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DVRPC

WHITE PAPER

An Assessment of Planning Tools for Climate Change Resiliency in the Delaware Valley

DELAWARE VALLEY dvrpc REGIONAL PLANNING COMMISSION

The Delaware Valley Regional Planning Commission is the federally designated Metropolitan Planning Organization for a diverse nine-county region in two states: Bucks, Chester, Delaware, Montgomery, and Philadelphia in Pennsylvania; and Burlington, Camden, Gloucester, and Mercer in New Jersey.

DELAWARE VALLEY dvrpc REGIONAL PLANNING COMMISSION

DVRPC's vision for the Greater Philadelphia Region is a prosperous, innovative, equitable, resilient, and sustainable region that increases mobility choices by investing in a safe and modern transportation system; that protects and preserves our natural resources while creating healthy communities; and that fosters greater opportunities for all.

DVRPC's mission is to achieve this vision by convening the widest array of partners to inform and facilitate data-driven decision-making. We are engaged across the region, and strive to be leaders and innovators, exploring new ideas and creating best practices.

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Section 1: Introduction

The Delaware Valley Regional Planning Commission has been helping communities, local governments and planning partners understand, plan and prepare for the impacts of climate change throughout the Greater Philadelphia region since the early 2000s. DVRPC has conducted numerous studies and projects on sea level rise in the Delaware Estuary, prepared climate vulnerability assessments for local governments, published climate change adaptation plans, researched and assembled over-arching guides on the projected impacts of climate change in the Delaware Valley, and played a key role in initiating efforts by the Pennsylvania and New Jersey departments of transportation and SEPTA to assess the vulnerability of their respective transportation assets to climate change.

While DVRPC has already generated resources targeted directly at the region's communities, such as *Municipal Management in a Changing Climate*, published in 2018, there has been a recent proliferation of online tools, resources, guides and websites published by a wide variety of academic, governmental and nonprofit organizations designed to help practitioners plan for the impacts of climate change. Some, though not all, of these tools and resources may be of use to our region's communities and add value to the products DVRPC has already created. DVRPC is therefore preparing this assessment so that our planning partners can avoid the confusion of assessing and learning about hundreds of potentially superfluous tools and resources and quickly identify and prioritize those tools that will best meet their climate change planning and data needs.

Climate Change and Resiliency

In recent years, preparing for the impacts of climate change and extreme weather events has become synonymous with the term "resiliency." *Resilience* is defined as "the capacity of individuals, communities, institutions, businesses, agencies, and systems to survive, adapt, and grow no matter what kinds of chronic stresses and acute shocks they experience." "Chronic stresses" could include factors such as high unemployment, poor or overtaxed infrastructure, concentrated poverty, or fiscal mismanagement, while "acute shocks" are the disruptions that often get conversations about resilience going: flooding, extreme weather events, earthquakes, disease outbreaks, terrorist attacks, and economic downturns. Not surprisingly, the concept of "resiliency" now applies to a wide range of

sectors, circumstances and societal concerns. Even so, "resiliency" as a term is most commonly linked to the idea of communities adapting, surviving, and bouncing back from *climate-related* "shocks," such as

Figure 1: Schuylkill River flooding in Manayunk (City of Philadelphia, 2014)

coastal storms, flooding, extreme heat, drought, and wildfires. With the growing concern over the impacts of sustained climate change and the high-visibility of events like hurricanes Katrina, Sandy, Harvey, and Maria, and the 2018 and 2019 California wildfires, this emphasis is more than justified. Accordingly, the following discussion will focus on tools and data needed to make communities across Greater Philadelphia more resilient to the impacts of climate change.

This investigation began with a broad review of hundreds of resiliency tools and then performed a more in-depth analysis on their applicability to planning in the Delaware Valley, eventually winnowing the list down to the 60 tools included in Appendix A of this paper. That list was *further* refined into a list of eighteen tools deemed most useful for helping Delaware Valley communities identify, coordinate and implement resiliency actions across multiple departments, sectors, and disciplines. The tools and planning frameworks contained in this guide are targeted toward agency staff, professional planners, public managers, government officials, and non-profits that play a role in planning, designing, owning, maintaining, or managing community resources and support services. The level of technical skill

required to utilize these tools ranges from nominal to advanced, but the majority of the tools and resources are designed to be as easy as possible to use. Direct links to the recommended tools are provided in Section 4 and in Appendix A.

Although flooding, drought, extreme heat, winter storms, high winds, wildfires, and tidal surges have always posed threat to communities, and communities have always tried to plan for and address these threats in one form or another, climate change has introduced new dimensions and new uncertainties into this milieu. As a result, communities everywhere are now trying to understand how climate hazards will change and what the implications will be for sectors like transportation, energy, water, agriculture, the economy, and public health. The tools presented in this guide may initially seem to add an unnecessary level of effort to this process, but they can potentially assist communities in forecasting and understanding how climate change will impact their communities over the short and long term. A more significant challenge will be developing the community buy-in, political consensus, equitable outcomes, and resources needed to effect meaningful actions.

Section 2: Organizing Resiliency Tools

Tools useful for climate resiliency planning have proliferated extensively over the past decade. In order to develop an understanding of the scope and range of these tools, this investigation conducted an open-ended review of web resources, academic articles, government publications, and private-sector reports. Although the initial review considered the broadest possible range of tools, a set of over 60 tools were ultimately identified and reviewed based on their diversity and potential usefulness to planners and practitioners in the Delaware Valley. This list was further distilled into a set of 18 tools that may be the *most* useful to communities in the Delaware Valley.

