Spatial Allocation of Nitrogen and Phosphorus from Livestock Manure in Yakima County, Washington

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Why should we be interested in nutrients ?

Why should we be interested?

Nutrients are important building blocks for life but elevated levels can lead to excessive plant growth and degraded habitat and water quality

Yakima River
Washington

Where do nutrients in the environment come from?

Nutrient movement through the Landscape

Loading to land

Delivery to surface waters

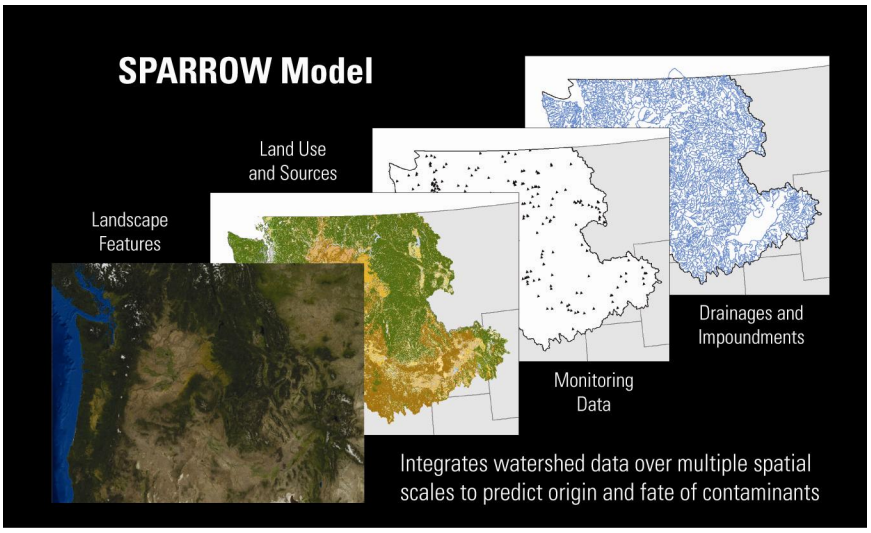
Processing in streams, lakes, and reservoirs

SPARROW Geoprocessing

Point-Source Data	Land Cover Data	Agricultural Data	Continuous Data
nutrient loads from wastewater treatment plants, septic systems, fish hatcheries, and industrial facilities	area of forest land, developed land, agricultural land	nutrient loads from fertilizer use, confined animals, grazing animals	nitrogen in precipitation; phosphorus in geologic materials; landscape properties
point locations	30 meter gridded data	county-level data	continuous surfaces
summation by catchment	summation by catchment	distribution to land cover grid and summation by catchment	transformation to gridded data and summation or averaging by catchment

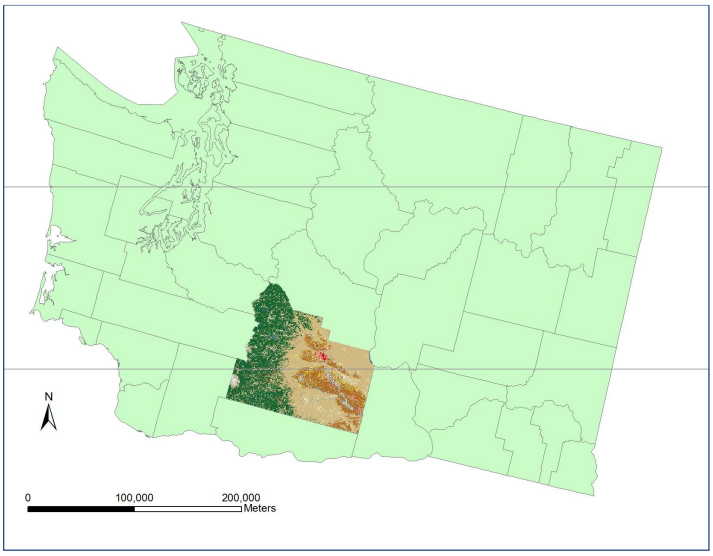
SPARROW is Spatially Explicit

SPARROW requires an accurate spatial accounting of nutrient sources and landscape properties



