# Arc GIS Spatial Analysis

# A Definition of *GIS*

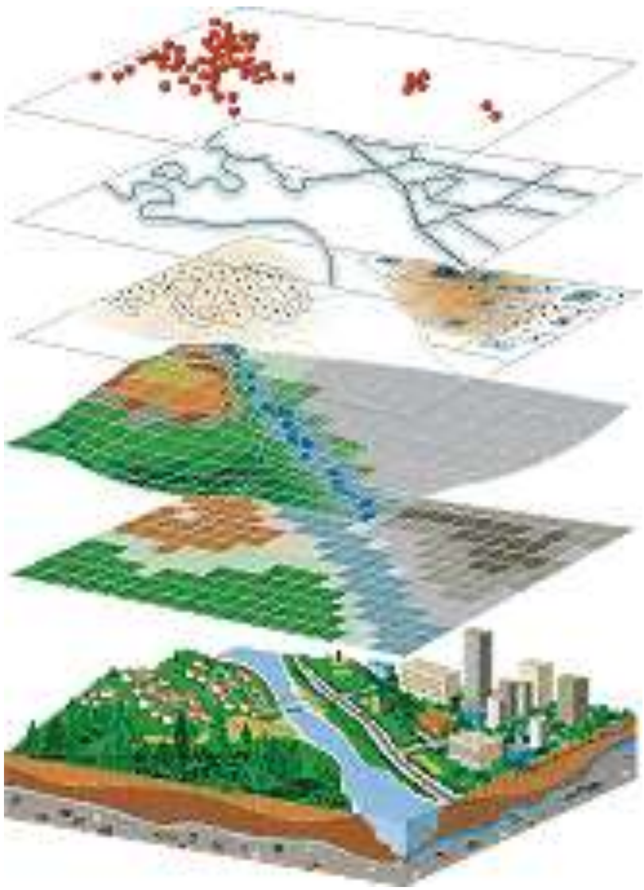
GIS is a ***system*** of hardware, software, and procedures designed to support the capture, management, manipulation, analysis, modeling and display of spatially referenced data for solving complex planning and management problems

# GIS Tools - Geometry

- A GIS stores data as different ***layers*** of information
- Different feature types are stored in individual files

Vector models
- Polygons (lakes)
- Lines (rivers)
- Points (water wells)

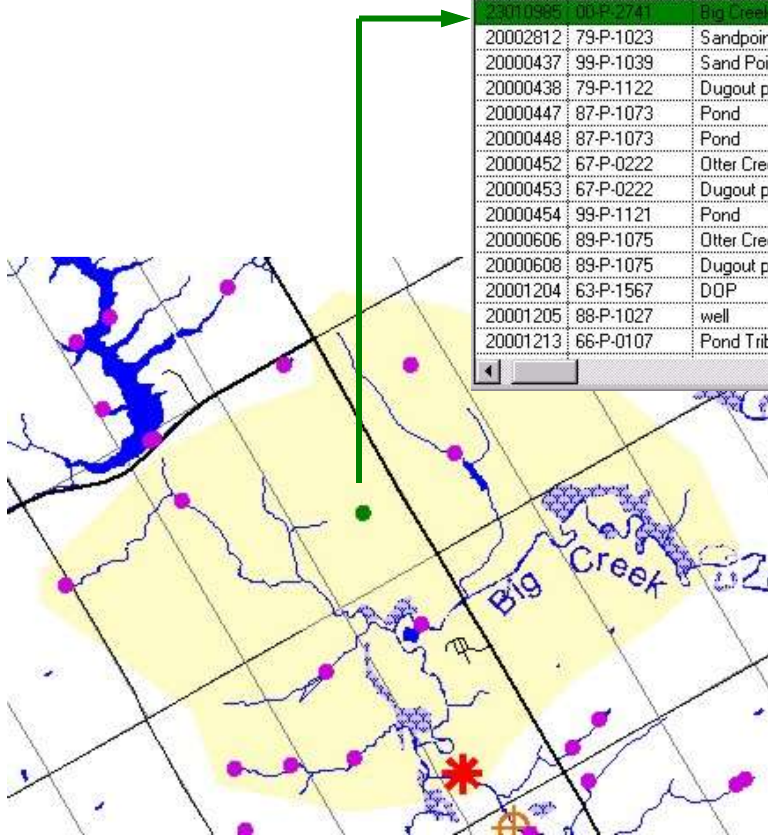
Raster models
- Pixels



# GIS Tools - Attribute Tables

Spatial features are not "static"

GIS layers are linked to database tables, also referred to as 'attribute' tables




Attributes of PTTW

| Sourceid | Permitno | Sourcename | Sourcedesc |
|---|---|---|---|
| 23009397 | 63-P-1675 | Dugout pond | |
| 23010985 | 00-P-2741 | Big Creek | pond on tributary |
| 20002812 | 79-P-1023 | Sandpoint wells & On-stream Pi | Taking may be from bot |
| 20000437 | 99-P-1039 | Sand Points | |
| 20000438 | 79-P-1122 | Dugout pond | |
| 20000447 | 87-P-1073 | Pond | |
| 20000448 | 87-P-1073 | Pond | |
| 20000452 | 67-P-0222 | Otter Creek Pond | |
| 20000453 | 67-P-0222 | Dugout pond | |
| 20000454 | 99-P-1121 | Pond | |
| 20000606 | 89-P-1075 | Otter Creek | |
| 20000608 | 89-P-1075 | Dugout pond | |
| 20001204 | 63-P-1567 | DOP | dugout pond |
| 20001205 | 88-P-1027 | well | |
| 20001213 | 66-P-0107 | Pond Trib of Big Creek | |

# Attribute Data and Databases

| | Type | Name | Species |
|---|---|---|---|
| 01 | Point | Birch | |
| 02 | Point | Oak | |
| | | | |

| | Type | Object | Length |
|---|---|---|---|
| 01 | Polyline | Stream | 17 |
| 02 | Polyline | Pathway | 3 |
| | | | |

| | Type | Object | Area |
|---|---|---|---|
| 01 | Polygon | Clay Soil | .4 |
| | | | |
| | | | |

## D. Spatial Data Files…

3) Spatial Data File Formats (“Data Models” – how data are recorded on the computer)

   1. Several formats/models are available

   2. Use depends on application

   3. Separated into two primary categories

      a) VECTOR

         - discrete geographic features are represented are built by a collection of points, vertices and arcs (lines).

      b) RASTER

         - the geographic features across an entire area are represented by a continuous set of “pixels” or “cells”.

# Spatial Analysis

## Playing with places

When you think of a name and address database, you probably visualise a table of data in rows and columns. What you might miss is that each of these records represents a person or family that lives in a particular place (location). Furthermore, that particular place (location) can tell us something about a person's standard of living, neighbourhood, access to schools, access to hospital, distance to the main market, vulnerability to local crime, exposure to pollution levels and so on. Through GIS analysis, it allows us to visualise the 'bigger picture' by allowing us to see patterns and relationships within the geographic data. The results of analysis give insight into a place, help focus actions or select an appropriate option. The beauty of GIS is its ability to perform spatial analysis.

# What is Spatial analysis ?

- Heart of GIS which Allows to study real-world processes
- Uses the existing geographic information and generates new information
- Important use of the analysis is predicting what will happen after certain time which provides the opportunity to select the best possible alternative

# Functions of GIS Analysis

**Presentation of Data**

- Where are the forest ?
- What is trend of current road network ?
- What is the trend of population distribution ?

**GIS**

**Presentation of Pattern of data**

- What is the total area of forest ?
- Show me the settlements within 1km from road
- Show me the Districts with pop. Density > 500/sq.km.

**Analysis and prediction**

- Where should I build a new building ?
- Identify the suitable area for locating carpet industries.
- Assuming that a field will produce the same crop next year as this year; what will happen if there is change in stream flow ?

## Overview

**ArcGIS Spatial Analyst is an extension to ArcGIS Desktop that provides powerful tools for comprehensive, raster-based spatial modeling and analysis. Using ArcGIS Spatial Analyst, you can derive new information from your existing data, analyze spatial relationships, build spatial models, and perform complex raster operations.**

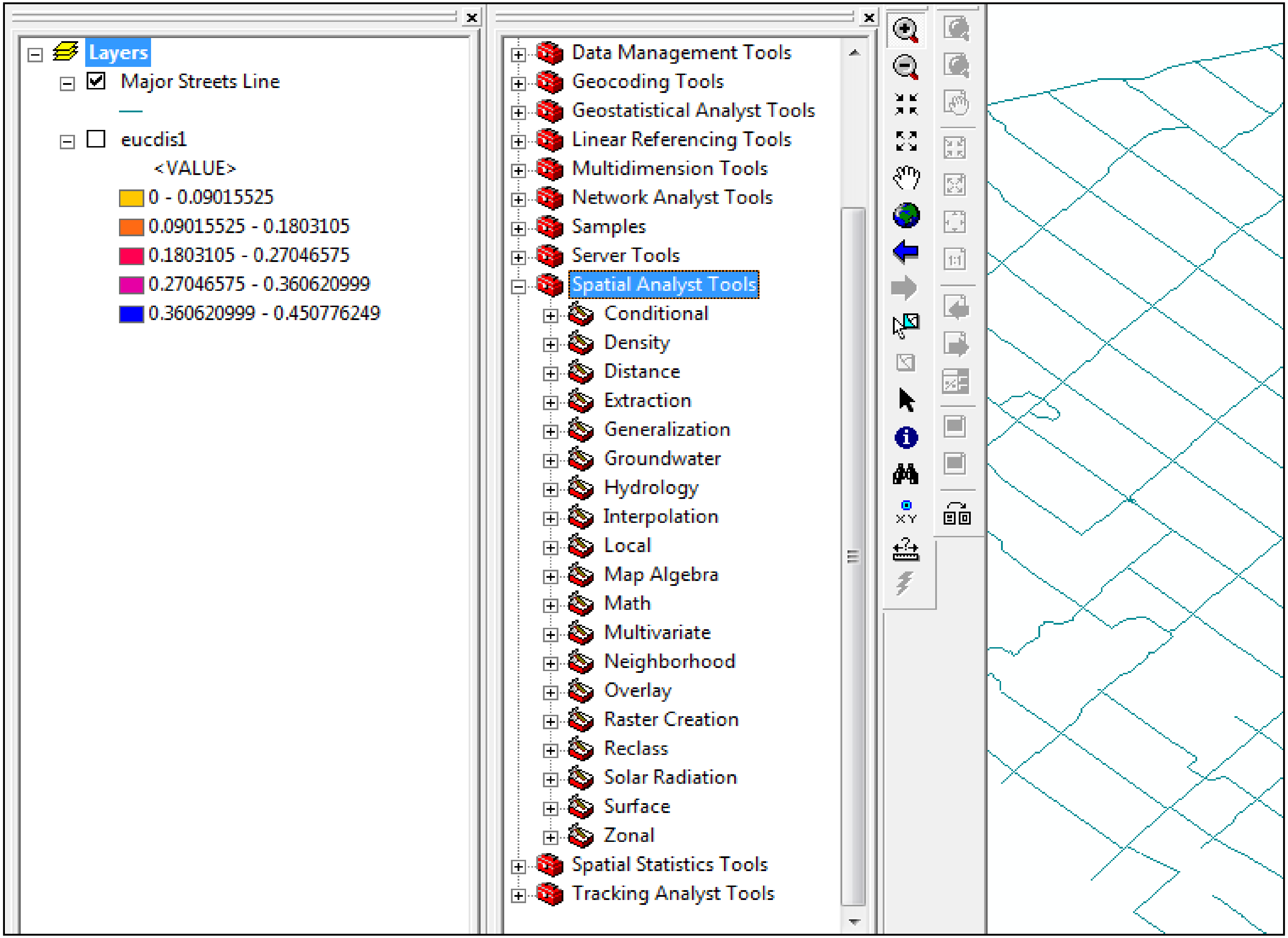
**With ArcGIS Spatial Analyst tools, you can**

- **Find suitable locations.**
- **Calculate the accumulated cost of traveling from one point to another.**
- **Perform land-use analysis.**
- **Predict fire risk.**
- **Analyze transportation corridors.**
- **Determine pollution levels.**
- **Perform crop yield analysis.**
- **Determine erosion potential.**
- **Perform demographic analysis.**
- **Conduct risk assessments.**
- **Model and visualize crime patterns.**

Modeling and Analysis

ArcGIS Spatial Analyst is fully integrated with ArcGIS Desktop and provides more than 150 tools and functions that users can access in the same environment as the more than 200 other ArcGIS Desktop tools. This allows users to conduct analysis and modeling tasks via ModelBuilder™, scripts, dialog boxes, and the command line without having to change environments between processes.

Suitability Modeling
Surface Creation
Surface Analysis
Distance Analysis
Statistical Analysis
Map Algebra and Overlay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Data Management Tools
Geocoding Tools
Geostatistical Analyst Tools
Linear Referencing Tools
Multidimension Tools
Network Analyst Tools
Samples
Server Tools
Spatial Analyst Tools
Conditional
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Generalization
Groundwater
Hydrology
Interpolation
Local
Map Algebra
Math
Multivariate
Neighborhood
Overlay
Raster Creation
Reclass
Solar Radiation
Surface
Zonal
Spatial Statistics Tools
Tracking Analyst Tools

## Suitability modeling

**A suitability model typically answers the question, Where is the best location?—whether it involves finding the best location for a new road or pipeline, a new housing development, a retail store or to install new cell phone antenna.**

**For instance, a commercial developer building a new retail store may take into consideration distance to major highways and any competitors' stores then combine the results with land-use, population density, and consumer spending data to decide on the best location for the store.**

**ArcGIS Spatial Analyst derives new information from the overlay of multiple layers, which can then be used to determine the best location.**

**Site selection requirements**
In this study we consider the following criteria:

1. Altitude: areas with high altitude are preferred in the allocation of the cellular tower
2. Land use: the cellular tower should not be allocated on residential or parks land uses while it is better to allocate the towers on the industrial and vacant land uses
3. The tower should not be allocated within 200 meters from the city landmark
4. Areas that serve higher population density are preferred for the allocation of towers
5. The towers must be allocated within 250 meters from paved roads
6. The area of  candidate location must not be less than 400square meters.
7. It is preferable that the range of the final solution (combination of the five towers) maximizes service coverage. Assume that the range of one tower is 3km

**Key GIS analysis**

**Data Conversion**

(select command to exclude the very low and high values from data )

**Rasterization of Vector data**

(Available data was in the vector format so before the actual analysis the data was rasterized because the analysis is only possible with raster data)

**Raster Interpolation**

(The spot height map was interpolated to convert from point to continuous raster)

**Euclidean Distance command**

(The Road and Landmark map were first calculated by Euclidean Distace spatial analysis tool. With this tool we create a buffer of 250m and 200m to meet the specified criteria )

**Raster Classification**

(Continuous (floating point) rasters must be reclassified as integer before they can be used. Generally, the values of continuous rasters are grouped into ranges, such as for height, or Euclidean distance outputs as in case of Road and Landmarks. Before the final analysis all the map are classified into one uniform criteria so that the overlay analysis can be done)

**Standardization**

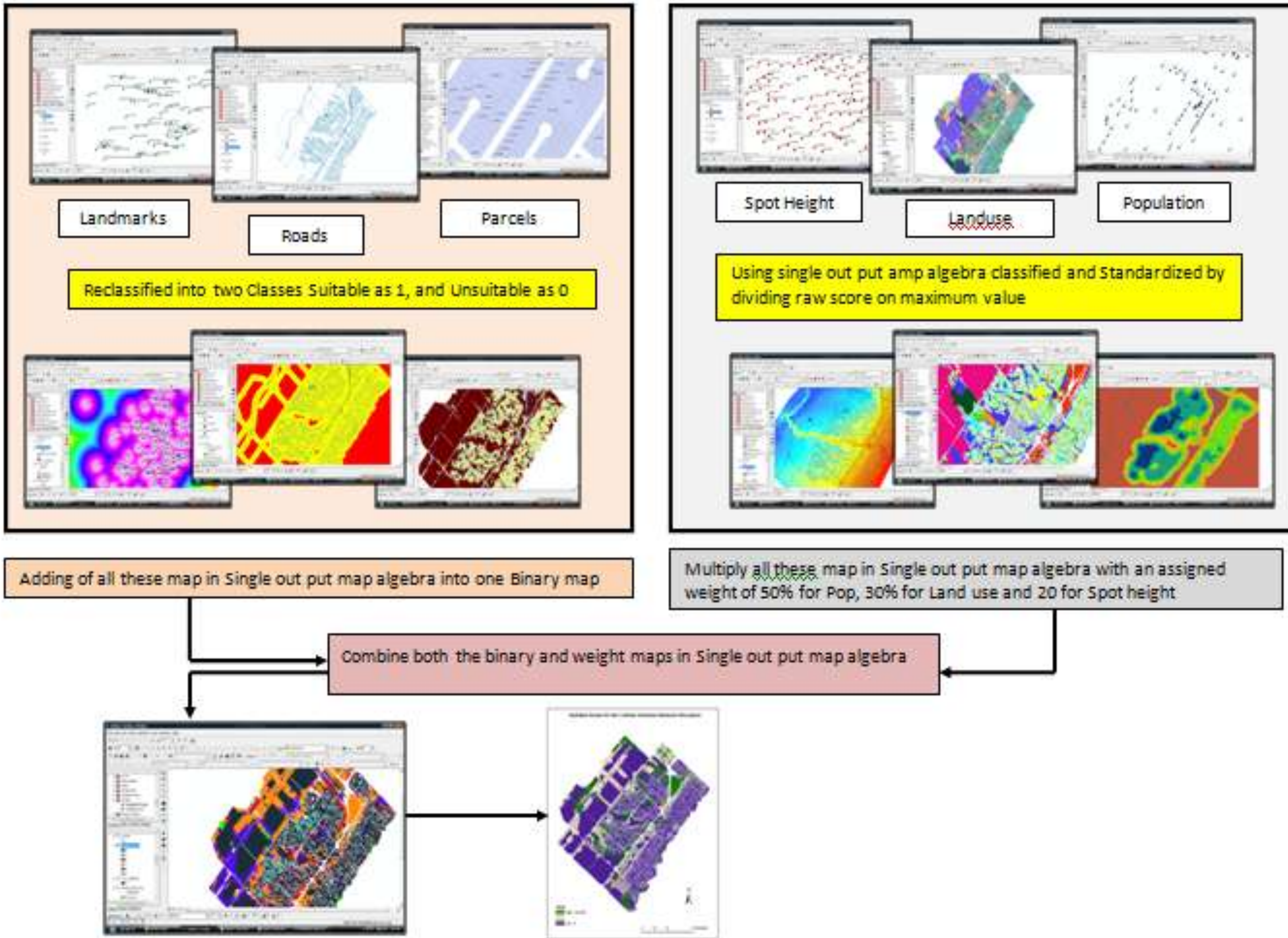
In order to convert all the reclassified data into one unit it become standardized. A number of different standardization methods are available. In this case study the raw score was divided by maximum score to standardized.

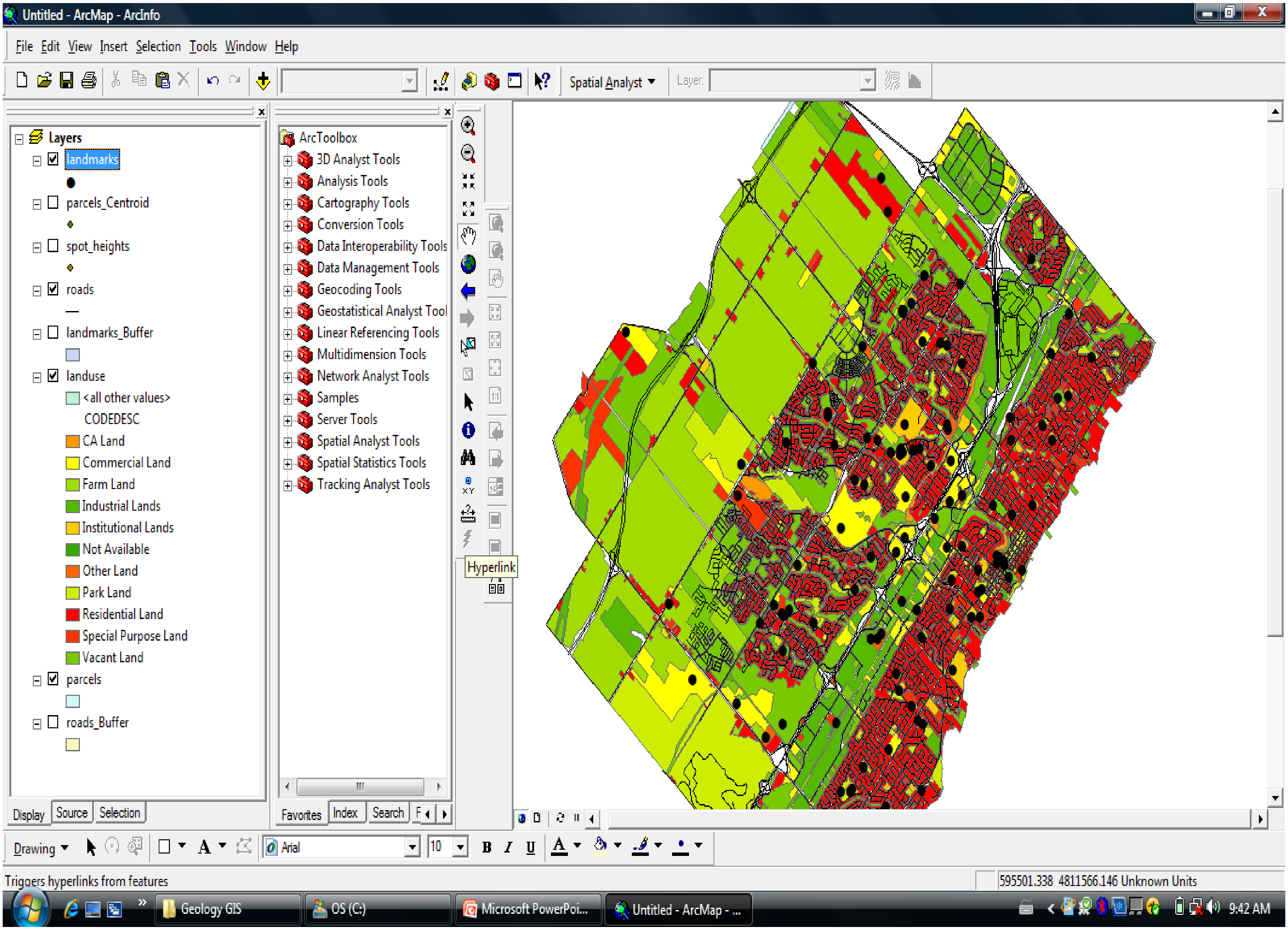
**Overlay analysis by map single map algebra method**

# Table showing classification and Standardization of Different data layers

| Criteria | Raster Data Set | Fields | Score | Standardization | Weight % Influence |
|---|---|---|---|---|---|
| Binary | Land use | Residential | 0 | Reclassification (Grouping) Of landuse classes into 0 & 1 | 30 |
| | | Park Land | 0 | | |
| | | Not available | 0 | | |
| | | Special Purpose Land | 0 | | |
| | | Institutional Land | 0 | | |
| | | Other Land | 0 | | |
| | | Farm Land | 0 | | |
| | | CA Land | 0 | | |
| | | Commercial Land | 0 | | |
| | | Industrial Land | 1 | | |
| | | Vacant Land | 1 | | |

| | | | | | |
|---|---|---|---|---|---|
| Ordinal | Population | Continuous population data converted into Point density with "pop" field and 100 meter circle distance | | Standardized by dividing density layer by maximum value in single out put map algebra | 50 |
| Ordinal | Spot Data | The Raster cell values | | Standardized the raster cell values by dividing maximum value in single out put map algebra | 20 |
| Binary | Parcels | 0-399 | 0 | Reclassification into 0 & 1 | 0 |
| | | 400+ | 1 | | |
| Binary | Road | Less than 250m | 0 | Reclassification into 0 & 1 | 0 |
| | | 250+ | 1 | | |
| Binary | Landmark | Less than 200m | 1 | Reclassification into 0 & 1 | 0 |
| | | 200+ | 0 | | |


Landmarks
Roads
Parcels
Reclassified into two Classes Suitable as 1, and Unsuitable as 0
Spot Height
Landuse
Population
Using single out put amp algebra classified and Standardized by dividing raw score on maximum value
Adding of all these map in Single out put map algebra into one Binary map
Multiply all these map in Single out put map algebra with an assigned weight of 50% for Pop, 30% for Land use and 20 for Spot height
Combine both the binary and weight maps in Single out put map algebra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CODEDESC
CA Land
Commercial Land
Farm Land
Industrial Lands
Institutional Lands
Not Available
Other Land
Park Land
Residential Land
Special Purpose Land
Vacant Land
parcels
roads_Buffer
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ArcToolbox
3D Analyst Tools
Analysis Tools
Cartography Tools
Conversion Tools
Data Interoperability Tools
Data Management Tools
Geocoding Tools
Geostatistical Analyst Tool
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Multidimension Tools
Network Analyst Tools
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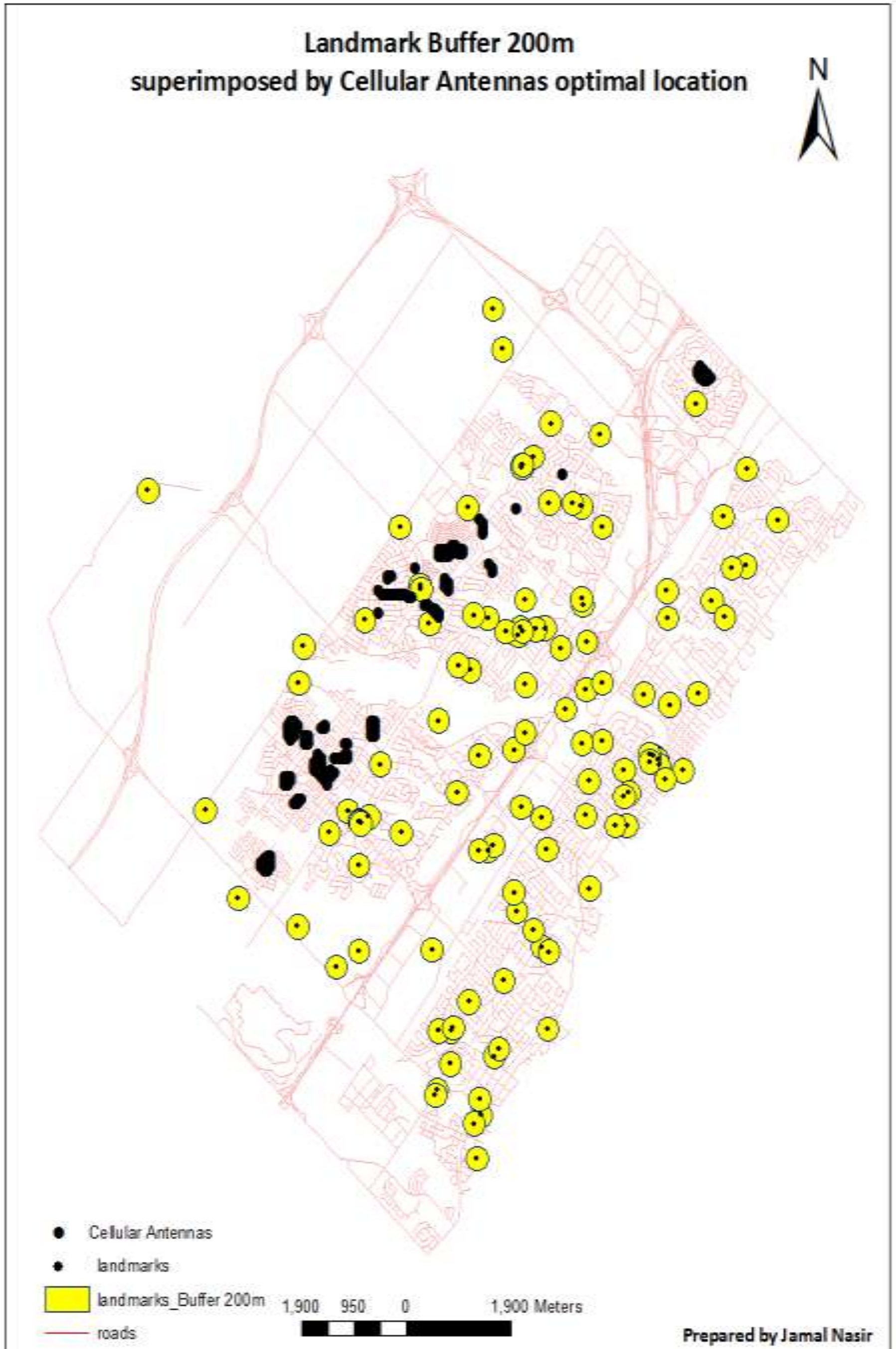
Landmark Buffer 200m
superimposed by Cellular Antennas optimal location
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Cellular Antennas
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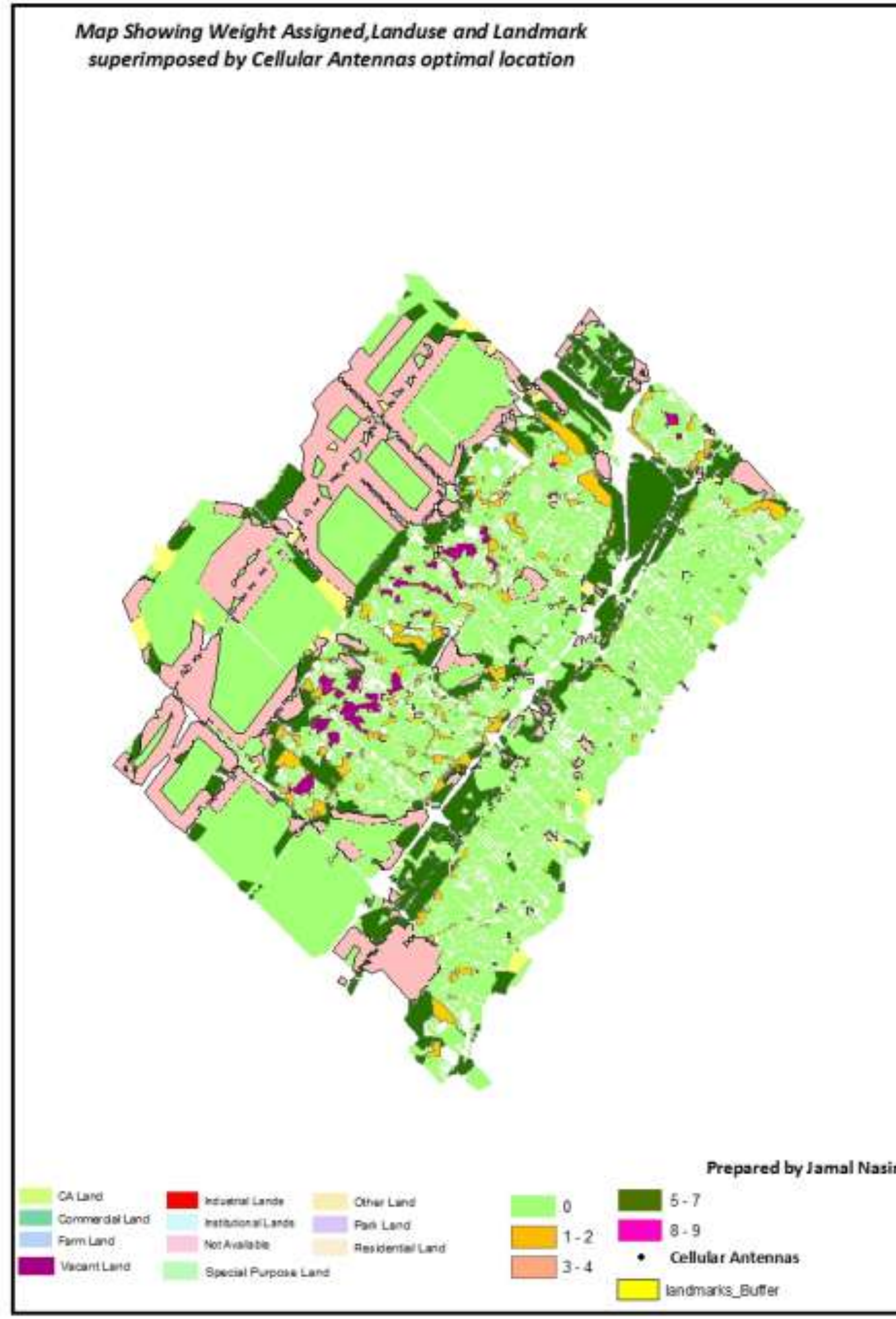
Prepared by Jamal Nasir


Map Showing Weight Assigned,Landuse and Landmark
superimposed by Cellular Antennas optimal location
Prepared by Jamal Nasir
CA Land
Commercial Land
Farm Land
Vacant Land
Industrial Lands
Institutional Lands
Not Available
Special Purpose Land
Other Land
Park Land
Residential Land
0
1 - 2
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8 - 9
Cellular Antennas
landmarks_Buffer

## Surface analysis

### Interpolation

Visiting every location in a study area to measure the height, magnitude, or concentration of a phenomenon is often difficult or expensive. Instead, you can measure the phenomenon at strategically dispersed sample locations and create a continuous surface by predicting values for all other locations. Input points can be either randomly or regularly spaced or based on some sampling scheme.

ArcGIS Spatial Analyst provides inverse distance weighted (IDW), kriging, and spline interpolation, as well as polynomial trend and natural neighbor methods, which can be used to estimate elevation, rainfall, temperature, chemical dispersion, or other spatially continuous phenomena.

ArcGIS Spatial Analyst can also create nontraditional surfaces using various other functions. These include the ability to derive a density surface showing the density of objects, such as number of people per square kilometer; distance-based surfaces showing distance to various features, such as retail stores; and other surfaces. Using the derived surfaces, users can then directly display this new data, such as elevation from a terrain surface, or color-coded density areas for crime analysis.

The inverse distance weighted and spline methods are referred to as deterministic interpolation methods because they assign values to locations based on the surrounding measured values. A second family of interpolation methods consists of geostatistical methods such as kriging, which are based on statistical models that include autocorrelation, the statistical relationship among the measured points. These geostatistical techniques not only have the capability to produce a prediction surface but also provide some measure of the certainty or accuracy of the predictions.

# Spatial Interpolation
# Point Based Interpolation

**Spatial Interpolation is…..**

- **Estimation of a z value for the surface at an unsampled location from a set of z values observed on surrounding points. (Locations on the surface at which measurements have been made)**

- **It is the observation that points close together in space are more likely to have similar values than points far apart (Tobler's Law of Geography)**

## *Point Based Interpolation Methods*

- ***Exact (quantitative interpolation) Methods***
- ***Approximate Method***

**Exact (quantitative interpolation) Methods**

1. Proximal / Nearest Neighbour
2. B-Spline
3. Kriging

**Approximate Method**

1. Inverse Distance Weighted

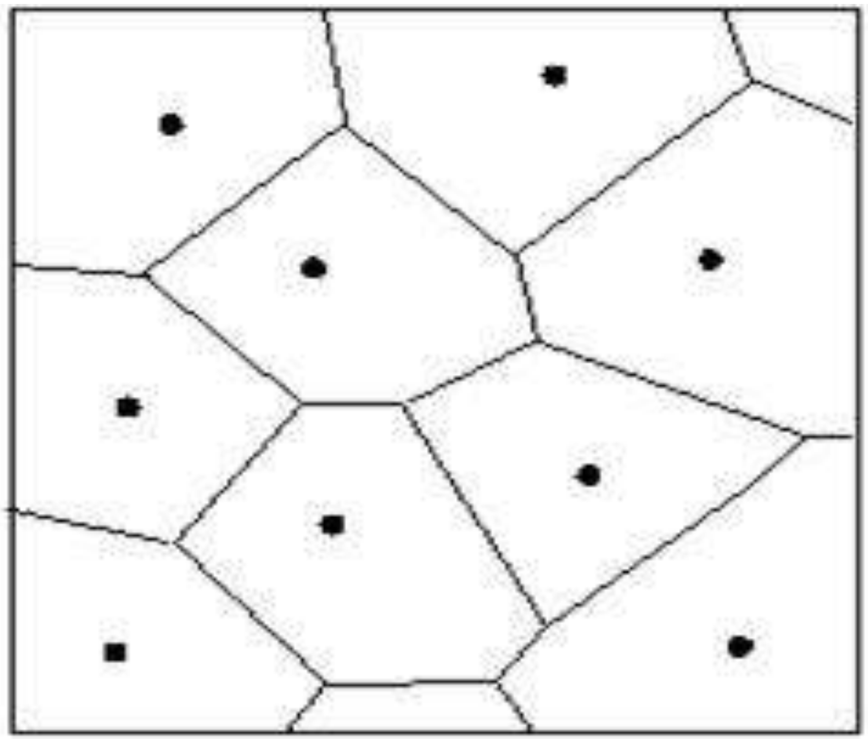
## Point Based Interpolation Methods

***Exact (quantitative interpolation) Methods***

1. Proximal Interpolation/ Nearest Neighbour **Method**

- Assumes the value at each grid cell location is the same as the value at the nearest observation
- Uses concept of thiessen polygons
- Thiessen polygons are defined around each observation.
- Only one observation is contained in each polygon.
- The boundaries of the polygon are MIDWAY between each neighbouring observation

# Example of Thiessen polygons:



Thiessen polygons or Dirichlet tessellations.