A major source of information for this review was *tool aggregation websites*. These websites are clearinghouses for other tools, reports, and resources. A prime example is the *U.S. Climate Resilience Toolkit*, which is an interagency web repository initiative led by the National Oceanic and Atmospheric Administration (NOAA) and containing more than 200 tools to help communities build resilience. Other examples include the U.S. Environmental Protection Agency's *Climate Adaptation Resource Center/ARC-X*, which includes a library of primarily sectoral-based adaptation tools; and the Georgetown Climate Center's *Adaptation Clearinghouse*, which includes a voluminous list of tools, plans, reports, guides and case studies. Although the clearinghouses provide ready access to a host of tools, they can be overwhelming to look through. Accordingly, one purpose of this effort is to simplify this abundance of information and direct planners and practitioners in the Delaware Valley to tools that are useful, accessible, and broadly applicable to their needs.

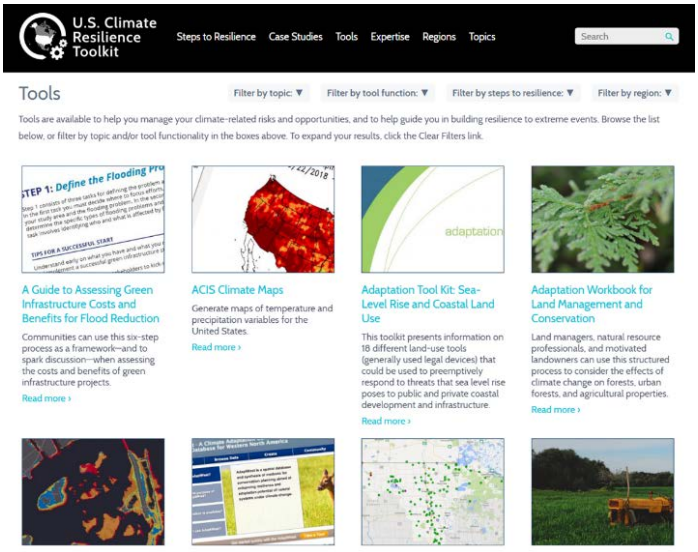

Figure 2: U.S. Climate Resilience Toolkit (U.S. 2020)

The Tool Categories

Given the number and diversity of tools, we organized them into four categories or groups to enable planners to more quickly find and prioritize tools that may be useful to them. The four groups include planning process tools, decision support tools, data analysis and interpretation tools, and communication and stakeholder engagement tools. These groupings should not be thought of as restrictive or absolute. They are merely meant to serve as a basic organizing framework to help make sense of the many tools now offered for the purpose of building resiliency. Outlined below are descriptions of the categories and examples of how tools fit into each of these groups.

Planning Process Tools

Planning process tools are comprehensive guides outlining the steps a community should follow to effectively plan for and build resilience. These tools generally outline a sequence of planning steps: e.g., (1) assess past and future (climate) trends, (2) identify and engage stakeholders, (3) identify and characterize vulnerabilities, (4) develop and prioritize resilience strategies, (5) implement actions, and (6) monitor and reassess. These steps for resiliency planning are not dissimilar from most other types of community planning processes, and, like other community planning processes, the intended outcome of these tools is a comprehensive plan that can be used to guide a wide range of decisions.

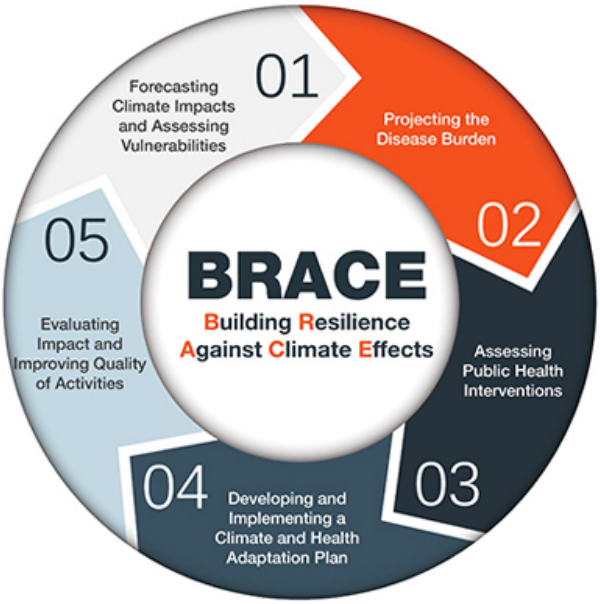

Figure 3: Five-step BRACE Framework (CDC, 2019)

Examples of tools within this grouping include the *Climate Ready Communities* manual published by the Geos Institute and *Building Resilience Against Climate Effects (BRACE)*, published by the Centers for Disease Control and Prevention (CDC). The Geos Institute guide was developed for communities to work through a step-by-step climate change preparedness planning process for the entire community. It uses creative graphics and clearly defined planning steps to illustrate the adaptation planning process. The CDC's guide (shown on the right), by contrast, is focused on the public health sector, helping officials integrate climate change into the public health planning processes.

