Partnerships for Resilience and Empowered Planning (PREP)

Community Resilience Planning Handbook

Spring 2015

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INTRODUCTION

PREP is an initiative of the Southeast Sustainability Directors' Network in collaboration with the Urban Sustainability Directors' Network, the National Environmental Modeling and Analysis Center and the University of Arkansas. The main goal of this initiative is to prepare participating Municipal Sustainability Directors to assist communities in resilience planning, especially with regard to extreme weather events. The PREP initiative included conference calls, webinars, workshops, the development of an online tool and this guidance document to familiarize leaders in community resilience planning. The participating municipalities have faced extreme weather events in their communities and are projected to experience more frequent and severe weather events in the future. One of the most valuable outcomes of PREP is the collaboration between participating communities and learning from one another's experiences.

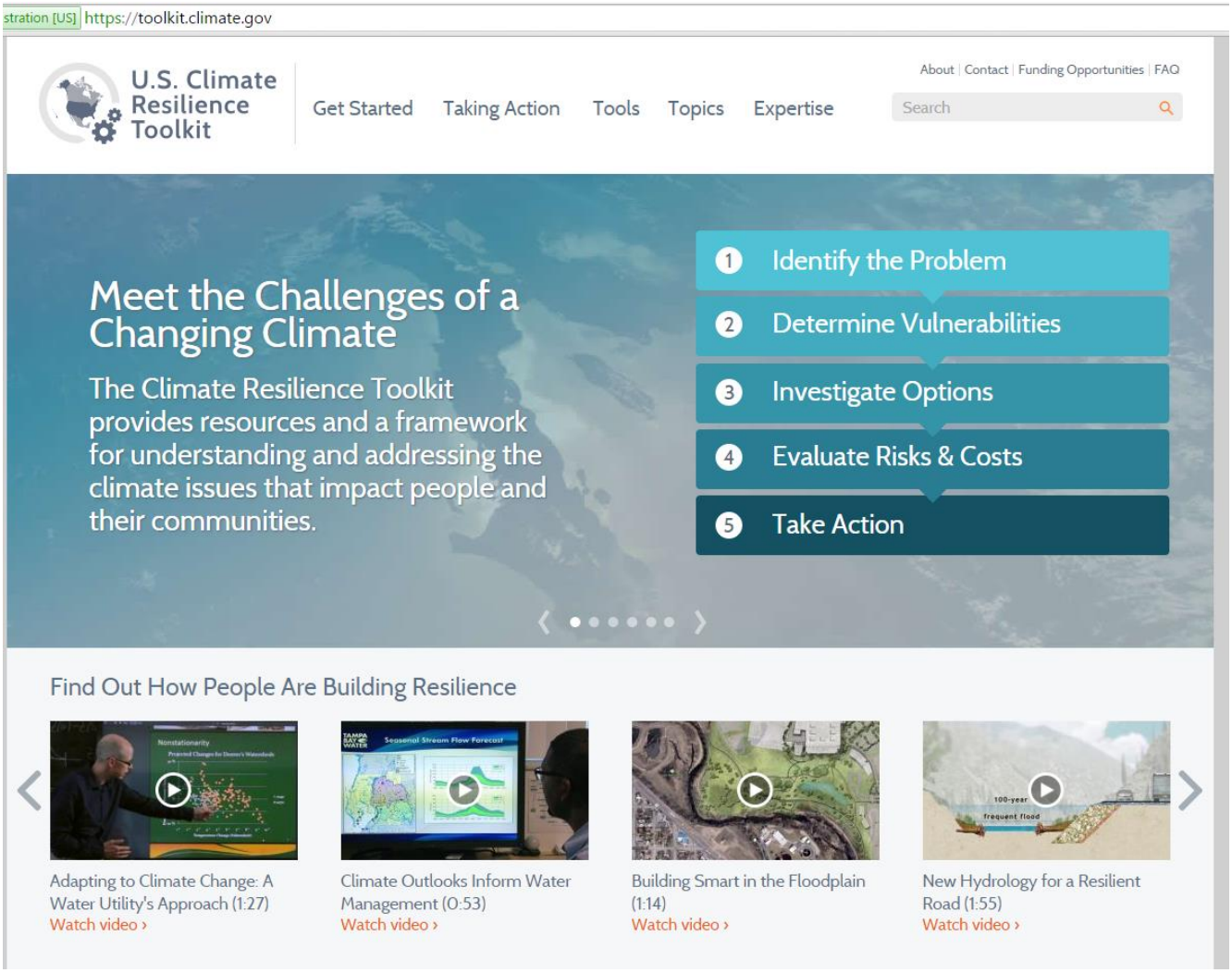
COMMUNITY RESILIENCE PLANNING STEPS

There is not one way for communities to reduce disaster risk because the impacts they face and the communities themselves are all unique. However, by sharing our process and lessons learned we can assist one another as we endeavor. Furthermore, within particular regions the climate stressors, impacts, and strategies to reduce vulnerability may be similar. We can especially learn from those communities that are already taking action to become more resilient.

Figure 1: Community resilience domains.

"Resilience," is the new buzz and we are well advised to stay abreast of new information and wisdom that will continue to develop. There are currently multiple resources available online that can assist us in our shared process. Those of us in PREP have been fortunate to work alongside the development of the Climate Resilience Toolkit since we collaborated with the National Environmental Modeling and Analysis Center. Visit toolkit.climate.gov/ often and tell a friend. This document provides guidance for initiating community resilience planning, which inherently involves at least four community systems that interconnect and overlap, namely natural, built, social and managed.

Figure 2: Screenshot of the Climate Resilience Toolkit Homepage.



Step One: Identify the problem and build a team

Climate change is the broader context that we all exist within, but extreme weather is the manifestation that we prepare for based on what we expect for our region. As we have learned from experience, climate change is not always easy to discuss in our culture, but fortunately *managing the risk of extreme weather* is something most can agree upon. Managing the risk of extreme weather is a way to get the resilience discussion started in our own communities.

The complexities of climate and extreme weather events make them difficult to predict. But what we can do is identify existing climate and non-climate stressors and potential impacts in our region. After all, humanity has never had a crystal ball, but we can still prepare to the best of our ability with the information we have. Climate science gives us enough information to reduce our vulnerability and disaster risk. Therefore, we are empowered to plan for our own resilience.

