Resources

Introducing Green Infrastructure for Coastal Resilience

Flood Hazards

Courses

- **Using Flood Exposure Maps**
  This course is offered in a two-part, "blended webinar" format. Participants view Part 1, a recorded demonstration on how to use the Coastal Flood Exposure Mapper (about 1 hour). Later, they can join other participants for Part 2, a live, online session (about 1 hour) that includes both an opportunity to ask questions about the mapper and hear an interview with a guest speaker. Webinars offered quarterly.
  coast.noaa.gov/digitalcoast/training/flood-exposure

Resources

- **Coastal Flood Exposure Mapper**
  Resource that provides maps showing where people, places, and natural resources are exposed to coastal flood hazards including sea level rise, storm surge, shallowing coastal flooding, flood zones, and a composite flood hazard view. Can download maps or share online with others to help facilitate conversations around community resilience.
  coast.noaa.gov/digitalcoast/tools/flood-exposure

- **Sea Level Rise and Coastal Flooding Impacts Viewer**
  This viewer creates maps of potential impacts of sea level rise along the coast and provides related information and data for community officials.
  coast.noaa.gov/digitalcoast/tools/slr

- **Lake Level Viewer**
  This viewer creates maps of potential lake level fluctuations ranging from six feet above to six feet below historical long-term average water levels in the Great Lakes. Information can be used to help communities with planning decisions such as zoning restrictions, infrastructure improvements, and habitat conservation.
  coast.noaa.gov/digitalcoast/tools/llv

- **Coastal Resilience Network**
  The Nature Conservancy's Coastal Resilience network supports a community of practitioners who are applying planning innovations to coastal hazard and adaptation issues. The network provides access to peer practitioners, tools, information, and training focused on nature-based solutions, and interactive maps to help assess hazard risks and opportunities for natural solutions.
  http://maps.coastalresilience.org/network

Ecosystem Services

Resources

- **Econ 120: Ecosystem Services**
  This short video explains economic principles involved when evaluation ecosystem services.

coast.noaa.gov/digitalcoast/training/econ-120-ecosystem-services
- **Green Infrastructure Protective Services Visualization**
  Short animation that explains ecosystem services for coastal hazard resilience and provides examples of the various natural resources that can provide protective benefits for coastal communities.
  coast.noaa.gov/digitalcoast/training/gi-animation
- **Gulf of Mexico Ecosystem Services Database**
  This site provides searchable information about ecosystem service valuation studies for habitats relevant to the Gulf region, although the studies may have been conducted elsewhere.
  www.gecoserv.org

Reports
- **Assessing Green Infrastructure Costs and Benefits for Flood Reduction**
  This guide lays out a six-step watershed-based approach to documenting the costs of flooding, projecting increased flooding and associated costs under future land use and climate conditions, and calculating benefits and costs of reducing flooding with green infrastructure over the long term.
  coast.noaa.gov/digitalcoast/training/gi-cost-benefit
- **The Value of Green Infrastructure: A Guide to Recognizing Its Economic, Environmental, and Societal Benefits**
  www.cnt.org/publications/the-value-of-green-infrastructure-a-guide-to-recognizing-its-economic-environmental-and
- **The Value of Urban Green Infrastructure and Its Environmental Response in Urban Ecosystem: A Literature Review**
  www.water.ca.gov/wateruseefficiency/landscapeordinance/pubcomments/Melanie%20Stanton/Turfgrass%20Benefits%20Literature%20Review%20for%20Developing%20Nations.pdf
- **Natural Defenses from Hurricanes and Floods: Protecting America's Communities and Ecosystems in an Era of Extreme Weather**
  This report by the National Wildlife Federation and others discussion principles for increasing resilience to floods and hurricanes using natural infrastructure and some critical policies that could be reformed to address growing risks.
  www.nwf.org/~/media/PDFs/Global-Warming/2014/Natural-Defenses-Final-Embargoed-Until-102114-10amET.pdf
- **Performance of Natural Infrastructure and Nature-based Measures as Coastal Risk Reduction Features**
  Report developed by the Environmental Defense Fund in 2015 that assesses various natural infrastructure and nature-based strategies for reducing coastal risk. Findings provide information on methods, strengths and weaknesses, uncertainties around risk reduction, suitable conditions, performance, capacity and limitation, and examples of projects

