Climate Adaptation for Floodplain Management: An Introductory Guide

THE UW CLIMATE IMPACTS GROUP

Climate Adaptation for Floodplain Management: An Introductory Guide

THIS 20-PAGE GUIDE IS WRITTEN FOR STAKEHOLDERS AND MANAGERS ENGAGED IN INTEGRATED FLOODPLAIN MANAGEMENT.

This guide will help you answer the question....

How can we best manage flooding to improve outcomes for farms, fish and the floodplains, keeping in mind our changing climate?

.... by breaking down the fundamental elements of this process, which are:

- ASK how climate is expected to change in your region
- REFLECT on your community's values
- CONDUCT a vulnerability assessment of your region
- PRIORITIZE your action areas
- SET goals and make a plan
- ACT on the plan
- EVALUATE and ADJUST

Throughout this process, keep in mind that preparing for climate change is not about making your community "climate proof," but rather making it "climate resilient." A climate-resilient community is one that takes proactive steps to prepare for projected climate change impacts by reducing their vulnerability and risks (Snover 2007)

A climate-resilient community is one that takes proactive steps to prepare for projected climate change impacts by reducing their vulnerability and risks.

This guide is organized into the fundamental elements of the adaptation process. Though we have organized this document in a discrete, chronological manner for ease of reading; in reality, your process will almost certainly be iterative and may not follow this order. We encourage you to jump around to different phases of this guide as you see fit.

Through this process, you'll recognize gaps in our collective knowledge of how climate change will affect certain systems, how we build adaptive capacity, and more. Filling in these gaps where possible and working around gaps as necessary is important and inevitable.

Finally, this document was developed from several resources and studies related to climate adaptation and resilience-building (listed in the references section), as well as the collective knowledge of the Climate Impacts Group team. While we have included perspectives from different academic disciplines, positions and experiences, we recognize this does not illustrate a comprehensive picture of the resilience-building process. We encourage you to provide feedback on this guide and to add to it as you see fit to best serve your community and your peers.

ASK: "How could climate change affect my region, and do these impacts pose a risk for my community?

IN THIS PHASE, YOU WILL COLLECT AND EVALUATE BASIC INFORMATION FROM PUBLISHED RESEARCH ON HOW CLIMATE IS EXPECTED TO CHANGE IN YOUR AREA. THIS IS A FUNDAMENTAL AND ONGOING STEP IN PREPARING FOR CLIMATE CHANGE IMPACTS.

We've put a lot of this information together in a companion document and resource library. It includes:

1. Documents organized in Airtable, a simple, user-friendly online database
2. An overview of the available data for your region

It's useful because:

1. It allows you to identify knowledge gaps
2. General understanding of this information improves communication on why preparing for climate impacts is important

The Pacific Northwest is expected to warm by 4.2°F (range 2.9°F to 5.4°F) by the 2050s, if we significantly reduce our greenhouse gas emissions by the 2030s (Mauger et al., 2015). With this warming will come considerable changes to the hydrology of the region. Snow-dominant watersheds will behave more like rain-dominant watersheds, shifting peak stream flows from spring to winter and decreasing late summer stream flow magnitude (Elsner et al. 2010). Heavy precipitation events are expected to be more intense, increasing peak stream flows during the winter (Warner and Mass, 2015; Mauger et al., 2015). Steady sea level rise is expected to cause inundation of coastal areas (Huppert et al., 2009; Mauger et al. 2015). All of these changes will

Nooksack River. Photo credit Roy Luck

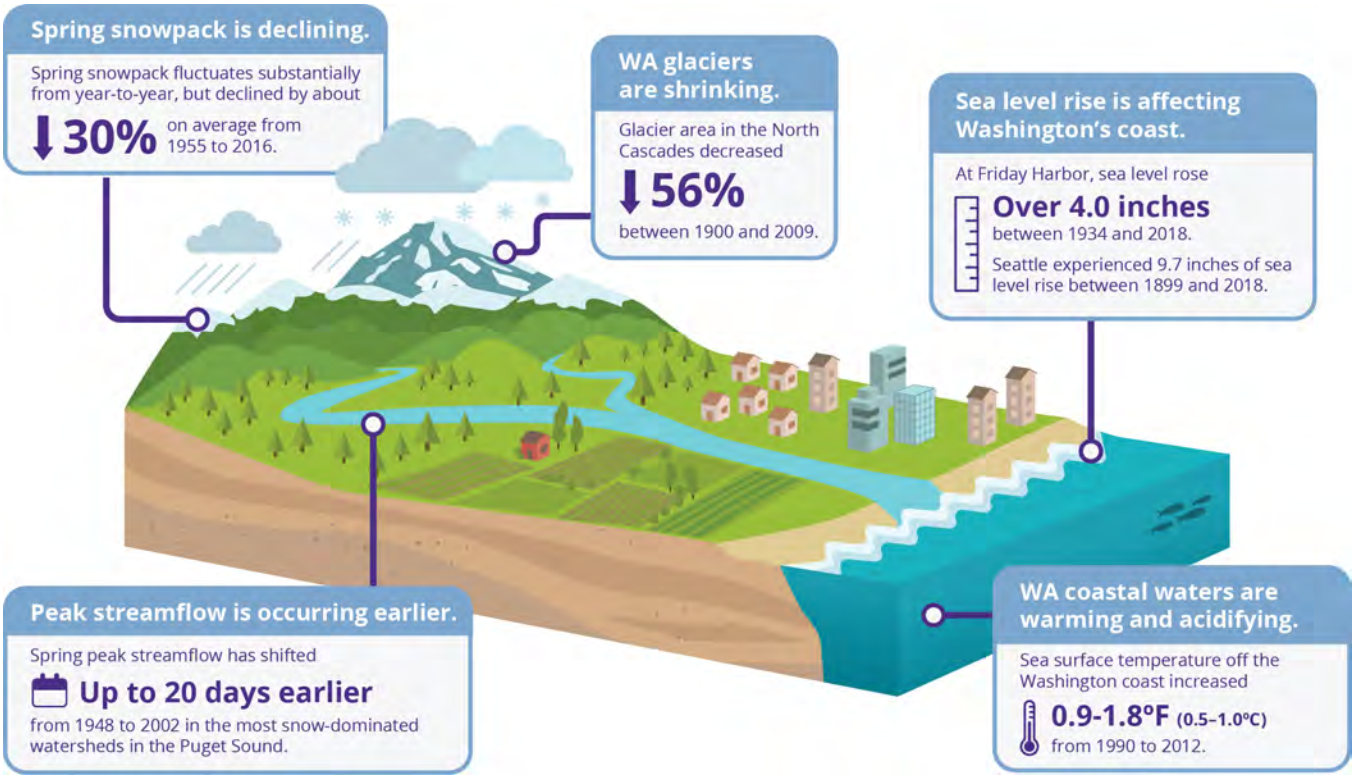


Figure 1: *Adapted from Roop et al. 2019*. In Washington state, long-term changes observed in our local ocean and cryosphere reflect the influence of warming. These changes are expected to worsen with continued warming. The text says: 1) Spring snowpack is declining. Spring snowpack fluctuates substantially from year-to-year, but declined by about 30% on average from 1955 to 2016; 2) WA glaciers are shrinking. Glacier area in the North Cascades decreased by 56% between 1900 and 2009; 3). Sea level rise is affecting Washington's coast. At Friday Harbor, sea level rose over 4.0 inches between 1934 and 2018. Seattle experienced 9.7 inches of sea level rise between 1899 and 2018; 4). Peak streamflow is occurring earlier. Spring peak streamflow has shifted up to 20 days earlier from 1948 to 2002 in the most snow-dominated watersheds in the Puget Sound; 5). WA coastal waters are warming and acidifying. Sea surface temperature off the Washington coast increases 0.9-1.8ºF (0.5-1ºC) from 1990 to 2012.

