

Remotely Sensed Habitat Heterogeneity

Mao-Ning Tuanmu

Texture Measures

- 6 first-order and 9 second-order texture measures (500m) based on NDVI and NDMI derived from Landsat images (30m)
- Ability to capture spatial heterogeneity of land cover/ landscape patterns
- Ability to capture vegetation structure

Land Cover Heterogeneity

- NLCD land cover data (30 m)
- 9 aggregated land cover classes
 - Snow/ice, developed, barren, forest, shrubland, grassland, cropland, wetland, water
- 14 landscape metrics at the landscape-level
- 500 by 500 m

Landscape Metrics

Area-edge
Edge density (ED)
Largest patch index (LPI)
Shape
Coefficient of variation of fractal dimension index (FRAC-CV)
Mean of fractal dimension index (FRAC-MN)
Coefficient of variation of perimeter-area ratio (PARA-CV)
Mean of perimeter-area ratio (PARA-MN)
Aggregation
Landscape division index (DIVISION)
Area-weighted mean of Euclidean nearest neighbor distance (ENN-AM)
Landscape shape index (LSI)
Diversity
Patch richness (PR)
Shannon's diversity index (SHDI)
Simpson's diversity index (SIDI)
Shannon's evenness index (SHEI)
Simpson's evenness index (SIEI)

Multiple Linear Regression

- Dependent variable:
 - Edge density (ED)
 - Coefficient of variation of fractal dimension index (FRAC-CV)
 - Landscape shape index (LSI)
 - Simpson's diversity index (SIDI)
 - Patch richness (PR)
 - Coefficient of variation of perimeter-area ratio (PARA-CV)

Multiple Linear Regression

- Predictor variables
 - PCA
 - 15 PCs for NDVI texture measures
 - 15 PCs for NDMI texture measures
 - 30 PCs for both
 - Standardized component scores
- Randomly selected 10,000 pixels (500m) for training and 10,000 pixels for testing
- Stepwise variable selection based on AIC

Results

ED

	# of parameters	AIC	Adjusted R ² (training)	Adjusted R ² (testing)
NDVI	14	82247	0.270	0.282
NDMI	13	82528	0.249	0.265
Both	25	81841	0.300	0.309

FRAC_CV

	# of parameters	AIC	Adjusted R ² (training)	Adjusted R ² (testing)
NDVI	13	16128	0.253	0.254
NDMI	11	16320	0.238	0.247
Both	25	15802	0.277	0.279

Results

LSI

	# of parameters	AIC	Adjusted R ² (training)	Adjusted R ² (testing)
NDVI	14	-6898	0.269	0.282
NDMI	13	-6620	0.248	0.264
Both	25	-7303	0.299	0.309

PR

	# of parameters	AIC	Adjusted R ² (training)	Adjusted R ² (testing)
NDVI	15	-2745	0.339	0.338
NDMI	13	-2382	0.315	0.322
Both	26	-3176	0.368	0.367

Results

SIDI

	# of parameters	AIC	Adjusted R ² (training)	Adjusted R ² (testing)
NDVI	13	-34731	0.340	0.349
NDMI	13	-34536	0.327	0.342
Both	27	-35273	0.375	0.385

PARA_CV

	# of parameters	AIC	Adjusted R ² (training)	Adjusted R ² (testing)
NDVI	13	63304	0.181	0.166
NDMI	12	63359	0.176	0.171
Both	22	63129	0.196	0.182

Summary

- Texture measures derived from NDVI and NDMI capture some information about landscape patterns and land cover heterogeneity
- While high spatial resolution land cover data are not available for many places, texture measures may provide an alternative approach for quantifying land cover heterogeneity

Vegetation Structure

- NBCD (30m)
 - Canopy height
 - Aboveground biomass
- Dependent variable
 - SD, range and CV of canopy height and biomass within 500-m areas

Multiple Linear Regression

- Predictor variables
 - PCA
 - 15 PCs for NDVI texture measures
 - 15 PCs for NDMI texture measures
 - 30 PCs for both
 - 14 PCs for landscape metrics
 - Standardized component scores
- Randomly selected 10,000 pixels (500m) for training and 10,000 pixels for testing
- Stepwise variable selection based on AIC

Results - SD

SD of canopy height

	# of parameters	AIC	Adjusted R ² (training)	Adjusted R ² (testing)
NDVI	15	69675	0.349	0.321
NDMI	11	70186	0.314	0.303
Both	26	69015	0.391	0.377
LM	12	71723	0.2	0.205

SD of aboveground biomass

	# of parameters	AIC	Adjusted R ² (training)	Adjusted R ² (testing)
NDVI	13	68189	0.626	0.603
NDMI	15	68185	0.627	0.624
Both	23	67277	0.659	0.644
LM	15	77667	0.036	0.028

