TUTORIAL

NOAA Coastal Services Center
LINKING PEOPLE, INFORMATION, AND TECHNOLOGY

Impervious Surface Analysis Tool (ISAT) for ArcGIS 10.x

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NOAA Coastal Services Center

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Introduction

The Impervious Surface Analysis Tool (ISAT), which is available as a geographic information system script, is used to calculate the percentage of impervious surface area within user-selected geographic areas (e.g, watersheds, municipalities, subdivisions). In small watersheds, the correlation between an increase in impervious surfaces and a decrease in water quality has been well established. Users can use the information derived from ISAT to predict how different management scenarios might impact local water quality.

The National Oceanic and Atmospheric Administration (NOAA) Coastal Services Center has developed ISAT to help managers and planners make a determination about the impact of impervious surface coverage on local water quality. ISAT 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 effects of land cover change on a watershed's imperviousness. The coefficients in ISAT were developed to be used with the NOAA Coastal Services Center's Coastal Change Analysis Program (C-CAP) land cover data, but can be modified for use with various types of land cover data or to match the land cover/land use practices within a specific geographic region.

Although this tutorial describes the basic operations of the ISAT tool, it does assume the user has an intermediate level of familiarity with standard ArcView functionality and a basic understanding of land cover data. For more detailed information on C-CAP land cover data, please refer to the C-CAP Web site at *www.csc.noaa.gov/digitalcoast/data/ccapregional*.

Setup Instructions for Installing ISAT

When you downloaded ISAT, you received a zip file containing **ISAT Toolkit.tbx** (an ArcGIS custom toolbox) and the sample data files required to walk through this tutorial. Create a

C:/ISAT_Tutorial directory and extract the zipped **ISAT** files into this folder.

1. To add the ISAT tool to ArcMap, double-click the **ISAT_Tutorial.mxd** map project located in the Tutorial folder at **C:/ISAT_Tutorial**.
2. Open the **ArcToolbox** sidebar and dock it so that it displays in the ArcMap user interface.
3. In the ArcToolbox sidebar right-click on the ArcToolbox folder at the top and select **Add Toolbox**. Navigate to the **C:/ISAT_Tutorial** folder and select **ISAT Toolkit.tbx**. The ISAT tool will now be added as a custom Toolbox.
4. Expand the ISAT Toolbox in ArcToolbox to view the scripts.

Note: The Spatial Analyst Extension must be turned on for the ISAT tool to work. This tutorial was also written using ArcGIS version 10.1. If using ArcGIS version 10.0, you will need to make a new map project (mxd) other than the one provided and add the required layers as noted in the steps below.

Required Layers

Specific data is required to run the ISAT Tool in ArcGIS. The sample data provided in this tutorial describes the necessary data in detail and should be used as a guide when obtaining data for use in other areas. The processes in this Tutorial can be recreated for any area depending on data availability.

1. Analysis Theme - shapefile that contains polygons of the areas you want to analyze.
2. Land Cover Grid - land cover data.
3. Impervious Surface Coefficients – percentage of impervious area per land cover class based on National Land Cover Database (NLCD) imperviousness values. (*Note: These coefficients will be derived as an example in the Tutorial and the process can be repeated for other areas.*)
4. Population Data *(required only for imperviousness coefficient derivation process)*

Obtaining the Data

The Tutorial data provided is sufficient for learning the ISAT tool but the below data resources can be used to obtain datasets for performing ISAT analyses for your own study area. The resources below cover two of the required data components for running the ISAT tool. The Analysis Theme polygons data is entirely up to the user and can be provided by a host of data sources.

C-CAP Land Cover Change Data

The land cover data used in this Tutorial was downloaded from the NOAA Coastal Services Center Digital Coast website (*www.csc.noaa.gov/digitalcoast*). C-CAP data is available for the coastal intertidal areas, wetlands, and adjacent uplands of the contiguous U.S., Puerto Rico, the

U.S. Virgin Islands, Hawaii, and the Pacific Islands territories. There are many dates available to be used for comparison of land use change over time as well as multiple resolution options. The Tutorial data set is located in New Jersey, has a horizontal resolution of 30 meters, with a spatial reference of the North American Datum of 1983 (NAD 83). To download C-CAP data for your area please refer to the options available at the web page *www.csc.noaa.gov/digitalcoast/data/ccapregional/download*.