Data sources: Sea surface temperature for NE Pacific and glacier change: Mauger et al., 2015 (cig.uw.edu/resources/special-reports/ps-sok); WA State snowpack: Mote et al., 2018; Historical sea level rise: NOAA, 2019 (tidesandcurrents.noaa.gov/sltrends). Data note: sea level rise at Friday Harbor = 4.0 (± 0.9) inches (10.2 ± 2.3 cm); Seattle = 9.7 (± 0.7) inches (24.6 ± 1.8 cm) including local vertical land movement.

increase the likelihood and magnitude of flood events throughout the region in the future.

Increasing summer temperatures, lower summer streamflow and ocean acidification are a few of the impacts of climate change that will negatively affect salmon populations in the Pacific Northwest (Mantua et al. 2010). Lower summer streamflow and increased saltwater intrusion from sea level rise will negatively impact agriculture in the region as well (Hatfield et al., 2008).

Climate impacts occur on a variety of scales and can vary considerably throughout a region. Knowing how climate impacts affect the region as a whole may not translate to reach-scale or watershed-scale change. To understand a climate impact such as flooding on a smaller scale, we use a process called a vulnerability assessment. Vulnerability assessments are discussed later in this guide.

REFLECT on your community's values

YOUR TEAM'S UNDERSTANDING OF WHAT YOUR COMMUNITY VALUES WILL HELP GUIDE YOUR ASSESSMENT AND PLANNING PROCESS.

Climate change will impact floodplains in numerous ways. Some of those impacts will be more severe, or more consequential, than others. Understanding your community's values can help you decide where to focus your limited resources when preparing for climate change.

Discussions of your community's values will be most influential in the prioritizing and planning stages. We encourage you to start these discussions early and continue them throughout the process. Here are some questions and prompts to guide your discussion:

- What economic and labor sectors are important to your community?
- What are the safety and quality-of-life standards your community expects or desires?
- What cultural and community values are tied to your region or natural resources?
- Where are the most popular public spaces or resources, such as parks or a community center, in your community?
- What are the most popular recreational activities in your community?

Photo credit Joe Mabel

CONDUCT a Vulnerability Assessment

CLIMATE CHANGE VULNERABILITY ASSESSMENTS IDENTIFY HOW ECOSYSTEMS, RESOURCES, LIVELIHOODS AND CULTURES ARE EXPECTED TO BE IMPACTED BY CLIMATE CHANGE.
AT THE CLIMATE IMPACTS GROUP, WE FREQUENTLY USE THESE ASSESSMENTS IN OUR WORK WITH DECISION MAKERS TO ILLUSTRATE HOW, AND TO WHAT EXTENT, CLIMATE CHANGE STANDS TO IMPACT A HUMAN, NATURAL OR BUILT SYSTEM.

In conducting a vulnerability assessment, your organization will develop a robust understanding of climate risks and identify adaptation strategies that reflect your community's priorities. Soliciting and integrating input from stakeholders and community members during this process can help you develop adaptation plans and actions that reflect the needs of your community members. This section provides an introduction to the fundamental concepts of a climate vulnerability assessment.

CLIMATE VULNERABILITY refers to the potential for an ecosystem or community to be negatively affected by climate change. One common way of conceptualizing vulnerability is as a combination of three basic factors:

SENSITIVITY is the extent to which a built, natural or human system is impacted by a changing climate. In other words, will climate change affect this system, and, if so, how much does the climate need to change before the system is affected? As an example, a town with 30

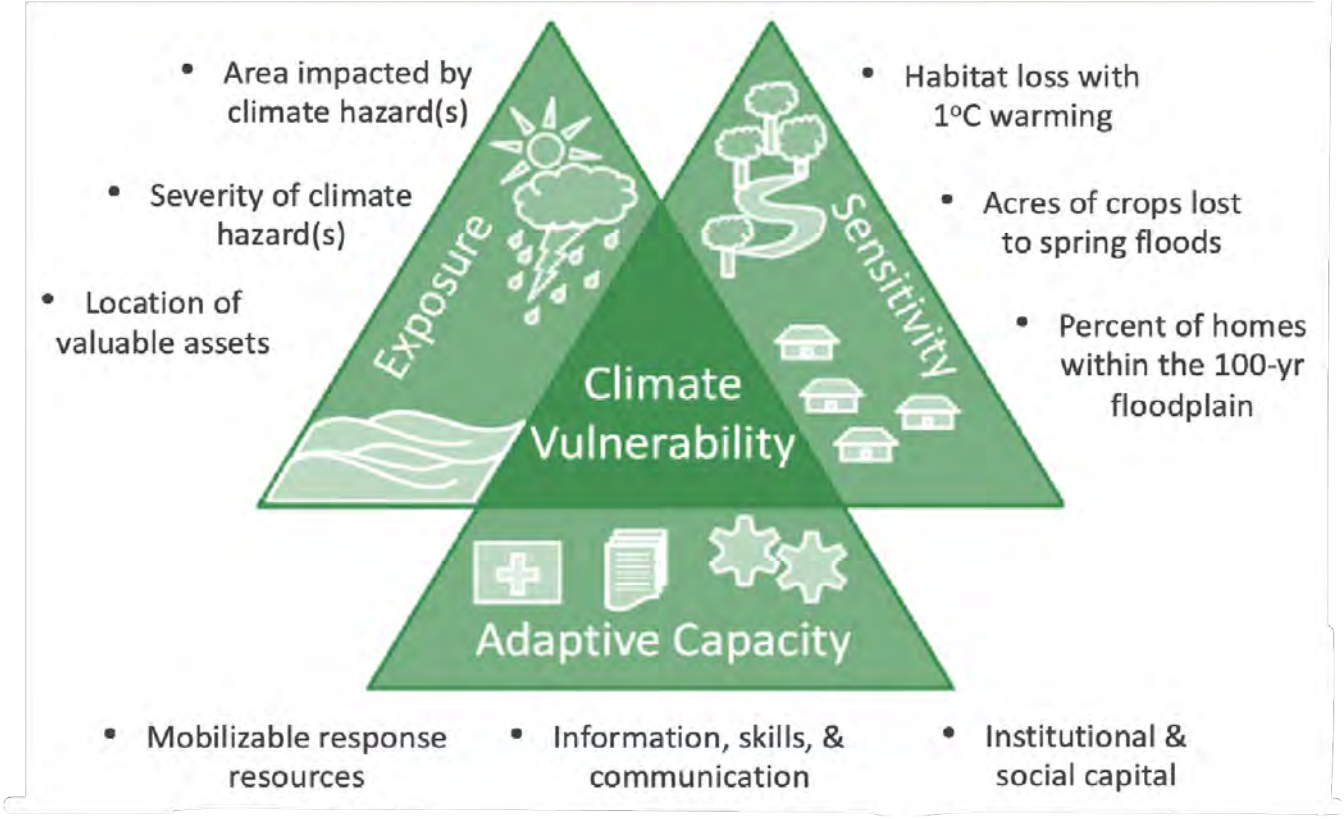


Figure 2. Climate Vulnerability Triangle. Adapted from Trundle and McEvoy, 2016.

