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Vegetation Suitability Mapping in Coarse Sandy Hilly Catchments, China

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October 2006





CONTENT

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- ◆ **Theory of Spatial Modelling of Vegetation Suitability**
- ◆ **Practice of Spatial Modelling of Vegetation Suitability**
- ◆ **Results for the modelling: single, collective and vegebin**
- ◆ **Conclusions and future work**



OBJECTIVES

Project:

- ◆ To optimise the impact of large-scale revegetation on the water resources of the research areas in both countries

Suitability mapping:

- ◆ To select the models to assess the suitability of main species in Coarse Sandy Hilly Catchments (CSHC), and
- ◆ To provide the results to stakeholders for CSHC re-plantation scheme



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Model selection: theory

Species distribution is mainly controlled by climatic, landscape, soil conditions and other resources.

- (1) Resources: consumed by the plant *e.g.*, CO₂;
- (2) Direct variables: not consumed by the plant yet have a direct physiological influence on growth *e.g.*, pH; and
- (3) Indirect variables: no direct physiological influence on growth, they are correlated with species distribution due to their correlation with variables.
(Austin, 1987)

In any vegetation site suitability assessment (or predictive vegetation mapping) exercise these variables can either be continuous or categorical

There are many models dealing with this problem



Model selection: theory



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Criteria for model approach selection :

- ◆ the goals of the project ; and
- ◆ the data availability (meaning both spatial environmental variables and either a database of species presence data, or rules defining the species' requirements or tolerances).





Model selection: model for CSHC



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The CSHC vegetation suitability mapping has the characteristics of:

- (1) being general;
- (2) not incorporating disturbance and dynamics;
- (3) is over a large spatial scale; and
- (4) will not incorporate climate change effects

the range of models could be either empirical or mechanistic, and

- (1) the variables used can be any combination of resources, direct variables, and indirect variables.

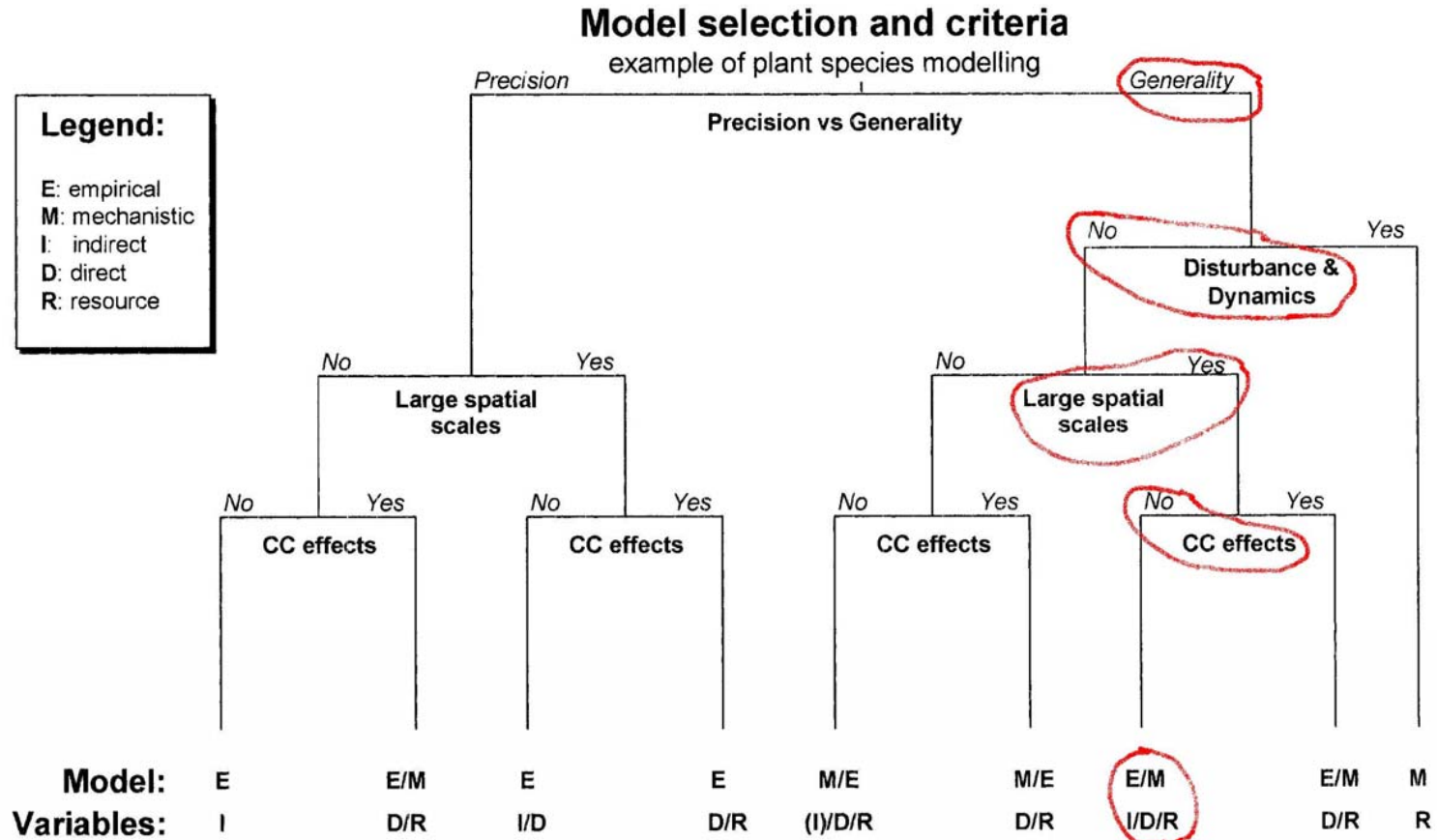
In our case, the conceptualisation of criteria for model / variable selection for predictive vegetation mapping has not assisted refining the options. Hence we are limited by readily available datasets (both spatial layers and knowledge of species resource needs).

