Development of grassland ecosystem monitoring in China

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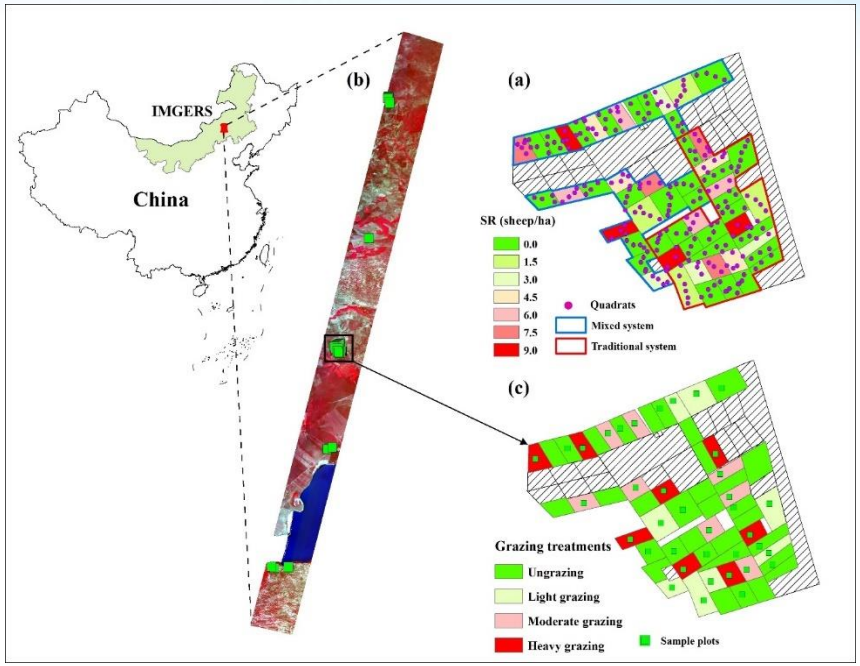
An introduction of China's pilot site

Inner Mongolia Grassland Ecosystem Research Station (IMGERS), Chinese Academy of Sciences.

- ✓ Developing and calibrating grassland Above Ground Biomass (AGB) estimation model. The grassland AGB includes standing AGB and theoretical AGB.
- ✓ Developing and calibrating Fractional Vegetation Cover (FVC) and Leaf Area Index (LAI) estimation model.
- ✓ Building and validating Net Primary Productivity (NPP) estimation model based on CASA and improved CASA.
- ✓ Grazing monitoring based on remote sensing. The grazing monitoring includes grazing intensity and livestock production.
- ✓ Hyperspectral remote sensing application in grassland.



The location of IMGERS &
The grazing experiment samples

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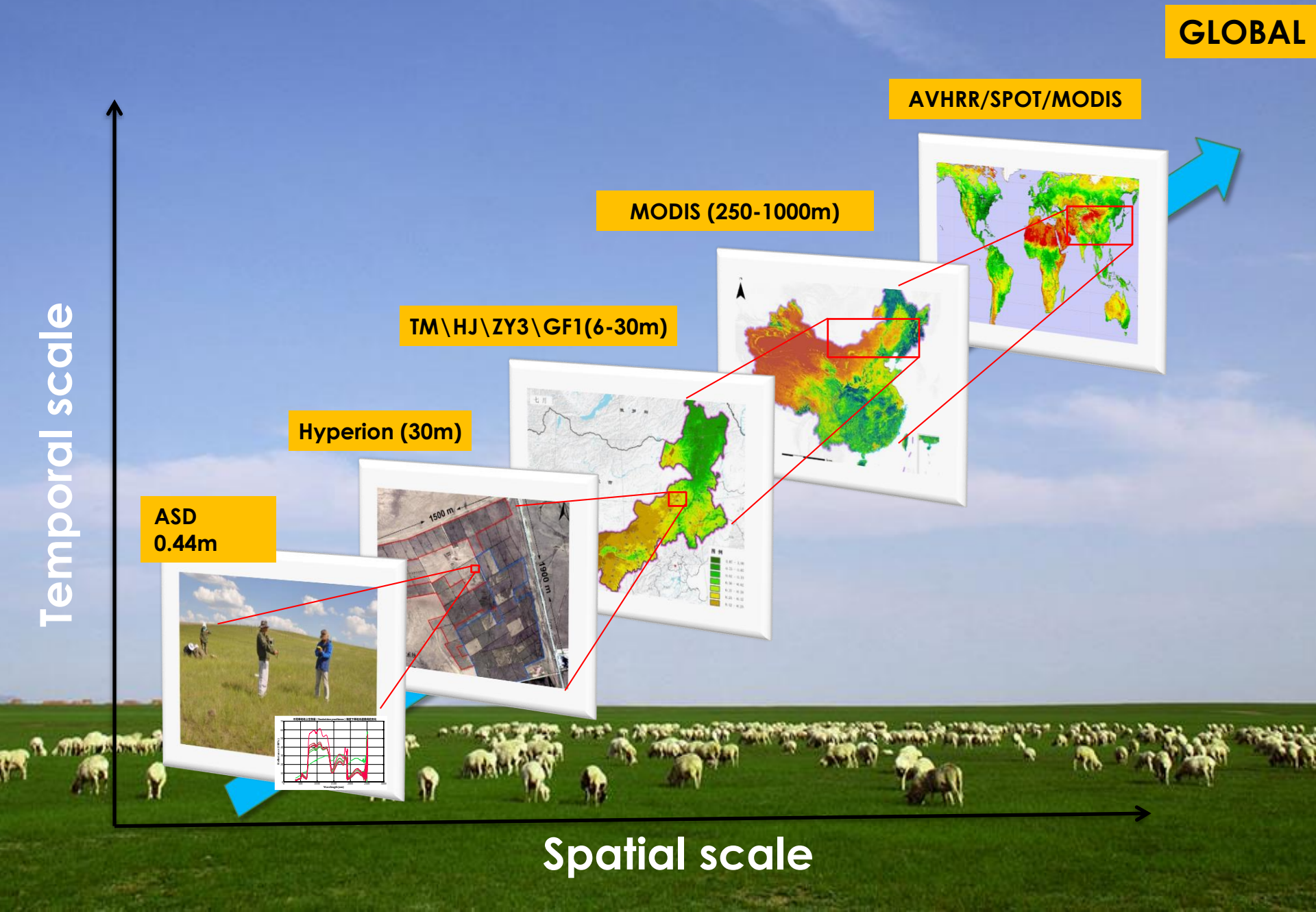
Dr. ZHAO Dan, zhaodan@radi.ac.cn

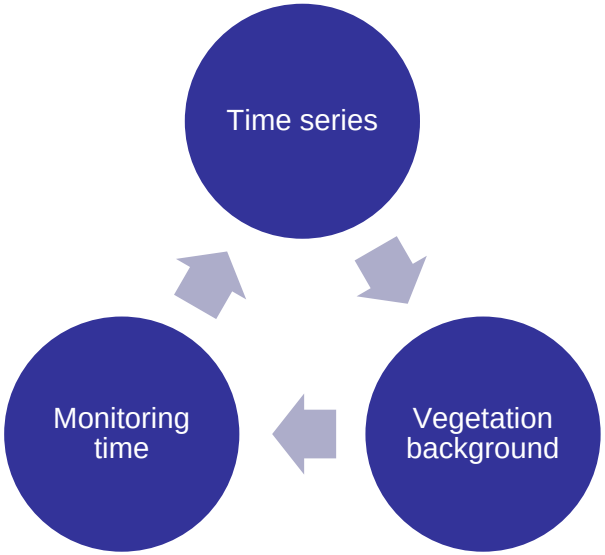
How we link works in pilot site to regional scale?