percent of its homes in an area at increased risk for flooding would be considered more sensitive to climate change than a town with only three percent of homes at increased flood risk. Sensitivity can be assessed at the watershed scale, reach-scale, or at a more specific location.

EXPOSURE quantifies how the climate is projected to change. We understand a region's exposure to climate change by observing or modeling different factors related to climate, with a goal of answering the question: how much change can we expect to see, and on what timeline? Taken together, sensitivity and exposure paint a picture of the risks climate change poses to a system if no preventative measures are taken. That's where the third factor, adaptive capacity, comes in.

ADAPTIVE CAPACITY refers to a region's ability to respond to shock, such as a natural disaster. Adaptive capacity can be measured in terms of resources including financial resources, political power, social ties and more.

Answering these questions will help you focus the scope of your vulnerability assessment (adapted from *Snover et al. 2007*).

- **What is your planning time frame?** Keep in mind that the consequence and/or probability of an impact might change over time – in most cases, the consequences will become more extreme and will be more likely to occur in 40 years than, say, 20.
- **What are the different geographic scales and administrative or planning scales that shape risks across the landscape?** Risks may vary across one floodplain or from one floodplain or jurisdiction to another. Are you using an appropriate scale to identify risks?
- **What is your community's attitude toward risk and what risks matter to them?** What level of risk is considered acceptable? Different individuals and communities have different risk tolerance to different types of risk.

You may also want to consult *Preparing for Climate Change: A Guidebook for Local, Regional, and State Governments'* list of questions before beginning your vulnerability assessment (chapter 8, page 67).

Understanding sensitivity

Sensitivity is the extent to which a built, natural or human system is impacted by a changing climate.

Photo credit Snohomish County

Some questions to consider when thinking about sensitivity are:

1. **Which climate change impacts are more likely to affect this system?** As an example, floodplains will likely be impacted by changes in precipitation,

the timing of snowmelt, wildfires, erosion and more.

2. **How much would these impacts need to change to create a problem?**
3. **What are the anticipated consequences — economic, ecological, social, cultural or legal — of a particular climate change impact?** As an example, sensitivity could be measured by the financial cost of repairing homes and buildings that have been flooded, or loss to the community if a particular park or center was unusable.

There are two benefits to answering these questions. First, you can identify and prioritize the impacts that are most important for assessing the consequences of climate change. Second, these questions will help uncover additional research that may be needed to quantify climate impacts.

Identify climate impact pathways

Identifying key pathways isn't necessarily complex. You — or one of your colleagues — likely understand the ways climate impacts affect your region based on your observations and experiences. For example, you might have noticed that heavy rains often lead to flooding on a particular road.

A useful approach to sensitivity is to consider when impacts occur for the area of interest, and when further impacts *might* occur as the climate changes. Some examples of applying this approach could be "*building X experiences severe damage when water levels rise above the floorboard*" or "*fish species Y will experience lower spawning rates when stream temperatures are high*."

As people working in integrated floodplain management, you might find it most helpful to consider how the impacts pathways for flood, fish and farm overlap. We have developed a worksheet to help you consider these overlaps, which is appended to this document. The chart on page eight provides an example of how Floodplains for the Future filled out the worksheet.

How much change is a problem?

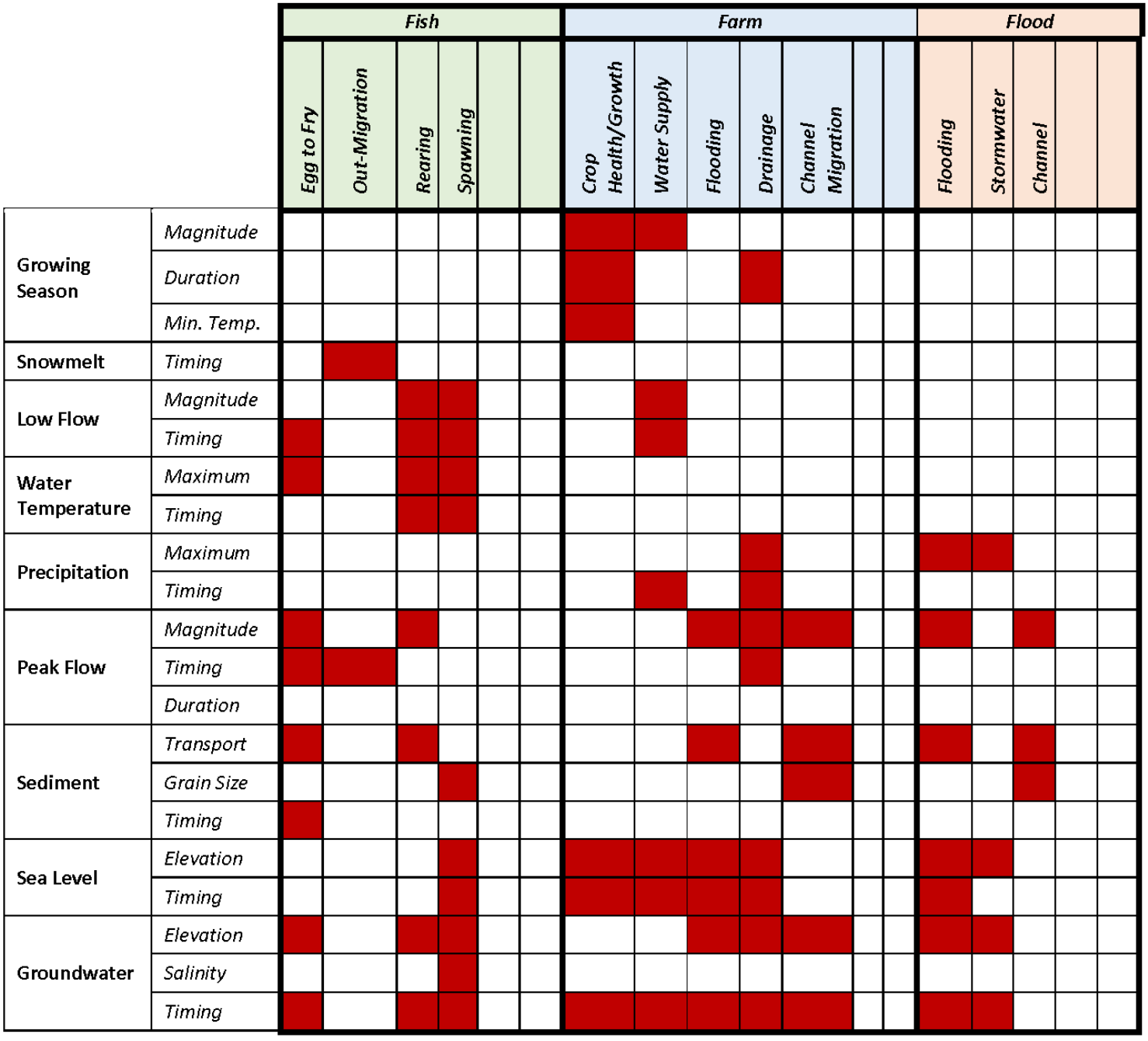
Once the pathways are identified, you'll need to consider how much change in the relevant climate impact drivers (precipitation, temperature, etc.) needs to happen to incur a problem. We use two approaches to answer this question: an observational approach and a modeling approach. Guidance on when to use these two different approaches is provided in the more technical companion document.