NLCD2006 Percent Developed Imperviousness

The land cover imperviousness coefficients used in this Tutorial are derived from a dataset contained in the Multi-Resolution Land Characteristics Consortium's (MLRC) National Land Cover Database for 2006 (NLCD2006). The database includes the NLCD2006 Percent Development Imperviousness raster layer which is used in conjunction with the C-CAP land cover data to derive imperviousness coefficients for high, medium, and low population scenarios. This layer is a nationally available data set that is updated on a five year cycle. The product has a 30 meter horizontal resolution and has an Albers Conical Equal Area projection. Once obtained, the layer should be projected to the same coordinate system as the land cover data. To download the national dataset navigate to *www.mrlc.gov/nlcd06_data.php* and download the NLCD2006 Percent Developed Imperviousness data from the Product Data Downloads section. The coefficient derivation process used in this Tutorial can be applied to other study areas.

ISAT Tutorial

Add Data

The required datasets have been downloaded for use in this tutorial. All data and necessary files are located in the ISAT_Tutorial folder that was saved to your C: drive. The data layers have been clipped to the study area and have all been projected to match the land cover data projection using ArcToolbox functions.

1. Open the **ISAT_Tutorial.mxd** map project if it is not already open.
2. Expand and review the **njccap06** layer in the Table of Contents. This is C-CAP land cover data for the New Jersey area collected in 2006 at a 30-meter resolution. There are 21 land cover types in this data set.
3. Click the **Add Data** button and add the **imprvs06** data set from the ISAT_Tutorial.gdb geodatabase to the map. This is the NLCD imperviousness layer for 2006, also collected at a 30-meter resolution.
4. Change the symbology for the **imprvs2006** layer from black and white to an inverted Spectrum-Full Bright (red-to-blue) color scheme. See image below. Note the red areas are areas of high imperviousness near 100%.
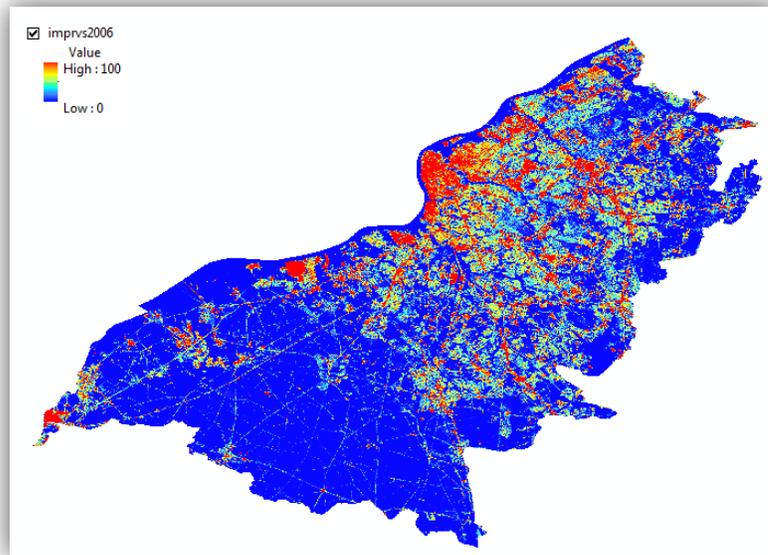
5. Add the Analysis Theme polygon. Navigate to the ISAT_Tutorial geodatabase and add **NJ_HUC14.shp** to your map. This is the analysis layer that will be used to determine imperviousness for areas based on hydrologic unit codes, or HUCs.
6. Turn all layers off except for **imprvs06** in preparation for the next steps.
7. Save your map.

Create the Imperviousness Coefficients

The NLCD2006 Imperviousness raster layer will be used in this step to create the imperviousness coefficients necessary to run ISAT. ArcMap and Microsoft Excel will be used to create the spreadsheet that is referenced by ISAT. The coefficients will be generated for each land cover type and high, med, and low population statistics.

NOTE: If you already have imperviousness coefficients for your study area in an acceptable format proceed to the next section of the tutorial. The coefficient attributes MUST be formatted like the example below in order for ISAT to run.

