Remotely sensed land cover heterogeneity

Mao-Ning Tuanmu

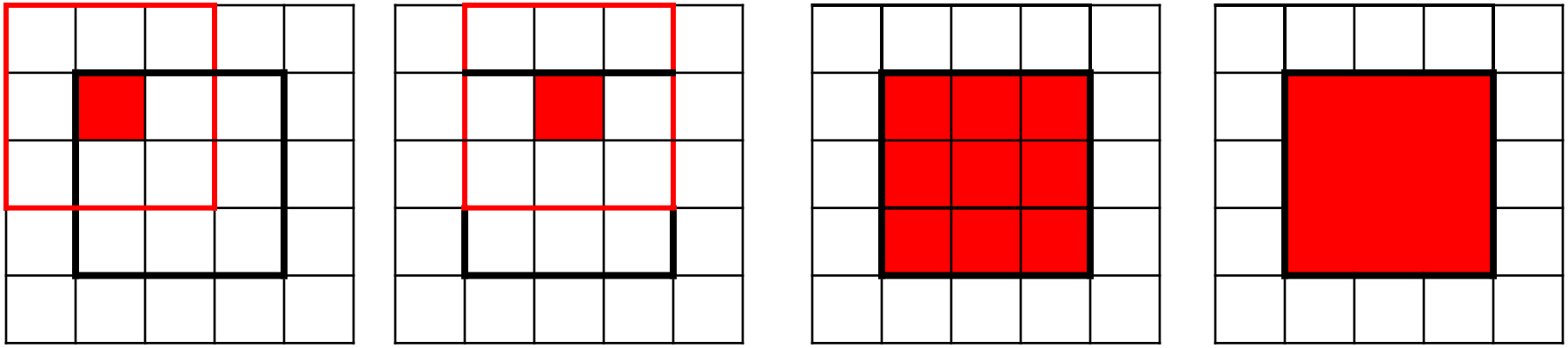
6/26/2012

Heterogeneity Metrics

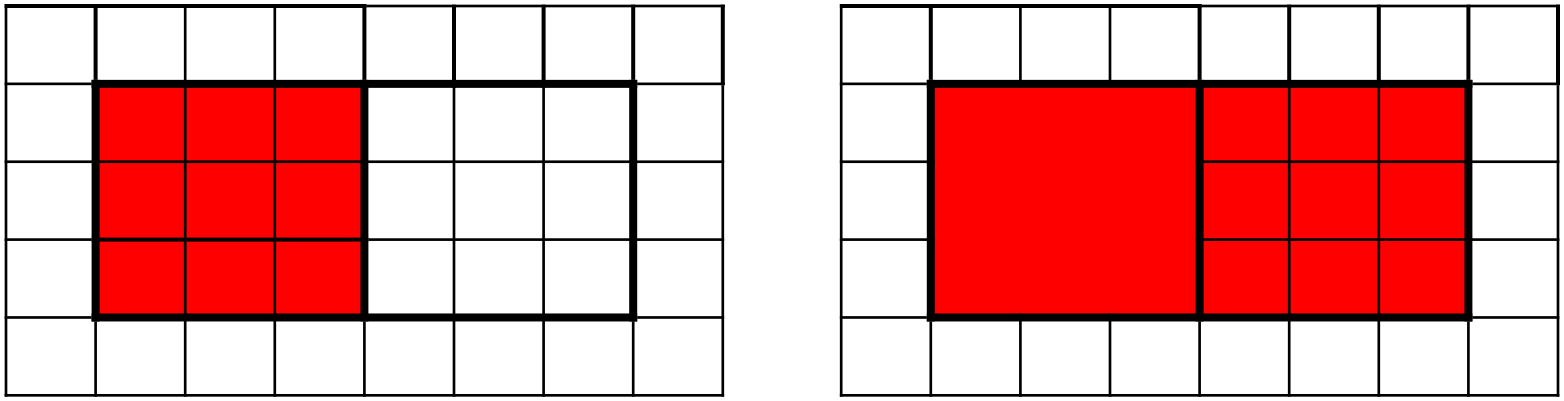
- Texture measures
  - First-order & second-order
  - NDVI & NDMI (Normalized Difference Moisture Index)
  - GLS 2000 Landsat imagery
- Landscape metrics
  - Categorical land cover data
  - NLCD2001 (Landsat imagery around 2001)
- Data layers of these metrics with the resolution of ~ 500 m (consistent with MODIS 500-m data)

Two Approaches

- Moving-window approach



- Fixed-grid approach



Two Approaches

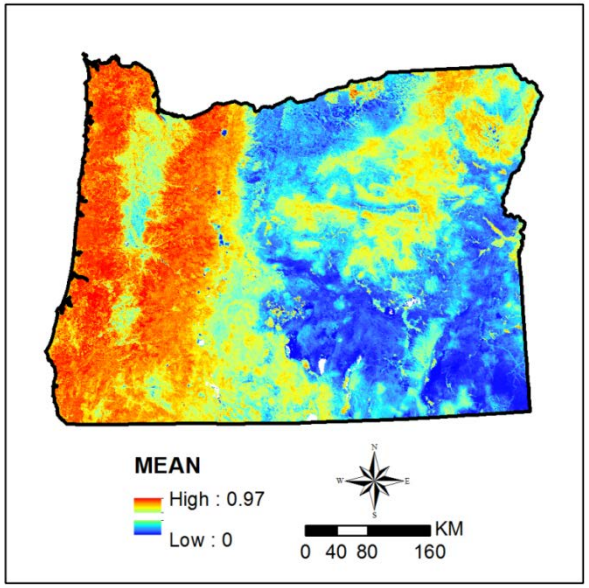
- Moving-window
  - Texture characteristics at different scales
  - Computation-intensive (~ one month for one metric with a 3x3 window)
  - Containing surrounding information
- Fixed-grid
  - Heterogeneity within a specified area
  - ~ 2 days for all (i.e., 10) second-order texture measures

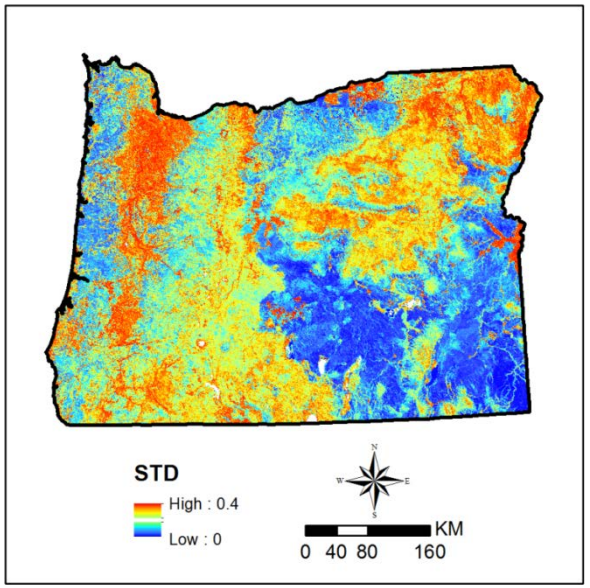
Two Approaches

- Metric values calculated with the two approaches are highly correlated
  - Absolute values of Pearson's r > 0.85 for all texture measures except the second-order correlation (0.71)
- Metric values at different scales are highly correlated
  - Pearson's r > 0.94 between 3-by-3-pixel and 11-by-11-pixel moving windows for first-order standard deviation and second-order homogeneity