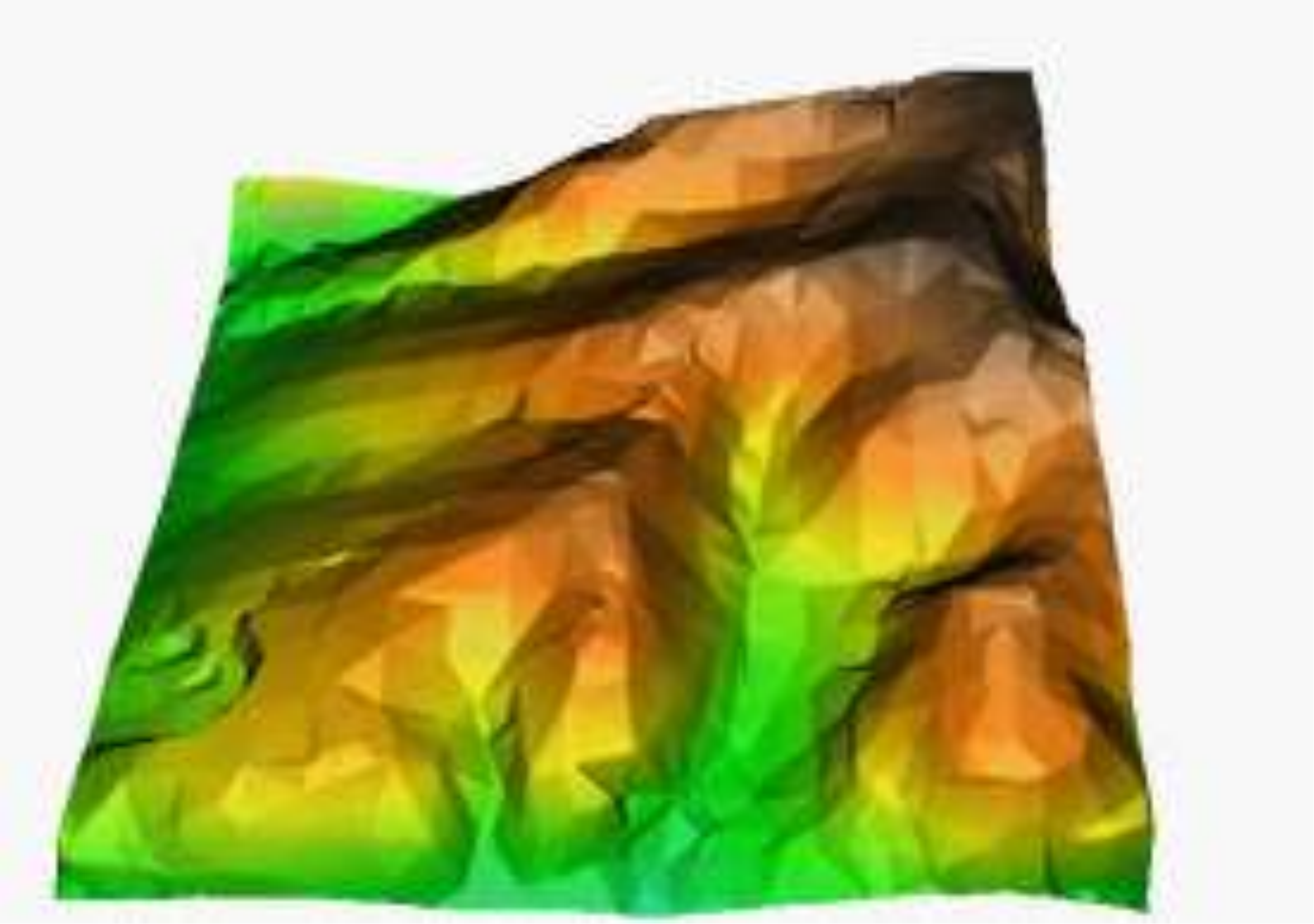
# Point Based Interpolation Methods

## *Exact (quantitative interpolation) Methods*

**2. B-Spline Method**

- **uses a piecewise polynomial to provide a series of patches resulting in a surface that has continuous first and second derivatives**
- **ensures continuity in:**
- **elevation (zero-order continuity) - surface has no cliffs**
- **slope (first-order continuity) - slopes do not change abruptly, there are no kinks in contours**
- **curvature (second order continuity) - minimum curvature is achieved**
- **produces a continuous surface with minimum curvature**
- **output data structure is points on a raster**
- **note that maxima and minima do not necessarily occur at the data points**
- **is a local interpolator**

B-Spline method can be approximated by smoothing contours drawn through a TIN model



# Point Based Interpolation Methods

***Exact (quantitative interpolation) Methods***

## 2. B-Spline Method

**Advantages:**

- **best for showing very smooth surfaces**
- **can be exact or used to smooth surfaces**

**Disadvantages:**

- **poor for surfaces which show marked fluctuations, this can cause wild oscillations in the spline**

# Point Based Interpolation Methods

## *Exact (quantitative interpolation) Methods*

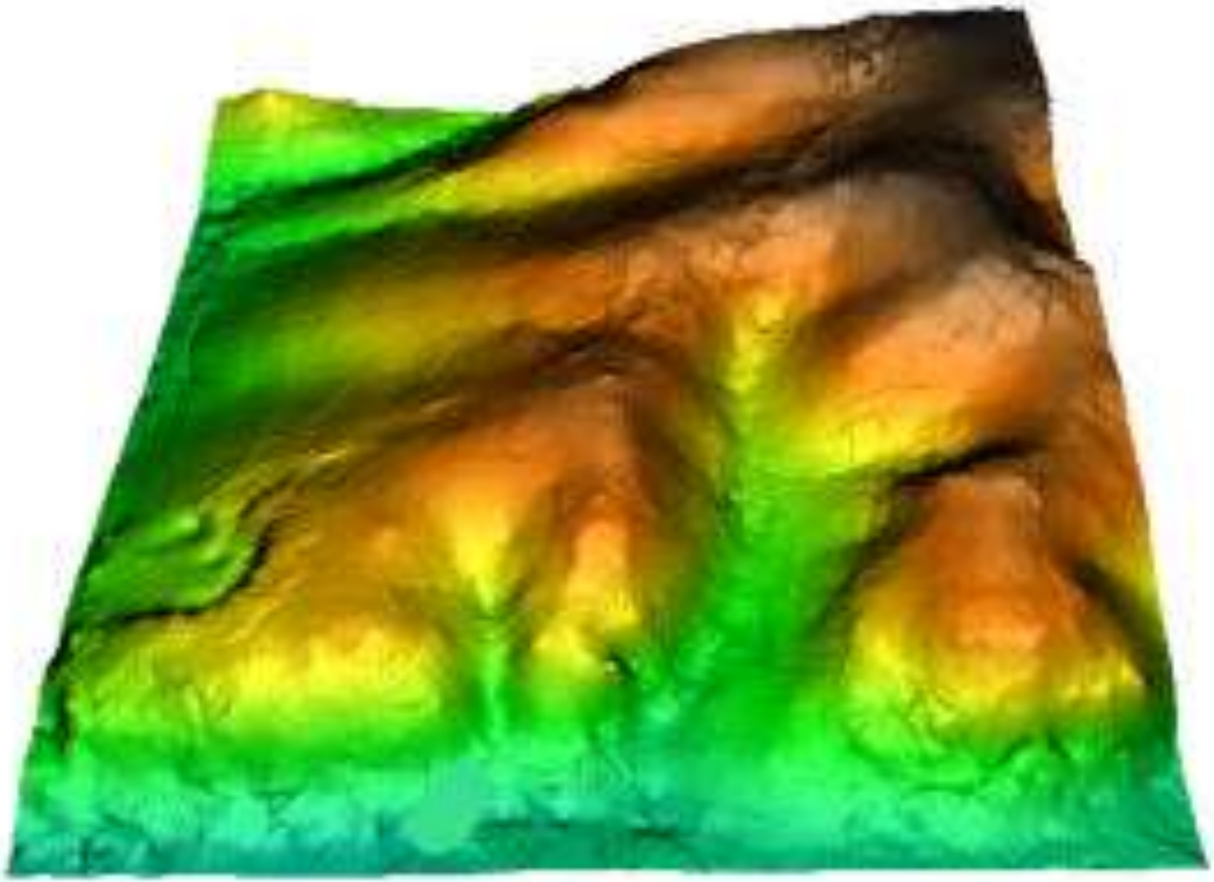
### *3. Kriging Method*

- **developed by Georges Matheron, as the "theory of regionalized variables", and D.G. Krige as an optimal method of interpolation for use in the mining industry**

- **Kriging is a stochastic technique similar to inverse distance weighted averaging in that it uses a linear combination of weights at known points to estimate the value at an unknown point.**

- **Kriging uses a semivariogram, a measure of spatial correlation between two points, so the weights change according to the spatial arrangement of the samples. Unlike other estimation procedures investigated, kriging provides a measure of the error or uncertainty of the estimated surface**

**Kriging example:**



## Point Based Interpolation Methods
## Approximate Method

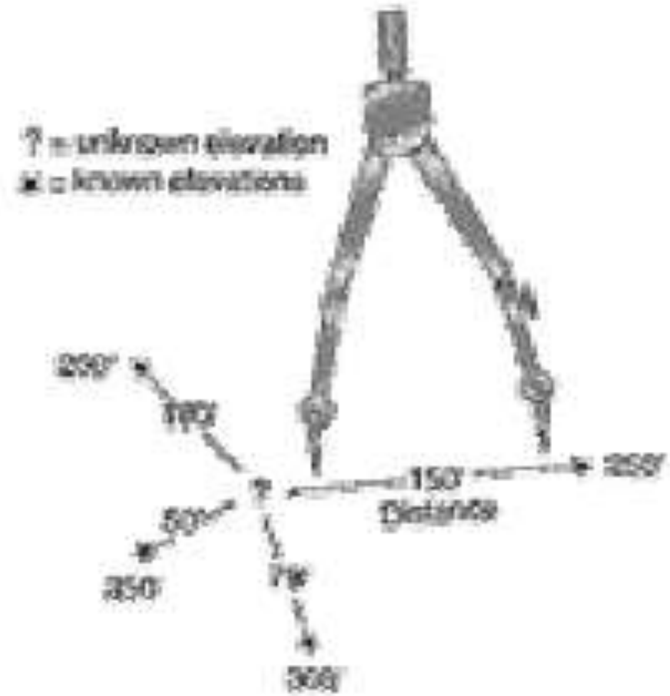
***Inverse Distance Weighted Interpolation Method:***

- The value at each grid cell location is a *DISTANCE-WEIGHTED AVERAGE* of values located at nearby observations. It averages the values of sample data points in the vicinity of each cell and the closer a point is to the center of the cell being estimated, the more influence (weight) is has.

- It is a deterministic estimation, where values at unsampled points are determined by a linear combination of values at known sampled points

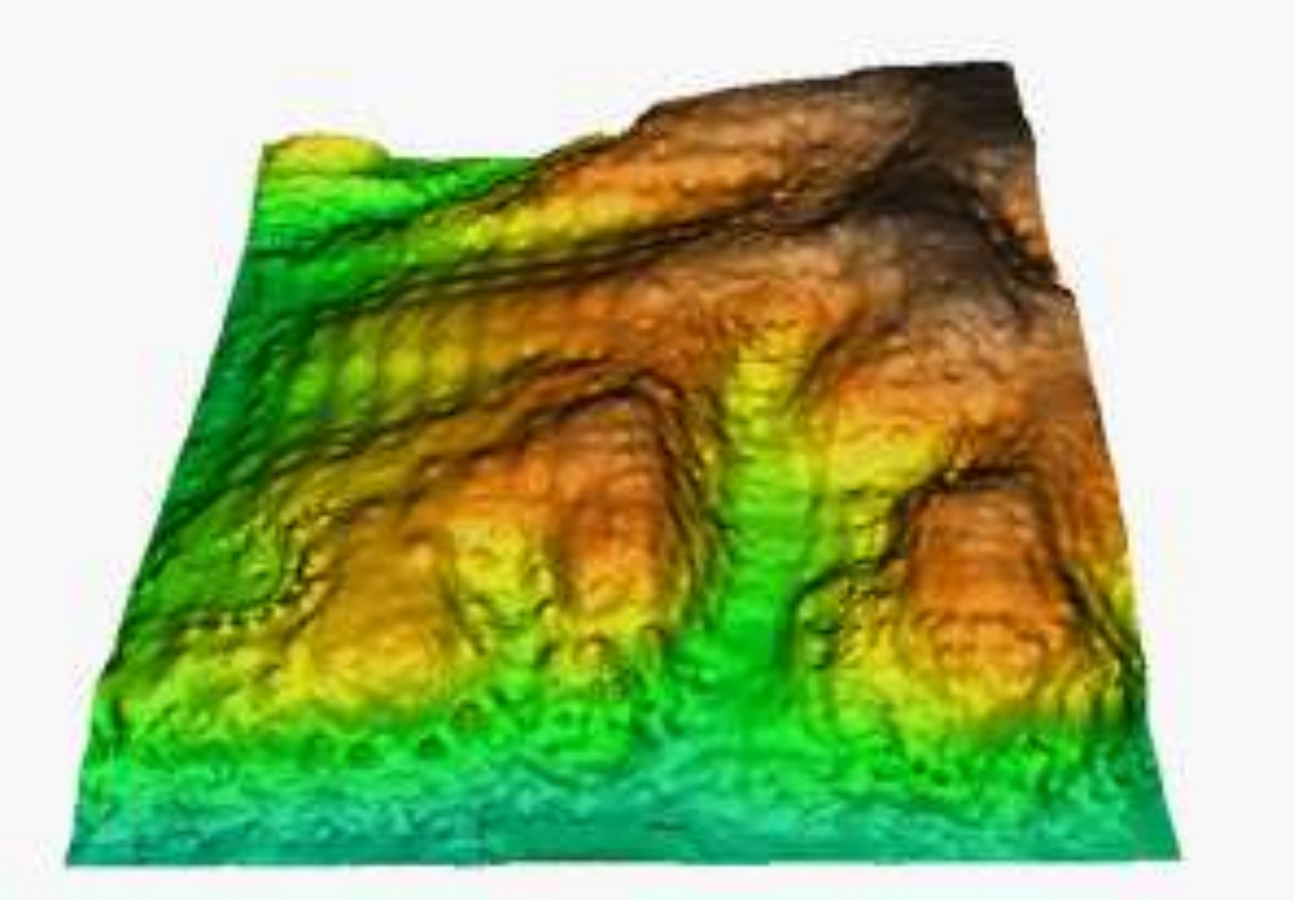
- It assumes that values closer to the unsampled location are more representative of the value to be estimated than samples further away

## Distance-Weighted Interpolation




DeMers , 1999. *Fundamentals of Geographic Information Systems (2nd Ed). New York: Wiley.*

## *IDW example:*



# Point Based Interpolation Methods

## Approximate Method

***Inverse Distance Weighted Interpolation Method:***

Advantages:

- Results in a smooth and continuous surface that changes between observations eg. Climatic data
- Derived surface passes through observed values

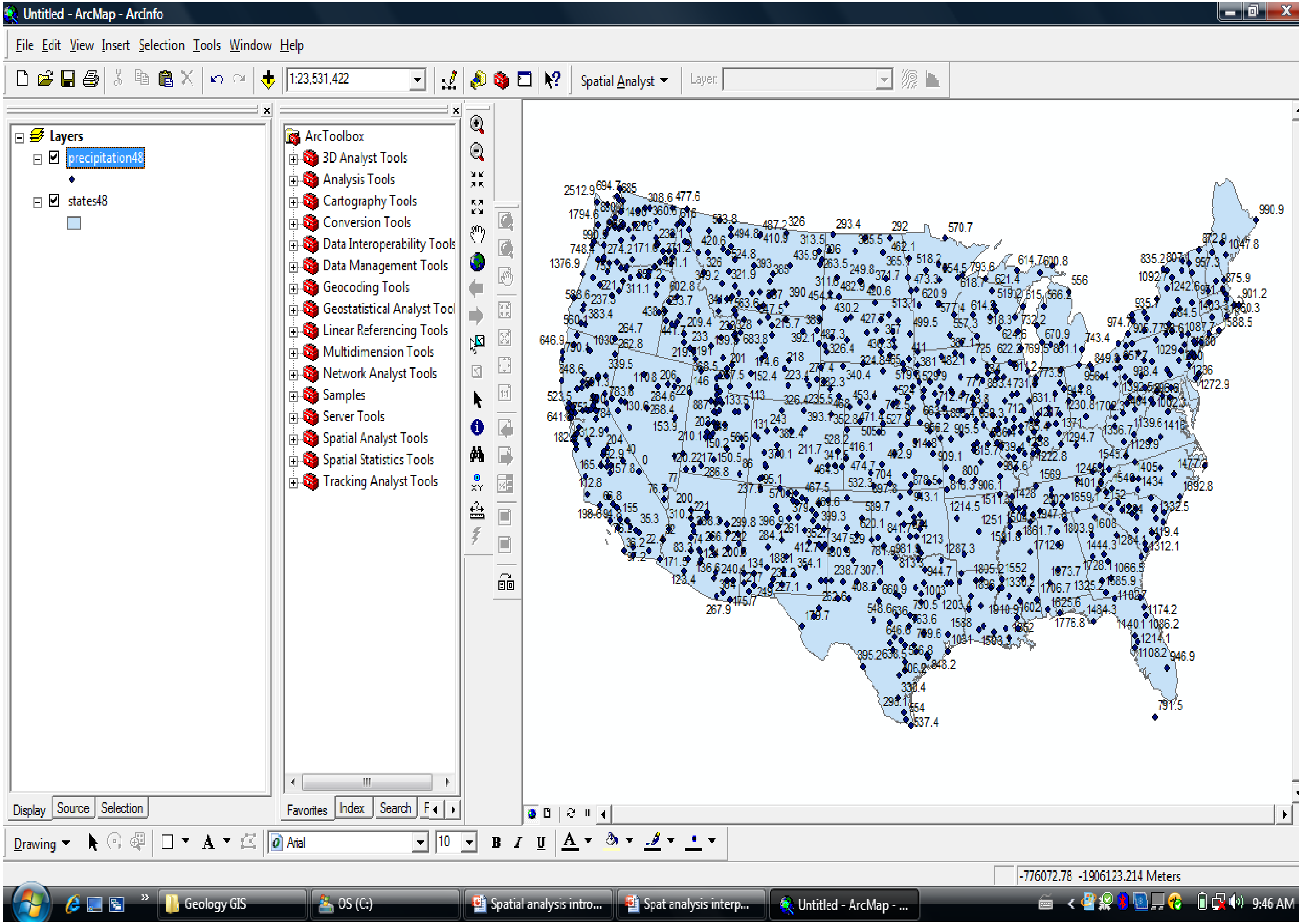
Disadvantages:

- Requires subjective selection of parameters
- Does not interpolate beyond min and max values

# Five Steps to Spatial Interpolation

1. Define purpose for interpolation
2. Define neighbourhood
3. Find points in neighbourhood
4. Choose mathematical function
5. Evaluate function for unknown points

**steps are looped for every cell in the grid (not just one)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ArcToolbox
3D Analyst Tools
Analysis Tools
Cartography Tools
Conversion Tools
Data Interoperability Tools
Data Management Tools
Geocoding Tools
Geostatistical Analyst Tool
Linear Referencing Tools
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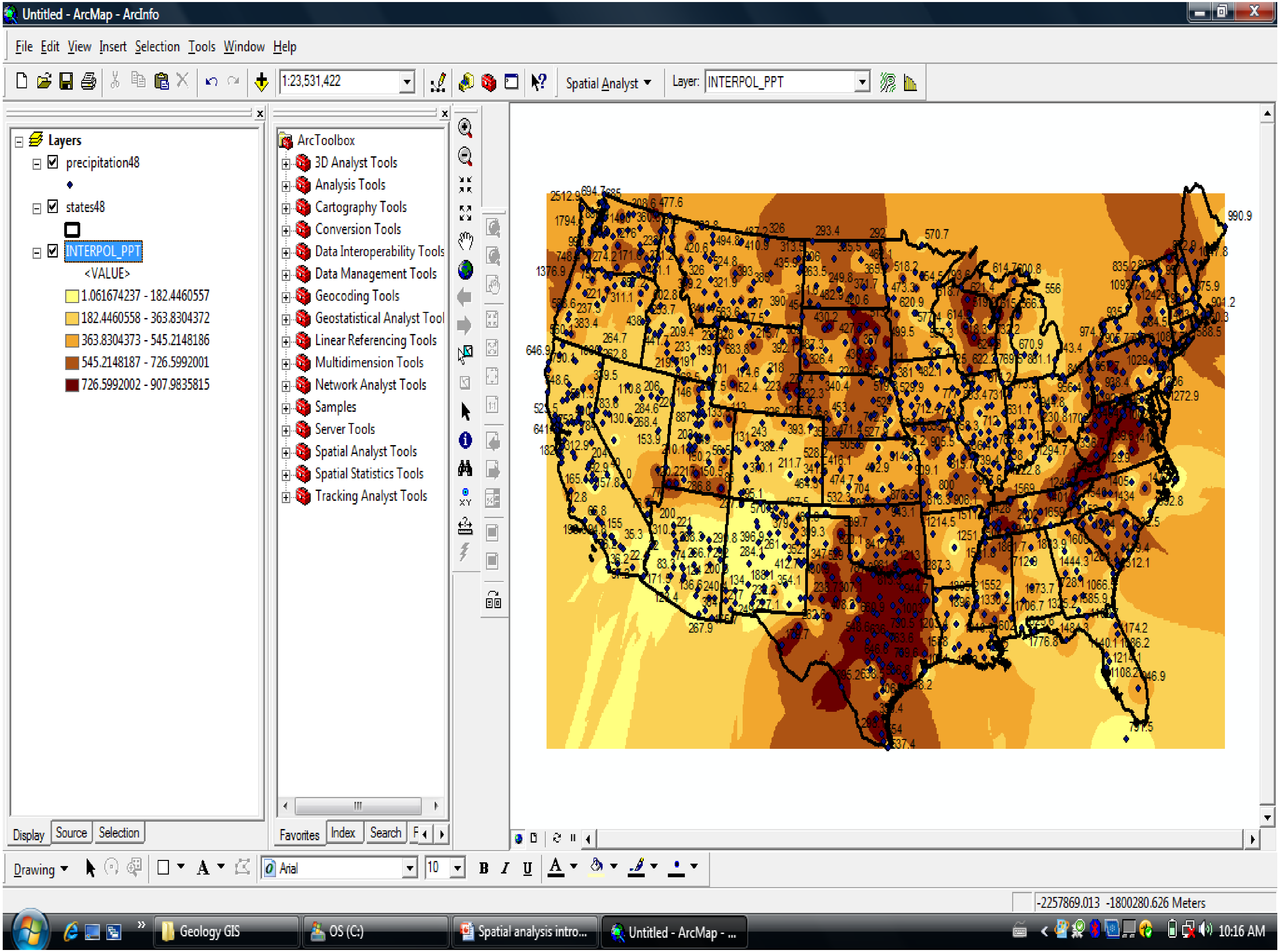

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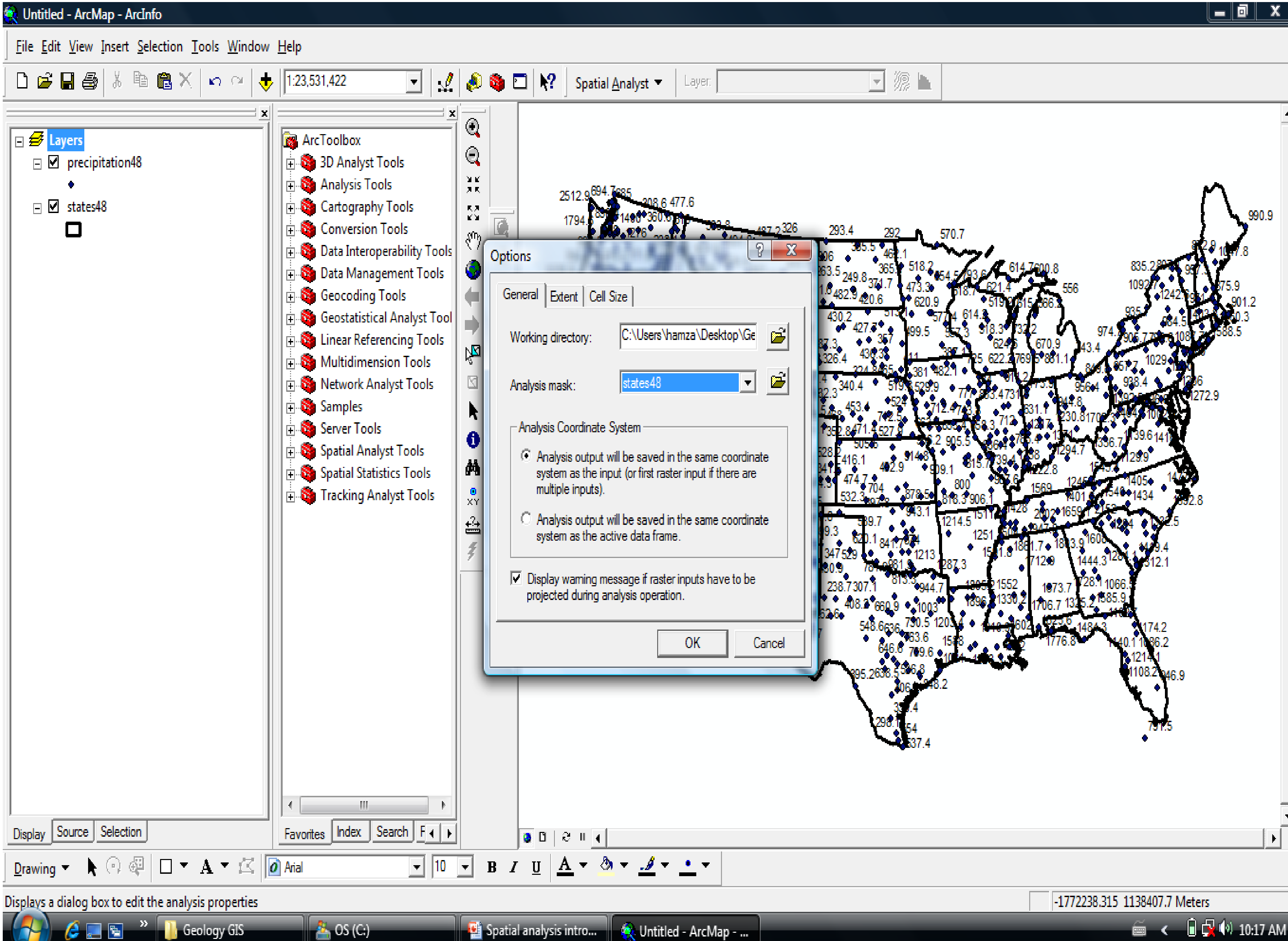
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Spatial Statistics Tools
Tracking Analyst Tools
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Working directory:
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Analysis mask:
states48
Analysis Coordinate System
Analysis output will be saved in the same coordinate system as the input (or first raster input if there are multiple inputs).
Analysis output will be saved in the same coordinate system as the active data frame.
Display warning message if raster inputs have to be projected during analysis operation.
OK
Cancel
Display
Source
Selection
Favorites
Index
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Displays a dialog box to edit the analysis properties
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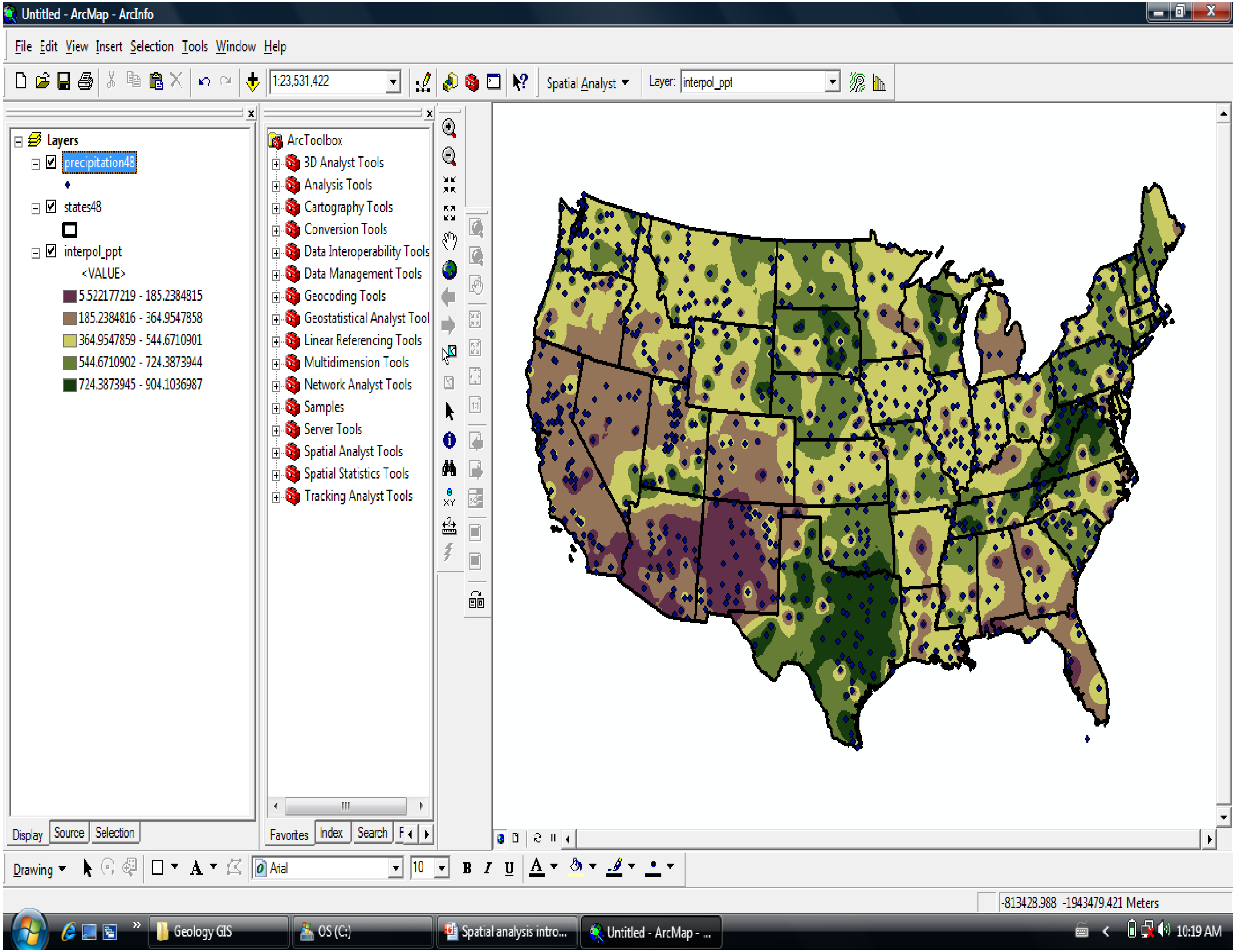

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364.9547859 - 544.6710901
544.6710902 - 724.3873944
724.3873945 - 904.1036987
ArcToolbox
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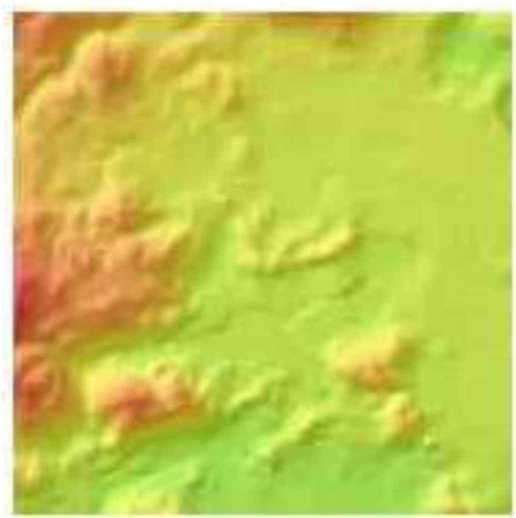
# Summary

| **Type of Interpolation** | **Classification** | **When to use:** |
|---|---|---|
| Inverse Distance Weight | Exact, Local, Deterministic | To get fast results |
| Spline – Regularized and Tension | Exact, Local Deterministic | To get optimal results without much effort |
| Kriging | Local Stochastic | To get the best general results for more advanced analyses and visualization |

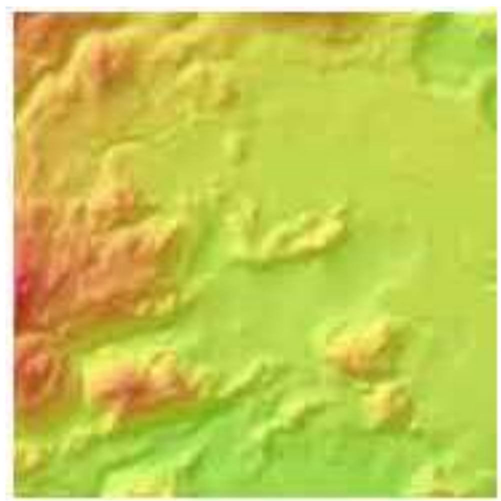
# Visual Comparison of DEMs Using Different Interpolation Methods

**Location: Lake of Bled in the western Slovenia**

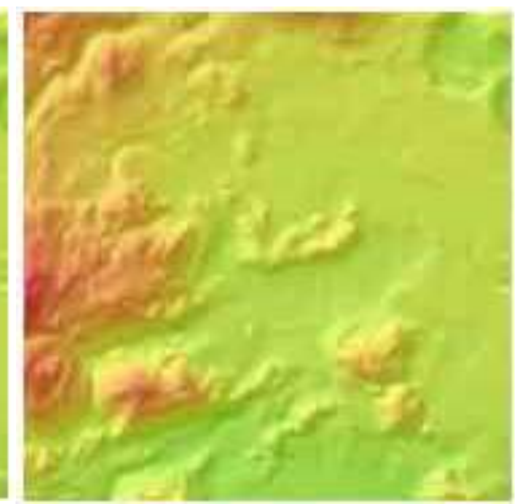
IDW



Spline



Kriging

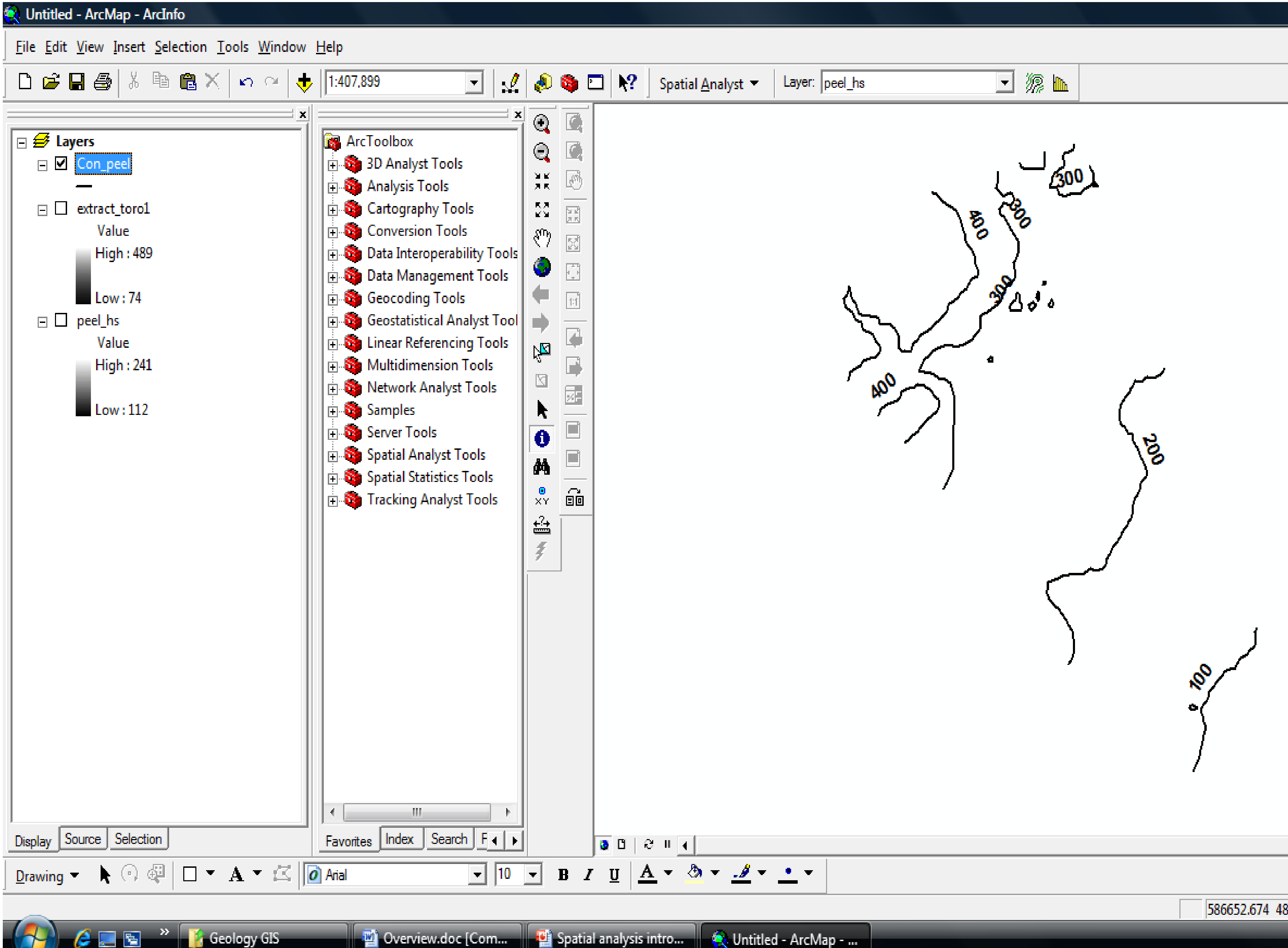


Source: http://www.gisdevelopment.net/technology/tm/tm003pf.htm

## Surface Analysis

Using ArcGIS Spatial Analyst, users can build and analyze complex surfaces to identify patterns or features within the data. Many patterns that are not readily apparent in the original data can be derived from the existing surface. These include shaded relief, contours, angle of slope, aspect, and hillshade.