Results - range

Range of canopy height

	# of parameters	AIC	Adjusted R ² (training)	Adjusted R ² (testing)
NDVI	15	85504	0.510	0.485
NDMI	13	85782	0.496	0.490
Both	25	85158	0.527	0.508
LM	13	91505	0.106	0.091

Range of aboveground biomass

	# of parameters	AIC	Adjusted R ² (training)	Adjusted R ² (testing)
NDVI	14	88660	0.732	0.717
NDMI	13	88214	0.744	0.742
Both	20	87603	0.759	0.748
LM	13	101347	0.048	0.044

Results - CV

CV of canopy height

	# of parameters	AIC	Adjusted R ² (training)	Adjusted R ² (testing)
NDVI	14	11858	0.337	0.329
NDMI	15	12305	0.307	0.304
Both	26	11391	0.368	0.355
LM	11	15199	0.074	0.066

CV of aboveground biomass

	# of parameters	AIC	Adjusted R ² (training)	Adjusted R ² (testing)
NDVI	14	11841	0.334	0.325
NDMI	15	12282	0.304	0.300
Both	26	11377	0.365	0.352
LM	10	15141	0.073	0.065

Summary

- Texture measures derived from NDVI and NDMI are useful for capturing spatial heterogeneity of forest structure (i.e., canopy height and aboveground biomass)
- Landscape metrics based on categorical land cover data cannot capture spatial heterogeneity in vegetation structure within a single land cover type (i.e., forests)

Next...

- Spatial autocorrelation
 - Simultaneously autoregressive models
 - Other methods
- Usefulness for mapping individual species habitat
- Usefulness for predicting species richness and diversity

Up-scaling

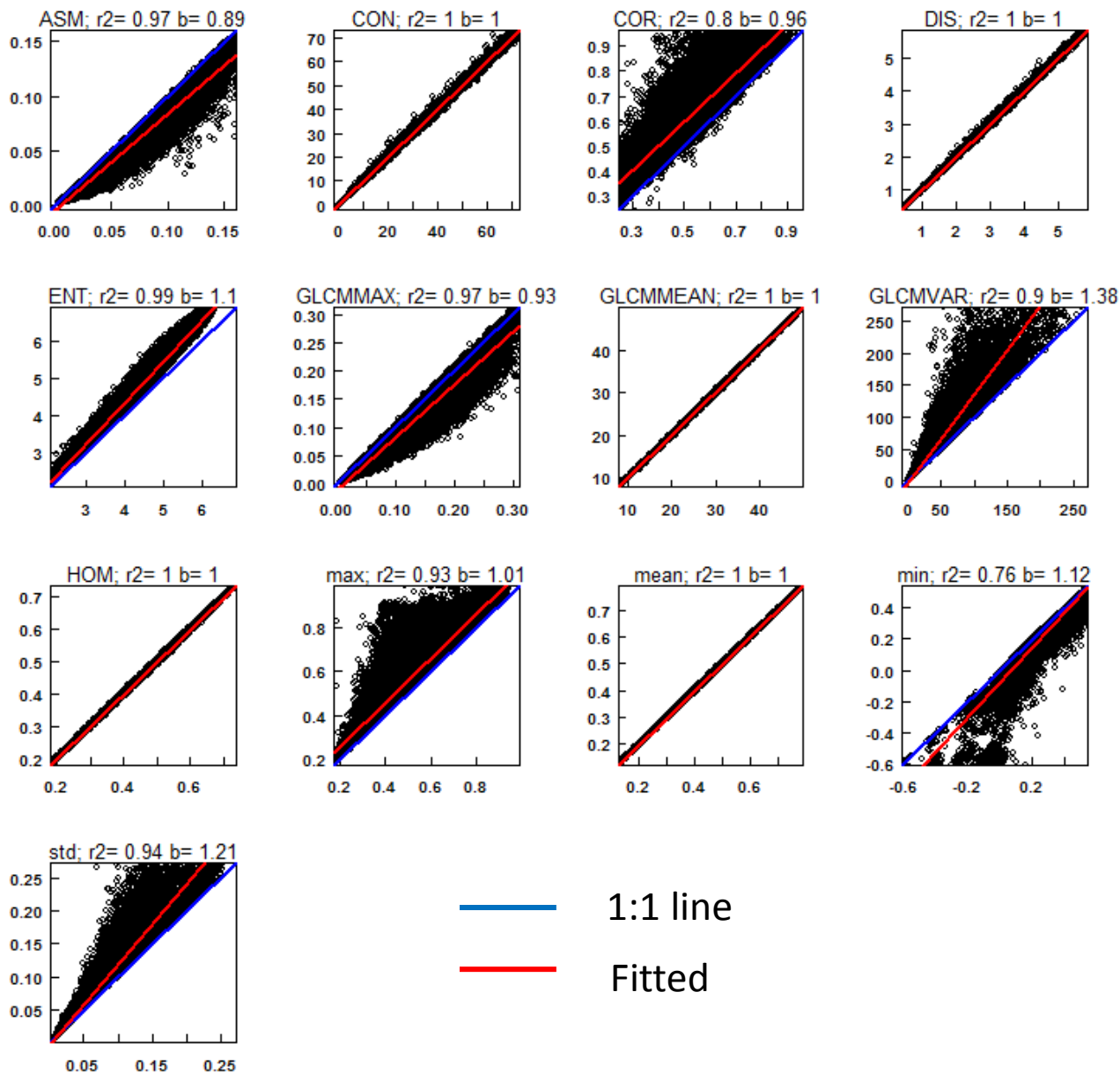
- Information about species distribution and biodiversity is usually available at coarser spatial resolutions
- Up-scaling information captured by texture measures

