

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



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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 in PLUS v1.3.5 and later versions. Please learning tutorial A before reading this tutorial . The planning data in this tutorial is the dummy data for model test. Please don' t regard them as real planning data.

01

Methodology

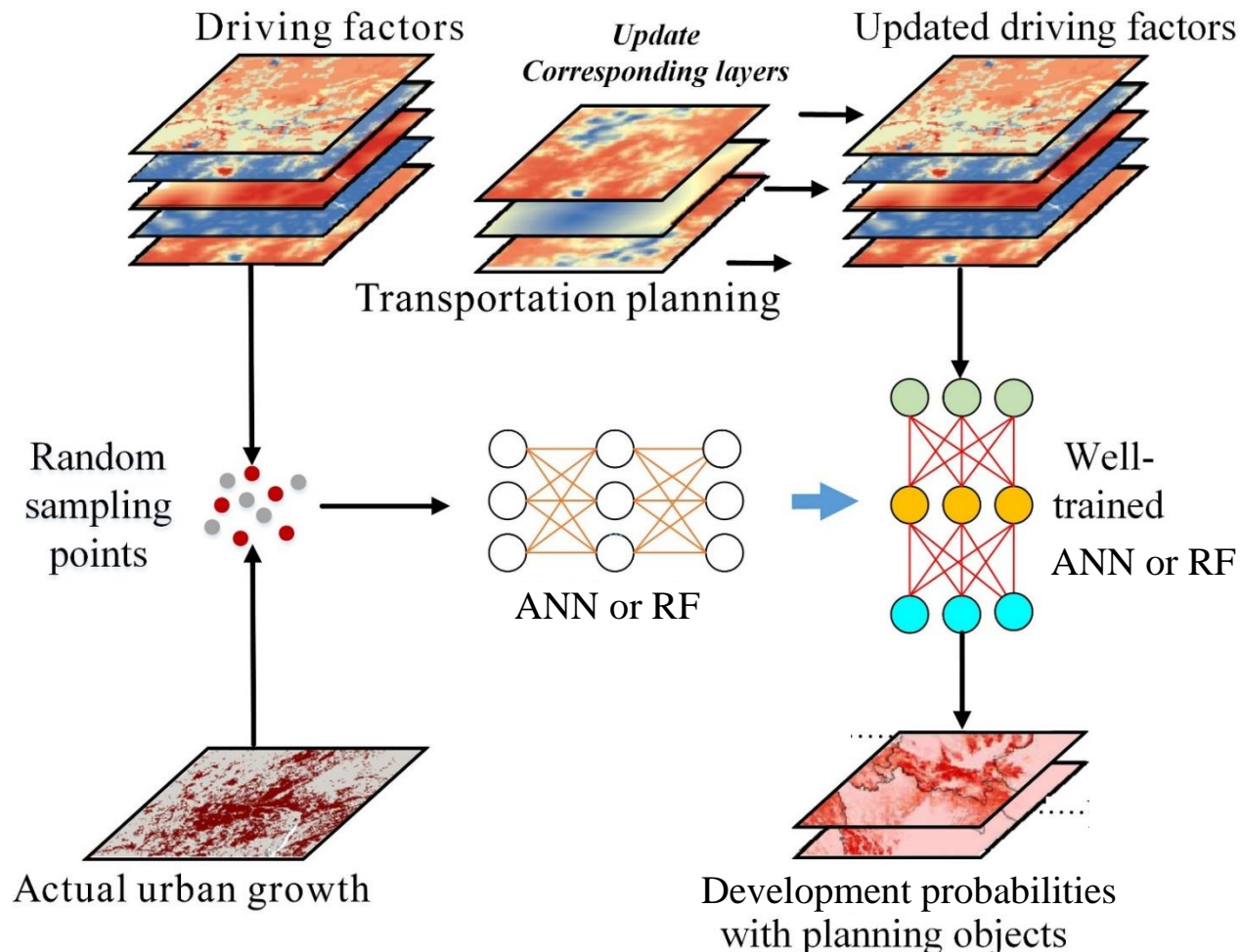
We proposed a update mechanism of planning transport infrastructure based on random forest (RF) and a random seeding mechanism based on planning development zone, which can consider the driving effects of planning policies or future variables on LUCC into simulation.