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implemented.
www.edf.org/sites/default/files/summary_ni_literature_compilation_0.pdf
- **Coastal Risk Reduction and Resilience: Using the Full Array of Measures**
www.corpsclimate.us/ccacrrr.cfm

Landscape Conservation
Resources
- **Conservation Gateway**
The Nature Conservancy provides information on conservation planning methods and practices, including Open Standards for the Practice of Conservation, Conservation by Design, and Conservation Action Planning.
www.conservationgateway.org
- **Guide for Considering Climate Change in Coastal Conservation**
This guide provides a step-by-step approach for incorporating climate change information into new or existing conservation plans - *coast.noaa.gov/digitalcoast/training/considering-climate-change*. The **online, interactive How To** summarizes these steps and points to relevant resources for each - *coast.noaa.gov/digitalcoast/training/coastal-conservation.*
- **Green Infrastructure Mapping Guide**
The Green Infrastructure Mapping Guide shows spatial analysts how to incorporate green infrastructure strategies into their GIS work. This online guide offers a GIS work plan and easy access to examples, process guidance, case studies, and templates.
coast.noaa.gov/digitalcoast/training/gi-mapping
- **Habitat Priority Planner**
This tool helps identify high priority locations for conservation and restoration planning.
coast.noaa.gov/digitalcoast/tools/hpp
- **Coastal Change Analysis Program Land Cover Atlas and Data**
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) - *coast.noaa.gov/digitalcoast/tools/lca*. You can also download land cover data here - *coast.noaa.gov/digitalcoast/data/ccapregional.*
- **ESRI's Green Infrastructure for the US**
This website provides a 6 step process for green infrastructure planning at the landscape scale - *www.esri.com/about-esri/greeninfrastructure/plan*. Under Resources, the site includes a Living Atlas of the World that contains many maps and different apps to leverage in your work - *www.esri.com/about-esri/greeninfrastructure/resources*. It also includes a nationwide green infrastructure map that includes good, better, and best core areas identified - *https://green-infrastructure.esri.com/AssetFinder/index.html.*
- **Land Trust Alliance Climate Change Toolkit**
This website provides many helpful resources on understanding climate impacts,

incorporating climate into conservation planning, identifying adaptation options, and learning from others.
http://climatechange.lta.org/get-started

- **Green Infrastructure Center**
The Green Infrastructure Center is a nonprofit organization founded in December 2006 to assist communities in developing strategies for protecting and conserving their ecological and cultural assets through environmentally sensitive decisions, lifestyles, and planning.
www.gicinc.org

- **U.S. Environmental Protection Agency – Healthy Watershed Initiative**
The healthy watersheds concept is based on a holistic systems approach to watershed protection and conservation. Maintenance of aquatic ecological integrity requires that we understand not only the biological, chemical, and physical condition of water bodies but also critical watershed functional attributes, such as hydroecology, geomorphology, and natural disturbance patterns.
www.epa.gov/healthywatersheds

- **National Park Service – Rivers, Trails, and Conservation Assistance Program**
This program, also known as the Rivers and Trails Program, is the community assistance arm of the National Park Service. The program staff provides technical assistance to community groups and local, state, and federal government agencies so they can conserve rivers, preserve open space, and develop trails and greenways. The Rivers and Trails Program implements the natural resource conservation and outdoor recreation mission of the National Park Service in communities across America.
www.nps.gov/orgs/rtca/index.htm

Community and Site-Scale Green Infrastructure

Resources

- **U.S. Environmental Protection Agency (EPA) – Green Infrastructure**
This EPA website provides basic information about green infrastructure along with tools, resources (such as cost-benefit analysis), funding opportunities, case studies, research, and reports on green infrastructure.
www.epa.gov/green-infrastructure

- **Low Impact Development Center**
The organization provides information on low impact development methods, examples, and provides access to related publications and manuals.
www.lowimpactdevelopment.org

- **Nonpoint Education for Municipal Officials (NEMO)**
NEMO provides information, education, and assistance to local land use boards and commissions on how they can accommodate growth while protecting their natural resources and community character. NEMO focuses its message on the use of geographic

information system and remote sensing technology as educational tools; the promotion of land use planning rather than mechanical devices as the primary weapon against water pollution; and the importance of local land use decision makers as the primary target audience.
nemo.uconn.edu