These topographic derivatives give you the power to effectively relate your data to real-world terrain and analyze how variations in the topography will affect the problem in question.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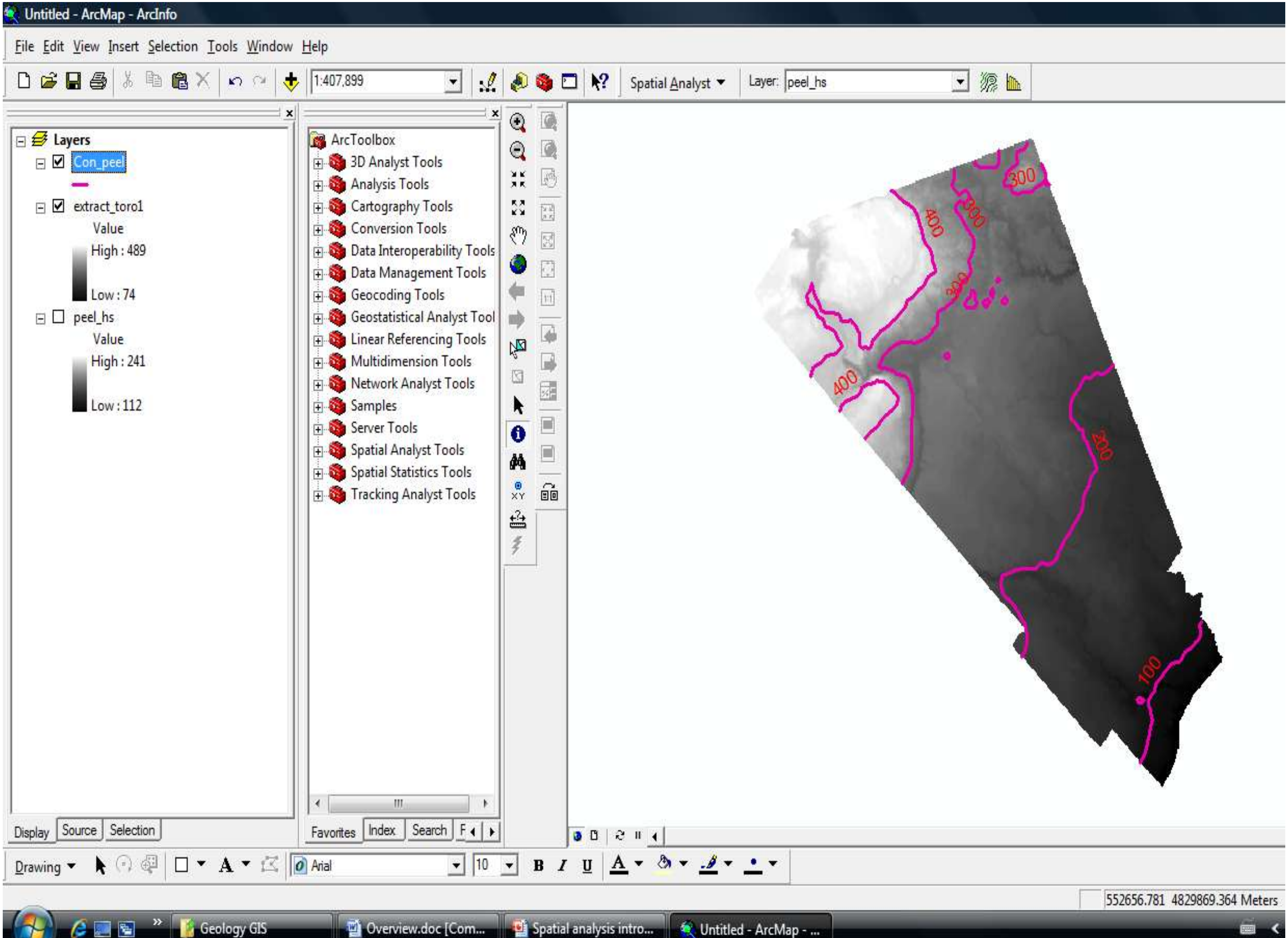

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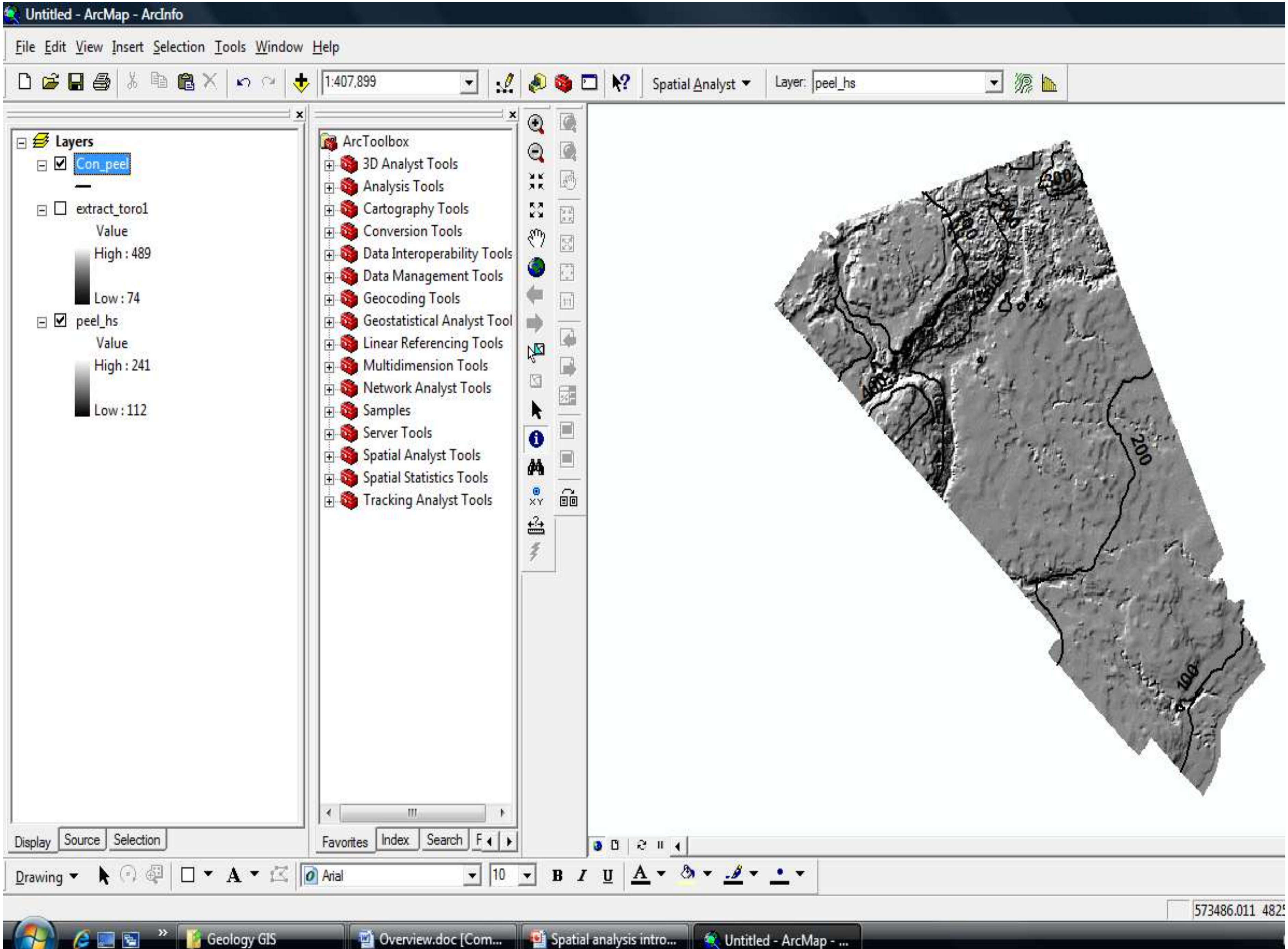
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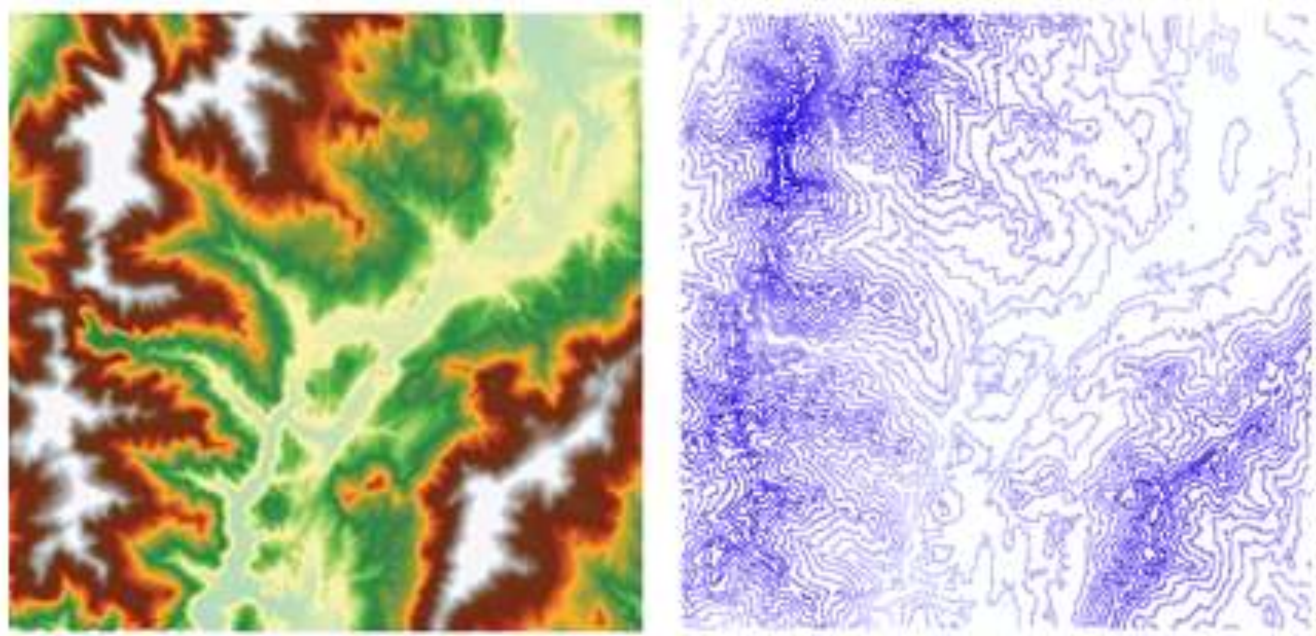
# Contours

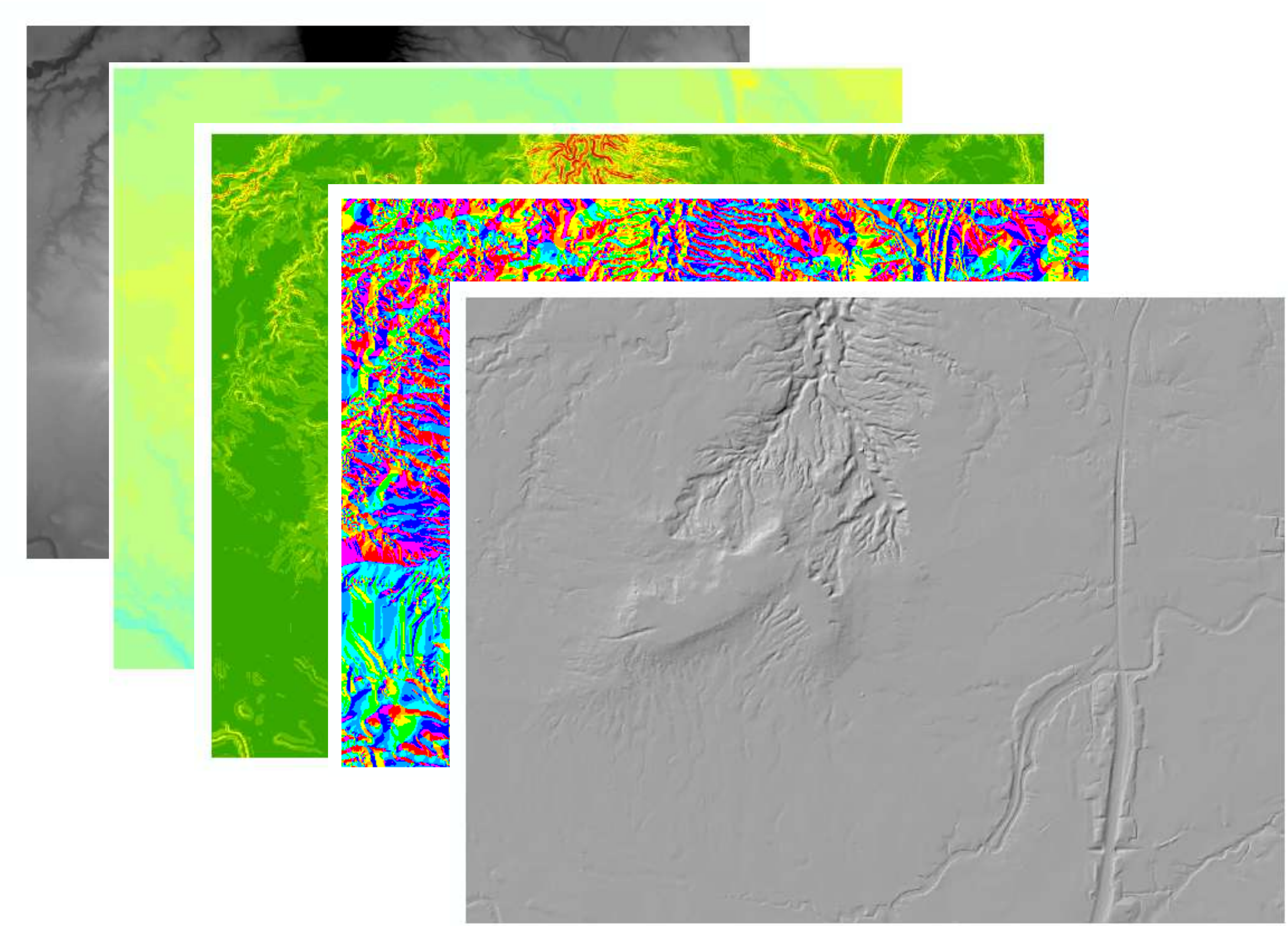
- Another but more simplistic ways of presenting terrain data is through contours
- Rasters → Polylines
- Contours are lines that connect points of equal value (such as **elevation**, temperature, precipitation, pollution, or atmospheric pressure).

# Contours …

- The example below shows an input elevation grid and the output contour map. The areas where the contours are closer together indicate the steeper locations.



# Surfaces from DEMs



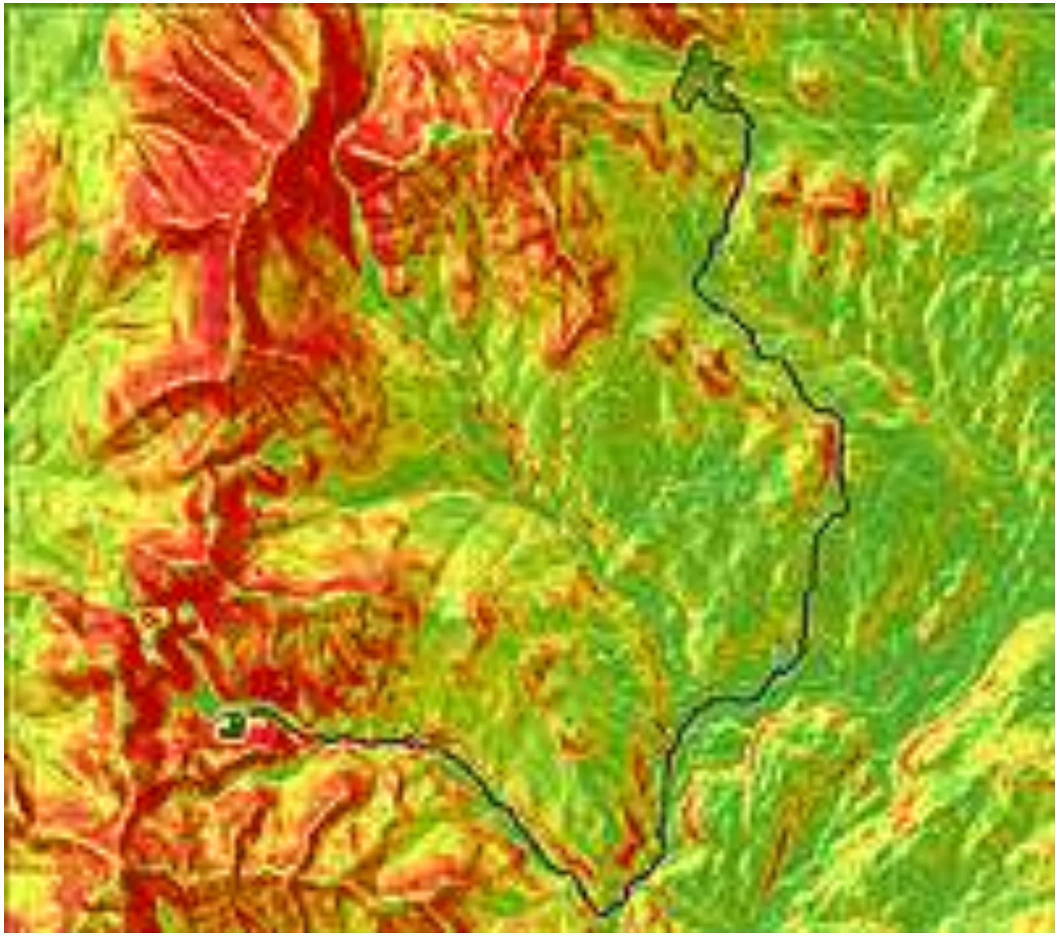
# Distance Analysis

**ArcGIS Spatial Analyst provides several distance mapping tools for measuring straight-line (Euclidean) distance and distance measured in terms of other factors such as slope, current road infrastructure, and land use.**

**Calculating the accumulated cost of traveling, or mapping distance, can provide the user with additional data with which to make decisions. For example, the accumulated least cost of travel to a number of processing mills can be calculated while taking into consideration obstacles to travel. Road and waterway costs can then be assigned to restrict travel.**

**Euclidean distance and cost distance are two main ways to perform distance analysis in ArcGIS Spatial Analyst. The Euclidean distance functions measure straight-line distance from each cell to the closest source. Not only can you determine allocation, but you can also calculate the distance and direction to the closest source.**

**Using the cost distance functions, you can create distance and direction rasters and compute the least-cost or shortest path from a chosen destination to your source point. The path distance functions add additional factors beyond the cost surface to account for actual travel distance over the terrain.**



This map shows the least-cost path between a stand of forest and the nearest sawmill. Factors such as slope, road infrastructure, and land use were combined with travel cost to find the optimal route

You can perform distance analysis in ArcGIS Spatial Analyst using two main methods***: Euclidean distance*** and ***cost distance***.

The ***Euclidean Distance*** tool measures straight-line distance from each cell to the closest source; the source identifies the objects of interest, such as wells, roads, or a school. The distance is measured from cell center to cell center. Not only can you determine the distance each cell is to the closest source, you can calculate for each cell the direction and determine which source is the closest.

The ***Cost Distance*** tool (or cost-weighted distance) modifies Euclidean distance by equating distance as a cost factor, which is the cost to travel through any given cell. For example, it may be shorter to climb over the mountain to the destination, but it is faster to walk around it. The Cost Allocation tool identifies the nearest (or least costly) source cell based on accumulated travel cost. The Cost Direction tool provides a road map, identifying the route to take from any cell, along the least cost-path, back to the nearest source.

## Objectives:

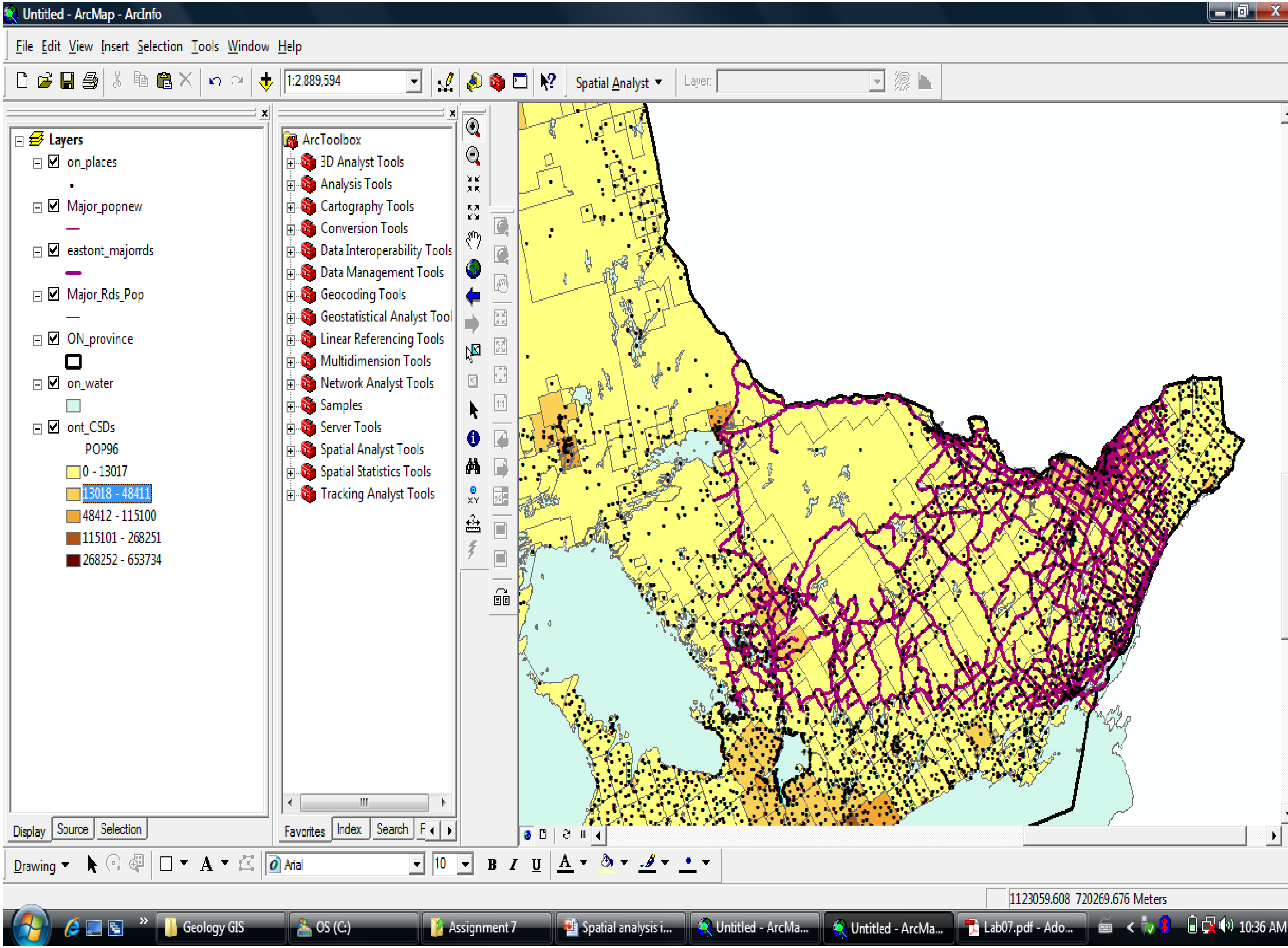
**This lab will introduce you to the network problems of minimum routes. We will examine the minimum travel distance, time and population exposure for moving hazardous materials along Ontario roads.**

## Software Environment:

**ArcGIS 9.2, Network Analyst, Spatial Analyst**

## Data:

1. **Major Roads of Eastern Ontario**
2. **Places in Ontario**
3. **Ontario Census Subdivisions (CSDs)**
4. **Province of Ontario /on_prov.shp**
5. **GRID of Ontario CSDs**
6. **Population Density GRID**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on_water
ont_CSDs
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13018 - 48411
48412 - 115100
115101 - 268251
268252 - 653734
ArcToolbox
3D Analyst Tools
Analysis Tools
Cartography Tools
Conversion Tools
Data Interoperability Tools
Data Management Tools
Geocoding Tools
Geostatistical Analyst Tool
Linear Referencing Tools
Multidimension Tools
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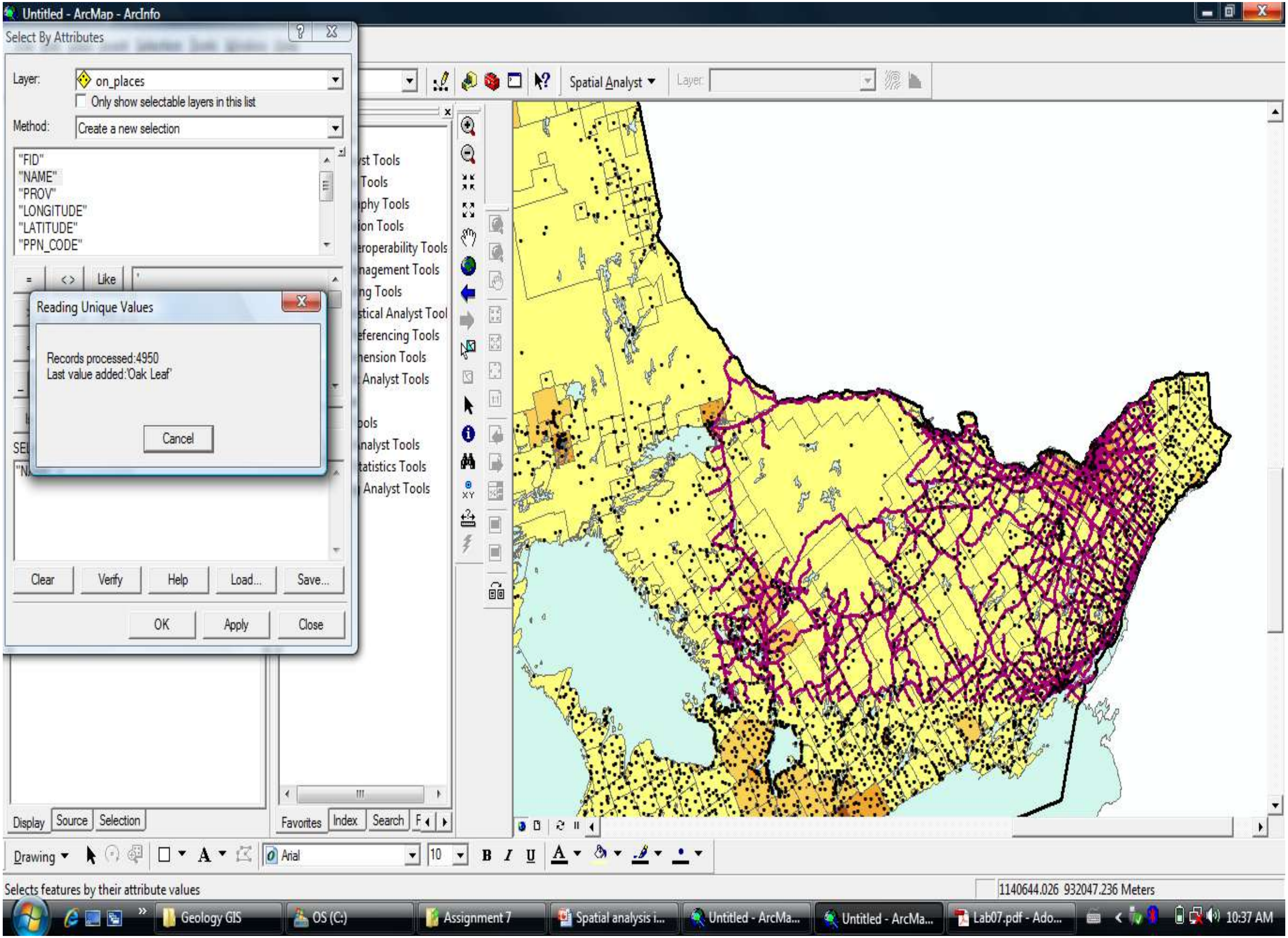
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Only show selectable layers in this list
Method:
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"FID"
"NAME"
"PROV"
"LONGITUDE"
"LATITUDE"
"PPN_CODE"
Like
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Last value added:'Oak Leaf'
Cancel
Clear
Verify
Help
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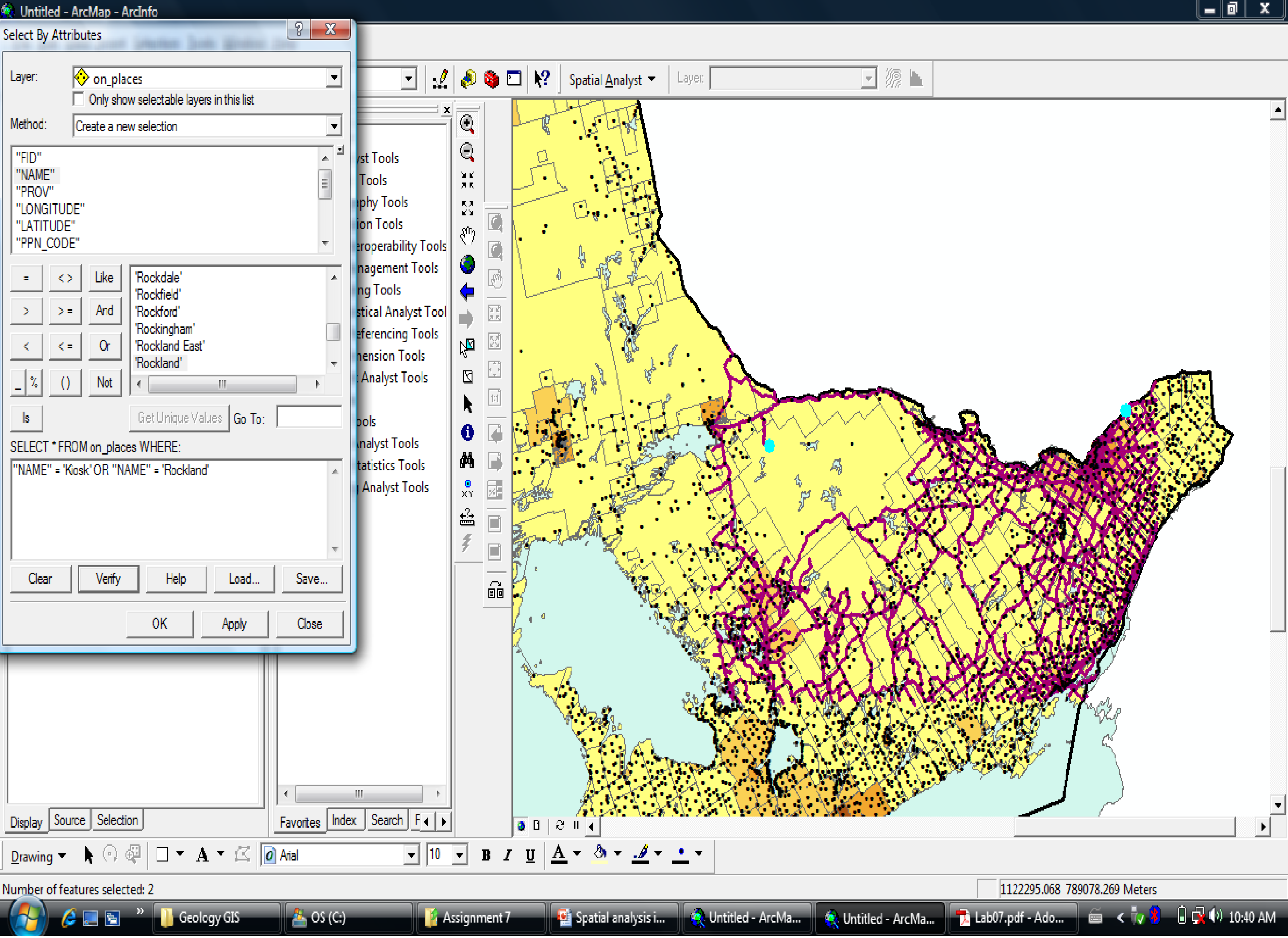
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'Rockland East'
'Rockland'
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SELECT * FROM on_places WHERE:
"NAME" = 'Kiosk' OR "NAME" = 'Rockland'
Clear
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Spatial Analyst
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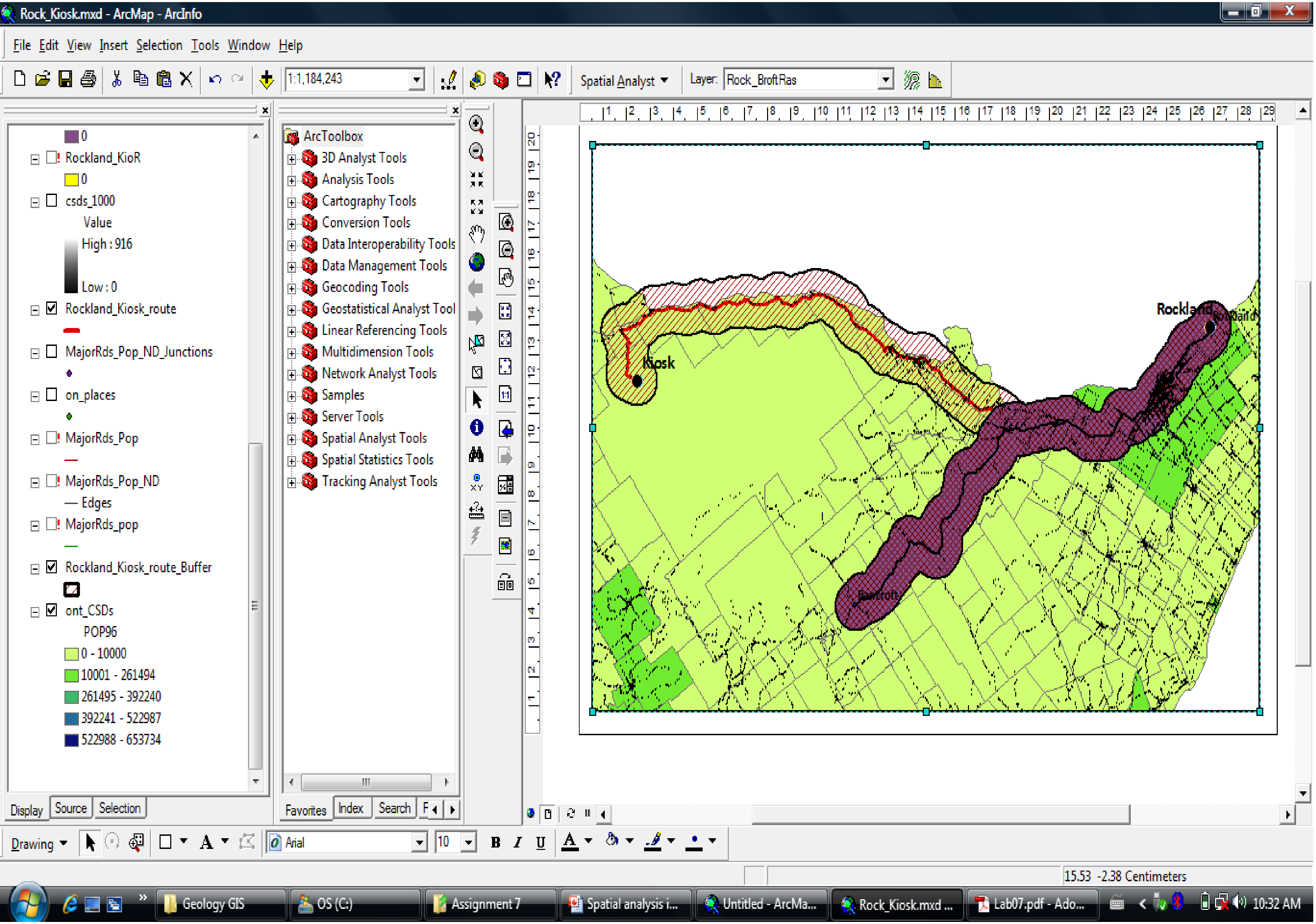

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Rockland_Kiosk_route_Buffer
ont_CSDs
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0 - 10000
10001 - 261494
261495 - 392240
392241 - 522987
522988 - 653734
Display Source Selection
ArcToolbox
3D Analyst Tools
Analysis Tools
Cartography Tools
Conversion Tools
Data Interoperability Tools
Data Management Tools
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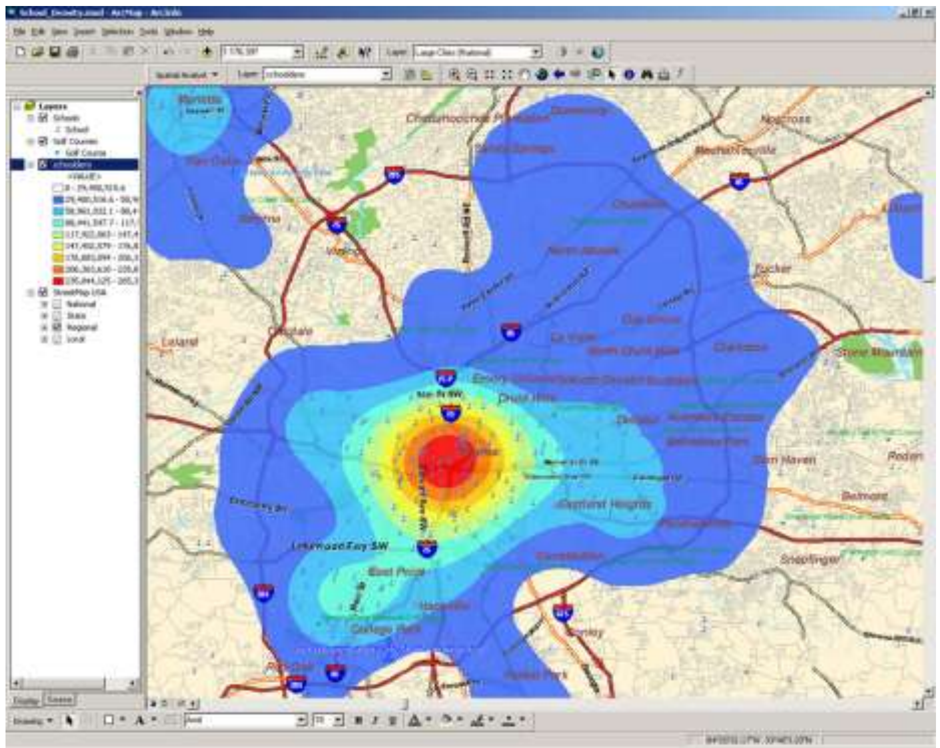
**Density Analysis**

The density function distributes a measured quantity of an input point layer throughout a landscape to produce a continuous surface.