Agricultural Fertilizer	Waste from Confined Animals	Waste from Grazing Animals
Applied to row crops, small grains, orchards/vineyards, pasture/hay	Applied to row crops, small grains, orchards/vineyards, pasture/hay	Applied to forest land, pasture/hay, grassland, scrub land
Land application weighted by crop fertilizer requirements	Land application weighted by distance to CAFO's, number/type of animals at CAFOS, and crop fertilizer requirements	Potential grazing land determined by access to water, slope, canopy cover, grazing suitability, federal grazing allotments, (*vegetation, soils, precipitation)*
summation by catchment	summation by catchment	summation by catchment

Study Area

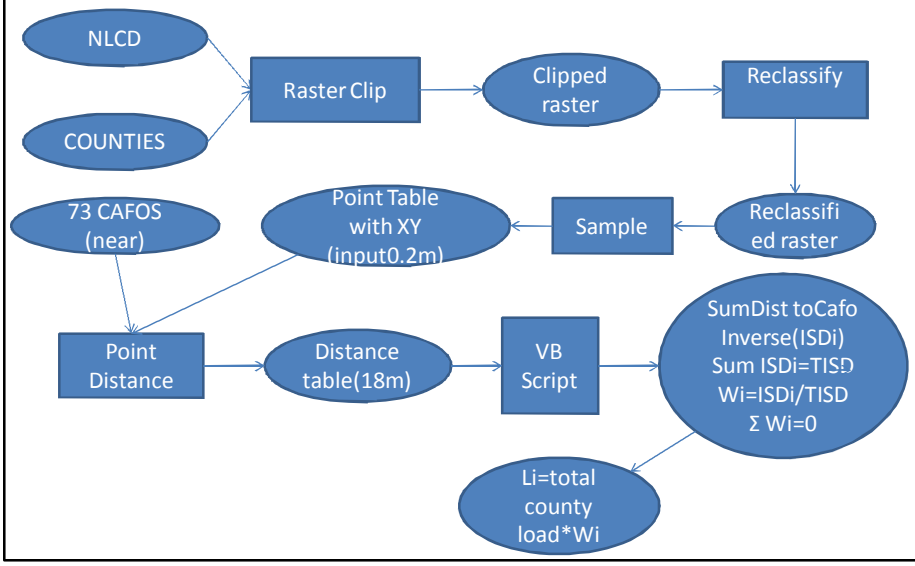


Yakima County WA.

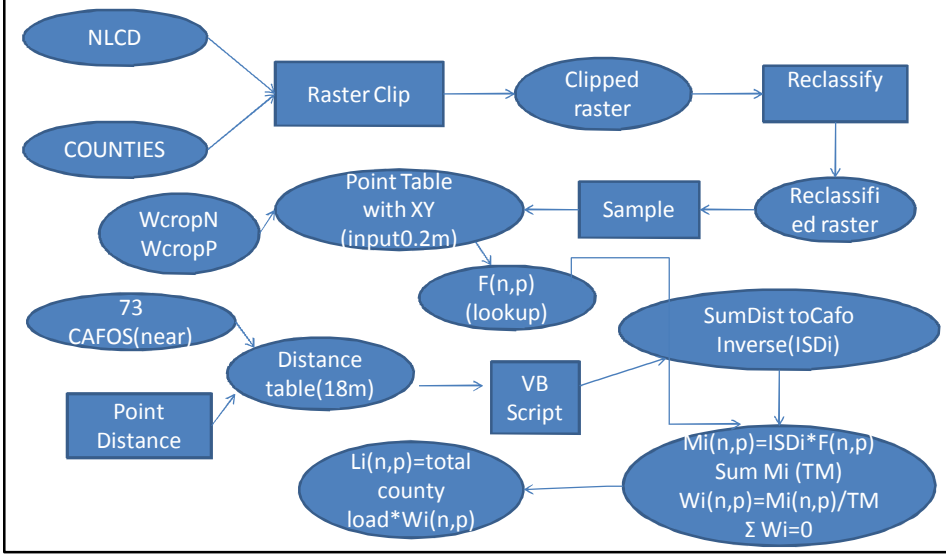
Inputs for Confined Animals

- 2007 National Land Cover Data
  81-pasture/hay, 82-cultivated crop
  (56m grid cells)
- Table for fertilizer application index for N and P to different crops variety
- Table for types and number of animals at each CAFO's

