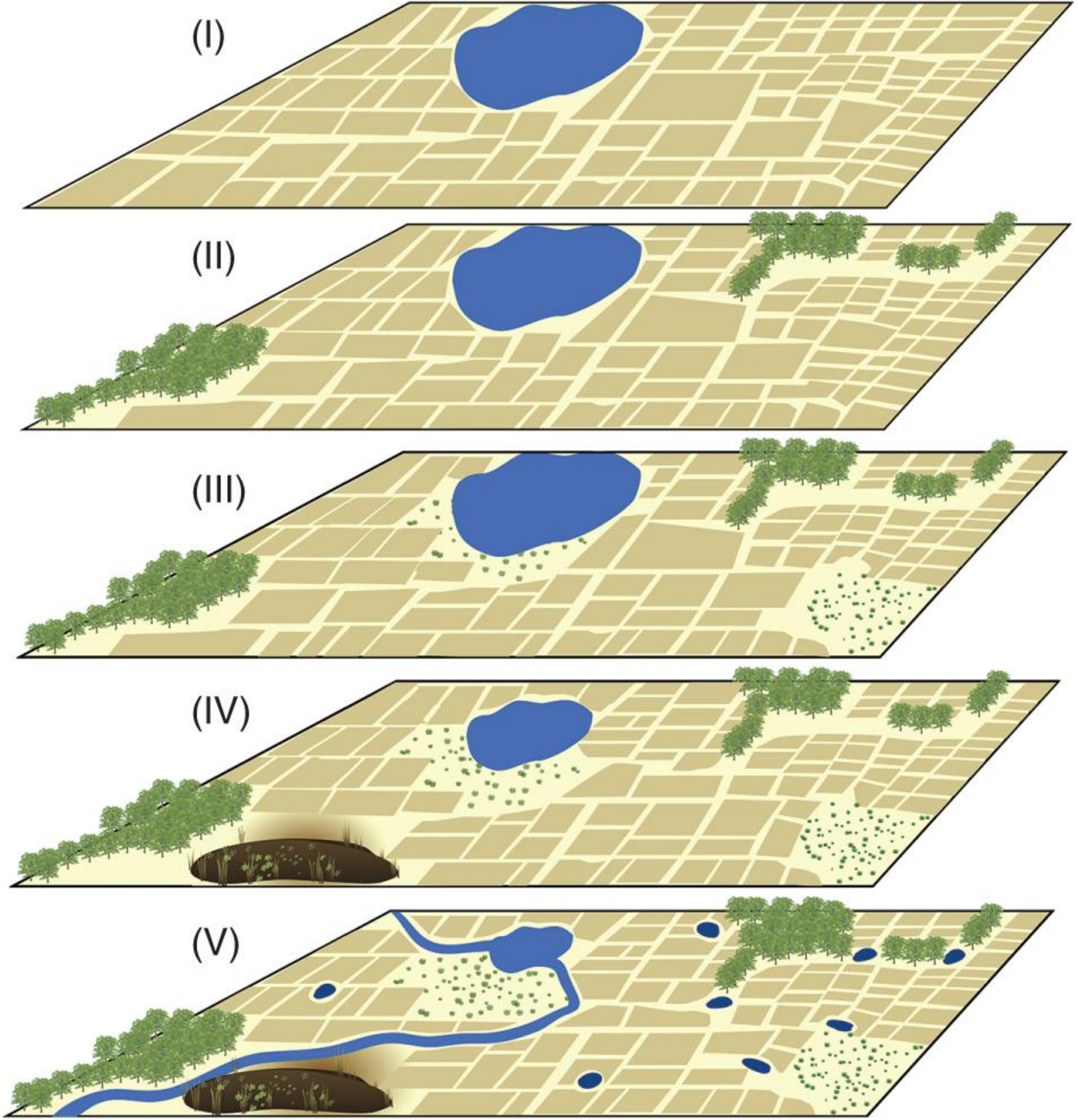
GEO 874

Remote Sensing

Zihan Lin, Nafiseh Hagtalab, Ranjeet John



Landscape Heterogeneity

S-I: homogeneous landscape using only cropland for the terrestrial domain and large lakes for the aquatic domain.
S-II: terrestrial area divided into croplands and forest lands.
S-III: croplands, forest lands and grasslands
S-IV: large lakes and peatlands,
S-V: large lakes, peatlands, rivers and small inland waters. Heterogenous

http://onlinelibrary.wiley.com/doi/10.1002/wat2.1147/full

Remote Sensing

- We will attempt to work within Google Earth Engine (GEE)
- Make use of available data layers in the GEE catalog as appropriate
- main goal is to obtain the highest possible resolution

Import flux tower table into GEE

- We will finalize the list of forest flux towers with David's group and Dr. Chen
- We will buffer the point shapefile (geographic, WGS84) to 3km (and/or 20km) based on footprint size
- Use "asset manager" to upload our shapefile
- Or import tables from google fusion table

https://developers.google.com/earth-engine/importing

Surface reflectance for vegetation indices (NDVI, EVI)

- Sentinel-2: MultiSpectral Instrument (MSI), Level-1C

Band	Use	Wavelength	Resolution
B1	Aerosols	443nm	60m
B2	**Blue**	**490nm**	**10m**
B3	**Green**	**560nm**	**10m**
B4	**Red**	**665nm**	**10m**
B5	Red Edge 1	705nm	20m
B6	Red Edge 2	740nm	20m
B7	Red Edge 3	783nm	20m
B8	**NIR**	**842nm**	**10m**
B8a	Red Edge 4	865nm	20m
B9	Water vapor	940nm	60m
B10	Cirrus	1375nm	60m
B11	SWIR 1	1610nm	20m
B12	SWIR 2	2190nm	20m