Decision Support Tools

Decision support tools use data, questionnaires, checklists, and decision trees to help practitioners draw conclusions and prioritize actions. Unlike planning processes tools, they aim to produce focused recommendations and prioritized actions, and/or serve as general reference sources. They do not seek to guide the creation of a full-scale planning document. Examples of this type of tool include the Delaware Valley Regional Planning Commission's (DVRPC's) *Municipal Management in a Changing*

Figure 4: Overview of City Resilience Index (Arup, 2012)

Climate tool, Sustainable Jersey's *Municipal Coastal Vulnerability Assessment* tool, and the *City Resilience Index*, designed by Arup and funded by the Rockefeller Foundation.

The Municipal Management in a Changing Climate tool summarizes the science and impacts of climate change for the Delaware Valley region and includes a short discussion on how climate change could impact areas important to municipal governance, including buildings and facilities, storm water systems, transportation infrastructure, municipal services, street trees, and public health. The Municipal Coastal Vulnerability Assessment tool, by contrast, helps users systematically evaluate the relative vulnerability of a community's assets to climate change–induced coastal flooding, and assess the consequences that the loss of a particular asset would pose to the community. By doing so, the tool helps planners identify where implementation efforts are most urgently needed. The City Resilience Index website is likewise unique in that it contains a collection of reports and spreadsheet-based tools that enable municipalities to accurately gauge their current level of climate resiliency and begin planning for specific interventions. A graphic displaying the indicators that these spreadsheets measure is shown on page 6. The tool's three-step process can either be used as part of a larger planning process or as a flexible and focused self-assessment.

Data Analysis and Interpretation Tools

Data tools include tools that provide data, data visualization, and data interpretation, in order to support a planning or decision-making process and/or educate audiences on the risks posed by climate change. They also typically provide clear and creative ways to display, visualize, access, or map data via an online platform and so can be used as ready-made public engagement tools. The *Climate Explorer* tool maintained by a collection of federal agencies as a part of the U.S. Climate Resilience Toolkit is a prime example of a data tool. The Climate Explorer allows users to look at and map climate change impacts, such as sea level rise, heat increases, and precipitation changes up to the year 2100 across both optimistic and pessimistic emissions scenarios. The *Coastal Effects of Climate Change in Southeastern PA* online story map tool created by DVRPC in 2019 also fits into this category. It was developed using data specific to the Delaware Valley region and allows users to explore how sea level rise will impact a variety of future probabilistic flooding scenarios along the tidal Delaware River in Pennsylvania.

Communication and Stakeholder Engagement Tools

Communication and stakeholder engagement tools are designed to do just that: engage diverse stakeholders and promote community dialogue and knowledge transfer. One example is the *Game of Floods,* a role-playing exercise developed by Marin County, California, that requires participants to engage in discussions on the benefits and tradeoffs of adaptation measures under a range of scenarios. DVRPC has used this tool to great effect in engaging communities and starting conversations about planning for climate change resiliency through a series of workshops.

Evaluating Resiliency Tools

There are several factors that must be considered when evaluating tools, including the geographic coverage, spatial resolution, customizability, complexity, and how a tool handles the uncertainties that are inevitable when attempting to forecast future climate, particularly at longer time scales. Because of these considerations and the differences among tools, communities should consider using a suite of tools that provide a combination of data outputs and processes that fit their specific needs, as opposed to focusing on a single approach. By doing so, the limitations of an individual tool will be minimized and the possibility for creating an effective adaptation and resiliency planning program will be increased.

Section 3: Utilizing Resiliency Tools

Three Approaches to Resiliency Planning

For many communities looking to improve resilience, **creating a dedicated or standalone plan** is often the most obvious route to assessing their vulnerabilities in a holistic and comprehensive manner. Standalone plans help create clarity of purpose, reduce vulnerability to shifting political concerns, highlight a more direct path to implementation, and increase issue visibility. They can also be valuable by helping to catalyze the adaptation and resiliency planning process in the first place and provide great communication benefits by highlighting a community's vulnerabilities to a wide range of constituents. However, standalone plans may give the impression to community members, city departments, and the private sector that adaptation and resiliency are separate issues to be managed by whoever produced the plan.

Another pathway is for organizations and communities to **integrate or "mainstream" climate adaptation and resiliency into existing planning practices and departments**. Mainstreaming allows offices or departments within a community to incorporate projections of climate change impacts into their existing work in ways that are specifically tailored to their needs. The downside to this approach is that it can result in uneven progress across a community since it is not easy to get multiple departments and offices—all of whom are busy executing their existing missions—to independently take on the issue of climate change in a consistent and informed manner. This approach can therefore result in a series of disjointed plans and actions across departments, staff, and sectors.

The final pathway is to effectively do both: **create a standalone resiliency plan (or plan element) and gradually integrate climate change into existing plans, procedures, policies, and investment strategies across multiple departments.** This helps to increase issue visibility and achieve overarching consistency of strategies and recommendations while also "mainstreaming" climate change projections and data into existing departments and programs. As shown on page 10, this is the pathway that Miami-Dade County has followed over the past 30 years. The county's Climate Change Advisory Task Force developed a countywide climate adaptation plan in the 2000s, after which the county began integrating climate change adaptation considerations into its Comprehensive Development Master Plan. Following

