

## ISAT: Impervious Surface Analysis Tool

NOAA Coastal Services Center  
University of Connecticut NEMO Project

## NEMO: Nonpoint Education for Municipal Officials

### Mission:

"An educational program for local land use officials that addresses the relationship of land use to natural resource protection."

- Education to address the issues of nonpoint source pollution and watershed management.
- Water resource protection is the focus of education. To reach this goal, NEMO promotes and educates good land use practices.
- NEMO's primary audience is local land use officials and also includes individual landowners such as farmers, forest owners, and riparian property owners.
- Through good natural resource-based planning, NEMO believes that natural resource protection, economic growth and preserving community character in the face of sprawl will be achieved.

## NEMO: Nonpoint Education for Municipal Officials

### Education through Technology:

- Geographic Information Systems (GIS)
- Remote Sensing (RS)
- World Wide Web (WWW)

### NEMO's Web Page:

[www.nemo.uconn.edu/](http://www.nemo.uconn.edu/)

- Publications and book reviews available
- Techniques and methods to reduce runoff

## NEMO: Nonpoint Education for Municipal Officials

### Indicators of Watershed Health:

The concept that impervious surface is a key indicator of watershed health.

Much of the research quantifying this relationship was conducted by Tom Schueler, now with the Center for Watershed Protection in Maryland (<http://www.cwp.org/>)

Arnold, C. and J. Gibbons. 1996. *Impervious Surface Coverage: The Emergence of a Key Environmental Indicator*. Journal of the American Planning Association 62(2):243-258.

## ISAT: Impervious Surface Analysis Tool

### Purpose:

- Estimates percentage area of watershed that is covered by impervious surfaces
- Uses land cover data and a set of land-cover specific impervious surface coefficients
- Displays results in ArcView in a color coded fashion to indicate possible water quality impacts
- Allows for testing of various scenarios to determine their impacts on water quality

### Created by:

- NOAA Coastal Services Center
- Connecticut NEMO Project

## ISAT: Impervious Surface Analysis Tool

### Software Required:

- ESRI's ArcView 3.x  
[www.esri.com](http://www.esri.com)
- ESRI's Spatial Analyst Extension  
[www.esri.com](http://www.esri.com)
- ISAT Extension  
Free Download <http://www.csc.noaa.gov/crs/is/>

# ISAT:

## Impervious Surface Analysis Tool

### Inputs Required:

- Land cover grid
- Polygon data set for which percentage of impervious surface is to be calculated
- Set of land cover impervious surface coefficients calibrated for low, medium, and high population densities
- Population density theme is optional

### Output Created:

- Shapefile that includes green, yellow, and red polygons to represent conditions of good, fair, and poor water quality
- Attribute table that includes a calculated value for the percent impervious area and total impervious surface area of each selected polygon

### ISAT Extension Download & Set-up

- Download the ISAT extension from NOAA at [www.csc.noaa.gov/crs/is](http://www.csc.noaa.gov/crs/is)

### Obtain Data for ISAT Analysis

- C-CAP land cover data can be obtained from [www.csc.noaa.gov/crs/lca/](http://www.csc.noaa.gov/crs/lca/)

- Add the Imagine Image Support Extension

- Add C-CAP data to ArcView

## ISAT Exercise



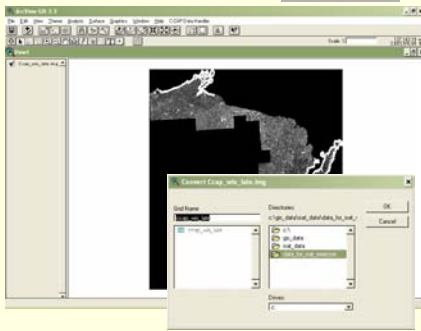
## ISAT Exercise

- Download the C-CAP Data Handler from [www.csc.noaa.gov/crs/lca/av\\_ext.html](http://www.csc.noaa.gov/crs/lca/av_ext.html)