Texture Measures

- Seven first-order texture measures
  - Mean (mean), standard deviation (std), maximum (max), minimum (min)
  - Variance (var), coefficient of variation (cv), range (range)

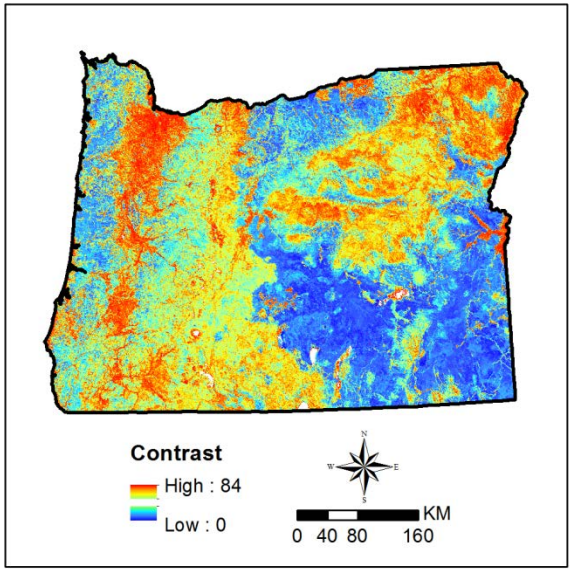


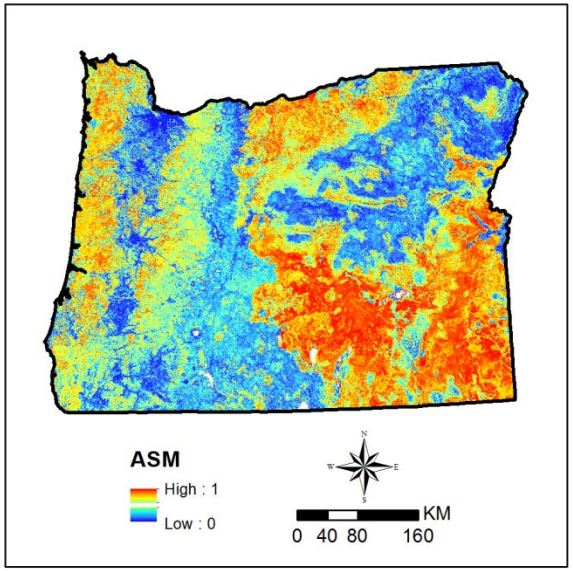


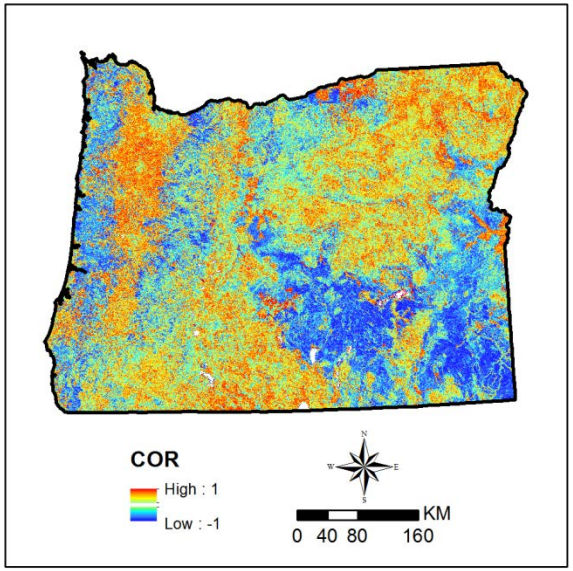
Texture Measures

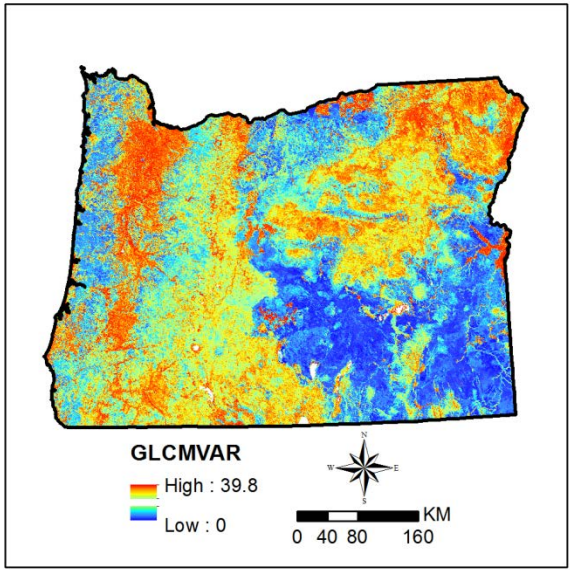
- Ten second-order texture measures (GLCM)
  - Contrast: contrast(CON), dissimilarity (DIS), homogeneity (HOM)
  - Regularity: angular second moment (ASM), entropy (ENT), maximum (GLCMMAX)
  - Descriptive statistics: correlation (COR), mean (GLCMMEAN), standard deviation (GLCMSTD), variance (GLCMVAR)

