2017

Municipal Climate Adaptation Guidance Series: Overview

AN OVERVIEW AND INTRODUCTION TO GUIDANCE DOCUMENTS FOR MAINE MUNICIPALITIES

MUNICPAL PLANNING ASSISTANCE PROGRAM,
MAINE DEPT. OF AGRICULTURE CONSERVATION AND FORESTRY
LINCOLN COUNTY REGIONAL PLANNING COMMISSION
BLUE SKY PLANNING SOLUTIONS

This document is the introduction to a guidance series that was developed for the Municipal Planning Assistance Program, Maine Department of Agriculture Conservation and Forestry through a collaborative effort of the following regional planning organizations:

Androscoggin Valley Council of Governments
Greater Portland Council of Governments
Hancock County Planning Commission
Kennebec Valley Council of Governments
Lincoln County Regional Planning Commission
Midcoast Council of Governments
Midcoast Regional Planning Commission
Northern Maine Development Council
Southern Maine Planning and Development Commission

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I. INTRODUCTION

CHANGING CLIMATE CONDITIONS IN MAINE

Historical data show that Maine's climate conditions have changed over the last 100 years and models predict changing conditions into the future. Precipitation patterns have changed, extreme events occur more frequently, average temperatures are higher, and sea levels have increased. Regardless of what is causing these changes, the data clearly show that not only are these changes from historic levels measurable, the changes are occurring at a rate not seen in the recorded history of climate data.[1] The following figures are taken from Maine's Climate Future, 2015 Update and illustrate changes already occurring or predicted to occur in Maine; more details on each of these figures is found in the report.

Figure 1 plots recorded temperature information revealing that Maine's average annual temperature has increased 3 degrees between the late 1800's and the present. Using this historical data and projections of future conditions shows that temperature conditions across Maine will continue to rise as illustrated in Figure 2 below.

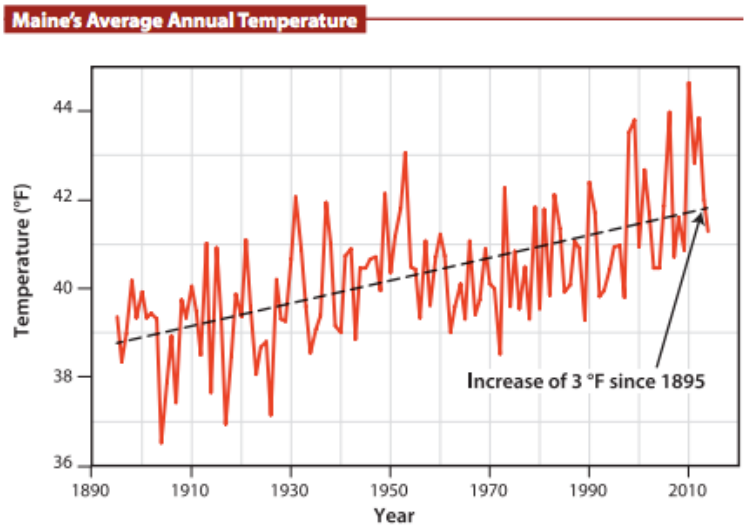


Figure 1. Mean annual temperature, 1895–2014, averaged across Maine from gridded monthly station records from the U.S. Climate Divisional Dataset (*ncdc.noaa.gov/monitoring-references/maps/us-climate-divisions.php*). A simplified linear trend (black line) indicates that temperature increased 3 °F over the record period.

[1] Fernandez et.al.