1. Open a new Microsoft Excel spreadsheet. Name the file **LC_ISvalues** and save the file type as a **.csv** in your ISAT_Tutorial folder.
2. Format the coefficients spreadsheet for ISAT. In the first row type the following text into the **A,B,C,D,** and **E** columns. **Value, LCName, High, Med, Low**. In row two type in the following text into the **A,B,C,D**, and **E** columns. **0, Unclassified, 0, 0, 0**. See image below for help.

	A	B	C	D	E
1	Value	LCName	High	Med	Low
2	0	Unclassified	0	0	0

3. Add land cover class names and values to the spreadsheet. Right-click on the **njccap06** layer in the Table of Contents and select **Open Attribute Table**. Using the **Table Options** dropdown in the attribute table select **Export**. Save the Output Table as **lc_names.dbf** and save to your Tutorial folder, making sure to select **dBASE Table** for the **Save as Type** option. Do not add the table to the current map when prompted.

4. Open the **lc_names.dbf** file using the Excel project you already have open. Be sure to select **dBase Files (*.dbf)** as the file type to open or you won't see the table in your folder.

5. Click on the **View** tab in Excel. Click the **Arrange All** button to view both excel projects side-by-side. Choose the **Vertical** option when prompted for display options.

6. In the **lc_names** spreadsheet click and drag to select the land cover values from the VALUE column from cells **B2** to **B22**. Right-click on the selected cells and select **Copy**. **Paste** the values into the **LC_ISvalues** spreadsheet at cell **A3**. (*Note that it should begin with a value of 2 and end with 22*).

7. Scroll over to the **CLASS_NAME** row in **lc_names** and copy the land cover class names starting at **G2** and ending at **G22**. Paste the data into **LC_ISvalues** in the **B3** cell so they are listed next to their corresponding class values. Your **LC_ISvalues** spreadsheet should now look identical to the image below.

	A	B	C	D	E
1	Value	LCName	High	Med	Low
2	0	Unclassified	0	0	0
3	2	High Intensity Developed			
4	3	Medium Intensity Developed			
5	4	Low Intensity Developed			
6	5	Developed Open Space			
7	6	Cultivated			
8	7	Pasture/Hay			
9	8	Grassland			
10	9	Deciduous Forest			
11	10	Evergreen Forest			
12	11	Mixed Forest			
13	12	Scrub/Shrub			
14	13	Palustrine Forested Wetland			
15	14	Palustrine Scrub/Shrub Wetland			
16	15	Palustrine Emergent Wetland			
17	16	Estuarine Forested Wetland			
18	17	Estuarine Scrub/Shrub Wetland			
19	18	Estuarine Emergent Wetland			
20	19	Unconsolidated Shore			
21	20	Bare Land			
22	21	Water			
23	22	Palustrine Aquatic Bed			

8. **Save** the **LC_ISvalues** spreadsheet but keep it open. Close the **lc_names** spreadsheet without saving. The **LC_ISvalues** spreadsheet is now formatted properly for ISAT and is ready for the coefficients to be added.

9. Next, you will use ArcToolbox tools to create the coefficients using the tutorial data.

10. Maximize your map. Open the ArcToolbox sidebar if necessary and dock it in your map window.

11. A population statistics layer is required for this analysis. Click **Add Data** and add the **NJPopData** polygon layer from your ISAT_Tutorial.gdb geodatabase. Right-click on the layer in the table of contents and select **Open Attribute Table**. Scroll through the attributes and scan the information. The data contains a variety of population information for municipalities and is generally publicly available for download for most geographic locations.

12. Scroll over to the **PopDensity** attribute column. This is population density for 2010 (population/sq. mile). You will use this to base your population parameters on for the imperviousness coefficients.

NOTE: The values used in this tutorial are not to be considered as the standard for use. The values are completely up to the ISAT user and can vary for location and desired analyses results.

13. Right-click on the **PopDensity** attribute column header and select **Statistics**. The **Frequency Distribution** table in the statistics is one example of where you would analyze the population distribution and decide on the **Low**, **Medium**, and **High** population parameters for the imperviousness coefficients. Ideally, you would locate breaks in the population ranges to determine the breakpoints. For this data set you will use the following pre-selected breakpoints.