Texture Measures

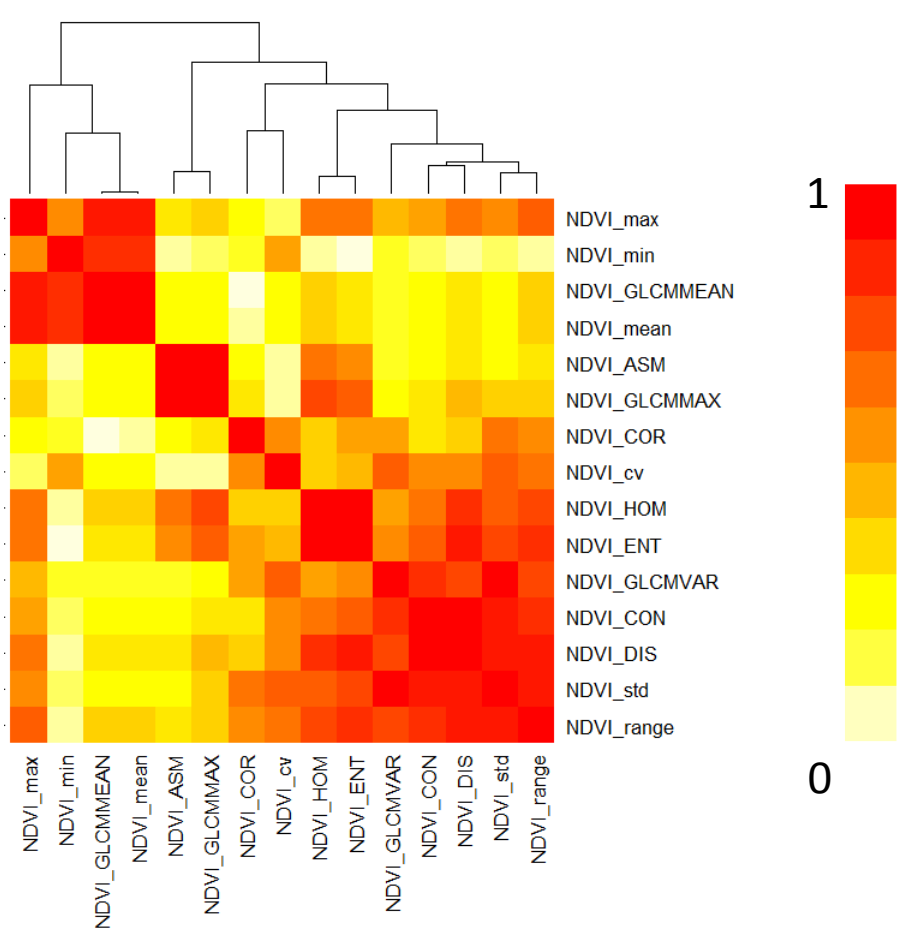




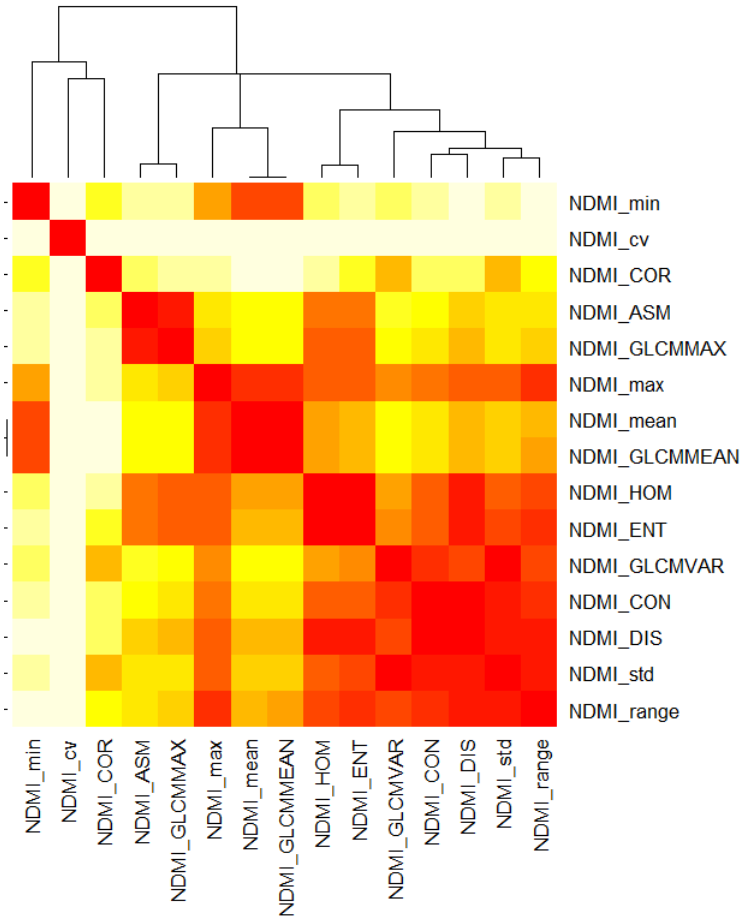




Correlations Among Texture Measures

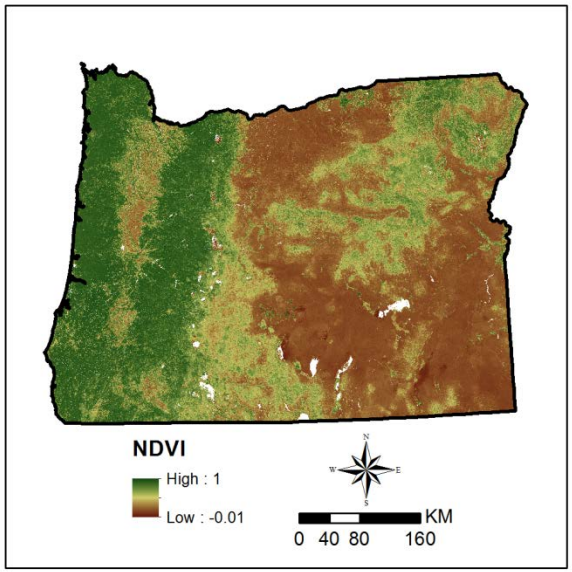


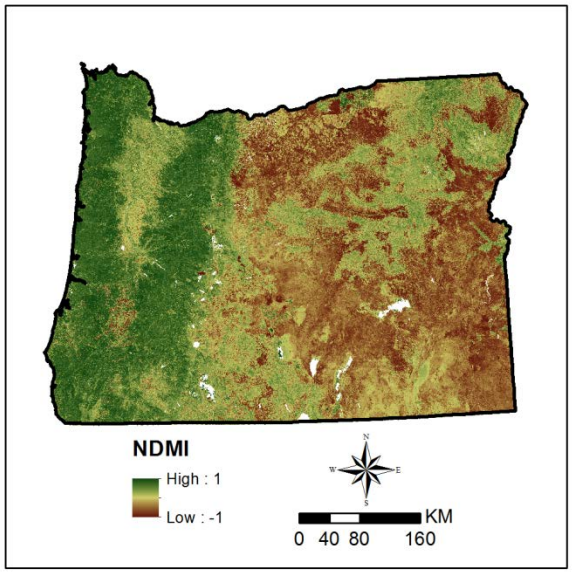
NDVI

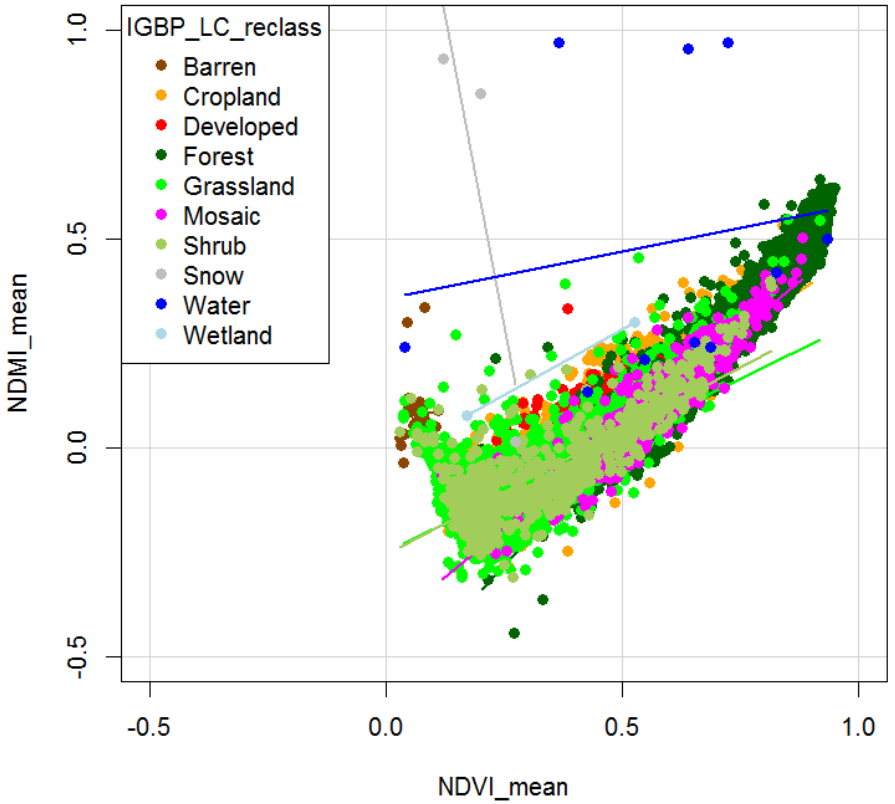


NDMI

NDVI vs. NDMI



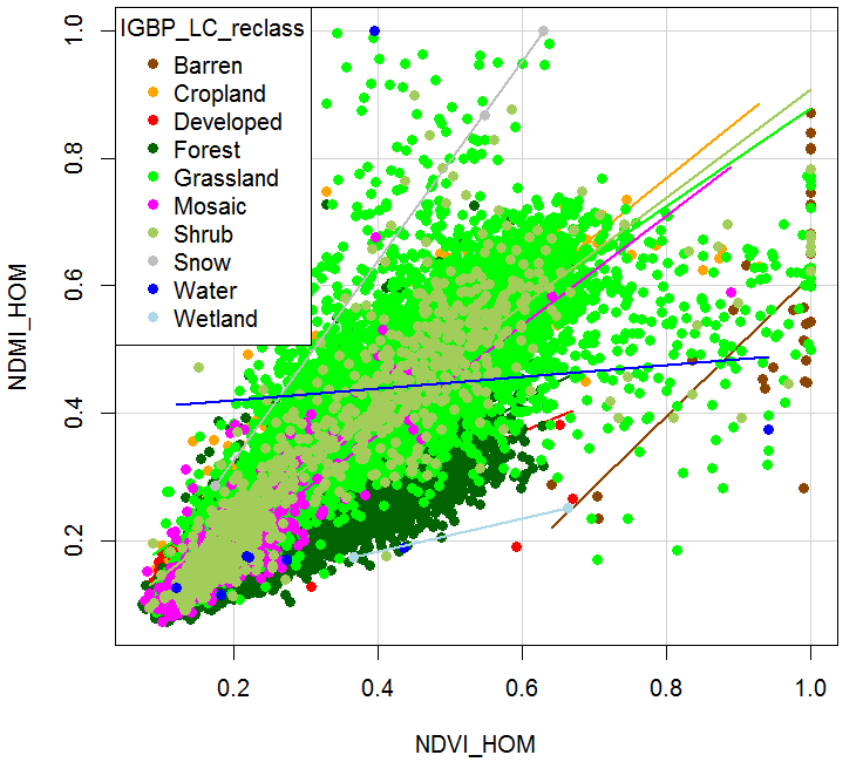