- Add C-CAP Data Handler Extension in ArcView

- Choose Import Imagine File from C-CAP Data Handler

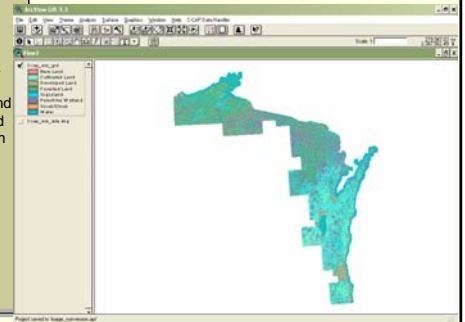
- Select .img file to convert and new grid name



## ISAT Exercise

- The Grid will be added to ArcView.

- Classify the legend by the C-CAP land cover classification scheme



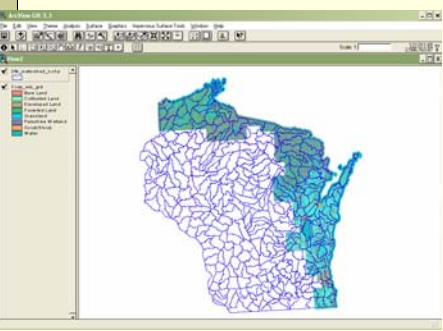
### Create Impervious Surface Analysis Project

- Add the Spatial Analyst Extension and the Impervious Surface Analyst Tool Extension

- The C-CAP Wisconsin Land Cover Grid is the **Land Cover Grid** in the ISAT analysis

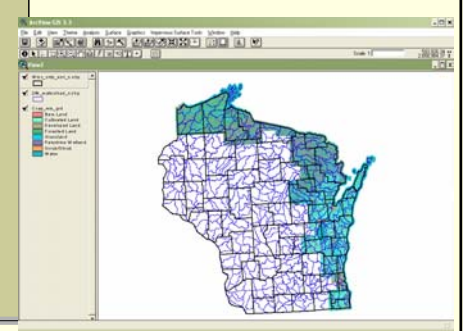
- The **Analysis Theme** for ISAT is Wisconsin's Watershed layer

## ISAT Exercise



## ISAT Exercise

- Add Wisconsin County shapefile, from ESRI, with population per square mile



For this exercise, we will perform an ISAT analysis on the Great Lakes coastal areas of Wisconsin, which are included in our land cover grid.

To begin using the Impervious Surface Analysis Tool (ISAT):

•Click on the "Impervious Surface Tools" command

•In the pull-down menu, select "Change Coefficients".

## ISAT Exercise

Value	Class Name	High	Medium	Low
1	Unclassified	0	0	0
2	High Intensity Developed	72	20.1	20.2
3	Low Intensity Developed	49	30.2	22.9
4	Cultivated Land	10.8	8.7	3.6
5	Grassland	14.9	3.9	5.7
6	Deciduous Forest	6.5	4.9	2.1
7	Evergreen Forest	6.5	4.9	2.1
8	Mixed Forest	6.5	4.9	2.1
9	Scrub/Shrub	3.9	4.9	2.1
10	Parklike Forested Wetland	22.1	3.5	3
11	Parklike Scrub/Shrub Wetland	22.1	3.5	3
12	Parklike Emergent Wetland	0	0	0

These are the impervious surface coefficients for the listed land cover classifications. Notice near the top, the "Coefficient Set" is set on "CCAP\_CT". These coefficients were derived based on impervious surface data in the state of Connecticut.

