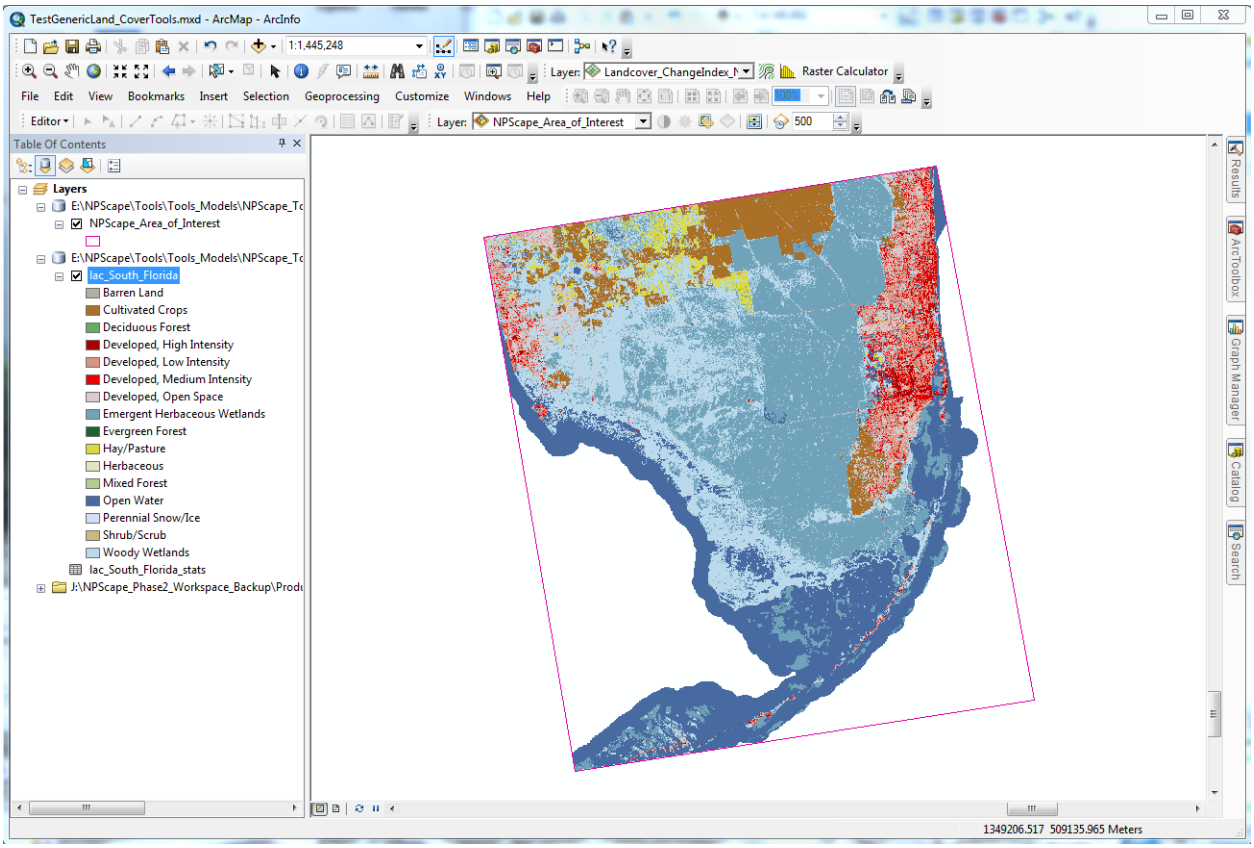
National Park Service
U.S. Department of the Interior

Natural Resource Stewardship and Science

NOTE: There may be revised processes and documentation available.

Check the NPScape methods webpage (http://science.nature.nps.gov/im/monitor/npscape/methods.cfm) for the most current version.

NPScape Standard Operating Procedure: Land Cover Measure – Area per Category, Impervious Surface, Change Index, and Natural vs. Converted



Suggested Citation: National Park Service. 2013. NPScape Standard Operating Procedure: Land Cover Measure – Area per Category, Impervious Surface, Change Index, and Natural vs. Converted. Version 2014-01-06. National Park Service, Natural Resource Stewardship and Science. Fort Collins, Colorado.

Contents

Overview **3**
Software Requirements **4**
Data Requirements **4**
Pre-Processed National Land Cover Dataset (NLCD) 2006 4
Pre-processed Coastal Change Analysis Program (C-CAP) 1996, 2001, 2006 4
Pre-processed North American Land Cover (NALC) 2005 4
Area of Analysis polygon 5
Input data spatial reference 5
Input Data Pre-Processing **5**
Determine AOA polygon 5
Re-project user-defined input datasets (if needed) 5
Download tool input datasets 5
Run Generic Area per Category tool **6**
Add toolbox to ArcMap 6
Run the Generic area per category tool 6
Run Impervious Surface tool **8**
Add toolbox to ArcMap 8
Run the Impervious Surface Tool 9
Run Change Index tool **10**
Add toolbox to ArcMap 10
Run the Change Index Tool 11
Run Natural vs. Converted Area per Category tool **11**
Add toolbox to ArcMap 12
Run the Generic area per category tool 12
Quality Control **13**
Verify dataset outputs 13
Verify statistics output 13
Interpretation Tips **14**
Output raster and statistics table attributes: 14
Frequently Asked Questions **15**
Can/should I use a different spatial reference? 15
I'm having trouble downloading the tool input dataset. Is there another way to get it? 16
My outputs don't show up in my map. What can I do? 16
Literature Cited **16**
Appendices **17**
Appendix 1: Known issues 17
Appendix 2: Default Reclassification tables 17
Appendix 3: Using custom AOAs and/or local input data 22
Appendix 4: Generate natural vs. converted or level 1 land cover metrics 23
Appendix 5: Tool scripts 23
Appendix 6: Tool input data processing details 24

Version History

Version	Update Date	Changes
20130213	20130213	Final draft to reflect seamless NLCD, NALC, and CCAP source data. Additional guidance in Appendices on using local sources of land cover data.
20130315	20130315	Note added regarding an issue in Geoprocessing Options between ArcMap 10.0 and 10.1 that could cause a script to fail in 10.1

20130808	20130808	Added capability to use Generic Landcover and Natural Converted tools on Pacific Island data, using native projections for each island group in Network. Change Index (2005-2011) for Guam.
20130918	20130918	Corrections to Reclass Tables in Appendix; clarification of tool instructions to include Pacific Island, USVI CCAP data products
20131223	20131223	Tool optimized for use with ArcMap 10.1, and tested for use with 10.2

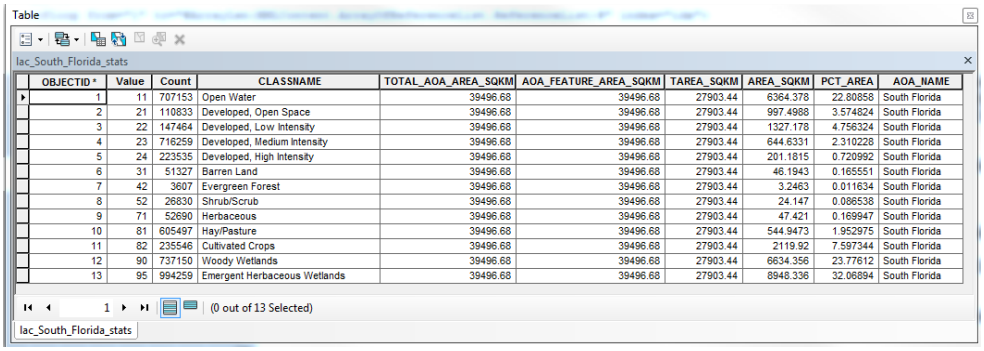
Overview

NPScape is a landscape dynamics monitoring project that provides landscape-level data, tools, and evaluations for natural resource management, planning, and interpretation (NPS 2013). This standard operating procedure (SOP) provides guidance on how to generate the following NPScape land cover metrics: area per category (LAC), impervious surface (LPI), natural vs. converted (LNC), and change index (LCI). Download the tool(s) and a copy of this SOP here: http://science.nature.nps.gov/im/monitor/npscape/methods.cfm

The purpose of this SOP is threefold. First, because these directions were followed in the processing of the NPS datasets, it provides detailed documentation on the methodology used by NPScape to calculate LAC, LPI, LNC, and LCI metrics for the Land Cover measure. Second, this SOP provides any user with the ability to replicate the creation of these data for custom areas of analysis. Finally, if an I&M park or network has a need to analyze other sources of land cover data, this SOP provides a processing template for recalculating focal metrics associated with the Land Cover measure.