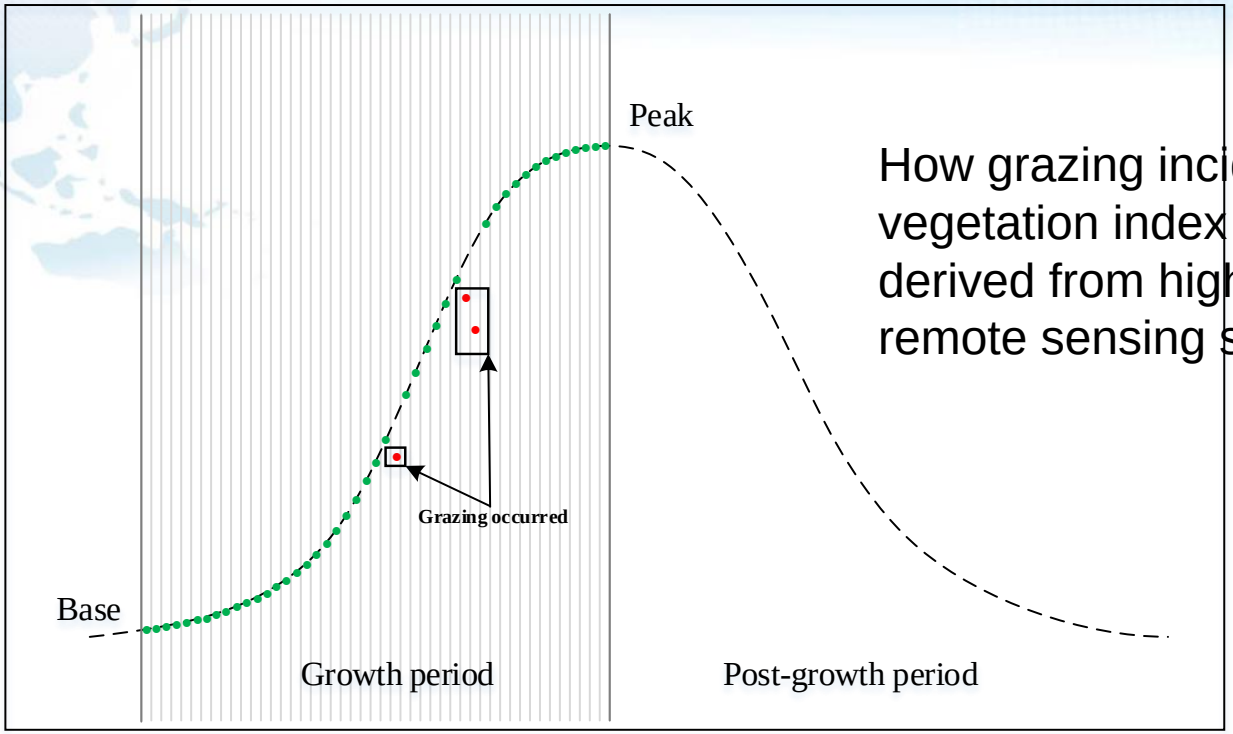
Current works

- More studies on grazing intensity
- AGB improvement

More studies on grazing intensity



Changes in NDVI time-series for a grazed grassland

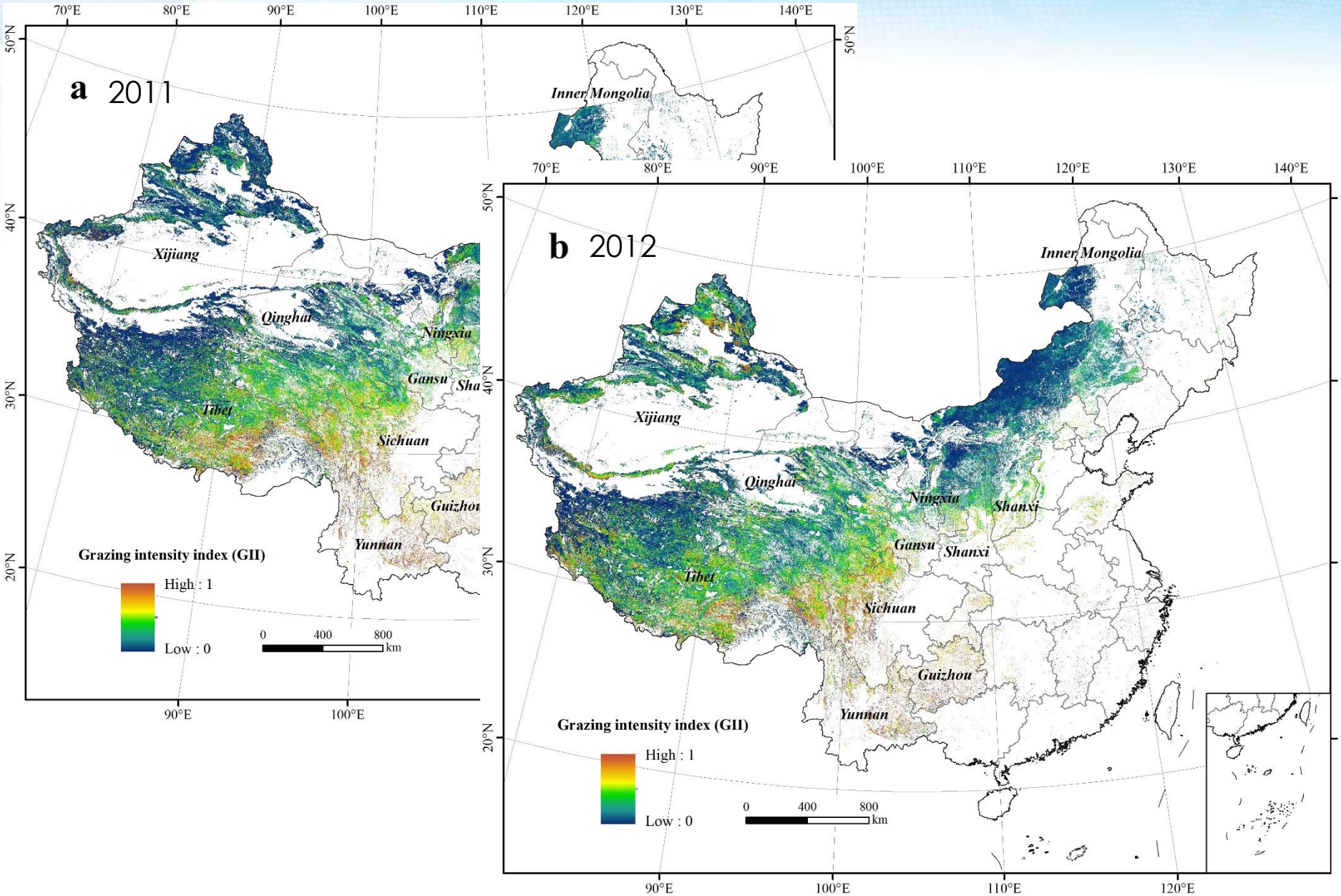


How grazing incidents are captured using vegetation index (e.g. NDVI) time-series derived from high-temporal-resolution remote sensing such as MODIS.