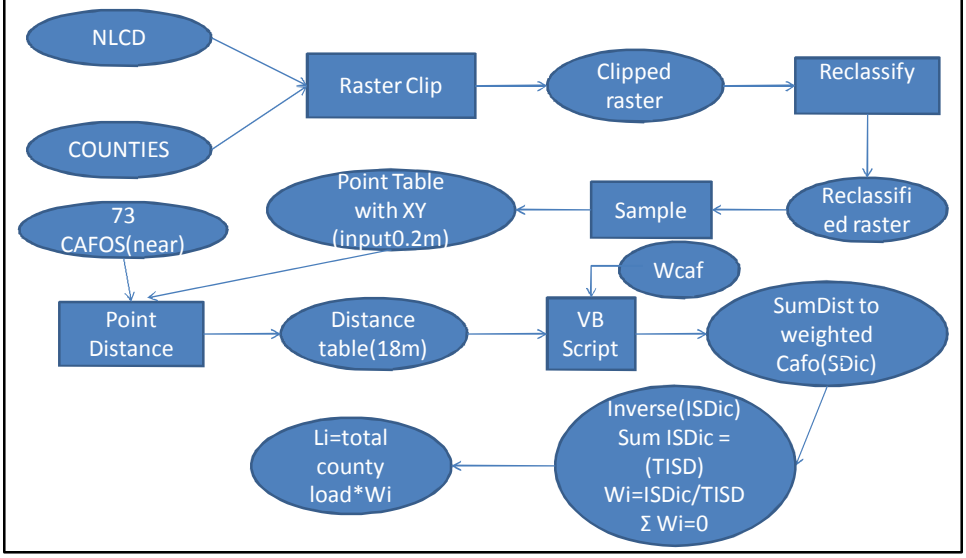
Distribution of 2007county estimates of N and P from CONFINED animals to farmland based on proximity to known concentrated animal feeding operations (CAFO)



Distribution of 2007 county estimates of N and P from CONFINED animals to farmland based on crop type and proximity to known concentrated animal feeding operations (CAFO)