Depending on the metric tool used, outputs include an AOA summary statistics table and a reclassified thematic land cover raster or a land cover change index raster, or an impervious surface raster.

- File Geodatabase (ESRI® format) with a raster dataset and a statistics table:
  - lac (land cover area per category)
  - lac_stats
  - lnc (landcover area per category for natural/converted)
  - lnc_stats
  - lpi_all (impervious surface all - categories)
  - lpi_all_stats
  - lpi_grouped (impervious surface - grouped categories)
  - lpi_grouped_stats
  - lci (change index)
  - lci_stats



Table

lac_South_Florida_stats

OBJECTID *	Value	Count	CLASSNAME	TOTAL_AOA_AREA_SQKM	AOA_FEATURE_AREA_SQKM	TAREA_SQKM	AREA_SQKM	PCT_AREA	AOA_NAME
1	11	707153	Open Water	39496.68	39496.68	27903.44	6364.378	22.80858	South Florida
2	21	110833	Developed, Open Space	39496.68	39496.68	27903.44	997.4988	3.574824	South Florida
3	22	147464	Developed, Low Intensity	39496.68	39496.68	27903.44	1327.178	4.756324	South Florida
4	23	716259	Developed, Medium Intensity	39496.68	39496.68	27903.44	644.6331	2.310228	South Florida
5	24	223535	Developed, High Intensity	39496.68	39496.68	27903.44	201.1815	0.720992	South Florida
6	31	51327	Barren Land	39496.68	39496.68	27903.44	46.1943	0.165551	South Florida
7	42	3607	Evergreen Forest	39496.68	39496.68	27903.44	3.2463	0.011634	South Florida
8	52	26830	Shrub/Scrub	39496.68	39496.68	27903.44	24.147	0.086538	South Florida
9	71	52690	Herbaceous	39496.68	39496.68	27903.44	47.421	0.169947	South Florida
10	81	605497	Hay/Pasture	39496.68	39496.68	27903.44	544.9473	1.952975	South Florida
11	82	235546	Cultivated Crops	39496.68	39496.68	27903.44	2119.92	7.597344	South Florida
12	90	737150	Woody Wetlands	39496.68	39496.68	27903.44	6634.356	23.77612	South Florida
13	95	994259	Emergent Herbaceous Wetlands	39496.68	39496.68	27903.44	8948.336	32.06894	South Florida

1 (0 out of 13 Selected)

lac_South_Florida_stats

Example area per category raster and statistics table for an AOA in South Florida.

Using an ArcGIS™ version 10 toolbox, processing steps include clipping the input land cover, impervious surface, or change index raster to the area of analysis (AOA), reclassifying the raster using an input reclassification table, calculating the total and class areas (km^2), and producing a table summarizing area

totals and percent total area for the AOA. Any AOA can be used as long as its spatial reference matches that of the tool input data.

The tools are designed to be generalized but were tested with National Land Cover Dataset, Impervious Surface, and Change Index 2006 (NLCD 2001-2006; 30 m resolution; Lower 48; Fry et al. 2011), the North American Land Cover (NALC 2005; 250 m resolution; AK, Canada, Lower 48, Mexico; CEC 2010) and the NOAA Coastal Change Analysis Project (C-CAP multiple years; 30 m resolution; eastern and western Lower 48, High Resolution for Pacific Islands; NPAA Coastal Services Center 2010) tool input data and reclassification tables. However, the tools should work with any land cover, impervious surface or change index source as long as the reclassification table matches the input raster values. Therefore, this SOP may be used with other (non-NLCD, non-NALC, or non-C-CAP) tool input rasters if appropriate reclassification tables are available. See Appendix 3 for details. Since some land cover metrics like natural vs. converted or level 1 thematic classes are straightforward reclassifications of an input land cover raster, this SOP can be used to generate these outputs. See Appendix 4 for details.

For ecological guidance on using and interpreting these metrics, see the NPScape Interpretive Guide (Monahan et al. 2012).

Software Requirements

ArcGIS software is required to generate the metric outputs. The data sources and tools used are assumed to be in ESRI ArcGIS™ format, version 10 Service Pack 5 or higher.

Data Requirements

The NPScape project provides three land cover tool input datasets which can be used with the processing tools.

If you are a NPS user, you can contact the NPScape team to request a custom clipped extent of these tool input datasets: mailto:NRSS_NRPC_NPScape@nps.gov

Pre-Processed National Land Cover Dataset (NLCD) 2006

GeoTIFF format: Landcover_Level2_NLCD2006.tif

http://science.nature.nps.gov/im/monitor/npscape/gis_data.cfm

Pre-processed Coastal Change Analysis Program (C-CAP) 1996 (30m), 2001 (30m), 2005/6 (30m, HighRes), 2007 (HighRes), 2011 (HighRes)

File GDB format:

Landcover_CCAP_1996_2006.gdb\ccap<YYYY>_landcover
Landcover_PacificIslands_CCAP.gdb\ccap<YYYY>_<islandname>_landcover_30m
Landcover_PacificIslands_CCAP.gdb\ccap<YYYY>_<islandname>_landcover_oldHighRes*

GeoTIFF format:

Landcover_CCAP<YYYY>.tif
Landcover_<islandname>_CCAP<YYYY>_30m.tif
Landcover_<islandname>_CCAP<YYYY>_HighRes*.tif

**Guam 2005 has two versions – make sure you are using the correct Reclass table for the right raster*

http://science.nature.nps.gov/im/monitor/npscape/gis_data.cfm

Pre-processed North American Land Cover (NALC) 2005

File GDB format:

Landcover_NALC2005.gdb\nalc2005_landcover_level2
Landcover_Alaska_NALC2005.gdb\nalc2005_alaska_landcover_level2

GeoTIFF format:
Landcover_Level2_NALC2005.tif
Landcover_Level2_Alaska_NALC2005.tif

http://science.nature.nps.gov/im/monitor/npscape/gis_data.cfm

See the Frequently Asked Questions section for other data access options.

Area of Analysis polygon

AOA polygons for boundaries and 3 km and 30 km buffers of parks, CEC ecoregions, FWS LCC polygons, and upstream watersheds (for selected parks) are available as NPScape datasets:

http://science.nature.nps.gov/im/monitor/npscape/methods.cfm

Alternatively, user-defined AOA polygons can be used if they conform to the input spatial reference.

Input data spatial reference

The NPScape project uses USA Contiguous Albers Equal Area Conic USGS as its standard spatial reference for all CONUS areas (including Puerto Rico, USVI). A local (i.e. custom, non-NPScape sourced) area of analysis polygon may be used if its spatial reference matches the NPScape-provided tool input raster or vector data. In this scenario, re-project your local AOA data (if necessary) and run repair geometry on it before running the tool(s). See the Frequently Asked Questions section for more details on re-projecting tool outputs or tool inputs. *See below for Alaska and Pacific Island spatial reference information.

Input Data Pre-Processing

Determine AOA polygon

If using an NPScape-sourced AOA, download the appropriate AOA geodatabase from the link in the Data Requirements section.

Re-project user-defined input datasets (if needed)

All user-defined, custom, non-NPScape sourced tool inputs (e.g. AOA polygon) for CONUS must be in the USA Contiguous Albers Equal Area Conic USGS spatial reference if used with NPScape-sourced tool inputs.

1. Open ArcCatalog or ArcMap. Click the search button and search for ‘Project’. Open the Project tool and re-project your data to USA Contiguous Albers Equal Area Conic USGS.
2. Search for ‘Repair Geometry’ and run that tool on your re-projected dataset.
3. See the Frequently Asked Questions section for more details.

*If working with Alaska data use Alaska Albers Equal Area Conic spatial reference.
*If working with Pacific Island CCAP data: Hawaii uses NAD_1983_UTM_Zone_5N. For Guam and Northern Mariana Islands areas use WGS_1984_UTM_Zone_55N. For American Samoa use NAD_1983_HARN_UTM_Zone_2S. Follow the steps above for re-projecting data to the desired spatial reference, if needed.

Download tool input datasets

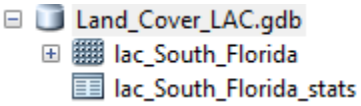
If using an NPScape source, download the metric dataset from the link in the Data Requirements section. These datasets are seamless across the maximum available extent of the source data.

ArcGIS may throw processing errors when trying to clip or extract from certain source rasters. The Area per Category tool uses extract by mask, while the impervious surface and change index tools use clip. Non-NPScape rasters may perform better with one tool vs. the other. Again, the only absolute requirement is that the respective reclassification table values match the values in the input raster dataset.