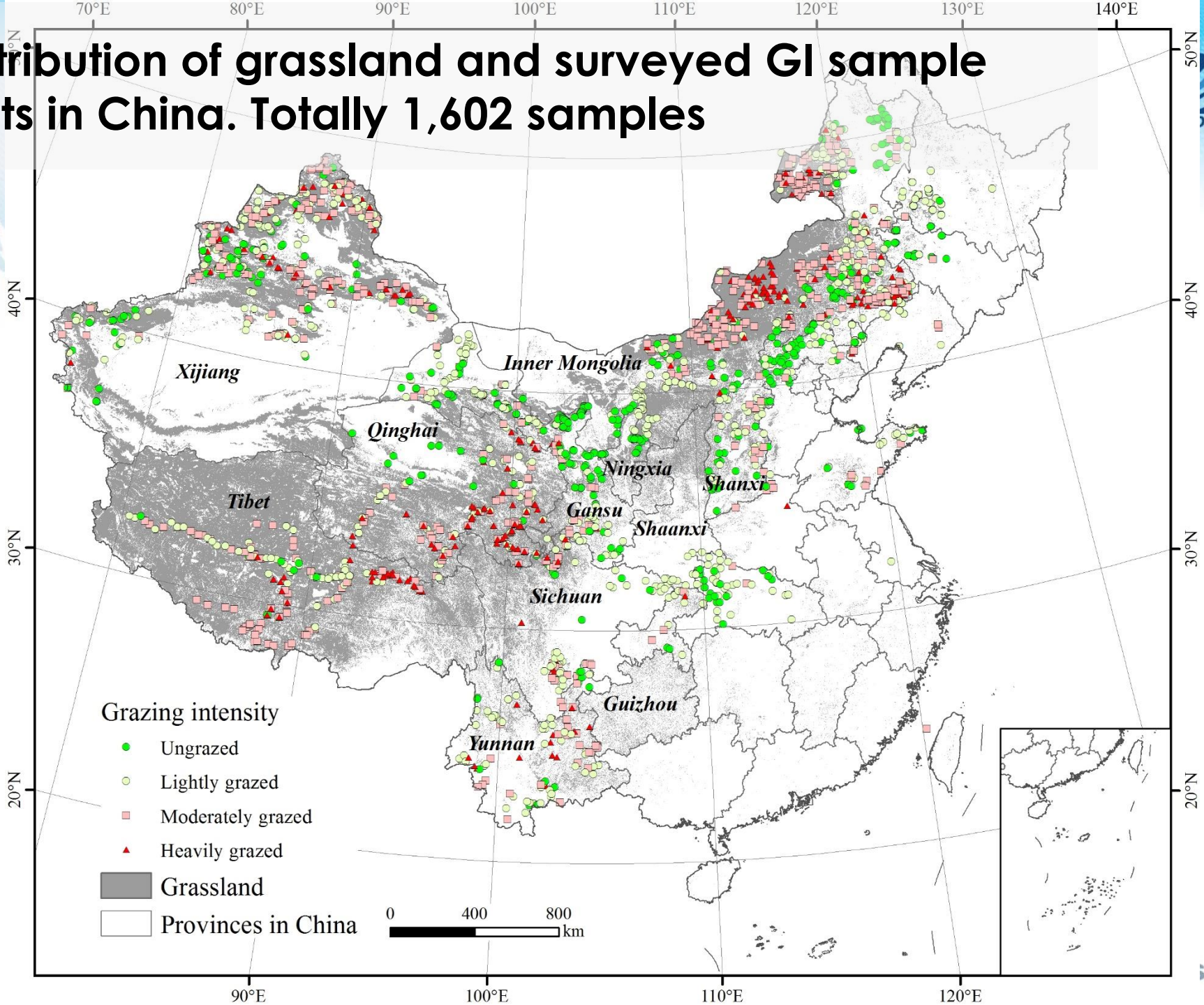
$$GII = \frac{\sum (VI_{t-1} - VI_t)}{VI_{peak} - VI_{base}}$$

GII is the grazing intensity index which quantifies GI; VI is a vegetation index such as the NDVI or EVI; VI_{peak} is the value of the vegetation index at the peak growth stage; VI_{base} is the value of the vegetation index before the returning green stage. t is the day of the year in the growth period

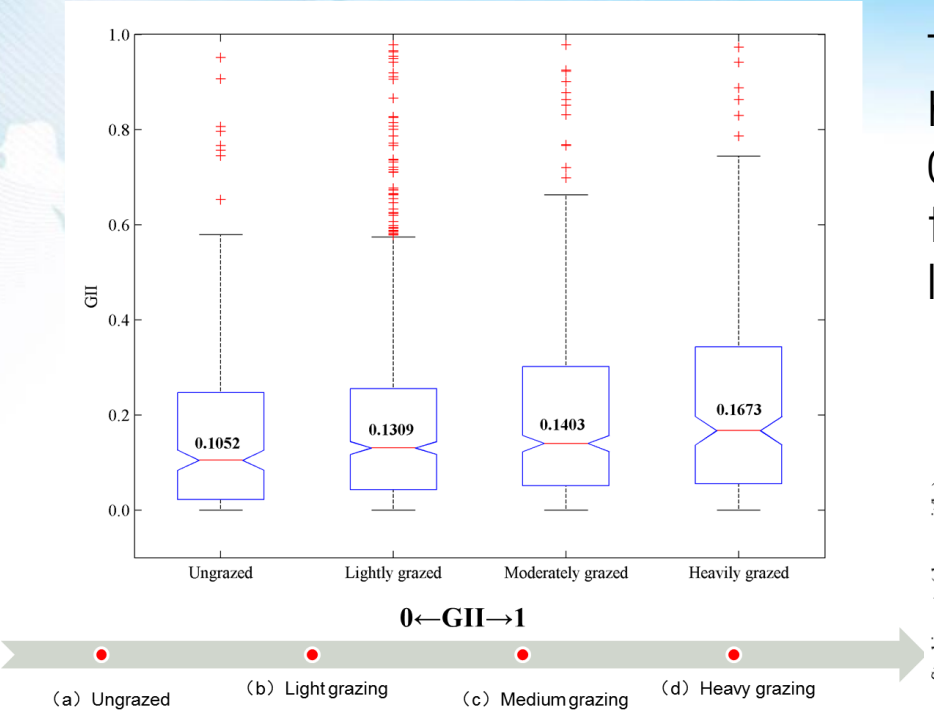
Distribution of grazing intensity in China, quantified by grazing intensity index calculated from high-temporal MODIS-NDVI



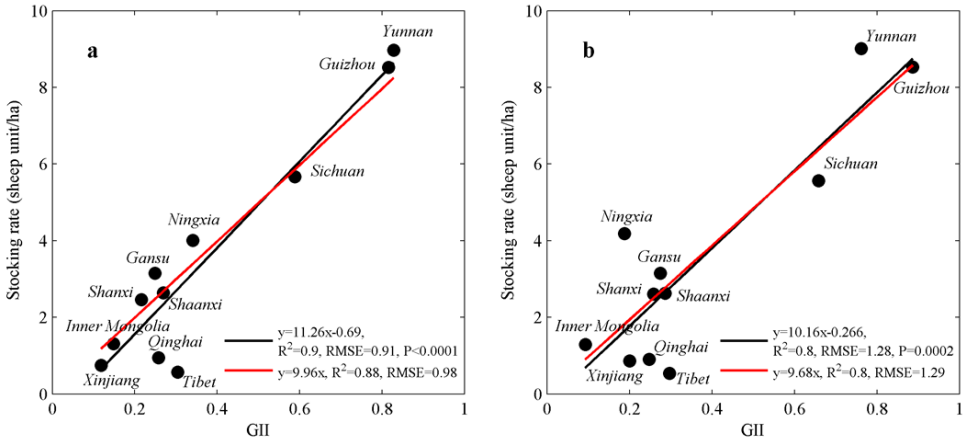
Distribution of grassland and surveyed GI sample plots in China. Totally 1,602 samples

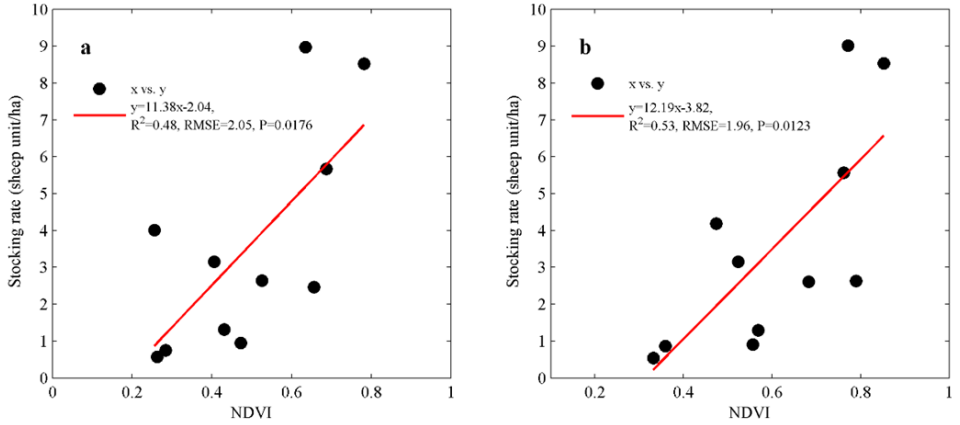


Validations



The median values for sample plots(red horizontal lines in Figure) are 0.1052, 0.1309, 0.1403 and 0.1673, confirming that GII consistently shifts to higher levels as GI increases.





