The Coastal Change Analysis Program and the Land Cover Atlas

Rebecca Love
NOAA Office for Coastal Management
Natural Infrastructure = Greater Resilience
C-CAP Regional Land Cover and Change

coast.noaa.gov/digitalcoast/data/ccapregional

- NOAA maps 25% of the contiguous U.S. + Hawaii and Caribbean
- Coastal expression of the NLCD (National Land Cover Database)
- Added focus on wetland detail
- 25 land cover categories at 30 meter resolution
  *Some areas go further back
Currently Funded 2015/2016 Updates

planning to complete full CONUS area by the fall-winter of 2018
Land Cover Atlas

coast.noaa.gov/digitalcoast/tools/lca

- Provides maps and statistics for land cover change throughout the coastal U.S.
- Offers land cover change information at the county and watershed level
- Eliminates the need for GIS software or advanced technical expertise

http://coast.noaa.gov/digitalcoast/tools/lca
Assessing Fire Hazard Risk in Southern California

- Increased fire risk due to drought and encroaching development
- Examined land cover change over time
- Highest rates of urban growth between Los Angeles and San Diego
How To Use Land Cover Data as a Water Quality Indicator

1. Identify Potential Impacts from Impervious Surfaces

Impervious surfaces and other forms of development reduce the infiltration of water into the ground. Impervious surfaces often contribute to higher storm water runoff, greater sediment yields, and increased pollutant loads, all of which can degrade water quality. Sensitive streams, for instance, can be impacted by as little as 5 to 10 percent impervious surface area, with greater impairments expected when rates exceed 20 to 25 percent.

2. Identify Potential Effects of Forest Cover

3. Examine Relationship of Forest Cover to Impervious Area

4. Identify Whether Developed Grasses Could be a Factor

5. Examine Riparian Buffers

6. Examine Other Potential Water Quality Factors

coast.noaa.gov/digitalcoast/data/ccapregional
1. Identify Potential Impacts from Impervious Surfaces

2. Identify Potential Effects of Forest Cover

3. Examine Relationship of Forest Cover to Impervious Area

   Watersheds are composed of groundwater recharge and storm water runoff generation areas. Forests and impervious surfaces represent the two ends of that continuum, with other land covers falling in between. In general, where impervious surfaces are limited in size and scope, forest cover exerts the most influence on water quality. Once impervious surfaces exceed a threshold, they are the determining factor.

4. Identify Whether Developed Grasses Could be a Factor

5. Examine Riparian Buffers

6. Examine Other Potential Water Quality Factors
More Than Just Data
Dive into the Digital Coast to Get the Data, Tools, and Training Communities Need to Address Coastal Issues.

What is the Digital Coast?
This NOAA-sponsored website is focused on helping communities address coastal issues and has become one of the most-used resources in the coastal management community. The dynamic Digital Coast Partnership, whose members represent the website’s primary user groups, keeps the effort focused on customer needs.

Learn more in our About section, or just dive in. And please provide feedback as often as possible. Hearing from you is what makes the Digital Coast work.

Learn More about the Digital Coast
About  Contributing Partners  Watch the Video

cost.noaa.gov/digitalcoast
Topics

Water Quality

Green Infrastructure

Climate Adaptation
Partnerships Keep It Real

- NOAA Office for Coastal Management
- American Planning Association
- Association of State Floodplain Managers
- Coastal States Organization
- National Association of Counties
- National Estuarine Research Reserve Association
- National States Geographic Information Council
- The Nature Conservancy
- Urban Land Institute
Connect with the Digital Coast

www.coast.noaa.gov/digitalcoast

Lake Level Viewer
coast.noaa.gov/llv
Brandon.Krumwiede@noaa.gov

Coastal Flood Exposure Mapper
coast.noaa.gov/floodexposure
Lauren.Long@noaa.gov

C-CAP data & Land Cover Atlas
coast.noaa.gov/ccapatlas
Rebecca.Love@noaa.gov
Nate.Herold@noaa.gov

http://www.facebook.com/NOAADigitalCoast

@NOAADigitalCoast
Today’s Agenda

• The Importance of Hazard Resilience in Coastal Communities

• Visualize the Impacts: The Lake Level Viewer
  – Brandon Krumwiede

• Communicate Hazard Vulnerabilities: Coastal Flood Exposure Mapper
  – Lauren Long