Available density mapping tools include

- Kernel Density
- Line Density
- Point Density

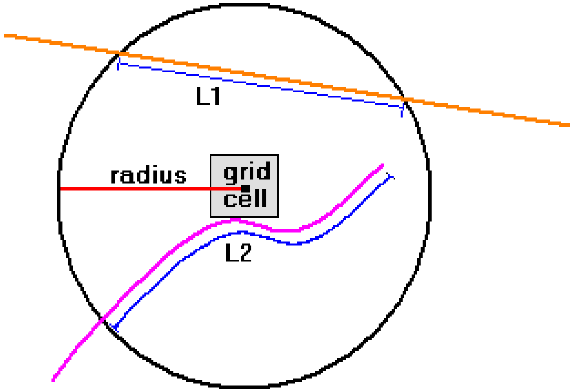


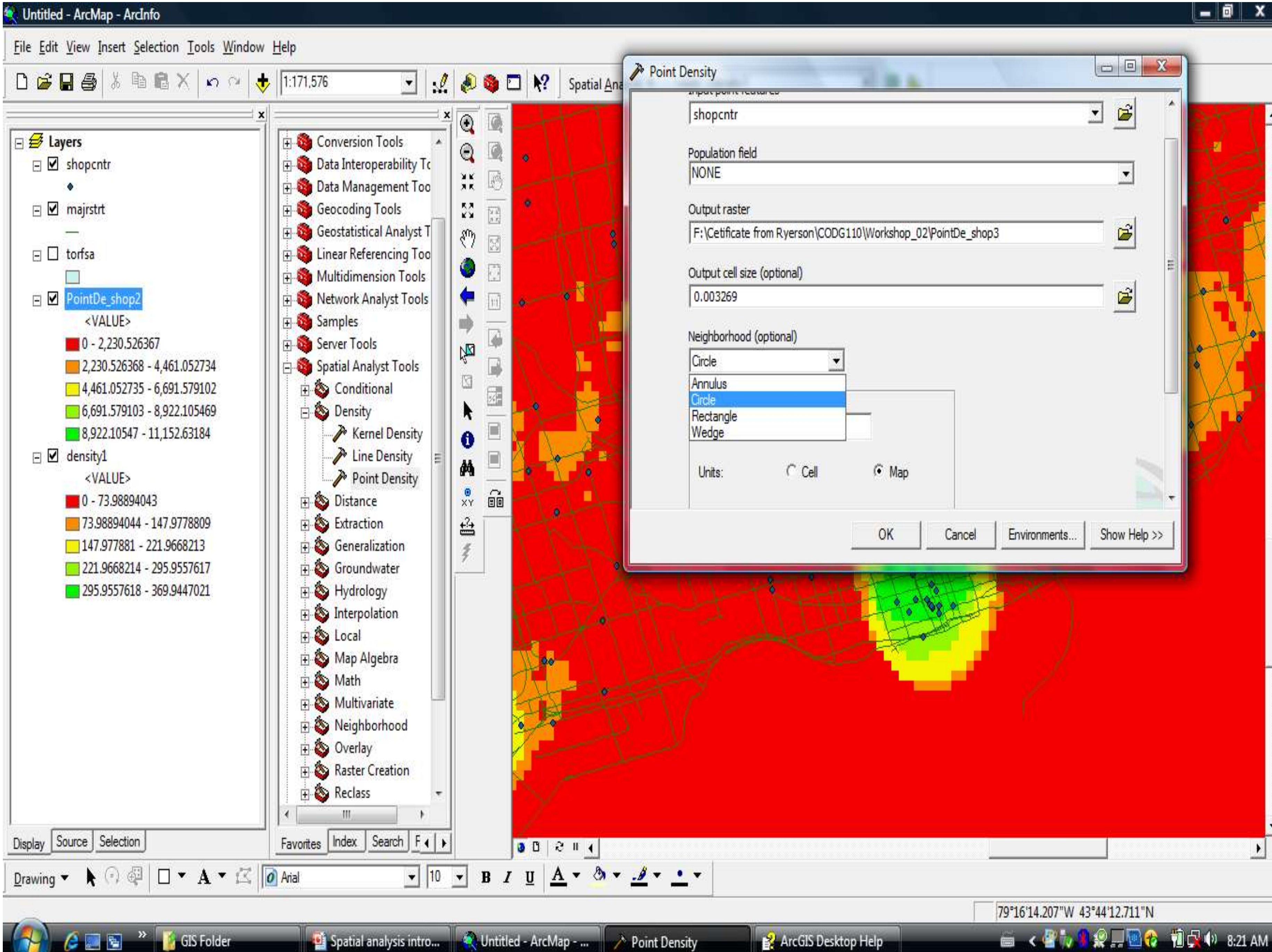
Performing density analysis with ArcGIS Spatial Analyst.

By calculating density, you can create a continuous density surface from a set of input features. It can provide a more realistic interpretation of your values—point values are spread out, giving you a better indication as to their distribution over a surface.

Point Density calculates the density of point features around each output raster cell. Conceptually, a neighborhood is defined around each raster cell center, and the number of points that fall within the neighborhood is totaled and divided by the area of the neighborhood.

Line Density calculates the density of linear features in the neighborhood of each output raster cell. Density is calculated in units of length per unit of area. Conceptually, a circle is drawn around each raster cell center using the search radius. The length of the portion of each line that falls within the circle is multiplied by its Population field value. These figures are summed and the total is divided by the circle's area. The figure below illustrates this concept:

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4,461.052735 - 6,691.579102
6,691.579103 - 8,922.105469
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density1
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221.9668214 - 295.9557617
295.9557618 - 369.9447021
Conversion Tools
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Network Analyst Tools
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Server Tools
Spatial Analyst Tools
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Groundwater
Hydrology
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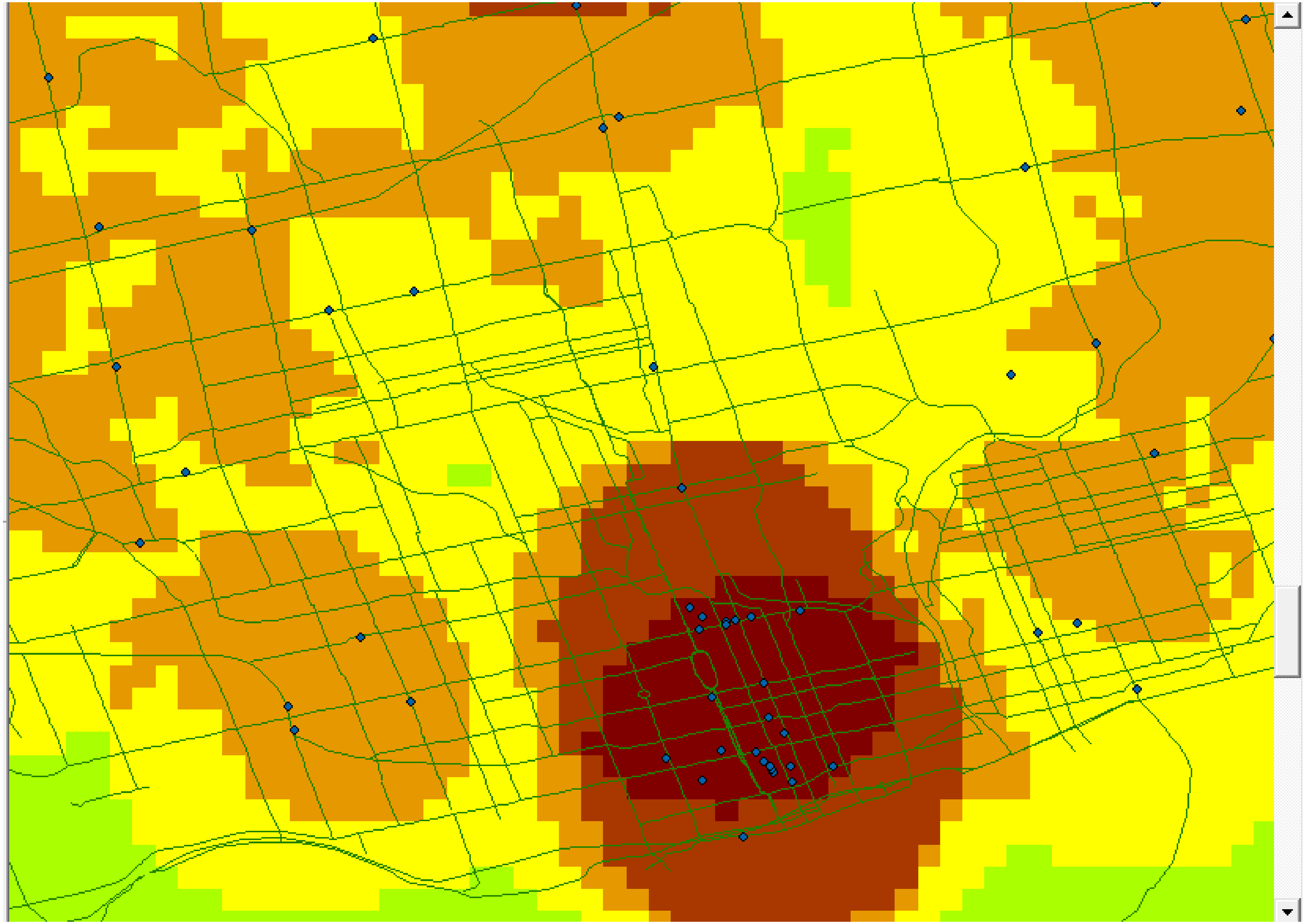
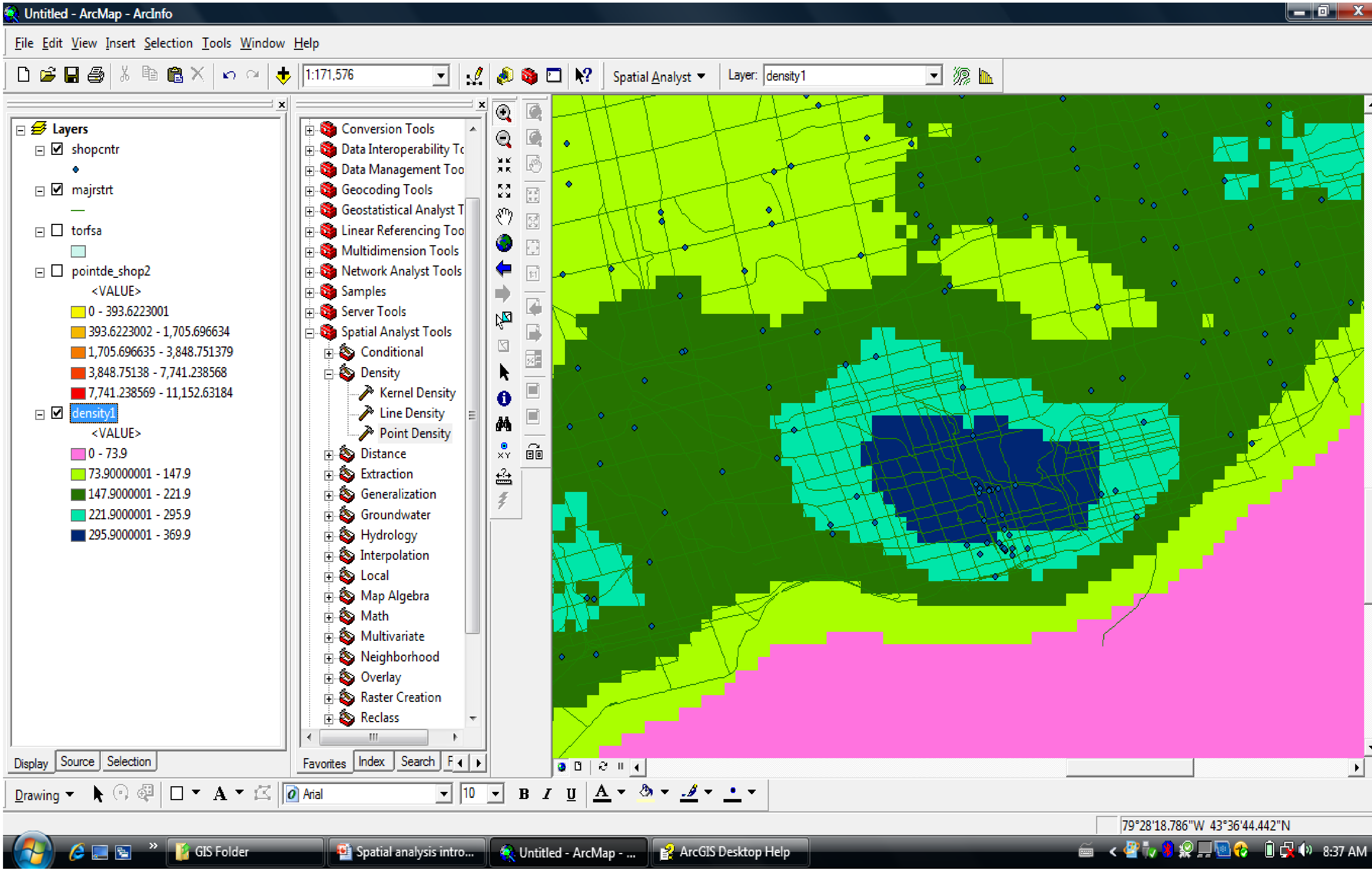
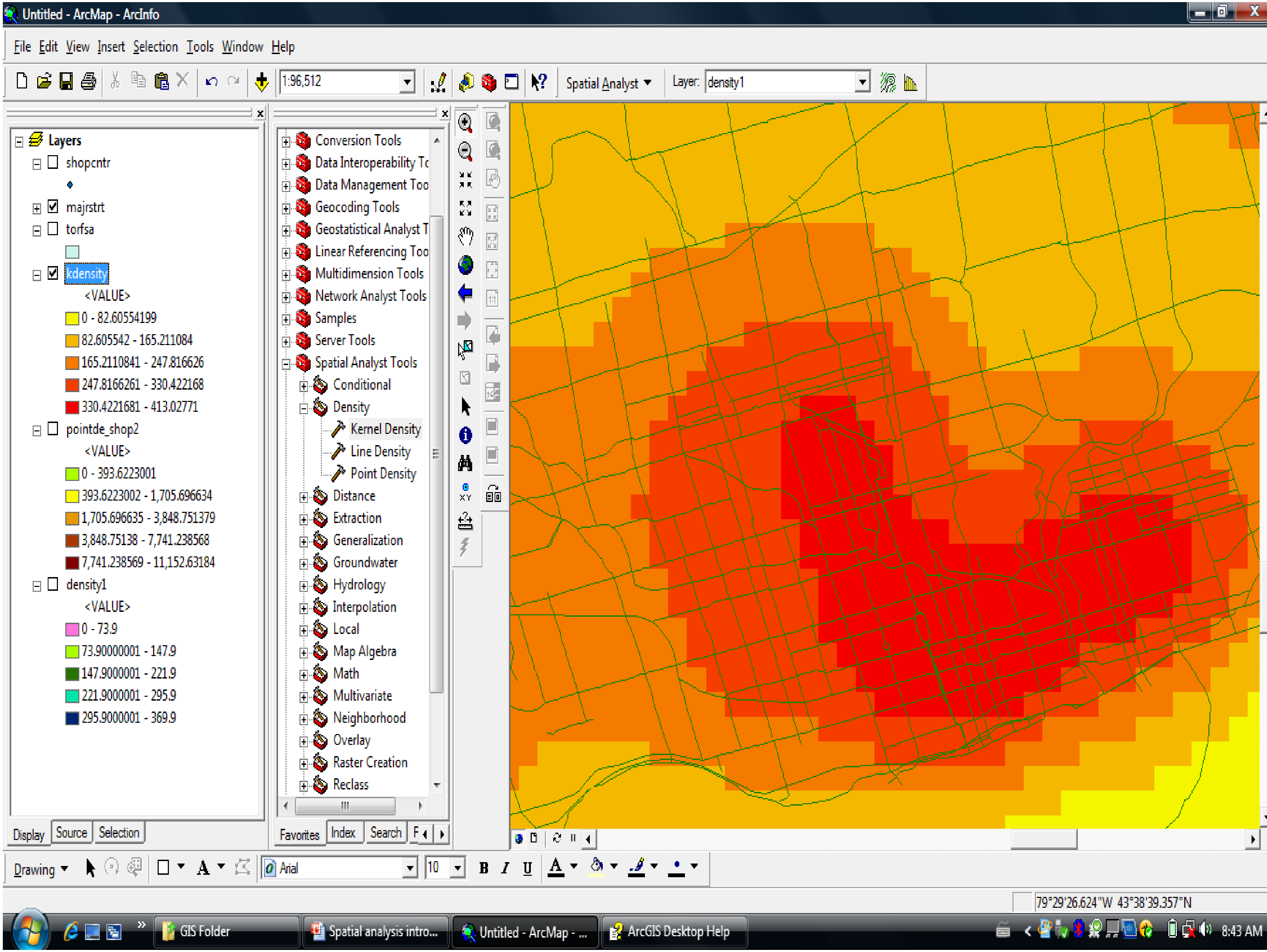


Kernel Density calculates the density of point features around each output raster cell.

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247.8166261 - 330.422168
330.4221681 - 413.02771
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393.6223002 - 1,705.696634
1,705.696635 - 3,848.751379
3,848.75138 - 7,741.238568
7,741.238569 - 11,152.63184
density1
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221.9000001 - 295.9
295.9000001 - 369.9
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**Map Algebra**

**ArcGIS Spatial Analyst includes advanced map algebra functions for combining multiple maps, performing suitability analyses, assigning weights, and identifying relationships.**

**Map algebra provides an easy-to-use and powerful way to define geographic analyses as algebraic expressions. This allows users to take their real-world data and apply algebraic functions to derive new results.**

**For example, a single expression can be constructed to find the combined value of two datasets:**

**>[(Raster1) + (Raster2)]**

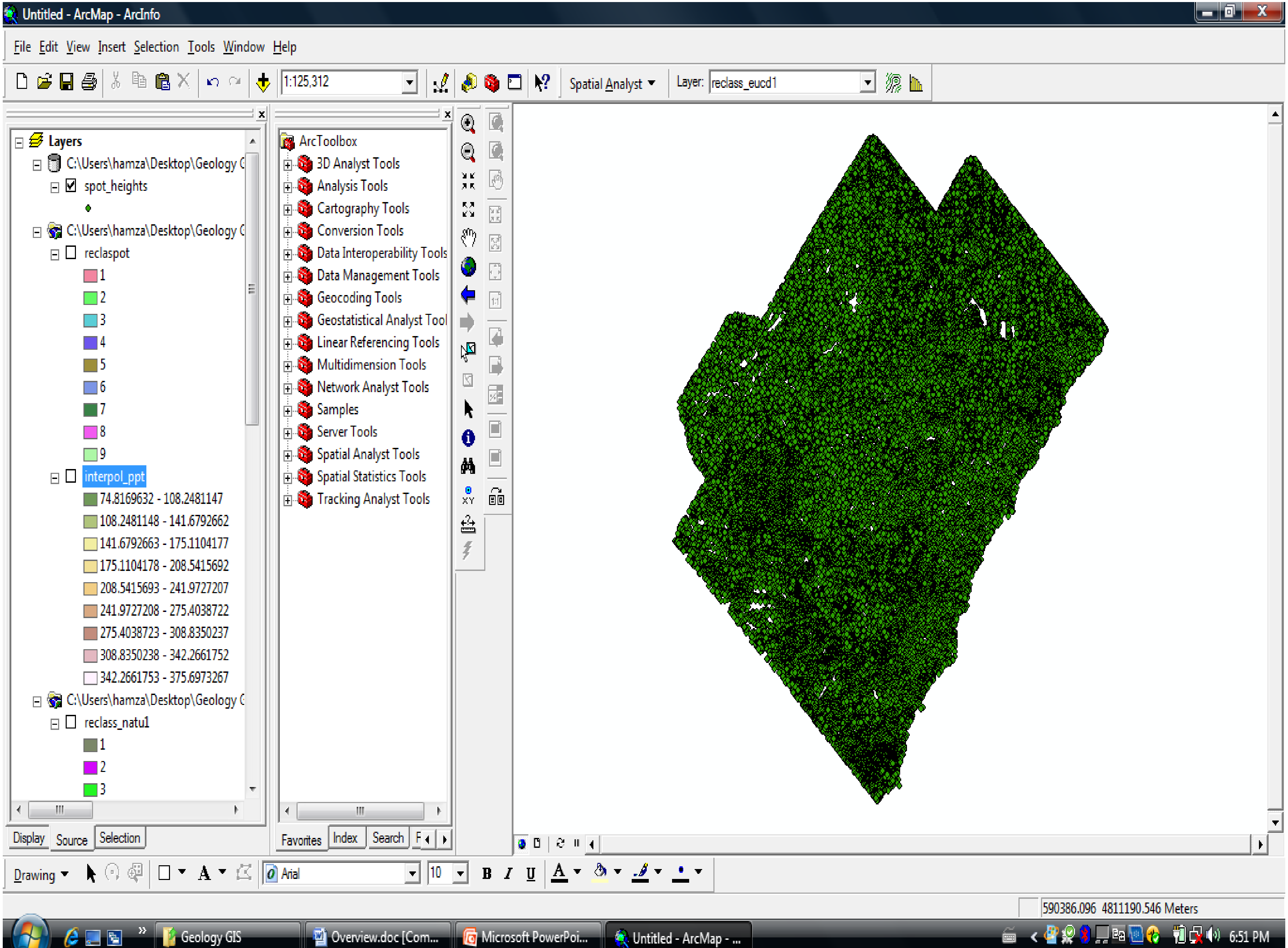
**These algebraic expressions can be simple arithmetic expressions or can consist of complex spatial and algebraic functions.**

**You can build complex expressions and process them as a single command. For example, you can use a single expression to find all the cells within a specific elevation range, apply a unit conversion such as feet to meters, and calculate the slope at each of those cells. Such an expression might look like the following:**

>=Elev_meters=Elev_feet*3.2808=

Rain_total=Rain_April+Rain_May+Rain_June

This graphic illustrates how mathematical operators and functions can be used to combine data on a cell-by-cell basis to derive new information.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175.1104178 - 208.5415692
208.5415693 - 241.9727207
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308.8350238 - 342.2661752
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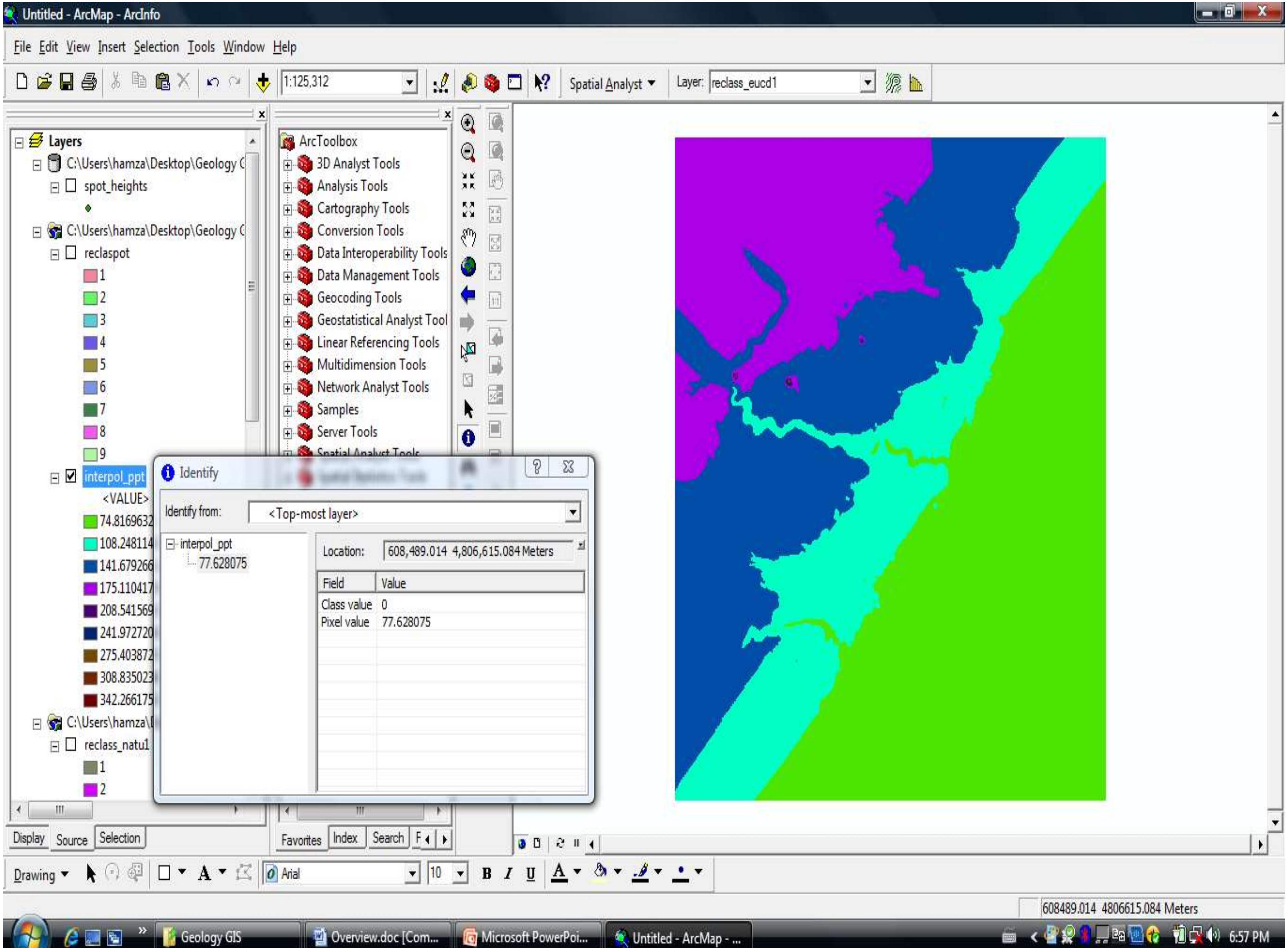
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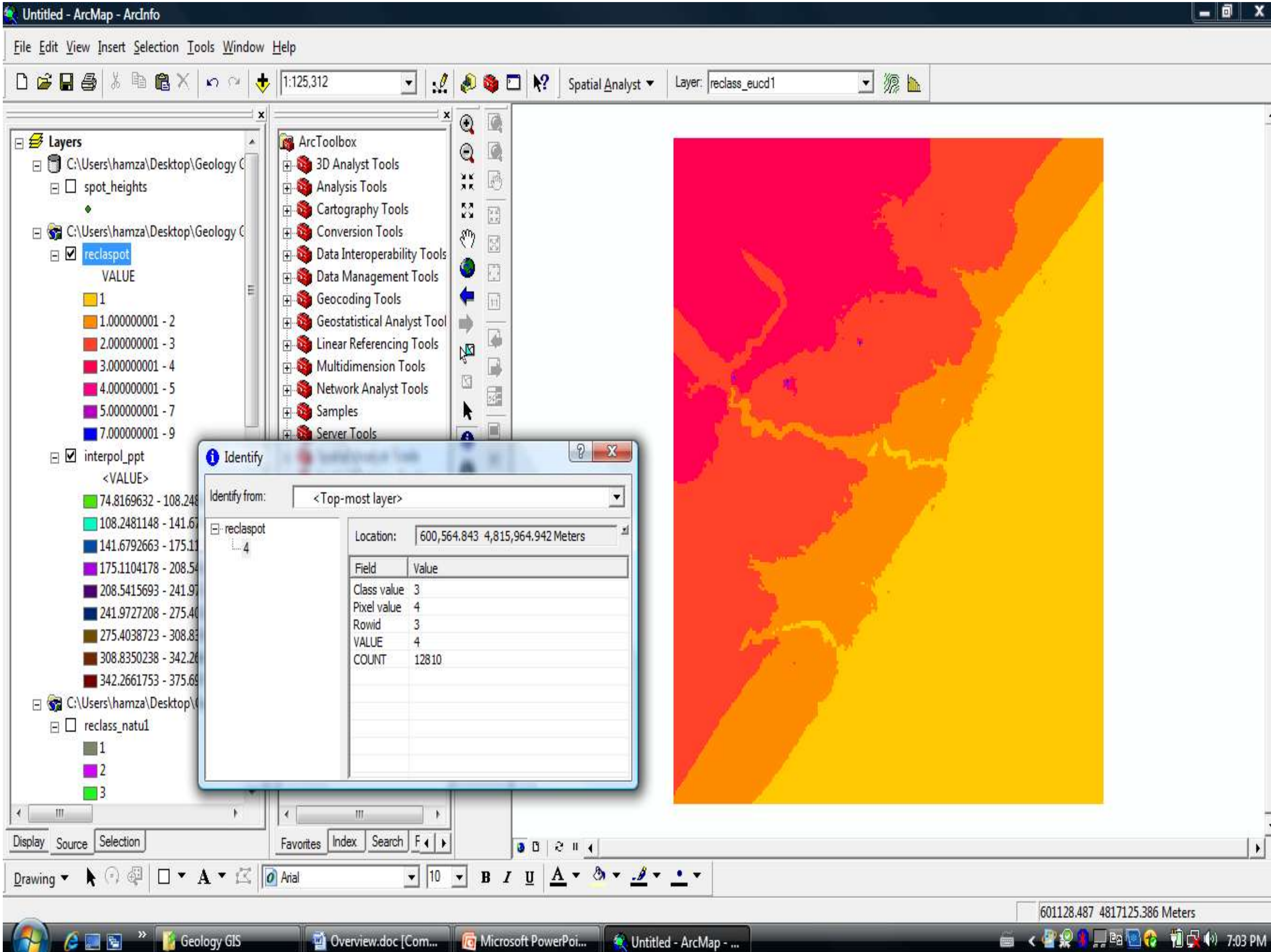
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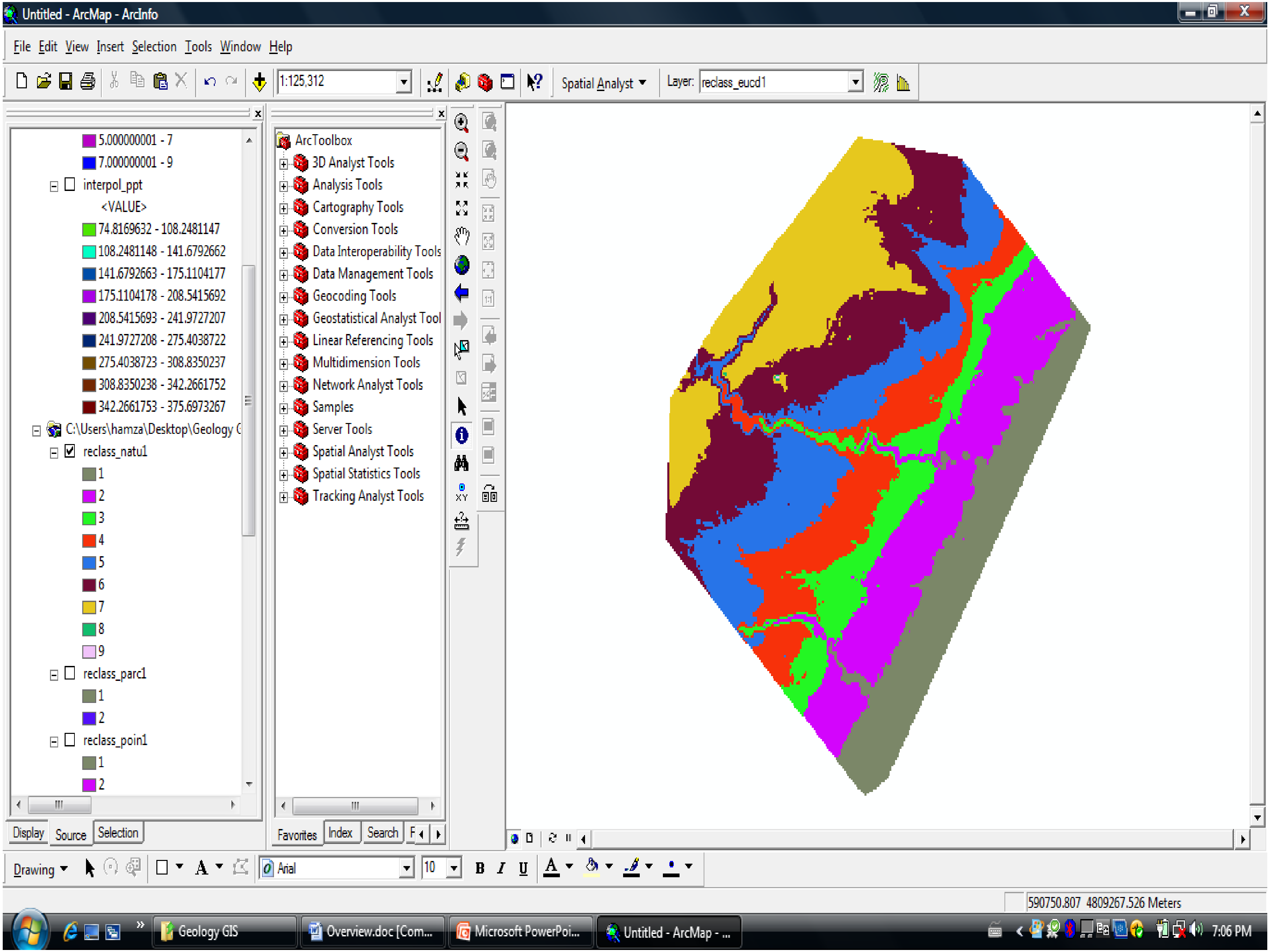
4
Location:
600,564.843 4,815,964.942 Meters
Field
Value
Class value
3
Pixel value
4
Rowid
3
VALUE
4
COUNT
12810
Drawing
Arial
10
601128.487 4817125.386 Meters
Geology GIS
Overview.doc [Com...
Microsoft PowerPoi...
Untitled - ArcMap - ...
7:03 PM