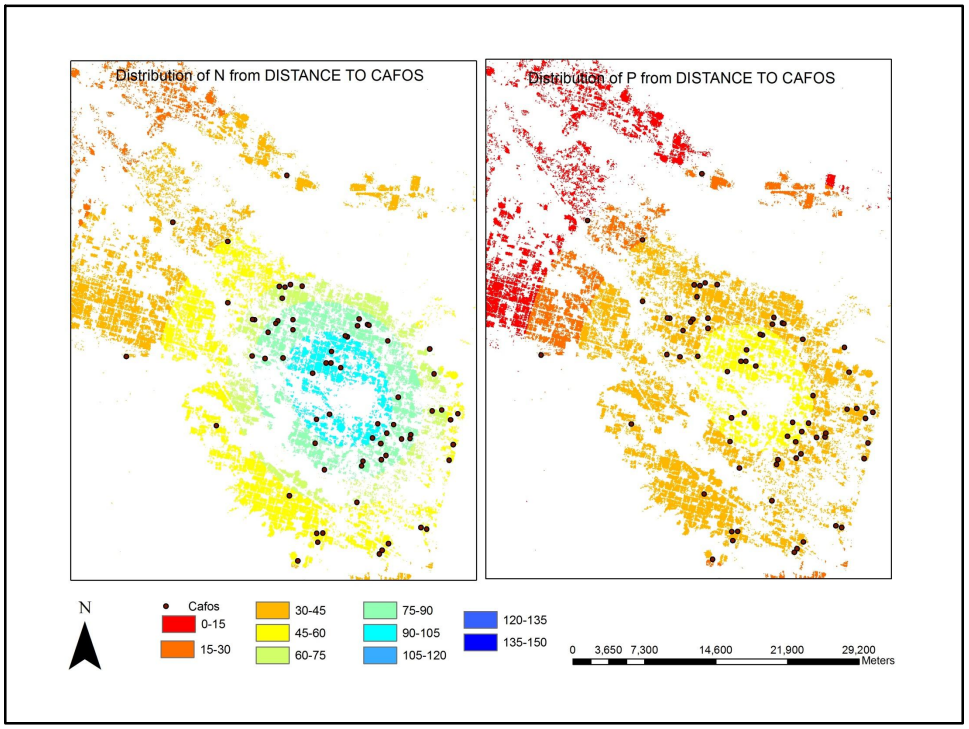


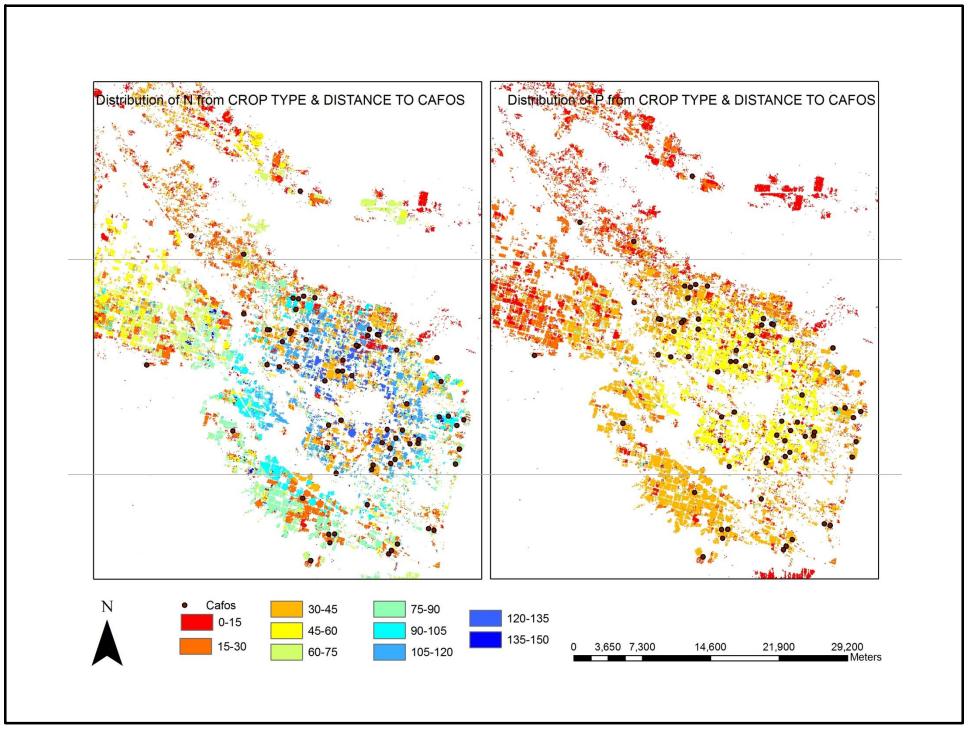
Distribution of 2007county estimates of N and P from the NUMBER of CONFINED animals to farmland based on proximity to known concentrated animal feeding operations (CAFO)