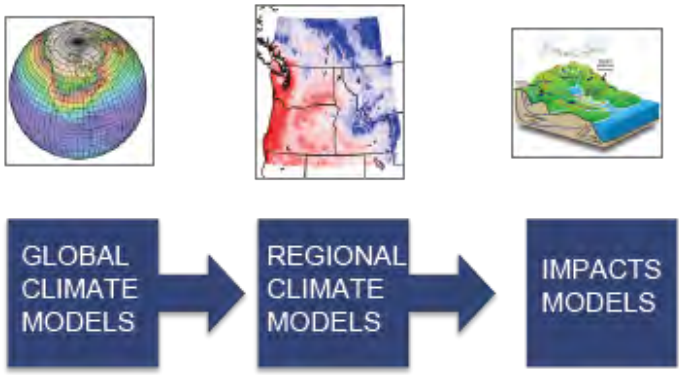
In some situations, assigning a quantitative value to this change can be tricky. This is especially true if the pathway or impact you are considering is complex. Regardless, taking time to consider sensitivity is important. Gathering information on the sensitivity of your region to climate impacts helps prioritize among possible climate studies and ensures resources are put towards studies that are likely to lead to greater resilience.

Integrated floodplain management work underway in Whatcom and Snohomish Counties will mostly rely on observational data in the form of intuition and experience. This is a common starting place for measuring sensitivity. In practice, most approaches use a combination of observations and modeling, building on prior work to improve understanding over time. We recommend taking an iterative approach by

starting simple, then developing more refined estimates as needed to support decision-making.

Once we understand a system's sensitivity to climate change, the next phase of the vulnerability assessment is to assess the region's exposure to climate.





Quantifying exposure

When we measure an area or system's exposure to climate change, we ask the question, "what will happen here?" Another way of viewing the question is: "How likely is it that a projected impact will occur?

Communities working to assess their climate vulnerability often jump straight to quantifying exposure before considering their sensitivity to climate change. We recommend starting with sensitivity, as described above. Understanding your community's exposure is more useful when taken in the context of sensitivity, because your sensitivity will guide which exposures you need to study.

The following sections summarize the different approaches that can be taken to quantify exposure: global climate projections, downscaling and impacts modeling.

Global climate model projections

Global climate models show us anticipated changes in climate associated with different levels of greenhouse gas concentrations. In other words, they help us understand how Earth's climate will change if greenhouse gas emissions continue to stay the same, increase or decrease.

The role global climate models will play in your assessment depends on what you want to study. Global models provide very coarse-scale information, at a resolution of about 50–100 miles. Global models can be useful for studying regional-scale changes in weather and climate; yet some quantities, such as precipitation, are not accurately projected by global models. Global models do not directly simulate changes in streamflow, forest productivity or other quantities that may be more directly related to impacts.

In those cases where exposure to climate change cannot be captured accurately enough by global models, a more detailed approach may be needed.

Downscaled Climate Projections

Global climate models do not resolve many landscape-scale features that could be important in driving impacts. This is the case for heavy rain events, where global models are not able to capture how features of the landscape — such as mountains and valleys — can affect local weather conditions. In these cases, a separate modeling step is needed to translate the global projections to the local scales. This step is often referred to as "downscaling."

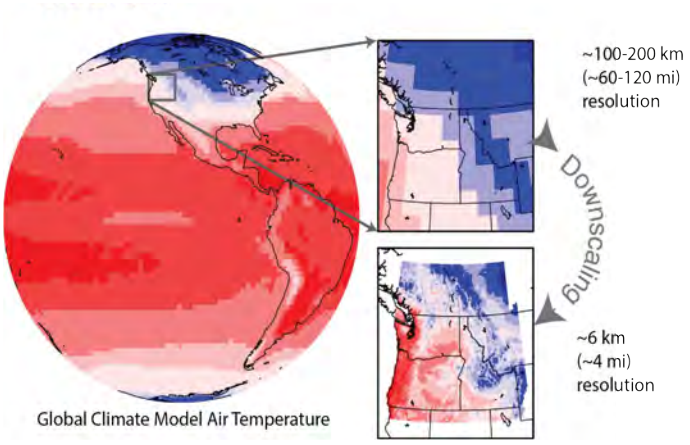


Figure 3. Eric Salathé, UW Bothell

There are two approaches to downscaling: statistical and dynamical. The approach you choose depends on several factors, which are

explored in a companion document we have prepared.

As with global projections, downscaled climate projections only provide changes in climate conditions, such as temperature and precipitation. In some cases this can still be one step removed from the processes that drive impacts. This is where impacts modeling comes in.

Impacts models

Many climate change impacts cannot be evaluated without an additional modeling step that links weather and climate variations to a climate impact. Examples of impacts that require this extra step include streamflow, groundwater, forest growth and wildfire.

Hydrologic models (a type of impacts model) are used to study flooding. Hydrologic models take climate variables as input — temperature, precipitation, etc. — and translate them to streamflow, soil water, evaporation and other aspects of the water balance.

Several different hydrologic model datasets are available for the Snohomish, Stillaguamish and Nooksack watersheds. Each dataset was developed using a different combination of methods and assumptions about future climate conditions. Which one you use will depend on your specific needs. Which one you use will depend on your specific needs. Climate Impacts Group partners will help you understand the available datasets and their relative strengths and weaknesses. We have also prepared a technical companion document which provides further information on the strengths and weaknesses of existing datasets.

Floodplains will be affected by a variety of climate change impacts. In addition to changes in flooding, floodplains will be impacted by changes in low flows, water temperatures, forest health, wildfire risk, the growing season and other changes. Not all of these impacts can be evaluated with hydrologic models. A variety of impacts models might be needed to quantify some of these changes.