Untitled - ArcMap - ArcInfo
File Edit View Insert Selection Tools Window Help
1:125,312
Spatial Analyst
Layer: reclass_eucd1
5.000000001 - 7
7.000000001 - 9
interpol_ppt
<VALUE>
74.8169632 - 108.2481147
108.2481148 - 141.6792662
141.6792663 - 175.1104177
175.1104178 - 208.5415692
208.5415693 - 241.9727207
241.9727208 - 275.4038722
275.4038723 - 308.8350237
308.8350238 - 342.2661752
342.2661753 - 375.6973267
C:\Users\hamza\Desktop\Geology G
reclass_natu1
1
2
3
4
5
6
7
8
9
reclass_parc1
1
2
reclass_poin1
1
2
Display Source Selection
ArcToolbox
3D Analyst Tools
Analysis Tools
Cartography Tools
Conversion Tools
Data Interoperability Tools
Data Management Tools
Geocoding Tools
Geostatistical Analyst Tool
Linear Referencing Tools
Multidimension Tools
Network Analyst Tools
Samples
Server Tools
Spatial Analyst Tools
Spatial Statistics Tools
Tracking Analyst Tools
Favorites Index Search
Drawing
Arial
10
590750.807 4809267.526 Meters
Geology GIS
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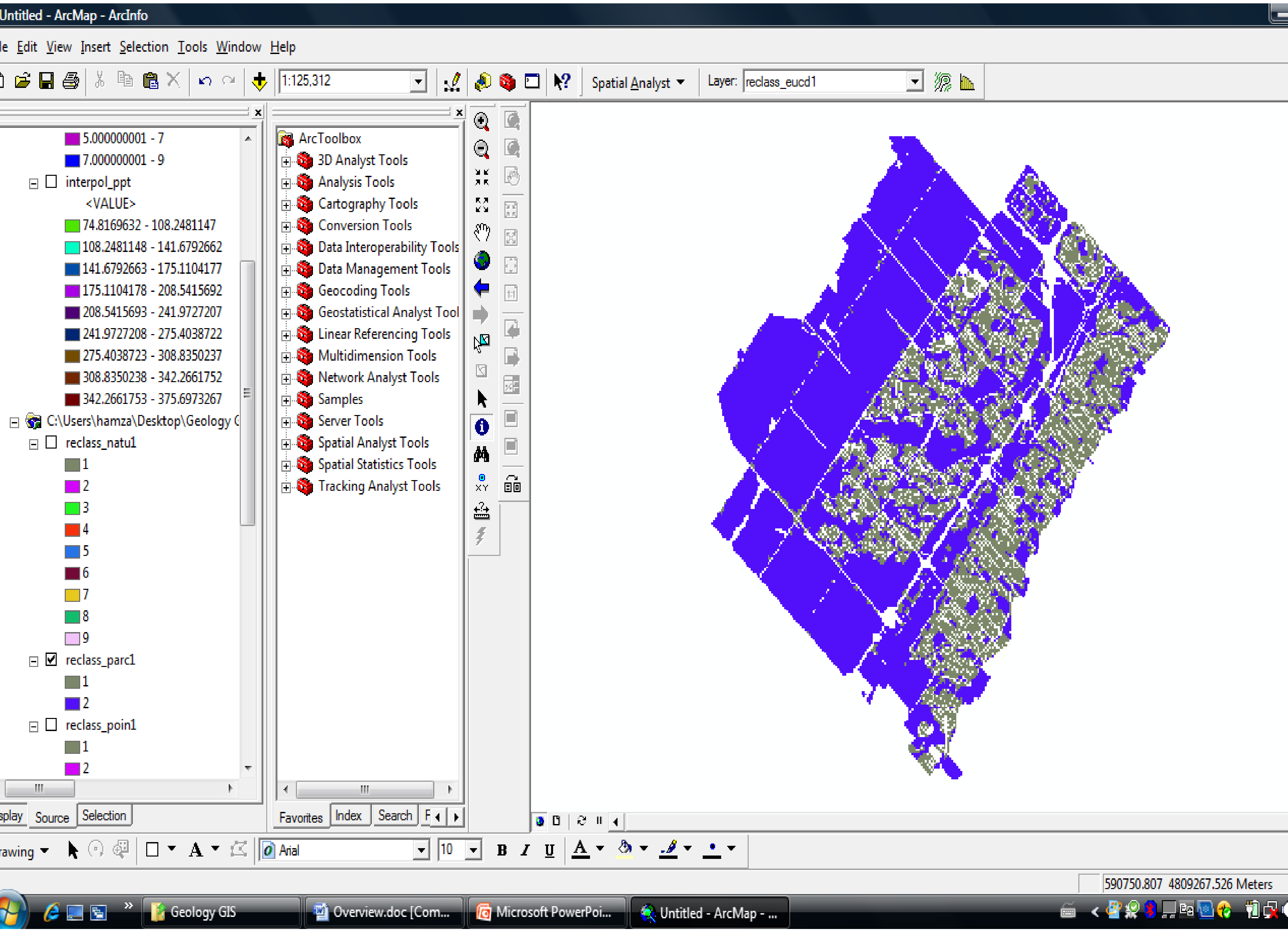
7:06 PM


Untitled - ArcMap - ArcInfo
le Edit View Insert Selection Tools Window Help
1:125,312
Spatial Analyst
Layer: reclass_eucd1
5.000000001 - 7
7.000000001 - 9
interpol_ppt
<VALUE>
74.8169632 - 108.2481147
108.2481148 - 141.6792662
141.6792663 - 175.1104177
175.1104178 - 208.5415692
208.5415693 - 241.9727207
241.9727208 - 275.4038722
275.4038723 - 308.8350237
308.8350238 - 342.2661752
342.2661753 - 375.6973267
C:\Users\hamza\Desktop\Geology G
reclass_natu1
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reclass_parc1
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reclass_poin1
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splay
Source
Selection
ArcToolbox
3D Analyst Tools
Analysis Tools
Cartography Tools
Conversion Tools
Data Interoperability Tools
Data Management Tools
Geocoding Tools
Geostatistical Analyst Tool
Linear Referencing Tools
Multidimension Tools
Network Analyst Tools
Samples
Server Tools
Spatial Analyst Tools
Spatial Statistics Tools
Tracking Analyst Tools
Favorites
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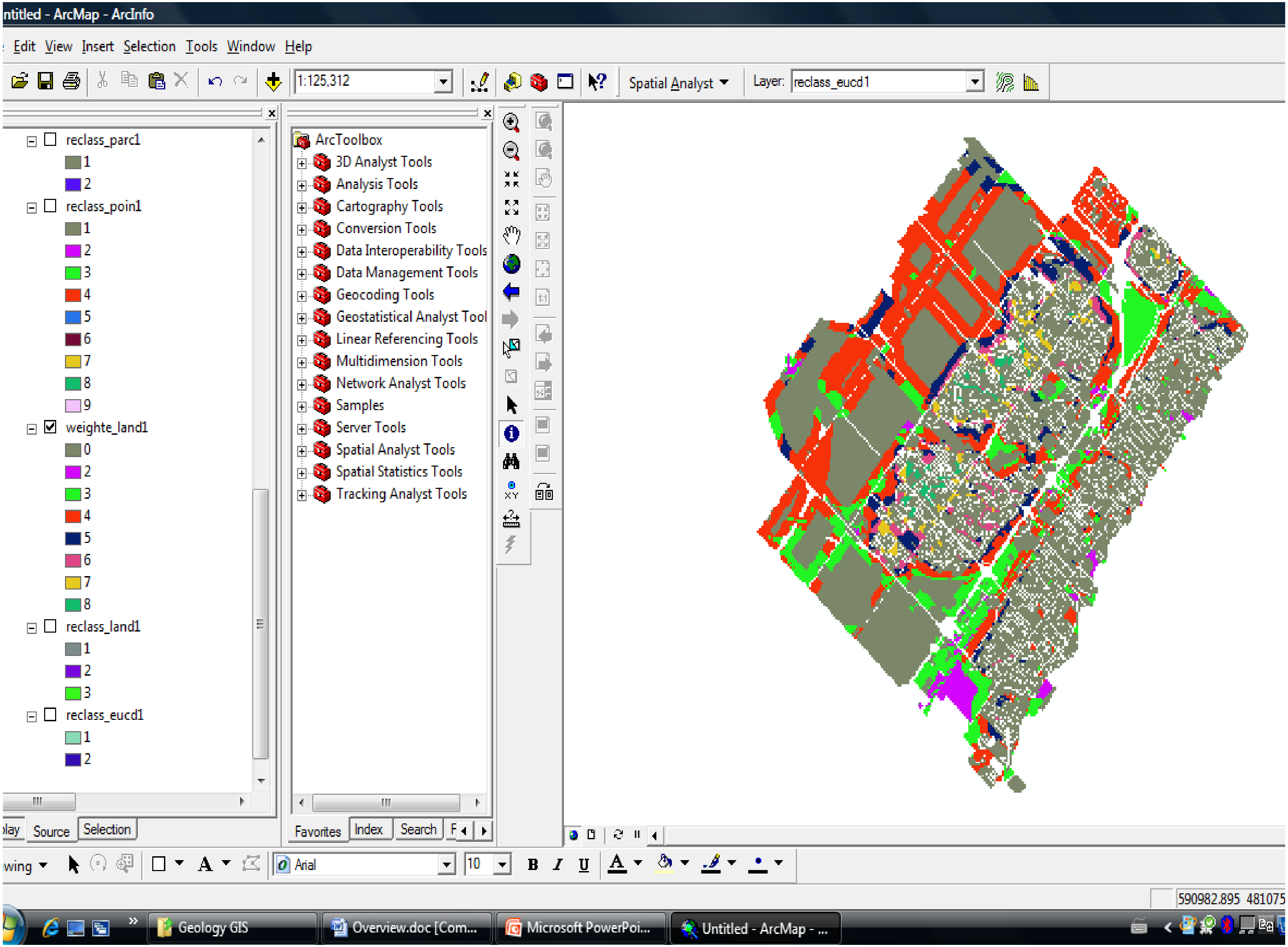
ntitled - ArcMap - ArcInfo
Edit View Insert Selection Tools Window Help
1:125,312
Spatial Analyst
Layer: reclass_eucd1
reclass_parc1
1
2
reclass_poin1
1
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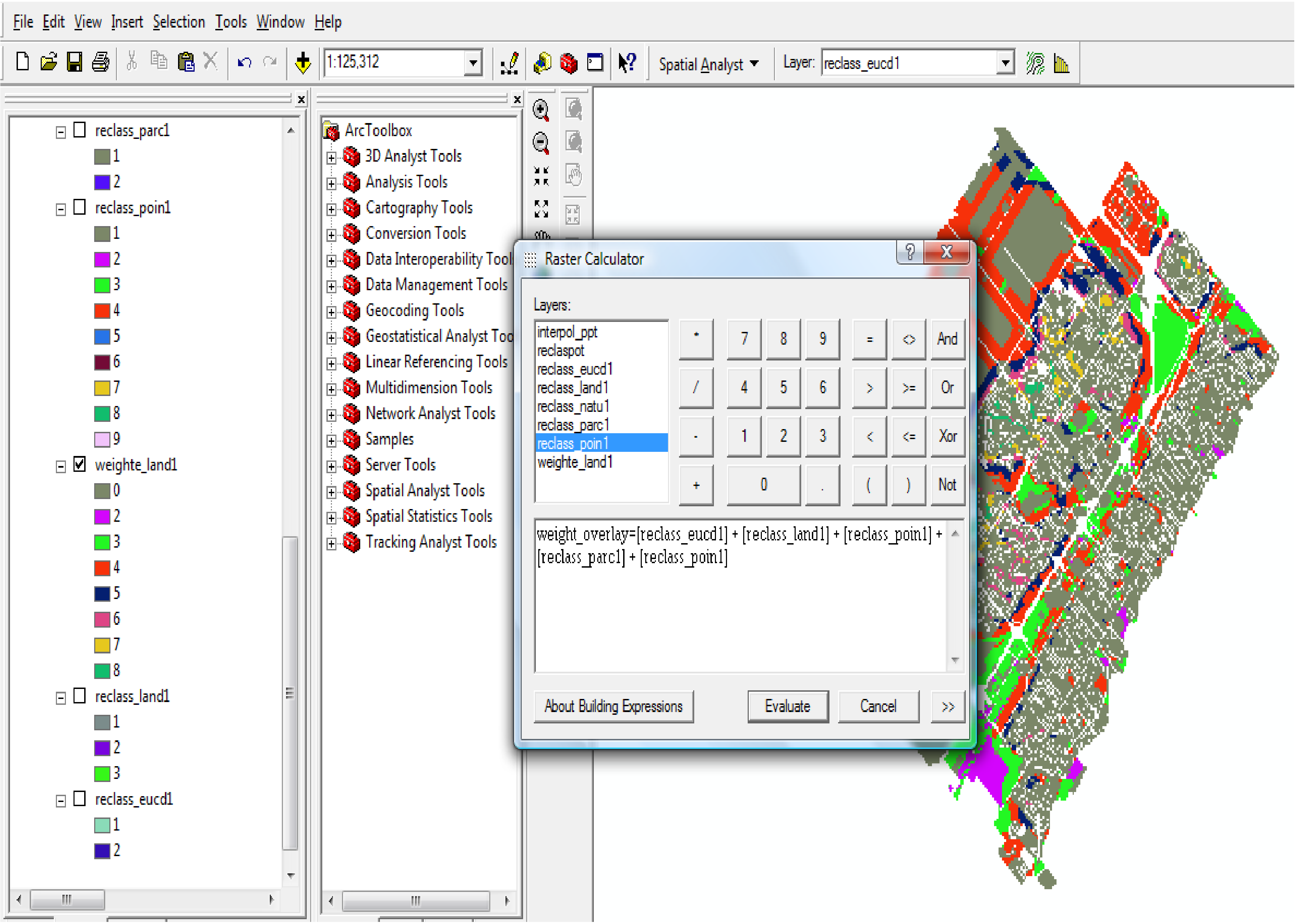
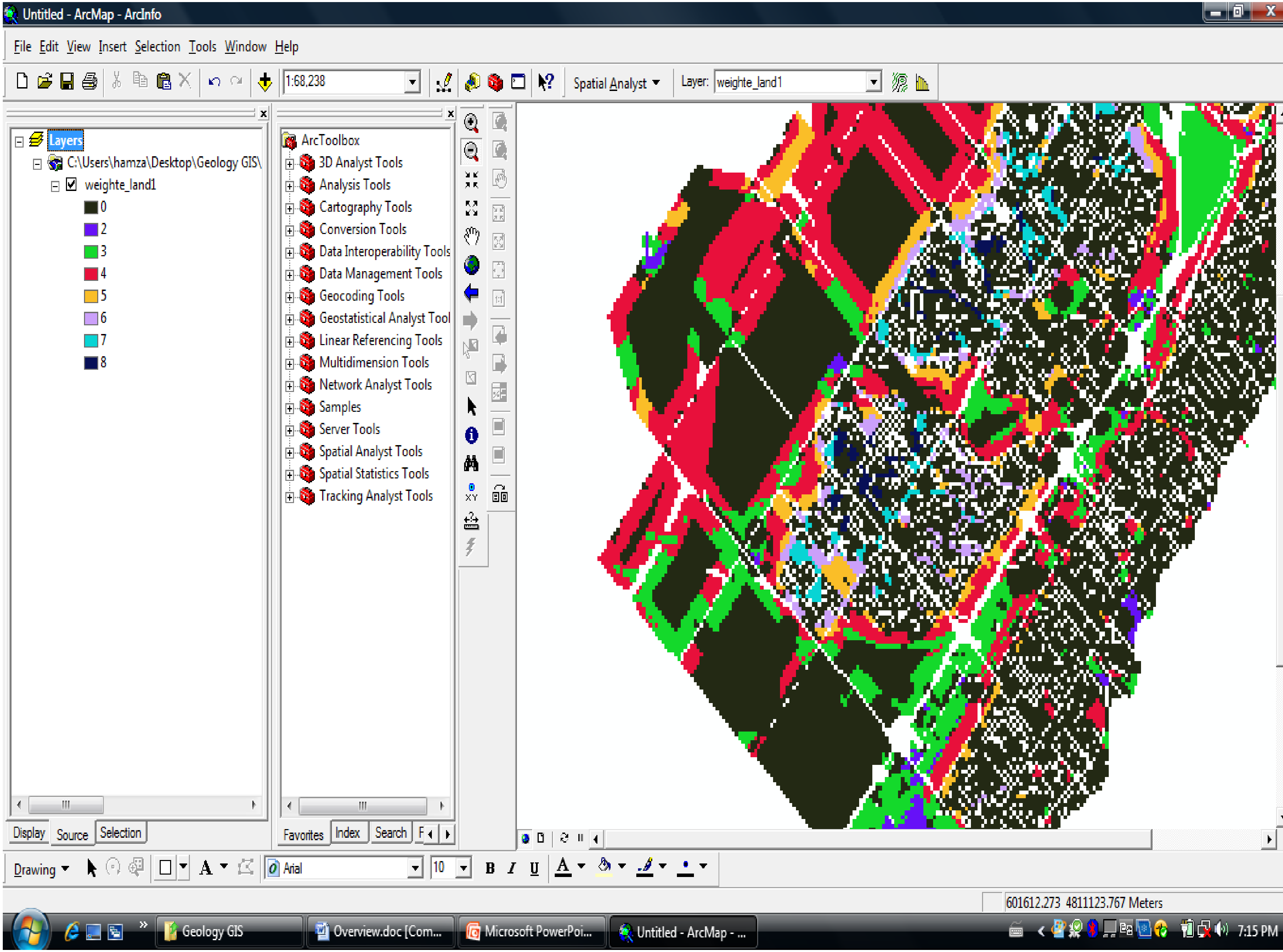
8
9
weighte_land1
0
2
3
4
5
6
7
8
reclass_land1
1
2
3
reclass_eucd1
1
2
ArcToolbox
3D Analyst Tools
Analysis Tools
Cartography Tools
Conversion Tools
Data Interoperability Tools
Data Management Tools
Geocoding Tools
Geostatistical Analyst Tool
Linear Referencing Tools
Multidimension Tools
Network Analyst Tools
Samples
Server Tools
Spatial Analyst Tools
Spatial Statistics Tools
Tracking Analyst Tools
Source
Selection
Favorites
Index
Search
Arial
10
590982.895 481075
Geology GIS
Overview.doc [Com...
Microsoft PowerPoi...
Untitled - ArcMap - ...


File Edit View Insert Selection Tools Window Help
1:125,312
Spatial Analyst
Layer: reclass_eucd1
reclass_parc1
1
2
reclass_poin1
1
2
3
4
5
6
7
8
9
weighte_land1
0
2
3
4
5
6
7
8
reclass_land1
1
2
3
reclass_eucd1
1
2
ArcToolbox
3D Analyst Tools
Analysis Tools
Cartography Tools
Conversion Tools
Data Interoperability Tool
Data Management Tools
Geocoding Tools
Geostatistical Analyst Too
Linear Referencing Tools
Multidimension Tools
Network Analyst Tools
Samples
Server Tools
Spatial Analyst Tools
Spatial Statistics Tools
Tracking Analyst Tools
Raster Calculator
Layers:
interpol_ppt
reclaspot
reclass_eucd1
reclass_land1
reclass_natu1
reclass_parc1
reclass_poin1
weighte_land1
weight_overlay=[reclass_eucd1] + [reclass_land1] + [reclass_poin1] + [reclass_parc1] + [reclass_poin1]
About Building Expressions
Evaluate
Cancel
>>


Untitled - ArcMap - ArcInfo
File Edit View Insert Selection Tools Window Help
1:68,238
Spatial Analyst
Layer: weighte_land1
Layers
C:\Users\hamza\Desktop\Geology GIS\
weighte_land1
0
2
3
4
5
6
7
8
ArcToolbox
3D Analyst Tools
Analysis Tools
Cartography Tools
Conversion Tools
Data Interoperability Tools
Data Management Tools
Geocoding Tools
Geostatistical Analyst Tool
Linear Referencing Tools
Multidimension Tools
Network Analyst Tools
Samples
Server Tools
Spatial Analyst Tools
Spatial Statistics Tools
Tracking Analyst Tools
Display
Source
Selection
Favorites
Index
Search
Drawing
Arial
10
601612.273 4811123.767 Meters
Geology GIS
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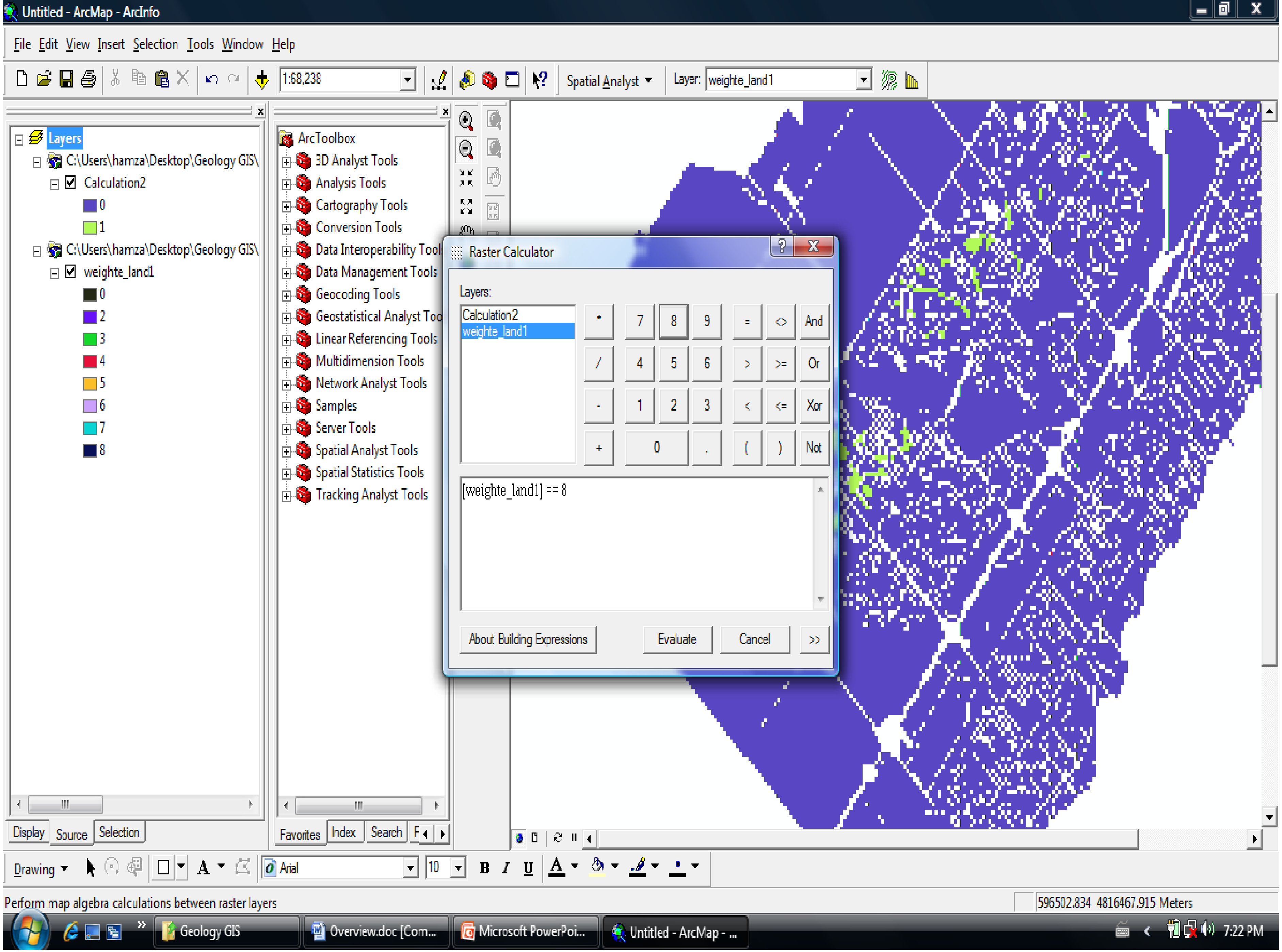
Microsoft PowerPoi...
Untitled - ArcMap - ...
7:15 PM


Untitled - ArcMap - ArcInfo
File Edit View Insert Selection Tools Window Help
1:68,238
Spatial Analyst
Layer: weighte_land1
Layers
C:\Users\hamza\Desktop\Geology GIS\
Calculation2
0
1
C:\Users\hamza\Desktop\Geology GIS\
weighte_land1
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2
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4
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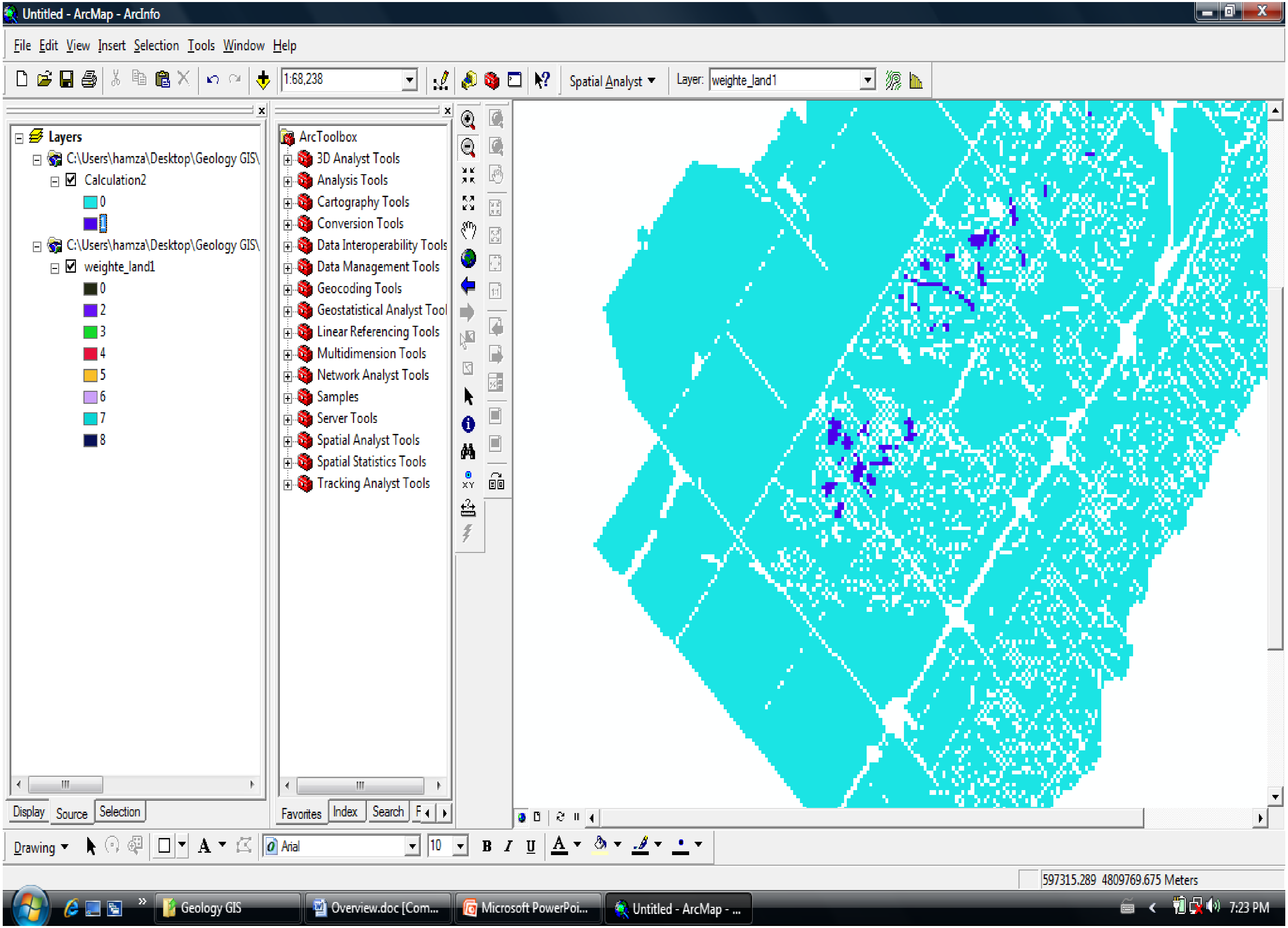
6
7
8
ArcToolbox
3D Analyst Tools
Analysis Tools
Cartography Tools
Conversion Tools
Data Interoperability Tool
Data Management Tools
Geocoding Tools
Geostatistical Analyst Too
Linear Referencing Tools
Multidimension Tools
Network Analyst Tools
Samples
Server Tools
Spatial Analyst Tools
Spatial Statistics Tools
Tracking Analyst Tools
Raster Calculator
Layers:
Calculation2
weighte_land1
* 7 8 9 = <> And
/ 4 5 6 > >= Or
- 1 2 3 < <= Xor
+ 0 . ( ) Not
[weighte_land1] == 8
About Building Expressions
Evaluate
Cancel
>>
Display Source Selection
Favorites Index Search
Drawing
Arial
10
Perform map algebra calculations between raster layers
596502.834 4816467.915 Meters
Geology GIS
Overview.doc [Com...
Microsoft PowerPoi...
Untitled - ArcMap - ...
7:22 PM


Untitled - ArcMap - ArcInfo
File Edit View Insert Selection Tools Window Help
1:68,238
Spatial Analyst
Layer: weighte_land1
Layers
C:\Users\hamza\Desktop\Geology GIS\
Calculation2
0
1
C:\Users\hamza\Desktop\Geology GIS\
weighte_land1
0
2
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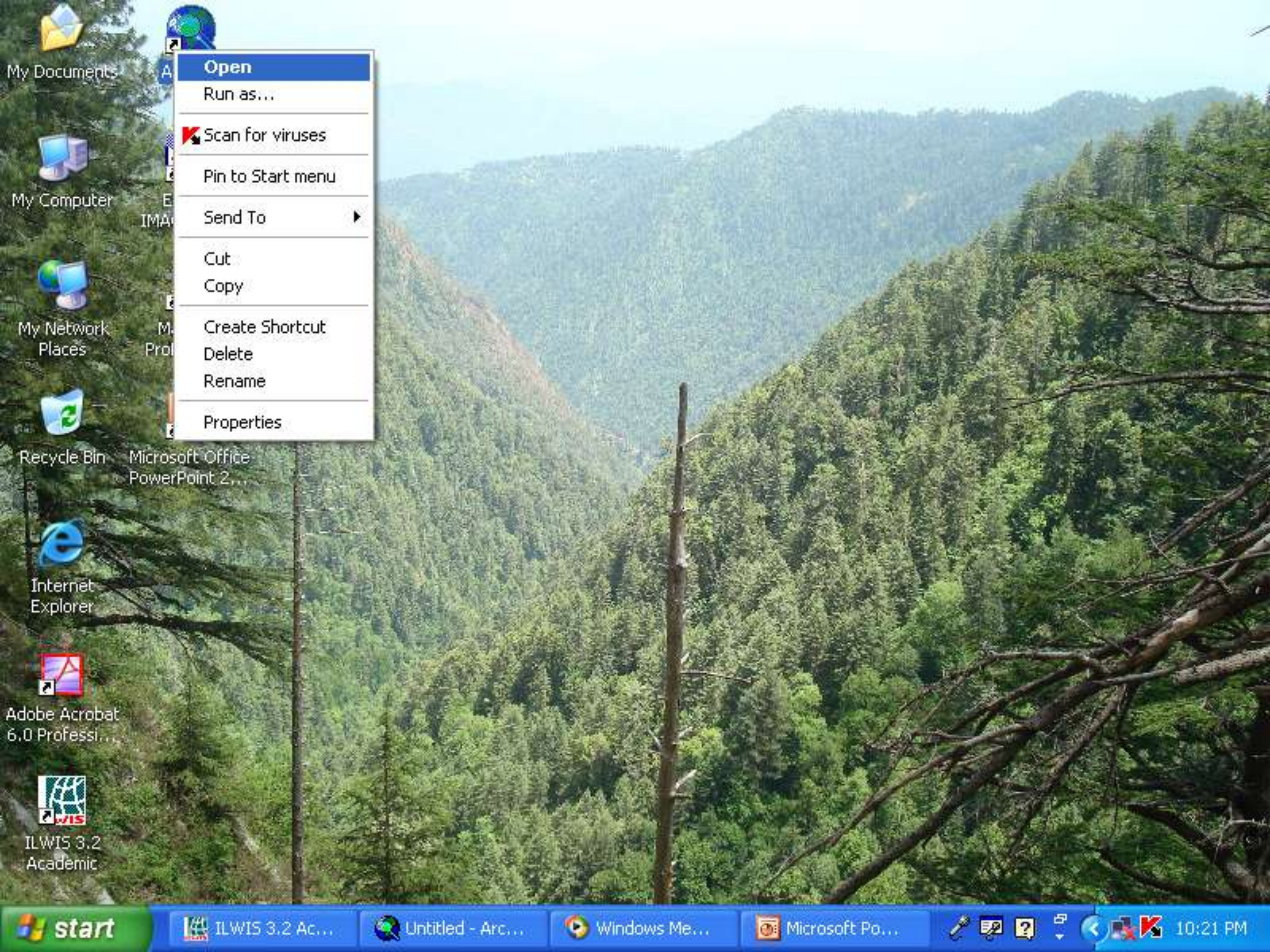
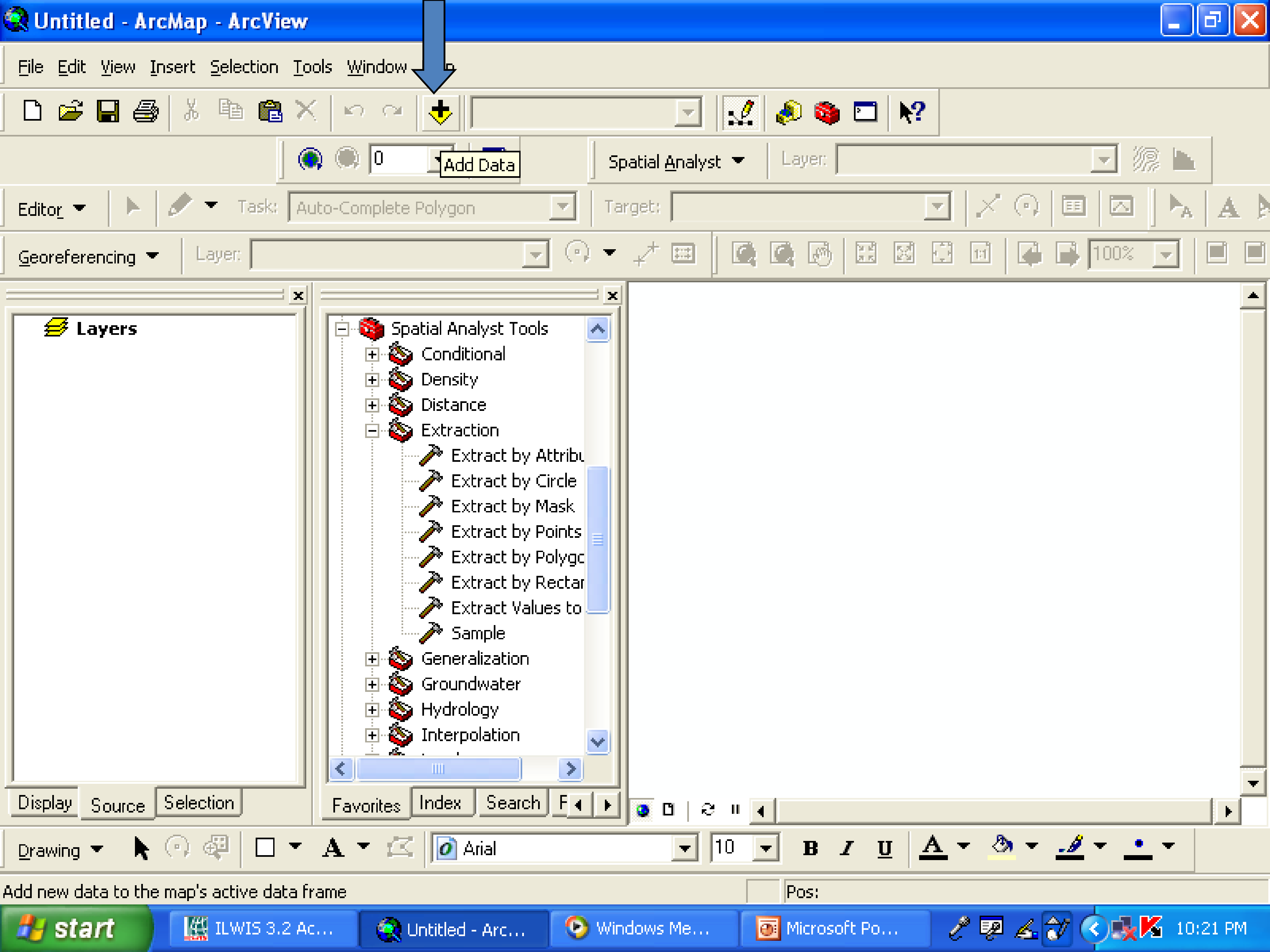
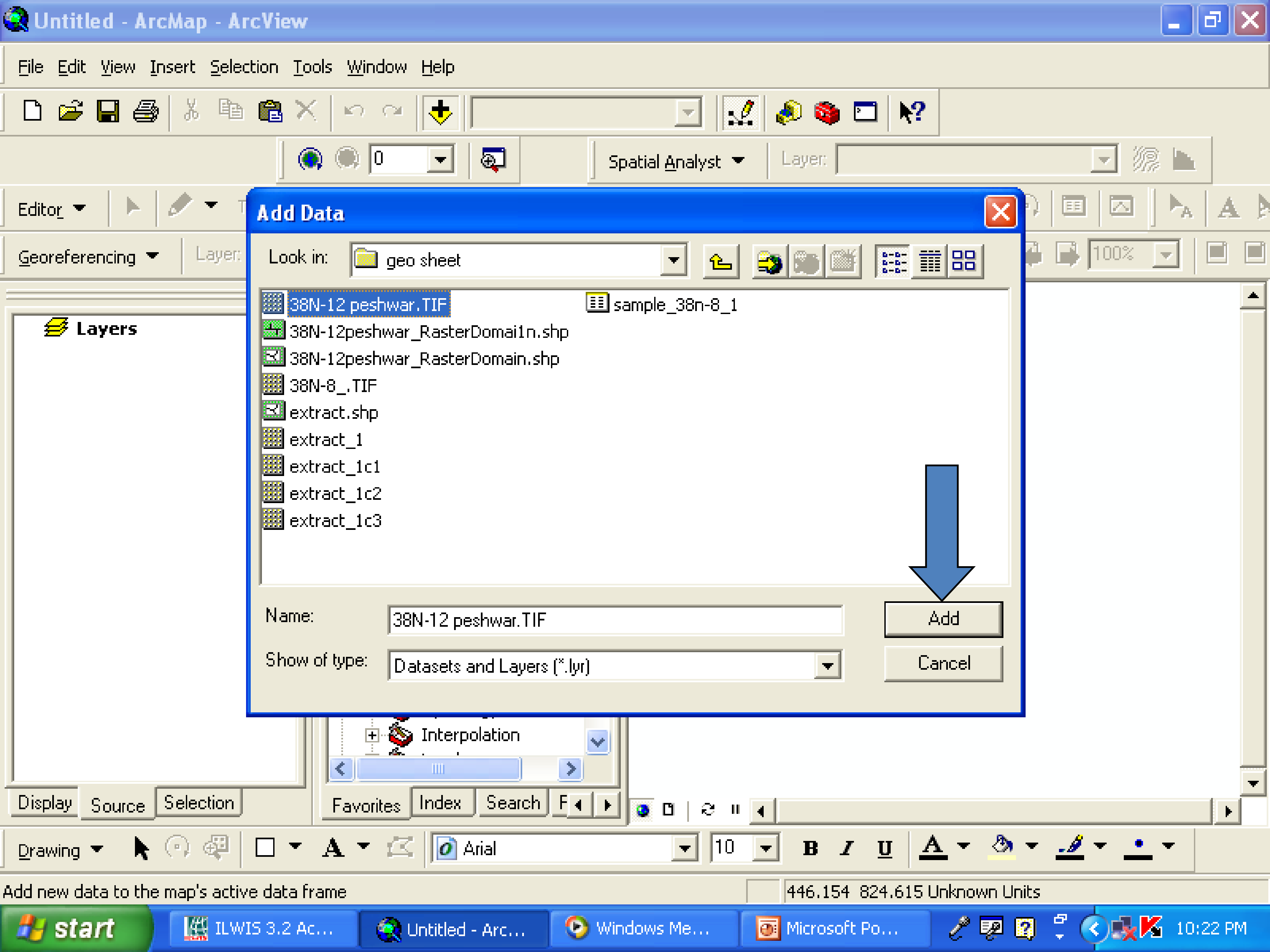
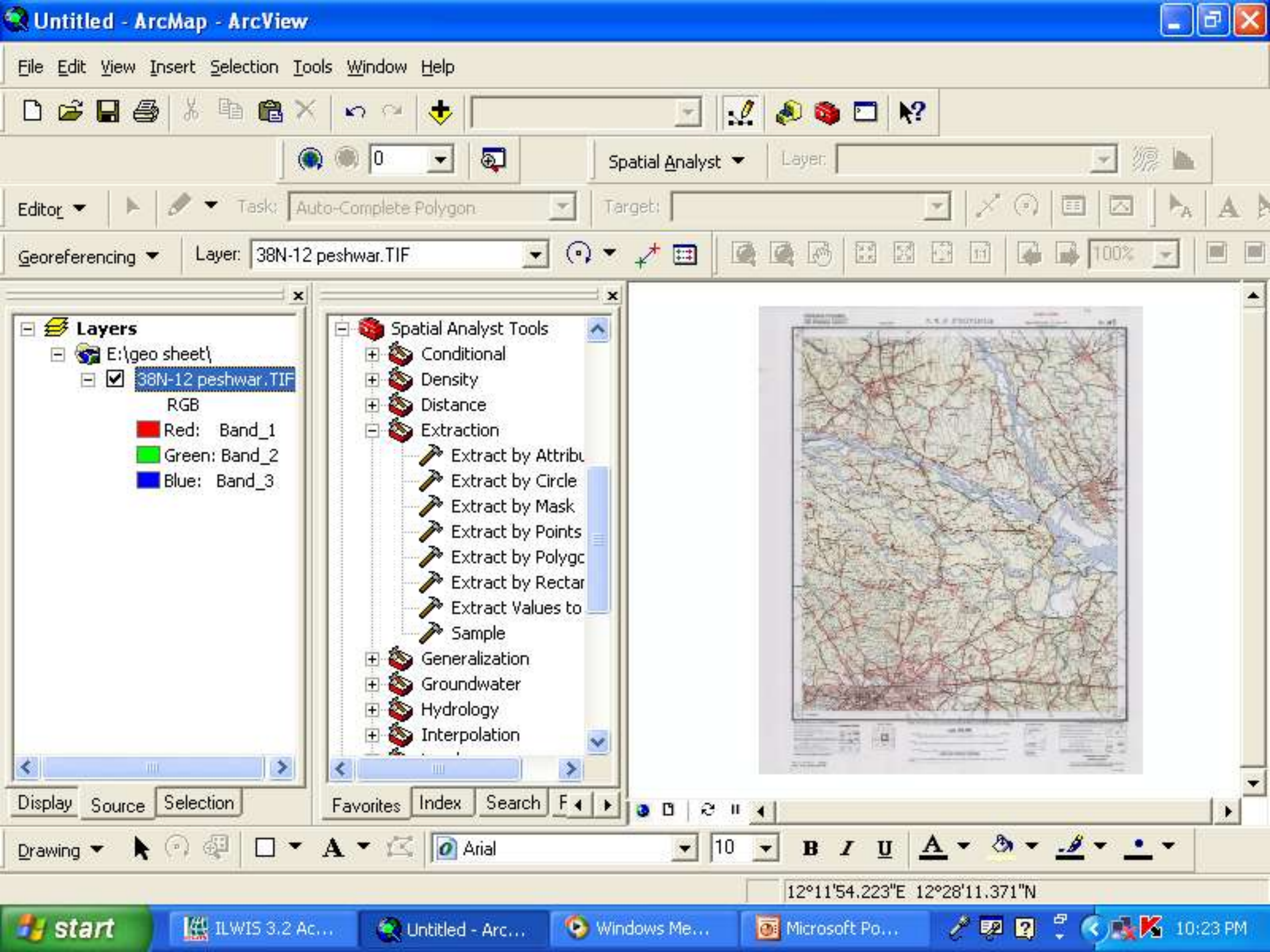
4
5
6
7
8
ArcToolbox
3D Analyst Tools
Analysis Tools
Cartography Tools
Conversion Tools
Data Interoperability Tools
Data Management Tools
Geocoding Tools
Geostatistical Analyst Tool
Linear Referencing Tools
Multidimension Tools
Network Analyst Tools
Samples
Server Tools
Spatial Analyst Tools
Spatial Statistics Tools
Tracking Analyst Tools
Display
Source
Selection
Favorites
Index
Search
Drawing
Arial
10
597315.289 4809769.675 Meters
Geology GIS
Overview.doc [Com...
Microsoft PowerPoi...
Untitled - ArcMap - ...
7:23 PM

