



Using GIS to Visualize and Analyze Sensor Data

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Making Sense of Sensors

South Coast AQMD

Agenda

- **What is GIS**
- **Example workflow: analyze asthma rates**
- **Example workflow: near real time sensor analytics**

What is GIS

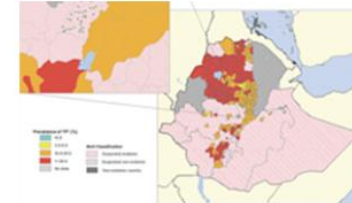
- “In the strictest sense, a GIS is a computer system capable of assembling, storing, manipulating, and displaying geographically referenced information, i.e. data identified according to their locations. Practitioners also regard the total GIS as including operating personnel and the data that go into the system.” ~ USGS
- <http://www.esri.com/what-is-gis>



Government

GIS helps governments increase efficiency, reduce costs, improve coordination, and deliver transparency and accountability.

[Learn more](#)



Health & Human Services

GIS helps health organizations leverage limited resources and positively impact individuals, families, and society.

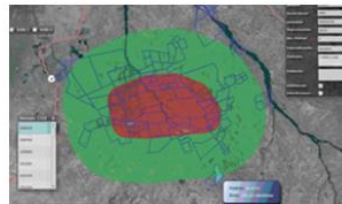
[Learn more](#)



Mapping & Charting

GIS allows aeronautical, cartographic, and nautical organizations to implement an effective and efficient workflow.

[Learn more](#)



Natural Resources

Natural resource professionals rely on GIS to help make critical decisions as they manage the earth's resources.

[Learn more](#)



Public Safety

GIS gives public safety personnel the ability to visualize relationships and reveal trends critical to response and planning.

[Learn more](#)



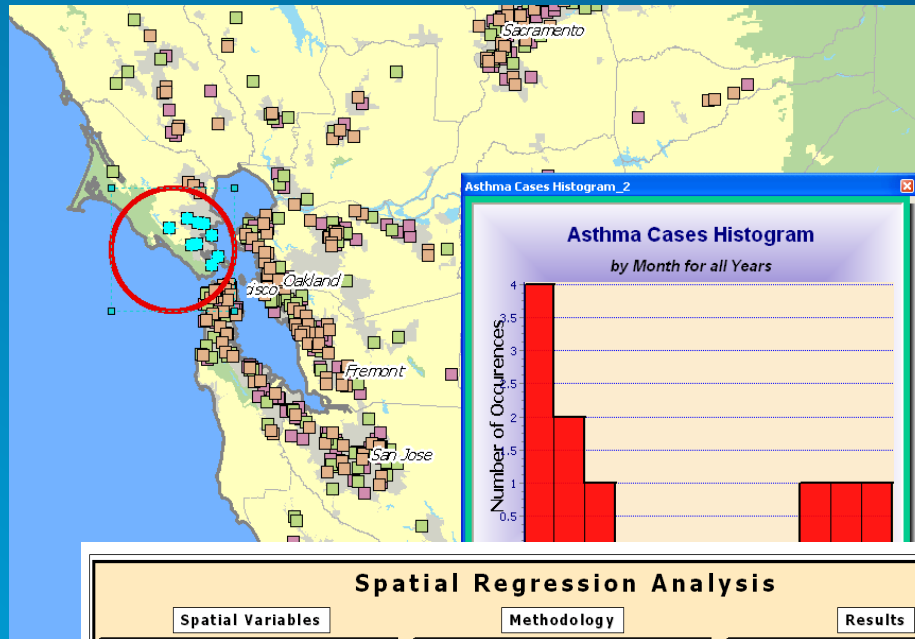
Transportation

Transportation professionals use GIS to help in managing, planning, evaluating, and maintaining transportation systems.

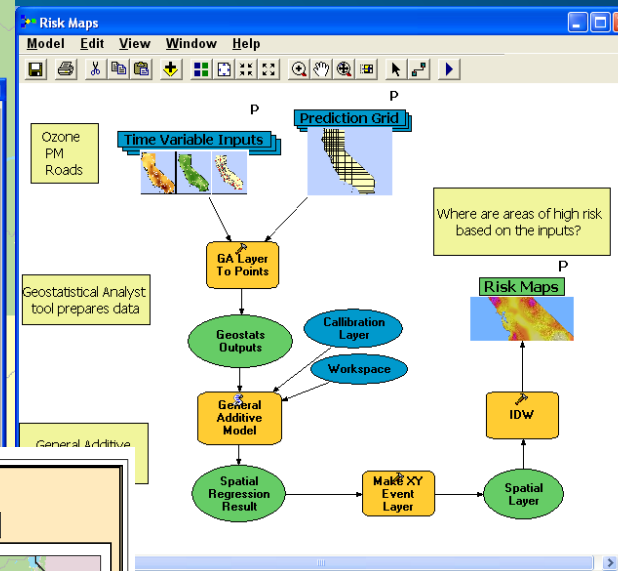
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Example workflow: Asthma Analysis