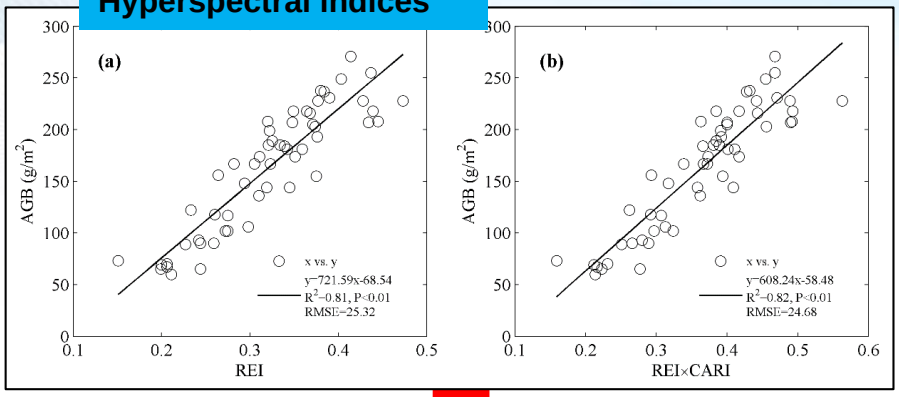
The average GII in a province is significantly correlated with SR

The yearly maximum NDVI is correlated with SR

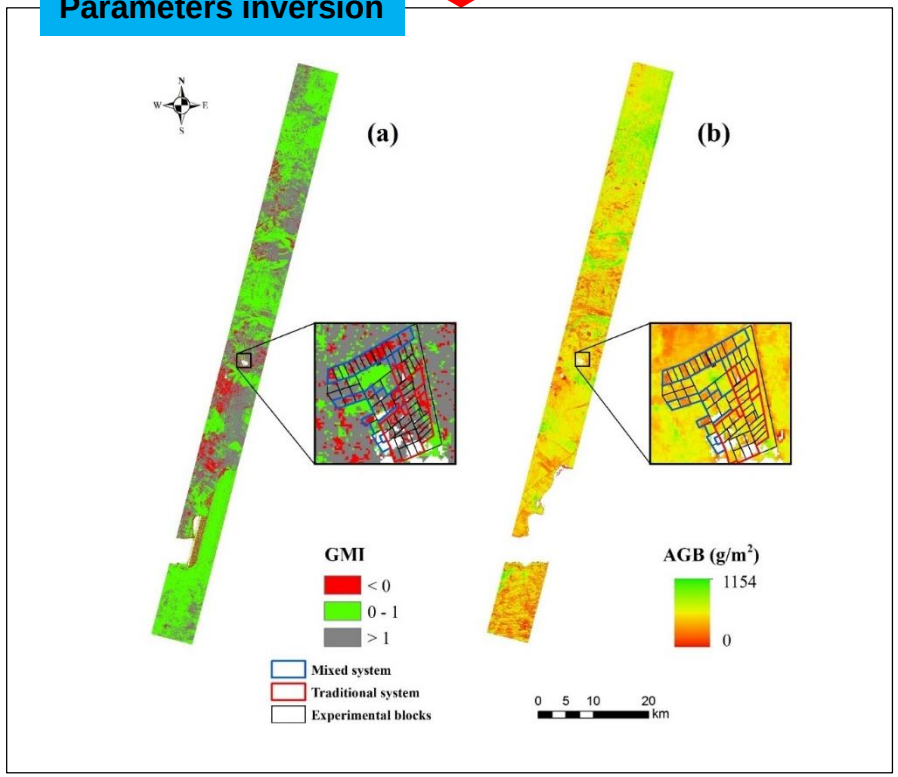
Superior grassland conditions can accommodate more SR:

Experiment: Grazing intensity based on hyperspectral data

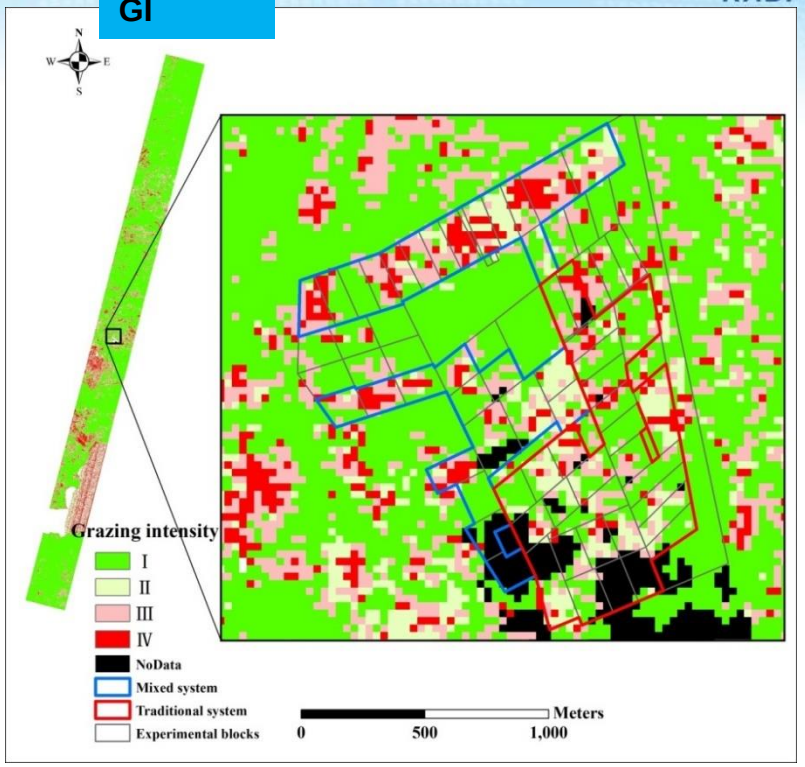
Hyperspectral indices



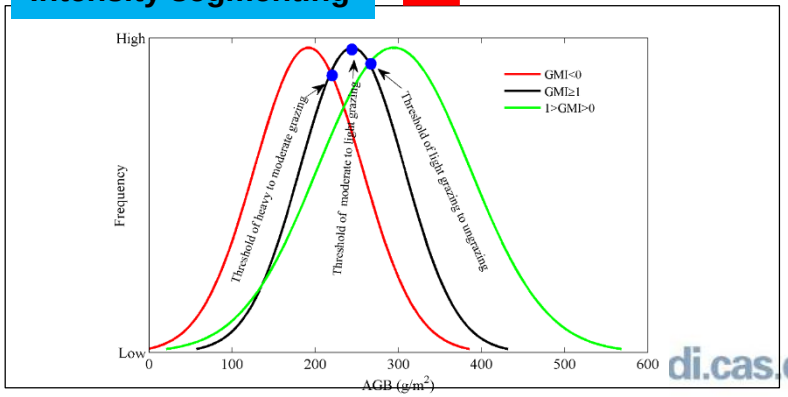
Parameters inversion



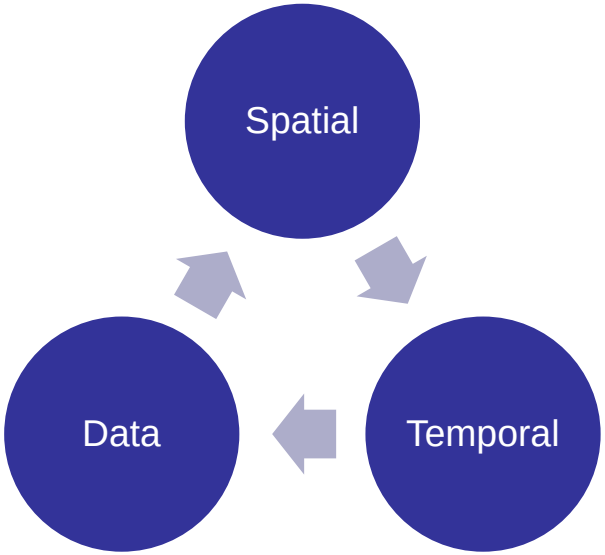
GI



Intensity segmenting

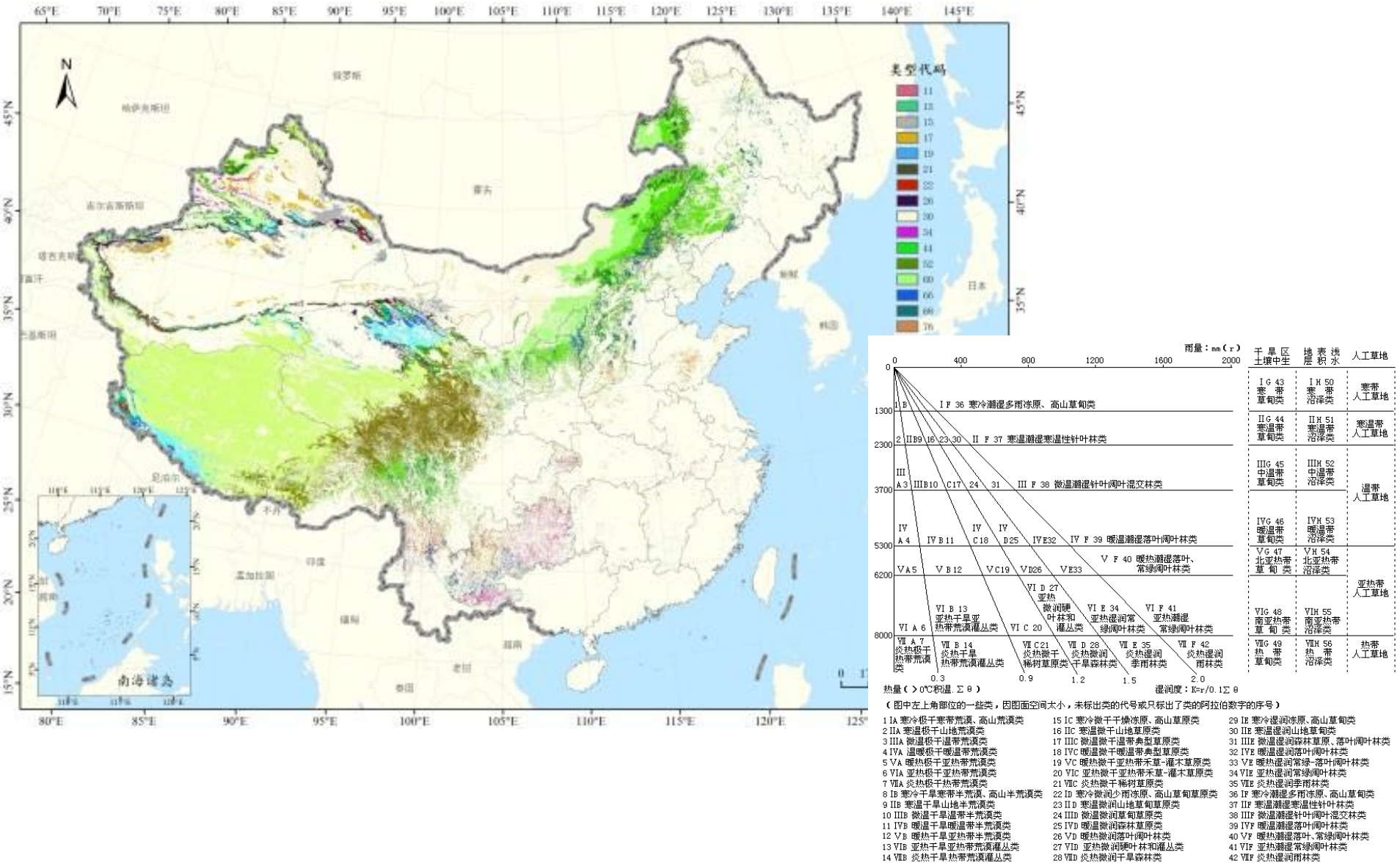


Improvement on Grassland aboveground biomass



LI Fei, ZENG Yuan, LUO Juhua, MA Ronghua, WU Bingfang. Modeling grassland aboveground biomass using a pure vegetation index. Ecological Indicators, 62(2016): 279-288