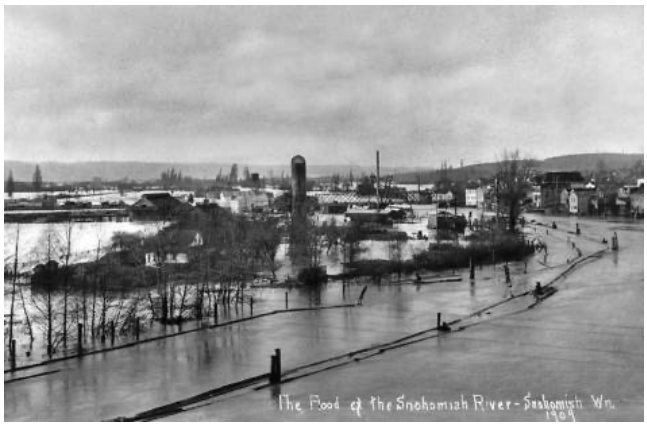


Photo credit Paul Dor Pat

Understanding the strengths and limitations of your projections

Regardless of the approach to quantifying exposure — whether it's with global climate models, downscaled projections, impacts models or a combination of these — it's important to understand the strengths and limitations of the projections. By better understanding the range of possible impacts, you can decide what level of risk is acceptable and plan accordingly.

Sensitivity and exposure paint a picture of the impacts of a changing climate if we do nothing to intervene. The third and final step of the vulnerability assessment is to measure adaptive capacity – that is, the resources available to prepare for a changing climate.

Assessing Adaptive Capacity

Adaptive Capacity refers to a community's or ecosystem's ability to respond to a shock, such as a natural disaster.

Adaptive capacity is typically measured in terms of resources, including financial resources, political power, social ties and more. It is often thought of as the resources and ability to recognize vulnerabilities and adapt as circumstances change, rather than a single response or set of actions (Smith et al 2003).

Adaptive capacity is a complex topic. Here, we summarize the aspects we think are most relevant to floodplain management and provide guiding questions and examples to help you reflect on your community's adaptive capacity.

Assessing adaptive capacity

Adaptive capacity is often best assessed by a group of community members, local leaders and practitioners. Working together across positions and sectors, this group can develop a more in-depth understanding of the implications of climate change for each interest, the tools available for managing impacts and the resources needed to accommodate or manage changes.

Because adaptive capacity is often connected to social, economic and political processes, it varies across and within communities. Components of adaptive capacity are not always equitably or evenly distributed; for example, different governments have different levels of economic resources to support climate resilience efforts. This means that organizing across different stakeholder groups, each with different strengths and capacities, is critical for successful adaptation efforts. Building social cohesion across stakeholder groups — and, in particular, recognizing the interdependencies across groups rather than emphasizing their differences — is a highly effective means for building adaptive capacity.

The following questions and examples will help you reflect on your organization or group's adaptive capacity *(adapted from Gupta et al. 2010).*

1. **Does your organization encourage and support different actors, perspectives and solutions to be active in the decision-making process?** This might look like: groups of people working across sectors and different positions of power and open brainstorming sessions.
2. **Does your organization support its members and communities in improving processes and approaches to your work?** This might look like: a culture of promoting mutual respect and trust; openness to and acceptance of uncertainty and change; a history of updating practices and approaches in response to feedback.
3. **Does your organization encourage shared learning and growth?** This might look like: promoting a culture of trust and feedback; support for holding difficult conversations; spaces for leadership that support long-term, collaborative visions and holistic thinking.
4. **Does your organization have access to resources for implementing adaptation measures?** This might look like: sufficient expertise, knowledge and capacity; financial resources and incentives are available.

5. **Does your organization enhance principles of fair governance?** This might look like: Your organization has public support; your rules are seen as legitimate across different stakeholder groups; your institution is responsive to societal needs; your organization attempts to identify mutually-beneficial solutions.
6. **Does your organization or team connect to policy and allocation decisions needed to accomplish its tasks?** This might look like: drafting proposed legislation; reviewing and revising operational plans, managerial priorities, and capital investments.

Adaptive capacity in integrated floodplain management:

In a study of Floodplains by Design, an integrated floodplain management program, researchers found that enduring collaborations were critical in building adaptive capacity and contributed to durable relationships and flexible institutions. (Breslow, 2020).

The activities that build adaptive capacity can be loosely grouped into three main goals: to communicate, support and mobilize. The figure on the following page outlines actions that support these goals.

Figure 4, Adaptive Capacity Pathway *(see Figure on page 13).* Illustrates activities to build adaptive capacity and examples of where those activities are already happening in Whatcom and Snohomish counties.tivities in this figure were adapted from Moser and Ekstrom 2010 and Snover et. al 2007.

Description of figure: This graphic shows a winding river with stones along the riverbank. Each stone on the river has text on it that describes an action that could build adaptive capacity. Each stone is color-coded to fall into one of three categories: support; communicate; mobilize.

The graphic shows four activities/stones that fall into the support category. These activities are: 1) Establish regular and effective communication among leaders and peers. This might happen through professional or personal networks; 2) Encourage the participation and integration of people with diverse perspectives, including community expertise and Indigenous knowledge; 3) Provide training and education in climate adaptation; 4) Establish partnerships and hire personnel dedicated to addressing climate impacts.