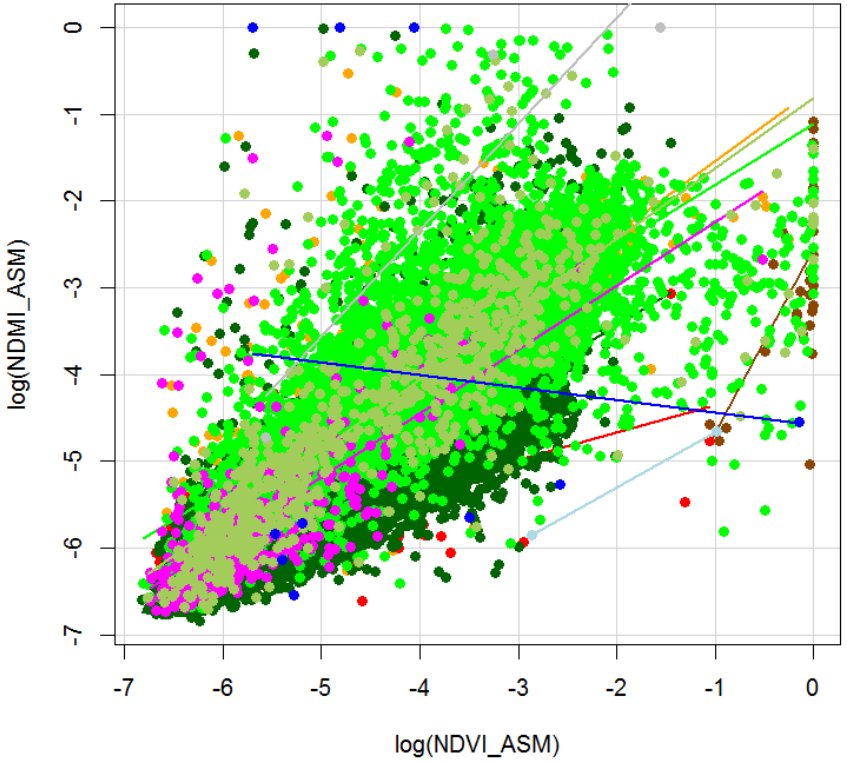


Overall R2 = 0.92

NDVI vs. NDMI

- Highly correlated (> 0.7), except for cv





Landscape Metrics

- Fragstats
  - ~ 12 hrs for 12 landscape-level and 1 class-level metrics
- SDMTools in R
  - Only for patch-level metrics
- r.le and r.li in GRASS
  - Could be an alternative to Fragstats