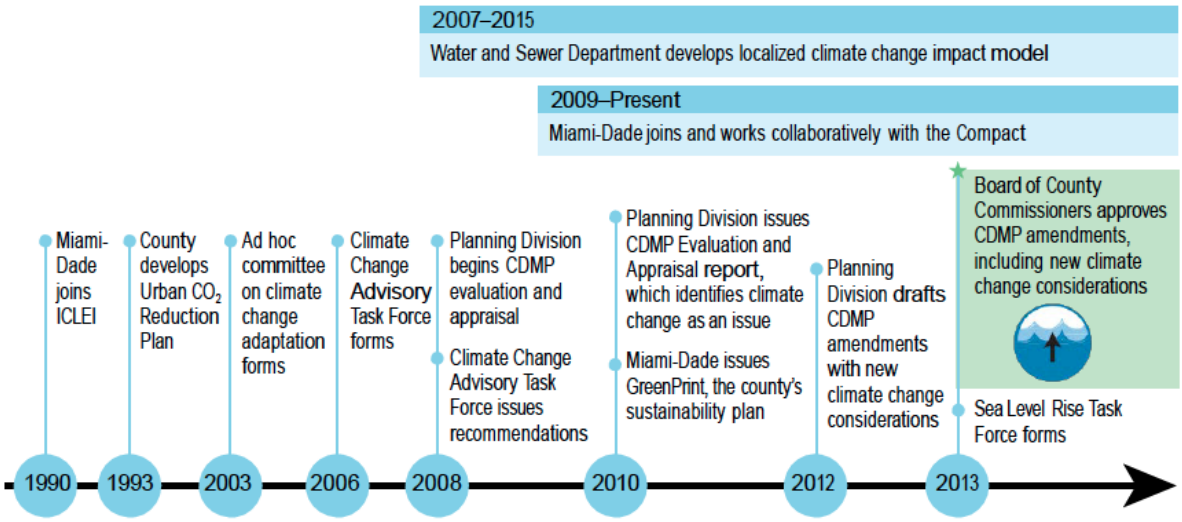

Figure 5: Timeline of Miami-Dade County's climate planning mainstreaming process (Kresge, 2016)

this integration, the county required all departments to consider climate change adaptation in their capital improvement projects and everyday decision-making processes.

Building a Toolkit

Selecting tools to use for climate resiliency planning in the Delaware Valley is not as simple as ranking all available options and creating a single toolkit that works equally well in every community across the region. Communities will have different needs depending on their goals and capacities, their physical circumstances, the unique vulnerabilities they face, how much work they have already completed in climate resiliency planning, and the quality and character of their existing plans and policies. For some communities that have already completed work on this subject, identifying tools that could strengthen their current planning efforts will be relatively straightforward. For others who may be just starting out, more guidance may be needed to determine which tools are most helpful.

Communities that want to engage robustly on the topic of climate change resiliency planning may want to take advantage of one of the overarching, comprehensive planning guides presented in Appendix A. As they work through the document, they can use other data and decision support tools as needed to help gather, understand, and evaluate pertinent data and information. Howsoever a community or

organization decides to develop a toolkit, it is important to maintain a flexible and iterative process that considers the capabilities, capacities, needs, requirements, and level of engagement within each community. Regardless of a community's needs, the tools and resources highlighted in this review should help with this effort.

Figure 6: Climate Adaptation Forum at DVRPC (DVRPC, 2019)

Section 4: Resiliency Planning Tools for the Delaware Valley

Although the full Resiliency Planning Toolkit identifies over 65 tools, tool aggregation websites, and resiliency-focused resources useful for planning purposes (Appendix A), 18 of these tools were identified as particularly useful for communities and organizations in the Delaware Valley. These tools have broad applicability across the region, are not focused on a niche sector, and are not overly duplicative of one another. They are a starting point for communities interested in exploring how to plan for climate change and extreme weather events. As needed, communities can then tap the larger pool of resources, tools, and applications available to assist practitioners with resiliency planning. The following describes one noteworthy tool in each of the four major categories and lists all of the 18 priority tools by category. More information and links to all 18 tools can be found in Appendix A.

Planning Process Tools

Preparing for Climate Change: A Guidebook for Local, Regional, and State Governments was developed by the Climate Impacts Group at the University of Washington in association with King County, Washington, and ICLEI – Local Governments for Sustainability. A seminal document in the field, this guide was developed for use by King County to plan for the impacts of climate change, but it is broadly applicable to a wide range of local, regional, and state governments. The fundamental principles can also be applied in non-governmental organizations and private-sector businesses sensitive to climate change.

The guidebook begins with a short overview of the science of climate change and the reasons why local, regional, and state decision makers should take proactive steps to prepare for a changing climate. The guidebook then outlines how to build a climate change preparedness team, identify relevant planning areas, and conduct a *vulnerability and risk assessment* while considering key resiliency concepts such as sensitivity, adaptive capacity, consequence, and probability. The guidebook recommends guiding principles—such as mainstreaming climate change into planning, policy, and investment decisions—and provides a roadmap for setting preparedness goals and selecting and prioritizing preparedness actions.

The remainder of the guide focuses on implementation, managing risk and uncertainty, and measuring progress.

Although the *Preparing for Climate Change* guidebook was first developed in 2007, it has served as a blueprint for nearly all subsequent guides on adaptation planning, and the terminology and concepts developed for the guide have been widely adopted into the resilience planning field. The logical steps and clear language continue to make this guide a go-to resource for all levels of government looking to comprehensively plan for the impacts of climate change.