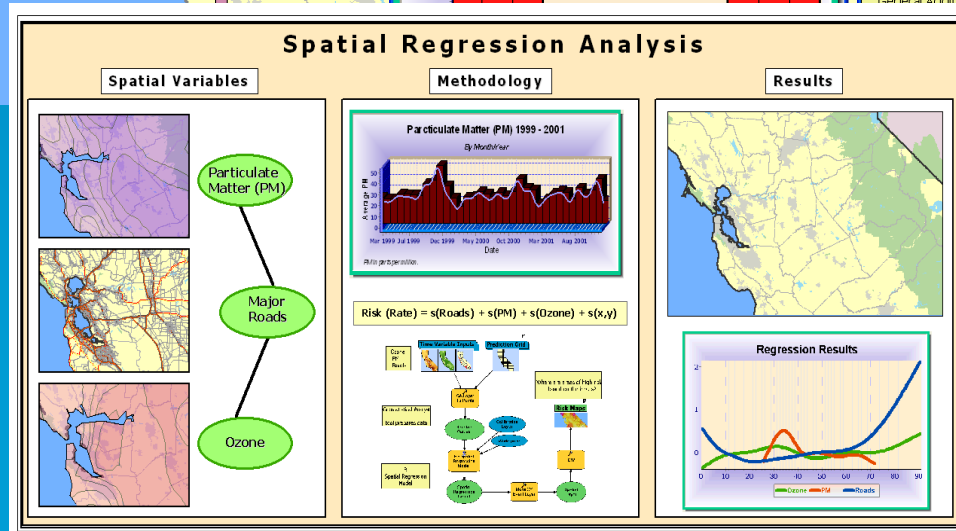
Visualization



Spatial Data Exploration



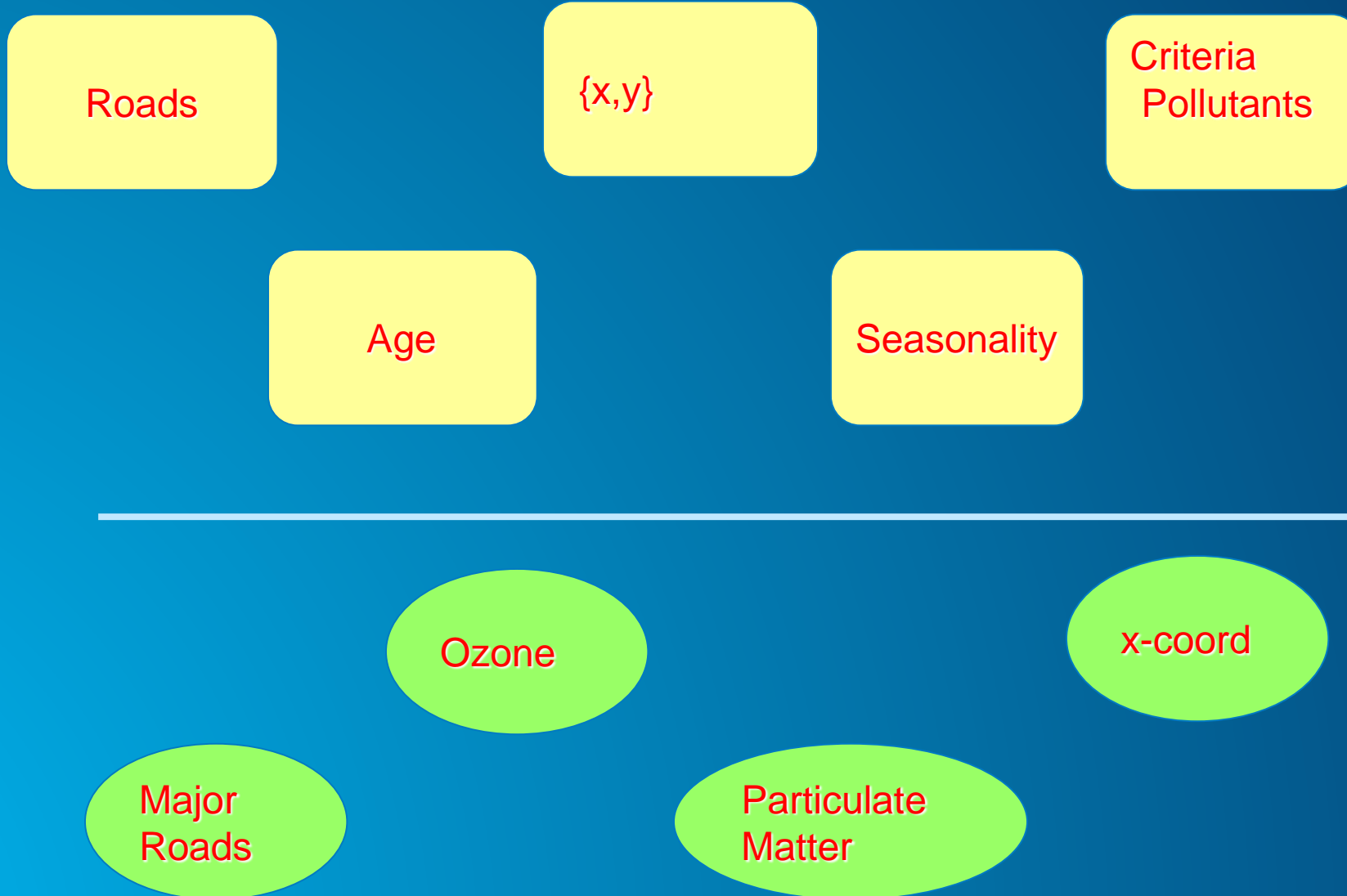
Risk Analysis



Asthma Study: Methodology

- ESDA of asthma deaths point data (1999-2001)
- Obtain zip code population rates
- Calculate asthma death rate for zip codes
- Assign road density values to California zip codes
- Explore effects of criteria pollutants, age, month of death, proximity to roads, and density of roads on asthma deaths (in R)
- Create ozone and pm surfaces (1995-2004)