# Extraction in ArcGIS

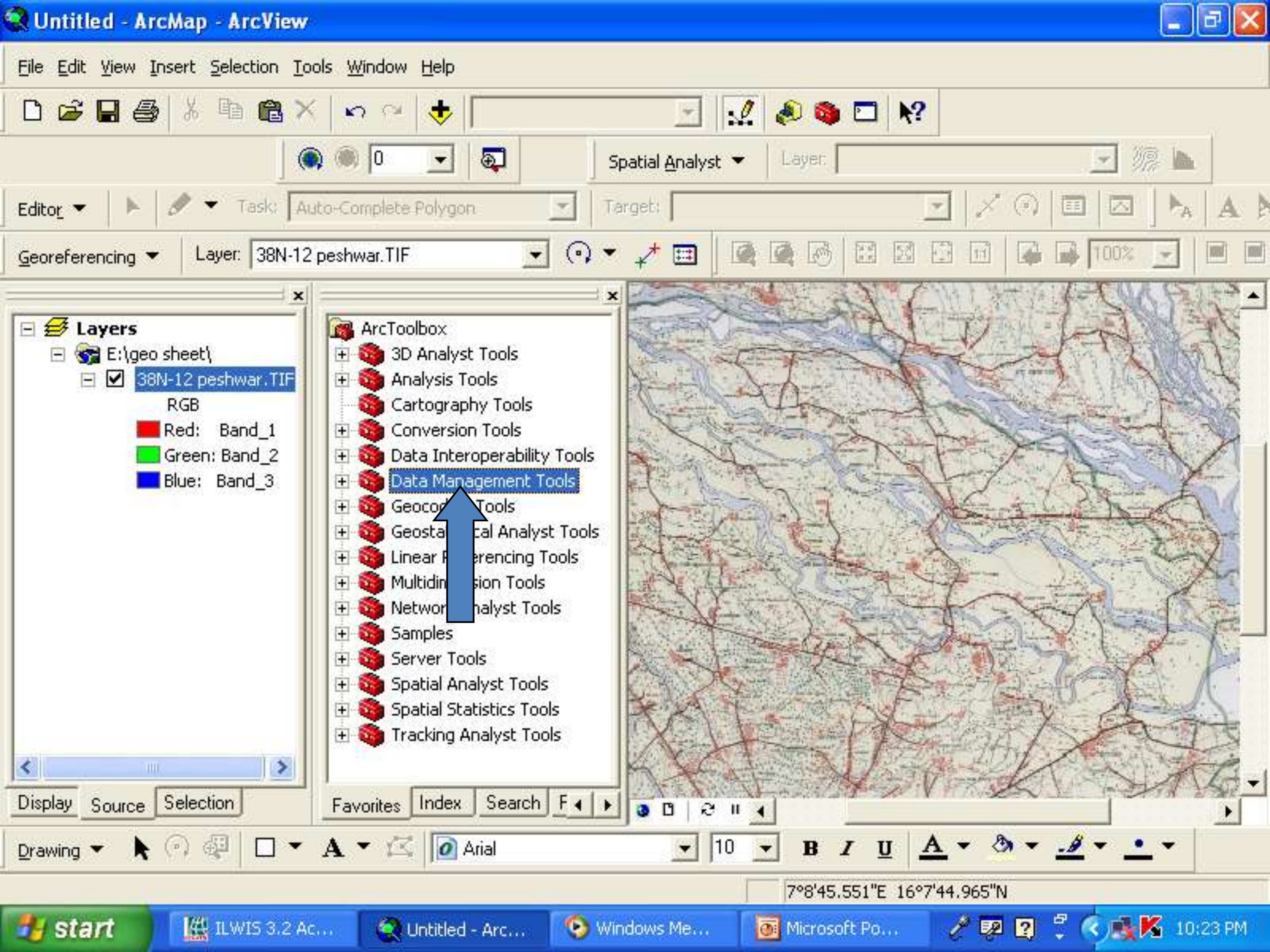

My Documents
My Computer
My Network Places
Recycle Bin
Microsoft Office PowerPoint 2...
Internet Explorer
Adobe Acrobat 6.0 Professi...
ILWIS 3.2 Academic
Open
Run as...
Scan for viruses
Pin to Start menu
Send To
Cut
Copy
Create Shortcut
Delete
Rename
Properties
start
ILWIS 3.2 Ac...
Untitled - Arc...
Windows Me...
Microsoft Po...
10:21 PM

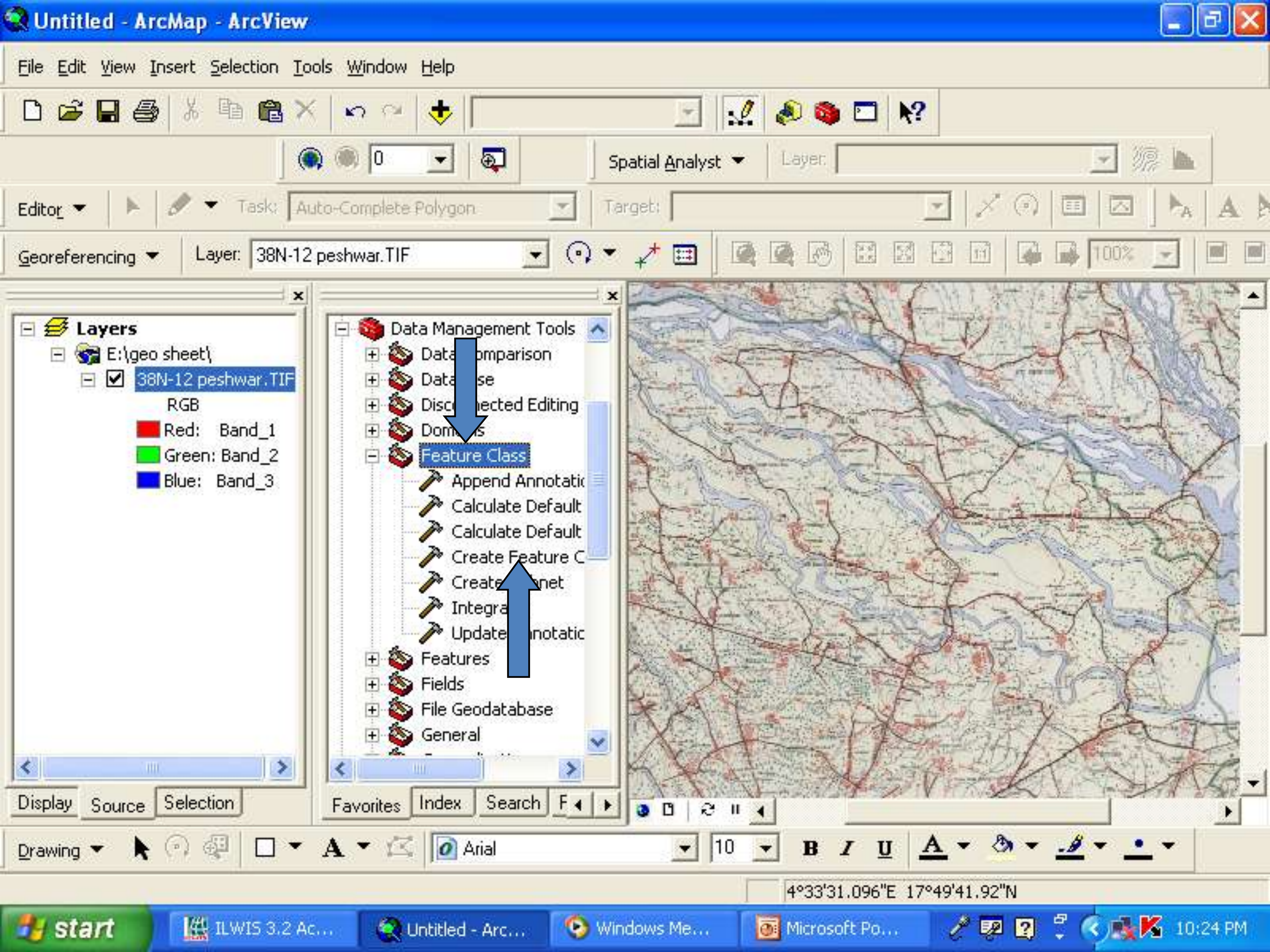

Untitled - ArcMap - ArcView
File Edit View Insert Selection Tools Window
Add Data
Spatial Analyst
Layer:
Editor
Task: Auto-Complete Polygon
Target:
Georeferencing
Layer:
100%
Layers
Spatial Analyst Tools
Conditional
Density
Distance
Extraction
Extract by Attribu
Extract by Circle
Extract by Mask
Extract by Points
Extract by Polygo
Extract by Rectar
Extract Values to
Sample
Generalization
Groundwater
Hydrology
Interpolation
Display
Source
Selection
Favorites
Index
Search
Drawing
Arial
10
Add new data to the map's active data frame
Pos:
start
ILWIS 3.2 Ac...
Untitled - Arc...
Windows Me...
Microsoft Po...
10:21 PM

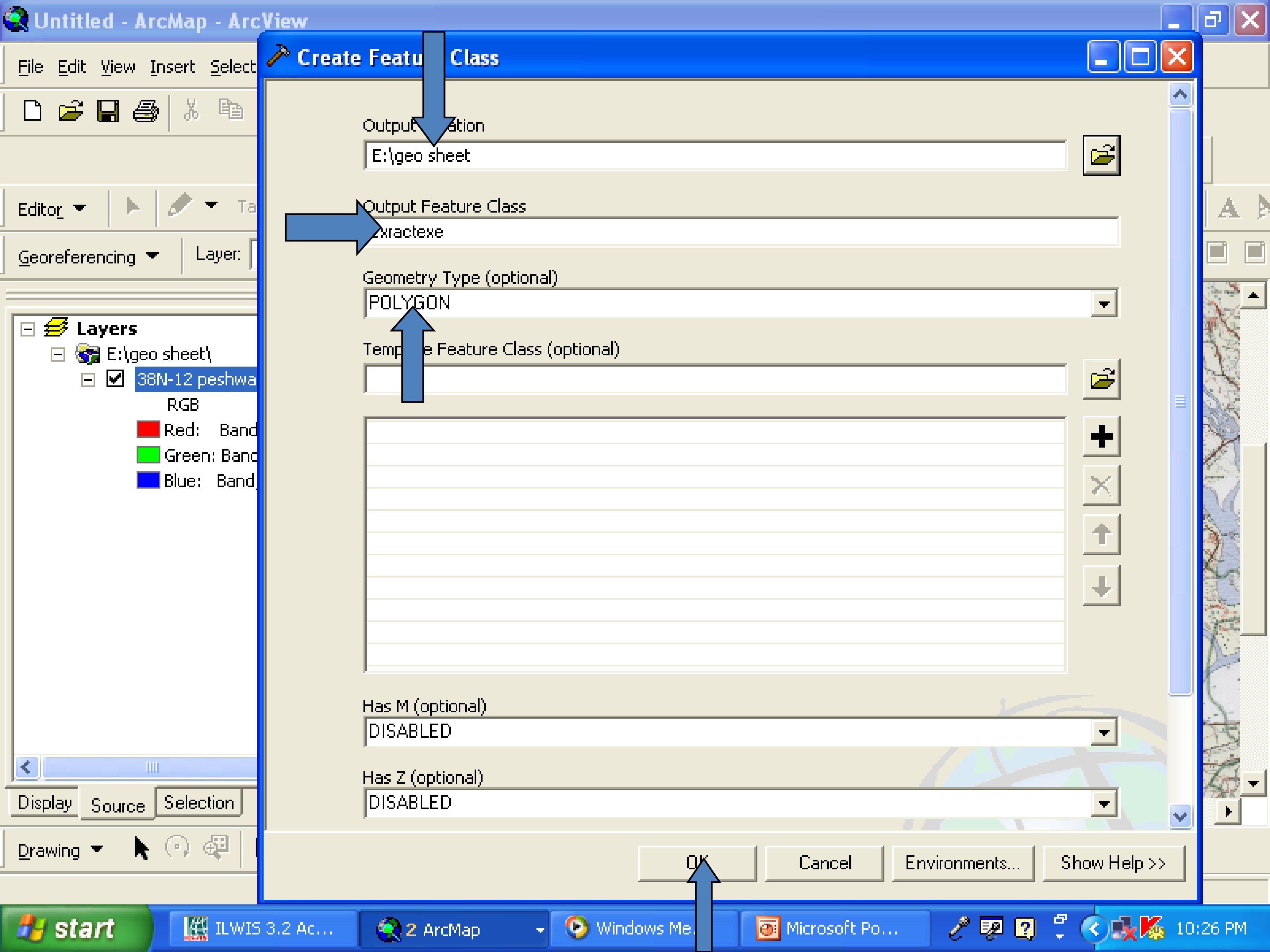

Untitled - ArcMap - ArcView
File Edit View Insert Selection Tools Window Help
Spatial Analyst
Layer:
Editor
Georeferencing
Layers
Add Data
Look in: geo sheet
38N-12 peshwar.TIF
38N-12peshwar_RasterDomai1n.shp
38N-12peshwar_RasterDomain.shp
38N-8_.TIF
extract.shp
extract_1
extract_1c1
extract_1c2
extract_1c3
sample_38n-8_1
Name: 38N-12 peshwar.TIF
Show of type: Datasets and Layers (*.lyr)
Add
Cancel
Interpolation
Display Source Selection
Favorites Index Search
Drawing
Arial
10
Add new data to the map's active data frame
446.154 824.615 Unknown Units
start
ILWIS 3.2 Ac...
Untitled - Arc...
Windows Me...
Microsoft Po...
10:22 PM

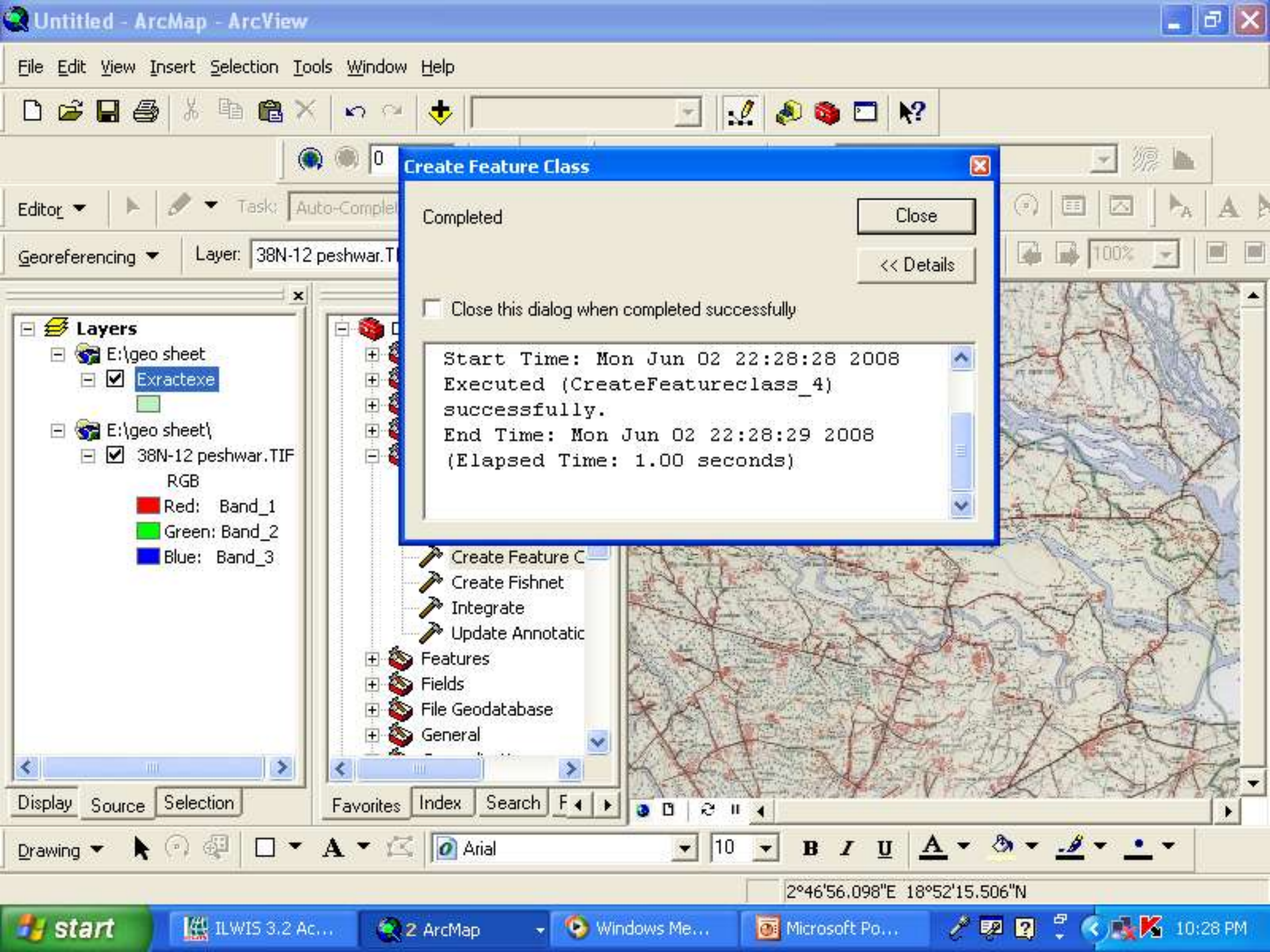


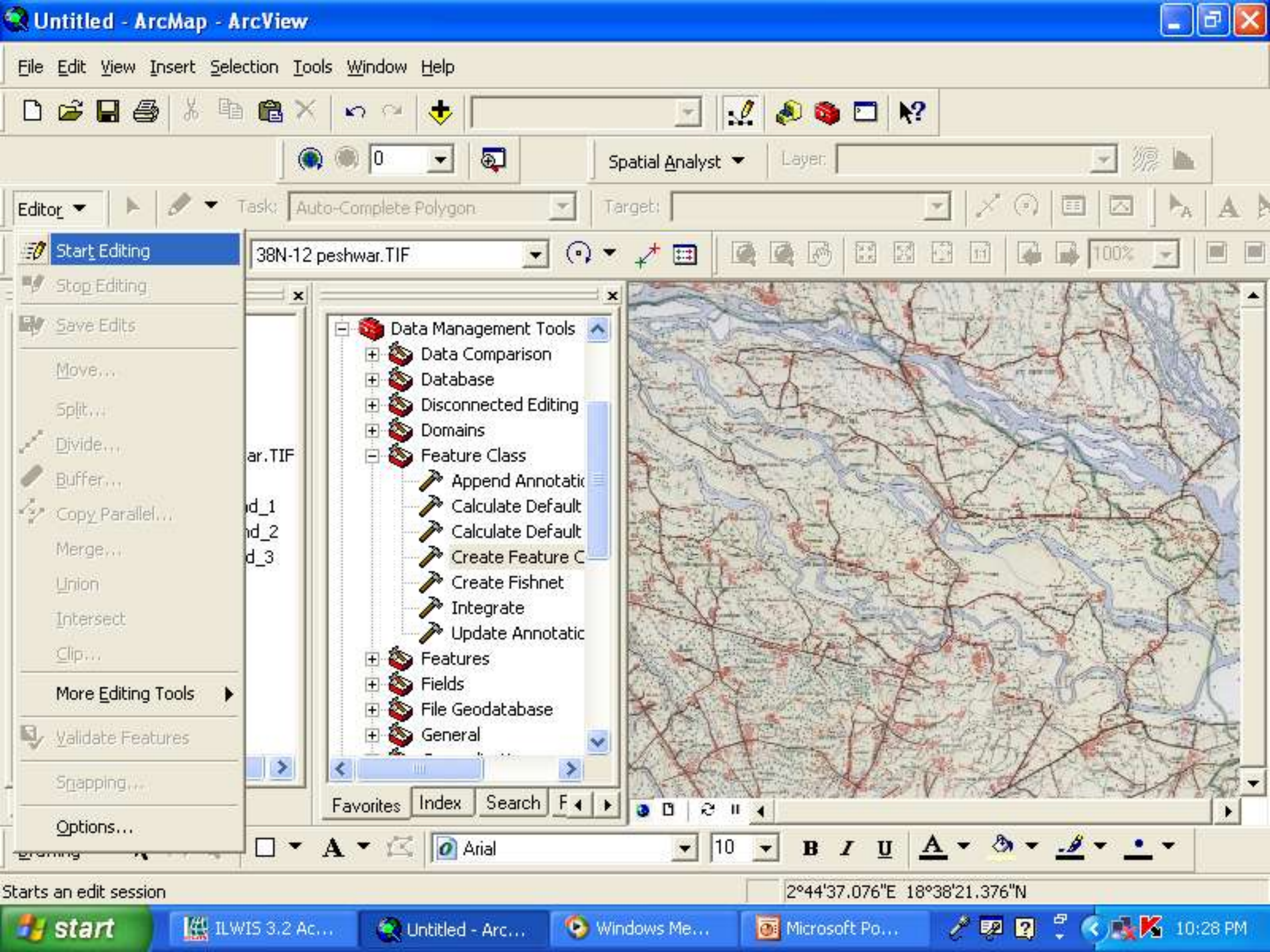
Untitled - ArcMap - ArcView
File Edit View Insert Selection Tools Window Help
Spatial Analyst
Layer:
Editor
Task: Auto-Complete Polygon
Target:
Georeferencing
Layer: 38N-12 peshwar.TIF
100%
Layers
E:\geo sheet\
38N-12 peshwar.TIF
RGB
Red: Band_1
Green: Band_2
Blue: Band_3
Display Source Selection
Spatial Analyst Tools
Conditional
Density
Distance
Extraction
Extract by Attribu
Extract by Circle
Extract by Mask
Extract by Points
Extract by Polygo
Extract by Rectar
Extract Values to
Sample
Generalization
Groundwater
Hydrology
Interpolation
Favorites Index Search
Drawing
Arial
10
B I U
12°11'54.223"E 12°28'11.371"N
start
ILWIS 3.2 Ac...
Untitled - Arc...
Windows Me...
Microsoft Po...
10:23 PM

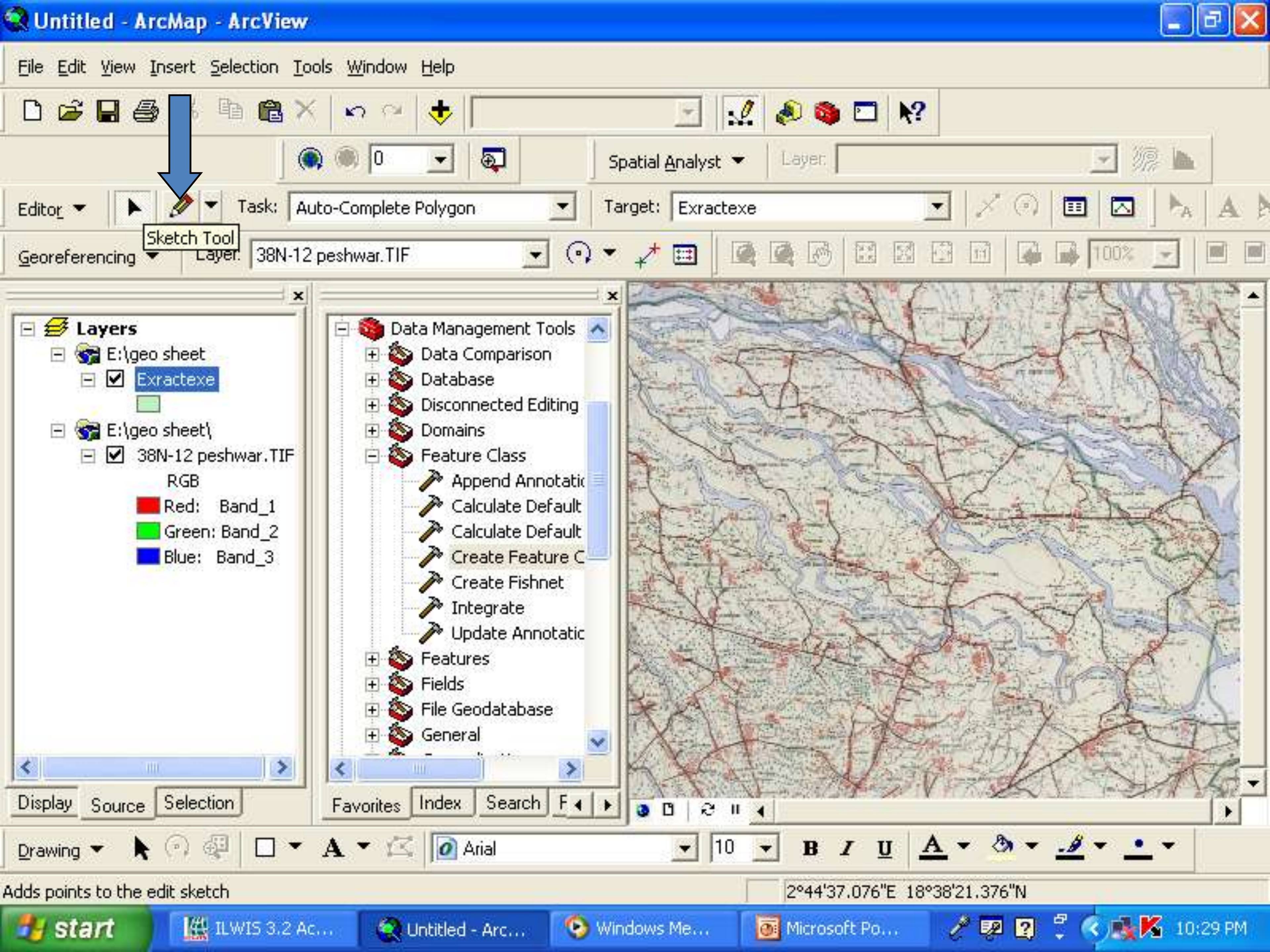

Untitled - ArcMap - ArcView
File Edit View Insert Selection Tools Window Help
Spatial Analyst
Layer:
Editor
Task: Auto-Complete Polygon
Target:
Georeferencing
Layer: 38N-12 peshwar.TIF
100%
Layers
E:\geo sheet\
38N-12 peshwar.TIF
RGB
Red: Band_1
Green: Band_2
Blue: Band_3
Display
Source
Selection
ArcToolbox
3D Analyst Tools
Analysis Tools
Cartography Tools
Conversion Tools
Data Interoperability Tools
Data Management Tools
Geocod Tools
Geosta cal Analyst Tools
Linear R erencing Tools
Multidin sion Tools
Networ nalyst Tools
Samples
Server Tools
Spatial Analyst Tools
Spatial Statistics Tools
Tracking Analyst Tools
Favorites
Index
Search
Drawing
Arial
10
7°8'45.551"E 16°7'44.965"N
start
ILWIS 3.2 Ac...
Untitled - Arc...
Windows Me...
Microsoft Po...
10:23 PM

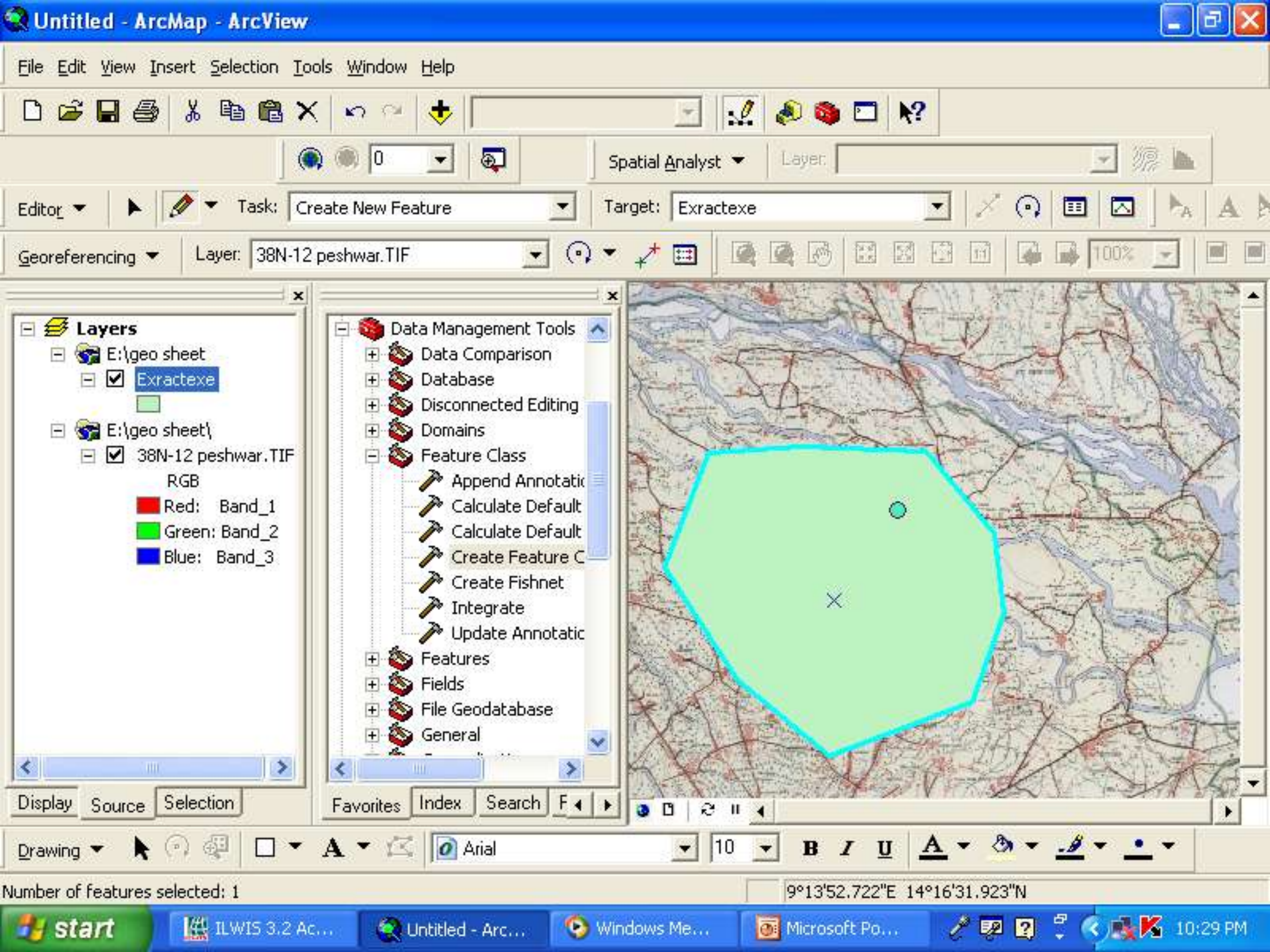

Untitled - ArcMap - ArcView
File Edit View Insert Selection Tools Window Help
Spatial Analyst
Layer:
Editor
Task: Auto-Complete Polygon
Target:
Georeferencing
Layer: 38N-12 peshwar.TIF
100%
Layers
E:\geo sheet\
38N-12 peshwar.TIF
RGB
Red: Band_1
Green: Band_2
Blue: Band_3
Display Source Selection
Data Management Tools
Feature Class
Append Annotatic
Calculate Default
Calculate Default
Create Feature C
Features
Fields
File Geodatabase
General
Favorites Index Search
Drawing
Arial
10
4°33'31.096"E 17°49'41.92"N
start
ILWIS 3.2 Ac...
Untitled - Arc...
Windows Me...
Microsoft Po...
10:24 PM

