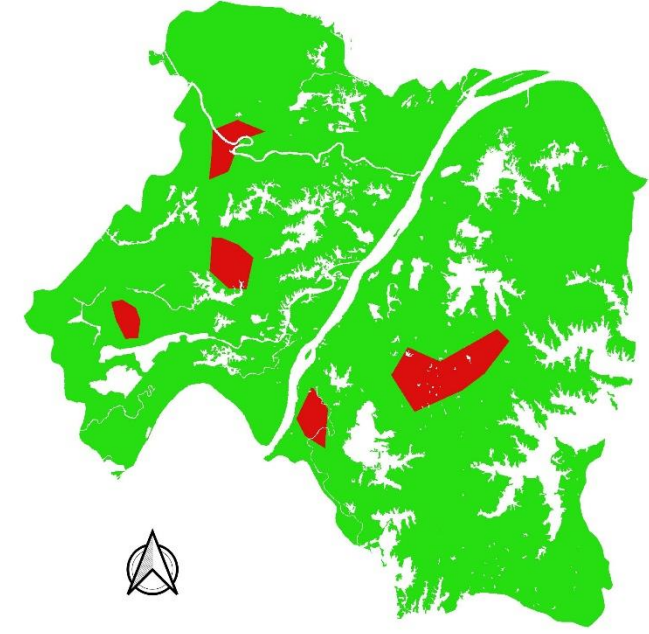
Make the “conversion constraints area and planning development zones”, the value of conversion constraints area is 0, and the value of planning development zone is 2. Value 1 means transitions are allowed.



Import this file to the conversion tools of the PLUS model to convert it to ‘unsigned char’ format.



The value 0 will be converted to nodata value in this tool and will not be shown in the final results.





CARS

Neighborhood Size Thread

Data Preparation

Land use pattern

Development potential

1 C:/Users/HP/Downloads/PLUS/PLUS_test_data/result/devprob_Update_band_1.tif
 2 C:/Users/HP/Downloads/PLUS/PLUS_test_data/result/devprob_Update_band_2.tif
 3 C:/Users/HP/Downloads/PLUS/PLUS_test_data/result/devprob_Update_band_3.tif
 4 C:/Users/HP/Downloads/PLUS/PLUS_test_data/result/devprob_Update_band_4.tif
 5 C:/Users/HP/Downloads/PLUS/PLUS_test_data/result/devprob_Update_band_5.tif
 6 C:/Users/HP/Downloads/PLUS/PLUS_test_data/result/devprob_Update_band_6.tif

Conversion constraint

1 C:/Users/HP/Downloads/Patch-generating_La Development type ☒ Development Zone
 Development weight

Simulation result

Patch generation threshold Expansion coefficient Percentage of seeds

Weights Transition Matrix Land Demands

	Type 1	Type 2	Type 3	Type 4	Type 5	Type 6	Type 7
Start Amounts	0	0	0	0	0	0	0
Future Amounts 1	147705	308025	1377648	1998479	39707	1355776	98729

Color ☒ Dynamic Display

Parameter Stop Run

Initial land use data

Development potential

The value of urban land is 4 in this data. When the value is 0, the development zone will not take effect.

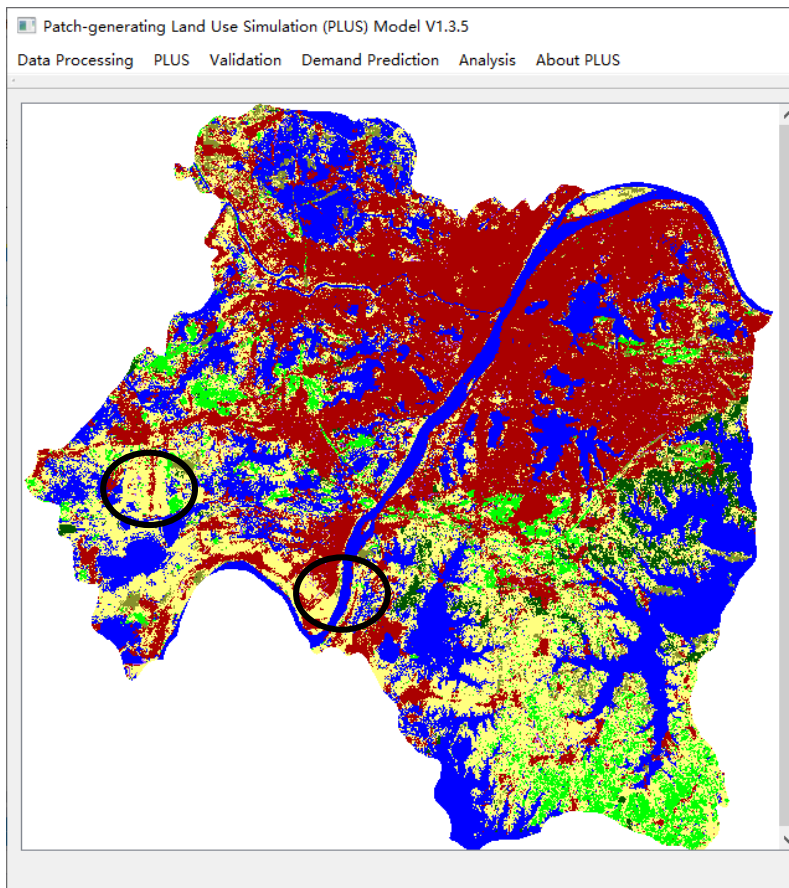
The default development weight is 0.5.