This is what drives our selection of implemented a Boolean model – or a discrete gradient approach – we allow for multiple species in each grid cell





Model selection: theory



Criteria for model selection. Examples of considerations for modeling vascular plant species in space and/or time, given a set of possible criteria to reach the project goals, CC: climatic change. From **Guisan and Zimmerman (2004) Ecological Modelling**



Model selection: model for CSHC



Environmental Variables:

1. Annual precipitation (R)—from Lingtao and Tim's work
2. Air temperature (D))—from Lingtao and Tim's work
3. Land position (I))—from DEM improved by Qinke
4. Soil pH (D)— from soil map by Xiaoping
5. Soil TN (R) — from soil map by Xiaoping



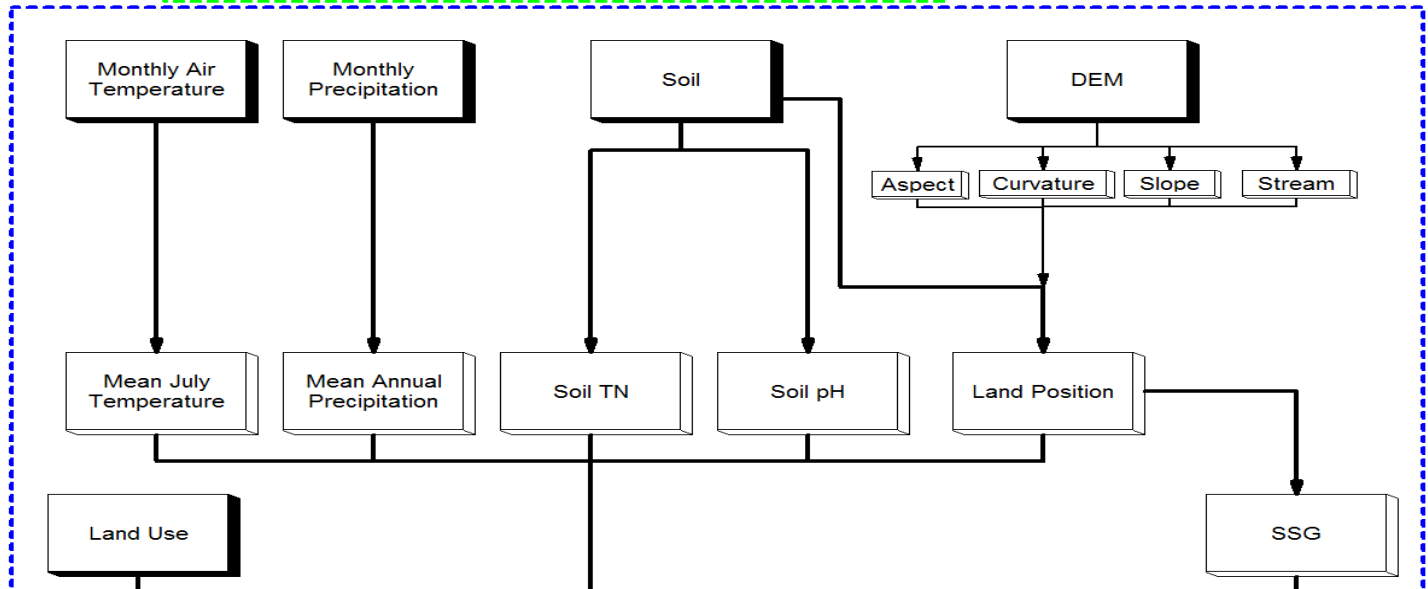


Suitability mapping: flowchart

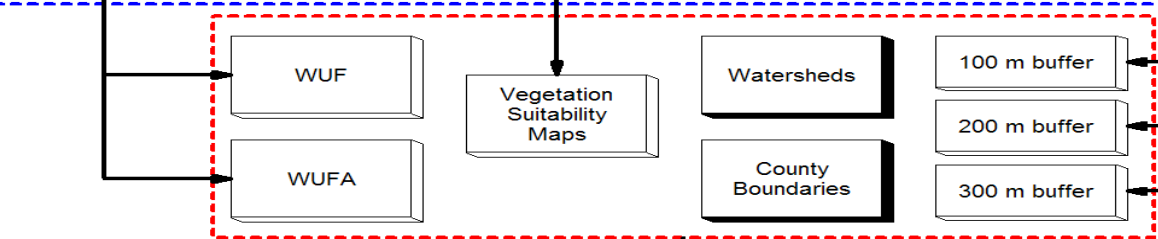
Model Selection



Data Preparation



Map Generation



Legend

Existing Data

Generated Data

SSG = steep slope & gully
 WUF = water, urban, forest
 WUFA = water, urban, forest, Agriculture

Vegetation Suitability Maps for each of 42 watersheds for each of 70 counties taking into account priority and land limitation



Suitability mapping: species selection, land position definition and suitability assessment



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Code Number	Native	Growth form	Chinese Name	Latin Name
1 *	Yes	T	油松	<i>Pinus tabulaeformis</i> Carr.
2 *	Yes	T	白桦	<i>Betula Platyphylla</i> Suk.
3 *	Yes	S	山毛桃	<i>Amygdalus davidiana</i> (Carr.) C. de Voe ex Henry