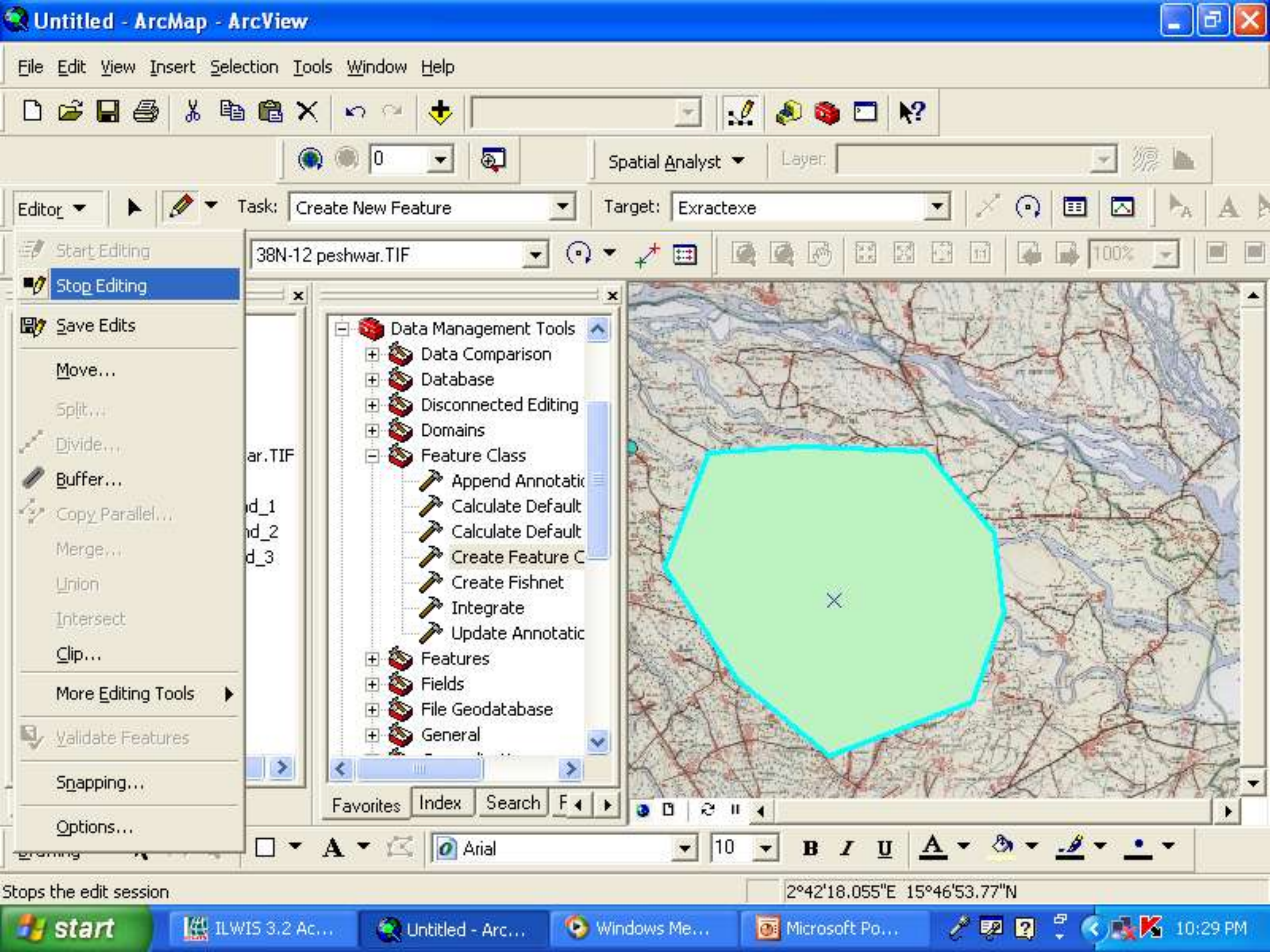

Untitled - ArcMap - ArcView
File Edit View Insert Select
Editor
Georeferencing
Layer:
Layers
E:\geo sheet\
38N-12 peshwa
RGB
Red: Band
Green: Band
Blue: Band
Display
Source
Selection
Drawing
Create Featu Class
Output ation
E:\geo sheet
Output Feature Class
xractexe
Geometry Type (optional)
POLYGON
Temp e Feature Class (optional)
Has M (optional)
DISABLED
Has Z (optional)
DISABLED
OK
Cancel
Environments...
Show Help >>
start
ILWIS 3.2 Ac...
2 ArcMap
Windows Me
Microsoft Po...
10:26 PM

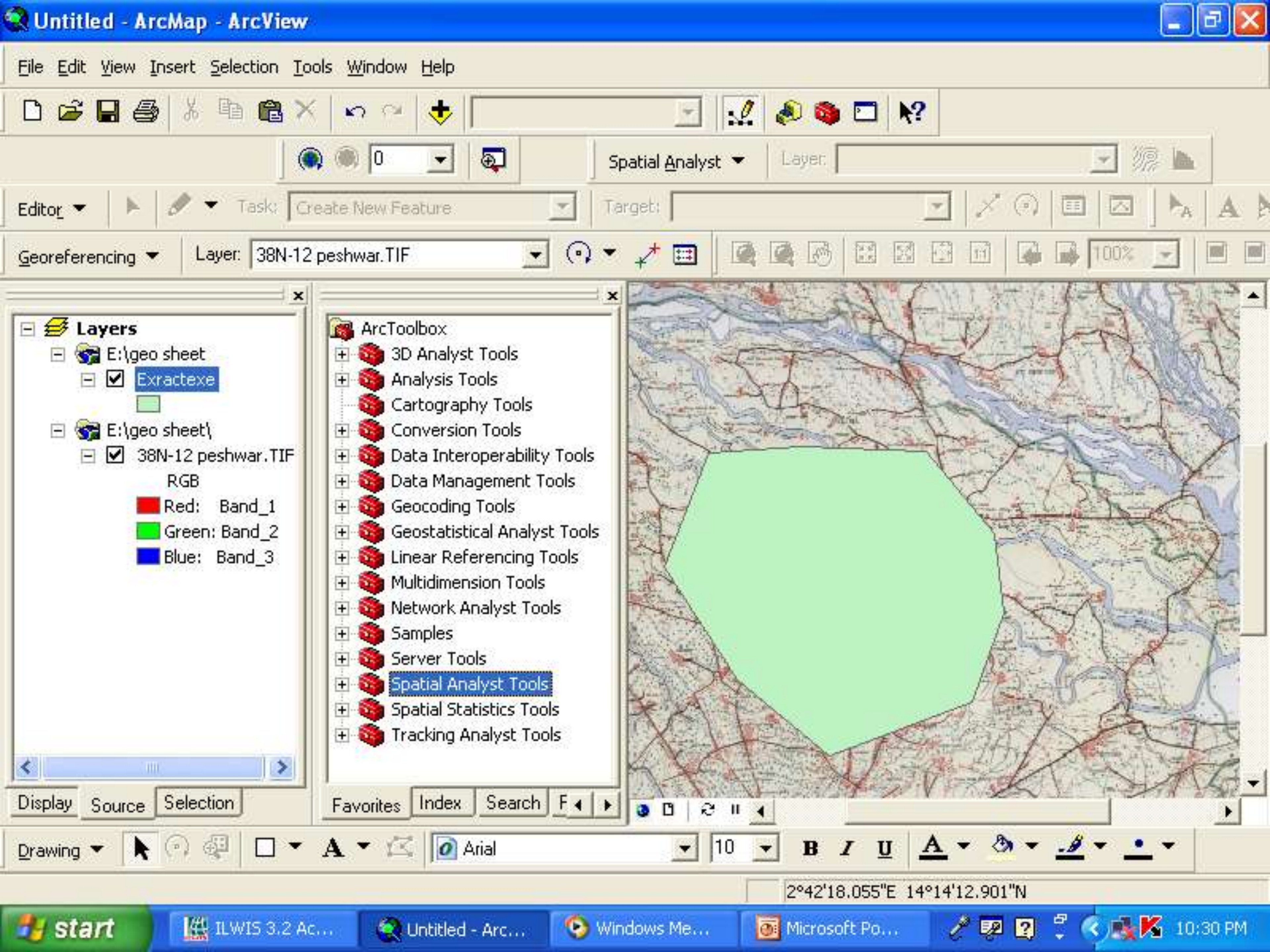

Untitled - ArcMap - ArcView
File Edit View Insert Selection Tools Window Help
Editor
Task: Auto-Complet
Georeferencing
Layer: 38N-12 peshwar.TI
Create Feature Class
Completed
Close
<< Details
Close this dialog when completed successfully
Start Time: Mon Jun 02 22:28:28 2008
Executed (CreateFeatureclass_4)
successfully.
End Time: Mon Jun 02 22:28:29 2008
(Elapsed Time: 1.00 seconds)
Layers
E:\geo sheet
Exractexe
E:\geo sheet\
38N-12 peshwar.TIF
RGB
Red: Band_1
Green: Band_2
Blue: Band_3
Create Feature C
Create Fishnet
Integrate
Update Annotatic
Features
Fields
File Geodatabase
General
Display
Source
Selection
Favorites
Index
Search
Drawing
Arial
10
2°46'56.098"E 18°52'15.506"N
start
ILWIS 3.2 Ac...
2 ArcMap
Windows Me...
Microsoft Po...
10:28 PM


Untitled - ArcMap - ArcView
File Edit View Insert Selection Tools Window Help
Spatial Analyst
Layer:
Editor
Task: Auto-Complete Polygon
Target:
Start Editing
Stop Editing
Save Edits
Move...
Split...
Divide...
Buffer...
Copy Parallel...
Merge...
Union
Intersect
Clip...
More Editing Tools
Validate Features
Snapping...
Options...
38N-12 peshwar.TIF
100%
Data Management Tools
Data Comparison
Database
Disconnected Editing
Domains
Feature Class
Append Annotatic
Calculate Default
Calculate Default
Create Feature C
Create Fishnet
Integrate
Update Annotatic
Features
Fields
File Geodatabase
General
Favorites
Index
Search
Arial
10
Starts an edit session
2°44'37.076"E 18°38'21.376"N
start
ILWIS 3.2 Ac...
Untitled - Arc...
Windows Me...
Microsoft Po...
10:28 PM


Untitled - ArcMap - ArcView
File Edit View Insert Selection Tools Window Help
Spatial Analyst
Layer:
Editor
Task: Auto-Complete Polygon
Target: Exractexe
Sketch Tool
Georeferencing
Layer: 38N-12 peshwar.TIF
Layers
E:\geo sheet
Exractexe
E:\geo sheet\
38N-12 peshwar.TIF
RGB
Red: Band_1
Green: Band_2
Blue: Band_3
Data Management Tools
Data Comparison
Database
Disconnected Editing
Domains
Feature Class
Append Annotatic
Calculate Default
Calculate Default
Create Feature C
Create Fishnet
Integrate
Update Annotatic
Features
Fields
File Geodatabase
General
Display
Source
Selection
Favorites
Index
Search
Drawing
Arial
10
Adds points to the edit sketch
2°44'37.076"E 18°38'21.376"N
start
ILWIS 3.2 Ac...
Untitled - Arc...
Windows Me...
Microsoft Po...
10:29 PM


Untitled - ArcMap - ArcView
File Edit View Insert Selection Tools Window Help
Spatial Analyst
Layer:
Editor
Task: Create New Feature
Target: Exractexe
Georeferencing
Layer: 38N-12 peshwar.TIF
100%
Layers
E:\geo sheet
Exractexe
E:\geo sheet\
38N-12 peshwar.TIF
RGB
Red: Band_1
Green: Band_2
Blue: Band_3
Display
Source
Selection
Data Management Tools
Data Comparison
Database
Disconnected Editing
Domains
Feature Class
Append Annotatic
Calculate Default
Calculate Default
Create Feature C
Create Fishnet
Integrate
Update Annotatic
Features
Fields
File Geodatabase
General
Favorites
Index
Search
Drawing
Arial
10
Number of features selected: 1
9°13'52.722"E 14°16'31.923"N
start
ILWIS 3.2 Ac...
Untitled - Arc...
Windows Me...
Microsoft Po...
10:29 PM


Untitled - ArcMap - ArcView
File Edit View Insert Selection Tools Window Help
Spatial Analyst
Layer:
Editor
Task: Create New Feature
Target: Exractexe
Start Editing
Stop Editing
Save Edits
Move...
Split...
Divide...
Buffer...
Copy Parallel...
Merge...
Union
Intersect
Clip...
More Editing Tools
Validate Features
Snapping...
Options...
38N-12 peshwar.TIF
Data Management Tools
Data Comparison
Database
Disconnected Editing
Domains
Feature Class
Append Annotatic
Calculate Default
Calculate Default
Create Feature C
Create Fishnet
Integrate
Update Annotatic
Features
Fields
File Geodatabase
General
Favorites
Index
Search
Arial
10
Stops the edit session
2°42'18.055"E 15°46'53.77"N
start
ILWIS 3.2 Ac...
Untitled - Arc...
Windows Me...
Microsoft Po...
10:29 PM


Untitled - ArcMap - ArcView
File Edit View Insert Selection Tools Window Help
Spatial Analyst
Layer:
Editor
Task: Create New Feature
Target:
Georeferencing
Layer: 38N-12 peshwar.TIF
100%
Layers
E:\geo sheet
Exractexe
E:\geo sheet\
38N-12 peshwar.TIF
RGB
Red: Band_1
Green: Band_2
Blue: Band_3
Display
Source
Selection
ArcToolbox
3D Analyst Tools
Analysis Tools
Cartography Tools
Conversion Tools
Data Interoperability Tools
Data Management Tools
Geocoding Tools
Geostatistical Analyst Tools
Linear Referencing Tools
Multidimension Tools
Network Analyst Tools
Samples
Server Tools
Spatial Analyst Tools
Spatial Statistics Tools
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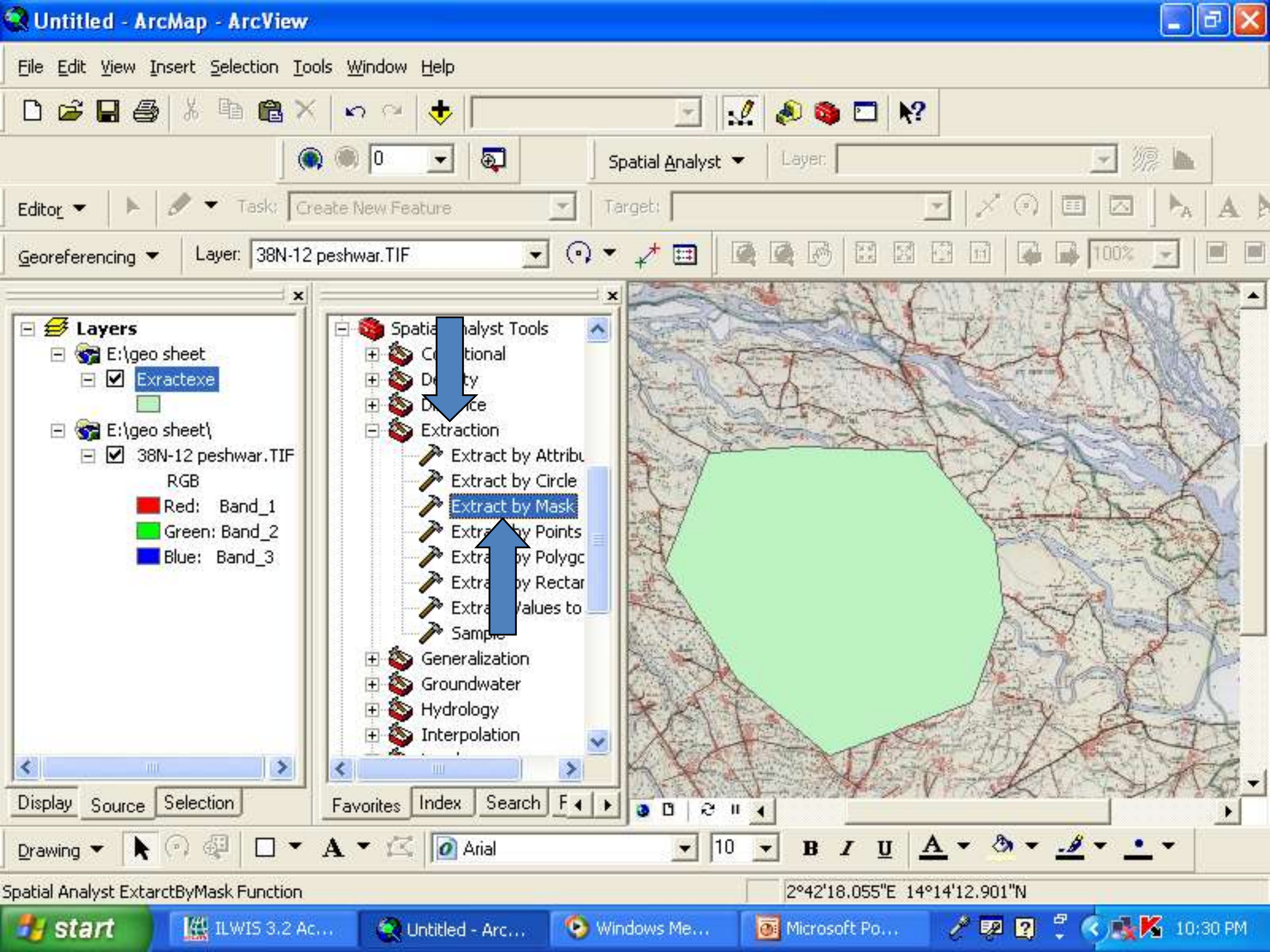
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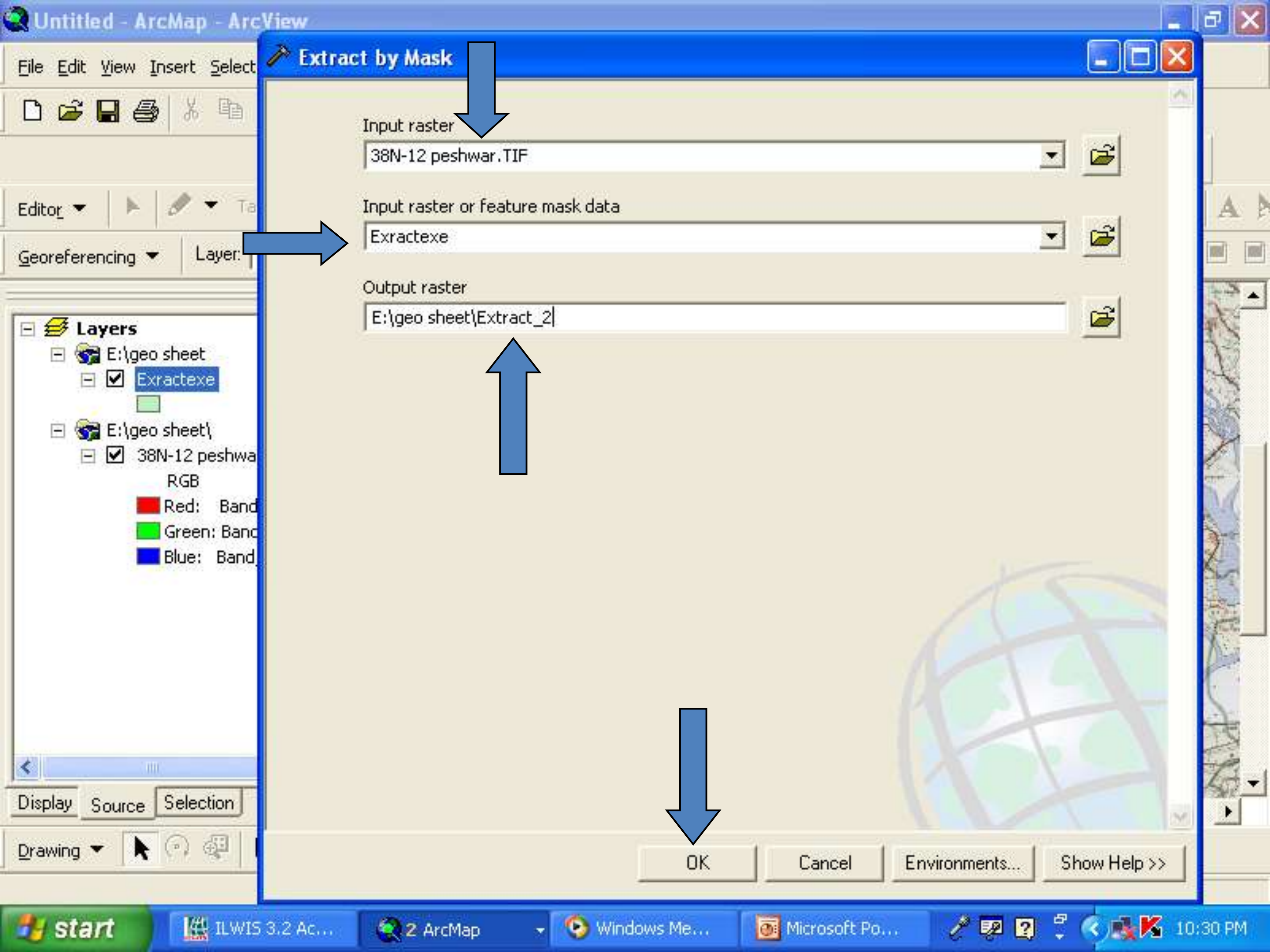
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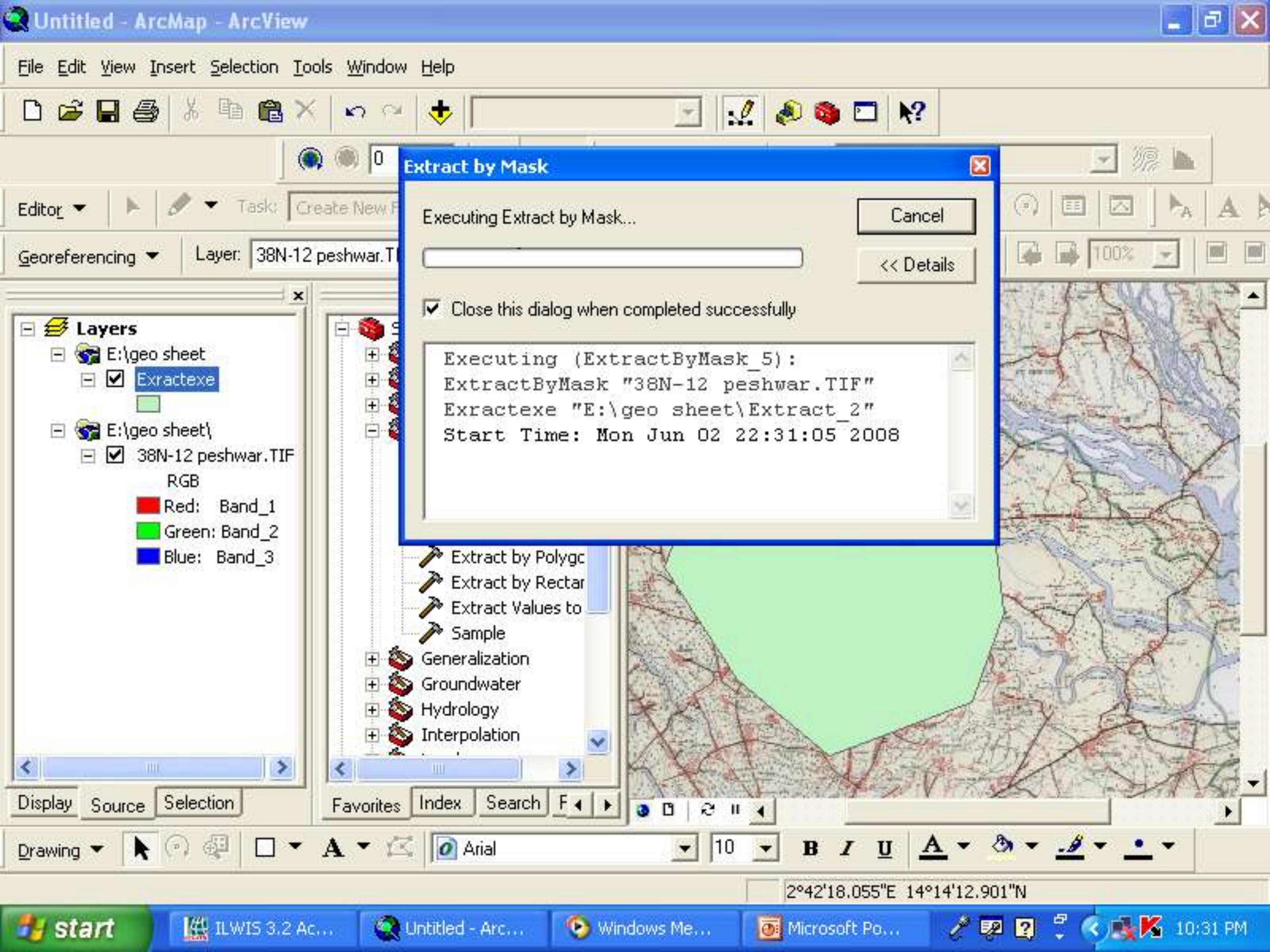
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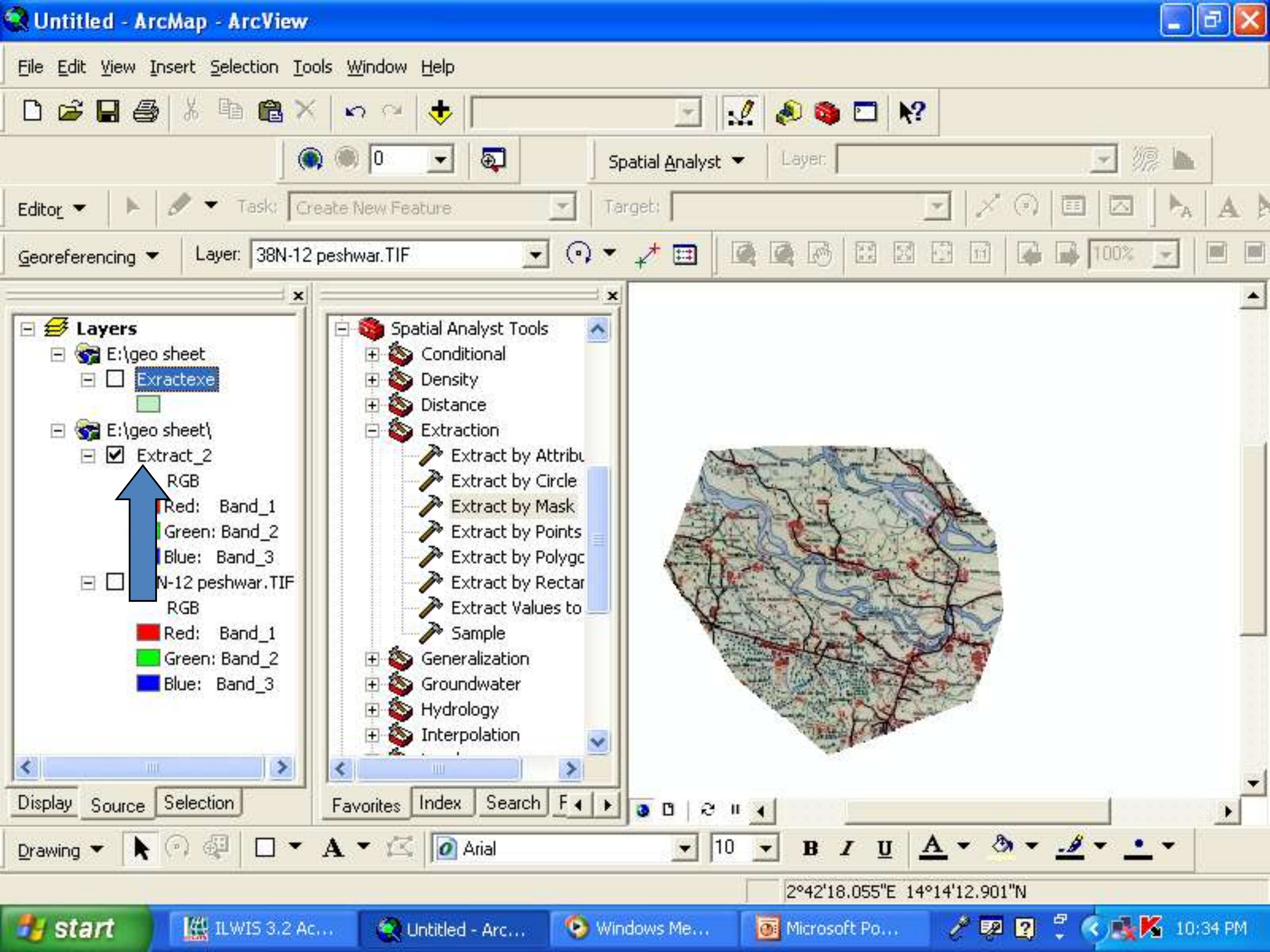
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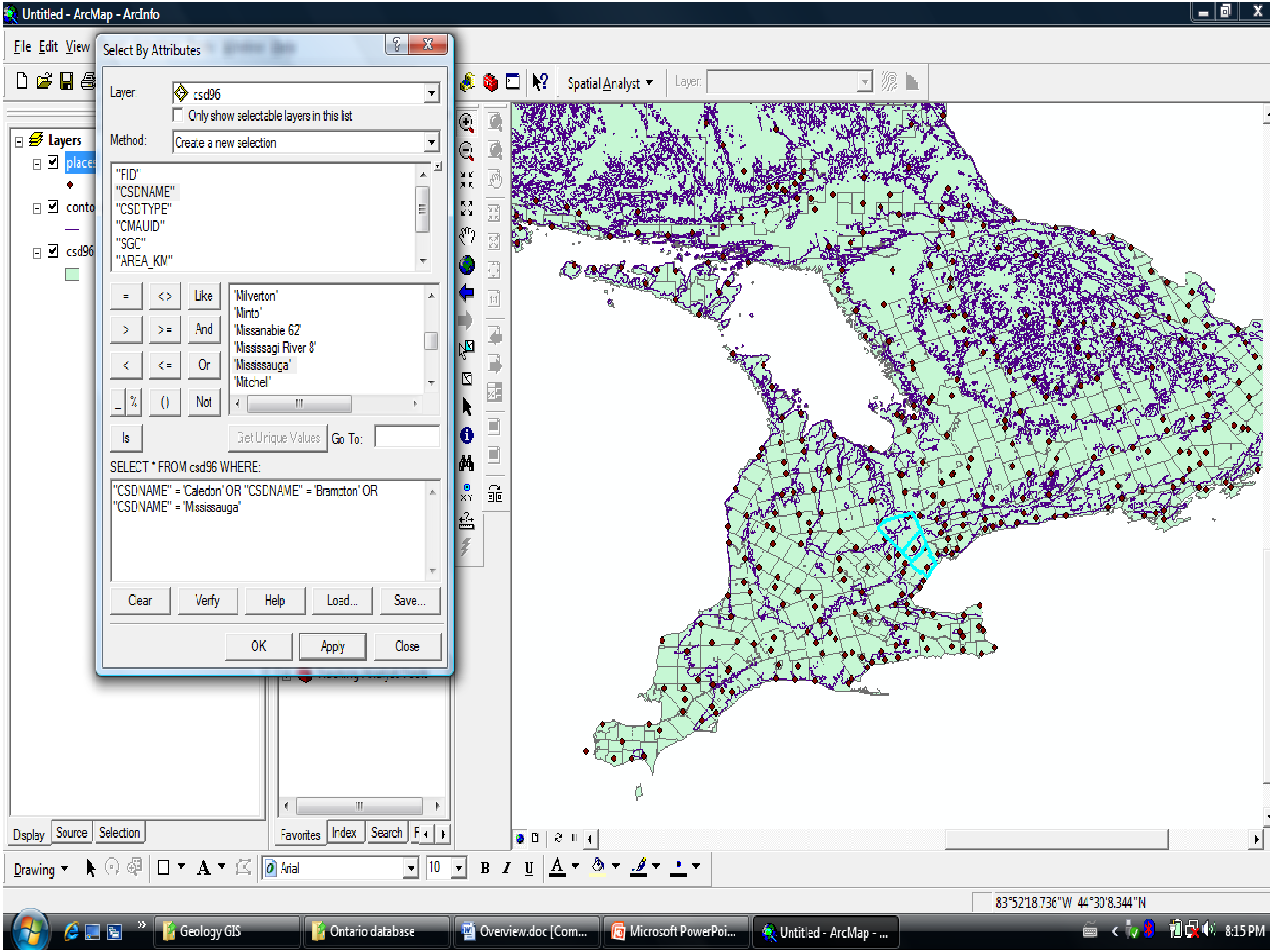
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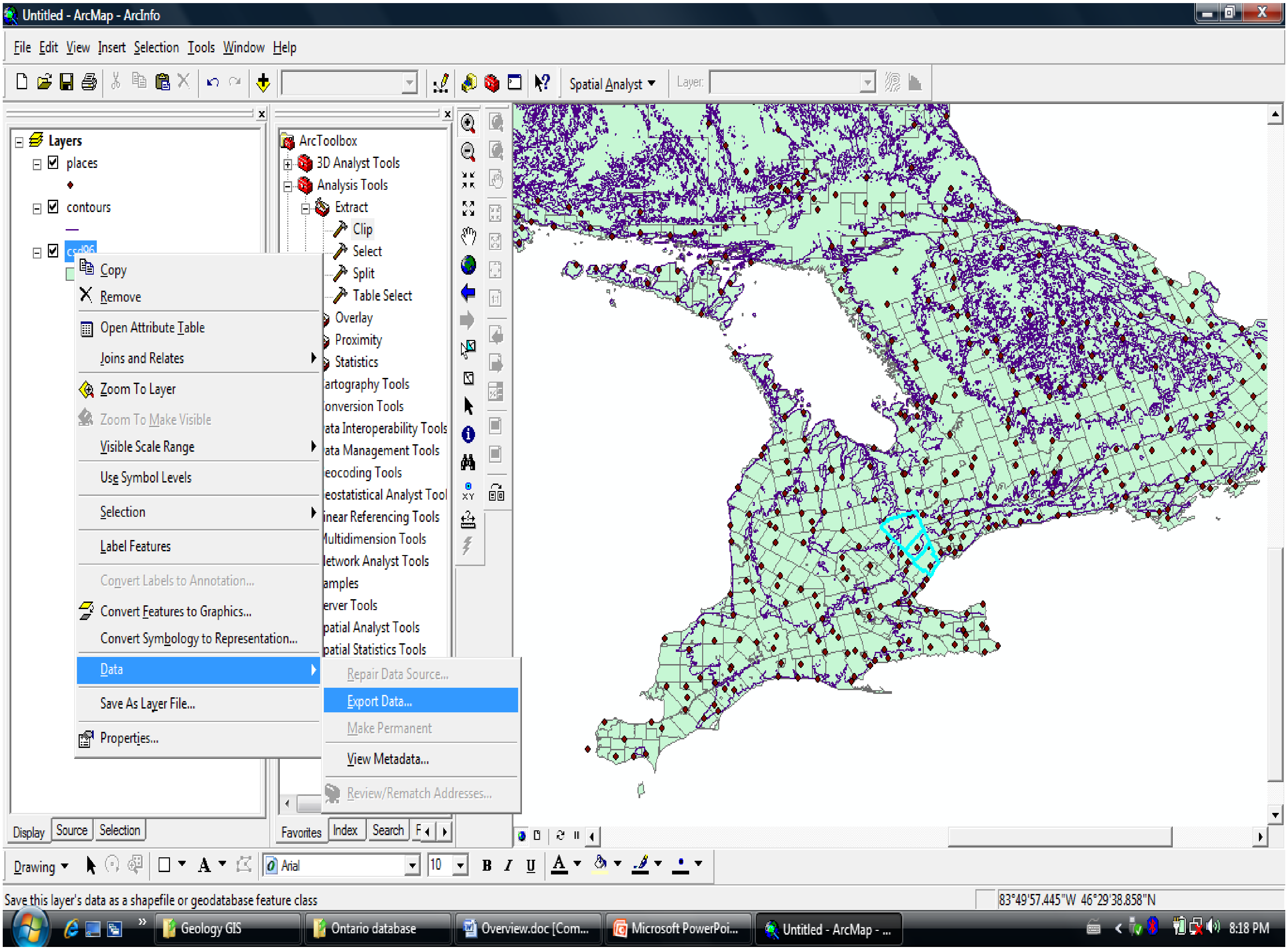
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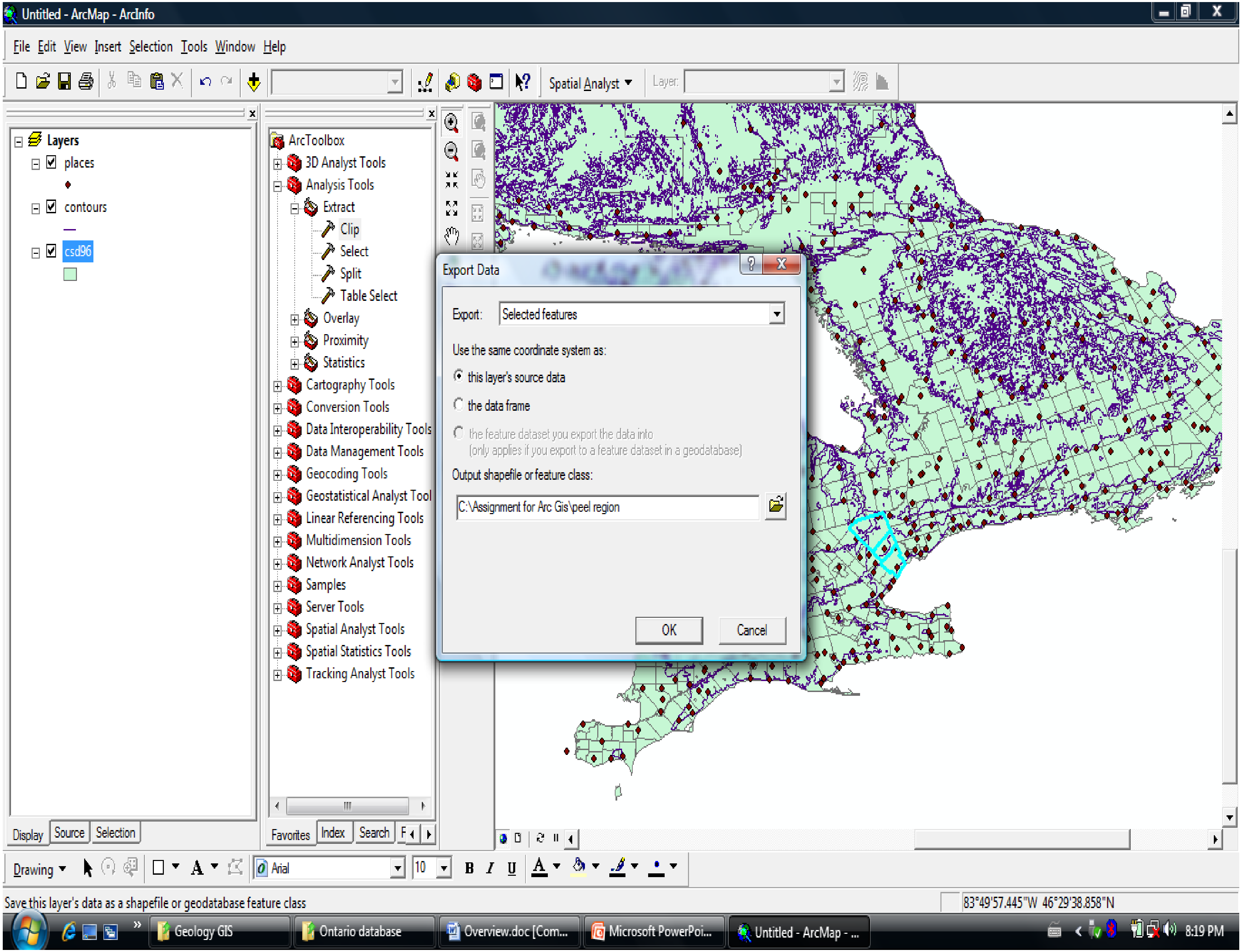
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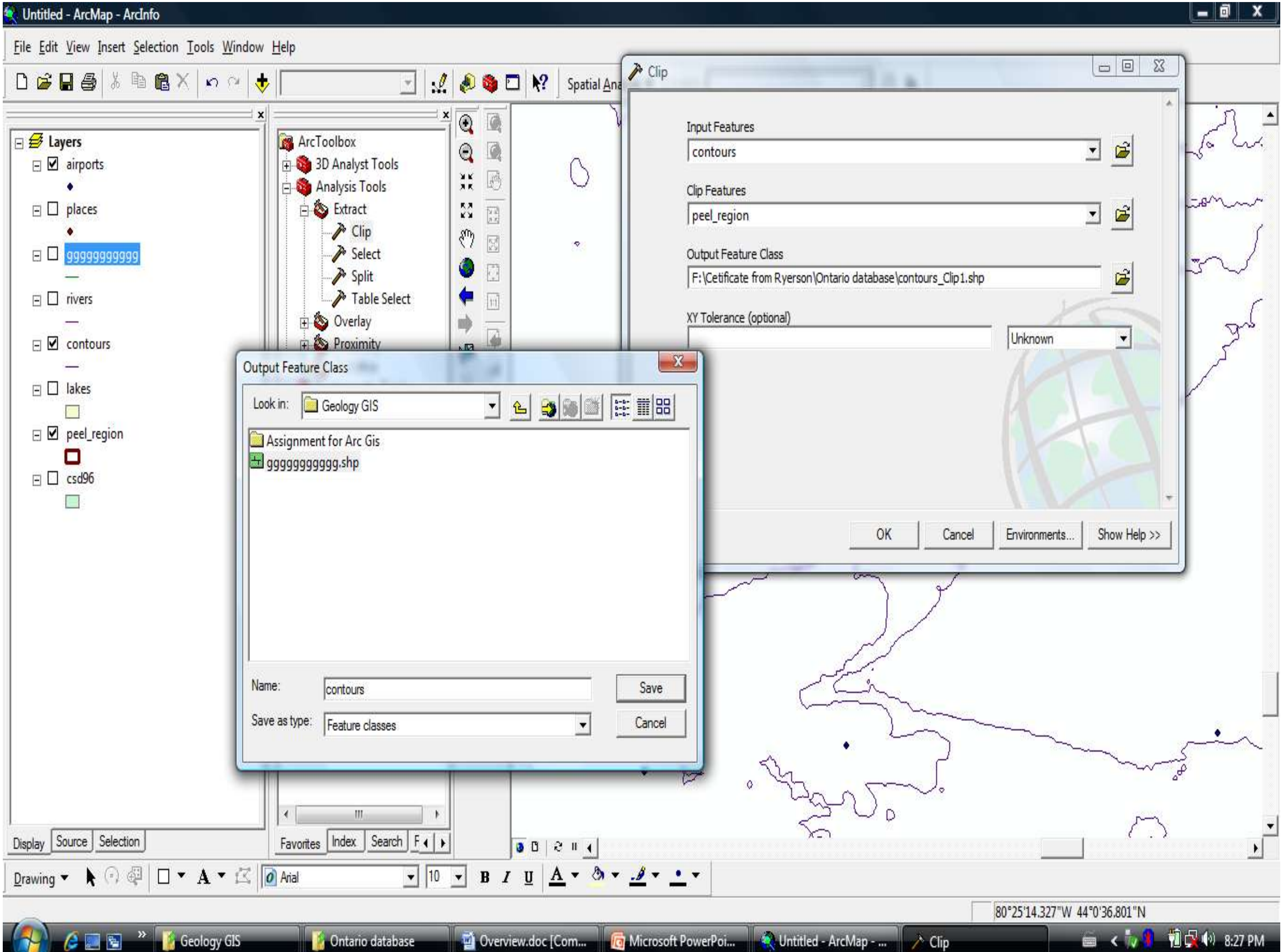
# Extract by cliping