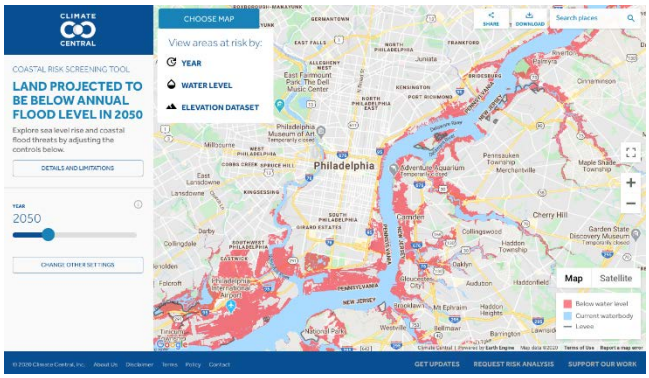

Figure 7: Surging Seas (Climate Central, 2020)

Priority planning process tools for the Delaware Valley:

- Building Resilience Against Climate Effects (BRACE) (CDC)
- Climate Ready Communities: A Practical Guide to Building Climate Resilience (Geos Institute)
- Community Resilience Planning Guide (National Institute of Standards and Technology)
- Preparing for Climate Change: A Guidebook for Local, Regional, and State Governments (ICLEI, University of Washington, and King County, Washington)

Decision Support Tools

Naturally Resilient Communities is a tool developed by a range of partners, including the American Planning Association, the American Society of Civil Engineers, and the private design firm Sasaki. The tool is designed to enable communities and organizations to quickly investigate nature-based solutions to a range of flooding problems. The tool also provides case studies for each nature-based solution and provides information about a range of funding sources to support decision making.

The Naturally Resilient Communities tool directs users to select the flooding hazard type they are most concerned with, along with basic characteristics about their community, such as community type (i.e., urban, suburban, rural) and geographic scale. Upon identifying the hazard(s) and community

characteristics, the tool presents users with a series of relevant solutions and case studies, with accompanying details and implementation strategies. With over 50 solutions and case studies available, the options cover a wide range of potential interventions to build resilience against flooding risks.

Priority decision support tools for the Delaware Valley:

- City Resilience Index (Arup)
- Climate Change Adaptation Toolkit (Royal Melbourne Institute of Technology)
- Municipal Coastal Vulnerability Assessment (Sustainable Jersey)
- Municipal Management in a Changing Climate (DVRPC)
- Naturally Resilient Communities (American Planning Association, American Society of Civil Engineers, and others)
- Vista (NatureServe)

Data Analysis and Interpretation Tools

Surging Seas is a suite of tools designed to help coastal communities visualize and understand the risks posed by sea level rise. It is managed by Climate Central, an independent organization of leading scientists and journalists researching and reporting the facts about climate change. The site allows users to map and visualize a wide range of scenarios for future sea level rise and flooding events. In addition to basic inundation maps, Surging Seas adds value by showing the probability of flooding events at different depths across a spectrum of future time intervals, i.e., "what is the probability that a given coastal location will experience a flood of six feet during the year 2050, etc.?" The tool also shows what is at risk in each flooding scenario in terms of housing, property values, infrastructure, and demographic groups. The strengths of Surging Seas include quality data, detailed mapping, informative charts and graphs, a simple interface, and fast-rendering speeds.

Priority data analysis and interpretation tools for the Delaware Valley:

- Climate Explorer (NOAA and the National Environmental Modeling and Analysis Center)
- Coastal Effects of Climate Change in Southeastern PA (DVRPC)
- NJ Flood Mapper (Rutgers University)
- Social Vulnerability Index (CDC)
- Surging Seas (Climate Central)

Communication and Stakeholder Engagement Tools

Climate Change Adaptation Workshops: A Planning Guide for Local Government Staff is a tool designed to help communities and organizations engage the public around climate change adaptation planning. By clearly and effectively communicating the impacts of climate change, a public engagement process can help build support for taking actions to build resiliency. Created by the Office of Sustainability for Alameda County, California, the guide lays out core principles for engaging the public on the issue of climate change adaption. The principles stress "narrowing the frame" to reduce the chance of getting overwhelmed, "integrating with existing goals" to increase the chance of future implementation, and "finding champions" to imbue people with passion, capacity, and vision in the process.

Priority communication and stakeholder engagement tools for the Delaware Valley:

- Climate Change Adaptation Workshops: A Planning Guide for Local Government Staff (Alameda County Office of Sustainability)
- Climate Training Toolkit 2.0 (Urban Sustainability Directors Network)
- High Water Mark Initiative (Federal Emergency Management Agency [FEMA])

Section 5: Conclusion

As a result of the proliferation of online tools and resources over the past decade, urban planners, public officials, non-profit leaders, and private citizens have no lack of access to climate science and data. The tools presented in this analysis offer planners in the Delaware Valley a curated list of quality tools that will assist them in their efforts to assess, analyze, plan, and advocate for actions that build resilience in their respective communities. However, no tool will result in action on its own: analyzing climate change information, making sense of it, and using it to develop plans and strategies that build resilience will ultimately require individual effort, dedication, collective action, and political will.

As communities and organizations begin to fully engage in this process, they should keep in mind that planning for adaptation and resiliency is a multifaceted and non-linear activity. As one climate adaptation specialist put it by modifying a quote from a seminal 1970s guide to spiritual growth: "Climate Change Adaptation is complex. There are no self-help manuals, no formulas, no easy answers. The right road for one is the wrong road for another. The journey of Climate Change Adaptation is not paved in black top, it is not brightly lit. It has no road signs. It is a rocky path through the wilderness" (M. Scott Peck, modified by Harmut Funfgeld).

What is important is that communities throughout the region are empowered and motivated to use the tools and suggestions in this paper to take the first step in the climate adaptation planning process. Despite the challenges and complexities of climate adaptation planning, the process itself holds tremendous potential for improving communities and preparing them to be resilient to changes and uncertainties in the decades to come.