4	Yes	S	黄刺梅	<i>Rosa xanthina</i> Lindl.
5 *	Yes	T	辽东栎	<i>Quercus liaotungensis</i> Koidz.
6 *	Yes	T	白榆	<i>Ulmus pumila</i>
7 *	Yes	T	小叶杨	<i>Populus simonii</i> Carr.
8 *	Yes	T	侧柏	<i>Platycladus orientalis</i> (L.)
9	Yes	S	荆条	<i>Vitex negundo</i> Linn. var. <i>heterophylla</i> (Franch.) Rehd
10	Yes	S	狼牙刺	<i>Sophora davidii</i>
11 *	No	T	刺槐	<i>Robinia pseudoacacia</i>
12 *	Yes	T	旱柳	<i>Salix matsudana</i>
13	Yes	S	酸枣	<i>Ziziphus jujuba</i> var. <i>spinosa</i>
14	Yes	T	山杨	<i>Populus davidiana</i>
15 *	Yes	S	虎榛子	<i>Ostryopsis davidiana</i> Decne
16 *	No	S	紫穗槐	<i>Amorpha fruticosa</i>
17	Yes	S	沙枣	<i>Elaeagnus angustifolia</i>
18 *	Yes	S	柠条	<i>Caragana microphylla</i>
19 *	Yes	S	沙柳	<i>Salix psammophila</i>
20	Yes	S	怪柳	<i>Tamarix spp</i>
21	Yes	S	乌柳	<i>Salix cheilophila</i> Schneider
22 *	Yes	T	臭椿	<i>Ailanthus altissima</i>
23 *	Yes	S	沙棘	<i>Hippophae rhamnoides</i>
24	Yes	T	青杨	<i>P. cathayana</i> Rehd
25	No	T	新疆杨	<i>Populus alba</i> cv
26 *	Yes	T	桃	<i>Prunus davidiana</i>
27 *	Yes	T	杏	<i>Prunus armeniana</i> var. <i>ansu</i>
28	Yes	T	毛白杨	<i>Populus tomentosa</i> carr.
29 *	Yes	T	河北杨	<i>Populus hopeiensis</i>
30 *	Yes	T	苹果	<i>Malus domestica</i> Borkh.
31 *	Yes	T	梨	<i>Pyrus bretschneideri</i>
32	Yes	T	桑	<i>Morus alba</i> L.
33	Yes	T	核桃	<i>Juglans regia</i>
34	Yes	S	文冠果	<i>Xanthoceras sorbifolia</i> Bge.
35 *	Yes	T	杜梨	<i>Pyrus betulaefoli</i>
36	Yes	T	楸树	<i>Catalpa bungei</i> C.A. Mey
37 *	Yes	T	枣	<i>Zizyphus jujuba</i> Mill
38	No	T	箭杆杨	<i>Populus nigra</i> var. <i>thevestina</i> (Dode) Beain