Low <=500   Medium >500 and <=2500   High > 2500

***NOTE:** ISAT users should make an informed decision on what parameter(s) to use to change impervious coefficients (we recommend population density) and also to determine what their thresholds, or breaks, will be. We recommend looking at a well-resolved histogram to do this, but it could be done in other ways not described in this tutorial. A good way to view the data is to use the Histogram tool in the Microsoft Excel Analysis ToolPak Add-In. A good resource for using this method can be found at the link: http://support.microsoft.com/kb/214269*

14. Close the statistics table. Remaining in the **NJPopData** attribute table click **Table Options** and select **Select by Attributes**. Create a new selection on the layer that reads **"PopDensity" > 2500**. This will select all of the HIGH population areas to be used for the imperviousness coefficients development. Click **Apply**.

15. Close the Attribute Table and examine the data layer to see the selected polygons with a **HIGH** population designation. Toggle the **NJPopData** layer on and off with the **imprvs06** layer to see how high population density corresponds with imperviousness.

16. Right-click on the **NJPopData** layer in the Table of Contents and select **Data > Export Data**. Save the selected features to your ISAT_Tutorial.gdb geodatabase and name the layer **NJPopHigh**. Click **OK**. Add the layer to the map when prompted. Turn off the **NJ_PopData** layer. Clear all selected layers in the map.

17. In the ArcToolbox sidebar navigate to the **Spatial Analyst Tools > Zonal** toolbox and double-click the **Zonal Statistics as Table** tool. Populate the tool parameters with the inputs below.

> Input raster or feature zone data: **njccap06**
> Zone field: **VALUE**
> Input value raster: **imprvs2006**
> Output table: C:\ISAT_Tutorial.gdb**NJPopHigh**

Leave the other options at their defaults. Click on the **Environments** tab at the bottom of the tool interface. Expand the **Processing Extent** section. From the **Extent** dropdown choose the **Same as layer NJPopHIGH** option. Click **OK**. Click **OK** again to run the tool.

18. An output table named **NJPopHIGH** will be added towards the bottom of your Table of Contents. Right-click the table and select **Open**. Identify the **MEAN** column. These values represent the imperviousness coefficients for the High population land cover types. The **VALUE** row represents the class name codes that will be used to link the coefficients to the land cover types found in the **LCISvalues** spreadsheet.

*NOTE: Count down through the **VALUE** attribute column from **2** to **22** noting any missing values. The land cover class names that correspond with the values should all be accounted for. Notice that as you count through the rows from **2** to **22** that the value **16** is missing. This is very important to note as it can cause improper coefficient values if not adjusted. Maximize the **LC_ISvalues** worksheet and see which land cover class name corresponds to the class name value of **16**. The value of **16** should correspond to the **Estuarine Forested Wetland** land cover type. This means that during the analysis there was no **Estuarine Forested Wetland** found in the analysis theme area and was therefore omitted. In the next steps you will adjust the coefficients worksheet for this but it is very important to note and address any omitted land cover types for future analyses. If using your own data there may be other land class types omitted if they are not present within the analysis theme polygon area.*

19. Click the **Table Options** dropdown and select **Export**. Save the table as **LC_High.dbf** to the ISAT_Tutorial folder making sure to select the **Save as Type** as **dBASE Table** from the dropdown option. Click **OK** to export the table. Do not add the table to your map when prompted.
20. Maximize your **LC_ISvalues.csv** worksheet. Select **File > Open**, navigate to the ISAT_Tutorial folder and open the **LC_High.dbf** table. On the **Main Menu** in Excel select the **View** tab. Click the **Arrange All** function to view the two files side-by-side. Choose the **Vertical** option when prompted.
21. Select and copy the cells in the **MEAN** column in **LC_High.dbf** starting at **G2** and ending at **G21**.
22. Paste the data into cell **C3** of the LC_ISvalues worksheet.
23. Fix the coefficient for the omitted land cover classes if necessary, from step 18. Right-click in the cell to the right of Estuarine Forested Wetland in the LC_ISvalues worksheet and select **Insert > Shift Cells Down**. Click **OK** to shift the cells down.

24. Type a **0** in the **corresponding** empty cell. The coefficients worksheet is now complete for the High Population analysis scenario.

