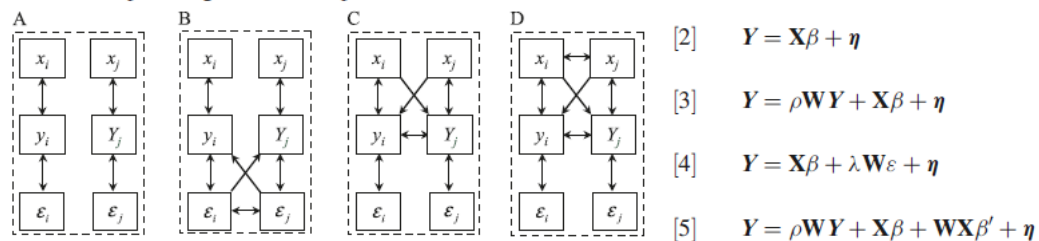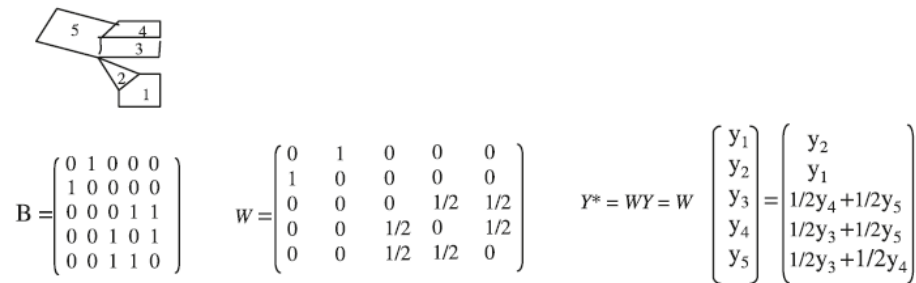- Epidemiology, Environment, and Landscape. Apply integrated cartography/GIS, spatial statistics, and spatial regression models to West Nile Virus.
- Landscape Ecology and Wildfire Ecology. Natural gas fracking landscape modeling and prediction (Meng, 2013), multi-strata forest fire severity modeling (Meng and Meentemeyer, 2011).
- Forest Stand Parameters, Biomass, and Carbon Estimation, Classification / Segmentation, and Mapping. Details are in Meng et al. 2004, 2006 (Proceedings of 2nd International Conference on Forest Measurements and Quantitative Methods and Management, and SOFOR GIS Conference Proceedings), Meng et al. (2007) Forest Ecology and Management, Meng et al. 2009 ISPRS Journal, and Meng 2014.
- Spatial Analysis and GIS
  a. *Spatial regression modeling*: spatial dependence, spatial weight matrix, and residual diagnostics. One example below, A is for [2], B for [3], C for [4], D for [5]. Details are in Meng et al. 2009, Canadian Journal of Forest Research.

Fig. 1. Conceptual comparisons of the classic linear model and spatial regression models. (A) classic linear model, (B) spatial error model, (C) spatial lag model, (D) spatial Durbin model.

[1] $\quad Y = \rho WY + X\beta + \lambda W\varepsilon + \eta$

[2] $\quad Y = X\beta + \eta$

[3] $\quad Y = \rho WY + X\beta + \eta$

[4] $\quad Y = X\beta + \lambda W\varepsilon + \eta$

[5] $\quad Y = \rho WY + X\beta + WX\beta' + \eta$

Fig. 2. An example of the spatial weight matrix (W) and the new weighted variable Y* of a variable Y based on the contiguity matrix (B) from five trees (depicted at the top of the figure) located at the lower-right corner of the study plot (Fig. 1).

$$B = \begin{pmatrix} 0 & 1 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 1 \\ 0 & 0 & 1 & 0 & 1 \\ 0 & 0 & 1 & 1 & 0 \end{pmatrix} \quad W = \begin{pmatrix} 0 & 1 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1/2 & 1/2 \\ 0 & 0 & 1/2 & 0 & 1/2 \\ 0 & 0 & 1/2 & 1/2 & 0 \end{pmatrix} \quad Y^* = WY = W \begin{pmatrix} y_1 \\ y_2 \\ y_3 \\ y_4 \\ y_5 \end{pmatrix} = \begin{pmatrix} y_2 \\ y_1 \\ 1/2y_4 + 1/2y_5 \\ 1/2y_3 + 1/2y_5 \\ 1/2y_3 + 1/2y_4 \end{pmatrix}$$

  b. *Regression Kriging and geostatistical modeling*. Details are explored in Meng et al. 2006(SOFOR GIS Conference Proceedings) and Meng et al. (2009) *IJRS*.
  c. *Univariate and Multivariate Point Pattern Diagnostics*: complete spatial randomness, spatial autocorrelation, spatial heterogeneity, spatial association of multivariate, and spatial clustering. Details are explored in Meng and Cieszewski (2007), *Physical Geography*.
  d. *Spatial prediction for ordinal or categorical data*. Details are in Meng (2014) Landscape and Urban Planning.

$$y_i = \begin{cases} 1 & \text{if a location is a drilling site} \\ 0 & \text{otherwise} \end{cases} \qquad y_i \sim B(n_i, \pi_i)$$