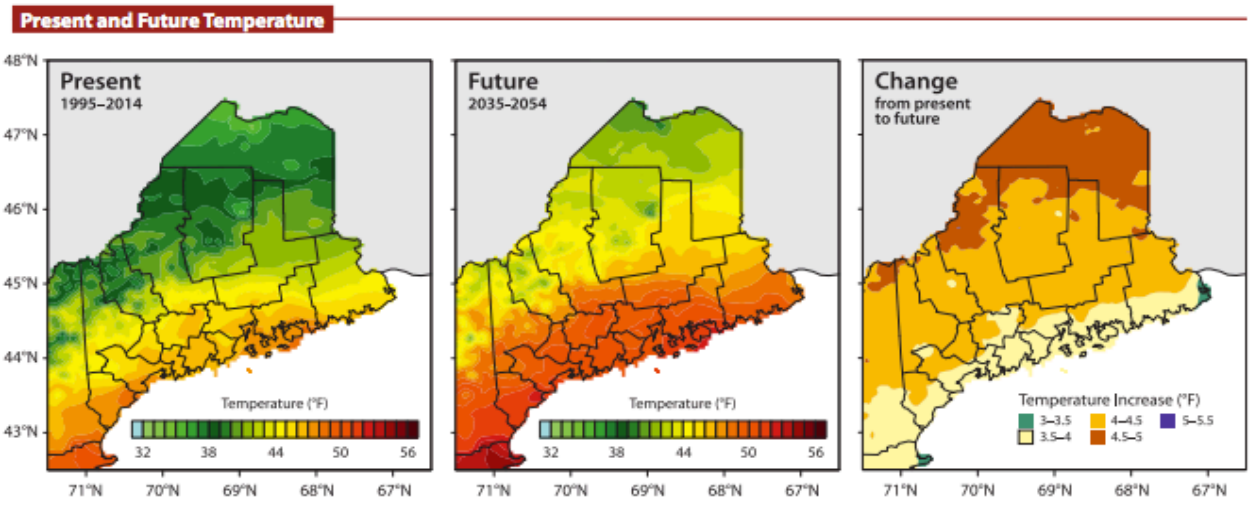


Figure 2. Maps showing mean annual temperature for 1995–2014 (left), 2035–2054 (center), and the predicted change or difference between the two time periods (right). The predicted rise in temperature by 2050 ranges 3.0–5.0 °F from the coast inland to the Canadian border. Maps derived from an ensemble simulation of the IPCC A2 emissions scenario.[1]

Increasing temperatures will have impacts on humans as well as natural systems. The number of days with a heat index over 95 degrees are predicted to increase across the state, as shown in Figure 4. Maine's housing stock and population are among the oldest in the nation. These factors in combination with the prediction of higher temperatures in general and more extreme high temperatures in summer months forecast increased stress on some of our most vulnerable citizens.

Maine's Climate Future, 2015 Update documents similar changes to precipitation – an increase in the overall amount of precipitation with more of it falling in extreme events (defined as 2' of precipitation falling in a 24-hour period). Scientists also predict a change to the pattern of precipitation with less snow overall.

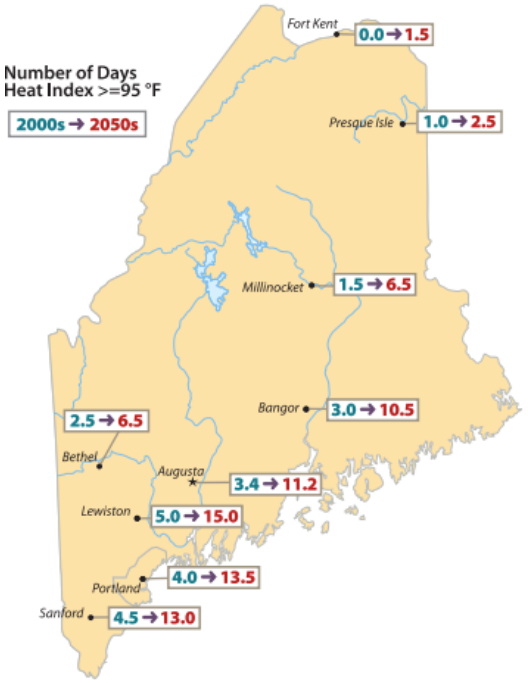
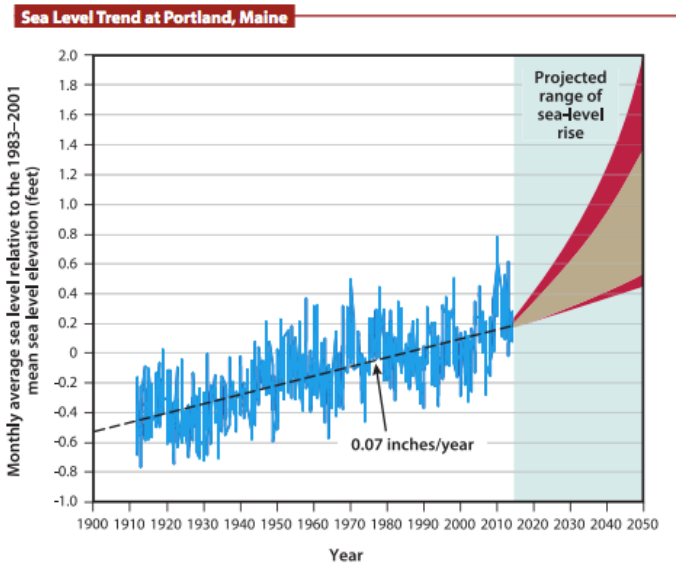