25. Format the cells. Click and drag over the **C,D**, and **E** column headers above the **High**, **Med**, and **Low** entries to select the entire contents of the columns. Right-click and select **Format Cells**. For the **Category** select **Number** and select the default at **2** decimal places. Click **OK**.

26. Make sure your worksheet looks identical to the image below up to this point. Note the red box illustrating the replaced **Estuarine Forested Wetland** value. **Save** your worksheet.

	A	B	C	D	E
1	Value	LCName	High	Med	Low
2	0	Unclassified	0		
3	2	High Intensity Developed	76.45		
4	3	Medium Intensity Developed	49.21		
5	4	Low Intensity Developed	25.72		
6	5	Developed Open Space	11.15		
7	6	Cultivated	3.21		
8	7	Pasture/Hay	2.06		
9	8	Grassland	9.3		
10	9	Deciduous Forest	2.18		
11	10	Evergreen Forest	1.44		
12	11	Mixed Forest	2.74		
13	12	Scrub/Shrub	3.86		
14	13	Palustrine Forested Wetland	1.16		
15	14	Palustrine Scrub/Shrub Wetland	1.31		
16	15	Palustrine Emergent Wetland	1.46		
17	16	Estuarine Forested Wetland	0		
18	17	Estuarine Scrub/Shrub Wetland	0.01		
19	18	Estuarine Emergent Wetland	1.23		
20	19	Unconsolidated Shore	14.1		
21	20	Bare Land	14.91		
22	21	Water	0.82		
23	22	Palustrine Aquatic Bed	1.94		

27. Repeat the coefficient derivation process for the **Medium** and **Low** population breakpoints. Starting at step **14** in this section of the tutorial repeat the process first for the Medium category population parameters (**Medium >500 and <=2500**) and then finally for the Low population category (**<=500**).

*NOTE: Remember to check for any missing land cover classes by scanning the **Value** list in the Zonal Statistics by Output tables and comparing them with the LCName column in LC_ISvalues! There should be no numeric break between **2** and **22**.*

28. Review your **LC_ISvalues** coefficients worksheet for use in ISAT. Your **LC_ISvalues** worksheet should look identical to the image below after calculating and adding in the **Medium** and **Low** population imperviousness coefficients. Make sure of this before moving on to the next steps.

|	A	B	C	D	E
1	Value	LCName	High	Med	Low
2	0	Unclassified	0.00	0.00	0.00
3	2	High Intensity Developed	76.45	76.61	76.36
4	3	Medium Intensity Developed	49.21	49.02	48.99
5	4	Low Intensity Developed	25.72	25.55	25.57
6	5	Developed Open Space	11.15	10.95	10.93
7	6	Cultivated	3.21	2.59	2.44
8	7	Pasture/Hay	2.06	1.51	1.40
9	8	Grassland	9.30	8.74	8.47
10	9	Deciduous Forest	2.18	1.88	1.77
11	10	Evergreen Forest	1.44	1.23	1.20
12	11	Mixed Forest	2.74	2.22	2.08
13	12	Scrub/Shrub	3.86	3.50	3.28
14	13	Palustrine Forested Wetland	1.16	0.96	0.92
15	14	Palustrine Scrub/Shrub Wetland	1.31	1.27	1.26
16	15	Palustrine Emergent Wetland	1.46	1.44	1.46
17	16	Estuarine Forested Wetland	0.00	0.00	0.00
18	17	Estuarine Scrub/Shrub Wetland	0.01	0.01	0.01
19	18	Estuarine Emergent Wetland	1.23	1.31	1.22
20	19	Unconsolidated Shore	14.10	14.37	13.87
21	20	Bare Land	14.91	14.73	14.49
22	21	Water	0.82	0.89	1.00
23	22	Palustrine Aquatic Bed	1.94	1.88	2.15

Run a Basic Analysis using the ISAT Tool

All of the necessary data is now available to run the ISAT tool. Some additional data sets provided for you will be used in this section for the reclassification scenarios. These data may or may not be required depending on your use of ISAT.