This study only consider 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 with the same way, for example, the future population, GDP, temperature, precipitation and 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

Flow chart

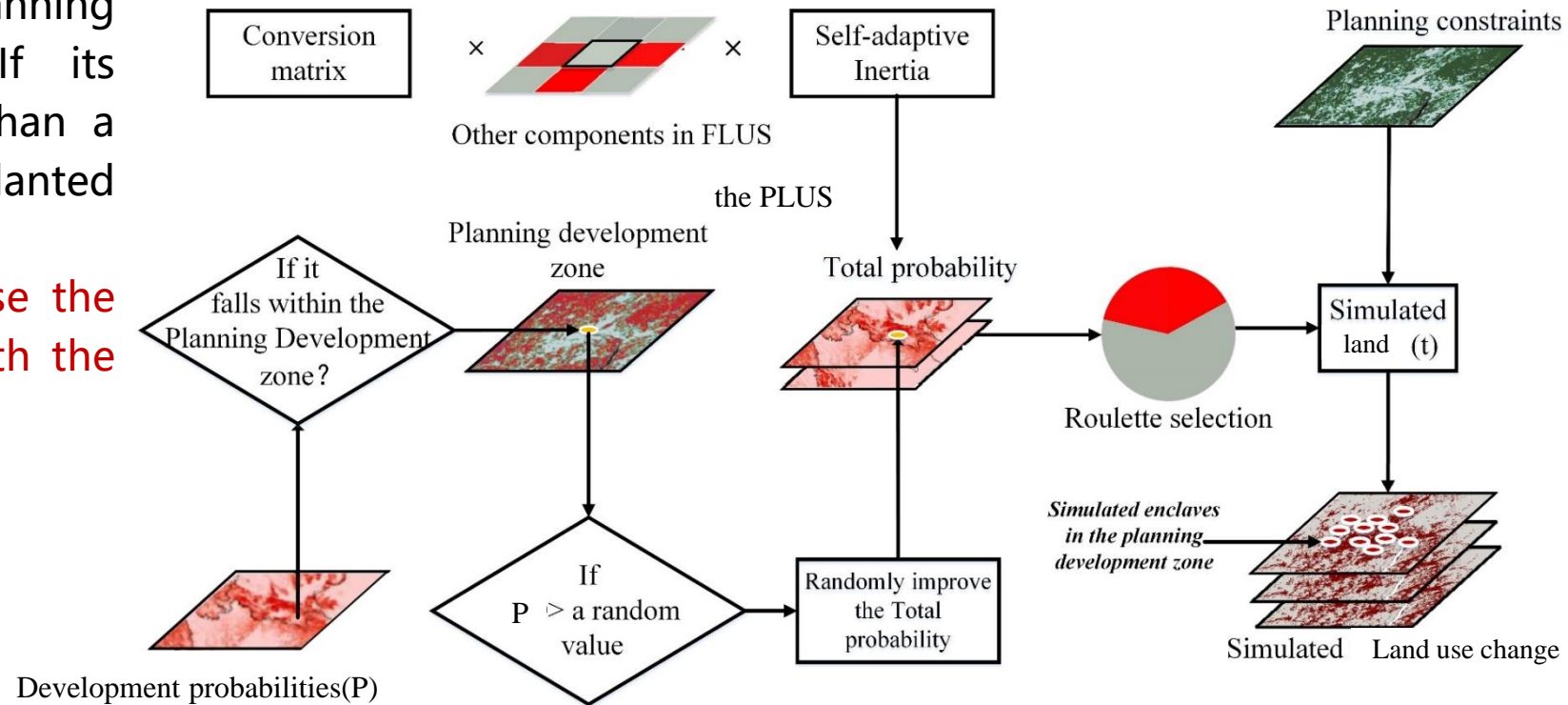


- First, sampled land-use map data and historical driving force data are employed to train the RF.
- The driving factors that will be updated are specified in this step (only driving factors with both historical and planning schemes (or future variables) can be updated).
- In the RF prediction process,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

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



TP_k - denotes the total probability of specific land k

r - a random value within [0, 1]