Run Generic Area per Category tool

This tool generates a file geodatabase containing Land Cover-derived raster datasets and summary tables. These outputs correspond to the NPScape Area per Category (LAC) metric. Also, the generic land cover area per category tool can be used to generate simplified (e.g. level 1) land cover outputs. Simply select the appropriate reclassification table when running the tool.

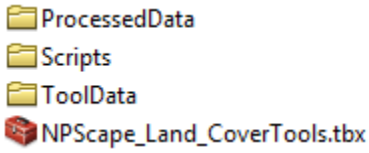
Example tool outputs*****:



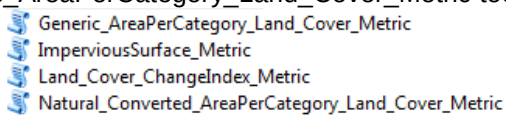
****NOTE:*** *Beginning with ArcGIS 10.0 SP2 and running through ArcGIS 10.1 SP1 there is a bug that outputs any GEOTIFF raster created with "Reclass by Table" as* ***32 bit,*** *regardless of the bit-size of the input raster(s). This increases data size significantly (and unnecessarily). If this increased file size is prohibitive to your use, please see the Frequently Asked Questions for how to 'Copy Raster' back to 8 bit. This bug has been fixed with the release of ArcGIS 10.2.*

Add toolbox to ArcMap

1. Check Geoprocessing Options settings: Geoprocessing → Geoprocessing Options → 'Overwrite the Outputs of Geoprocessing Operations' should be checked. This addresses an issue in ArcGIS 10.1 Service Pack 1 when using feature layers.
2. Extract the tools zip file downloaded from the methods link in the Overview section above. The following folder structure will be created:

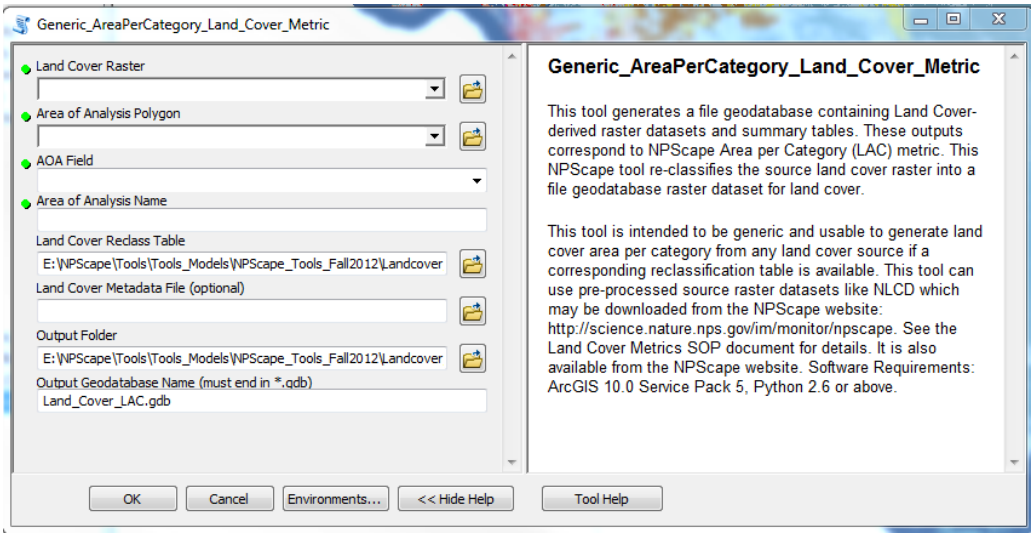


   ProcessedData contains ArcMap layer files and is the default tool output folder. Scripts contains the Python code used by the NPScape_LandCoverTools.tbx toolbox.
3. Open ArcMap use the Catalog window to navigate to the folder where the tools were extracted. Open the NPScape_LandCoverTools.tbx toolbox.
4. Double-click on the Generic_AreaPerCategory_Land_Cover_Metric tool to open it.



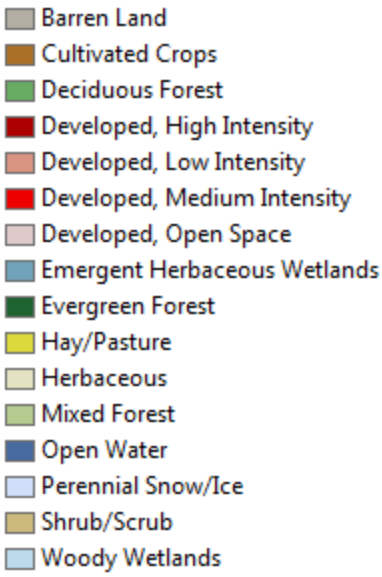
Run the Generic area per category tool

1. Add input data to the map:
   - Tool input raster (e.g. Landcover_Level2_NLCD2006.tif from NPScape)
   - Polygon feature class for AOA (single or multi-part)
2. Populate values for each of the required parameters in the tool:



Land Cover Raster: Input Land Cover Raster (NLCD, NALC, Landfire, CCAP, etc)
Area of analysis polygon: Area of analysis polygon used to clip out land cover raster
AOA Field: Text format attribute from Area of Analysis Polygon. Used to label output rasters and tables for multi-feature AOAs. If AOA polygon is a single feature, only one output raster and output table will be generated.
Area of Analysis Name: Area of analysis name. For example, ROMO or Upper Lost Creek Watershed. This value is copied to all output feature classes and summary tables
Land Cover Reclass Table: Reclassification table (geodatabase table or DBF) used to re-classify the input land cover raster. Must match values in the Land Cover Raster.
Land Cover Metadata File (optional): XML format (FGDC) metadata for output files
Output Folder: Output folder for file geodatabase. You must have write permission to this folder.
Output Geodatabase Name: Name for output geodatabase. Must end in *.gdb.
Note: if the geodatabase already exists, feature classes and the table will be overwritten if for the same AOA feature class name.

3. Depending on the extent of the AOA feature class, the tool may take several minutes to run. Processing status will display in ArcMap, either as a popup or as a message in the geoprocessing background bar. The full tool summary is found in the ArcMap → Geoprocessing → Results popup, including error messages.
4. The LAC output raster and statistics table will be added automatically to the map. If single-part AOA polygons were used, only the raster and statistics table for the last feature will be added to the map. Other output rasters and tables can be added manually and symbolized with *.lyr files in the ProcessedData subfolder. *Note: If a non-NLCD input raster was used (e.g. CCAP), the output raster may need to be re-symbolized since the layer symbology defaults to the Anderson Level 2 NLCD color map. Use the appropriate *.lyr files in the Landcover_Tools\ProcessedData subfolder to re-symbolize the features. NALC Symbology can be imported from the source raster if needed.*

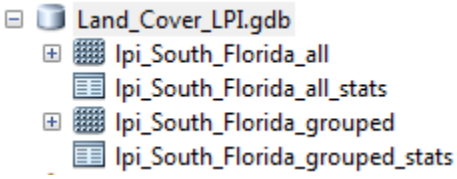


5. See tables in the Interpretation Tips section for a description of attributes in the output raster and statistics table.
6. Running the tool again: open Geoprocessing → Results. Double-click on the Generic_AreaPerCategory_Land_Cover_Metric tool name to open the tool dialog. Change parameters as needed. Change the output geodatabase name if you don't want your original output over-written.

Run Impervious Surface tool

This tool generates a file geodatabase containing impervious surface-derived raster datasets and summary tables. These outputs correspond to the NPScape Impervious Surface (LPI) metric.