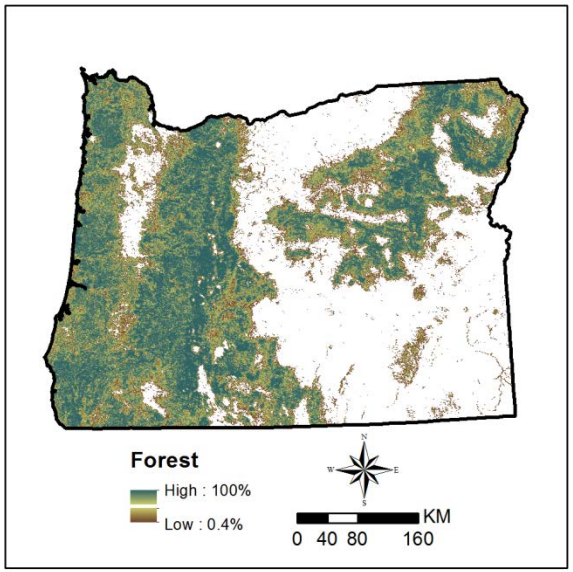
Landscape Metrics

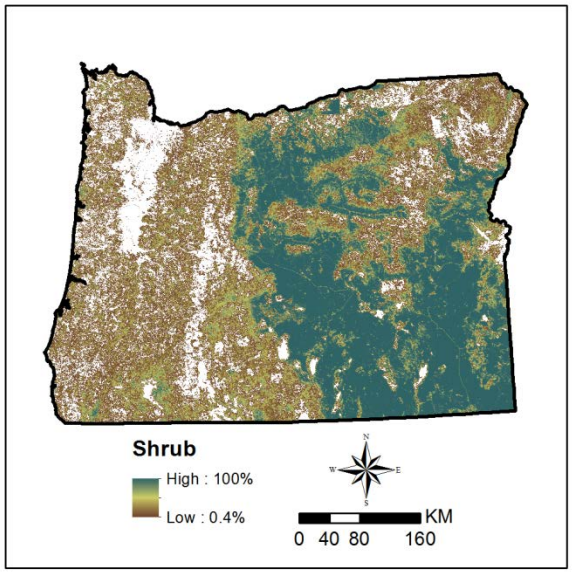
- Class-level
  - Percentage of landscape covered by each land cover type
- Area-edge
  - Edge density (ED)
  - Largest patch index (LPI)
- Shape
  - Mean and CV of fractal dimension index (FRAC)
  - Mean and CV of area-perimeter ratio (PARA)

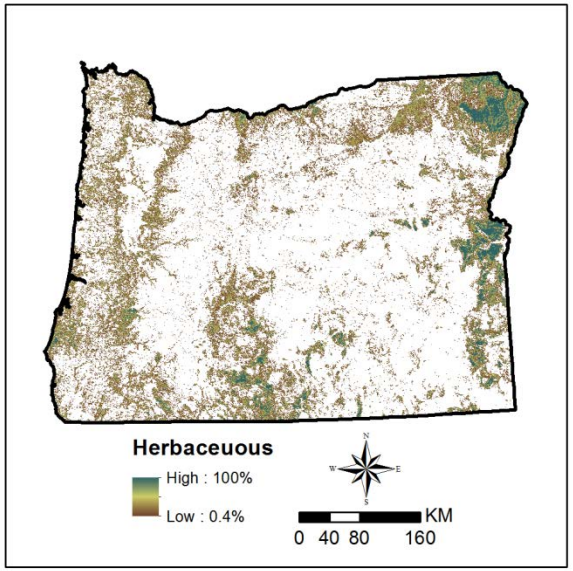
Landscape Metrics

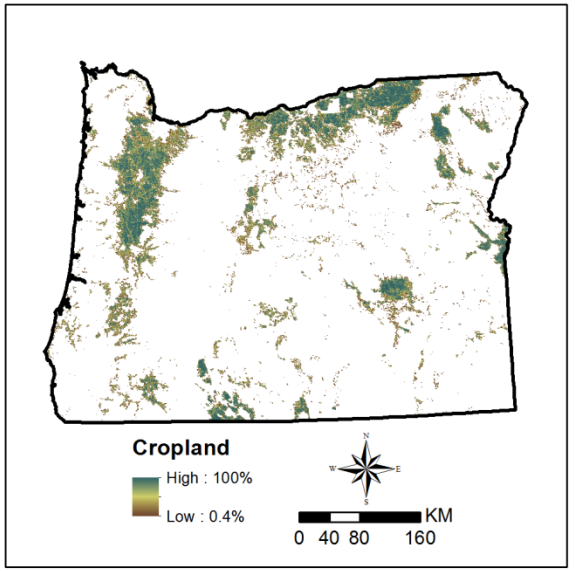
- Aggregation
  - Landscape division index (DIVISION)
  - Mean of Euclidean nearest neighbor distance (ENN)
  - Landscape shape index (LSI)
- Diversity
  - Patch richness (PR)
  - Shannon's and Simpson's diversity indices (SHDI, SIDI)
  - Shannon's and Simpson's evenness indices (SHEI, SIEI)