• See What’s on the Ground: C-CAP Land Cover Data & Land Cover Atlas
  – Rebecca Love

• Questions & Answers
More People in Coastal Communities

Population Density

Figure 5 | Population Density Change in Coastal Shoreline Counties and Inland Counties from 1970 to 2020

The Bottom Line

In 2010, 39 percent of the U.S. population lived in Coastal Shoreline Counties (less than 10 percent of the total land area excluding Alaska). The population density of Coastal Shoreline Counties is over six times greater than the corresponding inland counties.

Note: Density values include U.S. Territories and exclude Alaska.
Source: U.S. Census Bureau, 2011b; NOAA, 2012; Crowell et al., 2010
Coastal Communities Are at Risk
Visualizing the Impacts of Changing Water Levels in the U.S. Great Lakes: NOAA’s Lake Level Viewer

Brandon Krumwiede
Great Lakes Geospatial Coordinator
TBG at NOAA Office for Coastal Management
Great Lakes Coastlines

The Challenge...
The Impacts of Changing Water Levels
Water Level Variability

Great Lakes Water Levels (1918-2014)

Lake Superior

Lake Michigan-Huron

Lake St. Clair

Lake Erie

Lake Ontario

The monthly average levels are based on a network of water level gauges located around the lakes. Elevations are referenced to the International Great Lakes Datum (1985).
Water Level Variability

Great Lakes Water Levels

<table>
<thead>
<tr>
<th>Lake</th>
<th>Difference from Long Term Average (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Superior</td>
<td>601.1</td>
</tr>
<tr>
<td>Michigan-Huron</td>
<td>578.4</td>
</tr>
<tr>
<td>St. Clair</td>
<td>573.8</td>
</tr>
<tr>
<td>Erie</td>
<td>571.1</td>
</tr>
<tr>
<td>Ontario</td>
<td>245</td>
</tr>
</tbody>
</table>
The sun rises over Chicago on the shores of Lake Michigan, which – along with Lake Huron – has hit its lowest water level ever recorded.
What is the Lake Level Viewer?

• Work on the Lake Level Viewer began over 2 years ago
• First official release in November 2014
• Funded by the Great Lakes Restoration Initiative
• Fills a critical information data gap:
  1. 40% of Coastal Storms Program survey respondents said current data on future lake level changes are inadequate
  2. Only 26% said existing tools to work with or visualize these data are adequate

Source: 2013 Shoreline Change Workshop: Perspectives on the Great Lakes Survey
What is the Lake Level Viewer?

Use this data...
What is the Lake Level Viewer?

...to visualize the impacts
Lake Level Viewer Development

Requirements

• Use best available, high accuracy topo/bathy Lidar data to build a seamless Digital Elevation Model (DEM) for Great Lakes coastline
• Map lake levels below and above each lake’s long term average water to visualize the impacts of both flooding and low lake levels (+/- 6 feet)
• Develop photo simulations at local landmarks to see impacts
• Make the data available
Lake Level Viewer Development

US Interagency Elevation Inventory: coast.noaa.gov/inventory/
Green Areas denote current coverage
Lake Level Viewer Demonstration
Lake Level Viewer Next Steps

- Update with new topo/bathy data and fill in data gaps (LiDAR, USACE Dredge Surveys, multibeam)

- Adjust buffers and extend coverage to reflect full inundation areas

- Continue to collect user feedback on Version 1.0

- Enhancements for management applications based on user feedback
Thank You!
Coastal Flood Exposure Mapper

**Contributing Partners:** NOAA Office for Coastal Management

**Overview**

This tool supports users undertaking a community-based approach to assessing coastal hazard risks and vulnerabilities by providing maps that show people, places, and natural resources exposed to coastal flooding. This product is based on knowledge and experiences the Office for Coastal Management has in community-based risk and vulnerability assessments.