Suitability mapping: species selection, land position definition and suitability assessment



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Code number	TN (%)	pH	precipitation (mm)	Temperature July (°C)	Land positions
*1	No limit	5.6<pH(<6.5)	200≤R(≤400)	T≥14	LM, NFS, RM
*2	No limit	5.6<pH<6.5	R>400	No limit	SFS,RM
*3	No limit	No limit	R>200	No limit	SFS,RM
4	No limit	No limit	R>400	No limit	(SFS +),RM
*5	No limit	No limit	R>200	No limit	RM
*6	No limit	No limit	R>200	No limit	SFS,NFS,FB,RM
*7	≥0.05	No limit	R>200	No limit	SFS,NFS,FB
*8	No limit	No limit	R>200	T≥14	(LM +),SFS,FB,RM
9	No limit	No limit	R>200	T≥14	SFS
10	No limit	No limit	R>200	T≥14	SFS
*11	No limit	No limit	R>200	T≥14	(LM -), SFS,NFS,FB,RM
*12	No limit	No limit	R>200	T≥14	(SFS +),FB
13	No limit	No limit	R>300(400)	T≥14	SFS,RM
14	No limit	No limit	R>400	T≥14	(NFS +),RM
*15	No limit	No limit	R>400	T≥14	(NFS +),RM
*16	No limit	No limit	R>200	No limit	(LM +),SFS,FB,RM
17	No limit	No limit	R>200	No limit	SFS,FB,RM,
*18	No limit	No limit	R>200	No limit	LM,SFS,FB
*19	No limit	No limit	R>200	No limit	FB,
20	No limit	No limit	R>400(200)	No limit	(LM -),SFS,NFS,FB
21	No limit	No limit	R>200	No limit	FB,
*22	No limit	No limit	R>200	No limit	LM,SFS,FB
*23	No limit	No limit	R>200(400)	T≥14	LM,SFS,NFS,FB,RM
24	≥0.05	No limit	R>200(400)	No limit(T≥14)	(LM -),NFS,FB
25	≥0.05	No limit	R>200(400)	No limit(T≥14)	(LM -),FB
*26	≥0.05	No limit	R>400	T≥14	LM,FB,RM
*27	≥0.05	No limit	R>200(400)	T≥14	LM,SFS,FB,RM
28	≥0.05	No limit	R>500(400)	T≥14	LM,FB
*29	≥0.05	No limit	R>200(400)	T≥14	NFS,(FB+),RM,(SFS-)
*30	≥0.05	No limit	R>400	T≥14	LM,FB,RM
*31	≥0.05	No limit	R>400	T≥14	LM,FB,RM
32	≥0.05	No limit	R>400	T≥14	LM,FB,(RM -)
33	≥0.05	No limit	R>400	T≥14	LM,SFS,FB,RM
34	≥0.05	No limit	R>400	T≥14	LM,SFS
*35	≥0.05	No limit	R>300(400)	T≥14	LM,SFS,FB,
36	≥0.05	No limit	R>400	T≥18	NFS,FB,(LM -)
			0	T≥18	NFS,FB,(LM -)



Suitability mapping: species selection, land position definition and suitability assessment



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Name	Description	Identities			
		Slope (°)	Aspect (°)	Curvature	River buffer area
LM	Liang_Mao and high flat area;	<0.8	N/A	>=0	N/A
SFS	South facing slopes	0.8=< & <15	>=270°; <90°	N/A	N/A
NFS	North facing slopes	0.8=< & <15	90°=<; <270°	N/A	N/A
FB	Flat bottom	<0.8	N/A	<=0	In
SSG	Steep slope and gullies	>=15	N/A	N/A	N/A
RM	Rock mountains	Derived from the soil map			



Suitability mapping: species selection, land position definition and suitability assessment



Yuan: Plain highland covered by deep loess. Generally big and flat



Mao: Small quaquaversal hill, looks like a steamed bun.