Figure 4. The average number of days when the heat index is greater than or equal to 95 °F at selected sites for 2000–2004 and 2050–2054. Predicted values derived from a 48-km downscale simulation of one ensemble member of the CCSM3 model for the IPCC A2 emissions scenario.

Coastal communities now experience and will continue to be vulnerable to the impacts of climate change on the ocean. Thermal expansion of the ocean in response to climbing temperatures is causing sea levels to rise. This is well documented through the historical record of tide gauges along the length of Maine's coast. Figure 14 shows the historical tide data from Portland with projected future tidal heights. Rising sea levels will result in storm surges traveling farther inland. Increased moisture captured by the warming atmosphere over the ocean will drive larger more dangerous coastal storms.



WHAT DOES THIS MEAN FOR MUNICIPALITIES?

1. Infrastructure built to withstand conditions based on historical data may not withstand future conditions.
2. Coastal development and its corresponding portion of the current tax base are at risk from increasingly severe and frequent storm events as well as from sea level rise.
3. Emergency management resources based on past events may be inadequate to meet future needs.
4. Reacting to emergencies without adequate preparation is more expensive than responding based on good preparation.
5. Economic disruptions from climactic events (e.g., floods, rain storms, ice storms, heat events) will become more frequent.

WHAT TO DO

The number of reports, studies, decisions support tools, and web tools on climate change has grown dramatically over the last five years. The situation has gone from too little information and guidance to an overload that can be difficult to sort through. Many of these tools were created to assist communities in dealing with climate change through entirely new planning initiative which is unrealistic for already busy staff, tapped out volunteers, and limited budgets. Few of these new tools are based on data that are useful for decision- making at the local level. Research in Maine has clearly shown that municipalities are most likely to undertake climate resilience and adaptation planning when that work can be integrated into existing municipal efforts and priorities and is based on data appropriate for use at the local scale.

"Resilience is the ability to prepare and plan for, absorb, recover from, and more successfully adapt to adverse events." (National Academies, 2012)

Accordingly, the Maine Department of Agriculture Conservation and Forestry's Municipal Planning Assistance Program has worked with Regional Planning Organizations from across the state to develop a series of guidance documents to help Maine municipalities find ways to improve community resilience from sea level rise and increasing levels of precipitation by integrating climate change considerations into their existing plans, policies and regulations. (Note that there are other potential impacts of changing climate conditions for a municipality to consider (e.g., drought, increasing high heat days) that are beyond the scope of this series.)

This series of documents provides suggestions for integrating climate change considerations into Maine's most commonly employed land use tools, discusses key issues for community consideration, and provides links to Maine data appropriate for use in local decision making. New resources such as The Nature Conservancy Coastal Resilience Tool and the Maine Community Resilience Checklist provide Maine municipalities useful data and guidance on ways to increase resilience from the impacts of a changing climate.

`Impacts from climate change intersect a broad range of municipal issues. Finding solutions and adapting to the changes will be an on-going process in response to changing conditions.

HOW TO DO IT

To address impacts from climate change, a community first needs to determine its level of vulnerability. This is called a Vulnerability (or Impact) Assessment and there are many formats for them. The following five-step process from the U.S. Resilience Toolkit[2], is a straightforward approach to help a community go from identifying the problem to developing a solution. The American Planning Association offers a similar 6-step process[3]. Regardless of which method a community chooses to use, a successful process will be based on meaningful community involvement at all steps along the way. Links to helpful materials, both Maine-specific and more general, are provided in the Resources Table at the end of this section.