Class-level Landscape Metrics

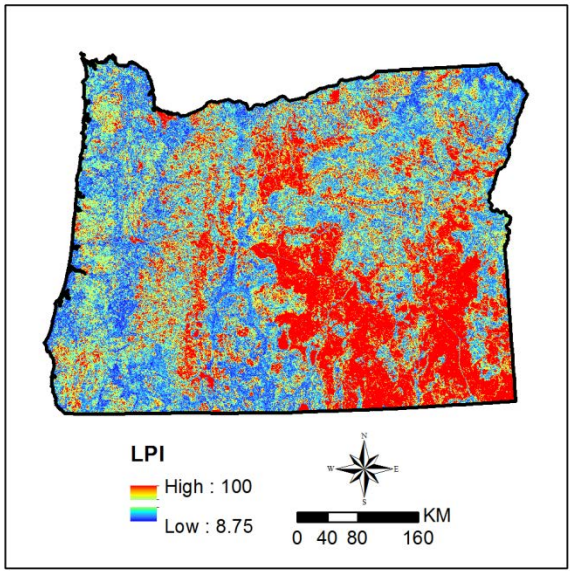


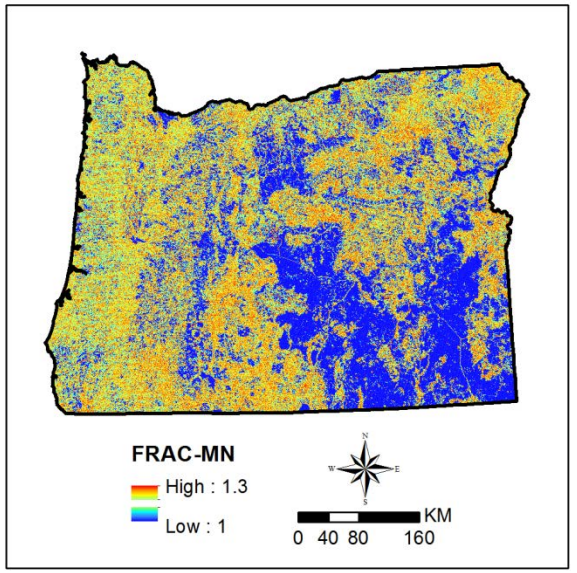


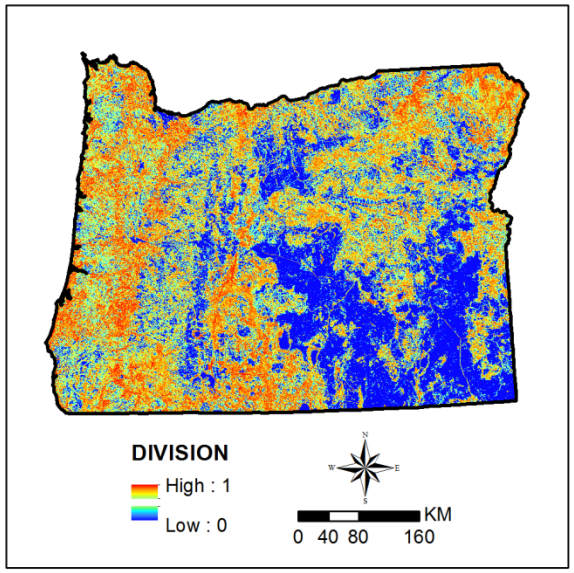


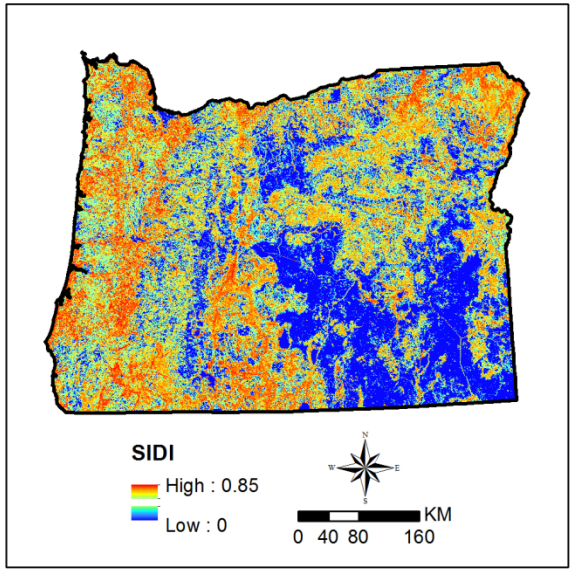


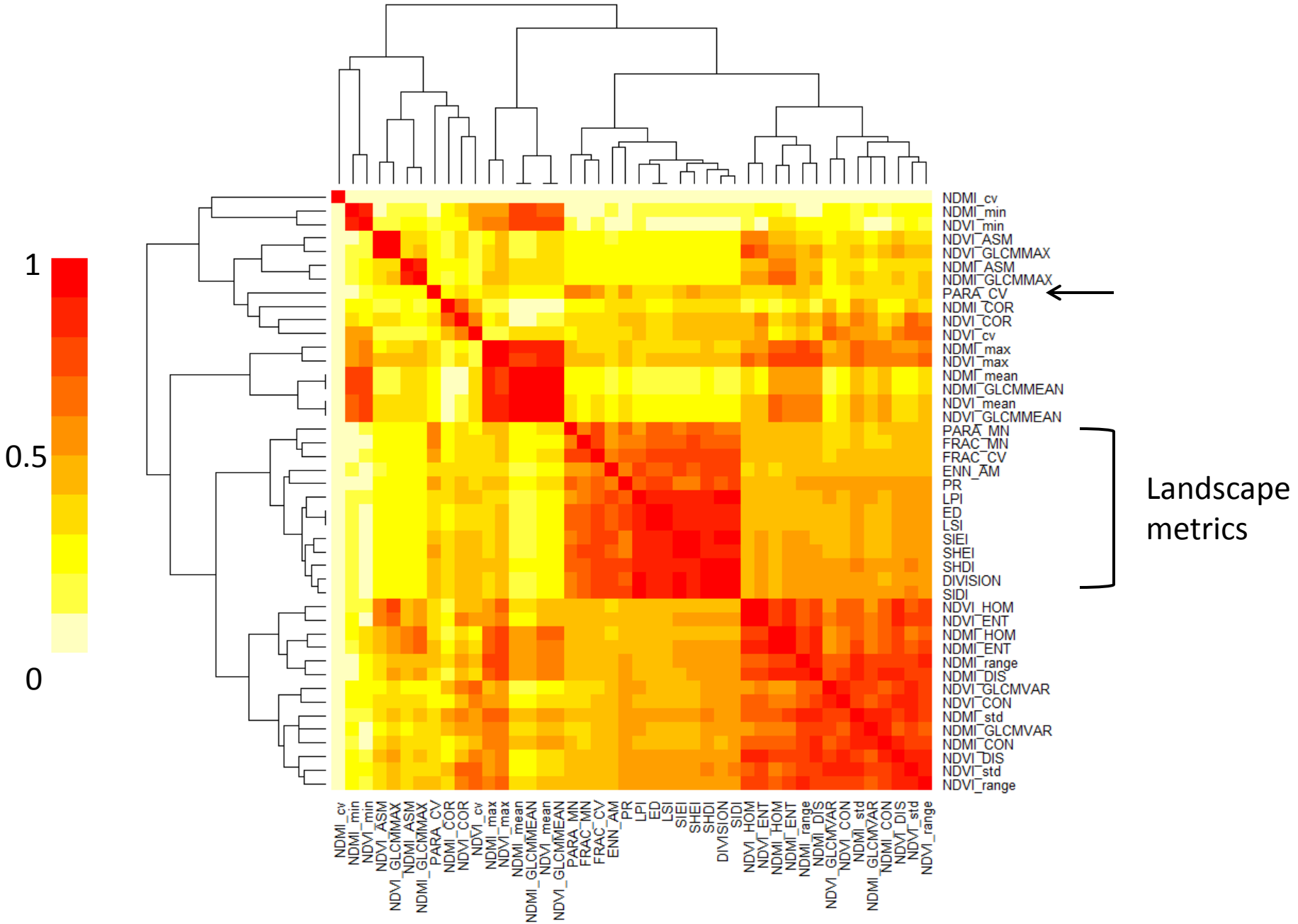
Landscape-level Metrics









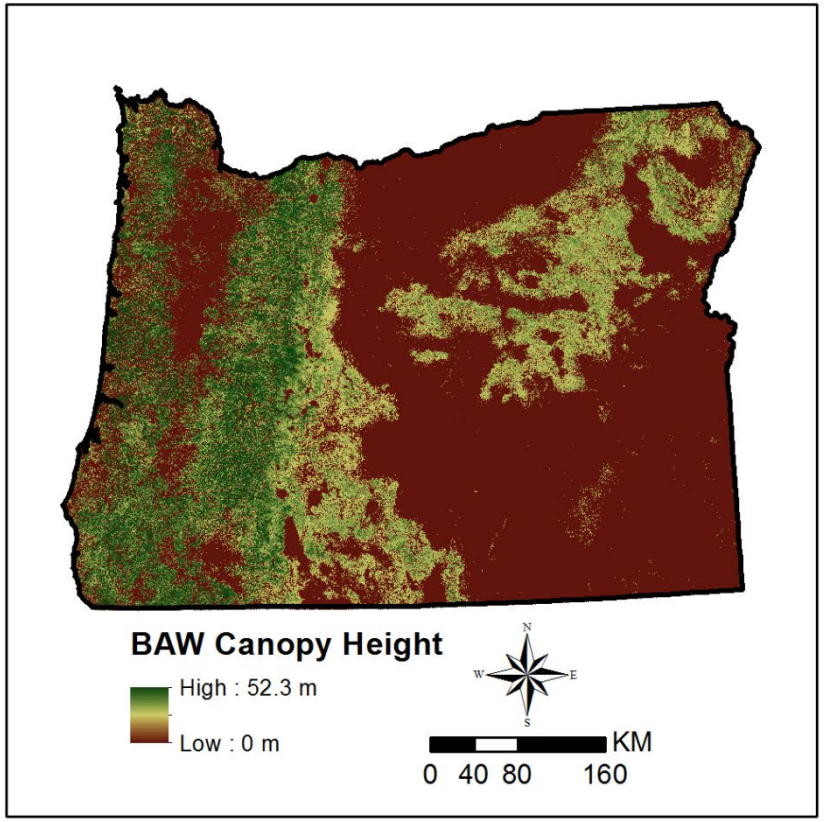

1
0.5
0
NDMI_cv
NDMI_min
NDVI_min
NDVI_ASM
NDVI_GLCMMAX
NDMI_ASM
NDMI_GLCMMAX
PARA_CV
NDMI_COR
NDVI_COR
NDVI_cv
NDMI_max
NDVI_max
NDMI_mean
NDMI_GLCMMEAN
NDVI_mean
NDVI_GLCMMEAN
PARA_MN
FRAC_MN
FRAC_CV
ENN_AM
PR
LPI
ED
LSI
SIEI
SHEI
SHDI
DIVISION
SIDI
NDVI_HOM
NDVI_ENT
NDMI_HOM
