NR512- INTRODUCTION TO SPATIAL STATISTICAL MODELING OF NATURAL RESOURCES

Exam I

Fall 2001 **Name_____**

1. What does it mean when a variable is said to be spatially correlated? What is the difference between a positive spatial autocorrelation and a negative spatial autocorrelation?

2. Moran's I was used to test for spatial autocorrelation in percent clay from the Pinon Canyon Maneuver Site. The results are summarized below.

```
morani(clay$z,w=soils.wt)

 UNDER NORMAL APPROXIMATION
 Moran's I is    =  0.073848
 Mean of I is    = -0.004975
 St. Dev of I    =  0.012038
 Z-Value         =  6.548058
 P-Value(2-side) =  0

 UNDER RANDOMIZATION ASSUMPTION
 Moran's I is    =  0.073848
 Mean of I is    = -0.004975
 St. Dev of I    =  0.012035
 Z-Value         =  6.549606
 P-Value(2-side) =  0
```

Interpret the results.

3. Combinatorial screening was used to identify a second degree polynomial to describe the large-scale spatial variability in percent clay. The results of the OLS model are given below:

```
ols(clay$z,cbind(x,y,x^2,x*y),w=soils.wt)

Residual Standard Error = 9.180626, Multiple R-Square = .1203
N = 202, F-statistic = 6.736307 on 4 and 197 df, p-value = 0
              coef   std.err    t.stat    p.value
Intercept  26.95376  3.339834  8.070388 0.00000000
        x  35.65503 10.821866  3.294721 0.00116818
        y -22.35013 13.564975 -1.647635 0.10102164
      x^2 -81.26798 19.279729 -4.215203 0.00003800
      x*y  71.79814 32.088154  2.237528 0.02637196
```

```
 Log(like)   =  -731.9474
 AIC         =  1473.8948
 AICC        =  1474.2009
 Schwartz    =  1490.4361

 Moran's I (res) =  0.0324
 Mean of I       = -0.4288
 Std Dev of I    =  0.6996
 Z-value of I    =  0.6592
 P-value(2-side) =  0.5098

 Lagrange Mult   =  5.3954
 P-value(2-side) =  0.0202
```

Interpret the output from the OLS model? Be specific.

4. The trend surface model was refitted using a spatial autoregressive model.

```
spatar1(clay$z,cbind(x,y,x^2,x*y),w=soils.wt)

Residual Standard Error = 8.9025, Multiple R-Square = 0.1518
N = 202, F-Statistic = 6.0259 on 6 and 196 df, p-value = 0
             coef std.err   t.stat p.value
Intercept  25.9296  4.5425   5.7715  0.0000
      x    37.1553 13.3982   2.7732  0.0061
      y   -21.4604 16.3803  -1.3101  0.1917
      x^2 -81.2030 22.4025  -3.6247  0.0004
      x*y  70.5219 37.2707   1.8922  0.0599
   lambda   0.6761  0.1917   3.5273  0.0005
 Variance  79.2549  7.9135  10.0152      NA

 Log(like)   =  -729.4364
 AIC         =  1470.8728
 AICC        =  1471.3035
 Schwartz    =  1490.7224
                                Value  P-Value
 Likelihood Ratio Test (df=1)  5.022 0.025
```

a. Is the spatial autoregressive model significantly better than the OLS model? Why?

b. Are all of the variables in the spatial autoregressive significantly different from 0 at 0.10 level of significance? How does the presence of spatial autocorrelation influence the estimates of the standard errors associated with individual regression coefficients? R^2 value? Residual standard error?

c. The spatial autoregressive model was refitted after removing the y term. Compare this model to the one describe in (4a) and the OLS model in (3).

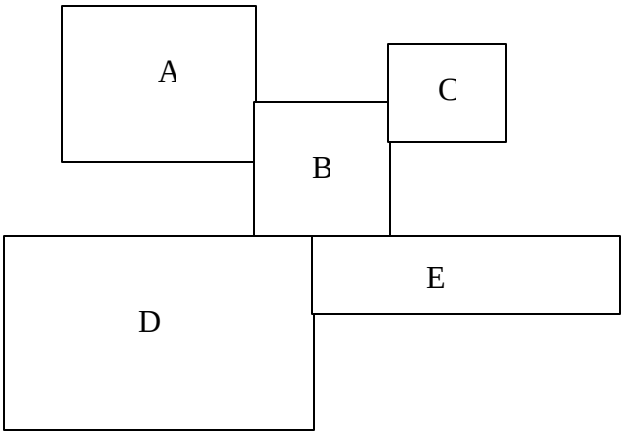
```
spatar1(clay$z,cbind(x,x^2,x*y),w=soils.wt)

Residual Standard Error = 8.9307, Multiple R-Square = 0.1464
N = 202, F-Statistic = 6.9307 on 5 and 197 df, p-value = 0
             coef std.err   t.stat p.value
Intercept  21.7567  3.5677   6.1930  0.0000
      x    37.6540 13.6775   2.7530  0.0065
      x^2 -63.5531 18.1211  -3.5071  0.0006
      x*y  26.3119 15.7050   1.6754  0.0954
   lambda   0.7187  0.1722   4.1741  0.0000
 Variance  79.7579  7.9654  10.0131      NA

 Log(like)   =  -730.2741
 AIC         =  1470.5481
 AICC        =  1470.8542
 Schwartz    =  1487.0895
                                  Value  P-Value
 Likelihood Ratio Test (df=1)  6.1113 0.0134
```

5. Five monitoring stations are located along the Poudre River. Write out the spatial weights matrix (0,1 weights) you would use to test for spatial autocorrelation in the data obtained from the monitoring stations. (Remember to take into consideration the flow of the river when designing your spatial weights matrix).

6. Consider the figure below. If the data associated with an individual square is proportional to its size would you expect the data to be positively, negatively or uncorrelated? Why?



How would the spatial autocorrelation change if the data associated with the squares are (A = 10, B = 1, C = 6, D = 5, E = 7)?

7. Describe the difference between large and small-scale spatial variability. Why do you think it is important to be able to model both of these components? How do you think the sampling design influences ones ability to model the spatial variability in a given data set? Taking your response to the previous questions into consideration, how would you design a cost-efficient survey to model both the large and small-scale spatial variability in percent clay at the Pinon Canyon Maneuver Site? Be specific in your answers.

8. What are some of the advantages of using remotely sensed data (Landsat TM, Spot, Landsat MSS, Radar) in developing spatial predictive models? Do differences in the resolution of the sensors, and the spectral bands influence ones ability to spatially model a particular variable of interest?

9. In lab, we used the Vegetation Index and Tasseled Cap indices as potential input variables in a model to describe the large-scale spatial variability in percent sand, silt and clay. What are the ecological interpretation of having these variables in the model? How many layers of Tasseled Cap indices result when using Landsat TM, MSS or Spot data? Why does the number of indices differ between sensors?