

### (1) The choice of driving factors

This study follows the principles of accessibility, continuity, reliability, diversity, and representativeness in the choice of driving factors [R1]-[R7]. Specifically, according to the common strategies and the accessibility and quantifiability of driving factors, this study mainly selected three natural factors such as elevation, slope, and average temperature as well as human six location factors and transportation factors as socio-economic factors, including distance from trunk road, primary/second road, highway, railway, and important towns for land use simulation of the Guangdong Hong Kong Macao Greater Bay Area (GBA) under different scenarios.

Generally, in most studies, the driving factors mainly involve the following aspects: 1) terrain factors, include elevation and slope; 2) climate factors, such as average temperature and precipitation; 3) economic factors, include population and GDP; 4) location factors, such as the distance to city center or district/county center; 5) transportation factors, such as the distance to main roads and railways, etc. The former two aspects belong to the natural factors, with the latter three aspects belonging to socio-economic factors. Due to the interaction between driving factors, it is necessary to consider the applicability of various driving factors when using them to create land use suitability maps.

In this study, the nine driving factors are selected from 1), 2), 4) and 5), except 3). The reasons mainly include three aspects. Firstly, these nine factors are widely used in most studies, which are verified to be favorable and effective for land use simulation. Secondly, these nine factors are highly correlated with land use changes and involve point, line and polygon data, which contribute to land system evolution from different perspectives, with the interactions between them being more reasonable. Thirdly, the population and GDP may be not the best option. Because the population and GDP of the GBA are highly concentrated in the Pearl River Delta region, and the impacts of these two factors on build-up land is very significant. If these two factors are used, it will lead to the growth of build-up land concentrated in the core areas, such as Hong Kong, Macao, and Shenzhen, which may be inconsistent with the regional policy and plan of driving the development of surrounding areas. Furthermore, the political and economic differences between Hong Kong, Macau, and the other inland cities in the GBA increase the accessibility difficulty of continuous population and GDP data of the GBA. Therefore, this study selects the most representative and reliable nine driving factors, including the distance from trunk road, primary/second road, highway, railway, important towns, annual mean temperature, elevation and slope.

### (2) Parameterization of the CA-Markov model

The details for the processing of driving factors and how to determine driving factor weight matrix for each land use type in AHP are given in Tables S1–S3. The Idrisi uses the fuzzy module to select the appropriate function, such as monotonically increasing (MI) or monotonically decreasing (MD) J-Shaped, Sigmoid, linear or other customized function, to complete factor standardization processing. In addition to the most important parameter settings of Idrisi CA-Markov model, the parameters for standardization processing of driving factors are set as Table S1.

Table S1. The parameters for driving factors.

LULC suitability class	Factors	Membership function	Membership function shape	Control points	Constraints
Cropland	Elevation	MD	J-Shaped	c=500, d=1000	Water
	Slope	MD	J-Shaped	c=0, d=25	
	Annual Temperature	MI	Sigmoid	a=17, b=22	
	Distance to the primary road	MI	J-Shaped	a=0.01, b=0.1	
	Distance to the railway	MI	J-Shaped	a=0.03, b=0.3	
	Distance to the highway	MI	J-Shaped	a=0.07, b=0.2	
	Distance to the secondary road	MI	J-Shaped	a=0.01, b=0.04	
	Distance to the trunk	MI	J-Shaped	a=0.04, b=0.35	
	Distance to the important town	MI	J-Shaped	a=0.04, b=0.35	
Forest and Grassland	Elevation	MI	J-Shaped	a=100, b=1000	Water
	Slope	MI	J-Shaped	a=6, b=25	
	Annual Temperature	MI	Sigmoid	a=14, b=20	
	Distance to the primary road	MI	J-Shaped	a=0.01, b=0.1	
	Distance to the railway	MI	J-Shaped	a=0.03, b=0.3	
	Distance to the highway	MI	J-Shaped	a=0.07, b=0.3	
	Distance to the secondary road	MI	J-Shaped	a=0.01, b=0.05	
	Distance to the trunk	MI	J-Shaped	a=0.04, b=0.35	
	Distance to the important town	MI	J-Shaped	a=0.08, b=0.3	
Build-up Land	Elevation	MD	Sigmoid	c=50, d=100	Water
	Slope	MD	Sigmoid	c=10, d=20	
	Annual Temperature	MI	Sigmoid	a=18, b=22	
	Distance to the primary road	MD	J-Shaped	c=0.01, d=0.06	
	Distance to the railway	MD	J-Shaped	c=0.02, d=0.05	
	Distance to the highway	MD	J-Shaped	c=0, d=0.02	
	Distance to the secondary road	MI	J-Shaped	a=0.01, b=0.03	
	Distance to the trunk	MD	J-Shaped	c=0.04, d=0.15	
	Distance to the important town	MD	J-Shaped	c=0.04, d=0.15	
Water	The suitability image comes from Markov chain				
Unused Land	The suitability image comes from Markov chain				