## ISAT Exercise

•Select the "Impervious Surface Tools" pull-down menu

•Choose the "Run Impervious Surface Analysis"

•The ISAT screen will appear, fill in the following information:

•Select "Calculate" for "Which Coefficient" to spawn new screen

•The Population Density Calculation window is where we will add our population density data

•Enter the following criteria

## ISAT Exercise

## ISAT Exercise

•Enter the Output Shapefile in the ISAT window

•Select "Run"

•Processing will take a minute or two

•If any grid cells in the selected polygon have no data or values, a warning will appear

•Check the imperv\_surface.shp table to determine which polygons are affected. In making your final interpretation, it will be important to remember these polygons

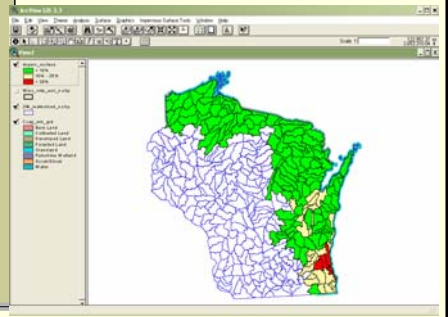
## ISAT Exercise

Performing Impervious Surface Analysis. Please wait...

## ISAT Exercise

•The Impervious Surface Tool has classified each watershed polygon that overlaps with the land cover data

•The watershed polygons are now classified by the potential impact to water quality based on the estimated percentage of imperviousness within each watershed



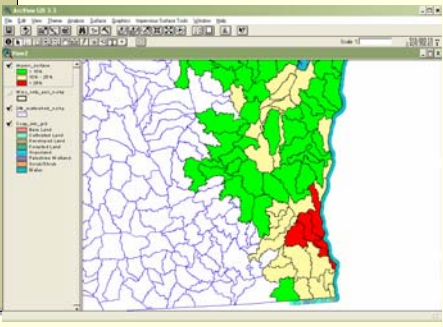
The Impervious Layer is broken into classic NEMO colors:

•Green polygons depict areas < 10% impervious surface (water quality is Protected)

•Yellow polygons are areas between 10% - 25% impervious surface (water quality is Degraded)

•Red polygons represent areas > 25% impervious surface (water quality is Impacted)

## ISAT Exercise



•Open attribute table for new theme

•Notice that the Impervious Surface Tool has retained the key field from the watershed shapefile (Sdednr\_wt\_)

•New fields: total acres/hectares, total impervious surface acres/hectares and percentage of impervious surfaces

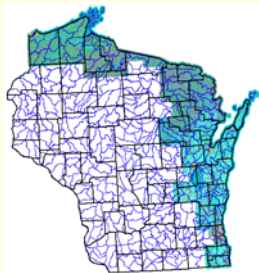
•The polygons that did not have data have "N"s in "Complete" column

## ISAT Exercise

Shape	Sdednr_wt_	TotalAcres	TotalHectares	percI	Complete
Polygon_1	6010	6010.000000	4380.152520	56.251%	
Polygon_1	15105040	6762.100000	2260.956000	34.881%	
Polygon_1	15101040	6762.100000	1390.160000	20.561%	
Polygon_1	11106100	63066.010000	4902.919110	7.781%	
Polygon_1	15106200	56762.500000	1628.573040	2.771%	
Polygon_1	15107200	59667.070000	1689.499340	3.651%	
Polygon_1	15105200	29462.100000	2136.799320	9.421%	
Polygon_1	15105200	74842.200000	2493.950010	3.301%	
Polygon_1	15102200	29177.100000	881.002720	2.791%	
Polygon_1	15116200	29006.200000	648.120760	2.291%	
Polygon_1	171445171	43464.010000	1021.243000	2.351%	
Polygon_1	151141171	12056.200000	60.907960	2.181%	
Polygon_1	15113100	48071.010000	2008.795770	4.191%	
Polygon_1	15109190	40303.620000	1416.673470	3.911%	
Polygon_1	151048112	2337.900000	123.194020	5.271%	
Polygon_1	15104111	12094.100000	1067.326440	14.411%	
Polygon_1	15102000	91307.000000	1052.570640	11.711%	
Polygon_1	151080011	1436.100000	149.102060	9.361%	
Polygon_1	15112011	31482.500000	2711.018540	8.611%	
Polygon_1	15104000	33463.070000	2416.948280	10.301%	
Polygon_1	15111011	19101.070000	1021.122440	10.241%	
Polygon_1	15113011	39981.020000	3745.980030	9.401%	
Polygon_1	15110101	12122.400000	1200.116220	10.1801%	
Polygon_1	15103000	25260.470000	12288.109510	25.161%	
Polygon_1	15112012	7290.020000	1172.464470	15.861%	
Polygon_1	15102000	222796.000000	2967.168400	30.311%	
Polygon_1	151090011	21823.800000	2060.284240	13.111%	

•Remember that the scale of this exercise is not appropriate for many types of analysis. For example, the scale can be change to perform an analysis of a particular subdivision, per lot, instead of per watershed.