1. EXPLORE CLIMATE THREATS. A community first needs to understand how climate conditions are changing and which changing climate conditions are of most concern over a certain period of time. Then it needs to decide what degree of climate change to plan for. For example:

Decide on your timeframe and corresponding climate change during that timeframe - adapting to the impacts of climate change is not a one-time action.

[2] U.S. Climate Resilience Toolkit (https://toolkit.climate.gov/)

[3] APA

1 feet of sea level rise? 2 feet? In 25 years? 100 years? This should be done through an open and inclusive community conversation; these choices will determine the types of actions that a community considers and ultimately decides to take. Ultimately, this is a choice about how much risk the community is willing to accept from changing climate conditions much the same way that risk is considered in other community decisions such as the risk that a community will actually realize the predicted benefits from a TIF district. If the TIF district is approved, the community has determined that it is willing to accept the risk that the predicted benefits outweigh the possibility that those benefits will not accrue to the community. All decisions have costs and benefits and are made using information of varying degrees of accuracy– decisions about how to adapt to changing climate conditions are the same.

2. DETERMINE VULNERABILITY BASED ON STEP 1.

Once a community determines which climate conditions within a specified timeframe it is concerned about, the next step is to determine the community's level of vulnerability to those conditions based on various scenarios. This process can run the gamut from assessing impacts from a single climate element on a single asset (e.g., rising sea level on the municipal town hall) or to a group of assets (e.g. sea level rise impacts to culverts) to assessing impacts from multiple climate conditions (temperature, precipitation, sea level rise) on a variety of systems (built, economic, social, natural) using detailed methods with complicated equations. A community can also decide to act based on determining how much risk it is willing to tolerate and then adopting "no regrets" strategies based on that level of risk. That means that the actions the community takes, in and of themselves, will provide benefits in addition to increasing community resilience to climate change. The benefits could include, for example, improved economic conditions, increased protection from storm events (regardless of their severity), or improved conservation of natural systems that provide multiple benefits from recreational enjoyment to important habitat for commercial fish species to flood protection.

> A scenario-based approach to determining vulnerability identifies a range of potential impacts; this is the most realistic approach to determine how changing climate conditions will affect a community.

3. INVESTIGATE OPTIONS TO ADDRESS VULNERABILITIES IDENTIFIED IN STEP 2.

This is the point at which a community investigates what changes to their plans, regulations and policies will increase their resilience to changing climate conditions. Examples include changes to a zoning ordinance, adding language to a comprehensive plan, or changes to existing policies on culvert sizing.

> Determine the lifespan of your action and then determine what conditions the community expects in that period – e.g., are you considering culvert replacement or road maintenance? How long is a reasonable life span for that action?

Some of the more general climate tools included in the Resources Table can be helpful in identifying the link between climate impacts and possible responses.

4. PRIORITIZE ACTIONS. This is the time to tie the different options together to provide a logical path forward – a plan. To create that plan, determine which actions logically go together and can be implemented in a step-wise manner, which are the most important to the community, discuss how to fund them, and develop a projected timeline for implementation that includes milestones to allow you to measure progress.

> Are you making a change to a plan, policy or ordinance? Include a statement to revisit the change at specified intervals; evaluate it based on performance to date and review of current data at that time.

5. TAKE ACTION. Start working on the actions decided on in Step #4. Measure how effective the chosen options are as they are put in place– and don't hesitate to make mid-course adjustments.

II. KEY ISSUES FOR CONSIDERATION AT THE MUNICIPAL LEVEL

TRANSPORTATION INFRASTRUCTURE:

Maintaining a transportation network that can withstand rising sea levels and changing patterns and amounts of precipitation is essential to a community's ability to thrive. Transportation costs are frequently a large part of a community's budget. This is an area where determining the level of risk a community is willing to accept and long-term planning for transportation projects is essential to ensure that a community is aware of the trade-offs in costs and benefits to increase the resilience of its transportation network.