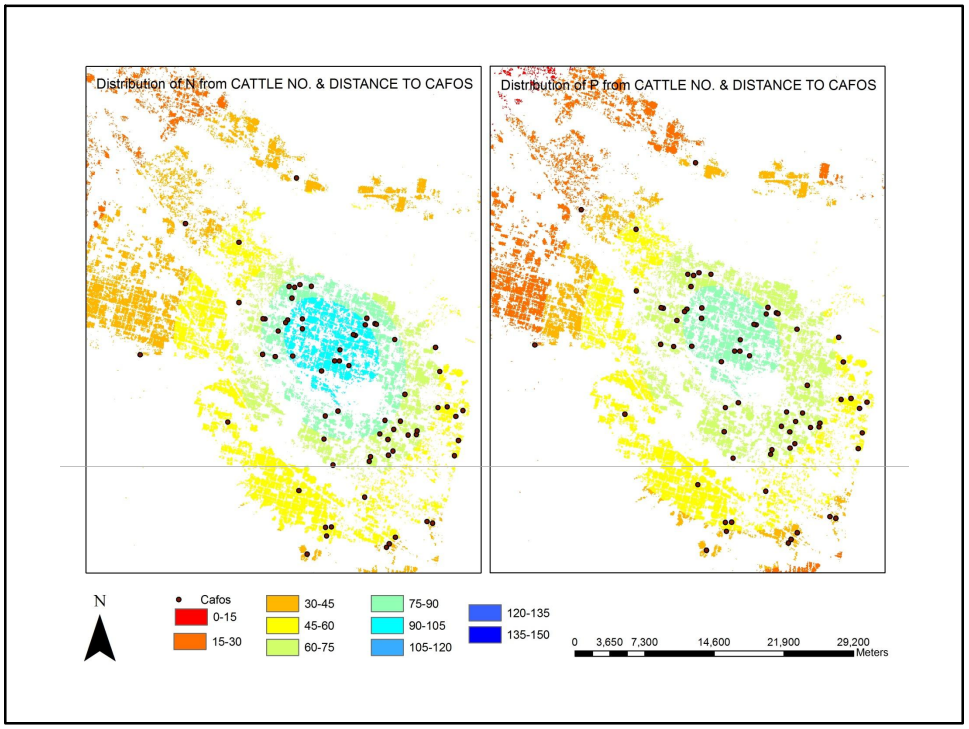


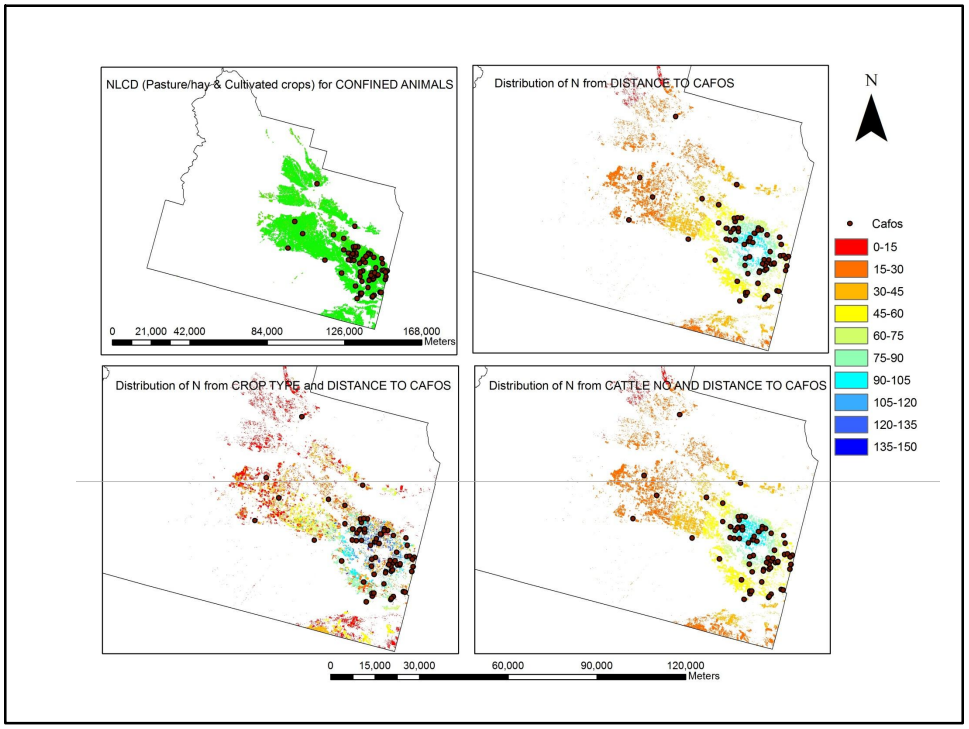
VB script to open 18 million points dataset