See tutorial A to know about the calculation of future Land use demand.

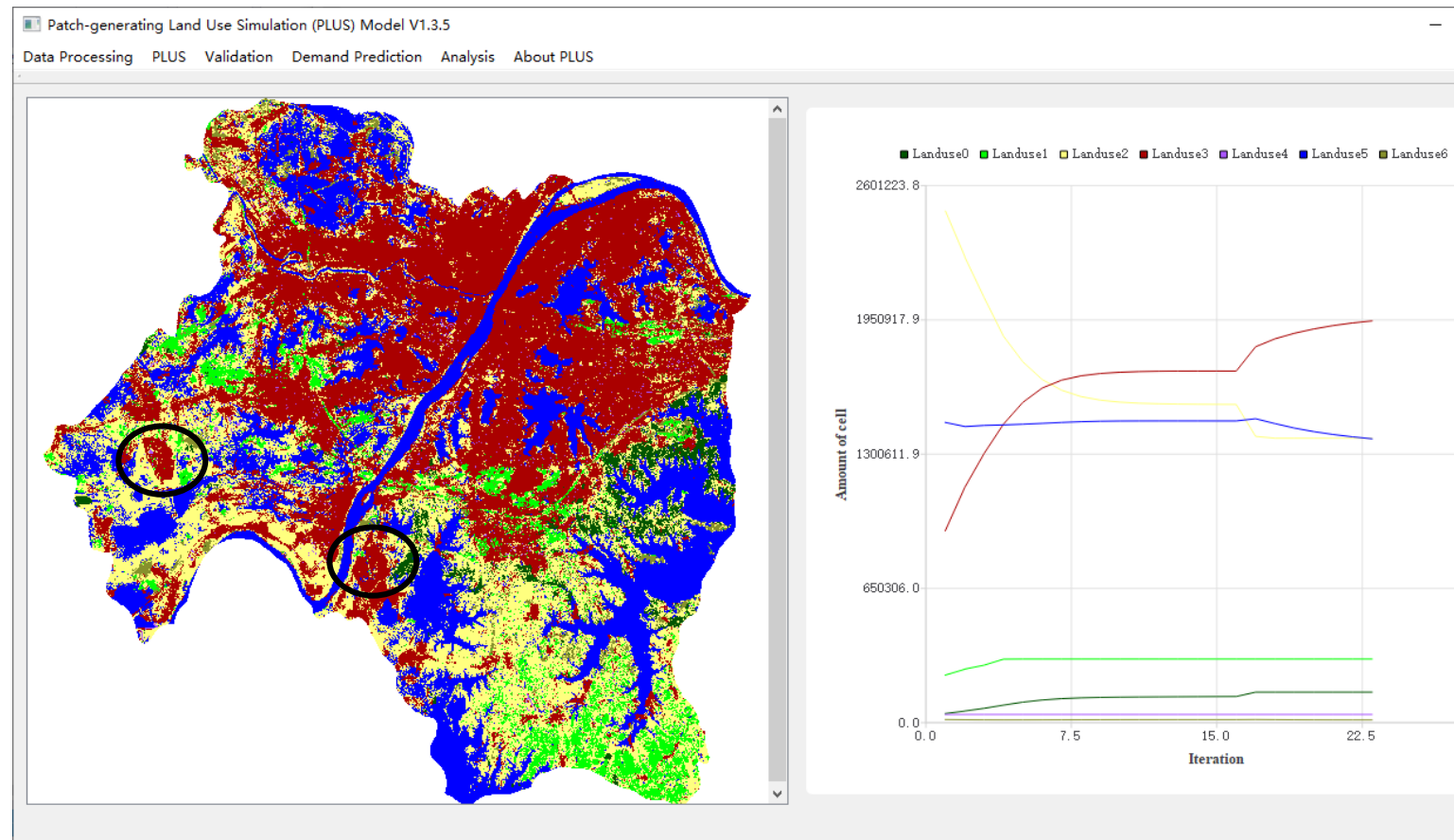
Click the 'Run' button to start simulation.

Import the conversion constraints area and planning development zones here:

The picture on the left is the result without the influences of planning development zones



The picture on the right is the result under the influences of planning development zones. We can see the newly developed urban patches affected by the planning development zones.





Team: High-performance Spatial Computational Intelligence Lab @ CUG

Contact: Dr. Xun Liang (liangxun@cug.edu.cn)

Supervised by: Prof. Qingfeng Guan (guanqf@cug.edu.cn)

China University of Geosciences

School of Geography and Information Engineering

National Engineering Research Center of GIS

Thanks!