The analytic hierarchical process (AHP) method determines the weights for driving factors by comparing the importance of pairwise driving factors. The meaning of AHP in the Idrisi for the scale of factor importance comparison is listed in Table S2.

Table S2. The meaning of AHP for the scale of factor importance comparison.

Scale	Meaning
1	Same importance of rows and columns
3	Relative to columns, rows are slightly more important
5	Relative to columns, rows are clearly more important
7	Relative to columns, rows are much more important
9	Relative to columns, rows are significantly more important
Reciprocal	The ratio of the important of factors $m$ and $n$ to the importance of factors $n$ and $m$ is reciprocal to each other

In this study, for different land use types, the impact of each driving factor on their changes varies. For example, for build-up land, compared to elevation and slope, the importance of the distance to the highway, important town, primary/second road, railway and trunk is higher. Relative to the distance to the important town, the importance of the distance to the highway is higher. Specifically, the importance of pairwise driving factors for important land use types is provided in Table S3.

Table S3. The importance of pairwise driving factors for important land use types.

Land use type	Factors	Elevation on highway	Distance to the highway	Distance to the important town	Distance to the secondary road	Slope	Distance to the primary road	Distance to the railway	Distance to the trunk	Annual Temperature	consistency ratio
Cropland	Elevation	1									
	Distance to the highway	1/3	1								
	Distance to the important town	3	9	1							
	Distance to the secondary road	1/3	1/3	1/9	1						0.08
	Slope	3	5	1/3	5	1					
	Distance to the primary road	1/3	1/3	1/9	1/3	1/5	1				
	Distance to the railway	1/3	1	1/7	3	1/5	3	1			

	Distance to the trunk	1/3	5	1/5	5	1/ 5	5	3	1	
	Annual Temperatu re	1	7	1/3	7	1/ 3	7	5	3	1
	Elevation	1								
	Distance to the highway	1/3	1							
	Distance to the important town	1/3	3	1						
	Distance to the secondary road	1/3	3	1/3	1					
Forest and Grassland	Slope	3	3	5	5	1				0.1
	Distance to the primary road	1/3	3	1/3	1/3	1/ 5	1			
	Distance to the railway	1/3	1/3	1/3	1/3	1/ 7	1/3	1		
	Distance to the trunk	1/3	1/3	1/3	1/3	1/ 5	1/3	3	1	
	Annual Temperatu re	1/5	1/3	1/3	1/3	1/ 5	1/3	1/3	1/3	1
	Elevation	1								
	Distance to the highway	1/3	1							
Build-up Land	Distance to the important town	1/3	1/5	1						0.09
	Distance to the secondary road	1/3	1/3	3	1					

Slope	3	3	5	3	1					
Distance										
to the					1/					
primary	1/3	1/3	3	3	5	1				
road										
Distance					1/					
to the	1/5	1/7	1/3	1/3	7	1/3	1			
railway										
Distance					1/					
to the	1/7	1/7	1/5	1/3	7	1/5	1/3	1		
trunk										
Annual										
Temperatu	1/3	1/3	3	3	1/	3	3	3	1	
re					5					

### (3) The ecological score for each land use

In this study, the ecology value  $EQ_t$  is used to utilized for scenario comparison, which considers different contributions of various land uses to comprehensively evaluate the regional ecology quality, with a range of  $[0, 1]$ . It is based on the ecological score  $R_i$ , which indicates the ecological contribution of the  $i$ -th land use type. The ecological score  $R_i$  for each land use is obtained by extensive statistical analysis and is provided in Table S4.

Table S4. The ecological score  $R_i$  for each land use.

Land use type	Cropland	Forest	Grassland	Water	Build-up land	Unused land
$R_i$	0.29	0.82	0.82	0.57	0.2	0.82