- Create spatial regression based on parameters that appear to predict asthma rates the best
 - Distance to roads, ozone, pm, and (x,y)

Asthma Study: Methodology



Spatial Statistics

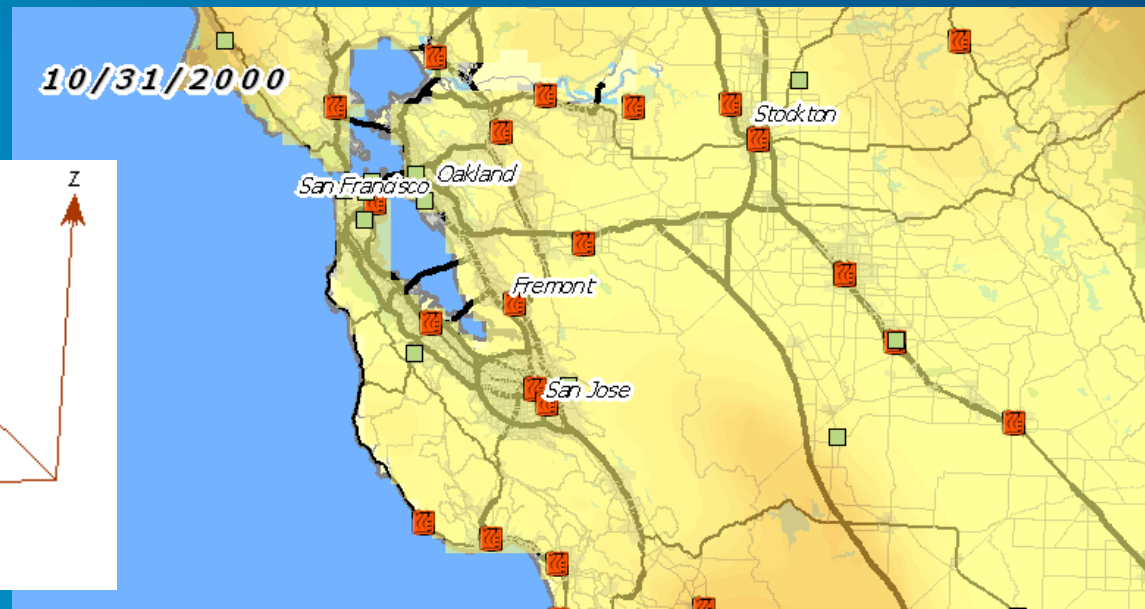
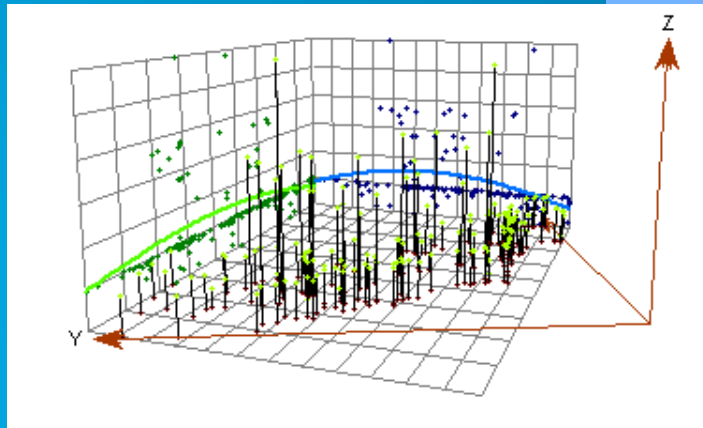
- **Geostatistical (continuous)**
 - **Geostatistical Analyst extension to ArcGIS**
- **Point pattern (non-continuous)**
 - **No tools in ArcGIS**
 - **use external statistical packages**
- **Lattice data (polygonal)**
 - **coming in future release of Geostatistical Analyst**

