

An IMPERVIOUS SURFACES MODEL for DETERMINING WATER QUALITY within WATERSHEDS

An Application of GIS and Remote Sensing to Coastal Issues

Water quality is an important concern in Hawaii because of the state's unique physical characteristics and development pressures. As a result of significant economic growth and an increase in population, development demands present a formidable challenge to sustainable management of Hawaii's water resources today. As development expands along our coasts, pressure on marine and fresh-water resources increases. Pollutant levels in these systems are amplified, stressing plant and animal species dependent on these resources, including humans. One factor associated with development and land use decisions that influences watershed pollutant levels is impervious surface coverage.



Unlike areas where soil and vegetation absorb rainwater, **impervious surfaces** are areas that water cannot penetrate. Rooftops, roads, and parking lots are examples of impervious surfaces associated with development. When rains wash over these surfaces, residue and debris are collected and delivered to streams, and are eventually drained into soil and groundwater or coastal waters. Not all impervious surfaces are manmade, however. Some soil and rock types, such as clays, are naturally impervious. When the percentage of impervious surface blanketing a watershed reaches a certain level, water quality is negatively impacted.

The **Impervious Surface Analysis Tool** created by the Coastal Services Center's Coastal Remote Sensing Program and the Nonpoint Education for Municipal Officials (NEMO) Project identifies the percentage of impervious surface resulting in water quality degradation. CZM Hawaii is currently partnering with the Coastal Services Center to adjust the tool for Hawaii's impervious surface issues.

THE TOOL

The Impervious Surface Analysis Tool, or ISAT, is an ArcView® extension that uses remote sensing data and impervious surface coefficients to calculate impervious surface area within specified polygons.

The extension adds an "Impervious Surface Tools" dropdown menu to the ArcView® GUI (Figure 1). The tool calculates the percentage of impervious surface within user-specified polygons using population density information and impervious surface coefficients (Figure 2) for each land cover type represented. These coefficients are applied to the land cover classifications in a land cover grid layer describing landscape features as natural or developed (Figure 3). The land cover grid and population themes are specified in the ISAT dialog box (Figure 4). The 3D image of the Waianae ahupua`a on the next page is composed of land cover information like that used in the ISAT model.

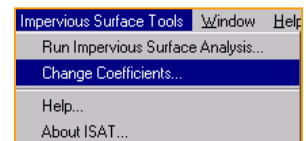


Figure 1: The ISAT menu

The output shapefile created by ISAT depicts areas where impervious surface coverage is less than 10 percent (*water quality is protected*), is 10 to 25 percent (*water quality is degraded*), and is greater than 25 percent (*water quality is severely degraded*). Figures 5 and 6 provide an example of the ISAT shapefile, legend, and attribute table created.

Change Coefficients					
Coefficient Set		CCAP_CT	New...		
ID	Class	Name	High	Medium	Low
1	Unclassified		0	0	0
2	High Intensity Developed		59.5	39.1	30.2
3	Low Intensity Developed		41.3	30.2	22.9
4	Cultivated Land		14.7	8.7	3.6
5	Grassland		14.9	9.9	5.7
6	Deciduous Forest		3.9	4.9	2.1
7	Evergreen Forest		3.9	4.9	2.1
8	Mixed Forest		3.9	4.9	2.1
9	Scrub/Shrub		3.9	4.9	2.1
10	Palustrine Forested Wetland		22.1	3.5	3
11	Palustrine Scrub/Shrub Wetland		22.1	3.5	3
12	Palustrine Emergent Wetland		0	0	0
13	Estuarine Forested Wetland		22.1	3.5	3

Figure 2: Sample coefficient set



Figure 3: Sample land cover grid legend

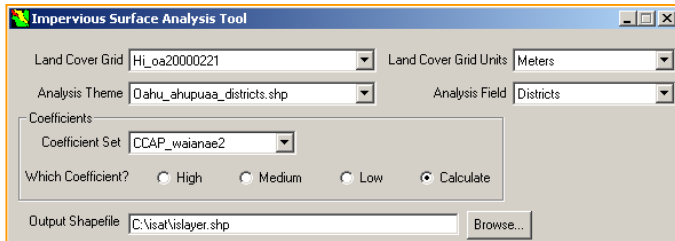


Figure 4: The ISAT dialog box

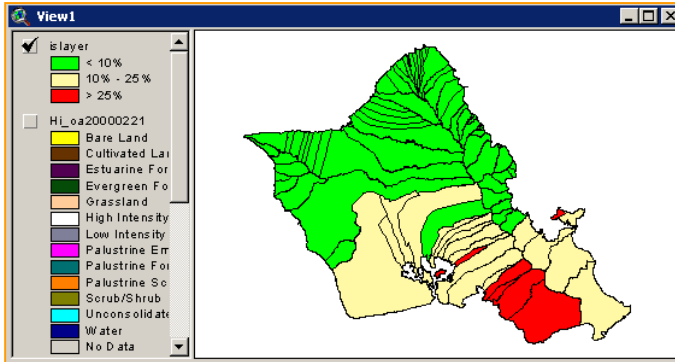


Figure 5: Sample impervious surface percentage shapefile (Islayer.shp)

APPLICATION

Impervious surface information can be used for community outreach and education, water quality and land cover research, urban planning, and land use decisions. The ISAT extension can be used to create land use change scenarios to determine impacts of human alteration of landscape, the results of which are important for effective decision-making and urban planning, and can be distributed to communities for education on development impacts and water quality. Researchers can also refine the tool to utilize higher resolution data and more accurate coefficients for a more detailed assessment.

To receive more information about the Impervious Surface Analysis Tool, including copies of the Hawaii ISAT Training Manual and project progress updates, please contact CZM Hawaii or the Coastal Services Center's Coastal Remote Sensing Program:

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DEVELOPMENT

Specify land cover theme and units
 Specify theme with population information

As part of CZM Hawaii's Cumulative and Secondary

Impacts initiative, development of the ISAT application will focus initially on the Waianae region, where little research has been completed on water resources and related problems. The Coastal Services Center recently completed impervious surface coefficients for the Waianae moku (district). To accomplish this, one-meter digital orthographic quarter quads (DOQQs) were used to delineate impervious surface features for areas representative of high, medium, and low impervious surface coverage. These features were then overlaid on land cover data to generate coefficients for each land cover type. These coefficients are entered into ISAT to calculate the percentage of impervious surface coverage of a user-specified area.

Shape	Huc14	TotalAcres	TotalSAcres	pctIS	Complete
Polygon	02040202110070	4994.403036	1213.143079	24.29	N
Polygon	02040202110060	5259.736256	1378.018874	26.20	N
Polygon	02040202110050	4543.581209	1087.727649	23.94	Y
Polygon	02040202120090	8680.599862	2299.863661	26.49	N
Polygon	02040202120070	3967.098636	1026.596030	25.88	Y
Polygon	02040202120110	7030.329532	1257.949695	17.89	N
Polygon	02040202120080	5397.629466	1070.959389	19.84	Y
Polygon	02040202120120	3665.068028	415.659949	11.34	N
Polygon	02040202120020	7976.232460	1630.167058	20.44	N
Polygon	02040202140010	7665.972737	802.304941	10.47	N
Polygon	02040202130060	3940.854445	595.758485	15.12	Y

Figure 6: Attribute table for the ISAT shapefile, listing total acres in the selected area, total acres of impervious surface, and percent impervious surface.