IOCSG的草原类型分区



（图中左上角部位的一些类，因图面空间太小，未标出类的代号或只标出了类的阿拉伯数字的序号）

1 IA 寒冷极干寒带荒漠、高山荒漠类
2 IIA 寒温极干山地荒漠类
3 IIIA 微温极干温带荒漠类
4 IVA 温暖极干暖温带荒漠类
5 VA 暖热极干亚热带荒漠类
6 VIA 亚热极干亚热带荒漠类
7 VIIA 炎热极干热带荒漠类
8 IB 寒冷干旱寒带半荒漠、高山半荒漠类
9 IIB 寒温干旱山地半荒漠类
10 IIIB 微温干旱温带半荒漠类
11 IVB 暖温干旱暖温带半荒漠类
12 VB 暖热干旱亚热带半荒漠类
13 VIB 亚热干旱亚热带荒漠灌丛类
14 VIIB 炎热干旱热带荒漠灌丛类
15 IC 寒冷微干干燥冻原、高山草原类
16 IIC 寒温微干山地草原类
17 IIIC 微温微干温带典型草原类
18 IVC 暖温微干暖温带典型草原类
19 VC 暖热微干亚热带禾草-灌木草原类
20 VIC 亚热微干亚热带禾草-灌木草原类
21 VIIC 炎热微干稀树草原类
22 ID 寒冷微润少雨冻原、高山草甸草原类
23 IID 寒温微润山地草甸草原类
24 IIID 微温微润草甸草原类
25 IVD 暖温微润森林草原类
26 VD 暖热微润落叶阔叶林类
27 VID 亚热微润硬叶林和灌丛类
28 VIID 炎热微润干旱森林类
29 IE 寒冷湿润冻原、高山草甸类
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31 IIIE 微温湿润森林草原、落叶阔叶林类
32 IVE 暖温湿润落叶阔叶林类
33 VE 暖热湿润常绿-落叶阔叶林类
34 VIE 亚热湿润常绿阔叶林类
35 VIIE 炎热湿润季雨林类
36 IF 寒冷潮湿多雨冻原、高山草甸类
37 IIF 寒温潮湿寒温性针叶林类
38 IIIF 微温潮湿针叶阔叶混交林类
39 IVF 暖温潮湿落叶阔叶林类
40 VF 暖热潮湿落叶、常绿阔叶林类
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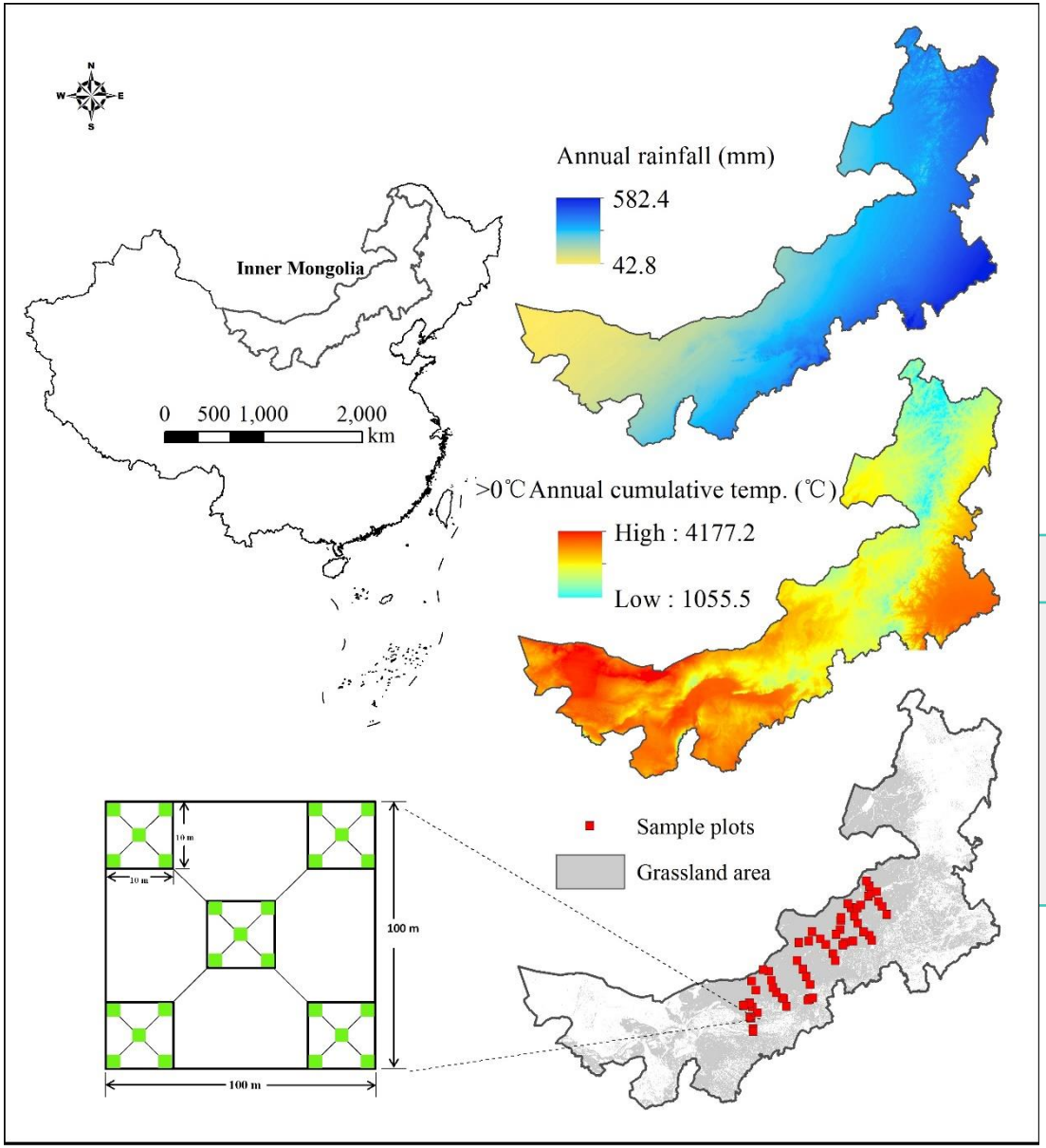
42 VIIF 炎热湿润雨林类

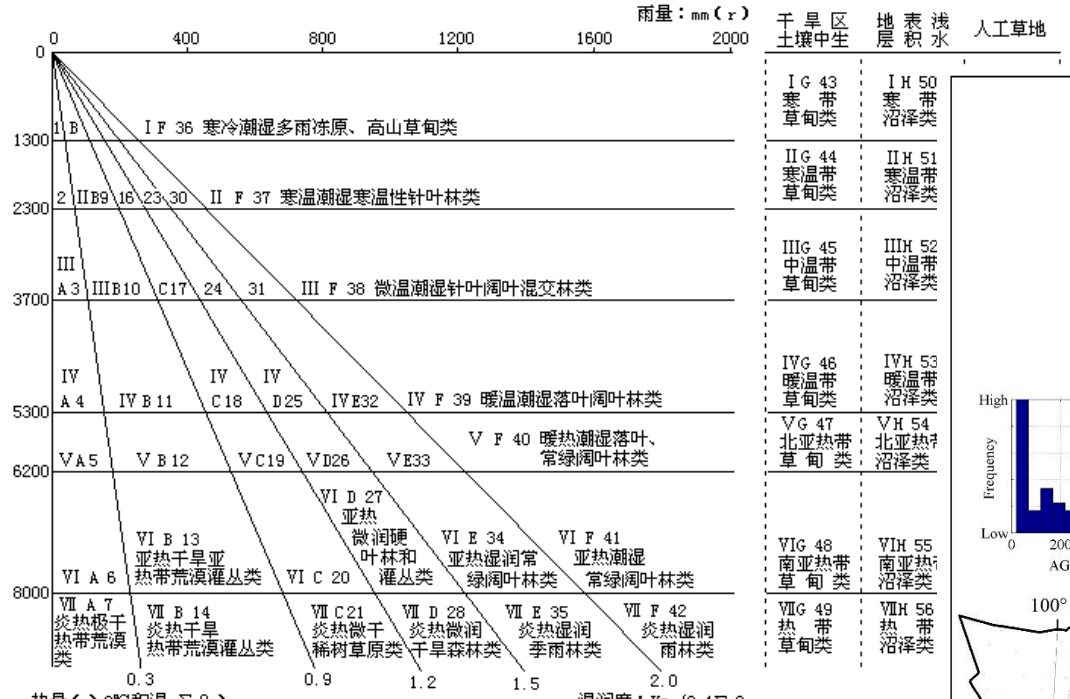
Standing AGB estimates in Inner Mongolia



Thermal grades	>0 ℃ Annual cumulative temp. (℃)	Suitable thermal zone
Frigid	<1300	(Alpine) Frigid zone
Cold temperate	1300-2300	Cold temperate zone
Cool temperate	2300-3700	Cool temperate zone
Warm temperate	3700-5300	Warm temperate zone
Warm	5300-6200	Temperate subtropics
Subtropical	6200-8000	Equatorial subtropics
Tropical	>8000	Tropics

Humidity grades	K-value	Suitable natural landscape
Extrarid	<0.3	Desert
Arid	0.3-0.9	Semidesert (desert steppe, steppe desert)
Semiarid	0.9-1.2	Typical steppe, xerophytic forest, savanna
Subhumid	1.2-1.5	Forest, forest steppe, meadow steppe, savanna, meadow
Humid	1.5-2.0	Forest, tundra, meadow
Perhumid	>2.0	Forest, tundra, meadow