## ISAT Exercise

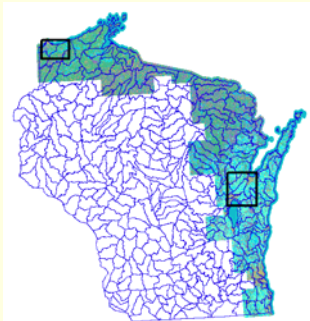


### Land Cover Change Scenarios

•ISAT also allows for Land Cover Change Scenarios to predict the effect that land cover change will have on water quality

•In this example we will create two scenarios that will demonstrate the effects of high intensity development on surrounding watersheds

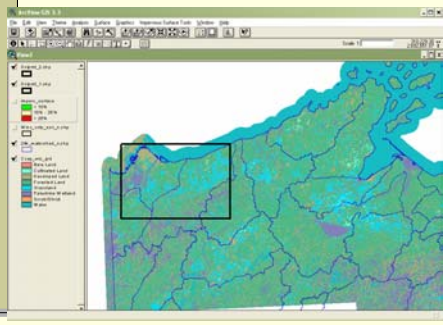
## ISAT Exercise



•Create a second shapefile named "dvlpmt\_1.shp"

•Draw a rectangle around Superior and its surroundings

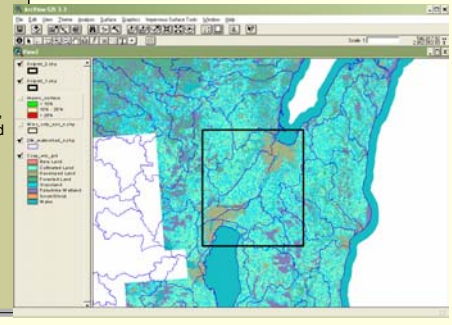
## ISAT Exercise



•Create a new shapefile named "dvlpmt\_2.shp"

• Using the "Draw Rectangle" button, draw a box around the Green Bay – Appleton corridor.

## ISAT Exercise



- From the "Impervious Surface Tools" command, select "Run Impervious Surface Analysis"

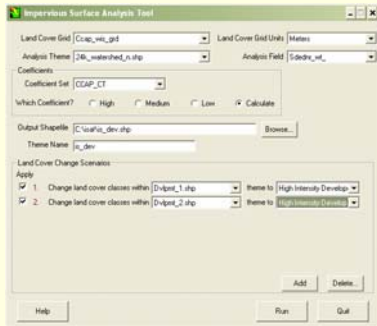
- Use parameters as earlier, but name output as "is\_dev.shp"

- Click on the "Add" button & enter "Dvlpmt\_1.shp" with a change to "High Intensity Develop"

- Repeat this procedure for "Dvlpmt\_2.shp"

- "Run" the analysis

## ISAT Exercise



- Processing will take a minute or two

Performing Impervious Surface Analysis. Please wait...