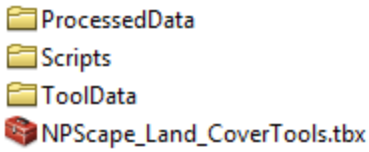
Example tool outputs (maps and tables with GDB diagram if appropriate)*****:



****NOTE:*** *Beginning with ArcGIS 10.0 SP2 and running through ArcGIS 10.1 SP1 there is a bug that outputs any GEOTIFF raster created with "Reclass by Table" as* ***32 bit,*** *regardless of the bit-size of the input raster(s). This increases data size significantly (and unnecessarily). If this increased file size is prohibitive to your use, please see the Frequently Asked Questions for how to 'Copy Raster' back to 8 bit. This bug has been fixed with the release of ArcGIS 10.2.*

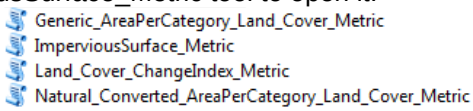
Add toolbox to ArcMap

1. Check Geoprocessing Options settings: Geoprocessing → Geoprocessing Options → 'Overwrite the Outputs of Geoprocessing Operations' should be checked. This addresses an issue in ArcGIS 10.1 Service Pack 1 when using feature layers.
2. Extract the tools zip file downloaded from the methods link in the Overview section above. The following folder structure will be created:



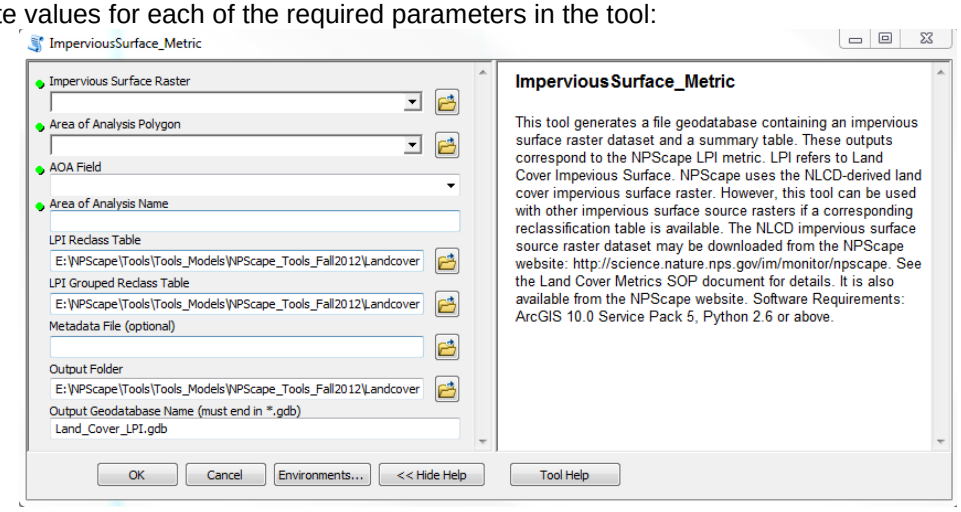
ProcessedData contains ArcMap layer files and is the default tool output folder. Scripts contains the Python code used by the NPScape_LandCoverTools.tbx toolbox.

3. Open ArcMap use the Catalog window to navigate to the folder where the tools were extracted. Open the NPScape_LandCoverTools.tbx toolbox.
4. Double-click on the ImperviousSurface_Metric tool to open it.

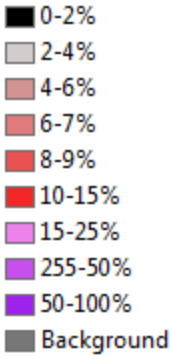


Run the Impervious Surface Tool

1. Add input data to the map:
   - Tool input raster (e.g. Landcover_Impervious_NLCD2006.tif from NPScape)
   - Polygon feature class for AOA (single or multi-part)
2. Populate values for each of the required parameters in the tool:



3. Depending on the extent of the AOA feature class, the tool may take several minutes to run. Processing status will display in ArcMap, either as a popup or as a message in the geoprocessing background bar. The full tool summary is found in the ArcMap → Geoprocessing → Results popup, including error messages.
4. The two LPI output rasters (all and grouped) and statistics tables will be added automatically to the map. If single-part AOA polygons were used, only the raster and statistics table for the last feature will be added to the map. Other output rasters and tables can be added manually and symbolized with *.lyr files in the ProcessedData subfolder.

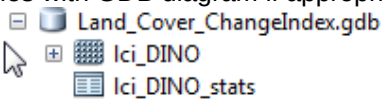


5. See tables in the Interpretation Tips section for a description of attributes in the output rasters and statistics table.
6. Running the tool again: open Geoprocessing → Results. Double-click on the tool name to open the tool dialog. Change parameters as needed. Change the output geodatabase name if you don't want your original output over-written.

Run Change Index tool

This tool generates a file geodatabase containing change index-derived raster datasets and summary tables. These outputs correspond to the NPScape Change Index (LCI) metric. This tool requires a custom reclassification table based on the input land cover raster thematic content. The toolbox defaults to a reclassification table based on NLCD2006 land cover data. Other Change Index reclassification tables are available in the ToolData subfolder.

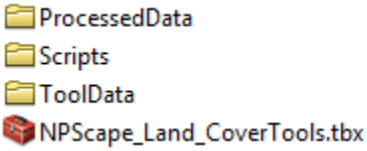
Example tool outputs (maps and tables with GDB diagram if appropriate)***:**



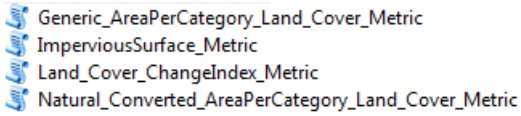
NOTE: *Beginning with ArcGIS 10.0 SP2 and running through ArcGIS 10.1 SP1 there is a bug that outputs any GEOTIFF raster created with "Reclass by Table" as* ***32 bit,*** *regardless of the bit-size of the input raster(s). This increases data size significantly (and unnecessarily). If this increased file size is prohibitive to your use, please see the Frequently Asked Questions for how to 'Copy Raster' back to 8 bit. This bug has been fixed with the release of ArcGIS 10.2.*

Add toolbox to ArcMap

1. Check Geoprocessing Options settings: Geoprocessing → Geoprocessing Options → 'Overwrite the Outputs of Geoprocessing Operations' should be checked. This addresses an issue in ArcGIS 10.1 Service Pack 1 when using feature layers.
2. Extract the tools zip file downloaded from the methods link in the Overview section above. The following folder structure will be created:

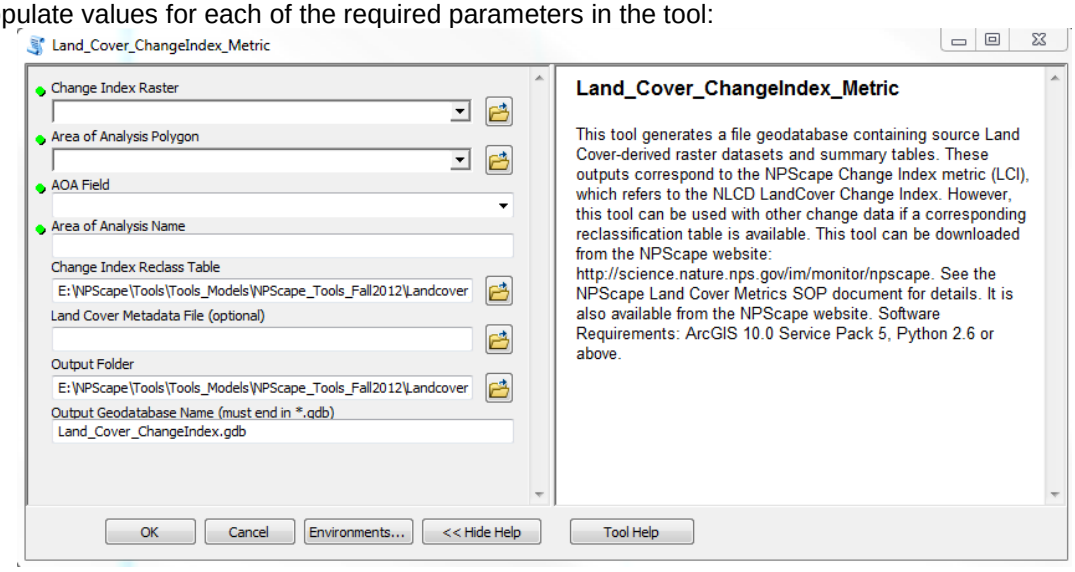


   ProcessedData contains ArcMap layer files and is the default tool output folder. Scripts contains the Python code used by the NPScape_LandCoverTools.tbx toolbox.
3. Open ArcMap use the Catalog window to navigate to the folder where the tools were extracted. Open the NPScape_LandCoverTools.tbx toolbox.
4. Double-click on the Land_Cover_ChangeIndex_Metric tool to open it.



Run the Change Index Tool

1. Add input data to the map:
   - Tool input raster (e.g. Landcover_ChangeIndex_NLCD2006.tif from NPScape)
   - Polygon feature class for AOA (single or multi-part)
2. Populate values for each of the required parameters in the tool:

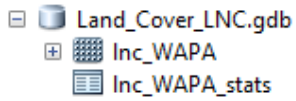


3. Depending on the extent of the AOA feature class, the tool may take several minutes to run. Processing status will display in ArcMap, either as a popup or as a message in the geoprocessing background bar. The full tool summary is found in the ArcMap → Geoprocessing → Results popup, including error messages.
4. The LCI output raster and statistics table will be added automatically to the map. If single-part AOA polygons were used, only the raster and statistics table for the last feature will be added to the map. Other output rasters and tables can be added manually and symbolized with *.lyr files in the ProcessedData subfolder.
5. See tables in the Interpretation Tips section for a description of attributes in the output raster and statistics table.
6. Running the tool again: open Geoprocessing → Results. Double-click on the tool name to open the tool dialog. Change parameters as needed. Change the output geodatabase name if you don't want your original output over-written.