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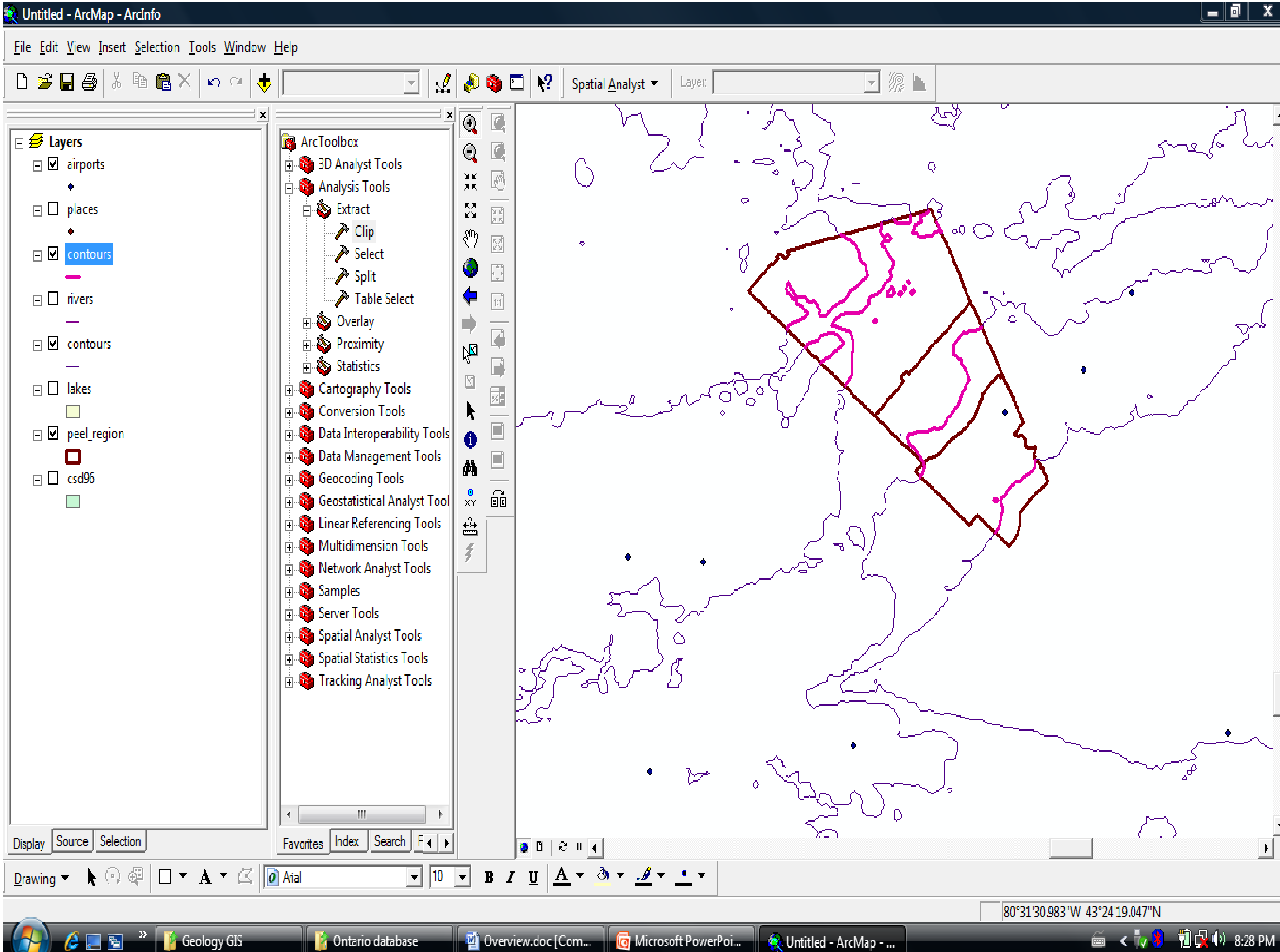

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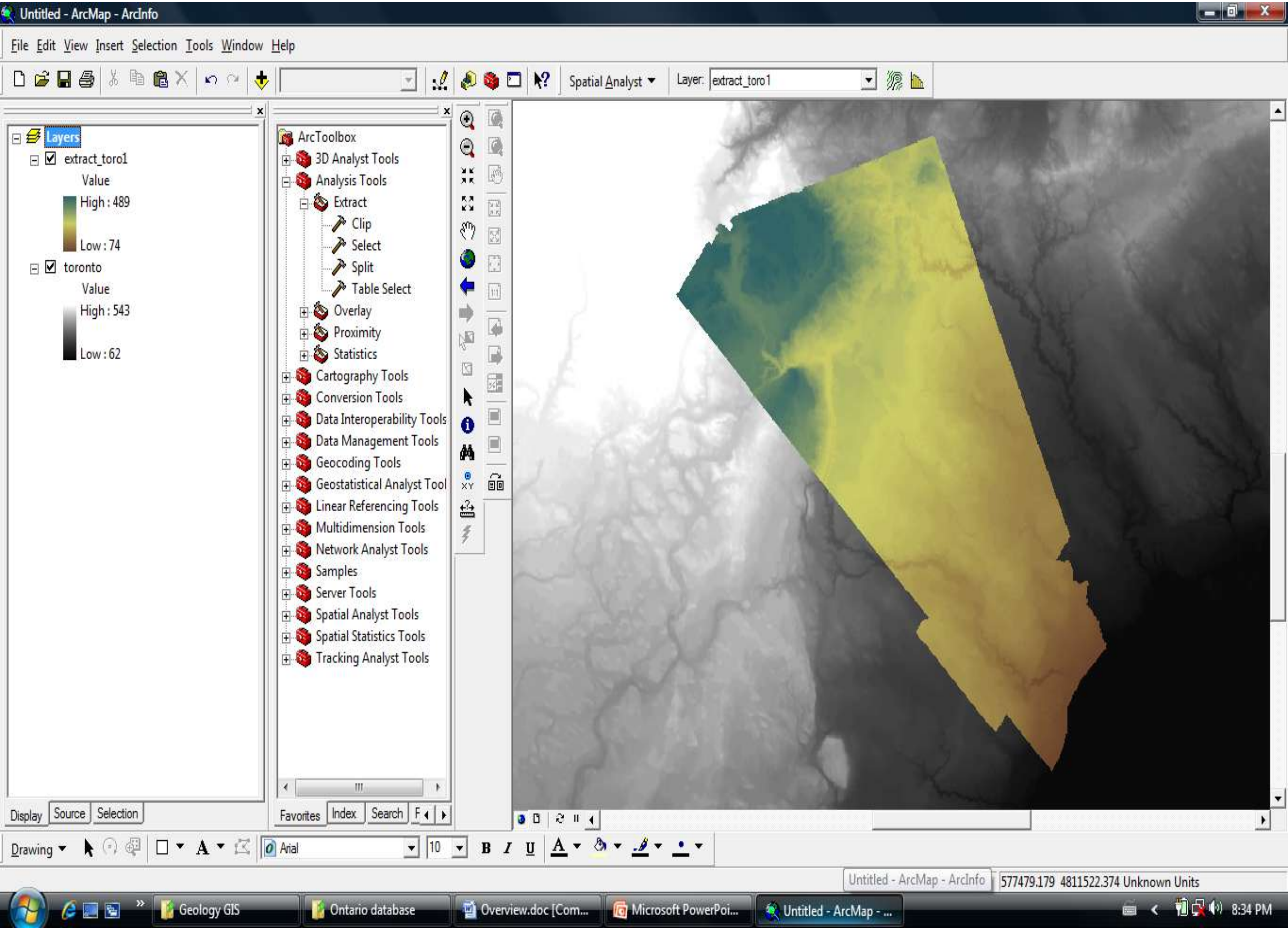
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# Creating surfaces from points

Surfaces of continuous data are usually generated from samples taken at points across the area.

- ie: the irregularly spaced weather stations in a region can be used to create raster surfaces of temperature or air pressure.

The resulting surface is a regular grid of values.

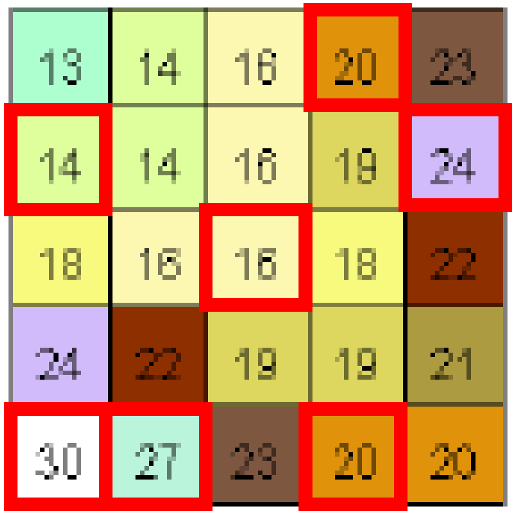
# Creating Raster Surfaces …

- Better Data = Better Grids
  - More sample points
  - More accurate measurements
  - More appropriately distributed

= better surface model

# Creating Raster Surfaces

Interpolation predicts values for cells in a raster from a limited number of sample data points. It can be used to predict unknown values for any geographic point data: elevation, rainfall, chemical concentrations, noise levels, and so on.


Interpolation assumes that spatially distributed objects are spatially correlated.

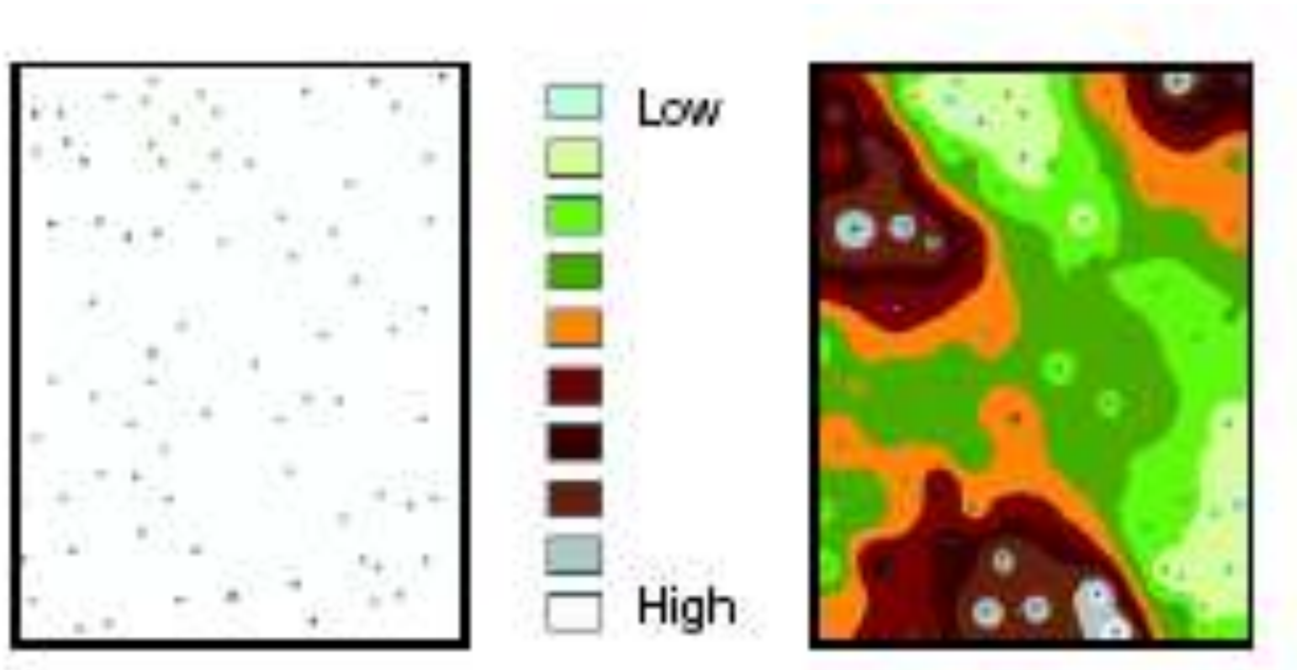
# Creating Raster Surfaces …

**Why Interpolate?**

- Visiting every location in a study area to measure the height, magnitude, or concentration of a phenomenon is usually difficult or expensive.
- Instead, dispersed sample input point locations can be selected and a predicted value can be assigned to all other locations.
- Input points can be either randomly, strategically, or regularly spaced points containing height, concentration, or magnitude measurements.

# Creating Raster Surfaces …

A typical use for point interpolation is to create an elevation surface from a set of sample measurements.



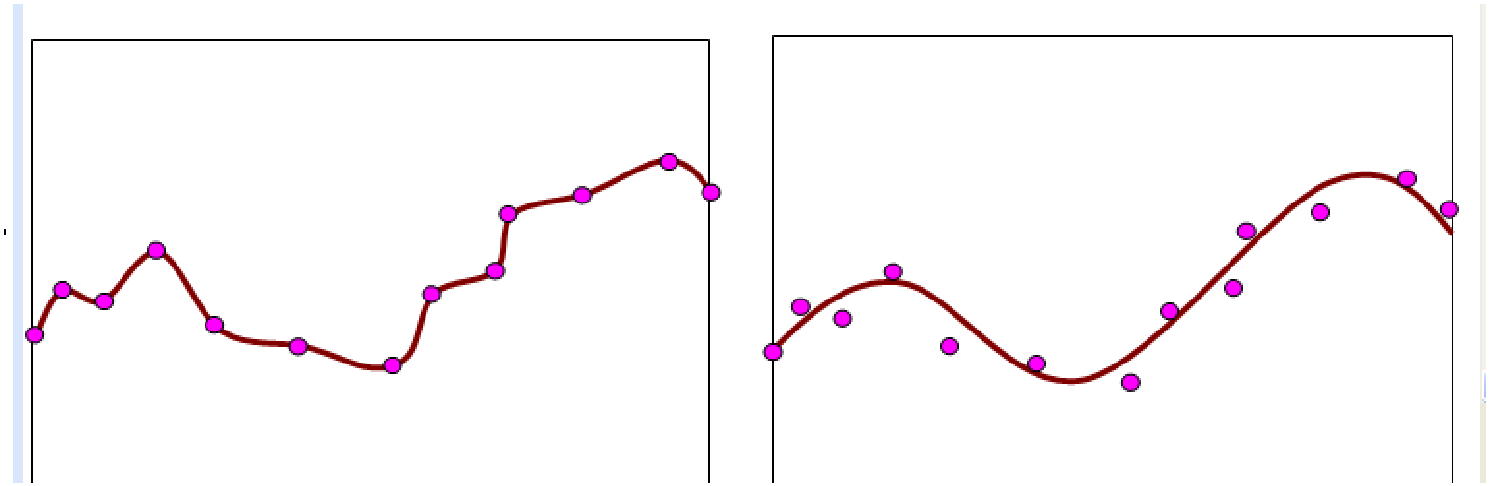

The resulting grid is a prediction of what the elevation is at any location on the actual surface.

# Spatial Interpolation

- Most GIS packages come with a number of interpolation methods. Classifications of interpolations are:
  - Exact or Approximate
  - Local or Global
  - Gradual or Abrupt
  - Stochastic or Deterministic

# Creating Raster Surfaces …

- <u>Exact Interpolator</u>
  - Interpolation surface agrees with original data values
- <u>Approximate (Inexact) Interpolator</u>
  - Algorithm does not force the grid to honour the original data points

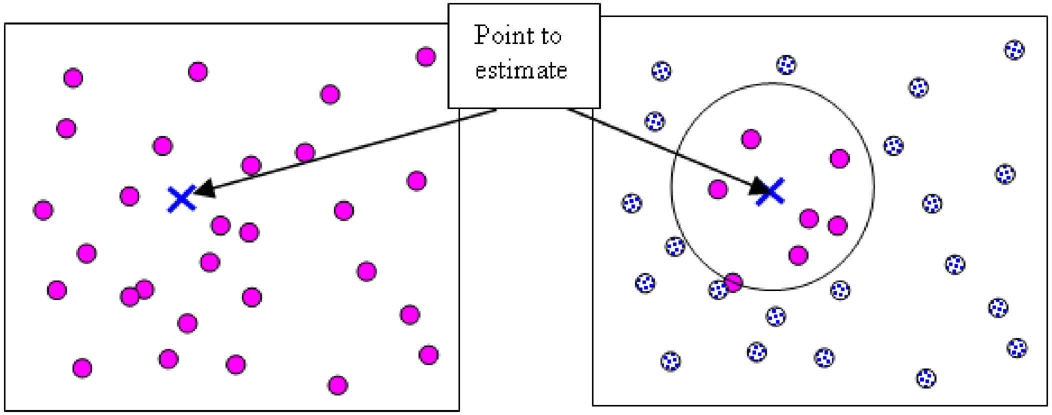


# Creating Raster Surfaces …

- Exact vs Approximate Interpolation
  - If data is believed to have random error or uncertainty, use an inexact interpolator
  - If data is believed to be absolutely accurate, and would be identical upon replication, use an Exact Interpolator
  - In a sense, using an inexact interpolator shows a mistrust in the data, while using an exact interpolator shows a mistrust in the algorithm

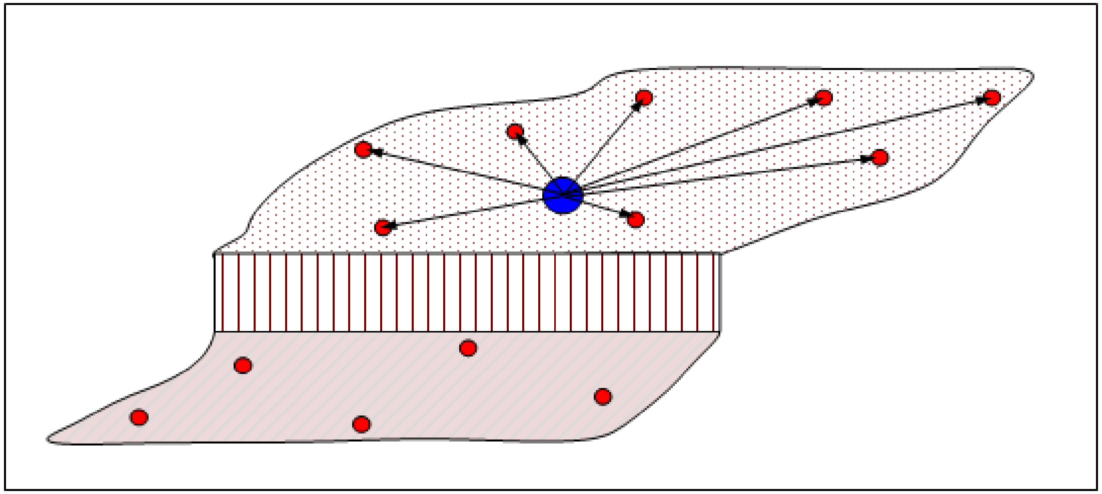
# Creating Raster Surfaces …

- Global:
  - methods apply a single mathematical function to all observed points and generally produce a smooth surface
  - a change in one input value affects the **entire** map
- Local:
  - methods apply a single mathematical function to small subsets of the total set of observed points and then link these regionally to create a composite surface covering the whole study area
  - a change in an input value **only** affects the result within the window



# Creating Raster Surfaces …

- <u>Gradual:</u>
  - Gradual methods produce a smooth surface between sample points
- <u>Abrupt:</u>
  - Abrupt methods produce surfaces with a stepped appearance
- Terrain models may use both methods to visualize rolling terrain versus cliffs, ridges or valleys



# Stochastic or Deterministic

- Stochastic:
  - stochastic methods incorporate the random variation
- Deterministic:
  - Used when sufficient knowledge about the geographical surface being modelled

# Creating Raster Surfaces …

- The best interpolation methods to use depends on:
  - Objectives of the study (type of surface you are trying to generate)
  - Ease of generating surface versus accuracy of the developed surface (the type of surface you are trying to model)
  - The data (distribution of sample points)

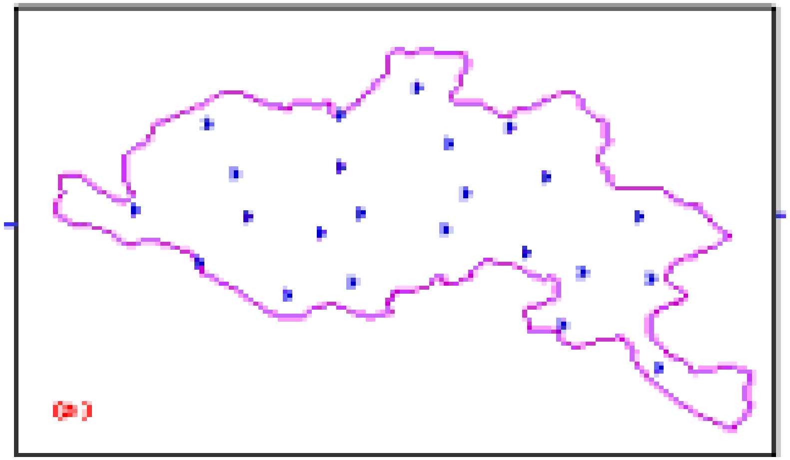
# Creating Raster Surfaces …

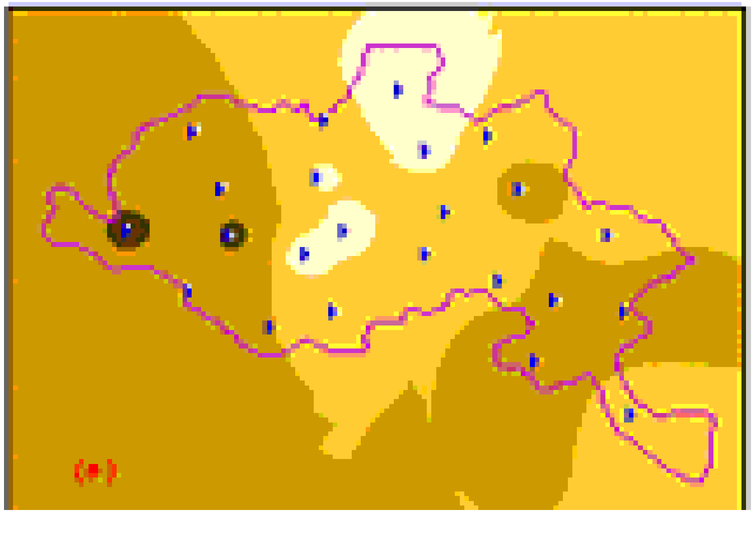
**<u>Basic Interpolation Methods</u>**

- Inverse Distance Weighted
- Spline
- Kriging

# Inverse Distance Weighting

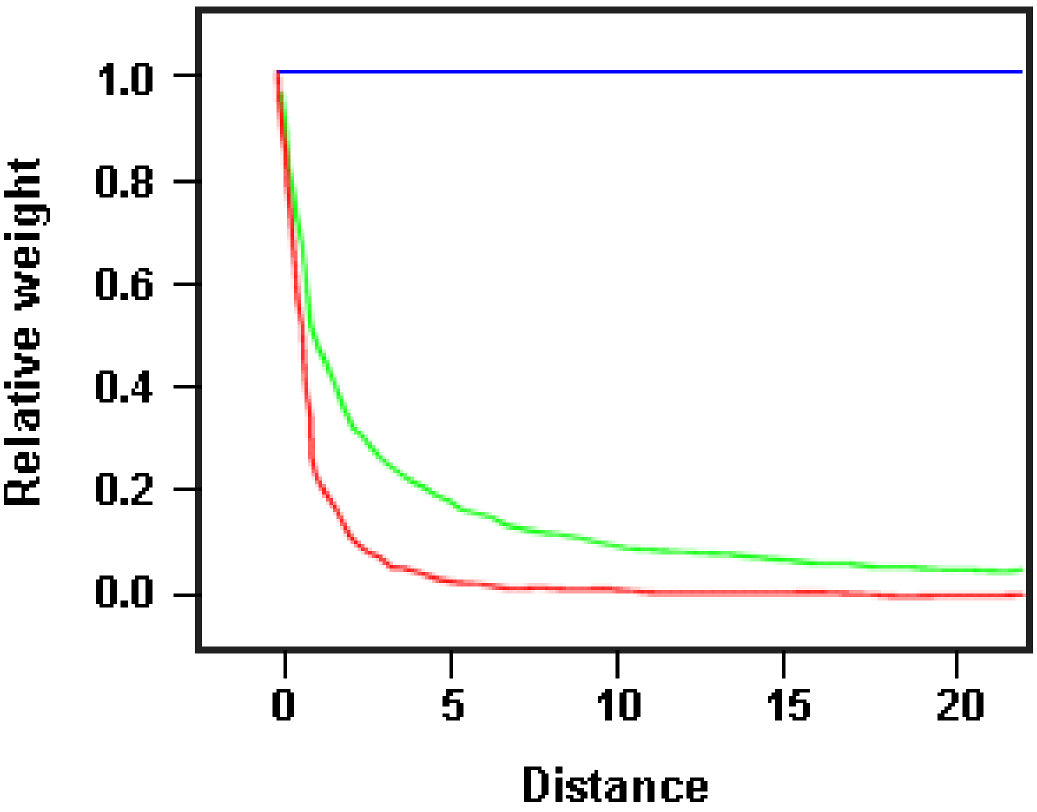
- IDW is a function that estimates cell values by averaging the surronding sample data points to each cell
- IDW assumes that each input point has a local influence that diminishes with distance. It weighs the points closer to the data source than those further away





# IDW …

In IDW, the predictive influence (weight) of a measured value depends on its distance from the prediction location. The strength of the dependency can be adjusted.

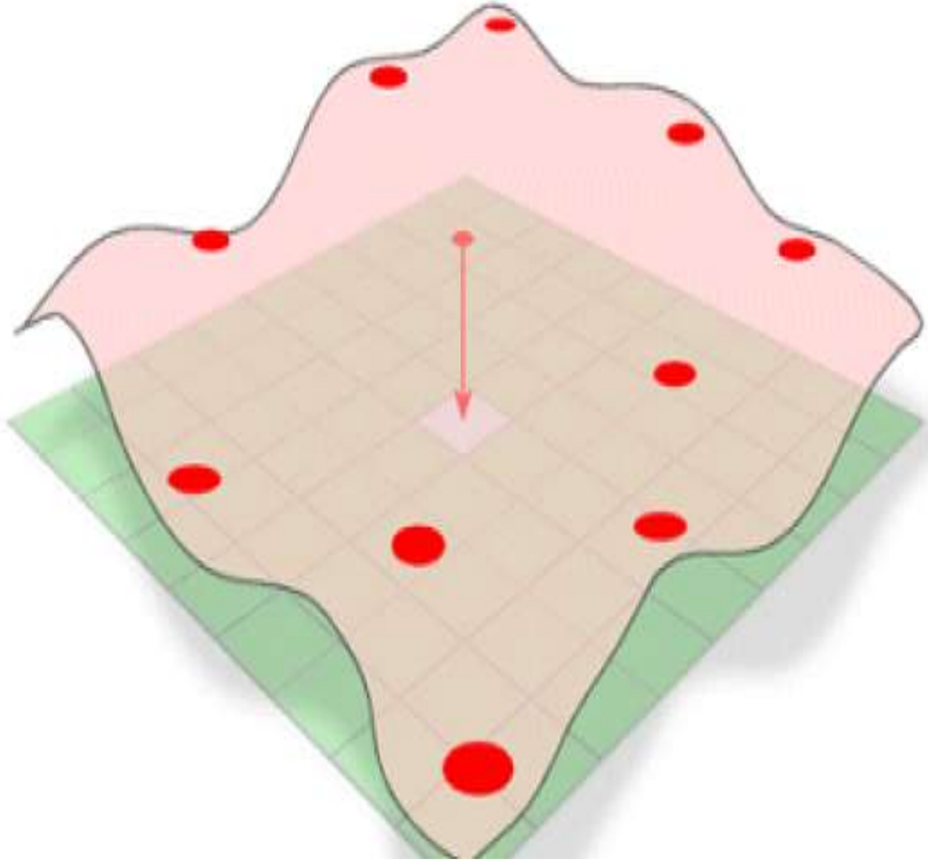


# IDW …

- A higher weighting factor results in less influence from distance points
- Distance-weighted average preserves sample data values, and is therefore an exact interpolation technique
- IDW is very fast – but has the tendency to generate “bull’s eyes”
- Simple to use, very fast and provides reasonable results

# Spline

- Instead of averaging values, like IDW does, the Spline interpolation method fits a flexible surface, as if it were stretching a rubber sheet across all the known point values.
- Useful if interested in estimated values that are below the minimum or above the maximum values found in the sample data. This makes the Spline interpolation method good for estimating lows and highs where they are not included in the sample data.



# Spline …

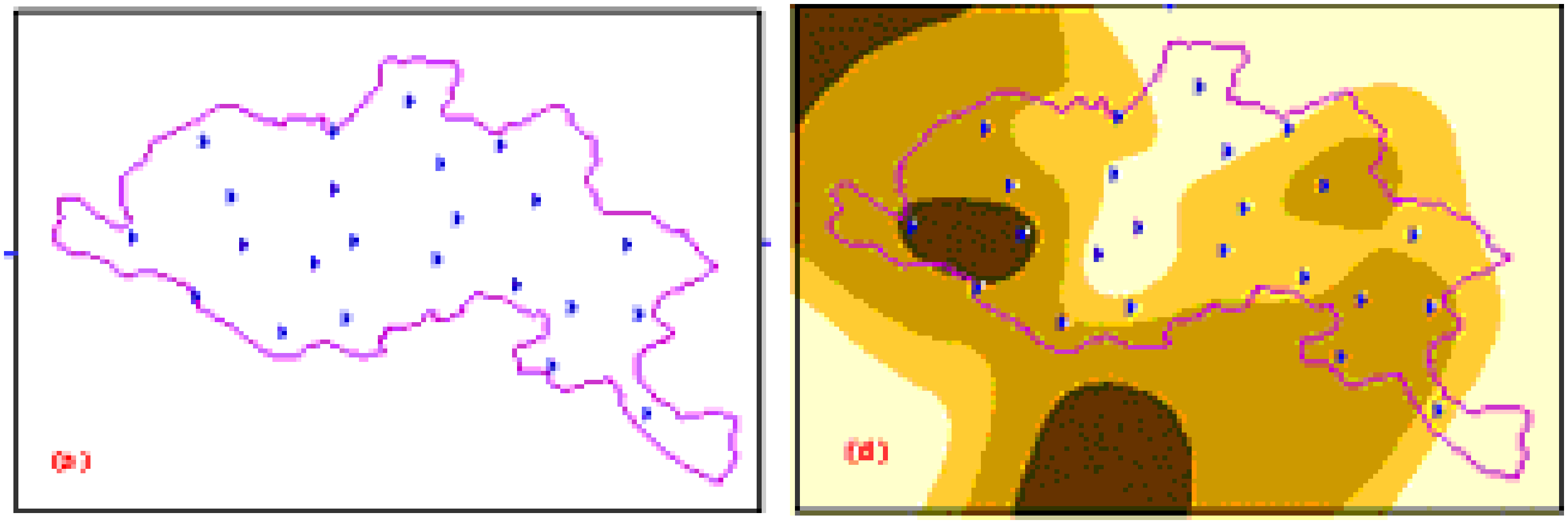
- Regularized
  - Curved, more smooth and may not stay true to the sample points
  - More elastic
  - The higher the weight value, the smoother the grid

- Tension
  - flatter therefore forcing the estimates to stay closer to the sample data.
  - More rigid
  - The higher the weight the coarser the surface

# Spline …

- This method is best for gently varying surfaces such as elevation, water table heights or pollution concentrations

- It is not appropriate if there are large changes in the surface within a short horizontal distance, because it can overshoot estimated values



# Kriging

- Kriging is a multistep process
- Similar to IDS because it uses a linear combination of weights at known points to estimate the value of the grid.
- Assumes that the distance or direction between sample points reflects a spatial correlation that can be used to explain variation in the surface.
- Kriging fits a mathematical function to a specified number of points, or all points within a specified radius, to determine the output value for each location.
- Works best with data sets which have regions of densely scattered data and regions of lightly scattered data
- Kriging preserves sample data values (exact interpolator)