Key considerations for increasing resilience in transportation infrastructure:

- Analyze a range of climate impacts over a specified period of time (scenario-based approach);
- Understand the condition of existing roads, culverts and bridges;
- Identify the assets most at risk from changing climate conditions;

KEY BEST PRACTICES TO IMPROVE TRANSPORTATION NETWORK RESILIENCE

1. Improvements to hydraulic performance are examined and protection against scour is incorporated for every new crossing and for replacement of existing crossings.

2. Documentation of work performed including, labor, equipment, and materials, is maintained by road segment and crossing location; records are filed to facilitate identification of changes in conditions over time.

3. A formalized program of periodic inspection of waterways crossings to identify, document, and monitor, over time, conditions known to contribute to vulnerability to flood damage is essential.

4. Inter-jurisdictional partnerships are formed to cost- effectively co-operate to provide for the overall safe functioning of local road networks.

5. Provisions are made for some anticipated flood-related expenditures that exceed the normal budget so that funds are not diverted from routine maintenance and scheduled capital improvements.

- How would the temporary or permanent loss of an asset affect public health and safety and vulnerable populations;
- What would the economic impacts be of service interruption?
- Determine priorities for maintenance, repair, or upgrade;
- Use updated precipitation data when engineering is needed;
- Refer to the Maine Department of Transportation guidelines for upgrading culverts.
- Adopt Stream Smart Crossing principles

Examples:

Warren Case Study

WASTEWATER INFRASTRUCTURE:

Wastewater infrastructure is essential for protecting the public health from waterborne diseases and protecting the quality of our fresh and coastal waters. Evaluating the vulnerability of wastewater infrastructure should include not only evaluating the treatment plant but pumping stations and sewer lines as well. This is an area where engineering expertise is a worthwhile investment as part of the vulnerability assessment process. Treatment plants are frequently located at the 'low point' in town – it could be in a flood plain, it could be in an area at risk from sea level rise. Sewer lines may run along road ways and be at risk if culverts or bridges are damaged from increased amounts of precipitation which then creates risk of sewerage spilling into rivers and streams. Understanding the level of vulnerability of all the components of the system and possible adaptation strategies is essential to being able to make an informed determination on whether cost/effective options exist to increase its resiliency. Several Maine communities have gone through this analysis; see links below for case studies.

Communities with septic systems should consider mapping the location of these systems in relation to flood plains and areas at risk from inundation from sea level rise. Increased fresh water flooding or impacts from sea level rise are both stressors which can impact if and how well a septic system continues to function. Malfunctioning septic systems can impact drinking water supplies, natural resources, and pose a serious risk to human health.

Key considerations for increasing resilience in wastewater infrastructure:

- Analyze a range of climate impacts over a specified period of time (scenario-based approach);
- Assess the location and condition of all parts of the wastewater system relative to sea level rise and flooding risks;
- Determine if adaptation is needed and if strategies exist and are cost effective;
- Use planned maintenance and repair as opportunities to implement adaptation strategies;
- Investigate funding options for work beyond the scope of planned maintenance and repair.
- For septic systems: map current location of septic systems;

- Analyze location of septic systems relative to increased flood risks and sea level rise; Consider ordinance language to add performance standards for installation of new systems in vulnerable locations and inspection and decommissioning of existing systems in vulnerable locations when certain conditions arise.

Examples:

Ogunquit Project Proposal ; Ogunquit Presentation
Boothbay Harbor Case Study; Boothbay Harbor Impact Assessment
Wiscasset Case Study; Wiscasset Resilience Study

DRINKING WATER INFRASTRUCTURE:

Regardless of whether drinking water comes from a public system or a private well, it is one of the most crucial elements making an area habitable. Maine is fortunate to have high quality and quantity of drinking water throughout most of the state. However, both public and private drinking water systems may be at risk from changing climate conditions. This is another issue for which engineering expertise as part of the vulnerability assessment may be a worthwhile investment. Drinking water supplies may be at risk from salt water contamination due to sea level rise and/or storm surges regardless of the type of drinking water infrastructure. Increasing temperatures are likely to increase demand for water and draw down for irrigation is likely to impact low-flow conditions differently. Maintaining adequate quantity and quality of drinking water requires long-term planning and budgeting.