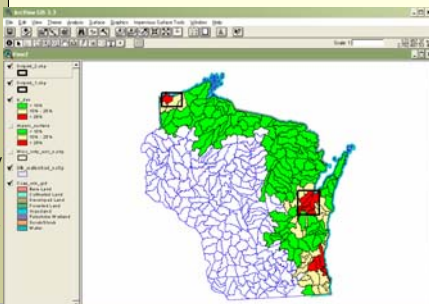
## ISAT Exercise

- The "is\_dev" theme depicts potential impact to water quality based on the estimated percentage of imperviousness within each watershed

- Notice watersheds around Dvlpmt 1 and Dvlpmt 2 Scenarios have experienced reduced water quality

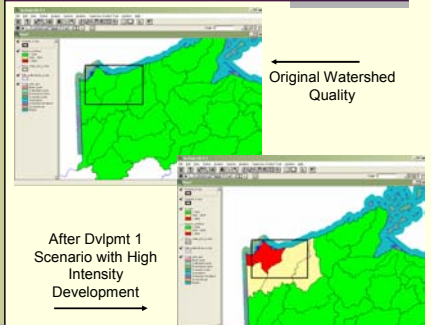
- Notice, that not just the watersheds within the confines of the Development Scenarios have been impacted

## ISAT Exercise



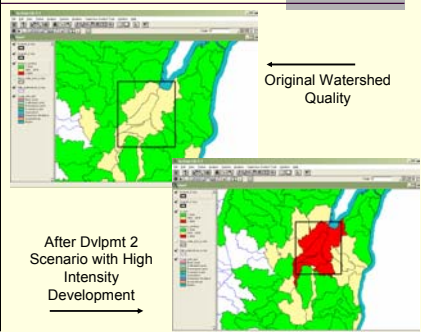
## ISAT Exercise

- Notice the changes in the watersheds around the Dvlpmt 1 Scenario



## ISAT Exercise

- Notice the changes around Dvlpmt 2 Scenario



## ISAT Exercise

- The impacts of the two scenarios can also be seen in the attribute tables

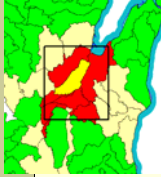
- The calculations of the percentages of imperviousness can be compared from the original scenario to the new scenarios

Shape	Intensity_wt	TotalArea	TotalIntensity	perc	Complete
Polygon_1407_090	86.791440000	4390.053250	50.701	Y	
Polygon_1810_040	1702.1700000	2245.794000	24.861	Y	
Polygon_1810_040	6962.2200000	1390.160000	20.901	Y	
Polygon_15106_100	62048.5300000	4987.091010	7.231	Y	
Polygon_15106_200	58762.5300000	1628.573400	2.771	Y	
Polygon_15107_200	19687.0700000	1878.484400	2.951	Y	
Polygon_15107_200	29402.1800000	12647.540910	27.431	Y	
Polygon_15107_200	74842.2000000	16681.509600	22.201	Y	
Polygon_15102_200	24517.1200000	4948.690200	12.201	Y	
Polygon_15116_200	29008.2000000	640.070700	2.201	Y	
Polygon_15144_175	42644.4700000	1927.200000	2.261	Y	
Polygon_15151_020	32358.4200000	439.907950	2.141	Y	
Polygon_15151_020	44079.0300000	2608.790710	4.261	Y	
Polygon_16090_190	40303.0200000	1415.620470	3.511	Y	
Polygon_16094_112	2237.8800000	121.144010	5.211	Y	
Polygon_16704_111	12964.1900000	1867.320440	14.411	Y	
Polygon_16402_060	89.305000000	1022.070400	11.301	Y	
Polygon_16704_011	1486.1900000	140.020000	9.261	Y	
Polygon_16712_011	29482.2000000	2771.016540	8.821	Y	
Polygon_16404_050	23463.0700000	3945.962400	15.201	Y	
Polygon_16711_011	18102.0700000	1671.127440	10.241	Y	
Polygon_16711_011	39803.0000000	3940.800000	9.861	Y	
Polygon_16710_011	12722.4000000	1309.116200	10.581	Y	
Polygon_16030_050	26230.4700000	12739.891010	26.761	Y	
Polygon_16711_012	2706.2000000	1174.464470	19.261	Y	
Polygon_16707_020	24278.4000000	7947.804400	30.221	Y	
Polygon_16404_011	27162.8000000	2862.944400	13.111	Y	
Polygon_18103_040	51536.7000000	12779.999400	24.801	Y	
Polygon_16708_020	3013.0000000	548.070000	18.211	Y	
Polygon_16704_020	38023.3700000	6929.343620	17.781	Y	
Polygon_18104_040	4800.2000000	1584.262400	30.261	Y	
Polygon_16705_020	12925.3800000	1263.024140	10.421	Y	
ISAT Exercise	142.0710000	1000.000000	70.701	Y	