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

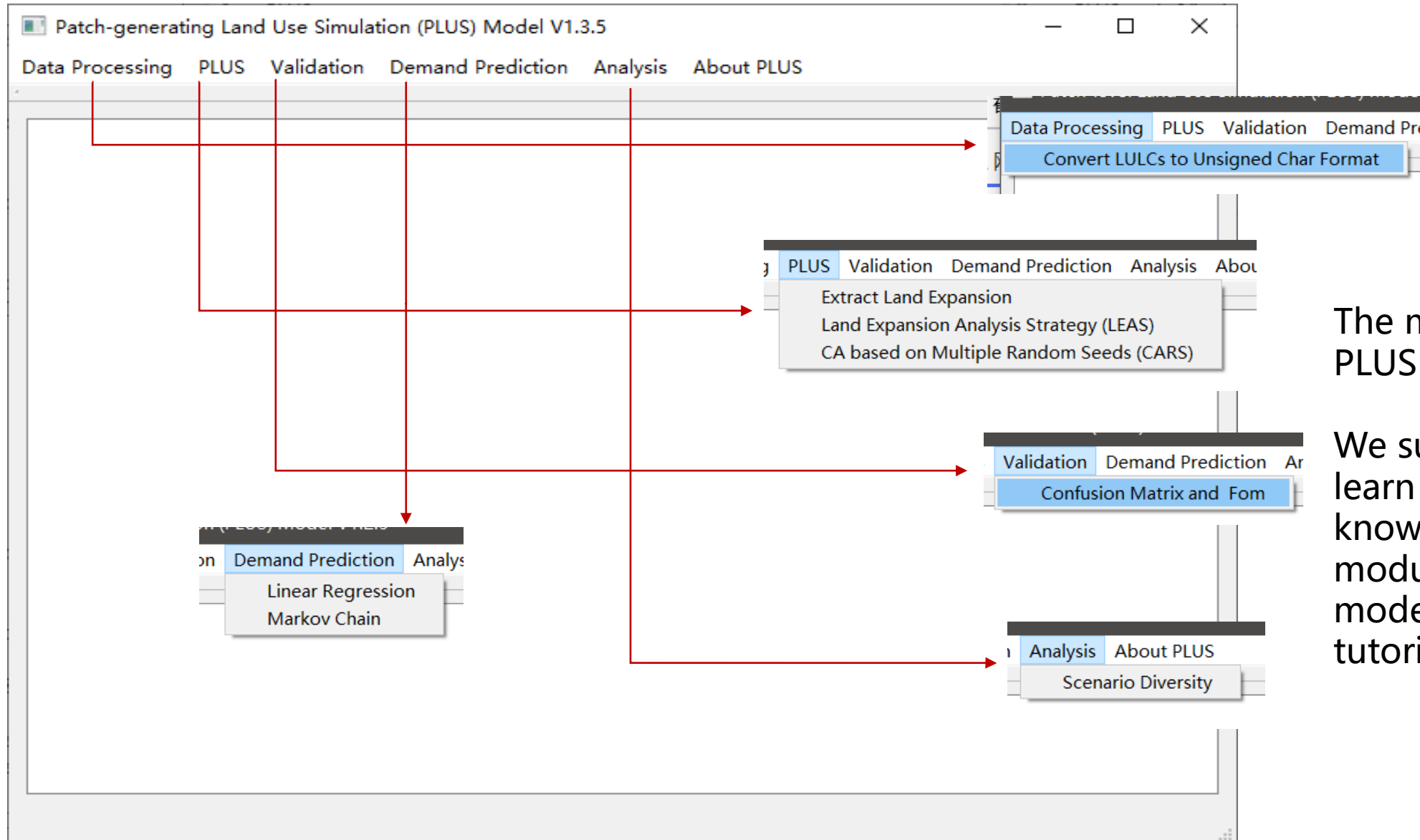
Click here to download

名称

- iconengines
- imageformats
- platforms
- styles
- translations
- pic1
- pic2
- PLUS V1.2.5
- PLUS_test_data
- README.md
- User Manual PLUS -20200219-Eng

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 the tutorial A to know about all the modules of the PLUS model before read this tutorial .

Add in the planning traffic data



Input&Output

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

Other parameters

- ✓ See tutorial A

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	Corresponding future variable(optional)
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 4