Appendix A: The Resiliency Planning Toolkit

(Priority tools for the Delaware Valley are listed first in each section, highlighted in light gray.)

Tool Aggregation Sites and General Resources	
Adaptation Clearinghouse (Georgetown Climate Center)	This clearinghouse created by the Climate Center at Georgetown University is a useful compendium of resources that focuses on community-level adaptation tools.
Climate Adaptation Knowledge Exchange (EcoAdapt)	This comprehensive online toolkit was developed by EcoAdapt and is a clearinghouse of adaptation tools that cities can use to inform their climate change planning efforts. It includes more private-sector tools than the government-led toolkits and is searchable by geographic area, adaptation phases, and subject area.
Climate Change Adaptation Resource Center/ARC-X (U.S. EPA)	This central repository for all the climate adaptation tools and resources developed by the U.S. EPA is searchable by geographical area, tool type, and subject matter.
U.S. Climate Resilience Toolkit (NOAA)	This comprehensive online toolkit, developed for U.S. federal, state, and local governments and led by NOAA, is a large and organized clearinghouse of adaptation tools that cities can use to organize their climate change plans.
Building Science Publications (FEMA)	This resource center contains sample building code specifications and regulations to help communities prepare for natural disasters. These include building codes for flooding, wildfires, and all hazard mitigation.
Climate Change in PA (Pennsylvania Department of Environmental Protection)	The Pennsylvania Department of Environmental Protection has developed an online story map that describes the impacts of climate change in the state of Pennsylvania and lists actions, resources, regulations, and funding opportunities for individuals and communities.
Climate Change Resilience Innovation Products (Urban Sustainability Directors Network)	The Innovation Lab of the Urban Sustainability Directors Network contains a number of case studies of adaptation examples among larger-sized American cities, as well as a section on resources and tools for municipal managers in more urbanized areas.
Green Infrastructure Wizard (U.S. EPA)	This searchable resource directory contains a large amount of green infrastructure reports, technical documents, regulations, and case studies to assist municipalities with creating a green infrastructure program.

The RESIN Tools (European Union)	This comprehensive online toolkit was developed for European cities by the European Union and is a large and organized clearinghouse of adaptation tools that cities can use to plan for climate change.
Sabin Center for Climate Change Law Adaptation Resources (Columbia Law School)	This database of legal codes, articles, and sample policies is maintained by the Sabin Center for Climate Change Law at Columbia Law School. It is useful for people and organizations interested in the legal ramifications of creating an adaptation and resiliency plan.

Planning Process Tools	
Building Resilience Against Climate Effects (BRACE) (CDC)	This decision-making framework helps guide public health departments through planning, preparing, and adapting to changes in public health situations due to climate change. This includes tools to help project the disease burden and other impacts.
Climate Ready Communities: A Practical Guide to Building Climate Resilience (Geos Institute)	This is an in-depth manual for local communities to prepare, develop, and implement a climate resiliency and adaptation plan. If communities are interested, they can then contract Geos Institute as consultants to help with developing the plan further.
Community Resilience Planning Guide (National Institute of Standards and Technology)	This in-depth, practical guide uses a systems-thinking approach to creating a community resiliency plan.
Preparing for Climate Change: A Guidebook for Local, Regional, and State Governments (ICLEI, University of Washington, and King County, Washington)	A step-by-step guide for governments to begin, work through, and complete a climate change preparedness planning process. A seminal work in the field.
The Adaptation Workbook (Northern Institute of Applied Climate Science)	This adaptation workbook is designed for natural resources managers, such as foresters, agriculture planners, and open-space planners to assess and plan for the impacts of climate change to their ecosystems.
Airport Climate Adaptation and Resilience (Airport Cooperative Research Program, National Academies of Sciences, Engineering, and Medicine)	This document provides airport managers with technical support to review the range of risks to airports from projected climate changes and the approaches for handling them.

Building Health Care Sector Resilience (U.S. Department of Health and Human Services)	This online toolkit helps health care organizations adapt to climate change. It includes an overview planning document, links to climate data websites, and checklists to guarantee preparation.
Climate Adaptation Planning and Public Life (Gehl Institute)	The Gehl Institute is working on a tool that will allow municipal leaders to measure the impacts of public spaces on climate adaptation and resilience projects. This will then enable more of these projects to be built and to increase community resiliency.
Climate Change Handbook for Regional Water Planning (U.S. EPA)	This handbook, developed in California, provides recommended steps for water managers to include climate change impacts in planning strategies and to assess their greenhouse gas emissions. It packages these steps in the Integrated Regional Water Management process.
Community-based Risk Screening Tool – Adaptation and Livelihoods (CRiSTAL) (International Institute for Sustainable Development)	A project planning tool designed for use in developing countries, which uses simple spreadsheets and user guides to help a community plan for climate change.
Community-Driven Climate Resilience Planning: A Framework (National Association of Climate Resilience Planners)	By focusing on communities and how they should be organized to plan for climate change, this guide helps planners and community members alike build coalitions that can help develop strong, community-driven climate resilience plans.
Creating Resilient Water Utilities (U.S. EPA)	An online comprehensive planning resource that includes a strategies guide, workshop guide, assessment tools, resource directory, inundation story map, and case studies to help water utilities assess their risk and plan for climate change.
A Guide to Equitable, Community-Driven Climate Preparedness Planning (Urban Sustainability Directors Network)	This guide and accompanying assessment tool were developed to evaluate and plan for how climate change will impact a community's more vulnerable populations. Through step-by-step processes and attention to detail in communication, this guide is helpful in ensuring equity in resilience.
Planning for Climate Change - Toolkit (UN Habitat)	This comprehensive planning guide walks local government officials through all the steps of putting together a climate change action plan. It contains extensive details about each strategy and lists multiple options for planning actions for officials to choose from.
Planning Framework for a Climate-Resilient Economy (U.S. EPA)	This document guides a municipality through assessing and planning for the impacts that climate change will have on their local economy.
Risk-Based Adaptation of the Climate Ready Estuaries program (U.S. EPA)	Originally created for individuals managing estuaries as part of the Climate Ready Estuaries program, this guidebook can also be used for general climate adaptation planning anywhere involving water.