Key considerations for increasing resilience in drinking water infrastructure:

- Analyze a range of climate impacts over a specified period of time (scenario-based approach);
- Assess the location and condition of all parts of the drinking water system relative to sea level rise and flooding risks;
- Determine if adaptation is needed in the face of climate impacts and if strategies exist and are cost effective;
- Use planned maintenance and repair as opportunities to implement adaptation strategies;
- Investigate funding options for work beyond the scope of planned maintenance and repair.

Key Stormwater Best Management Practices

1. Sized to treat stormwater on-site, preferably for a 100-yr. storm event.
2. Must have formal equipment access.
3. Ease and minimal cost of cleaning.
4. Permanent maintenance easement.
5. Method and access for evaluation of maintenance.
6. Pretreatment devices strongly recommended to prevent clogging or sedimentation problems.
7. Provisions for groundwater monitoring and assessment of quantities of water removed along with estimates in the design of expected sediment quantities.
8. A detailed and reasonable Operations and Maintenance plan exists.

STORMWATER INFRASTRUCTURE

Increasing levels of precipitation and more frequent storm events stress existing stormwater management systems. Increased

runoff carries more sediments and pollutants into our water bodies impacting water quality and all the organisms that rely upon clean water – including us. Green Infrastructure and Low Impact Development are cost effective techniques to help to reduce the amount of stormwater that leaves a site. Treating water on-site and reducing the amount of water that needs additional treatment are two key approaches to address the impacts of climate change on stormwater management systems. In larger communities, tying stormwater fees to the percent of impervious cover on a parcel ties the fee structure to actual use of the system and also gives individuals the power to take steps toward improving water quality while they also realize financial savings.

Key considerations for increasing resilience in stormwater infrastructure:

- Inventory existing stormwater infrastructure for location and condition.
- Require Low Impact Development techniques for new development.
- Investigate Green Infrastructure opportunities.
- Require conservation subdivisions that protect and maintain open space.

Examples:
Portland Case Study; Portland Service Charge Website; Supporting Documents; Portland Press Article

III. OPTIONS TO INCREASE MUNICIPAL RESILIENCE TO CHANGING PATTERNS OF PRECIPITATION AND INCREASING SEA LEVELS USING EXISITING PLANS, POLICIES AND ORDINANCES

Maine municipalities have many existing tools to address resilience to changing climate conditions. Hazard mitigation plans, comprehensive plans, economic development plans, transportation plans, capital improvement plans, zoning ordinances, and site plan review ordinances all provide existing platforms. In fact, these plans and ordinances should be interconnected to ensure that the municipality's plans for growth and development along with effective hazard mitigation are supportive of one another. The following section provides brief descriptions of the municipal planning tools that are covered in more detail in individual sections of this toolkit.

THE COMPREHENSIVE PLAN:

Developing a comprehensive plan is an extraordinarily powerful process through which a community develops a vision for its future along with the strategies to implement that vision. The Land Use and Planning Regulation Act (30-A MRSA, Chapter 187) also known as the Growth Management Act (GMA) sets forth the State's goals for economic growth and natural resource protection. The State relies on municipal and regional plans to support those goals. Comprehensive plans are also a municipality's 'business plan'; strategies in the plan become the basis for a municipality's approach to governing along with other important elements such as zoning, economic development efforts, natural resource protection, capital improvement plans, transportation, recreation, community engagement and public safety. This is a logical and important place for a municipality to integrate concerns about the impacts from a changing climate. Climate change resilience and adaptation can be incorporated into a comprehensive plan as a separate chapter or integrated throughout the document. Maine's Community Resilience Checklist is a useful blueprint for crafting a discussion around resilience and adaptation.

How to use the comprehensive plan to increase resilience to climate change:

Including policies, strategies and implementation recommendations in a municipal comprehensive plan that address climate change impacts provides the basis for a municipality to budget for and take actions that increase resilience. For example, a policy in the Transportation section might state that all culverts are able to handle increasing levels of precipitation; the strategy could be that all culverts accommodate flows from a 50 – year storm; the implementation recommendation would be to initiate a study to inventory and document the community's existing culverts current condition including prioritization of culverts for upsizing and recommendations for inclusion of funding in the capital improvement plan or annual budget. Model language can be found in the Comprehensive Plan section of this toolkit.