Start

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

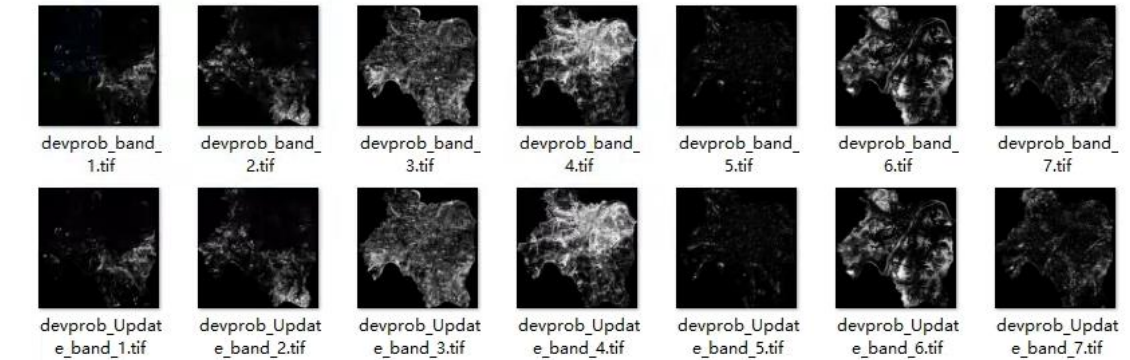
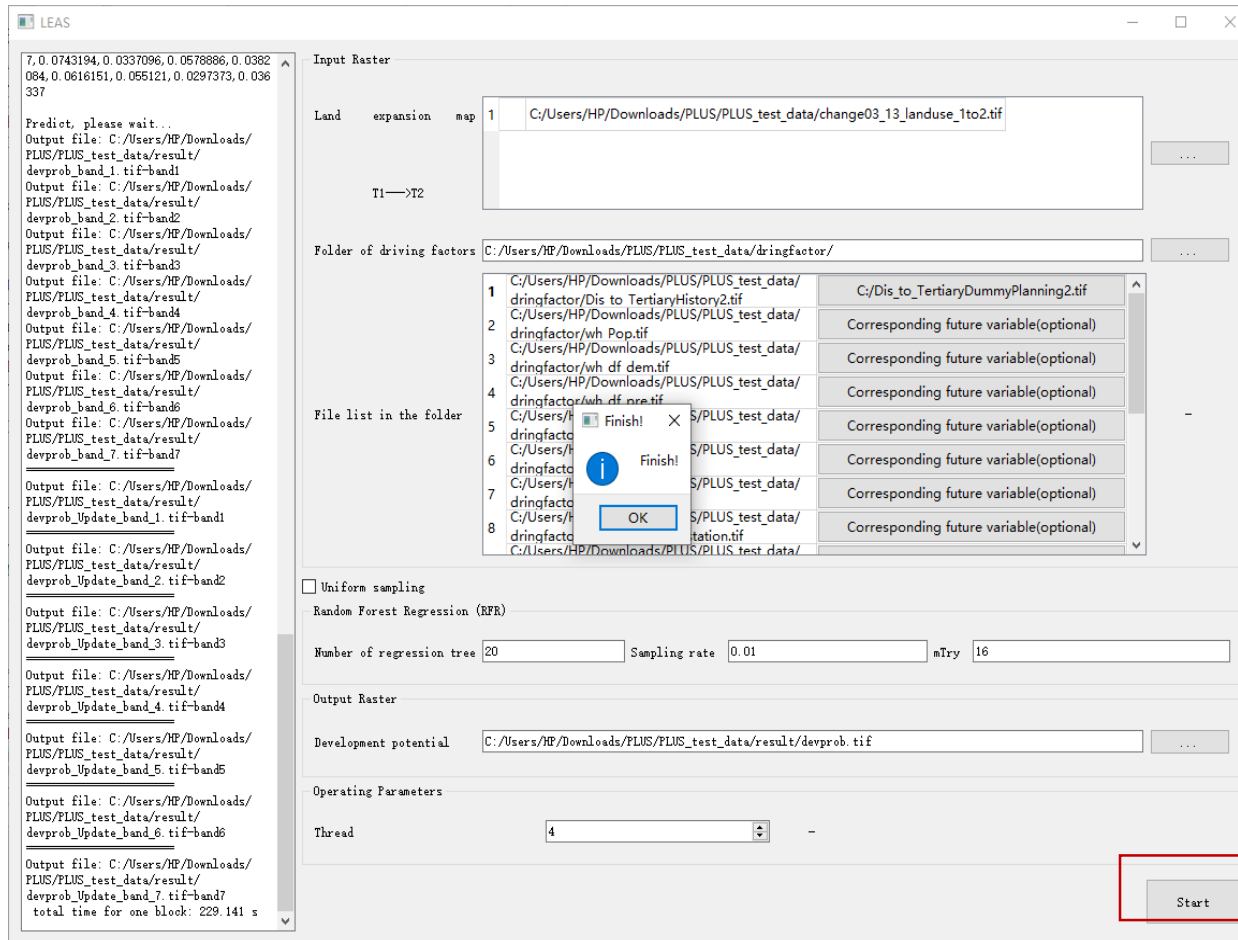
Operating Parameters