Storm Water Management Model (U.S. EPA)	A web-based application that calculates storm water flow in an urban environment. Planners can include green storm water infrastructure and climate change predictions in their models.
A Toolkit for Procuring Resilience (re:focus Partners)	This guide helps municipalities review their procurement policies and suggests ways to make these more efficient, more responsive to changing city conditions, more creative, and better suited to climate change adaptation.

Decision Support Tools	
City Resilience Index (Arup, 100 Resilient Cities)	Organized spreadsheets to categorize and rate a community's level of resiliency.
Climate Change Adaptation Toolkit (Royal Melbourne Institute of Technology)	Developed in partnership with consultants and Australian government, this toolkit is a simple and organized way for municipalities to think through climate adaptation actions.
Municipal Coastal Vulnerability Assessment (Sustainable Jersey)	Designed to help New Jersey communities at risk of sea level rise, this online tool enables communities to assess their risk and plan for sea level rise in an organized fashion.
Municipal Management in a Changing Climate (DVRPC)	This brochure was created by DVRPC to help guide local municipalities in planning for climate change by providing an overview of the expected climate changes in the Delaware Valley region and some basic short- and long-term responses that communities can undertake to prepare for these changes.
Naturally Resilient Communities (American Planning Association, American Society of Civil Engineers, Sasaki, and others)	This online collection of solutions and case studies allows communities to enter search criteria about the nature of their flooding problem and come up with a list of targeted interventions.
Vista (NatureServe)	An ArcGIS extension that helps organize geographic information system (GIS) maps for land use planning decisions and allows testing of scenarios.
Adaptation Solutions (Bosch Slabbers, Deltares, Sweco, Wittevenn+Bos, and KNMI)	This simple-to-use online tool allows users to enter a basic set of parameters and then receive a customized set of climate adaptation infrastructure and design solutions.
Climate Adaptation Framework and Indicator Evaluation (Urban Sustainability Directors Network)	This tool assesses climate adaptation frameworks and includes a guide to developing urban climate adaptation indicators and a spreadsheet of sample adaptation indicators.

Climate Change Adaptation Certification Tool (EcoAdapt and Foresight Partners Consulting)	This tool was developed to help communities incorporate climate planning goals and policies into community services, infrastructure planning, and local economic development. The three-step process also integrates climate considerations into local comprehensive planning.
Climate Resilience Evaluation and Awareness Tool (CREAT) (U.S. EPA)	CREAT is a risk assessment application that helps utilities adapt to extreme weather events by better understanding current and long-term weather conditions.
Envision Tomorrow (Fregonese Associates)	Open-access scenario planning package that allows users to create different scenarios to better understand how decisions about growth will impact public health, fiscal resiliency, and environmental sustainability.
Equity in Building Resilience in Adaptation Planning (National Association for the Advancement of Colored People)	This list of indicators enables planners to ensure that their climate adaptation and resilience plan covers all aspects of social equity.
Flood Resilience Checklist (U.S. EPA)	This checklist helps communities plan for and recover from flooding events and helps foster long-term resiliency against future events.
A Guide for Public-Sector Resilience Bond Sponsorship (re:focus Partners)	This guide describes in detail the new realm of public-sector bonds that can help finance climate adaptation and resiliency infrastructure projects. These bonds include resiliency bonds, environmental impact bonds, and catastrophe bonds.
Hazus (FEMA)	A GIS-based software model that produces loss estimates for earthquakes, floods, hurricanes, and tsunamis. This tool can be used for hazard mitigation planning efforts associated with climate change impacts.
National Stormwater Calculator (U.S. EPA)	Storm water modeling application that allows in-depth calculations of a site's storm water runoff and potential for flooding. Different climate change scenarios can also be used to gauge future impacts.
Open City Climate Resilience Planning (Resurgence)	This resource is a roadmap, showcase, and guide that features over 25 examples of cities from around the world that are innovating with open data to manage their disaster risk and build their resilience.
SimCLIM (CLIMsystems)	An online software tool designed to facilitate risk assessments relating to climate change. Users can create site-specific scenarios, as well as model extreme weather events.
Temperate Adaptation Planning Software (ICLEI)	An online planning application created in partnership with ICLEI and Azavea, which helps communities plan for the entire range of impacts relating to climate change. The application includes interactive web tools, online mapping software, and access to private consultants.
Vulnerability Assessment and Adaptation Framework (U.S. Department of Transportation, Federal Highway Administration)	This resource was created to help state departments of transportation and regional Metropolitan Planning Organizations assess vulnerabilities and integrate climate adaptation considerations into decision making.