Run Natural vs. Converted Area per Category tool

This tool generates a file geodatabase containing Land Cover-derived raster datasets and summary tables. These outputs correspond to the NPScape Natural vs.Converted Area per Category (LNC) metric. This tool requires a custom reclassification table based on the input land cover raster thematic content. The toolbox defaults to a reclassification table based on NLCD2006 land cover data. Other Natural/Converted reclassification tables are available in the ToolData subfolder.

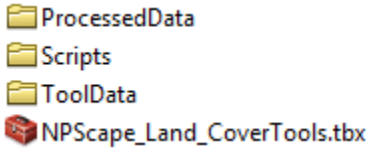
Example tool outputs*:



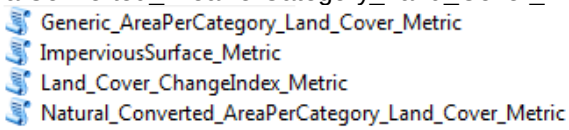
NOTE: *Beginning with ArcGIS 10.0 SP2 and running through ArcGIS 10.1 SP1 there is a bug that outputs any GEOTIFF raster created with "Reclass by Table" as* ***32 bit,*** *regardless of the bit-size of the input raster(s). This increases data size significantly (and unnecessarily). If this increased file size is prohibitive to your use, please see the Frequently Asked Questions for how to 'Copy Raster' back to 8 bit. This bug has been fixed with the release of ArcGIS 10.2.*

Add toolbox to ArcMap

1. Check Geoprocessing Options settings: Geoprocessing → Geoprocessing Options → 'Overwrite the Outputs of Geoprocessing Operations' should be checked. This addresses an issue in ArcGIS 10.1 Service Pack 1 when using feature layers.
2. Extract the tools zip file downloaded from the methods link in the Overview section above. The following folder structure will be created:

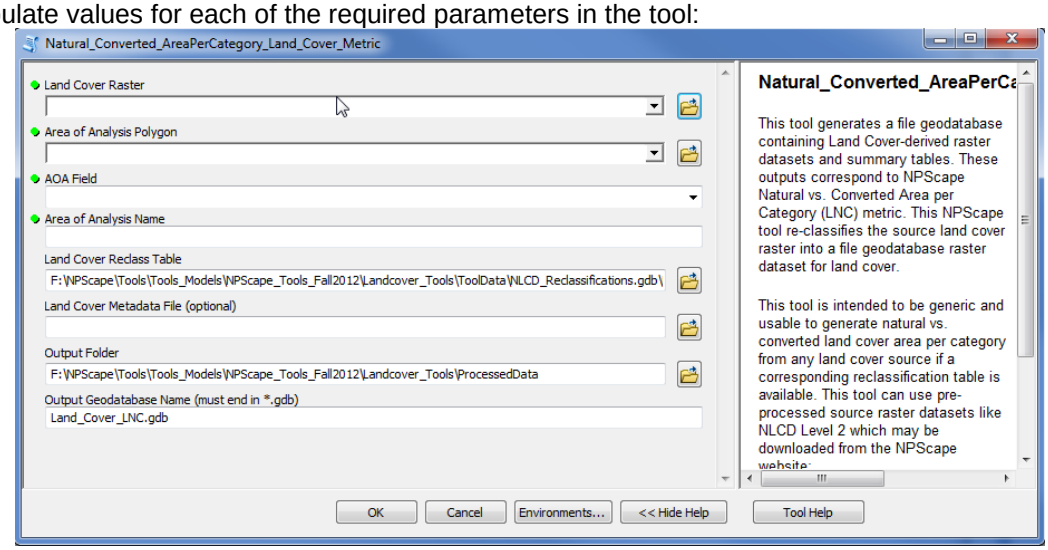


   ProcessedData contains ArcMap layer files and is the default tool output folder. Scripts contains the Python code used by the NPScape_LandCoverTools.tbx toolbox.
3. Open ArcMap use the Catalog window to navigate to the folder where the tools were extracted. Open the NPScape_LandCoverTools.tbx toolbox.
4. Double-click on the NaturalConverted_AreaPerCategory_Land_Cover_Metric tool to open it.



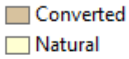
Run the Natural Converted per area category tool

7. Add input data to the map:
   - Tool input raster (e.g. Landcover_ChangeIndex_NLCD2006.tif from NPScape)
   - Polygon feature class for AOA (single or multi-part)
8. Populate values for each of the required parameters in the tool:



Land Cover Raster: Input Land Cover Raster (NLCD level 2, NALC, CCAP, etc)
Area of analysis polygon: Area of analysis polygon used to clip out land cover raster
AOA Field: Text format attribute from Area of Analysis Polygon. Used to label output rasters and tables for multi-feature AOAs. If AOA polygon is a single feature, only one output raster and output table will be generated.
Area of Analysis Name: Area of analysis name. For example, ROMO or Upper Lost Creek Watershed. This value is copied to all output feature classes and summary tables
Land Cover Reclass Table: Reclassification table (geodatabase table or DBF) used to re-classify the input land cover raster. Must match values in the Land Cover Raster
Land Cover Metadata File (optional): XML format (FGDC) metadata for output files
Output Folder: Output folder for file geodatabase. You must have write permission to this folder.
Output Geodatabase Name: Name for output geodatabase. Must end in *.gdb.
Note: if the geodatabase already exists, feature classes and the table will be overwritten

9. Depending on the extent of the AOA feature class, the tool may take several minutes to run. Processing status will display in ArcMap, either as a popup or as a message in the geoprocessing background bar. The full tool summary is found in the ArcMap → Geoprocessing → Results popup, including error messages.
10. The LNC output raster and statistics table will be added automatically to the map. If single-part AOA polygons were used, only the raster and statistics table for the last feature will be added to the map. Other output rasters and tables can be added manually and symbolized with *.lyr files in the ProcessedData subfolder.



11. See tables in the Interpretation Tips section for a description of attributes in the output raster and statistics table.
12. Running the tool again: open Geoprocessing → Results. Double-click on the Natural_Converted_AreaPerCategory_Land_Cover_Metric tool name to open the tool dialog. Change parameters as needed. Change the output geodatabase name if you don't want your original output over-written.

Quality Control

Verify dataset outputs

1. Verify the expected rasters are created and that the AOA_NAME, CLASSNAME(1), TOTAL_AOA_AREA_SQKM, AOA_FEATURE_AREA_SQKM, TAREA_SQKM, AREA_SQKM, and PCT_AREA fields are present in the raster value attribute tables. If a multi-feature singlepart AOA polygon was used, there will be an output raster and statistics table for each AOA feature, named with the value of the AOA Field attribute. However, only outputs for the last feature processed will be added to the map automatically.
2. Verify that raster edges align correctly with each other. Use the Effects → Swipe tool to help verify this. Note that the NPScape layer files for Anderson level 2, impervious surface (all and grouped) and NLCD change index (ProcessedData*.lyr) are used to standardize the raster symbology.
3. Look for areas of NODATA cells within the AOA. These cells are not included in statistics summaries, so care should be taken when interpreting outputs with NODATA areas.

Verify statistics output

1. Open each value attribute table and sort the PCT_AREA column in descending order. Look for outlying values (negative values, more than one value near 100, sum of values > 100).

2. By default, only the statistics table for the last feature is added to the map. Add the remaining statistics tables, if present, and sort each PCT_AREA column in descending order. Look for outlying values (negative values, more than one value near 100, sum of values > 100).
3. Select one record from each statistics table and double-check the PCT_AREA column values by re-calculating them by hand:

$$PCT_AREA = (AREA_SQKM / TAREA_SQKM) * 100$$

Interpretation Tips

Output raster and statistics table attributes:

Raster attributes:

VALUE	Raster cell value for thematic class
COUNT	Count of cells in thematic class
CLASSNAME(1)	Name of thematic class

Statistics table attributes:

CLASSNAME(1)	Name of thematic class
TOTAL_AOA_AREA_SQKM	Total area of the AOA in km^2, calculated from raster cells
AOA_FEATURE_AREA_SQKM	Total area of the AOA in km^2, calculated from polygon feature
TAREA_SQKM	Total class area in km^2, calculated from raster cells
AREA_SQKM	Class area in km^2, calculated from raster cells
PCT_AREA	Percent area of class, (AREA_SQKM/TAREA_SQKM) * 100
AOA_NAME	AOA name from AOA Identifier tool parameter concatenated with AOA Field value

Due to raster cell overlap outside the AOA polygon, the raster-derived total area value will be usually slightly larger than the polygon derived total area. In coastal or shoreline areas, the total AOA area values will be larger than the sum of TAREA_SQKM because source tool input rasters may have areas of NODATA values that begin a few kilometers off shore.