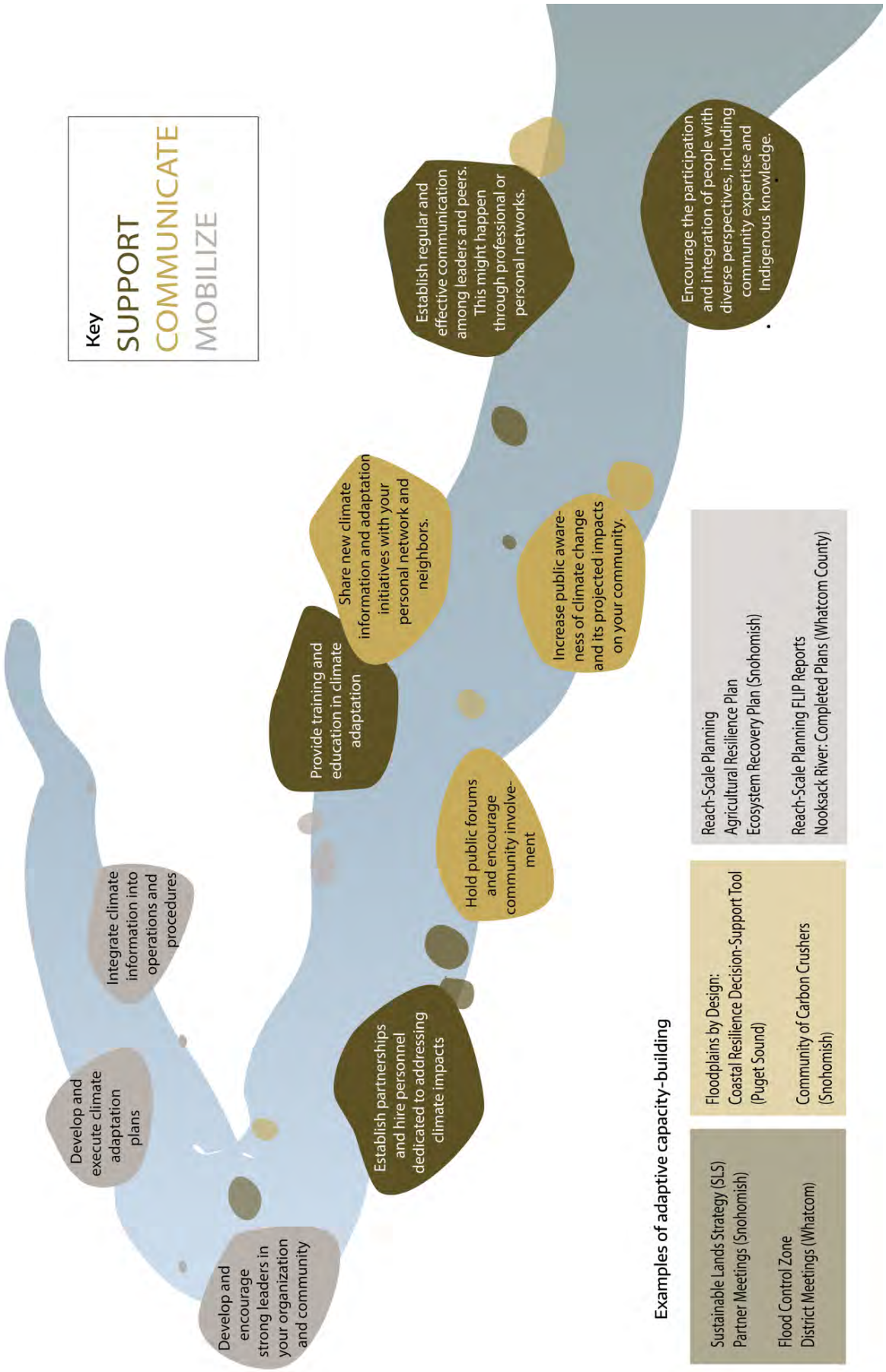
The graphic shows three activities/stones that fall into the communicate category. These activities are: 1) Share new climate information and adaptation initiatives with your personal network and neighbors; 2) Increase public awareness of climate change and its projected impacts on your community; 3) Hold public forums and encourage community involvement.

The graphic shows three activities/stones that fall into the mobilize category. These activities are: 1) Develop and encourage strong leaders in your organization and community; 2) Develop and execute climate adaptation plans; 3) Integrate climate information into operations and procedures.

At the bottom of the figure, there are several examples of activities that build adaptive capacity that are already being implemented in Snohomish and Whatcom Counties. These include: Flood Control Zone District Meetings (Whatcom); Sustainable Land Strategy Partnership Meetings (Snohomish); and Reach-Scale Planning in both counties.

ADAPTIVE CAPACITY PATHWAY

This pathway depicts suggested activities and actions to build adaptive capacity.



SYNTHESIZE your findings and PRIORITIZE your goals and actions

DRAW ON THE FINDINGS OF YOUR VULNERABILITY ASSESSMENT TO UNDERSTAND WHICH SYSTEMS ARE AT THE GREATEST RISK OF CLIMATE IMPACTS AND WHERE YOUR COMMUNITY'S PRIORITIES LIE. PRIORITIZING YOUR ADAPTATION ACTIONS IS A FIRST STEP IN CREATING A PREPAREDNESS PLAN.

This section is adapted from Snover et al., 2007, Chapter 9.

Measure the system's vulnerability

Now that you've evaluated the sensitivity, exposure and adaptive capacity of your areas of interest, you can synthesize these evaluations to better understand which systems are most vulnerable to climate change.

Develop a method for scoring the risk each climate change impact poses to the systems you are studying. Each score should combine an assessment of the sensitivity (high, medium, low), the exposure (high, medium, low) and the adaptive capacity (low, medium, high). Generally, you will want to prioritize systems where sensitivity and exposure are high, and adaptive capacity is low.

Keep in mind measures of risks are not objective. Asking "What's at risk, and to whom?" can help you consider how risks are shaped by different geographic scales and social influences.

Identify priorities

There are many ways to prioritize adaptation actions, but ultimately your priorities should represent the values of your community and team. This is easier said than done. Groups of stakeholders will often value outcomes differently, and in the face of incomplete information, come to different conclusions about what to prioritize.

To help ensure your priorities reflect the values of your whole community, this process should be transparent and inclusive, where the considerations and tradeoffs are made explicit and affected communities have a voice in those decisions. Here, we outline a few different methods for prioritizing your work and considerations for each method. You will likely consider more than one, and possibly all, of these methods in your prioritization process.

BASED ON SENSITIVITY AND EXPOSURE. A common way to identify priorities, mentioned above, is to prioritize areas where sensitivity and exposure are high and adaptive capacity is low. As an example, you could prioritize based on traditional risk frameworks that minimize physical risks to the greatest number of people.

One consideration is how to prioritize the needs of socio-economically vulnerable communities: ensuring your actions will have the maximum benefit for the least harm to those communities. You might also prioritize based on community input and collaborative feedback sessions.

Photo credit Washington Department of Ecology

BASED ON CERTAINTY. You might decide to prioritize based on the certainty of knowledge related to actions that are very likely to address the climate risk. The City of Anacortes' wastewater treatment plant redesign is an example of planning based on certainty.

BASED ON ACTIONS THAT ARE "NO REGRETS." A "no regrets" action provides benefits in current and future climate conditions even if no climate change occurs. A water conservation program, for example, provides benefits today by potentially reducing the need for water restrictions during drought, among other things. These benefits will accrue regardless of how climate changes in the 21st century but would be even greater with climate change given the potential for climate change to increase the frequency and intensity of drought in many regions of the country (Snover et al. 2007).

BASED ON OPPORTUNITIES. Your priorities might be more opportunistic. As examples, you might take advantage of a regular planning cycle to incorporate climate preparedness into your comprehensive plan; or use climate change data

to inform an infrastructure project that would have happened regardless of climate change.

Regardless of which processes you use to prioritize, it is important to include a range of community perspectives. Each of these ways of prioritizing embeds different values — including economic efficiency, justice, community and different tolerances for risk — that may not come to the forefront if diverse perspectives are not represented.

Set Preparedness Goals and Develop a Preparedness Plan

NOW THAT YOU HAVE A SENSE OF HOW CLIMATE CHANGE IS PROJECTED TO IMPACT YOUR COMMUNITY AND THE AREAS OF GREATEST CONCERN, IT'S TIME TO SET GOALS AND MAKE A PLAN TO ADDRESS CLIMATE IMPACTS.

This section is adapted from Snover et al, 2007, Chapter 10.