Up-scaling

- Calculate texture measures at 500-m and 1-km resolutions
- Calculate descriptive statistics (e.g., mean, max, min) of the 500-m texture measures for each 1-km pixel (four 500-m pixels)
- Compare the values of the up-scaled texture measures with those of the 1-km texture measures

Mean

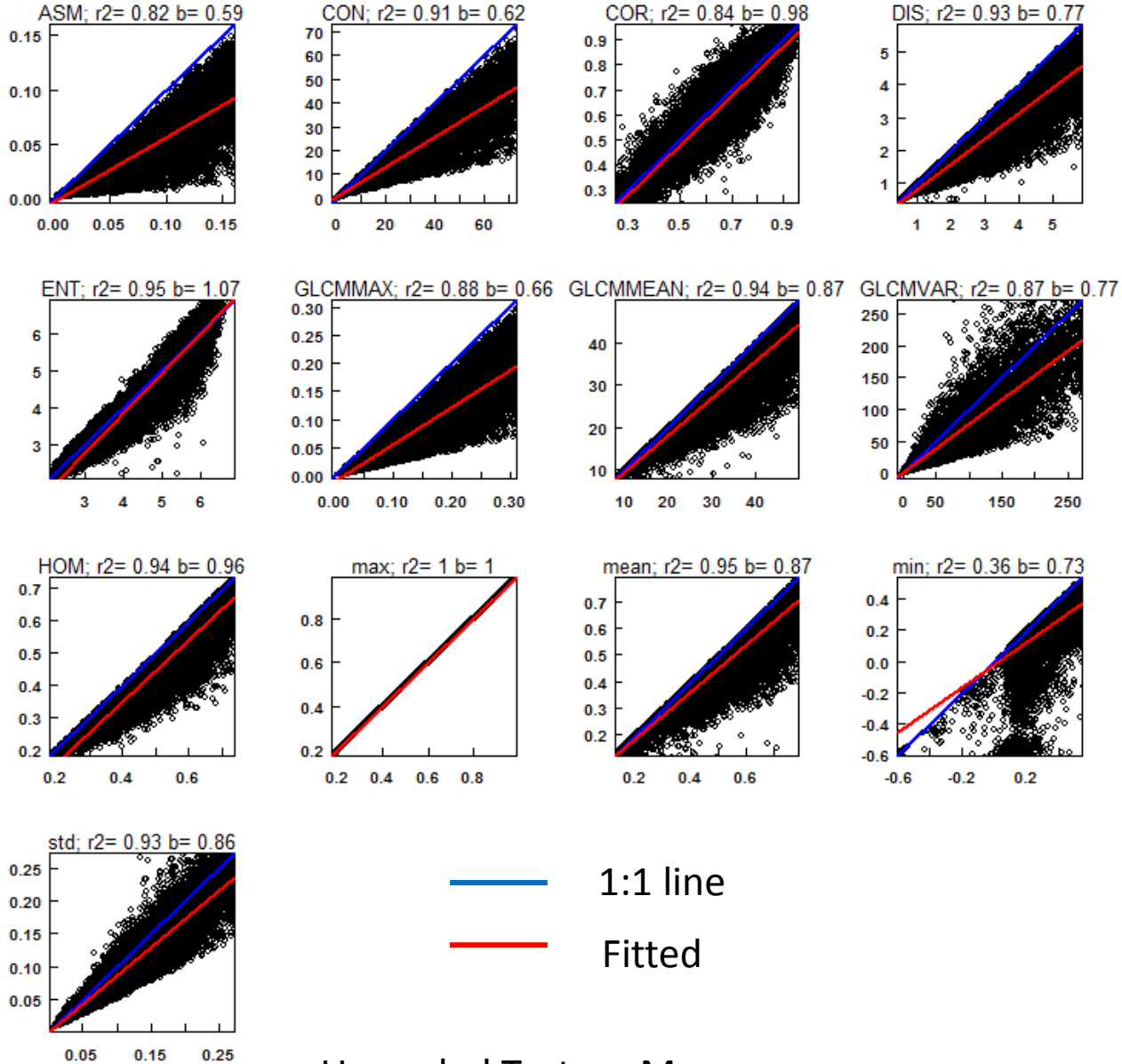
1-km Texture Measures



Up-scaled Texture Measures
(Mean of 500-m Texture Measures)