Examples:

Bowdoinham Comprehensive Plan: Includes sea level rise and climate change chapter
York Sea Level Rise Case Study; York Comprehensive Plan includes a chapter on sea level rise

ORDINANCES:

Ordinances are used as a strategy to implement the comprehensive plan. A zoning ordinance is used by a municipality to guide and incentivize growth and natural resource protection. In Maine, In order to adopt a zoning ordinance a municipality must have a comprehensive plan consistent with the GMA . Additionally, Maine law requires each municipality have a municipal shoreland zoning ordinance (adopted either by the municipality or imposed by the state). And for a municipality to take part in the National Floodplain Insurance Program it must adopt a floodplain ordinance. These ordinances and others are tools that can be used to increase resilience to the impacts of climate change.

How to use different ordinances to increase resilience to climate change:

Zoning Ordinance:

The zoning ordinance is the logical tool to use to manage development in areas vulnerable to the impacts of sea level rise or increased levels of precipitation. Overlay zones can be created in high hazard areas that set different standards based on the type of hazard the area is vulnerable to.

Shore land zoning:

The model shoreland zoning ordinance that most Maine communities have adopted includes a requirement that new construction be elevated a minimum of one foot above the base flood. Several communities in Lincoln County are considering amendments to their shoreland zoning ordinance to increase the minimum elevation to three feet about the base flood.

Floodplain ordinance:

Most towns with a floodplain management ordinance adopt the state's model floodplain management ordinance. Among other provisions it requires that new construction within certain flood zones be built to a minimum elevation of 1 foot above the base flood elevation (BFE). However, A municipality has the authority to adopt a higher minimum elevation above BFE to accommodate sea level rise and several Maine municipalities have done just that.

Examples:
York Floodplain Management Ordinance

Site Plan Review ordinance:

The SPRO can be used to encourage or require consideration of changing climate conditions in proposed projects. It can be used along a continuum from simply requiring that an applicant consider changing climate conditions to requiring an explanation of how the project proposal incorporates that consideration to requiring that projects meet certain specified standards related to changing climate conditions. Model language is provided in the Model Site Plan Review Ordinance guidance document.

IV. RESOURCES these are some of the resources that we think can be helpful

MAINE SPECIFIC RESOURCES

		Steps of a Vulnerability Assessment				
		1	2	3	4	5
	UMaine Climate Change Institute	X				
	Maine's Climate Future *This report includes details about what to expect in Maine for changing climate conditions.*	X				
	Maine's Climate Future 2015 Update *This update to the original report provides clear graphics and explanations of predicted changes to Maine's climate.*	X				
	The Nature Conservancy Coastal Resilience Tool*This tool is built on Maine-based data appropriate for use at the local level including the data developed by the Maine Geological Survey and Maine Natural Areas Program. It includes an easy to use inundation viewer and future habitats viewer. Data behind the tool is downloadable. Check back for new elements on this viewer.*	X	X			
	Maine Geological Survey Coastal Hazards*This viewer developed by the Maine Geological Survey includes data for sea level rise, storm surge, hurricane inundation, and marsh migration (developed in collaboration with Maine Natural Areas Program). Data is downloadable.*	X	X			
	University of New Hampshire Sustainability Institute *This report includes detailed assessments of historical climate changes and projected changes for Northern Maine and Southern Maine.*	X				
	Maine Coastal Program Coastal Resilience Checklist		X	X		
	Maine Coastal Program Case Studies (ADD LINK)			X		
	Comprehensive Plan			X	X	X
	Municipal ordinances and policies			X	X	X
	MaineDOT Culvert Sizing Guidelines		X	X	X	

GENERAL RESOURCES

	U.S. Climate Resilience Toolkit	X	X	X		
	National Climate Assessment	X				
	EPA Smart Growth and Climate Change	X				
	EPA Risk-based Adaptation Planning		X			
	EPA Stormwater Calculator			X	X	

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