Regression Analysis

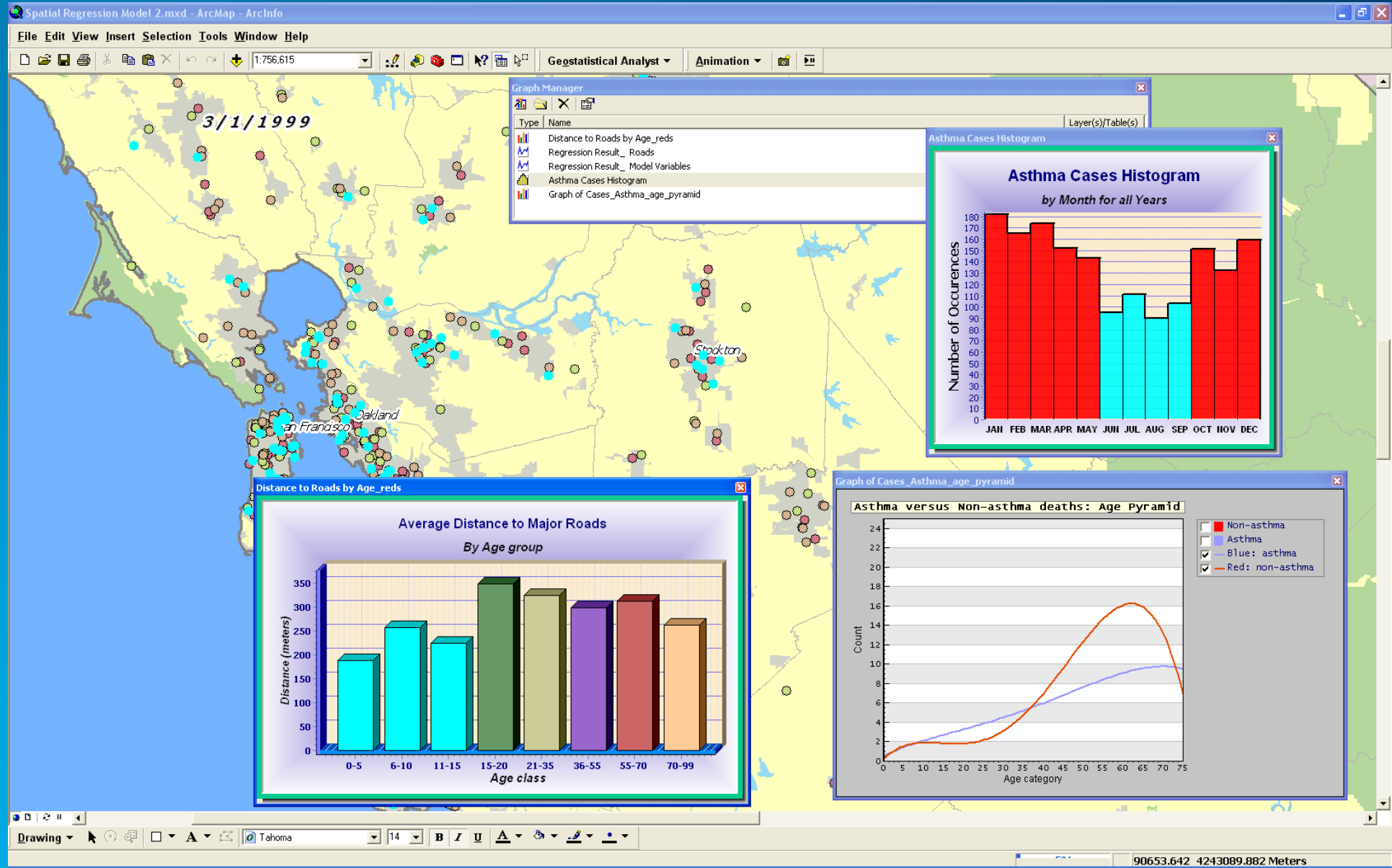
- **Asthma data are point-pattern data**
 - cannot use geostatistics
- **Have to use external package**
 - ArcGIS integration through geoprocessing framework
- **We used R**
 - can use other software
- **We used GAM (general additive model)**
 - use expert opinion to choose appropriate package