- **National Low Impact Development Atlas**
  This atlas highlights innovative low impact development practices around the country. Its goal is to encourage and educate local officials and others about these practices by providing specific, local examples of their use. The 31 member programs of the National NEMO Network have compiled the projects highlighted on this site and will continue to add new projects as they become available. Each project balloon contains project specifics, a summary of the project, photos (when available), and links to more information.
  http://lidmap.uconn.edu

- **Center for Watershed Protection**
  The Center for Watershed Protection, Inc. is dedicated to fostering responsible land and water management through applied research, direct assistance to communities, award-winning training, and access to a network of experienced professionals. As national experts in stormwater and watersheds, this organization takes a practical approach to complex, technical watershed management issues, providing collaborative leadership across disciplines and professions with a commitment to protect, restore, and enhance our streams, rivers, lakes, wetlands, and bays.
  www.cwp.org

Reports

- **Green Infrastructure Options to Reduce Flooding**
  This short publication provides green infrastructure techniques, benefits, limitations, and tips on how to estimate floodwater storage potential and costs.
  coast.noaa.gov/digitalcoast/training/gi-cost-benefit

Shoreline Protection

Resources

- **NOAA Living Shorelines**
  This website provides access to NOAA guidance for considering living shorelines as well as information on different techniques.
  www.habitat.noaa.gov/restoration/techniques/livingshorelines

- **Living Shorelines Academy**
  This website provides information and resources to homeowners interested in living shorelines as well as contractors and engineers looking to design and install them.
  www.livingshorelinesacademy.org/index.php

Reports

- **Natural and Structural Measures for Shoreline Stabilization**
  This brochure presents information on a continuum of shoreline stabilization techniques—from "green" to "gray"—that can help reduce coastal risks and improve resilience.
  coast.noaa.gov/digitalcoast/training/living-shorelines

Implementing Green Infrastructure

Overarching Resource
- **Georgetown Climate Center's Green Infrastructure Toolkit**
  A great resource that covers many aspects of green infrastructure implementation including planning and permitting, stakeholder engagement, and funding.
  www.georgetownclimate.org/adaptation/toolkits/green-infrastructure-toolkit/introduction.html

Transportation Planning
Resources
- **Georgetown Climate Center Adaptation Case Studies**
  This website provides over100 case studies about how communities are preparing their roads, airports, transit systems, and infrastructure for climate change.
  www.adaptationclearinghouse.org/sectors/transportation/case-studies-b.html
- **U.S. Department of Transportation Federal Highway Administration: Virtual Framework for Vulnerability Assessment**
  Provides a framework and training modules to help planners determine the vulnerability of transportation infrastructure to hazards and climate change. Each module provides key steps, videos, case studies, tools, and other resources.
  www.fhwa.dot.gov/environment/climate_change/adaptation/adaptation_framework/
- **U.S. Department of Transportation Federal Highway Administration: Green Infrastructure Techniques for Coastal Highway Resilience**
  Provides information, resources, and case study examples to help transportation planners link transportation planning and green infrastructure.
  www.fhwa.dot.gov/environment/climate_change/adaptation/ongoing_and_current_research/green_infrastructure/

Stormwater Planning
Reports
- **Banking on Green**
  This report focuses on the economic impacts caused by polluted stormwater runoff and economic benefits of using green infrastructure to reduce this significant source of water pollution. It's not intended to be an academic or technical document, but instead to be an "easy to read" compendium of current experiences, analysis and knowledge.

www.asla.org/uploadedFiles/CMS/Government_Affairs/Federal_Government_Affairs/Banki ng%20on%20Green%20HighRes.pdf

- **Enhancing Sustainable Communities with Green Infrastructure: A Guide to Help Communities Better Manage Stormwater While Achieving Other Environmental, Public Health, Social, and Economic Benefits**
  This guide developed by the Environmental Protection Agency (EPA) was developed to help communities better manage stormwater using green infrastructure.
  www.epa.gov/smartgrowth/pdf/gi-guidebook/gi-guidebook.pdf
- **Permitting Green Infrastructure: A Guide to Improving Municipal Stormwater Permits and Protecting Water Quality**
  This guide is intended to be a resource for community and watershed advocates that provides clear examples of new stormwater permits that encourage or require low impact development or green infrastructure.
  www.americanrivers.org/conservation-resource/permitting-green-infrastructure-guide/