Differentiation of grassland types in Inner Mongolia



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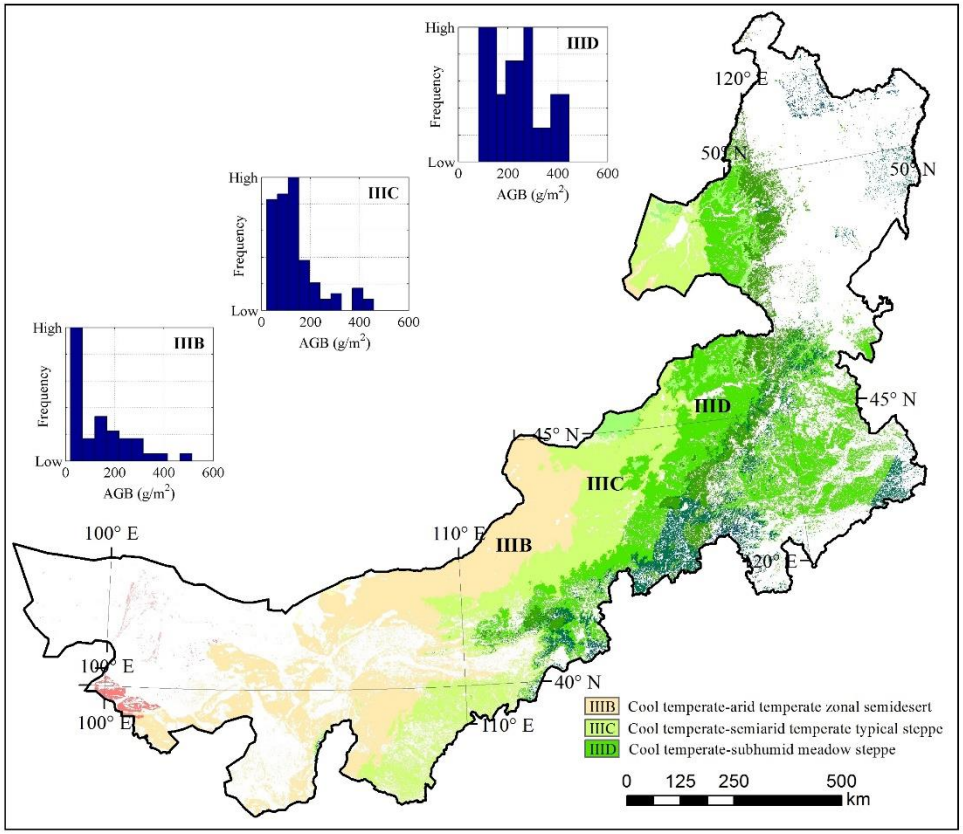


Spatial distribution of grassland types and frequency histograms of grassland AGB for each grassland type in Inner Mongolia

PVI model performance-1

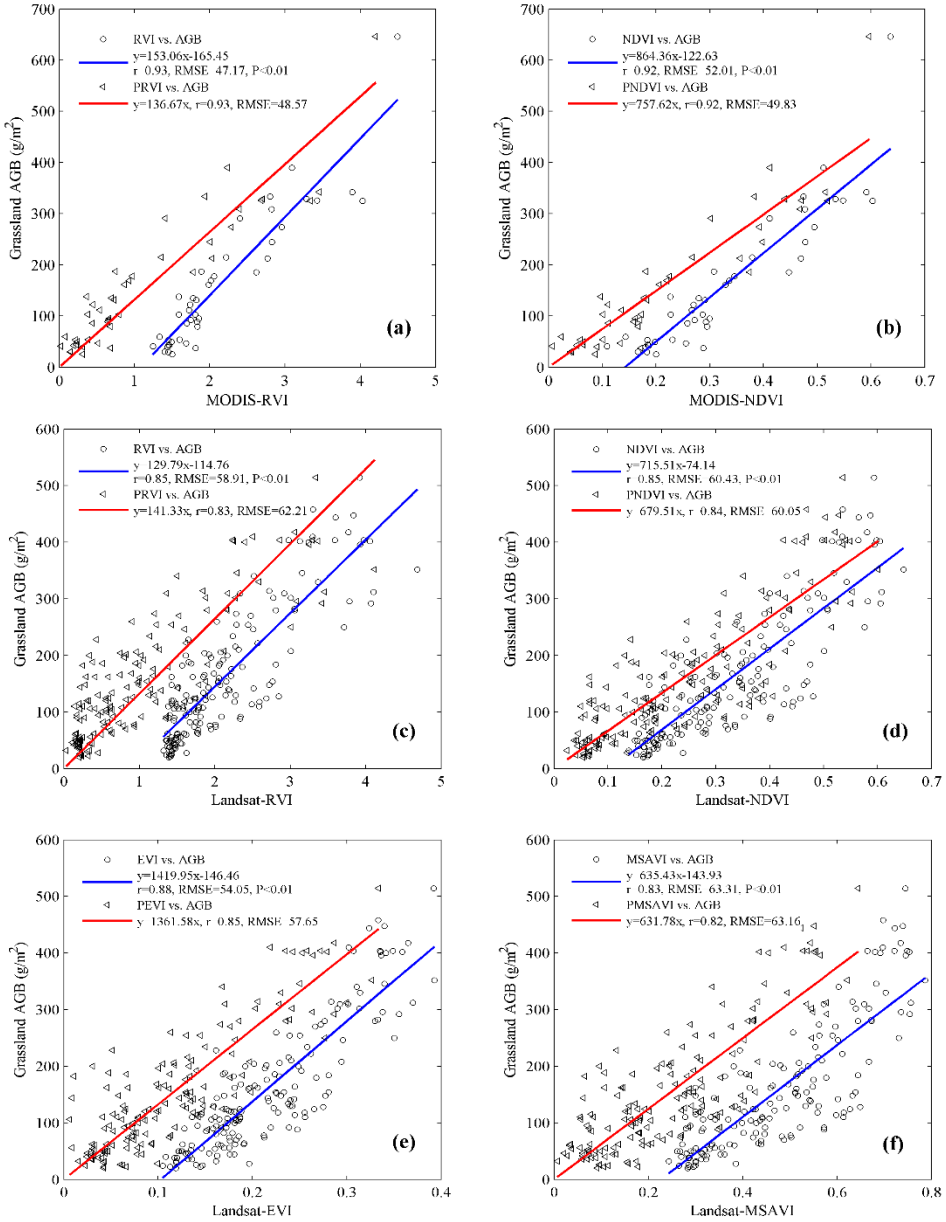
Grassland Type	PVI	PVI model	r	RMSE(g/m^2)	RE (%)
IIIB Cool temperate-arid temperate zonal semidesert	PRVI	y=124.86x+19.48	0.94	33.14	33.14
		y=138.14x	0.93	36.02	37.19
	PNDVI	y= 633.53x+8.68	0.93	36.24	41.74
		y=663.87x	0.93	36.71	39.70
IIIC Cool temperate-semiarid temperate typical steppe	PRVI	y=137.71x+26.78	0.90	40.51	36.23
		y=159.27x	0.88	43.75	34.30
	PNDVI	y= 808.48x-8.32	0.90	40.45	35.60
		y=773.08x	0.90	40.67	34.25
IIID Cool temperate-subhumid meadow steppe	PRVI	y=135.01x-20.94	0.92	56.61	14.66
		y=127.63x	0.92	57.20	12.67
	PNDVI	y=1041.38x-114.12	0.89	67.49	19.75
		y=782.85x	0.86	75.78	18.24
Entire study area	PRVI	y=122.52x+27.91	0.94	44.70	33.18
		y=136.67x	0.93	48.57	32.24
	PNDVI	y=783.13x-8.16	0.92	49.60	34.73
		y=757.62x	0.92	49.83	33.92