Asthma Study: The Data

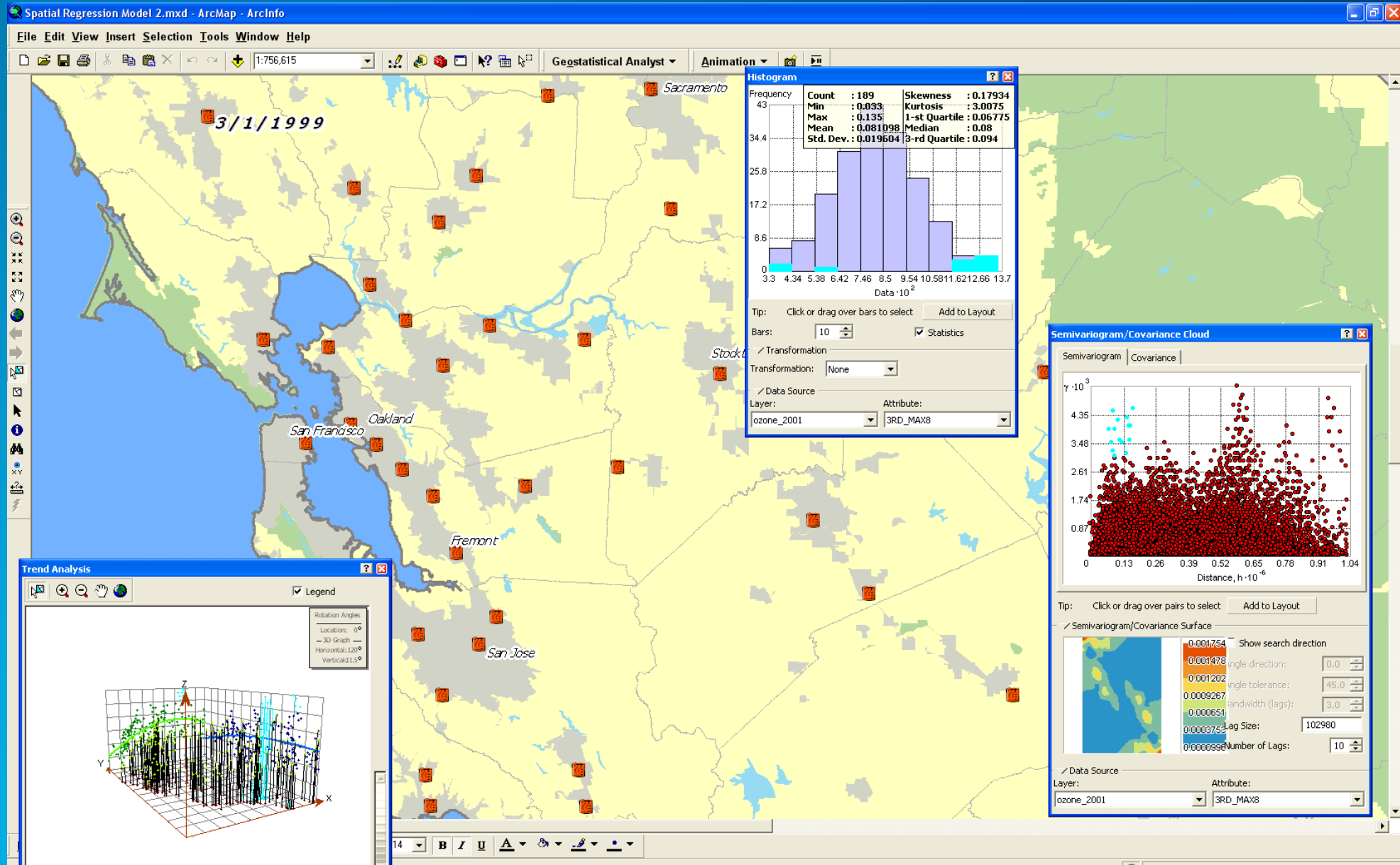
- Two asthma datasets used
 - 3-year address data (1999-2001)
 - 10-year zip-level data (1995-2004)
- Ozone and PM data (1995-2004)
- Road density surface created from StreetMap data (2004)