## ISAT Exercise

Analytical Example in Watershed Change

•Watershed LF02-113 has changed from 13.39% imperviousness to 39.10% imperviousness



ArcView GIS 3.3

File Edit Table Field Window Help

Map Legend

Map of Imperv\_srf12

Date	Class	TotalClass	TotalImperv	pc%	Complete
Polygon	LF02-113	2592.230000	351.763000	13.57	Y
Polygon	M07-050	8078.440000	4390.052000	54.35	Y
Polygon	S02-040	6762.130000	2465.766000	36.46	Y
Polygon	S01-040	6962.330000	1396.168000	20.05	Y

Map of Imperv\_srf12

Date	Class	TotalClass	TotalImperv	pc%	Complete
Polygon	LF02-113	2592.230000	1018.671500	39.31	Y
Polygon	M07-050	8078.440000	4390.052000	54.35	Y
Polygon	S02-040	6762.130000	2465.766000	36.46	Y
Polygon	S01-040	6962.330000	1396.168000	20.05	Y

## ISAT Exercise

### View ISAT Parameters for a Theme

•This function allows the user to review the parameters that were entered in the ISAT analysis, to create an impervious surface theme

ISAT parameters for is\_dev

Impervious surface analysis run: Sunday March 2, 2003 12:17 PM

View: View2

Output Theme Name: is\_dev

Land Cover Theme: Coap\_srs\_gnd

Land Cover Grid Unit: Meters

Analysis Theme: 246\_watershed\_n.shp

Analysis Field: Sdedir\_vt

Coefficient Option

Population coefficient was identified using the value of the Pop50\_srs field within the Wimp\_crsq\_est\_n.shp theme.

High >= 500

Medium between 500 and 55

Low <= 55

Coefficients (Value,ClassName,High,Medium,Low)

- 1.Unclassified,0,0,0
- 2.High Intensity Developed,72.39,1.30,2
- 3.Low Intensity Developed,45.30,2.22,3
- 4.Cultivated Land,18.0,2.0,6
- 5.Grassland,14.9,0.9,5,7

OK

## ISAT Exercise

### View ISAT Metadata for a Theme

•This function allows the user to view the metadata created for an impervious surface theme.

ISAT metadata for is\_dev

Identifiers Information

Creation

Creator: NGA Coastal Services Center

Publication Date: 2003/02

File: Percent Impervious Surface Area Coverage

Description

Abstract: The National Oceanic and Atmospheric Administration (NOAA) Coastal Services Center developed the Impervious Surface Analysis Tool (ISAT) in partnership with the Oregon Education for Municipal Officers (EMCO) program to help managers and planners make a determination about the impact of impervious surface coverage on local water quality. ISAT (an extension for ArcView® version 3.2) applies impervious surface coefficients to remotely sensed land cover data to determine the total and the percentage of impervious surface area within specified polygons. ISAT can also be used to demonstrate the effect of land cover change on a watershed's imperviousness. The data set includes the polygon shape in raster data based on the percentage impervious surface coverage calculated by ISAT, applying the processing and parameters described within the present\_html section of the metadata. See http://www.csc.noaa.gov/html for more detailed description of ISAT.

Purpose: This shapefile generated from ISAT indicates the percent area impervious surface coverage within user defined polygons.

Time Period of Content

Time Period Information

Single Date Time

Calendar Date: 2003/03/02

Time of Day: 12:17

Calendar Reference: 2003/03/02

Status

Progress: Complete

Maintenance and Update: Frequency None planned

Spatial Domain

Bounding Coordinates

West\_Bounding\_Coordinate: -122.59

East\_Bounding\_Coordinate: -121.72

OK