PVIs calculated from MODIS data

Grassland Type	PVI	PVI model	r	RMSE(g/m^2)	RE (%)
IIIB Cool temperate-arid temperate zonal semidesert	PRVI	y=139.18x+37.91	0.91	47.59	43.46
		y=163.95x	0.88	54.84	38.07
	PNDVI	y=780.72x+2.24	0.92	46.81	35.16
		y=788.65x	0.92	46.83	34.40
	PEVI	y=1434.43x+4.63	0.89	52.80	54.15
		y=1465.24x	0.89	52.87	51.83
	PMSAVI	y=617.25x+17.91	0.88	55.61	54.67
		y=670.32x	0.87	56.78	49.70
IIIC Cool temperate-semiarid temperate typical steppe	PRVI	y=99.23x+44.84	0.81	57.24	48.06
		y=126.79x	0.76	64.33	42.03
	PNDVI	y=554.57x+17.22	0.77	62.74	46.63
		y=611.53x	0.76	63.41	42.71
	PEVI	y=1180.84x+12.17	0.80	58.86	43.90
		y=1263.19x	0.80	59.21	42.24
	PMSAVI	y=545.15x+8.48	0.75	64.53	53.10
		y=572.14x	0.75	64.67	52.70
IIID Cool temperate-subhumid meadow steppe	PRVI	y=135.97x+34.69	0.93	39.25	16.62
		y=155.07x	0.92	42.06	17.48
	PNDVI	y=845x-38.58	0.91	42.50	18.29
		y=738.68x	0.91	44.37	18.71
	PEVI	y=1499.50x-6.46	0.88	49.25	19.78
		y=1464.46x	0.88	49.30	19.93
	PMSAVI	y=879.33x-56.24	0.90	45.51	20.10
		y=725.42x	0.88	48.70	21.93
Entire study area	PRVI	y= 116.39x+41.29	0.86	56.26	43.64
		y= 141.33x	0.83	62.21	38.73
	PNDVI	y= 656.73x+7.13	0.84	59.93	40.39
		y= 679.51 x	0.84	60.05	38.81
	PEVI	y=1326.55x+5.5	0.85	57.58	43.02
		y=1361.58x	0.85	57.65	41.83
	PMSAVI	y= 617.90x+4.59	0.82	63.11	50.20
		y= 631.78x	0.82	63.16	49.71

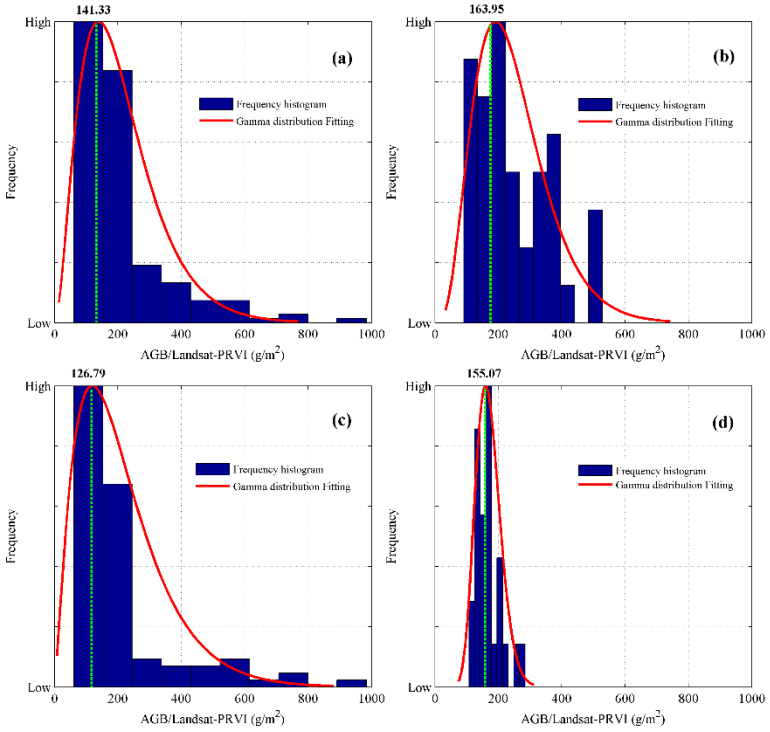
PVIs calculated from Landsat 8 OLI data

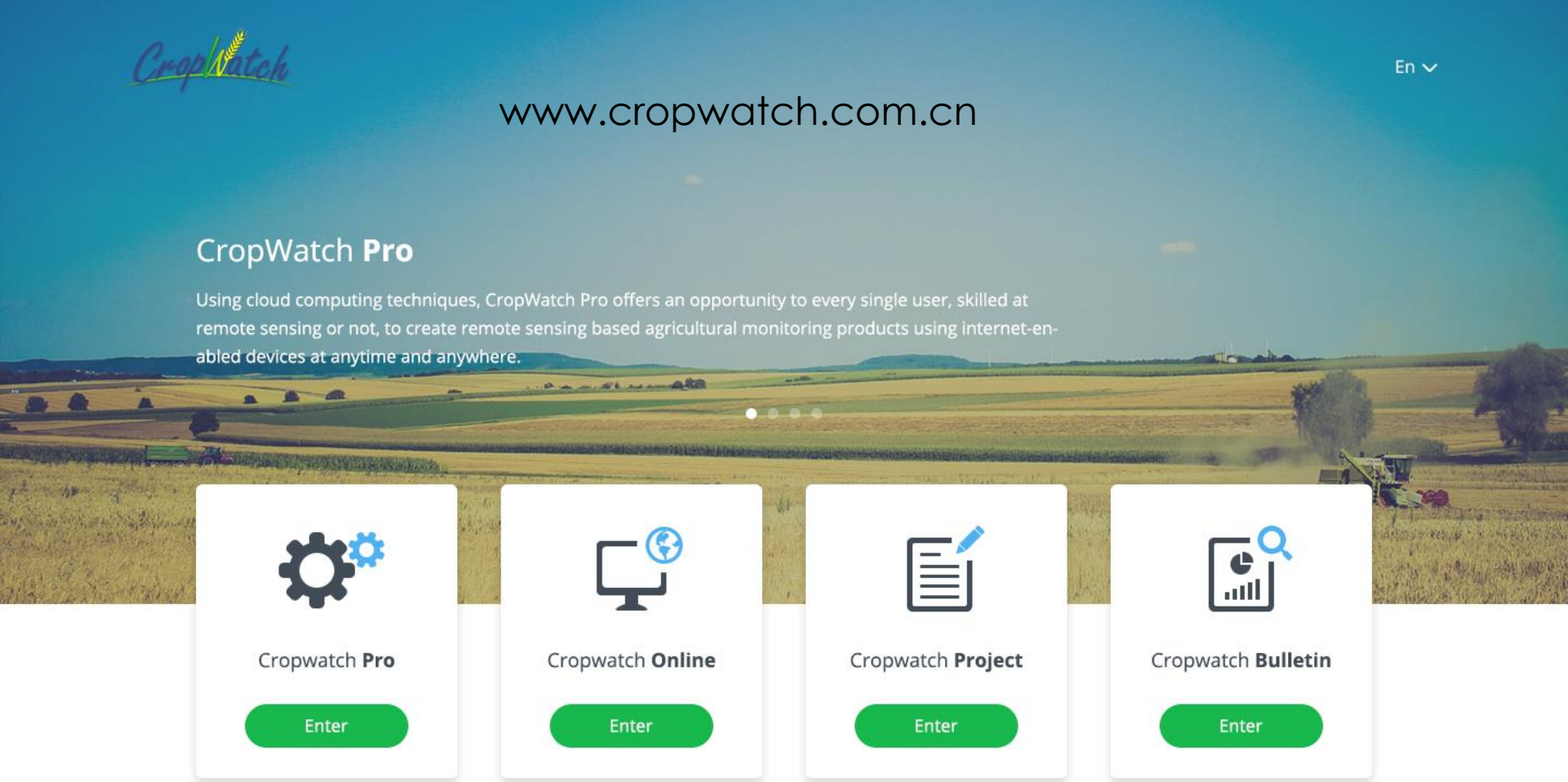
PVI model performance-2



Relationship of normal and pure VIs to grassland AGB.

The spatial variation of above ground biomass (AGB) for grass-land is directly related to grassland type.

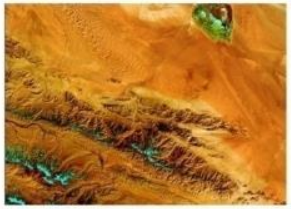


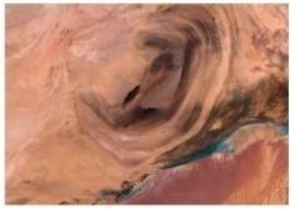


FUTURE WORKS

- GLOBAL-V
- Grassland quality and utilization intensity monitoring system
- Grassland degradation monitoring

Thanks!



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