Maximum

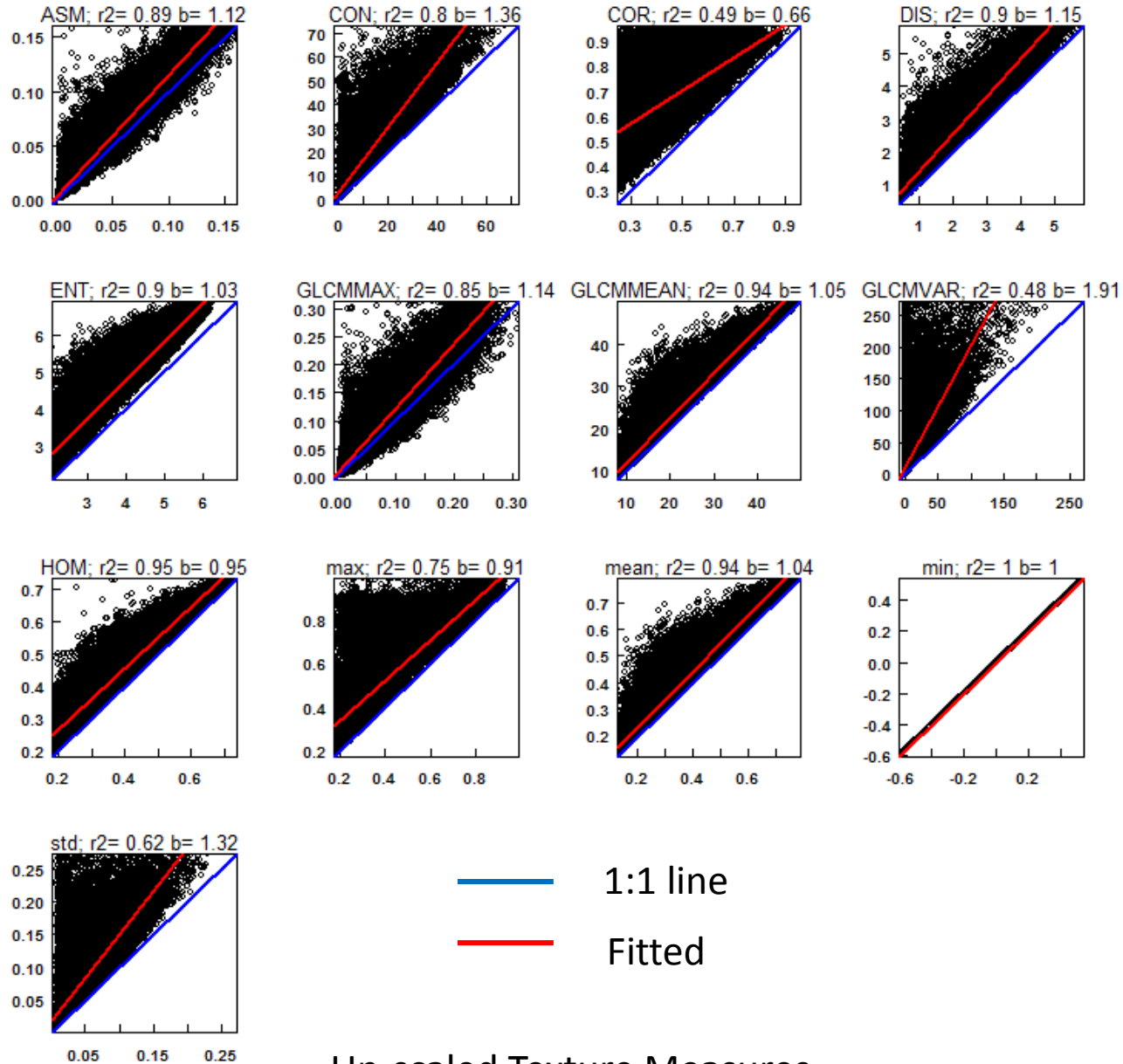
1-km Texture Measures



Up-scaled Texture Measures
(Maximum of 500-m Texture Measures)

Minimum

1-km Texture Measures



Up-scaled Texture Measures
(Minimum of 500-m Texture Measures)