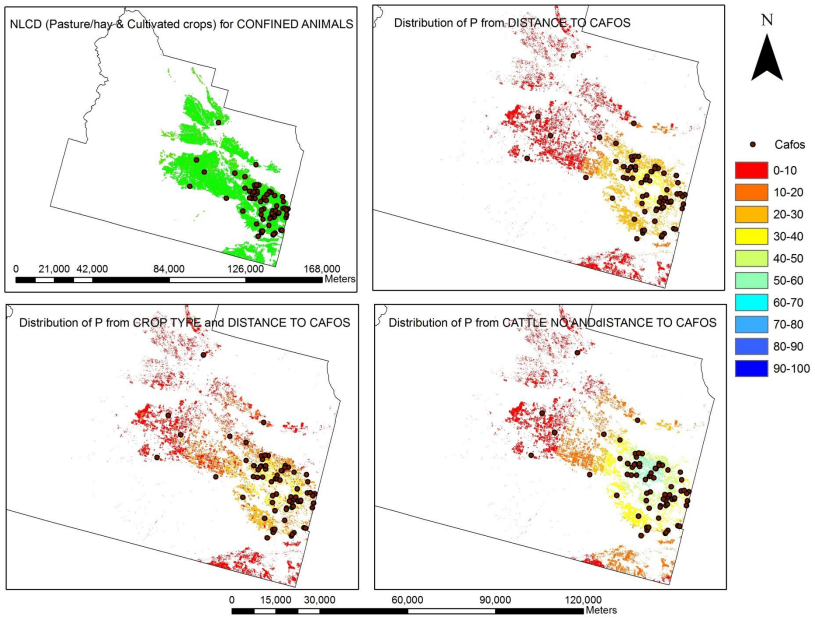
```
Set rs=CreateObject("ADODB.Recordset")
rs.Open tableName, dbConn, adOpenForwardOnly, adLockPessimistic, adCmdTable

Set myExcel=CreateObject("Excel.Application")
Set myWorkBook=myExcel.Workbooks.Add()
Set mySheet=myWorkBook.Sheets(1)
myExcel.Visible=TRUE
....
recSum = 0
recNum = 1

While Not rs.EOF

   tmp1 = rs.fields(0).value
   tmp2 = rs.fields(2).value
   tmp3 = rs.fields(1).value

   if ( tmp1 = recNum) then
      recSum=recSum+tmp2*weights(tmp3)
   Else
     fieldVals(0)=recNum
     fieldVals(1)=recSum
     fieldVals(2)=1/recSum
     mySheet.Range(mySheet.Cells(row,1),mySheet.Cells(row,3)).Value=fieldVals
     row=row+1
     recNum=tmp1
     recSum = tmp2*weights(tmp3)
   End if
   rs.MoveNext
Wend

fieldVals(0)=recNum
fieldVals(1)=recSum
fieldVals(2)=1/recSum
mySheet.Range(mySheet.Cells(row,1),mySheet.Cells(row,3)).Value=fieldVals
.....
```


Distribution of N from DISTANCE TO CAFOS
Distribution of P from DISTANCE TO CAFOS
N
Cafos
0-15
15-30
30-45
45-60
60-75
75-90
90-105
105-120
120-135
135-150
0 3,650 7,300 14,600 21,900 29,200
Meters


Distribution of N from CROP TYPE & DISTANCE TO CAFOS
Distribution of P from CROP TYPE & DISTANCE TO CAFOS
N
Cafos
0-15
15-30
30-45
45-60
60-75
75-90
90-105
105-120
120-135
135-150
0 3,650 7,300 14,600 21,900 29,200
Meters


Distribution of N from CATTLE NO. & DISTANCE TO CAFOS
Distribution of P from CATTLE NO. & DISTANCE TO CAFOS
N
Cafos
0-15
15-30
30-45
45-60
60-75
75-90
90-105
105-120
120-135
135-150
0 3,650 7,300 14,600 21,900 29,200
Meters


NLCD (Pasture/hay & Cultivated crops) for CONFINED ANIMALS
0 21,000 42,000 84,000 126,000 168,000
Meters
Distribution of N from DISTANCE TO CAFOS
N
Cafos
0-15
15-30
30-45
45-60
60-75
75-90
90-105
105-120
120-135
135-150
Distribution of N from CROP TYPE and DISTANCE TO CAFOS
Distribution of N from CATTLE NO AND DISTANCE TO CAFOS
0 15,000 30,000 60,000 90,000 120,000
Meters