Exploratory Spatial Data Analysis



Data over time



Regression Analysis - R

```
Rcom_gma.py - C:\Demos\EnvironmentalHealth\Asthma\AirPollutants\GAM\Rcom_gma.py
File Edit Format Run Options Windows Help

length = len(splitstring)
shp = splitstring[length-1]
inCallibration = shp.strip(".shp") + ".dbf"

gp = Dispatch("esriGeoprocessing.GpDispatch.1")
gp.overwriteoutput = 1

#Begin R

#Call R Com Server
r = Dispatch("StatConnectorSrv.StatConnector")
#Initialize an R session
r.Init("R")

#Set Workspace in R
workspace = workspace.replace("\\", "/")
cmd = 'setwd("'" + workspace + "'" )
r.EvaluateNoReturn(cmd)

#Load the required libraries
cmd = "library(foreign)"
r.EvaluateNoReturn(cmd)
cmd = "library(mgcv)"
r.EvaluateNoReturn(cmd)

#Load the plot file (must be located in the workspace specified above)
cmd = 'source("plot_gam.txt")'
r.EvaluateNoReturn(cmd)

#Load dbf files to be evaluated
cmd = 'tr <- read.dbf("'" + inCallibration + "'" )'
r.EvaluateNoReturn(cmd)
cmd = 'names(tr)'
r.EvaluateNoReturn(cmd)
cmd = 'te <- read.dbf("'" + inGrid + "'" )'
r.EvaluateNoReturn(cmd)
cmd = 'names(te)'

#Build variables from fields in dbf tables
cmd = 'm_tr <- data.frame(x=tr$x, y=tr$y, rate=tr$RESDRPOPO4, o3=tr$O3pred, pm25
```

```
R RGui
File Edit Misc Packages Windows Help

R Console

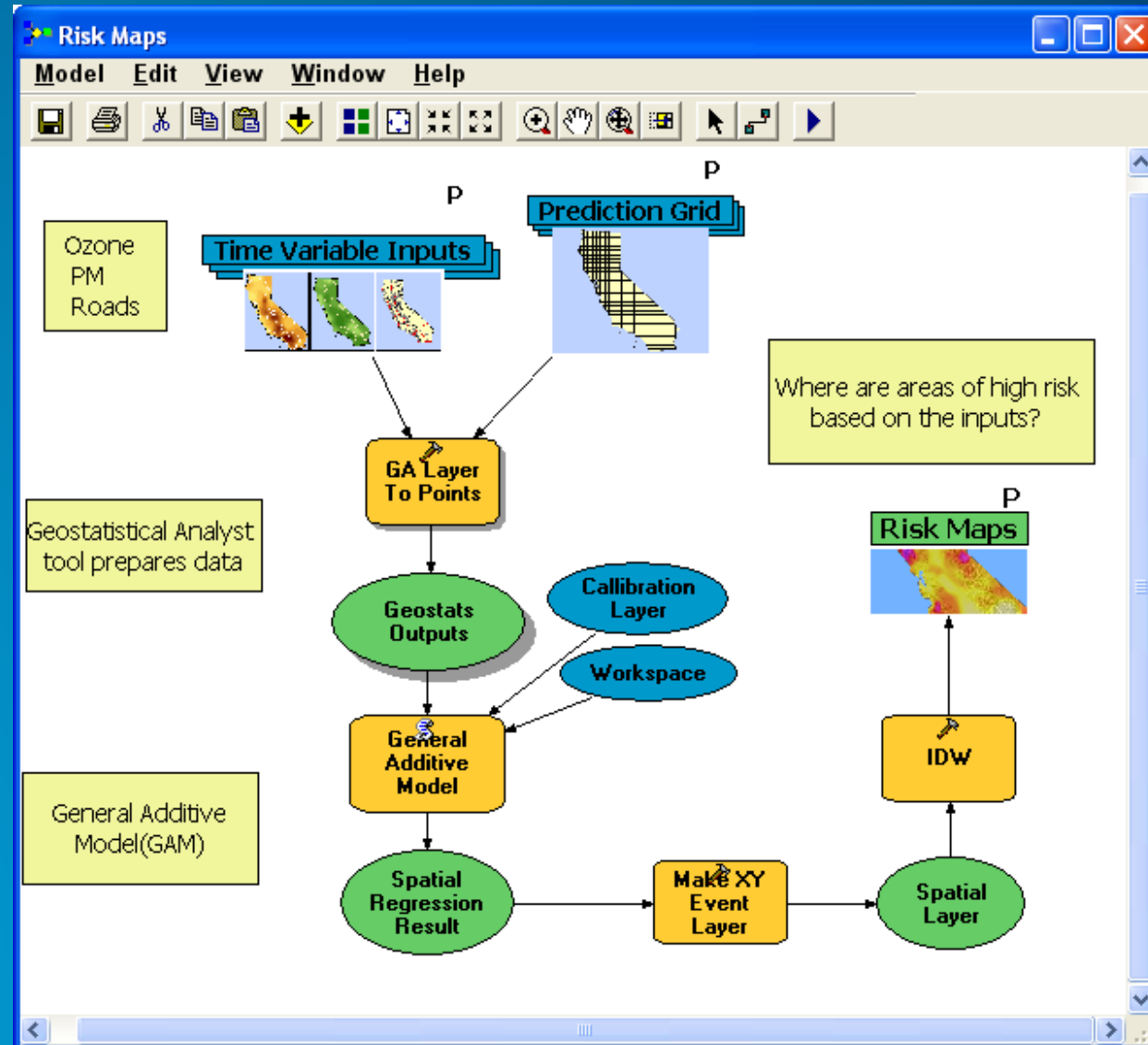
R is a collaborative project with many contributors.
Type 'contributors()' for more information and
'citation()' on how to cite R or R packages in publications.

Type 'demo()' for some demos, 'help()' for on-line help, or
'help.start()' for an HTML browser interface to help.
Type 'q()' to quit R.

> setwd('C:\\Demos\\EnvironmentalHealth\\Asthma\\AirPollutants\\GAM')
> library(foreign)
> library(mgvc)
Error in library(mgvc) : there is no package called 'mgvc'
> library(mgcv)
This is mgcv 1.3-17
> source("plot_gam.txt")
> tr<-read.dbf('zip5_PM_O3_NO2_2004_errorfree2.dbf')
> names(tr)
 [1] "OBJECTID_1" "ZIP" "PO_NAME" "STATE" "SUMBLKPOP"
 [6] "POP2004" "POPO4_SQMI" "SQMI" "RESP04" "RESPR04"
[11] "TOTDEATH04" "RESDRPOPO4" "STDERR" "CI_MINUS" "CI_PLUS"
[16] "PM25pred" "PM25stderr" "O3pred" "O3stderr" "roads"
[21] "proportion" "cell" "x" "y" "PM10pred"
[26] "PM10stderr" "NO2pred" "NO2stderr" "road_prop"
> te<-read.dbf('ga_prediction_1999.dbf')
> names(te)
```