1. Prepare your map display for ISAT analysis. In the Table of Contents make sure your view is the **List by Drawing Order** view. Remove the **NJPopLow**, **NJPopMed**, and **NJPopHigh** layers from your map. Remember, the **NJ_HUC14** analysis theme layer has already been added to your map.
2. Turn off all layers in your map project except for **NJ_HUC14**, **njccap06, and the Basemap imagery**.
3. Run the ISAT tool. Double-click the **ISAT with Change Scenarios** script in the ArcToolbox sidebar.
4. Populate the script interface with the following parameters.

   > Input Raster: **njccap06**
   > Statistical Zone Layer: **NJ_HUC14**
   > Statistical Zone Field: **HUC14**
   > Coefficient File: C:\ISAT_Tutorial**LC_ISvalues.csv**
   > Class of Coefficients to Use: **High**
   > Output Layer: C:\ISAT_Tutorial.gdb**ISAT_High**

5. Click **OK** to run the ISAT tool. The **ISAT_High** layer will be added to your map and should look similar to the image below.
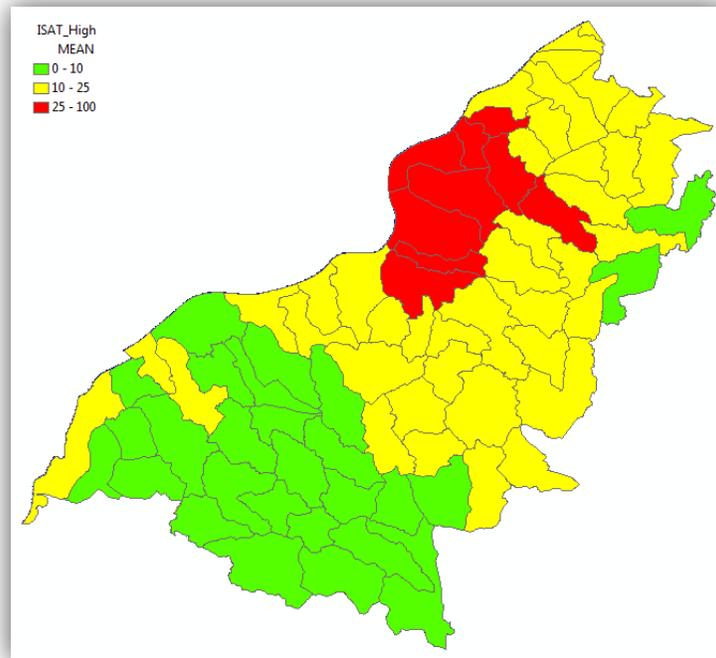
The default legend applied to the new theme indicates the potential impact to water quality based on the estimated percentage of imperviousness within each analysis field. Green areas correspond to **<10%** impervious surface (Protected), yellow areas correspond to **10%-25%** impervious surface (Degraded), and red areas correspond to **>25%** impervious surface (Impacted).

*NOTE: The above symbology for the ISAT output layers will not be applied if you choose to remove the layer from the map and then add it back in later. One solution to this is to export the layer as a LYR file which will capture and maintain the symbology. Once you have a LYR file you can import the symbology in the layer properties and apply it to any previous ISAT runs. A sample LYR file for the ISAT symbology above can be located in your ISAT_Tutorial folder (**ISAT_Symbology.lyr**).*

6. Right-click **ISAT_High** in the table of contents and click **Open Attribute Table** to analyze the results of the analysis.

The attribute table contains new columns for each analysis, two of which you are primarily interested in: **AREA_IS** and **MEAN_IS**. **AREA_IS** is the total impervious area within each analysis field. Note that this is in square meters, as the projection of the data and data frame properties are in meters. This value can be easily converted to acres or miles depending on needs by adding a field to the attribute table and using the field calculator. You can query the imperviousness of each polygon based on the coefficients for each land cover class by selecting and viewing the attributes. **MEAN_IS** is the percentage of impervious surface within each analysis field. This can also be queried for each individual polygon from the analysis theme.

7. **Close** the **ISAT_High** layer attribute table and **Save** your map project.

You have now completed a basic ISAT analysis. Note that this analysis was performed using the **High** class of coefficients from your **LC_ISvalues** worksheet. The same process can be applied using the **Medium** or **Low** coefficients by changing the parameters in the ISAT tool **Class of Coefficients to Use** dropdown. The additional analyses can be useful for comparing scenarios based on population parameters and their corresponding imperviousness coefficients.