Frequently Asked Questions

Can/should I use a different spatial reference?

Any NPScape spatial output can be re-projected to a 'final' local spatial reference. For vector outputs, Repair Geometry should be run after re-projection. This approach should be noted in explanatory or interpretive documentation to avoid misleading the user; re-projection of an output dataset will have no effect on area attributes in the summary table generated by the NPScape script.

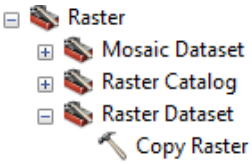
All NPScape tools generate area calculations from input data. If tool input data must be re-projected prior to running the tools, care should be taken to use a local spatial reference that distorts area minimally, such as an equal-area projection. For CONUS (Puerto Rico, USVI) tool input datasets, NPScape uses USA Contiguous Albers Equal Area Conic USGS (NAD_83) as the spatial reference. Alaska-specific tool input datasets are in Alaska Albers Equal Area Conic (NAD_83) while Hawaii-specific datasets use UTM Zone 5N (NAD_83). UTM WGS84 Zone 55N is used for Saipan (Mariana Islands) and Guam while UTN NAD83 Zone 2S is used for American Samoa.

<u>Re-projecting vector input data</u>:
NPScape tool input vector data can be re-projected prior to use as a tool input. The source dataset should be clipped to an extent larger than the intended area of analysis. Then, after clipping, Repair Geometry must be run to correct geometric errors. Finally, the clipped input can be re-projected to the local spatial reference, followed again with a Repair Geometry operation.

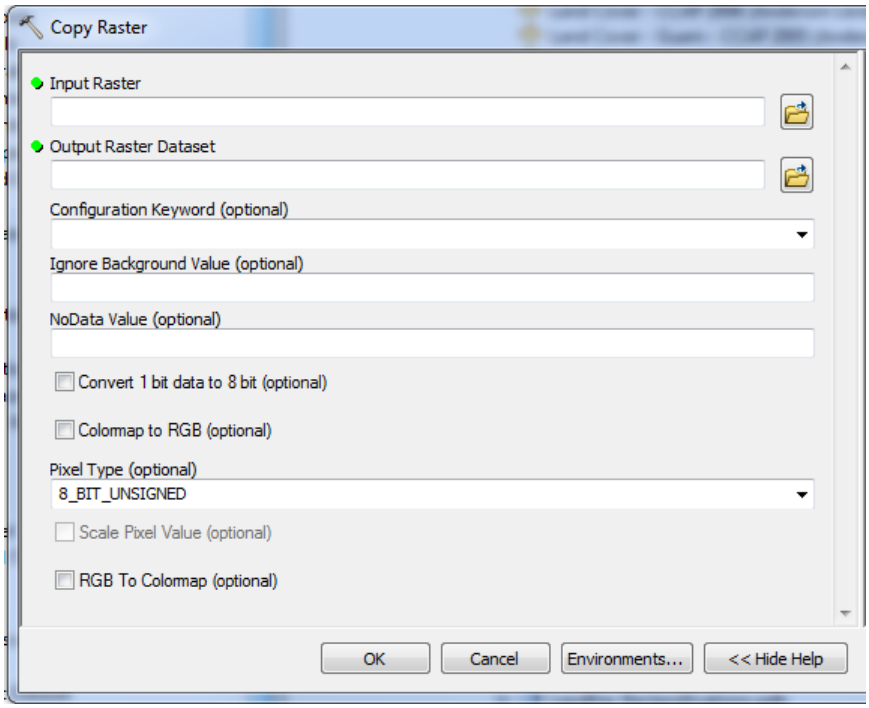
<u>Re-projecting raster input data</u>:
Re-projection to match a local spatial reference is not recommended for raster format NPScape tool input datasets. If re-projection is done, the source tool input raster should be clipped to an area of analysis rectangular extent first. Then, the Processing Extent → Snap Raster environment setting in ArcGIS should be populated with the source input tool raster. Warping will occur but should be less than it would be without the Snap Raster setting.

Alternatively, the AOA extent could be re-projected to the same spatial reference as the NPScape input raster followed by a repair geometry operation. Then, this polygon could be rasterized to a temporary raster dataset with a cell size matching the input raster, setting the snap raster to the input raster to minimize warping. Then, this temporary raster could be used to extract an area from the NPScape tool input raster. Finally, this extracted raster could be re-projected to the desired local spatial reference as described above.

My output Landcover Rasters are too big. How do I convert a 32-bit GEOTIFF to an 8-bit GEOTIFF?
The bug that automatically outputs 32-bit size rasters was fixed in ArcGIS 10.2. If you are not yet using ArcGIS 10.2 and need to reduce the size of your output rasters you can do so by running the Copy Raster tool on the final NPScape outputs. Search for 'Copy Raster', or go to the tool in ArcToolbox, Data Management Tools.



Fill in the parameters of the tool. Be sure the Pixel Type is set to "8 BIT UNSIGNED". If the NoData Value is some extreme positive or negative number, or missing altogether, you can manually edit it to '255'.



I'm having trouble downloading the tool input dataset. Is there another way to get it?

Many tool input datasets are very large. Please contact the NPScape team to request a custom delivery and/or a custom clipped extent: mailto:NRSS_NRPC_NPScape@nps.gov

My outputs don't show up in my map. What can I do?

The tools use ArcGIS display layers to visualize the metric outputs. If you see a red **!** by the layer name in the map, the layer can't find the feature class or raster to which it is linked. The most common reason is that the Output Geodatabase Name parameter differed from what the tool script expected. Fix the problem by clicking the red **!** and navigating to the output geodatabase. Then, select the correct feature class or raster.

If a multi-feature singlepart AOA polygon was used, there will be an output raster or feature class and statistics table for each AOA feature, named with the value of the AOA Field attribute. However, only outputs for the last feature processed will be added to the map automatically. Add the remaining output rasters/feature classes and statistics tables. Use the *.lyr files in the ProcessedData subfolder to symbolize the features.

Literature Cited

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Fry, J., Xian, G., Jin, S., Dewitz, J., Homer, C., Yang, L., Barnes, C., Herold, N., and Wickham, J., 2011. Completion of the 2006 National Land Cover Database for the Conterminous United States, PE&RS, Vol. 77(9):858-864.

Monahan, W. B., J. E. Gross, L. K. Svancara, and T. Philippi. 2012. A guide to interpreting NPScape data and analyses. Natural Resource Technical Report NPS/NRSS/NRTR—2012/578. National Park Service, Fort Collins, Colorado. https://irma.nps.gov/App/Reference/Profile/2184927 (Accessed 20121130).

National Park Service. 2013. NPScape: monitoring landscape dynamics of US National Parks. Natural Resource Stewardship and Science, Inventory and Monitoring Division. Fort Collins, Colorado. http://science.nature.nps.gov/im/monitor/npscape/ (Accessed 20130219).

NOAA Coastal Services Center. 2010. Coastal Change Analysis Program Regional Land Cover: http://www.csc.noaa.gov/digitalcoast/data/ccapregional/.

Xian, G, Homer, C, and Fry, J. 2009. Updating the 2001 National Land Cover Database land cover classification to 2006 by using Landsat imagery change detection methods. Remote Sensing of Environment, Vol. 113, No. 6. pp. 1133-1147.

Appendices

Appendix 1: Known issues

Data availability

NLCD-based land cover, imperviousness, and land cover change is available for CONUS, Hawaii, Guam, and Puerto Rico. C-CAP land cover is available for the coastal areas of the continental U.S, the US Virgin Islands and for Hawaii, Guam, American Samoa, and the Commonwealth of Northern Mariana Islands. NALC land cover is available for continental North America (including Mexico).

Additional issues

NLCD data contain different thematic classifications for CONUS vs. Hawaii vs. Guam data (NLCD2006). Also, C-CAP thematic content differs between CONUS, Hawaii, and Guam.

NLCD-based land cover pixels for open water extend off shore in coastal areas. Therefore, for areas of analysis in these locations, the acreage summary for this thematic class will be inflated in these areas and the percent area values will be skewed between classes. If explicit statistics in these areas are desired, clip the input raster(s) to the local coastline before using the NPScape tools.