*The current geography includes the East Coast and Gulf of Mexico.*

**Features**

- **Allows** users to select a location and explore maps that show people, places, and natural resources exposed to coastal flood hazards
- **Creates** a collection of maps to download or share online to communicate flood exposure
- **Provides** guidance for using the maps to engage community members and stakeholders in conversations about potential coastal flood impacts
- **Offers** access to map services and tips on using them in an online mapping platform

**Related Data**

- Coastal Change Analysis Program
- Regional Land Cover
- Spatial Trends in Coastal Socioeconomics

**Related Training**

- Climate Adaptation for Coastal Communities
- Coastal Inundation Mapping
- Introducing Green Infrastructure for Coastal Resilience
- Roadmap for Adapting to Coastal Risk

**Related Tools**

- C-CAP Land Cover Atlas
- Sea Level Rise Viewer

Coastal Flood Exposure Mapper

Help start your community discussions about hazard impacts with maps of your area that show people, places, and natural resources exposed to coastal flooding.

Start Collecting Maps

The information in this product is based on the Roadmap for Adapting to Coastal Risk approach to assessing coastal hazard risks and vulnerabilities.
Select the Flood Hazards Map or One of the Community Exposure Maps

Select a section below to view maps showing flood hazards or different aspects of community exposure to those flood hazards.

**Flood Hazards**
Flood events are among the more frequent, costly, and deadly hazards that can impact coastal communities. There are two types:
- **Short-term (episodic)** – Temporary flooding caused by extreme conditions, including storm surge, tsunamis, inland flooding, and shallow coastal flooding.
- **Long-term (chronic)** – Flooding caused by a rise in relative sea level or some other change in conditions.

**Societal Exposure**
Understanding the populations that live in or near coastal flood-prone areas is an important information need, since residents who are elderly, who live in high-density areas, or who are impoverished may merit special considerations.

**Infrastructure Exposure**
Community infrastructure, including roads, bridges, and water and sewer systems, can be damaged by coastal flooding. Communities should first assess infrastructure vulnerabilities and associated environmental and economic issues to determine what steps are needed to protect these assets.

**Ecosystem Exposure**
Natural areas provide important benefits to coastal communities, including hazard protection, flood storage, water quality maintenance, fisheries support, and recreational opportunities. Communities can increase resilience by protecting natural areas along the coast that are exposed to flooding and adjacent inland areas.

Coastal Flood Hazard Composite

This map shows areas prone to flooding from one or more of the following hazards:

- Shallow coastal flooding
- High- and moderate-risk flooding (designated by the Federal Emergency Management Agency)
- Category 3 hurricane storm surge
- Sea level rise of 3 feet

The darker the color on the map, the more flood hazard zones there are for that area. Click on the map to see the number and types of hazards that may occur in a location. Additional information about each category mentioned above is provided in the maps that follow.
www.coast.noaa.gov/digitalcoast/tools/flood-exposure
## Exposure Data and Information

This page provides information on the data used in the Coastal Flood Exposure Mapper, map services available for use in ArcGIS Online or other online mapping platforms, and instructions on using map services within ArcGIS Online. Click here to directly access all map services.

### Flood Hazards

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
<th>Where to Get It</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coastal Flood Hazard Composite</td>
<td>Spatial extents of multiple flood hazard data sets combined. Flood hazard data sets include shallow coastal flooding, Federal Emergency Management Agency (FEMA) flood data (V zones, A zones, and 500-year zones treated as individual layers), storm surge for Category 3 hurricane, and sea level rise of three feet above mean high tide.</td>
<td>Coastal Flood Hazard Composite Map Service</td>
<td>Provides a quick visual assessment of areas most prone to flood hazard events.</td>
</tr>
<tr>
<td>Shallow Coastal Flooding</td>
<td>Areas that flood when coastal flood warning thresholds are exceeded. Derived from the flood frequency layer within the Sea Level Rise and Coastal Flooding Impacts Viewer.</td>
<td>Shallow Coastal Flooding Map Service</td>
<td>Areas subject to shallow coastal flooding.</td>
</tr>
<tr>
<td>FEMA Flood Zones</td>
<td>Digital FEMA flood data. The data represent the digital riverine and coastal flood zones available as of June 2014 and are a combination of Digital Flood Insurance Rate Maps and Q3 flood data.</td>
<td>FEMA Flood Zones Map Service</td>
<td>Areas at risk from flooding.</td>
</tr>
<tr>
<td>Storm Surge</td>
<td>Areas of near-worst-case storm surge flooding scenarios for coastal areas along the Gulf of Mexico and Continental U.S. Atlantic coasts. Data were derived from storm surge inundation maps created by the National Hurricane Center (NHC) Storm Surge Unit with the Sea, Lake, and Overland Surges from Hurricanes (SLOSH) model.</td>
<td>Storm Surge Map Service</td>
<td>Areas at risk from storm surge.</td>
</tr>
<tr>
<td>Sea Level Rise</td>
<td>Sea level rise inundation scenarios ranging from zero to six feet above mean higher high water (MHHW). Derived from data created for the Sea Level Rise and Coastal Flooding Impacts Viewer.</td>
<td>Sea Level Rise Map Service</td>
<td>Areas likely to be inundated by sea level rise.</td>
</tr>
</tbody>
</table>