Climate Change Adaptation Planning
Courses
- **Climate Change for Coastal Communities**
  This course covers these essentials: understanding climate science and impacts, determining community vulnerabilities, communicating effectively, identifying adaptation strategies, and finding mechanisms to implement those strategies.
  coast.noaa.gov/digitalcoast/training/climate-adaptation
- **Climate Change Vulnerability Assessment**
  This course developed by the U.S. Fish and Wildlife Service and National Wildlife Federation is designed to guide conservation and resource management practitioners in essential elements of creating climate adaptation plans.
  http://nctc.fws.gov/NCTCWeb/catalog/CourseDetail.aspx?CourseCodeLong=FWS-ALC3184
- **Coastal Inundation Mapping**
  This course provides a better understanding of coastal inundation issues and mapping methods using GIS. Lecture topics include the different types of coastal inundation, the applications and limitations of various types of inundation products, elevation data sets and datums, and the spatial methods used to map flood areas in coastal environments.
  coast.noaa.gov/digitalcoast/training/inundationmap
- **U.S. Fish and Wildlife Service (USFWS) Climate Change Learning Center**
  USFWS provides access to climate training, workshops, webinars, and resources through its National Conservation Training.
  http://training.fws.gov/courses/programs/climate-change/
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- **Coastal Flood Exposure Mapper**

Resource that provides maps showing where people, places, and natural resources are exposed to coastal flood hazards including sea level rise, storm surge, shallowing coastal flooding, flood zones, and a composite flood hazard view. Can download maps or share online with others to help facilitate conversations around community resilience.
coast.noaa.gov/digitalcoast/tools/flood-exposure

- **Coastal Resilience**
  This site integrates coastal hazard, ecological, and socioeconomic information in geographies where the Nature Conservancy and partners are working to implement ecosystem-based adaptation strategies, providing interactive maps and information to help decision makers.
  www.coastalresilience.org
- **Georgetown Climate Center Adaptation Clearinghouse**
  This website provides a wealth of case studies and access to resources to help communities with adaptation efforts. It also includes specific information by state.
  www.georgetownclimate.org/
- **Sea Level Rise and Coastal Flooding Impacts Viewer**
  This viewer creates maps of potential impacts of sea level rise along the coast and provides related information and data for community officials.
  coast.noaa.gov/digitalcoast/tools/slr
- **Template for Assessing Climate Change Impacts and Management Options (TACCIMO)**
  This web-based tool developed by the U.S. Forest Service provides a searchable repository of peer-reviewed literature on climate change impacts and management options, a geospatial mapping application that provides national-extent downscaled climate data and other models for evaluating climate change impacts to forests, and report generators for capturing information for a specific location.
  www.taccimo.sgcp.ncsu.edu

Reports

- **National Fish, Wildlife, and Plants Climate Adaptation Strategy**
  This report provides effective steps to help natural resources and the communities that depend on them be more resilient and adaptable to a changing climate. These steps are the result of collaboration among federal, state, and tribal governments.
  www.wildlifeadaptationstrategy.gov/pdf/NFWPCAS-Final.pdf
- **Reducing Climate Risks with Natural Infrastructure**
  This publication by the Nature Conservancy provides details on nine case studies that illustrate the variety of ways to use green infrastructure to reduce the impacts of hazards and sea level rise.
  www.nature.org/ourinitiatives/regions/northamerica/unitedstates/california/ca-green-vs-gray-report-2.pdf
- **The State of Climate Change Adaptation in the United States: An Overview**

This 2013 synthesis report was written by EcoAdapt, the Climate Impacts Group at the University of Washington, the Georgetown Climate Center at Georgetown University, and the University of California-Davis. The report provides examples of societal responses to climate change in planning and management of cities, agriculture, and natural resources. *www.ecoadapt.org/data/documents/TheStateofAdaptationintheUnitedStates2013.pdf*

- **Green Infrastructure and Climate Change: Collaborating to Improve Community Resiliency**
  Report summarizing four community charrettes held by the U.S. Environmental Protection Agency to help communities in this type of planning. Every charrette focused on a different climate change issue.
  www.epa.gov/green-infrastructure/green-infrastructure-and-climate-change-collaborating-improve-community

- **Using Nature to Reduce Climate and Disaster Risk**
  This brochure provides information on how nature can play a role in reducing climate and hazard risks to society, the economy, and environment.
  www.conservationgateway.org/ConservationPractices/Marine/crr/library/Documents/Using%20Nature%20To%20Reduce%20Climate%20and%20Disaster%20Risks%20-%20TNC%20Brochure.pdf