Watershed Index Online (U.S. EPA)	This technical online mapping tool provides resources to help managers compare and analyze watershed characteristics. It is part of the U.S. EPA's Adaptation Resource Center (ARC-X) suite of tools for climate adaptation planning.

Data Analysis and Interpretation Tools	
Climate Explorer (NOAA and the National Environmental Modeling and Analysis Center)	Detailed website showing optimistic and pessimistic climate change scenarios for a range of weather conditions. The charts produced show the range of predictions at the community, county, regional, state, and national levels.
Climate Mapper (The University of Idaho)	GIS-based web tool showing a range of climate predictions with regional scale datasets. Useful parts of this tool include the ability to download GIS data directly from the map. The map is focused on the Pacific Northwest but also includes data for the rest of the country.
Coastal Effects of Climate Change in Southeastern PA (DVRPC)	This interactive online story map shows the full range of predicted future flooding scenarios and the impact these will have on infrastructure and property values. It also describes FEMA's Community Rating System and how that could be used to mitigate some of the flooding risks.
NJ Flood Mapper (Rutgers University)	This online mapping tool allows New Jersey communities to visualize their flooding risk due to sea level rise.
Social Vulnerability Index (CDC)	Web tool that produces maps of the social vulnerability factors for each county at the census tract level. These maps are useful to highlight areas that have populations more at risk to climate change.
Surging Seas (Climate Central)	A suite of tools that allows users to assess the social, environmental, and economic costs of a wide range of sea level rise scenarios.
Climate Data (Habitat Seven and NOAA)	Broad scale mapping website that allows side-by-side comparisons of high and low emissions scenarios in easy to understand maps. Great for visualizations at a regional scale, though it lacks specific community data.
The Climate Inspector (National Center for Atmospheric Research)	Online GIS tool with some community-level data on climate change trends for heat and precipitation. Data is downloadable, but the maps are at regional scale and not very useful for communities.
Digital Coast (NOAA)	Online database of tools, guides, and trainings related to sea level rise and flooding considerations. The main tool is an online mapping application that uses national climate models to predict sea level rise in local scenarios.
Integrated Climate and Land Use Scenarios (U.S. EPA)	This online mapping tool projects the impacts climate change will have on population growth, economic development, and land use.

Communication and Stakeholder Engagement Tools	
Climate Change Adaptation Workshops: A Planning Guide for Local Government Staff (Alameda County Office of Sustainability)	This guide provides principles for engaging the public on climate change adaptation. This occurs through building public participation into every aspect of the adaptation and resiliency planning process.
Climate Training Toolkit 2.0 (Urban Sustainability Directors Network)	The Climate Training Toolkit consists of interactive role-playing games designed to raise awareness about, and begin planning for, the impacts of climate change. The first version only included flooding as a hazard, while version 2.0 includes heat and extreme weather. DVRPC has extensively used this tool in workshops to engage audiences in mock decision making and planning around climate change adaptation.
High Water Mark Initiative (FEMA)	The High Water Mark initiative is a program by FEMA to build community awareness of the flooding potential of a community. By placing high water markers around town, residents can visualize flooding scenarios. This online toolkit contains press releases, a public information campaign, and supporting information.
Soak Up the Rain (U.S. EPA)	A public information campaign by the U.S. EPA to encourage private homeowners to install and maintain storm water management infrastructure, such as downspout disconnection and rain gardens.
Building Older Adults' Resilience by Bridging Public Health and Aging-in-Place Efforts (RAND Corporation)	This toolkit is designed to bring together those involved in aging-in-place support and those involved in disaster resilience efforts to improve the ability of older adults to withstand and rebound from the effects of natural and human-caused disasters.
The Hungrier Games: Disaster Resilience Skills for Youth (RAND Corporation)	This tool proposes a communication methodology and interactive game for officials and teachers who are trying to engage high schoolers in the climate resiliency planning process.

Appendix B: Image Citations and Disclaimer

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Centers for Disease Control and Prevention Disclaimer:

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ABSTRACT

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Key Words: Adaptation, Climate Change, Coastal Vulnerability, Flooding, Hazard Scenarios, Planning Tools, Preparedness, Resiliency, Sea Level Rise, Sustainability, Toolkit

Abstract:

Planning for climate change resiliency is an increasingly pressing requirement for communities throughout the world and the Delaware Valley Regional Planning Commission (DVRPC) region. In order to help local officials, non-profits, and communities with this process, numerous planning tools have been developed by a wide range of public and private agencies. Accordingly, the purpose of this paper is to explain, organize, and prioritize the tools that currently exist in order to select ones that are broadly accessible to a wide range of organizations, applicable across a range of sectors, and not overly redundant. During this selection process, a list of over 60 tools was winnowed down to a final toolkit of 18 that are particularly useful at any stage in the resiliency planning process and can be used for communities throughout the DVRPC region.

Staff Contacts:

Miles Owen | Environmental Planner, Office of Environmental Planning | Phone: 215.238.2813
Email: mowen@dvrpc.org

Chris Linn | Manager, Office of Environmental Planning | Phone: 215.238.2873
Email: clinn@dvrpc.org

190 N Independence Mall West
8th Floor
Philadelphia, PA 19106-1520
215.592.1800 | fax: 215.592.9125
www.dvrpc.org

DELAWARE VALLEY
dvrpc
REGIONAL
PLANNING COMMISSION

190 N Independence Mall West
8th Floor
Philadelphia, PA 19106-1520
215.592.1800 | fax: 215.592.9125
www.dvrpc.org

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