Data availability (time)
Jun 23, **2015 - Jan 11, 2018**

useful VI layers in GEE (30m)-Alternate

- Landsat 8 Annual EVI Composite (Jan 1, 2013 - Jan 1, 2018)
- Landsat 8 Annual Greenest (NDVI)-Pixel TOA Reflectance Composite (Jan 1, 2013 - Jan 1, 2018)

- Landsat 7 Annual NDVI Composite (Jan 1, 1999 - Jan 1, 2018)
- Landsat 7 Annual NDWI Composite (Jan 1, 1999 - Jan 1, 2018)
- Landsat 5 TM Annual NDVI Composite (Jan 1, 1984 - Jan 1, 2013)
- Landsat 5 TM Annual NDWI Composite (Jan 1, 1984 - Jan 1, 2013)

MODIS products in GEE (biophysical, *optional*)

- MOD44B.051 Vegetation Continuous Fields Yearly Global 250m (Mar 5, 2000 - Mar 6, 2015)
- LAI/fPAR 3g, 1km (external, not in GEE)

Influence of landscape on disturbance pattern

- landscape position refers to the topographic position of a site (relative elevation, landform, slope, aspect)
- Are some locations more susceptible than others to disturbance?
- e.g., windward vs. leeward slopes
- north facing vs. south facing slopes

Topography (data sources)

- SRTM 1 arc-second (30m), produced in 2000
- Limited to 56° S to 60° N, excludes high latitudes
- Elevation in meters
- Slope and Aspect will be calculated from DEM

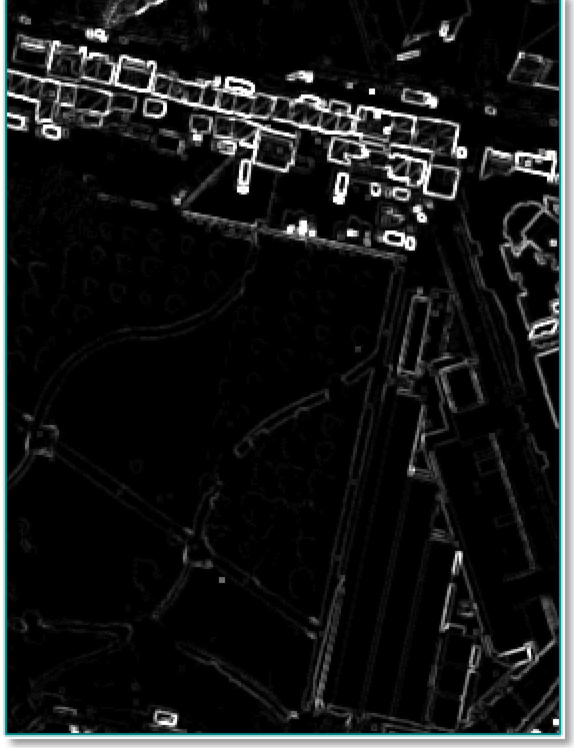
Texture Analysis

- **First-Order (Occurrence) Metrics**
- First-order metrics operate on the counts or *occurrences*, of the digital number (DN) values within a kernel (e.g., 3x3). Separate images with different spatial arrangements of the same pixels within a single kernel will yield the same first-order texture value in both kernels

$P(i)$ = Probability of each pixel value
N_g = Number of distinct grey levels in the quantized image

https://www.harrisgeospatial.com/docs/backgroundtexturemetrics.html

Original



Variance (3 x 3 kernel)

Variance

This is a measure of the dispersion of the values around the mean.

$$Variance = \sum_{i=0}^{N_g-1} (i - M)^2 \; P(i)$$

Original

Entropy (3 x 3 kernel)

Entropy

ENVI uses the following equation to compute entropy using the pixel values in a kernel centered at the current pixel. Entropy is calculated based on the distribution of the pixel values in the kernel and measures the disorder of the kernel values.

$$Entropy = -\sum_{i=0}^{N_g - 1} P(i) * \ln P(i)$$

Gray-level co-occurrence matrix (for Shape)

- Texture analysis cannot provide information about shape, i.e., the spatial relationships of pixels
- statistical method of examining texture that considers spatial relationship of pixels is the gray-level co-occurrence matrix (GLCM), [AKA spatial dependence matrix]
- GLCM functions characterize the texture of image by calculating how often pairs of pixel with specific values and in a specified spatial relationship occur in an image, creating a GLCM, and then extracting statistical measures from this matrix

https://www.mathworks.com/help/images/texture-analysis-using-the-gray-level-co-occurrence-matrix-glcm.html?s_tid=gn_loc_drop

Spatial autocorrelation

- **Geary's *C*** and **Morans I** are measures of spatial autocorrelation to determine if adjacent observations of the same phenomenon are correlated.
- **Moran's** I is produced by standardizing the spatial autocovariance by the variance of the data.
- **Geary's c** uses the sum of the squared **differences** between pairs of data values as its measure of covariation.

Second-Order (Co-Occurrence) Metrics metrics analyze the relationship between pixel pairs.

Contrast

$$Contrast = \sum_{i=1}^{N_g} \sum_{j=1}^{N_g} P(i,j)(i-j)^2$$

Dissimilarity

$$Dissimilarity = \sum_{i=1}^{N_g} \sum_{j=1}^{N_g} P(i,j)\,|i-j|$$

Homogeneity

AKA "inverse difference moment" equation.
Values range from 0 to 1.0.

$$Homogeneity = \sum_{i=1}^{N_g} \sum_{j=1}^{N_g} \frac{1}{1+(i-j)^2} P(i,j)$$

Entropy

Values range from 0 to the *log* of the kernel size.

$$Entropy = -\sum_{i=1}^{N_g} \sum_{j=1}^{N_g} P(i,j)\,\log(P(i,j))$$