Unconfined Animals

Includes Cattle, Horses and Sheep

USGS National Water Quality Assessment

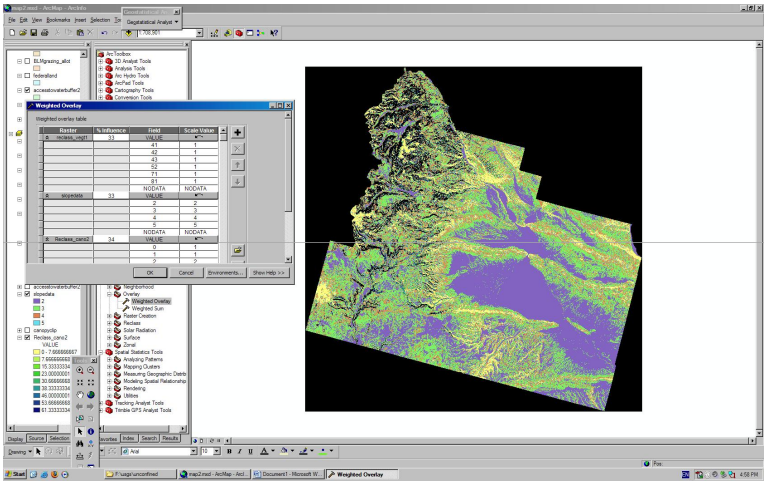
Approach

- Distribute county level estimates of nitrogen and prosperous from unconfined animals equally to NLCD crop types:
  - 81- Pasture/Hay
  - 82- Cultivated Crops
  - 71- Herbaceous Grassland
- This approach works well for many areas of the country but not for the North West.

Alternative Approach Sparrow Model

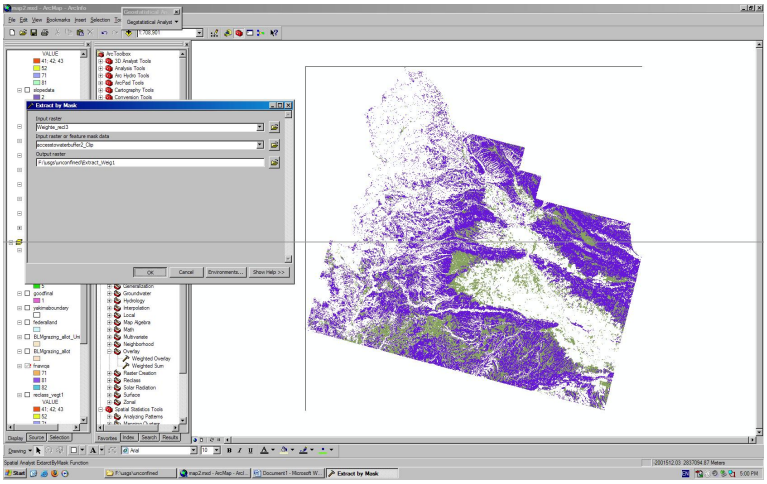
Factors	GIS data set	Grazing restrictions
Vegetation type	USFS vegetation survey	Land Cover Classes
Soils	USFS soils data	Exclude rock outcroppings very wet soil and unstable terrain
Access to Water	Points of diversion -surface and ground water shapefile	Within 2-3 miles for grassland and 1 mile for mountainous areas
Slope	DEM 30 meter grid	<30% cattle, horses, sheep <50% horses <60% sheep >60% No animals
Canopy Cover	NLCD 30 meter grid	<70%
Federal Grazing Allotments	Grazing allotments for BLM and USFS	Include Allotments

Methods



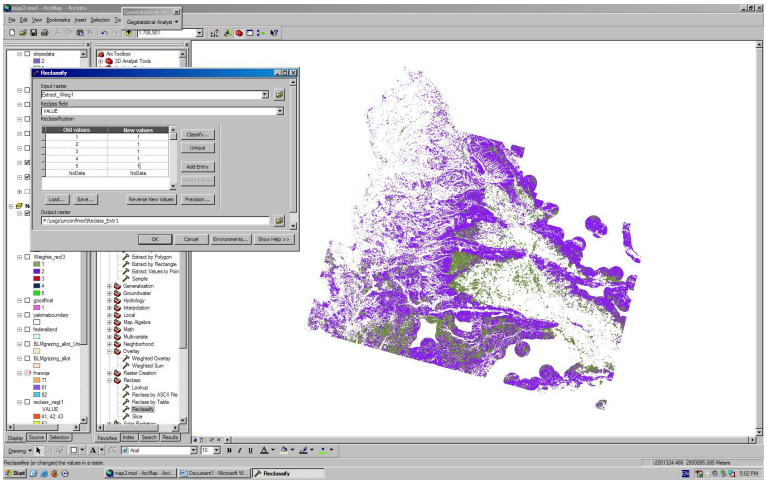
Weighted Overlay : Vegetation Type, Slope, Canopy Cover.