Appendix 2: Default Reclassification tables

Table 1: NLCD 2006 Anderson Level 2 and Natural/Converted Classification

Value	Level 2 Classname	Natural/Converted Value	Natural/Converted Classname
0	Unclassified	2	Natural
11	Open Water	2	Natural
12	Perennial Snow/Ice	1	Converted
21	Developed, Open Space	1	Converted
22	Developed, Low Intensity	1	Converted
23	Developed, Medium Intensity	1	Converted
24	Developed, High Intensity	1	Converted
31	Barren Land	2	Natural
41	Deciduous Forest	2	Natural
42	Evergreen Forest	2	Natural
43	Mixed Forest	2	Natural
51	Dwarf Scrub	2	Natural

52	Shrub/Scrub	2	Natural
71	Herbaceous	2	Natural
72	Sedge/Herbaceous	2	Natural
73	Lichens	2	Natural
74	Moss	2	Natural
81	Hay/Pasture	1	Converted
82	Cultivated Crops	1	Converted
90	Woody Wetlands	2	Natural
95	Emergent Herbaceous Wetlands	2	Natural

Table 2: NLCD 2006 Anderson Level 2 to Level 1 Classification

Level 2 Value	Level 2 Classname	Level 1 Value	Level 1 Classname
0	Unclassified	N/A	N/A
11	Open Water	1	Open Water
12	Perennial Snow/Ice	6	Perennial Ice/Snow
21	Developed, Open Space	2	Developed
22	Developed, Low Intensity		
23	Developed, Medium Intensity		
24	Developed, High Intensity		
31	Barren Land	3	Barren/Quarries/Transitional
41	Deciduous Forest	4	Forest
42	Evergreen Forest		
43	Mixed Forest		
51	Dwarf Scrub	5	Scrub/Shrub
52	Shrub/Scrub		
71	Herbaceous	7	Grassland/Herbaceous
72	Sedge/Herbaceous		
73	Lichens		
74	Moss		
81	Hay/Pasture	8	Agriculture
82	Cultivated Crops		
90	Woody Wetlands	9	Wetlands
95	Emergent Herbaceous Wetlands		

Table 3: NLCD 2006 Impervious Classification

Value	Impervious Classname	Grouped Impervious Value	Grouped Impervious Classname
0	0%	1	0% - 2%
1	1%		

2	2%	2	2% - 4%
3	3%		
4	4%	3	4% - 6%
5	5%		
6	6%	4	6% - 8%
7	7%		
8	8%	5	8% - 10%
9	9%		
10	10%, 11%, 12%, 13%, 14%	6	10% - 15%
11	15%, 16%, 17%, 18%, 19%, 20%, 21%, 22%, 23%, 24%	7	15% - 25%
12			
13	25% - 49%	8	25% - 50%
14	50% - 100%	9	50% - 100%

Table 4: NALC Anderson Level 2 to Level 1 and Level 2 to Natural/Converted (N/C) Classification

Level 2 Value	Level 2 Classname	Level 1 Value	Level 1 Classname	N/C Value	N/C Classname
1	Temperate or sub-polar needleleaf forest	4	Forest	2	Natural
2	Sub-polar taiga needleleaf forest				
3	Tropical or sub-tropical broadleaf evergreen forest				
4	Tropical or sub-tropical broadleaf deciduous forest				
5	Temperate or sub-polar broadleaf deciduous forest				
6	Mixed forest				
7	Tropical or sub-tropical shrubland	5	Scrub/Shrub	2	Natural
8	Temperate or sub-polar shrubland				
9	Tropical or sub-tropical grassland	7	Grassland/ Herbaceous	2	Natural
10	Temperate or sub-polar grassland				
11	Sub-polar or polar shrubland-lichen-moss	5	Scrub/Shrub	2	Natural
12	Sub-polar or polar grassland-lichen-moss	7	Grassland/ Herbaceous	2	Natural
13	Sub-polar or polar barren-lichen-moss	3	Barren/Quarries/Transitional	2	Natural
14	Wetland	9	Wetlands	2	Natural
15	Cropland	8	Agriculture	1	Converted

16	Barren Lands	3	Barren/Quarries/Transitional	2	
17	Urban	2	Developed	1	Converted
18	Water	1	Open Water	2	Natural
19	Snow and Ice	10	Snow and Ice	2	Natural

Table 5: C-CAP Anderson Level 2 and Natural/Converted Classification: CONUS

Value	C-CAP Level 2 Classname	Natural/Converted Value	Natural/Converted Classname
1	Unclassified	0	Unclassified
2	Developed High Intensity	1	Converted
3	Developed Medium Intensity	1	Converted
4	Developed Low Intensity	1	Converted
5	Developed Open Space	1	Converted
6	Cultivated Crops	1	Converted
7	Pasture/Hay	1	Converted
8	Grassland/Herbaceous	2	Natural
9	Deciduous Forest	2	Natural
10	Evergreen Forest	2	Natural
11	Mixed Forest	2	Natural
12	Scrub/Shrub	2	Natural
13	Palustrine Forested Wetland	2	Natural
14	Palustrine Scrub/Shrub Wetland	2	Natural
15	Palustrine Emergent Wetland (Persistent)	2	Natural
16	Estuarine Forested Wetland	2	Natural
17	Estuarine Scrub/Shrub Wetland	2	Natural
18	Estuarine Emergent Wetland	2	Natural
19	Unconsolidated Shore	2	Natural
20	Barren Land	2	Natural
21	Open Water	2	Natural
22	Palustrine Aquatic Bed	2	Natural
23	Estuarine Aquatic Bed	2	Natural
24	Tundra	2	Natural
25	Perennial Ice/Snow	2	Natural
26	Dwarf Scrub	2	Natural
27	Sedge / Herbaceous	2	Natural
28	Moss	2	Natural
29	Lichens	2	Natural

Table 6: C-CAP Land Cover and Natural/Converted Classification:Guam oldHighRes (2005)

Raw C-CAP Land Cover Value	C-CAP Land Cover Value	C-CAP Land Cover Classname	Natural/Converted Value	Natural/Converted Classname
2	2	Developed High Intensity	1	Converted
5	5	Developed Open Space	1	Converted
6	6	Cultivated Crops	1	Converted
7	7	Pasture/Hay	1	Converted
8	8	Grassland/Herbaceous	2	Natural
10	10	Evergreen Forest	2	Natural
12	12	Scrub/Shrub	2	Natural
13	13	Palustrine Forested Wetland	2	Natural
14	14	Palustrine Scrub/Shrub Wetland	2	Natural
15	15	Palustrine Emergent Wetland (Persistent)	2	Natural
16	16	Estuarine Forested Wetland	2	Natural
17	17	Estuarine Scrub/Shrub Wetland	2	Natural
18	18	Estuarine Emergent Wetland	2	Natural
19	19	Unconsolidated Shore	2	Natural
20	20	Barren Land	2	Natural
21	21	Open Water	2	Natural
22	22	Palustrine Aquatic Bed	2	Natural

Table 7: C-CAP Land Cover and Natural/Converted Classification: Hawaii 30m (2001)

Raw C-CAP Land Cover Value	C-CAP Land Cover Value	C-CAP Land Cover Classname	Natural/Converted Value	Natural/Converted Classname
1	1	Recent Lava Flow	2	Natural
2	2	Developed High Intensity	1	Converted
3	3	Developed Low Intensity	1	Converted
6	6	Cultivated Crops	1	Converted
8	8	Grassland/Herbaceous	2	Natural
10	10	Evergreen Forest	2	Natural
11	11	Mixed Forest	2	Natural
12	12	Scrub/Shrub	2	Natural
13	13	Palustrine Forested Wetland	2	Natural
14	14	Palustrine Scrub/Shrub Wetland	2	Natural
15	15	Palustrine Emergent Wetland (Persistent)	2	Natural
16	16	Estuarine Forested Wetland	2	Natural
18	18	Estuarine Emergent Wetland	2	Natural
19	19	Unconsolidated Shore	2	Natural

20	20	Barren Land	2	Natural
21	21	Open Water	2	Natural

Table 8: C-CAP Land Cover and Natural/Converted Classification: Pacific Islands HighRes (2005), Guam HighRes (2011)

Raw C-CAP Land Cover Value	C-CAP Land Cover Value	C-CAP Land Cover Classname	Natural/Converted Value	Natural/Converted Classname
0	0	Background	2	Natural
1	1	Unclassified	2	Natural
2	2	Impervious Surface	1	Converted
5	5	Developed Open Space	1	Converted
6	6	Cultivated Crops	1	Converted
7	7	Pasture/Hay	1	Converted
8	8	Grassland/Herbaceous	2	Natural
9	9	Deciduous Forest	2	Natural
10	10	Evergreen Forest	2	Natural
12	12	Scrub/Shrub	2	Natural
13	13	Palustrine Forested Wetland	2	Natural
14	14	Palustrine Scrub/Shrub Wetland	2	Natural
15	15	Palustrine Emergent Wetland	2	Natural
16	16	Estuarine Forested Wetland	2	Natural
17	17	Estuarine Scrub/Shrub Wetland	2	Natural
18	18	Estuarine Emergent Wetland	2	Natural
19	19	Unconsolidated Shore	2	Natural
20	20	Barren Land	2	Natural
21	21	Open Water	2	Natural
22	22	Palustrine Aquatic Bed	2	Natural