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www.coast.noaa.gov/digitalcoast/tools/flood-exposure
Coastal Flood Exposure Mapper

Charleston, South Carolina

Flood Hazards Map
Coastal Flood Hazard Composite
Shallow Coastal Flooding
FEMA Flood Zones
Storm Surge
Sea Level Rise
Layers Opacity 100%

Data Sources Map Services

www.coast.noaa.gov/digitalcoast/tools/flood-exposure

OFFICE FOR COASTAL MANAGEMENT
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
www.coast.noaa.gov/digitalcoast/tools/flood-exposure
Shallow Coastal Flooding

FEMA Flood Zones

Storm Surge

Sea Level Rise

www.coast.noaa.gov/digitalcoast/tools/flood-exposure
Societal Exposure Maps
Infrastructure Exposure Maps
Ecosystem Exposure Maps
Flood Hazard Layers

- Coastal Flood Hazard Composite
- Shallow Coastal Flooding
- FEMA Flood Zones
- Storm Surge Scenarios
- Sea Level Rise Scenarios

Societal Exposure Maps
- Population Density
- Percent in Poverty
- Percent Elderly (65 and Up)
- Employees
- Projected Population Growth

Infrastructure Exposure Maps
- Development
- Critical Facilities
- Development Patterns

Ecosystem Exposure Maps
- Natural Areas and Open Space
- Potential Pollution Sources
- Natural Protection

www.coast.noaa.gov/digitalcoast/tools/flood-exposure
Collect and Share Your Maps

Download and print these maps or copy the link to share online with colleagues or in a community workshop.

Important: These maps will not be saved once you leave this site. To ensure your work is safe, either create and download a PDF or save and share the map URLs.

Tips for using these maps

Coastal Flood Hazard Composite
View Map
Map URL
http://go.usa.gov/3aXkd

Population Density
View Map
Map URL
http://go.usa.gov/3aXCw

Population Density
View Map
Map URL
http://go.usa.gov/3aXCe
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  - View Map

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  - Map URL: http://go.usa.gov/3aXCw
  - View Map

- **Population Density**
  - Map URL: http://go.usa.gov/3aXCe
  - View Map

Tips for using these maps

Print Maps
Tips, Resources, and Case Studies

Tips for Using These Maps in Your Community

Stakeholders

When communities come together to assess hazards and their impacts on society, infrastructure, and the environment, solutions can be found that are win-win strategies for multiple sectors.

The map data and the discussions spurred from these maps are valuable and applicable to a variety of community planning processes—from comprehensive land-use to hazards mitigation and conservation planning.

- Learn ideas on who to include! Download a participants checklist.
- Learn ideas on how to engage stakeholders! Download guidance on stakeholder engagement.

Case Studies

The following case studies illustrate how communities are assessing their risks and vulnerabilities to hazards. These examples emphasize the importance of diverse stakeholders, local knowledge and experience, hazards and community exposure maps and photographs, and facilitated discussions to identify hazard impacts.

Building Community Resilience on Long Island, New York

To help the Town of Smithtown update and enhance its comprehensive plan, the Nature Conservancy, the Association of State Floodplain Managers, and the NOAA Office for Coastal Management provided a one-day workshop on the Roadmap for Adapting to Coastal Risk approach for assessing and planning for hazards and climate change vulnerabilities. During this workshop, the town was able to understand the benefits of considering future risks from climate change in its planning and of better connecting its hazards resilience strategy and comprehensive plan.