Methods



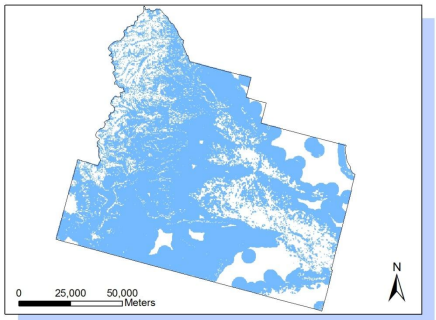
Extraction by Union of Surface and Ground Water Diversions Vector.

Methods



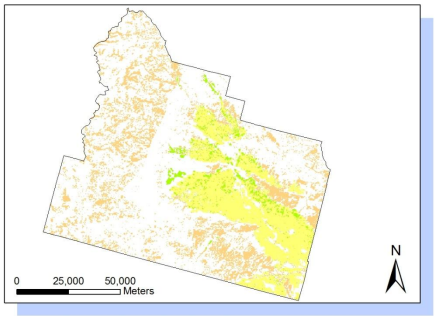
Boolean reclassification of 56 meter grid .

Alternative Approach Using:
NLCD crop Types:
81 - Pasture Hay
71 - Herbaceous Grassland
52 - Shrub Land
41-43 – forest land
Slope - 30 meter DEM
Canopy Cover
NLCD 30 meter grid

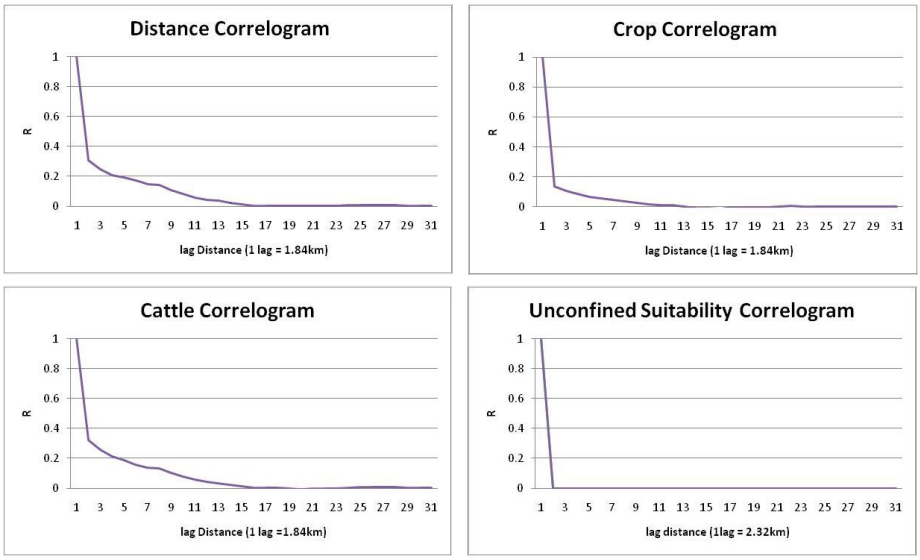


suitable unconfined area estimate about 5,060,427 30*30m cells

USGS NWQA Approach Using:
81- Pasture/Hay
82- Cultivated Crops
71- Herbaceous Grassland



NAWQA unconfined animals estimate area 2,292,508 30*30m cells



Results & Limitations

Confined Animals

- Distance – Nearest cells (ring) around CAFO's showing the max amount of loading.
- Crop - There are certain kind of crops (corn, potato..) giving max load around the CAFO's. Crops are showing the maximum contribution in adding N & P to water quality.
- Cattle - No of Cattles are adding more to loading from northern CAFO's.
- Distributing N and P evenly on Yakima county area is not true. There is no equal loading as seen from the results. Cattle and Distance from CAFO's are almost equal contributor but the crop variety adds maximum.
- These results will go as input in sparrow model and help in predicting water-quality conditions where no water-quality data are available.
- Combine all the three approaches for confined animals.

Unconfined Animals

- The addition of other factors limiting range land is needed to further restrict the allotments of grazing areas.
- Additional factors: Vegetation Productivity, Soil Type, Precipitation, and Grazing Suitability
- These factors will be necessary for input into the SPARROW model.

Because of the statistical process of the SPARROW model, we are not able validate the results of the analysis, but are able to estimate nutrient loading levels.


Questions