NDMI_ENT
NDMI_range
NDMI_DIS
NDVI_GLCMVAR
NDVI_CON
NDMI_std
NDMI_GLCMVAR
NDMI_CON
NDVI_DIS
NDVI_std
NDVI_range
Landscape metrics

National Biomass & Carbon Datasets

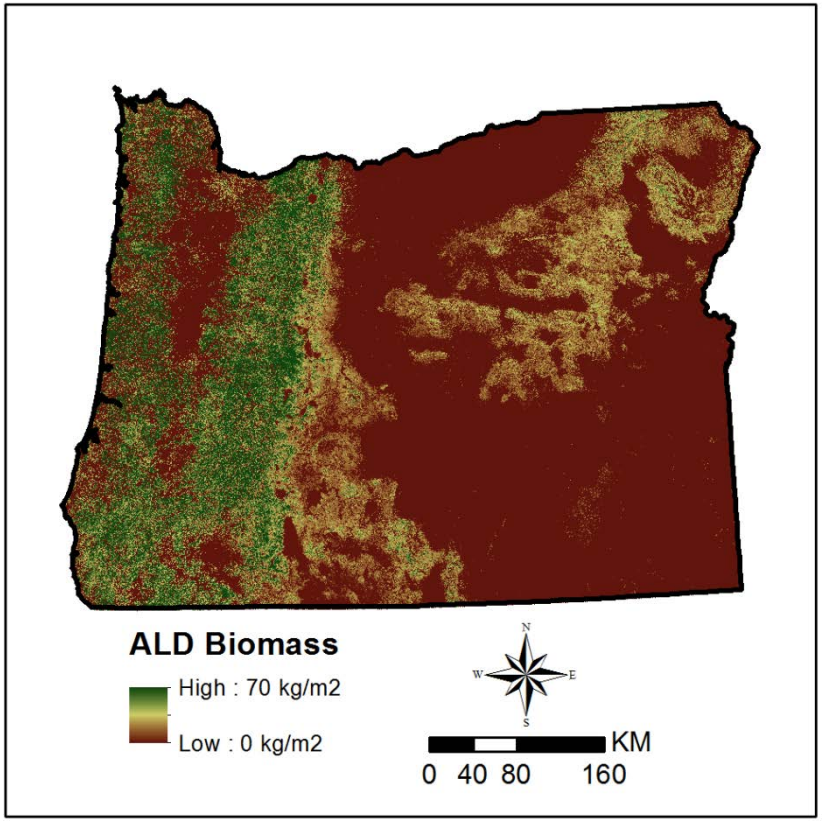
- Woods Hole Research Center
- High resolution (30m) estimation of basal area-weighted canopy height, aboveground live dry biomass, & standing carbon stock
- USDA Forest Service Forest Inventory and Analysis (FIA) data
  - Canopy height & biomass
- Predictors
  - NLCD 2001 (landcover & canopy density)
  - LANDFIRE project (existing vegetation type)
  - USDA National Elevation Dataset (NED)