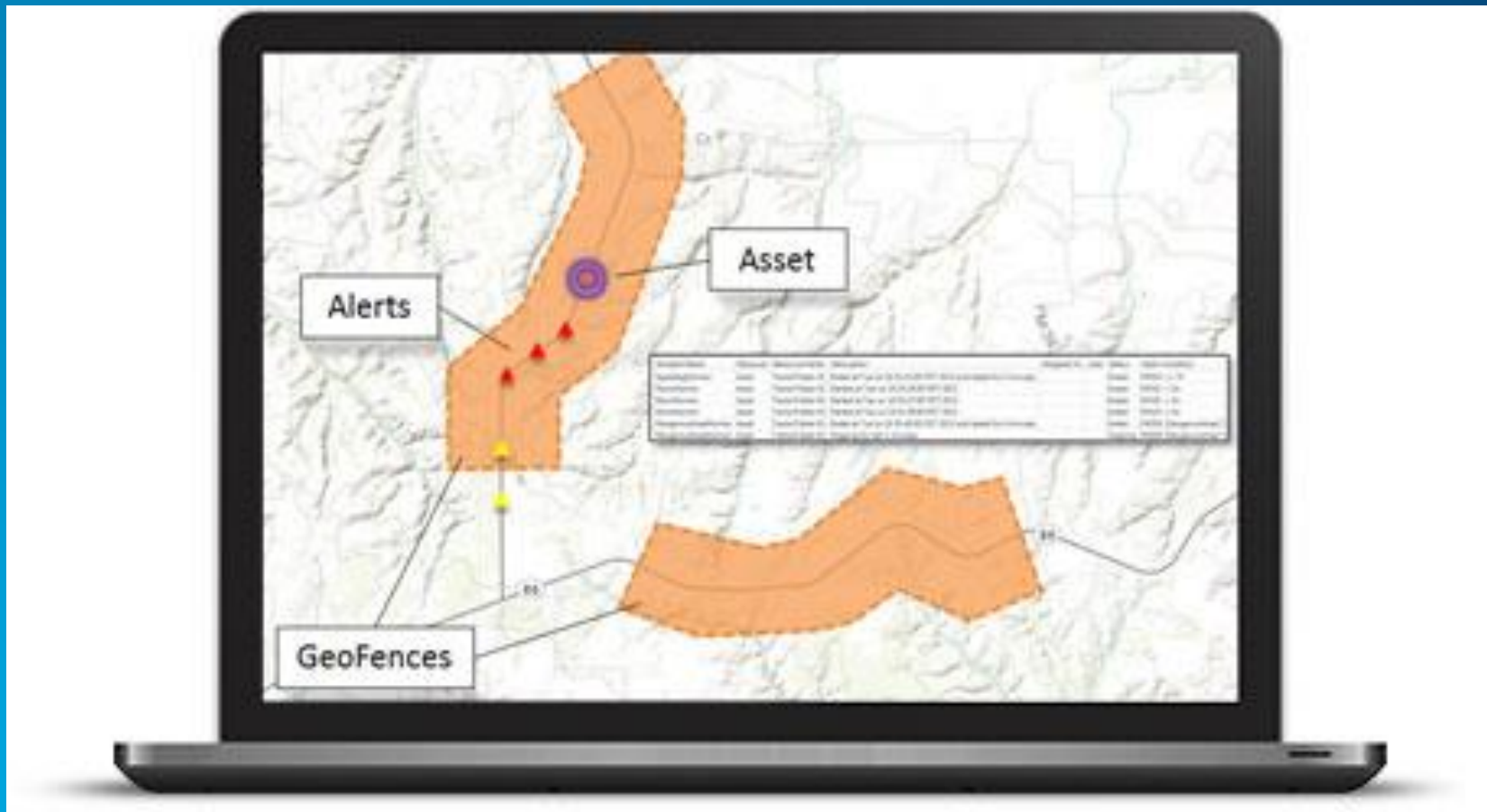
R 2.3.1 - A Language and Environment

Risk Model

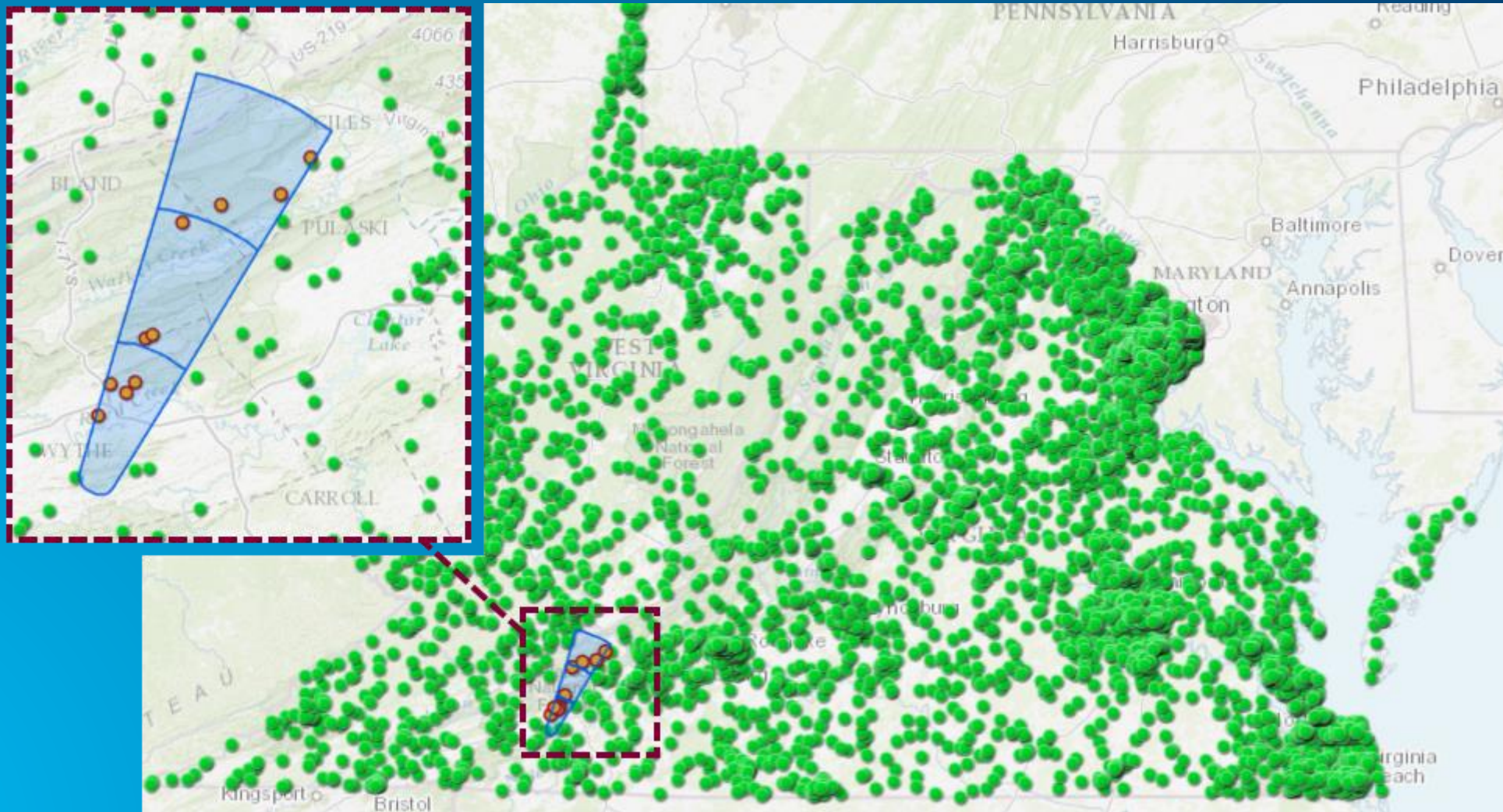


Real time GIS

Alerts when equipment enters or leaves an area



Example workflow: identify assets in storm's path



Questions?

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esri

THE
SCIENCE
OF
WHERE