Liang: Striped highland between gullies with quaquaversal top



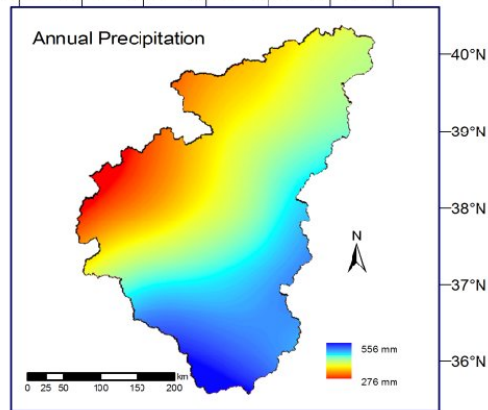
Suitability mapping: input data



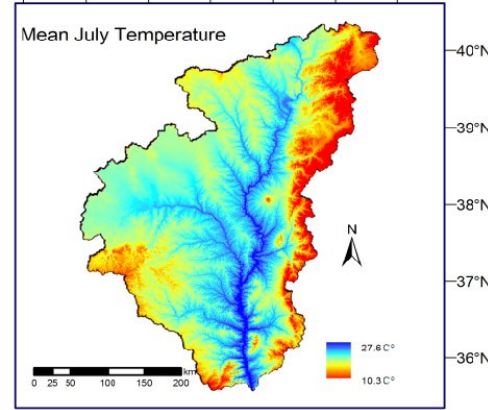
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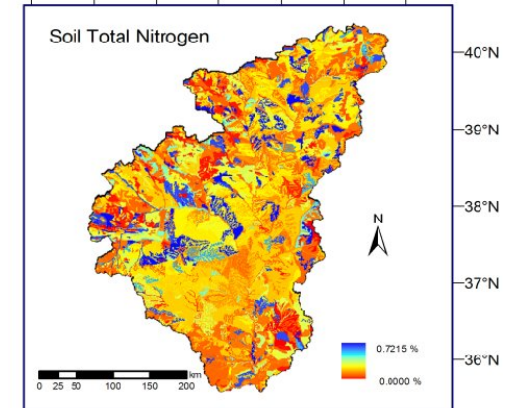