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)

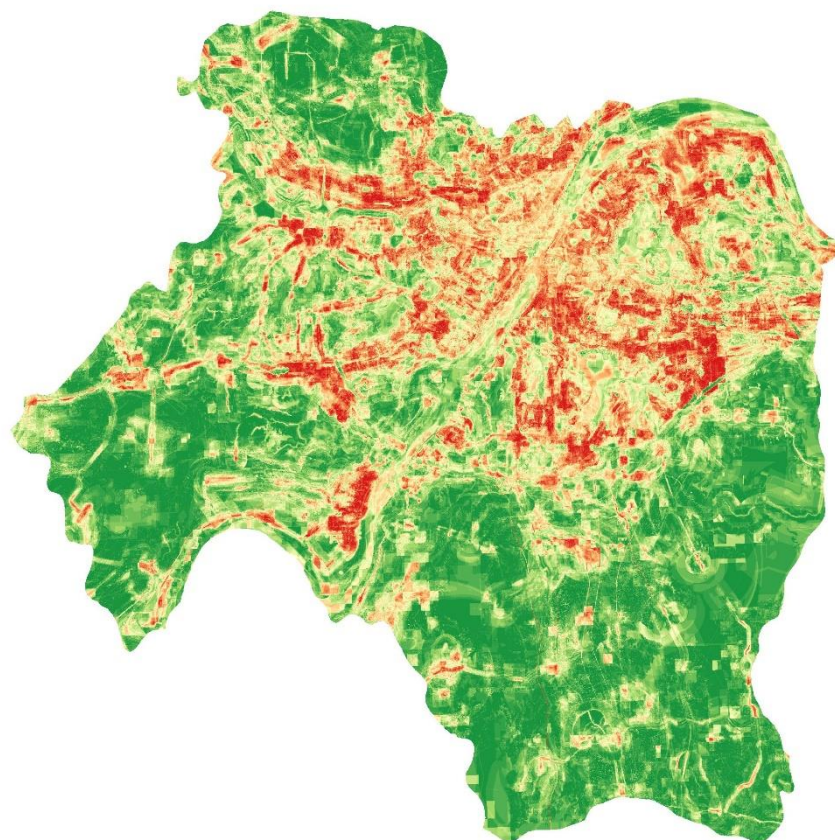
- ✓ Click “Start” button and wait for the output files



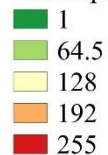
- ✓ Output two groups of development probabilities:
devprob_Update_band1-7.tif: development probabilities under the influences of planning policies, which is the input of the next step.

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



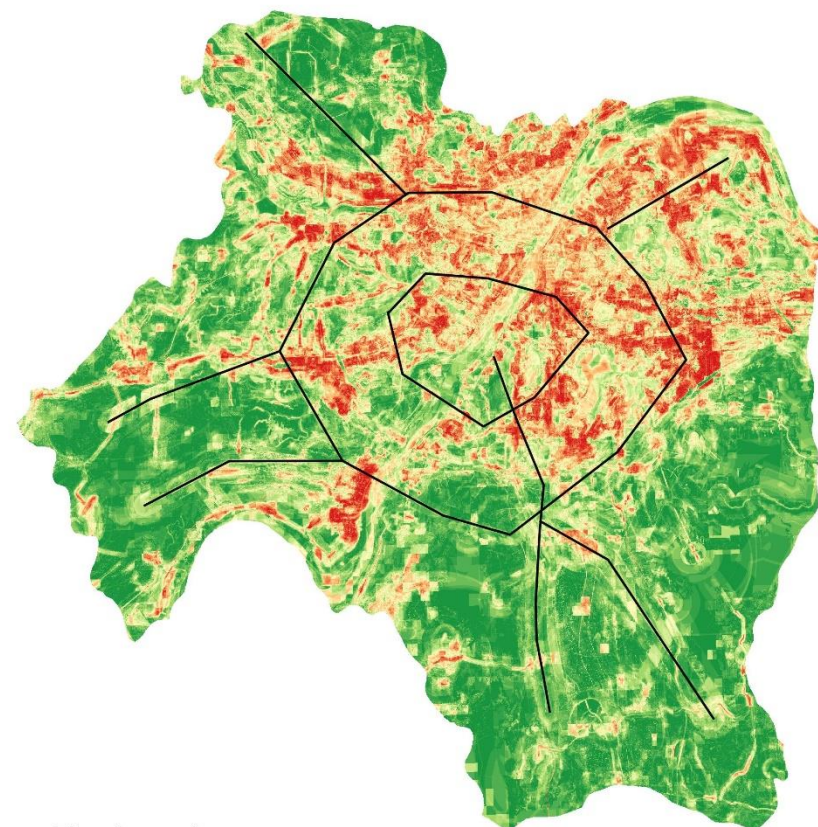
Development probability (project to 1-255)