NBCD

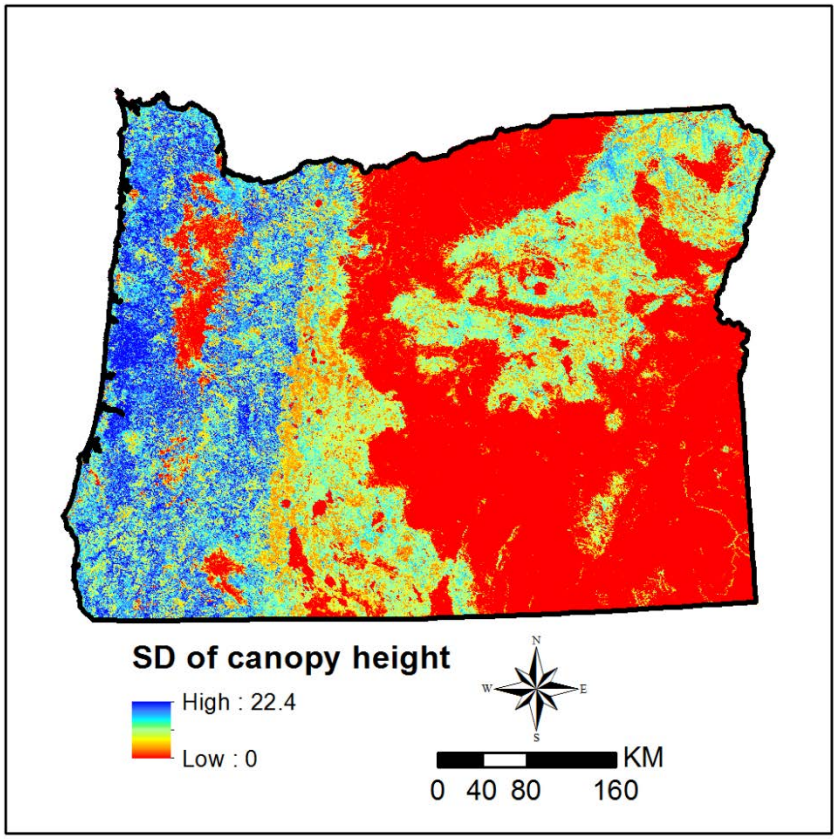
Basal-area weighted canopy height

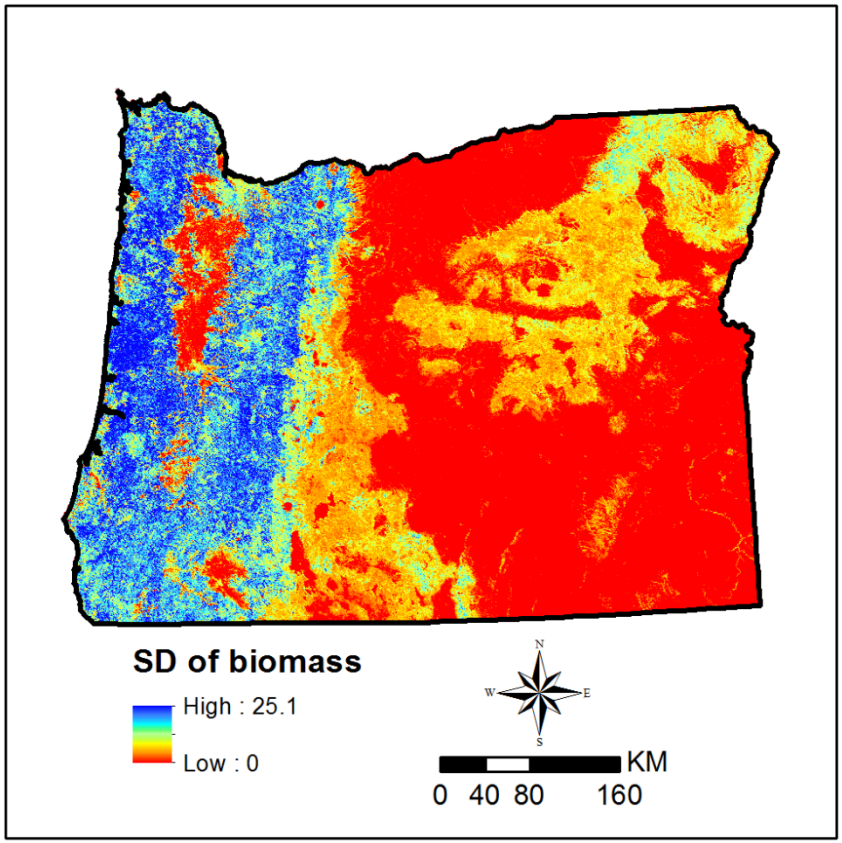


Above-ground live dry biomass

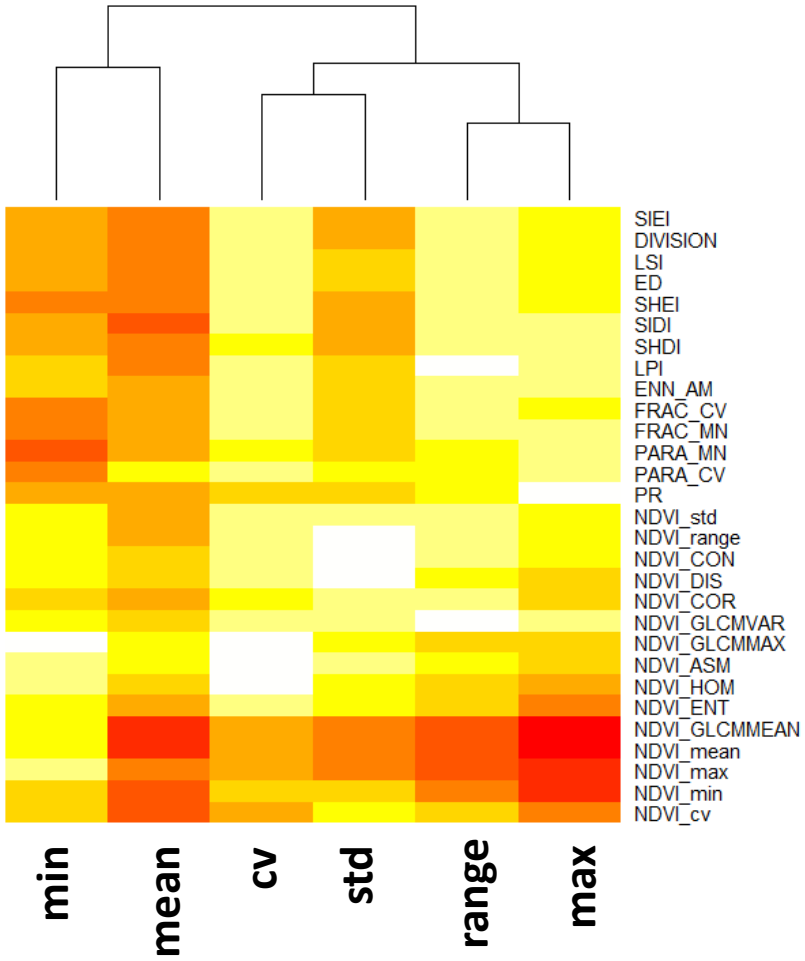


Heterogeneity of Canopy Height & Biomass

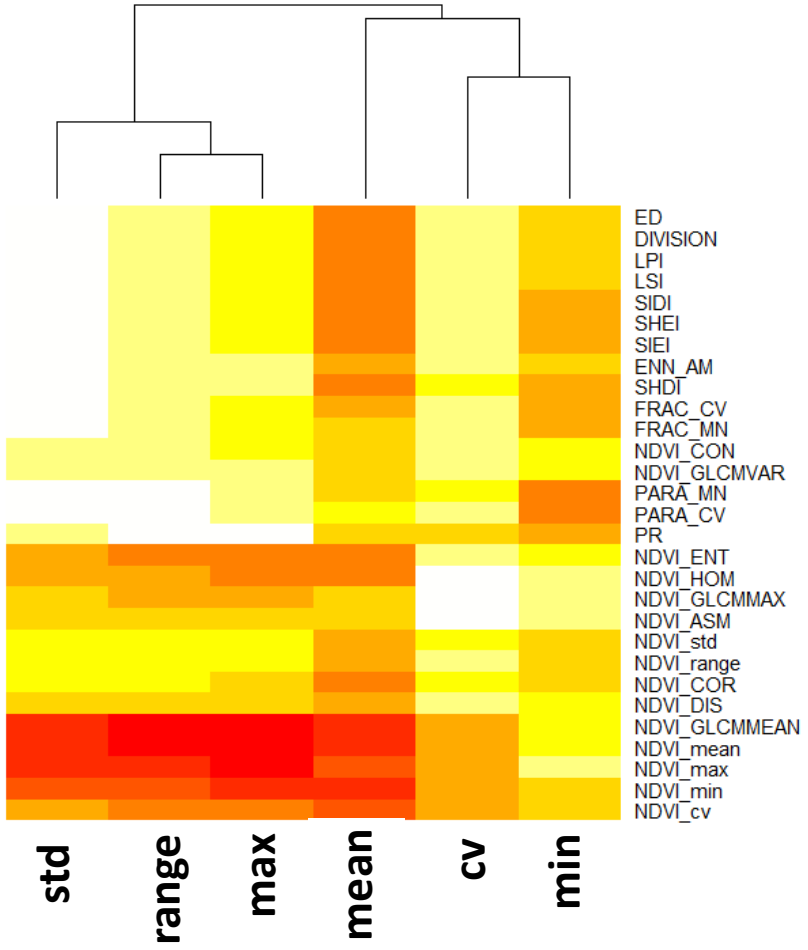




NBCD



Canopy Height



Biomass

Next

- Further evaluations of different heterogeneity metrics
  - Different land cover types or ecoregions
  - Vegetation structure
  - Biodiversity (species richness)
- Other vegetation indices or band combinations
  - Tasseled cap transformations…
- Other heterogeneity metrics