107°E 108°E 109°E 110°E 111°E 112°E 113°E



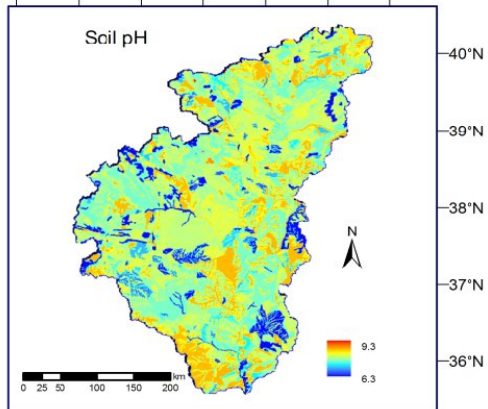
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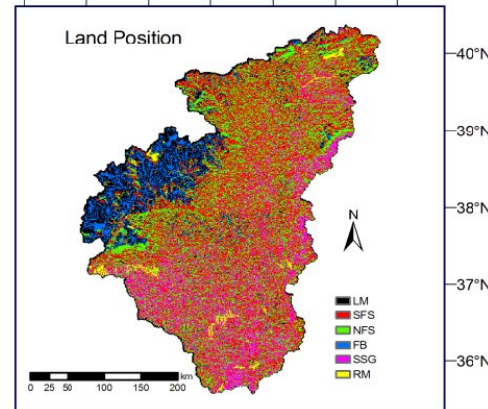
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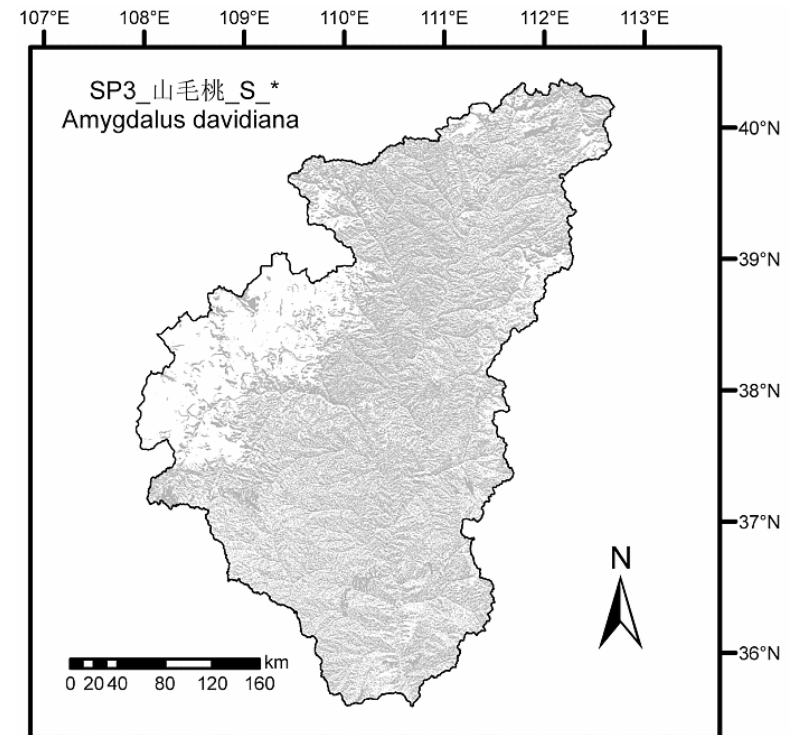
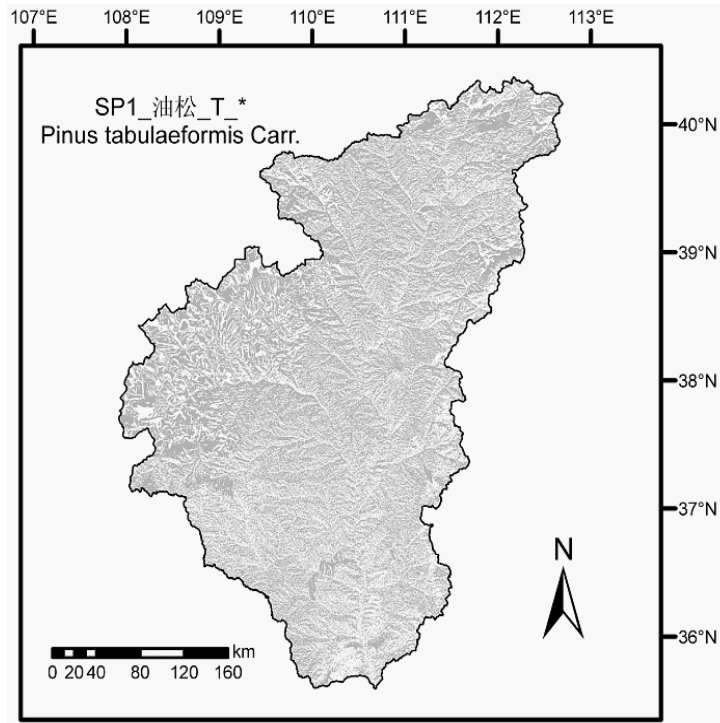