0 10 20 km

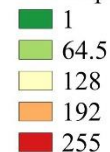


Urban development potential under the influences of planning policies



— Planning tertiary

Development probability (project to 1-255)



0 10 20 km



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 constraints ☐ 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

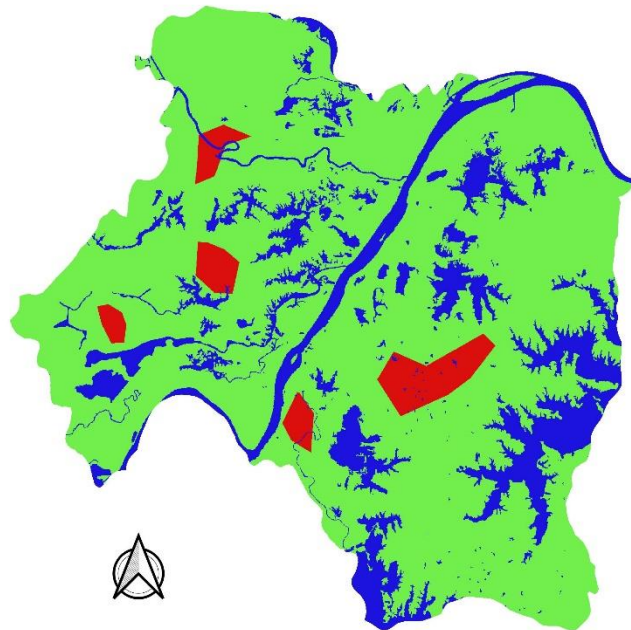
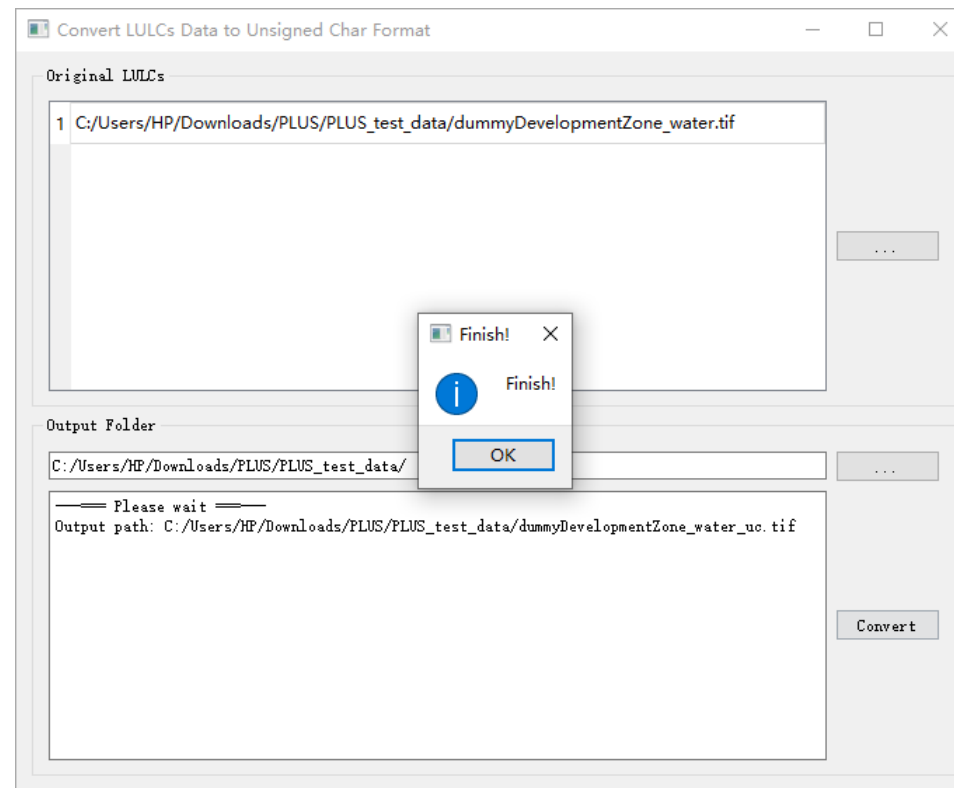
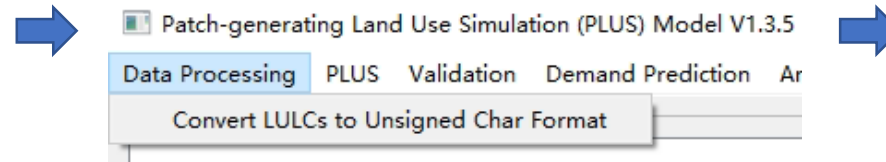
✓ Click the "Development Zone" checkbox to active the "Development type" and "Development weight" parameters