Table 8: C-CAP Land Cover and Natural/Converted Classification: US Virgin Islands HighRes (2007)

Raw C-CAP Land Cover Value	C-CAP Land Cover Value	C-CAP Land Cover Classname	Natural/Converted Value	Natural/Converted Classname
0	0	Background	2	Natural
2	2	Impervious Surface	1	Converted
5	5	Developed Open Space	1	Converted
6	6	Cultivated Crops	1	Converted
7	7	Pasture/Hay	1	Converted
8	8	Grassland/Herbaceous	2	Natural
9	9	Deciduous Forest	2	Natural
10	10	Evergreen Forest	2	Natural
12	12	Scrub/Shrub	2	Natural

13	13	Palustrine Forested Wetland	2	Natural
14	14	Palustrine Scrub/Shrub Wetland	2	Natural
15	15	Palustrine Emergent Wetland	2	Natural
16	16	Estuarine Forested Wetland	2	Natural
17	17	Estuarine Scrub/Shrub Wetland	2	Natural
18	18	Estuarine Emergent Wetland	2	Natural
19	19	Unconsolidated Shore	2	Natural
20	20	Barren Land	2	Natural
21	21	Open Water	2	Natural

Appendix 3: Using custom AOAs and/or local input data

Custom AOAs

The AOA feature class should include a text attribute with a name value for the AOA feature(s). The feature class can contain single or multi-part polygons. If single-part polygons are used, an output raster and statistics table will be produced for each feature, named with the attribute value selected in the AOA_Field parameter.

Local input data

Non-NLCD2006 land cover data can be used as tool input as long as appropriate reclassification tables are available. See the example tables in the ToolData subfolder for ideas on how to structure a local reclass table.

Appendix 4: Generate Natural vs. Converted or Level 1 land cover metrics

Natural vs. Converted land cover

The NLCD_Reclassification.gdb geodatabase contains reclass tables that can be used to generate natural vs. converted land cover from NLCD2006 or 2001. Run the Generic_AreaPerCategory_Land_Cover_Metric tool using the appropriate reclass table.

The NALC_Reclassification.gdb geodatabase contains reclass tables that can be used to generate natural vs. converted land cover from NALC 2005 input.

The CCAP_Reclassification.gdb geodatabase contains reclass tables that can be used to generate natural vs. converted land cover from CCAP 2005 input from the continental U.S. or from the Pacific Islands (Hawaii, Guam, American Samoa, Northern Mariana Islands), and CCAP 2011 from Guam.

Level 1 land cover

The NLCD_Reclassification.gdb geodatabase contains reclass tables that can be used to generate level 1 land cover from NLCD2006, 2001, or 1992 inputs. Run the Generic_AreaPerCategory_Land_Cover_Metric tool using the appropriate reclass table.

The NALC_Reclassification.gdb geodatabase contains reclass tables that can be used to generate level 1 land cover from NALC 2005 input.

Appendix 5: Tool scripts

See Scripts subfolder for Python scripts used by the metric tool(s).

Appendix 6: Tool input data processing details

Source data for the National Land Cover Dataset and Coastal Change Analysis data were downloaded from the websites noted below. Each source was processed into a seamless tool input file geodatabase raster dataset.

NLCD 2006 Source data

The 2006 CONUS extent land cover, land cover change, and developed imperviousness rasters for NLCD were downloaded from:

http://www.mrlc.gov/nlcd06_data.php

These source rasters have 30 m pixel resolution.

A detailed NLCD project description is available here (Fry et al. 2011):

http://www.mrlc.gov/nlcd2006.php

NLCD 2006 Processing steps – Summary

Data loading:

1. Each source raster (Leica IMG format) was imported into a v10 file geodatabase using Copy Raster. A classification lookup table was exported from the source (Anderson Level 2) raster.
2. Each file geodatabase raster was time stamped with two fields: TIMESTAMP (Date) and TIMESTAMP_TEXT (Text, YYYY)
3. If not present, Red, Green, and Blue decimal value colormap fields and a text-format CLASSNAME field were added to each file geodatabase raster.
4. The file geodatabase rasters were exported to GeoTIFF format.

NLCD Update schedule

The NLCD outputs are produced every five years. 2011 Landsat Thematic Mapper imagery will be used to produce NLCD 2011 outputs. These products are expected no earlier than December 2013.

Accuracy assessment data for NLCD2006 source data are expected by summer 2012.

NALC 2005 Source data

The 2005 North American extent land cover raster for NALC were downloaded from:

http://www.cec.org/naatlas/

These source rasters have 250 m pixel resolution.

NALC 2005 Processing steps – Summary

Data loading:

1. Each source raster was imported into a v10 file geodatabase using Copy Raster. A classification lookup table was exported from the source (Anderson Level 2) raster.
2. The source Anderson Level 2 raster was re-classified into a Level 1 raster and a Natural/Converted raster. See Table 5 in Appendix 2 above.

NALC Update schedule

Unknown

C-CAP Source data 2001 (and Guam 2005)

Regional (CONUS, Hawaii, Guam) Coastal Change Assessment Project land cover data were downloaded from:

http://www.csc.noaa.gov/digitalcoast/data/ccapregional/index.html

These regional CONUS rasters are served by eastern or western CONUS extents at 30 m pixel resolution for 1996, 2001, and 2006. The source Hawaii raster is from 2001 at 30 m resolution while the 30 m source Guam raster is from 2005.

High-resolution C-CAP land cover and impervious data are available from:

http://www.csc.noaa.gov/digitalcoast/data/ccaphighres/index.html

High-resolution data are available for a selected area in Puerto Rico, the U.S. Virgin Islands, American Samoa, the Commonwealth of the Northern Mariana Islands, the Lower Columbia River estuary, and Santa Cruz (CA). Spatial resolution, dates, and thematic content vary.

C-CAP Source data all Pacific Islands 2005, Guam 2011, Guam Landcover Change Index 2005-2011, and US Virgin Islands 2007

Regional (Hawaii, Guam, American Samoa, Mariana Islands, US Virgin Islands), High Resolution Coastal Change Assessment Project land cover data (2005, 2011 Guam) were downloaded from:

http://csc.noaa.gov/ccapftp/

Pixel Resolution for all C-CAP rasters is 2.4m.

C-CAP Processing steps – Summary CONUS, 2001 HI and Guam, and Guam_old 2005

Data loading:

1. CONUS regional source rasters from C-CAP (Leica IMG format) were mosaicked into eastern and western CONUS extents. These regional mosaics were imported into v9.3 file geodatabase using Copy Raster. The western CONUS 2006 source raster was re-registered to eliminate the single pixel shift (southward) present in the downloaded data.
2. The CONUS extent sources were mosaicked into a 'seamless' extent for each date (1996, 2001, and 2006). A classification lookup table was exported for the CONUS data.
3. The Pacific Island rasters were mosaicked into island groups, reprojected (when necessary), and then clipped to the GADM shorelines to eliminate extraneous bounding pixels (GeoTIFF format). A classification lookup table was exported for the islands.
4. Each file geodatabase raster was time stamped with two fields: TIMESTAMP (Date) and TIMESTAMP_TEXT (Text, YYYY)
5. If not present, Red, Green, and Blue decimal value colormap fields and a text-format CLASSNAME field were added to each GeoTIFF file geodatabase raster.
6. The file geodatabase rasters were exported to GeoTIFF format.

C-CAP Processing steps – Summary all Pacific Islands 2005, Guam 2011, Guam Landcover Change Index 2005-2011, and US Virgin Islands 2007

Data loading:

1. Pacific Island regional source rasters from C-CAP (Leica IMG format) were mosaicked into their respective island groups (Hawaii, American Samoa, Mariana Islands, Guam, US Virgin Islands) and reprojected to their respective, native projection.
2. Island group rasters were clipped to GADM shorelines data to eliminate extraneous bounding pixels.

   a. In the case of USVI no clip was done as the shoreline shape excluded many significant areas of data.Instead, all NoData cells were “removed” and the raster was processed from that result.
3. A classification lookup table was exported for each island group as needed.
4. If not present, Red, Green, and Blue decimal value colormap fields and a text-format CLASSNAME(1) field were added to each GeoTIFF.

C-CAP Update schedule

Approximately every 5 years, from the date at which the most recent data were released