- **What will Adaptation Cost? An Economic Framework for Coastal Community Infrastructure**
  This report provides a framework that community leaders and planners can use to make more economically informed decisions about adapting to sea level rise and storm flooding.
  coast.noaa.gov/digitalcoast/publications/adaptation

Stakeholder Engagement and Communication
Courses

- **Fostering Behavior Change for Coastal Management: An Introduction to Community-Based Social Marketing**
  This one-and-a-half-hour Web-based training course introduces participants to a basic approach that has been used in coastal management projects to influence the way people interact with their environment.
  coast.noaa.gov/digitalcoast/training/social-marketing

- **Planning and Facilitating Collaborative Meetings**
  This two-day instructor-led course is designed to increase participants' ability to plan and facilitate a meeting (or a series of meetings) that minimize conflict and enhance problem solving. Collaboration is often cited as a good way to address coastal resource management issues, but the collaborative process is complicated, requiring a systematic approach. This course provides the skills and tools to design and implement collaborative approaches. The skills will be useful even when attending, but not running, a collaborative meeting.
  coast.noaa.gov/digitalcoast/training/planning-and-facilitating

- **Seven Best Practices for Risk Communication**
  This 90-minute interactive webinar introduces participants to seven best practices, numerous techniques, and examples for how to more effectively communicate about coastal hazards. The webpage provides great resources to help as well.
  www.coast.noaa.gov/digitalcoast/training/risk-communication

Resources
- **CanVis**
  Developed by the U.S. Department of Agriculture's National Agroforestry Center, CanVis is a visualization program used to "see" potential impacts from coastal development or sea level rise.
  coast.noaa.gov/digitalcoast/tools/canvis
- **Econ 120: Ecosystem Services**
  This short video explains economic principles involved when evaluation ecosystem services.
  coast.noaa.gov/digitalcoast/training/econ-120-ecosystem-services
- **Green Infrastructure Protective Services Visualization**
  Short animation that explains ecosystem services for coastal hazard resilience and provides examples of the various natural resources that can provide protective benefits for coastal communities.
  coast.noaa.gov/greeninfrastructurevis/
- **Storm Surge Fast Draw**
  Short animation that explains storm surge and impacts.
  coast.noaa.gov/digitalcoast/training/what-is-storm-surge
- **Tidal Flooding Impacts Animation**
  Short animation that explains tidal flooding, potential increases in events, impacts, and adaptation strategies.
  coast.noaa.gov/digitalcoast/training/tidal-flooding
- **Coastal County Snapshots**
  The online tool turns complex data into easy-to-understand stories, complete with charts and graphs. Users select a coastal county of interest and the website provides information on flood zones, coastal economies, wetlands, and stormwater management (coming soon).
  coast.noaa.gov/digitalcoast/tools/snapshots/
- **US Army Corps of Engineers North Atlantic Coast Comprehensive Study**
  Website contains visualizations of risk management strategies for coastal communities that could be helpful in stakeholder communication.
  www.nad.usace.army.mil/CompStudy/
- **EPA's Overcoming Barriers to Green Infrastructure Webpage**
  Provides a wealth of information and resources to help communities overcoming barriers such as high cost perception and maintenance requirements and costs. There are a set of barrier bust fact sheets that are quick communication pieces to help with stakeholder

engagement.
www.epa.gov/green-infrastructure/overcoming-barriers-green-infrastructure

Reports

- **Communicating the Science of Climate Change**
  This article provides background on the public perception of climate change and ways that climate scientists can improve the ways they convey their findings to the public.
  climatecommunication.org/wp-content/uploads/2011/10/Somerville-Hassol-Physics-Today-2011.pdf

- **How To Communicate Successfully Regarding Nature-Based Solutions: Key Lessons from Research with American Voters and Elites**
  Report funded by The Nature Conservancy to gain insight on the most preferred terms and messages to use when communicating to the public about nature-based solutions.
  www.conservationgateway.org/ConservationByGeography/NorthAmerica/UnitedStates/Pages/nature-based-solutions.aspx

- **Introduction to Stakeholder Participation**
  This publication discusses some of the most important considerations in stakeholder participation and offers a guide to the most common techniques.
  coast.noaa.gov/digitalcoast/training/stakeholder

- **The Language of Conservation: How to Communicate Effectively to Build Support for Conservation**
  This document provides recommendations on how to communicate effectively to build support for conservation and is based on a national survey.
  Conservationtools.org/library_items/1319