Leverage your processes for developing goals and implementing plans for integrated floodplain management to plan for climate change. Here are some prompts specific to climate change to guide your thinking:

1. **Consider how you will build adaptive capacity in meeting your preparedness goals.** Aim to have each goal support at least one of the three elements of adaptive capacity described above — communicate, support, mobilize.
2. **Get public feedback on your preparedness goals** through public meetings, open comment periods, or another method.
3. **Be clear about your timeframe.** Whether you want your project to last 25, or 30, or 50 years will affect how you consider risk and rewards.

Next, identify preparedness actions that will help you achieve your goals. Your actions will likely involve a combination of the following:

1. Modifying policies, operating practices, development plans and other modes of governing to increase resiliency.
2. Developing climate "back-up plans" – for example, developing new groundwater sources to diversify your water supply.
3. Building new or upgrading existing infrastructure
4. Improving community awareness and preparedness
5. Partnership building with other communities and agencies.

Examples of preparedness goals:

Prioritize health and equity in climate preparedness actions and activities (King County Strategic Climate Action Plan, 2020).

Secure hazardous waste from exposure to flooding; Increase safety of water supply (Swinomish Climate Change Initiative Climate Adaptation Action Plan, 2010).

Develop landscape-scale projects to improve agricultural resilience (Snohomish Conservation District Agricultural Resilience Plan, 2019).

Take Action

This section is adapted from Snover et al, 2007, Chapter 11.

YOU'VE DONE YOUR RESEARCH, ORGANIZING AND PLANNING, AND NOW YOU'RE READY TO IMPLEMENT YOUR PREPAREDNESS PLAN. BUT HOW DO YOU MOVE FROM PLANNING TO ACTION?

Ensure you have the tools you need to implement your plans. These tools are the means or avenues your organization uses to influence policy, planning and infrastructure.

- Some tools that come up frequently in discussion include:
  - Zoning rules and regulations
  - Building codes and design standards
  - Management practices
  - Comprehensive planning
  - Partnership building with other communities
- Other tools to consider:
  - Levee setbacks
  - Logjams
  - Habitat restoration
  - Acquisitions and easements

Photo credit Washington State Department of Transportation

Remember that your best tools might be ones you're already using. Look for opportunities to merge preparedness actions into existing planning efforts, such as updates to your community water supply or development master plan. As with developing preparedness goals and plans, the strategies and processes you use for taking actions in floodplain management will serve you well in taking action to address climate impacts.

Examples of climate adaptation in Puget Sound floodplains:

Since 2012, King County has been widening bridge spans and replacing culverts to increase the resilience of bridges and roads to major flooding (Puget Sound Floodplains Fact Sheet: UW Climate Impacts Group, 2016).

In Tacoma, the popular Owens Beach is being redesigned to account for projections of sea level rise.

The Snohomish Conservation District has secured funding to begin a feasibility study for a landscape-scale project in DD13 that would improve drainage to nearby farmland and restore channels along marginal farmland to create fish habitat.

Evaluate and Adjust

EVALUATION IS A CRITICAL YET OFTEN NEGLECTED OR FORGOTTEN ELEMENT OF CLIMATE ADAPTATION.

This section is adapted from Snover et al, 2007, Chapter 12.

We encourage you to collect and analyze information about the successes and failures of your climate adaptation efforts in the same way that you would monitor the effectiveness of other floodplain management actions.

Why evaluate?

When you are looking to build on your project down the road, or start a new climate preparedness effort, the results of your evaluation can help you make more informed and more efficient decisions. Additionally, evaluating your efforts and reporting the results to different audiences — including your internal team, stakeholders and community — can help build trust in your organization and your project.

How to evaluate?

One approach is to assess whether your preparedness actions are helping you meet your vision for a climate-resilient community. Look at the actions you identified to build adaptive capacity (pages 10 and 11 of this guide) and compare your progress against those goals. As examples, you might ask yourself:

1. Has awareness about climate change and its projected impacts on your priority planning areas increased? Is there support among your government, your community and your stakeholders to prepare for climate change impacts?
2. Have you increased technical capacity in your government and community to prepare for climate change impacts?
3. Is climate information being considered in decisions in your priority planning areas?

Another approach is to evaluate your *processes* of working with scientists and other partners, instead of or in addition to measuring whether the outcomes of your project have been successful. These questions can help you evaluate the effectiveness of your process (adapted from Beier et al. 2016):

1. How well did scientists and managers specify the preparedness goals at the beginning of the project?
2. Would different scientific information and processes have been more useful to the process? What steps could have better set up the project from the outset?
3. Was the process collaborative, communicative and positive for both scientists and managers?
4. What obstacles to collaboration were encountered in shaping the goals and final results?
5. Were systems or mechanisms developed to support iterations of this work?

Make adjustments

One of the main reasons to evaluate your project actions and outcomes is so you can build on your successes and address your weaknesses in later phases of the project. Here are some ways to iterate on your work: (adapted from Snover et al 2007)

- Check the underlying assumptions of your preparedness plan. Ask yourself questions such as:
    - Have new peer-reviewed scientific findings improved or changed your understanding of your community's vulnerabilities?
    - Are your vision and guiding principles still relevant to the results your team wants to achieve?
- Update your plan based on your evaluations
    - Incorporate the most urgent and/or specific information in budget proposals and other short-term decisions
    - Incorporate new climate change information into your regular planning updates
- Share your learning with your community, stakeholders and partners.

Monitoring plans on-the-ground: *Floodplains for the Future has developed a monitoring plan that integrates the needs of fish, farms and flood.*

Photo credit Washington State Department of Transportation

Take Aways

Warming temperatures, rising sea levels, changes in streamflow and other climate impacts mean integrating climate change information into your floodplain management is critical for the long-term success of your projects. This doesn't mean re-thinking the practices and processes you use for floodplain management. If anything, the elements outlined in this guide should complement your current work, while helping to ensure the decisions you make today in the floodplains will benefit the floodplains of the future.

Funding Acknowledgement

"This project has been funded wholly or in part by the United States Environmental Protection Agency under assistance agreement PC-01J22301 through the Washington Department of Fish and Wildlife. The contents of this document do not necessarily reflect the views and policies of the Environmental Protection Agency or the Washington Department of Fish and Wildlife, nor does mention of trade names or commercial products constitute endorsement or recommendation for use."

Citations

Barry, S., J. Wandel, 2006. Adaptation, adaptive capacity and vulnerability. Global Environmental Change (282-292). Vol. 16(3). doi.org/10.1016/j.gloenvcha.2006.03.008

Beier, P. L. J. Hansen, L. Helbrecht, D. Behar, 2016. A How-to Guide for the Coproduction of Actionable Science. Conservation Letters (288-296). Vol. 10(3) doi.org/10.1111/conl.12300

Breslow, S. J, 2020. *Developing a Research and Monitoring Agenda for Floodplains by Design* [PowerPoint slides]. University of Washington.