107°E 108°E 109°E 110°E 111°E 112°E 113°E





Suitability mapping: single maps

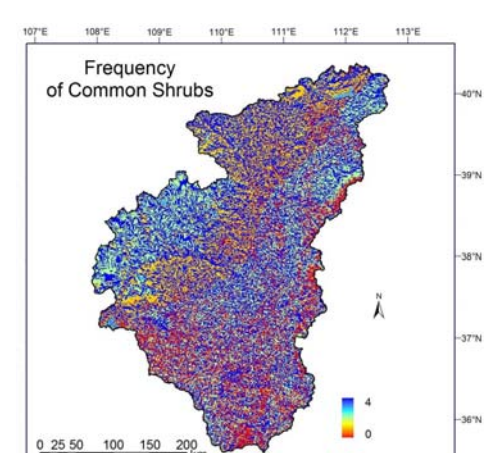
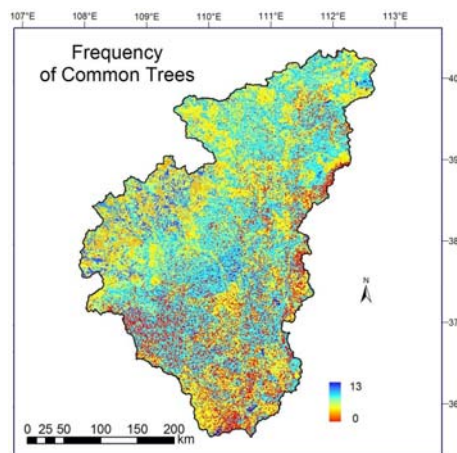
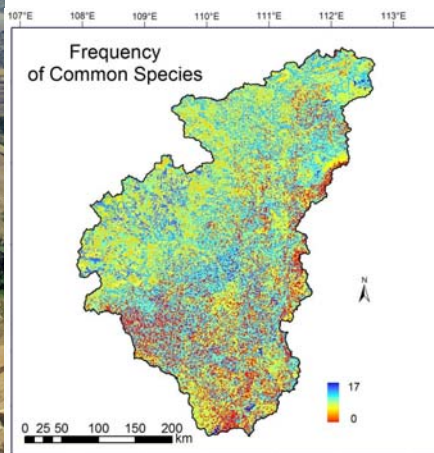
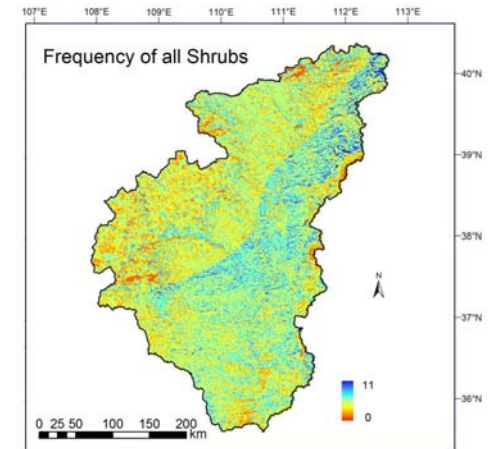
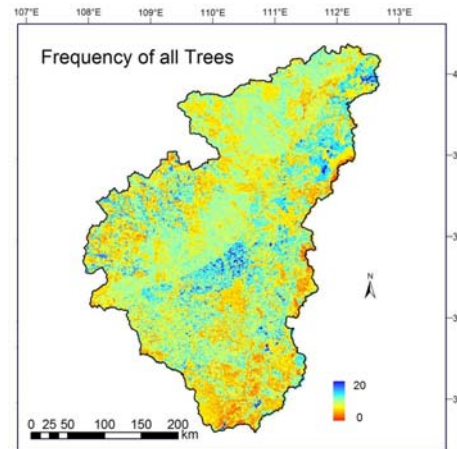
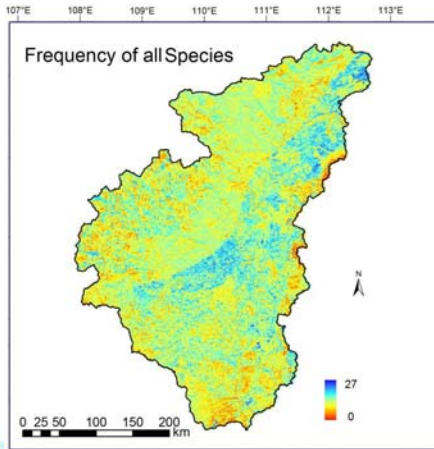




Suitability mapping: collective maps



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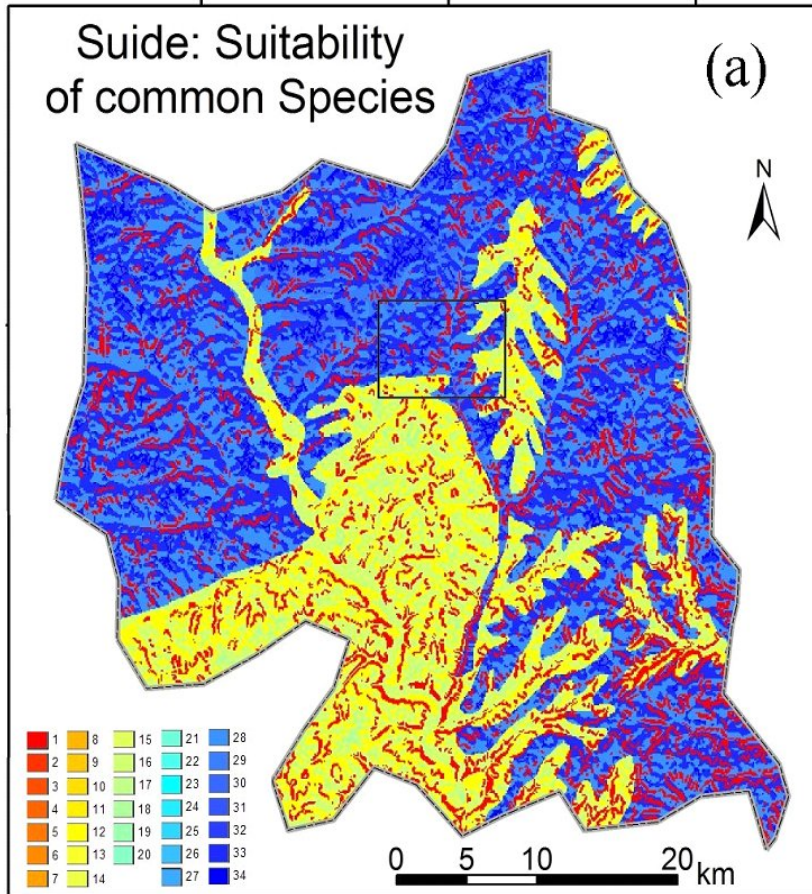
Suitability mapping: binary maps:

Double LUT:

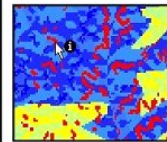
1. $vbcode = 2^0 + 2^1 + 2^2 + 2^3 + \dots + 2^n$

2. $vbcode \iff value$

110°12'E 110°24'E 110°36'E



37°36'N



(b)

37°24'N

(c)

vb_cspecies Location: [102969.182003]

Property	Value
Order_ID	32
Value	33
Count	1331533
Vbcode	2245297
Freq	8
Sp1	1
Sp2	0
Sp3	0
Sp5	0
Sp6	1
Sp7	1
Sp8	0
Sp11	1
Sp12	0
Sp15	1
Sp16	0
Sp18	0
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Sp27	0
Sp29	1
Sp30	0
Sp31	0
Sp35	0
Sp37	1

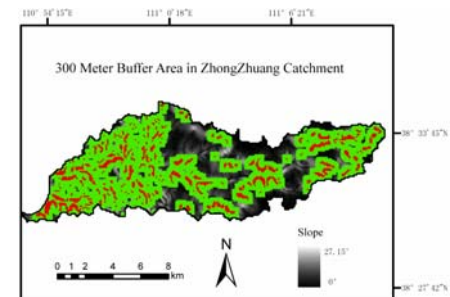
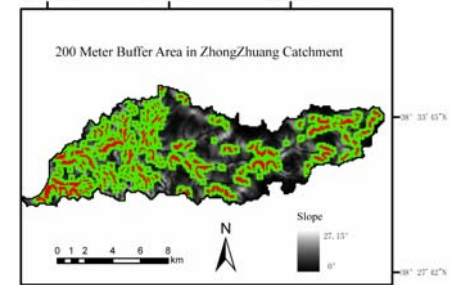
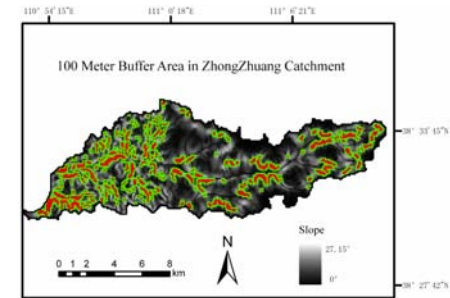
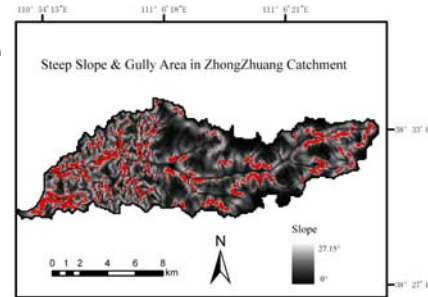


Priority area selection

SSG and buffer zone

- Land position SSG areas are too steep and any disturbance on land surface will cause severe soil erosion, thus this SSG is not for afforestation, but left for natural regeneration.

- It also implies that the area around SSG is critical to the soil erosion control, and need more attention.



	CSHC	SSG	SSG_100	SSG_200	SSG_300
Area (km ²)	112,728	15,766	20,961	34,911	44,259
Area (%)	100.00%	13.99%	18.59%	30.97%	39.26%

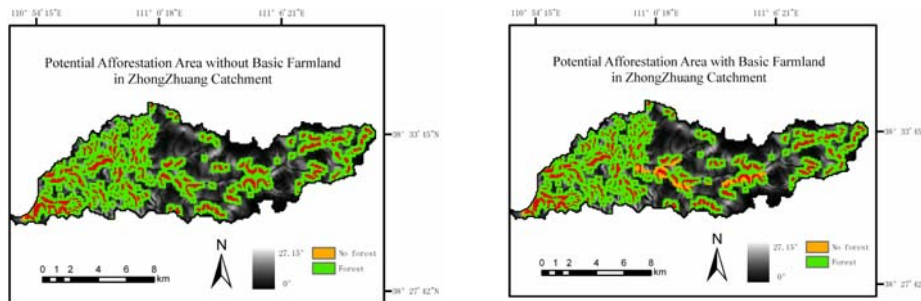


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Land limitation

Replantation will not occur in areas that currently are:
Water, urban, forest and possibly basic agricultural land





谢谢

Thank You

Dr. Zhongming Wen

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