Resources

Flood Hazards

Use these resources to explore relevant hazards, climate trends, and potential impacts as a starting point in assessing community risks and vulnerabilities.

Coastal inundation Mapping

This two-day instructor-led course offers a combination of lectures and hands-on exercises to give students a better understanding of coastal inundation issues and mapping methods using a geographic information system (GIS).

www.coast.noaa.gov/digitalcoast/tools/flood-exposure
Tips for Using These Maps in Your Community

Stakeholders

When communities come together to assess hazards and their impacts on society, infrastructure, and the environment, solutions can be found that are win-win strategies for multiple sectors.

The map data and the discussions spurred from these maps are valuable and applicable to a variety of community planning processes—from comprehensive land-use to hazards mitigation and conservation planning.

- Need ideas on who to include? [Download a participants checklist.]
- Need ideas on how to engage stakeholders? [Download guidance on stakeholder engagement.]

Discussion Questions

Along with the profile messages, the following questions can help facilitate a discussion about exposure to hazards.

- What’s driving your need to discuss and better plan for hazards?
- What types of societal, infrastructure, and environmental resources are located in the hazard-prone areas?
- What are the implications of these resources being located in hazard-prone areas?
- What other data and information are needed to assess societal, infrastructure, and environmental vulnerabilities to hazards?
- Who can provide the additional information needed to help your community learn more about potential damages to societal, infrastructure, and environmental resources?
- How, and when, can the information discussed be used to best inform existing community plans, policies, and projects?
- What other coastal hazards would you want to include in your assessment? Earthquake, liquefaction, coastal erosion, landslides, wind, fire, tsunami, or debris flow potential?

Using the Maps

Share knowledge, experiences, and concerns to encourage different perspectives and cross-sector connections by

- Showing the online maps during a community meeting and discussing the messages. Record conversations on flip charts and share with the larger group.
- Sharing specific maps by sending associated Web links.
- Downloading and printing maps for community meetings to write on to show where hazard concerns are located. Record conversations on flip charts and share with the larger group.
Increasing Coastal Resilience in New Jersey
Choose Community Exposure

Choose a section below to view maps showing different aspects of community exposure to flood hazards. Pick and choose the best maps to get the flood exposure conversation started in your community. You can also view our map services.

**Environment Map**
Natural areas provide important benefits to coastal communities, including hazard protection, flood storage, water quality maintenance, fisheries support, and recreational opportunities. Communities can increase resilience by protecting natural areas along the coast that are exposed to flooding and adjacent inland areas.

**Infrastructure Map**
Community infrastructure, including roads, bridges, and water and sewer systems, can be damaged by coastal flooding. Communities should first assess infrastructure vulnerabilities and associated environmental and economic issues to determine what steps are needed to protect these assets.

**Society Map**
Understanding the populations that live in or near coastal flood-prone areas is an important information need, since residents who are elderly, who live in high-density areas, or who are impoverished may merit special considerations.
Customized with Data
New Training!!

Using Flood Exposure Maps (flipped webinar)

Part 1 (August 4): email with information to watch a self-guided demo (1 hour) and submit questions to be addressed during the live portion.


Also time for Q&A from participants

To register, visit
http://noaacsc.adobeconnect.com/floodexposuremaps/event/event_info.html
or email Liz.Lasicki@noaa.gov
Thank you!

Lauren.Long@noaa.gov
Land Cover Atlas

coast.noaa.gov/digitalcoast/tools/lca

http://coast.noaa.gov/digitalcoast/tools/lca
C-CAP Land Cover Atlas

Contributing Partners: NOAA Office for Coastal Management

Overview | Requirements | In Action | Support

Get It Now

This online data viewer provides user-friendly access to regional land cover and land cover change information developed through NOAA’s Coastal Change Analysis Program (C-CAP). The Land Cover Atlas eliminates the need for desktop geographic information system software, or advanced technical expertise, by processing C-CAP data for the user and providing easy access to that distilled information. The tool summarizes general change trends (such as forest losses or new development) and can highlight specific changes of interest (salt marsh losses to open water, or evergreen forest losses to development, for instance).