Gupta, J. C. Termeer, J. Klostermann, S. Meijerink, M. van den Brink, P. Jong, S. Nooteboom, E. Bergsma, 2010. *The Adaptive Capacity Wheel: a method to assess the inherent characteristics of institutions to enable the adaptive capacity of society.* Environmental Science & Policy, 13(6), 459-471. doi.org/10.1016/j.envsci.2010.05.006.

Moser S.C. and J.A. Ekstrom. 2010. *A framework to diagnose barriers to climate change adaptation.* Proceedings of the National Academy of Sciences, 22026–22031, 107 (51). doi.org/10.1073/pnas.1007887107.

Siemann, D. and L. Whitely Binder. 2017. Preliminary Climate Change Assessment for Puget Sound Partnership. A Collaboration of Puget Sound Partnership and the University of Washington Climate Impacts Group. Seattle, WA. https://cig.uw.edu/wp-content/uploads/sites/2/2017/08/Preliminary-Climate-Assessment-for-PS-Partnership-FINAL.pdf

Smith, J.B., R.J.T. Klein, and S. Huq, 2003. *Climate change, adaptive capacity and development.* Singapore: World Scientific Publishing Pte. Ltd.

Snohomish Conservation District. Agricultural Resilience Plan for Snohomish County, 2019. https://snohomishcd.org/ag-resilience-plan-document

Developed for Whatcom and Snohomish Counties by the UW Climate Impacts Group

Snover, A.K., L. Whitely Binder, J. Lopez, E. Willmott, J. Kay, D. Howell, and J. Simmonds, 2007. *Preparing for Climate Change: A Guidebook for Local, Regional and State Governments.* In association with and published by ICLEI – Local Governments for Sustainability, Oakland, Calif. cig.uw.edu/resources/special-reports/adaptation-guidebook/

The UW Climate Impacts Group, 2016. Climate Change Impacts on Puget Sound Floodplains. cig.uw.edu/wp-content/uploads/sites/2/2014/11/TNC_Floodplains_3_25_16_bothlogos.pdf

Whitley Binder, L.C. (ed.), and the Climate Preparedness Steering Committee, 2020. Section III: Preparing for Climate Change. In: King County 2020 Strategic Climate Action Plan. [King County Climate Action Team (eds.)]. King County, Wash. your.kingcounty.gov/dnrp/climate/documents/scap-2020-approved/2020-scap-preparing-for-climate-change-section.pdf


Flood
Flooding
Stormwater
Channel Migration
Farm
Crop Health/Growth
Water Supply
Flooding
Drainage
Channel Migration
Fish
Egg to Fry Survival
Out-Migration
Rearing (fry, parr, smolt)
Spawning
Growing Season
Magnitude
Duration
Min. Temp.
Snowmelt
Timing
Low Flow
Magnitude
Timing
Water Temperature
Maximum
Timing
Precipitation
Maximum
Timing
Peak Flow
Magnitude
Timing
Duration
Sediment
Transport
Grain Size

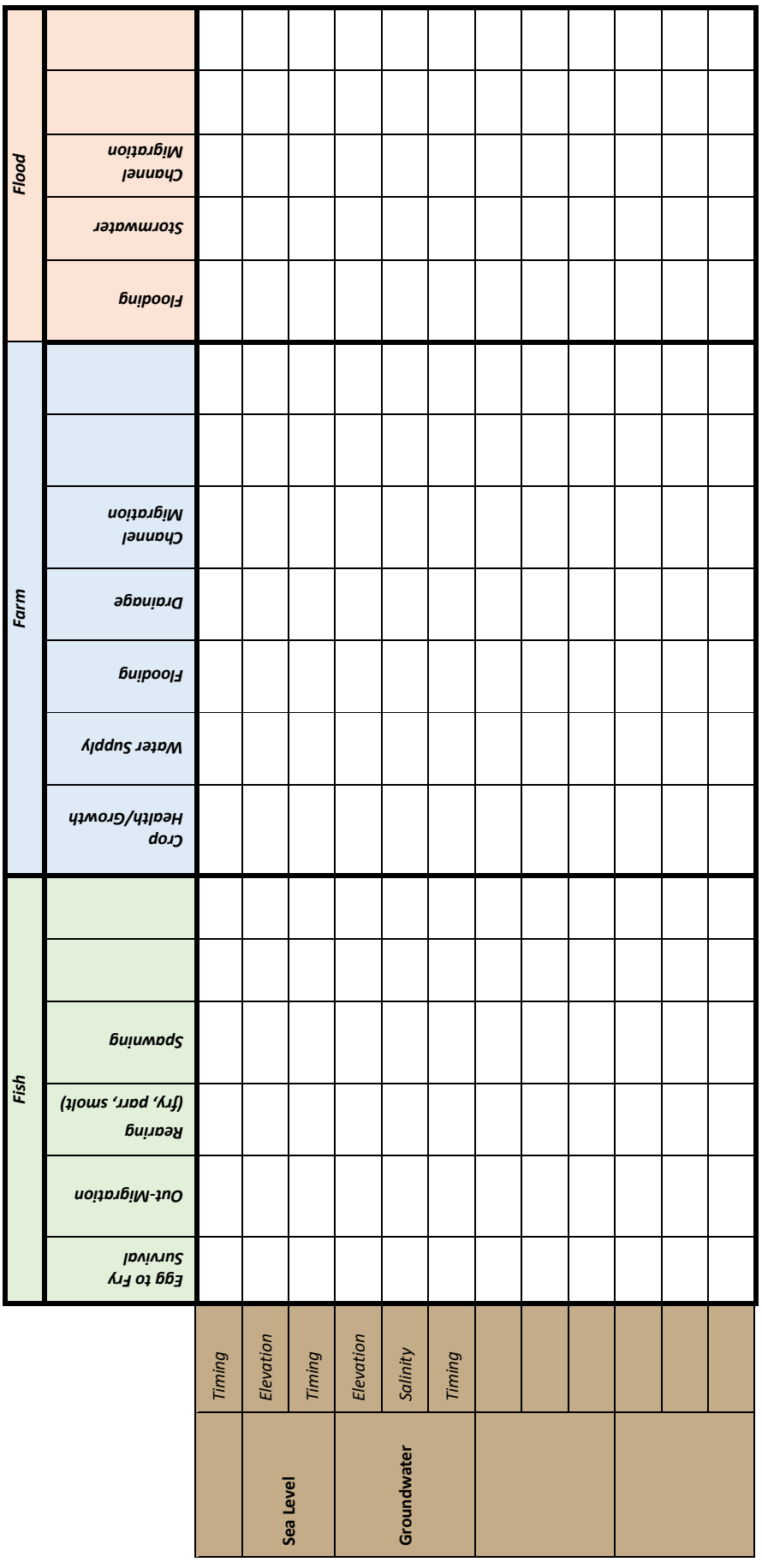


Chart 1. Worksheet for studying sensitivities to climate change across flood, fish and farm interests. Consider whether the climate change impact in the left column affects your area of interest, and if it does, color in the corresponding cell. The blank rows and columns are intended to allow users add their own impacts and interests.