"Development Zone" is used to define the land use type that influenced by the planning policies ; "Development weight" ranges from 0-1, which is used to define 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 convert to nodata value in this tool and will not be showed in the final results.



■ Open water/coversion restrict area (value=0)
 ■ Allow conversion (value=1)
 ■ Development zone(value=2)

0 10 20 km



■ Allow conversion (value=1)
 ■ Development zone(value=2)

0 10 20 km



Import the conversion constraints area and planning development zones here:

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 effects.

The default development weight is 0.5

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

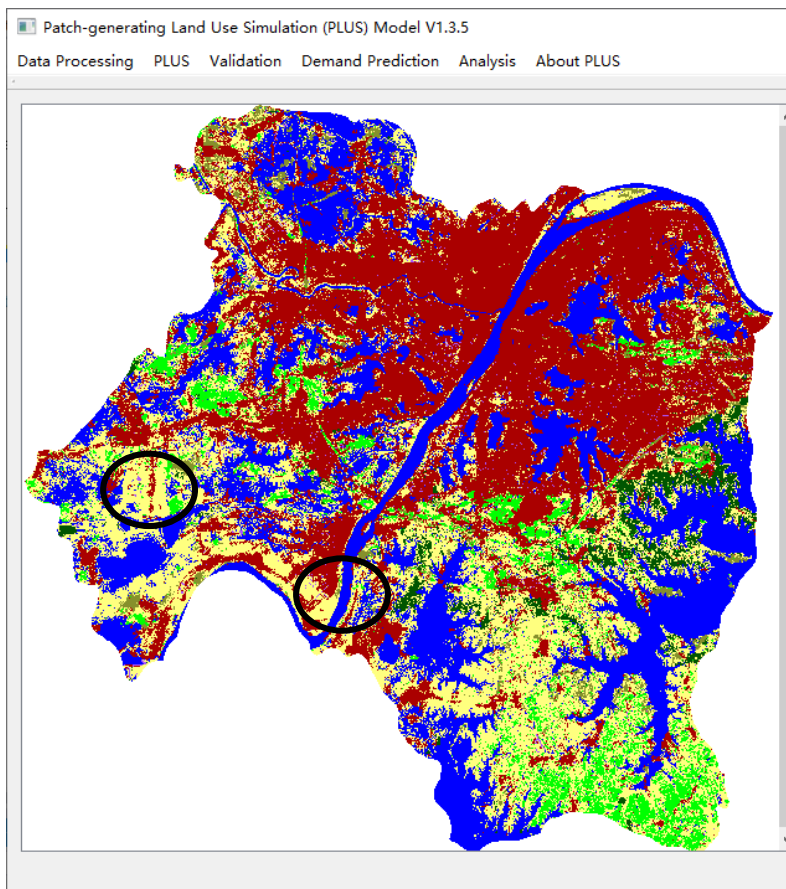
Click 'Run' to start simulation

The screenshot shows the CARS software interface with the following settings:

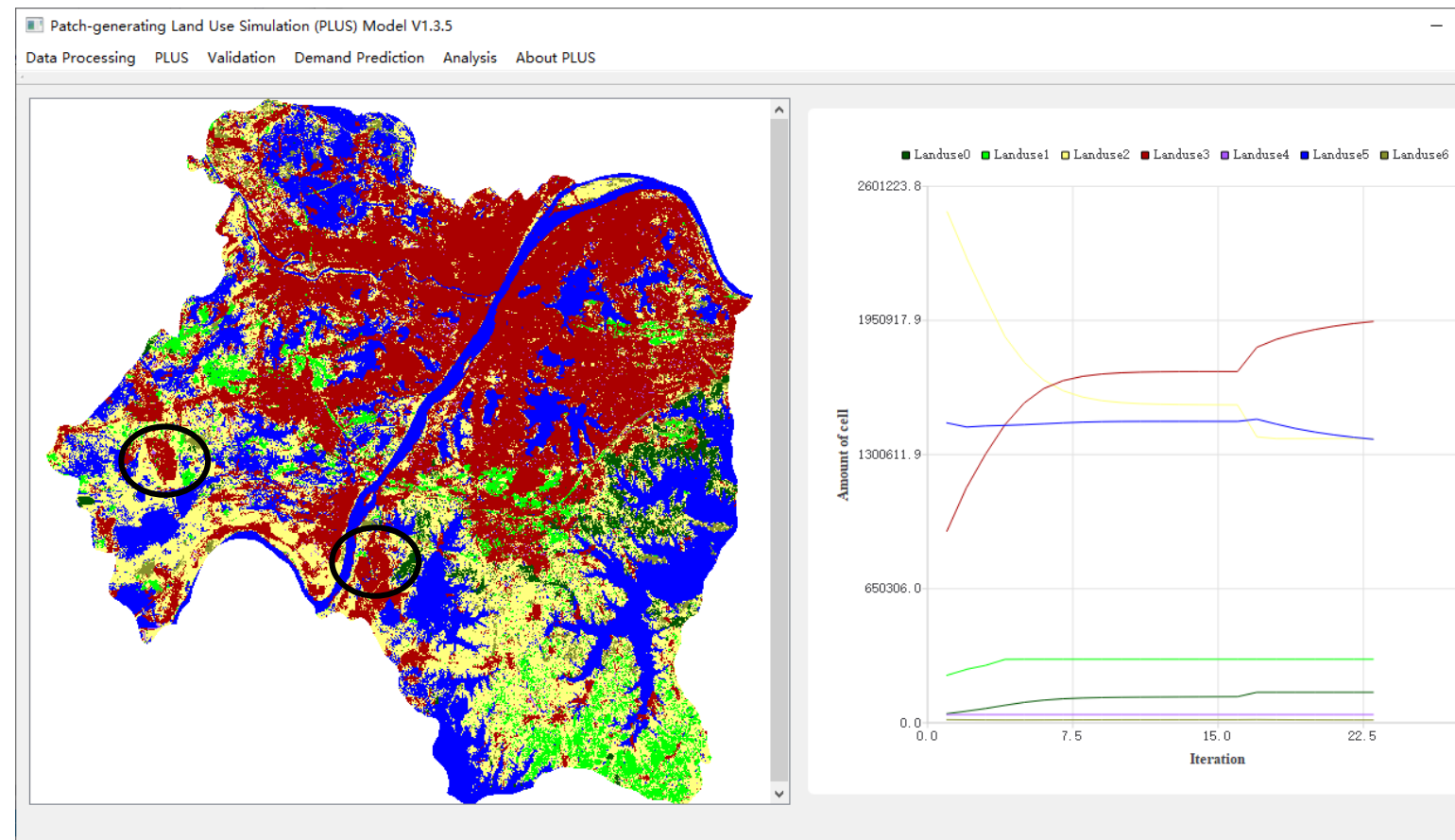
- Neighborhood Size:** 5
- Thread:** 8
- Data Preparation:**
 - Land use pattern:** C:/Users/HP/Downloads/Patch-generating_Land_Use_Simulation_Model/PLUS_test_data/LULCs/wh2013_refy.tif
 - Development potential:**
 - 1 C:/Users/HP/Downloads/PLUS/PLUS_test_data/result/devprob_Update_band_1.tif
 - 2 C:/Users/HP/Downloads/PLUS/PLUS_test_data/result/devprob_Update_band_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 constraints:** C:/Users/HP/Downloads/Patch-generating_La...
 - Development type:** 4
 - Development weight:** 0.5
 - ☒ Development Zone
 - Simulation Result:** C:/Users/HP/Downloads/PLUS/PLUS_test_data/result/simulationResult.tif
- Patch generation threshold:** 0.5
- Expansion coefficient:** 0.1
- Percentage of seeds:** 0.1
- Weights:**

	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
- Dynamic Display:** ☒
- Buttons:** Color, Parameter, Stop, Run

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 new developed urban patches affected by the planning development zones.





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Thanks!