Features

- Helps users to visually analyze and explore NOAA’s geospatial land cover data by county for areas of user interest
- Allows users to query specific types of land cover changes for specific date ranges and potentially evaluate their amount and location in relation to past management practices
- Creates summary reports and data tables to enhance communication and the decision-making process

Related Data
- Coastal Change Analysis Program
  Regional Land Cover

Related Tools
- C-CAP Coastal Comparison Tool
C-CAP Land Cover Atlas

To Start
- Select a state
- Pick a county or watershed
- Select a time frame
- Explore!

See Hints

New in this version
- Choose between Counties or Watersheds
- Year 2010 data available for all regions
- "Region Map" to select a geography using a map
- "Share Map" now provides shortened URL
- "Share Map" lets you share via Facebook or Twitter or Google+

View Disclaimer
Sarasota County, Florida
1996 to 2001

Percent of Sarasota County that changed
3.77%

Distribution of land cover by type

<table>
<thead>
<tr>
<th>Land Cover Classes</th>
<th>1996</th>
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<tbody>
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</table>

Square miles
Sarasota County, Florida
1996 to 2010

Percent of Sarasota County that changed
7.01%

Distribution of land cover by type:

<table>
<thead>
<tr>
<th>Land Cover classes</th>
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</table>
Sarasota County, Florida
1996 to 2010

Percent of Sarasota County that is developed
- 1996: 20.17%
- 2010: 23.82%

Percent of Sarasota County impervious surface area
- 1996: 6.89%
- 2010: 8.33%

Percent net increase in developed area
- 18.11%

Percent net increase in impervious surface area
- 20.95%
The C-CAP Land Cover Atlas provides detailed information on land cover changes in Sarasota County, Florida. The data shows an increase in impervious surface area and developed area from 1996 to 2010.

- **Percent of Sarasota County Impervious Surface Area**
  - 1996: 6.89%
  - 2010: 8.33%

- **Percent Net Increase in Developed Area**
  - 18.11%

- **Percent Net Increase in Impervious Surface Area**
  - 20.95%

The distribution of developed change by developed type shows a significant gain in each category from 1996 to 2010:

- **Developed, High Intensity**
- **Developed, Medium Intensity**
- **Developed, Low Intensity**
- **Developed, Open Space**

The atlas also allows users to select on map and change the land cover view for a more detailed analysis.
Sarasota County, Florida
1996 to 2010

Percent of Sarasota County that is developed
1996: 20.17%
2010: 23.82%

Percent of Sarasota County impervious surface area
1996: 6.89%
2010: 8.33%

Percent net increase in developed area
18.11%

Percent net increase in impervious surface area
20.95%

Distribution of developed change by developed type
- Agriculture
- Barren Land
- Forested
- Grassland
- Scrub/Shrub
- Woody Wetland
- Open Water

Distribution of areas lost to development by land cover
- Changed to developed

Square miles
Sarasota County, Florida
1996 to 2010

Percent of Sarasota County that is forested
1996 24.72%
2010 23.23%

Percent net decrease in forested area
-6.00%

Percent net decrease in core forested area
-8.46%

Percent net decrease in non core forested area
-4.83%

Percent net increase in new forested area gained
0.91%
Sarasota County, Florida
1996 to 2010

Percent of Sarasota County that is wetland
1996 33.25%
2010 31.72%

Percent net decrease of total wetlands
-4.60%

Percent net decrease of freshwater (palustrine) wetlands
-4.53%

Percent net decrease of saltwater (estuarine) wetlands
-4.10%

Distribution of wetland change by wetland type

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United States Department of Commerce | National Oceanic and Atmospheric Administration | National Ocean Service
Sarasota County, Florida
1996 to 2010

Percent of Sarasota County that changed

7.01%
Sarasota County, Florida

2010 Land Cover

Having an accurate picture of an area’s landscape and understanding how that landscape is changing is important information for any planning effort. Land cover data can help provide that big-picture view.

The data seen in the map below was derived through NOAA’s Coastal Change Analysis Program (C-CAP). C-CAP produces nationally standardized land cover and land change information for the coastal regions of the U.S. Multiple dates of satellite imagery are used to document changes in various types of land cover. The 2010 land cover for Sarasota County can be seen below.

These summary sheets provide an easy way to understand some of the important information derived from these data for Sarasota County.