Run a Basic ISAT Analysis using the Population Layer and Breakpoints Option

The ISAT tool also has an additional **Population Layer and Breakpoints** option. This option highlights the reason behind developing different coefficients for ISAT. If one set of coefficients were used for every analysis they would likely be developed differently. This option allows the user to customize the ISAT analysis to their desired scenario. To utilize this function, a population theme layer containing population statistics is required. An example data set has been provided for this tutorial.

1. Prepare your map display for another ISAT analysis. Turn off the **ISAT_High** analysis layer in the table of contents. Add the **NJPopData** layer from the ISAT_Tutorial.gdb geodatabase. This layer contains population density information for the study area. Right-click and open the attribute table to review the population density information.
2. Run the ISAT tool. Double-click the **ISAT with Change Scenarios** script in the ArcToolbox sidebar.
3. Populate the script interface with the following parameters.

    > Input Raster: **njccap06**
    > Statistical Zone Layer: **NJ_HUC14**
    > Statistical Zone Field: **HUC14**
    > Coefficient File: C:\ISAT_Tutorial**LC_ISvalues.csv**
    > Class of Coefficients to Use: **Calc**
    > Output Layer: C:\ISAT_Tutorial.gdb**ISAT_Calc**

4. Expand the **Population Layer and** Breakpoints optional dropdown. This will activate the optional function in which the **Population Field**, **Low Breakpoint**, and **High Breakpoint** population parameters can be defined for a data set containing population information. Input the following parameters.

    > Population Field: **PopDensity**
    > Low Breakpoint: **5000**
    > High Breakpoint: **5500**

5. Click **OK** to run the ISAT tool. The **ISAT_Calc** layer will be added to your map. Right-click **ISAT_Calc** in the table of contents and click **Open Attribute Table** to analyze the results of the analysis.

6. Examine the **AREA_IS** and **MEAN_IS** attributes to analyze the total and mean impervious area within each analysis field for the defined population parameters. Again, this is a customizable option for individual analysis and highly dependent on the population data and user input. Note that this example is in square meters, since the projection of the data and data frame properties are in meters. This value can be easily converted to acres or miles depending on needs by adding a field to the attribute table and using the field calculator.

Apply a Change Scenario (Reclassification) using the ISAT Tool

Now that you are familiar with the basic functionality of the **ISAT with Change Scenarios** script you can explore the more advanced functionality. The **Apply Change Scenarios** function is a great tool for analyzing imperviousness before and after land use change scenarios. Some additional data sets provided for you will be used in this section for the reclassification scenarios. These data may or may not be required depending on your use of ISAT.

1. Add additional data used for ISAT change scenarios. Click **Add Data** and add the **Golf_Course.shp** and **Development.shp** layers from the ISAT_Tutorial.gdb geodatabase. These layers will be used as the land use reclassification scenarios.
2. Turn off all layers except for **Golf_Course**, **Development**, and **njccap06**. Notice the shapes and locations of the proposed land use change scenarios. Toggle the layers on and off to note the C-CAP land cover classes beneath them.
3. Run the ISAT tool. Double-click the **ISAT with Change Scenarios** script in ArcToolbox to open the interface.
4. Populate the script with the following parameters.

> Input Raster: **njccap06**
> Statistical Zone Layer: **NJ_HUC14**
> Statistical Zone Field: **HUC14**
> Coefficient File: C:\ISAT_Tutorial**LC_ISvalues.csv**
> Class of Coefficients to Use: **High**
> Output Layer: C:\ISAT _Tutorial**ISAT_HighReclass.shp**

5. Apply the change scenarios. Expand the **Apply Change Scenarios** option in the tool interface. Drag and expand the tool interface window to see the all of the options. Click the **Class Field** dropdown and select **CLASS_NAME**.
6. In the **Polygon Layer** dropdown select **Development** from the choices.
7. For the **Reclassify as Class** option select **High Intensity Developed** from the dropdown.
8. Return to the **Polygon Layer** option this time selecting **Golf_Course** from the dropdown. For the **Reclassify as Class** option select **Developed Open Space** from the dropdown.

Notice that both of the change scenarios are now listed in the **Reclassifications** area. The **Apply Change Scenarios** option has the ability to do one or many reclassifications and integrate them into the ISAT tool simultaneously. When using your own data this option may be very useful to you. Note that it is wise to have the change scenario shapefiles in the same projection as the rest of your map data.

9. Leave the **Fill NODATA Cells** unchecked at its default. For more information on this function click the **Show Help** button at the bottom of the tool interface.
10. Run the tool. Click **OK** to run the ISAT tool. This process may take a few seconds longer than the basic ISAT analysis. The **ISAT_HighReclass** layer will be added to your map. Make sure it is above the **ISAT_High** layer in your Table of Contents.
11. Compare the outputs. Toggle the **ISAT_HighReclass** layer on and off to compare to the **ISAT_High** layer.

*NOTE: The ISAT run did not add a new reclassified C-CAP land cover layer into your map display. This layer is deleted as an intermediate step within the scripts. However, this layer could be useful for other analyses and for viewing the land cover changes within the land cover data set. To produce this dataset use the **Reclass Land Cover by Polygon** tool found within the ISAT Toolkit in ArcToolbox. This is a custom script that will generate a new land cover layer with the reclassification scenarios and class name symbology applied.*

12. Examine the statistics to determine change in imperviousness percentage. Turn on only the **ISAT_High** layer. Using the **Select** tool click the analysis theme polygon shown in the image below.
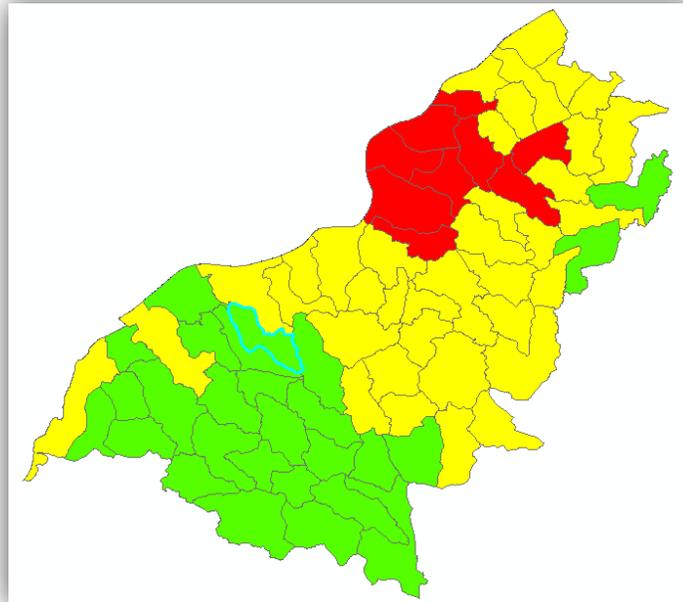
13. Right-click the layer and open its attribute table. Find the selected polygon in the attribute table by scrolling or choose the **Show Selected Records** only option at the

bottom of the attribute table. Locate the **MEAN_IS** attribute column and note that the percentage of imperviousness for this area was calculated at **6.58%** for the basic ISAT run without the change scenario.

14. Close the attribute table for **ISAT_High** and clear all selected layers. Turn on the **ISAT_HighReclass** layer and use the **Select** tool to select the same analysis them polygon area as in the previous step.

15. Right-click and open the attribute table. Find the selected polygon in the table again and locate the **MEAN_IS** statistic. The **MEAN_IS** percentage imperviousness for the same area is now **20.54%.**

Notice that the area designated for the **Development** change scenario changed three polygon percentages of imperviousness from **0-10%** to **10-25%,** which may be considered "degraded" in terms of imperviousness. This scenario shows that the **Development** change scenario could cause a **20%** percent increase in imperviousness for the selected area. The golf course change scenario resulted in the percent imperviousness of each impacted polygon approximately doubling, which can be seen by comparing the layers with the **Identify** tool or by looking at the Attribute Tables. However, this increase in imperviousness did not appear to change the classification of imperviousness for its area likely due to the percent imperviousness still being less than 10 percent. The power of the ISAT tool lies in being able to do the land use cover change scenarios and compare areas that may be impacted by an increase in imperviousness.

16. If time permits, perform the same statistics analysis for the proposed **Golf_Course** change scenario and calculate the increase or decrease of imperviousness based on the **MEAN_IS** values.

Appendix

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