Defining the problem, stressors and impacts

We simply begin by asking ourselves "What's the problem?" Climate and extreme weather events become stressors when they negatively affect the resources, services, or assets in a community. These negative effects are also known as climate related impacts, but they refer to the effects on lives, livelihoods, health, ecosystems, economies, services, and infrastructure. For example, drought can be a climate stressor on water supplies, crops or forests. Many communities can identify climate stressors based on past events and experiences in dealing with climate or weather events in their community. Understanding how natural and human systems have been affected in the past by climate and extreme weather is a start towards understanding potential impacts in the future. Your community team will define the scope, articulate objectives based on the climate stressors and potential impacts on social, natural, built or economic systems.

Framing the Climate Issue

Human and natural systems have always needed to deal with the effects of climate and extreme weather events. In the past, climate has been more static or predictable, so businesses and communities have been able to plan and operate based on a less variable climate. However, changes in climate conditions and variability, which include the frequency and severity of extreme weather events, present new challenges in the way businesses and communities deal with climate and extreme weather. Also, communities are not impacted by climate and extreme weather alone. Businesses and communities must also deal with the effects from other non-climate stressors, which may include economic changes, social issues, land use, the availability of natural resources, and others. Businesses and communities must be able to plan based on both climate and non-climate factors. Therefore, it is important to recognize that impacts to human and natural systems result from the combination of and sometimes the interaction between climate and non-climate stressors. Changes in climate variability means that extreme events that a community currently faces may occur more often and/or with greater severity.

Tools

Use all the tools and resources you have to examine the known and likely climate stressors and impacts in your community. Several recent national reports, such as the Third National Climate Assessment (http://nca2014.globalchange.gov/), describe existing and potential climate impacts affecting the region. Other resources, such as the Climate Resilience Toolkit, provide information on stressors and impacts and how other communities are considering them. The stressors and potential impacts that are identified in this step will later be assessed and prioritized based on risk. Once we have identified stressors and potential impacts then we can begin to make decisions regarding how to reduce risk and vulnerability in our communities. When we reduce risk and vulnerability we build resilience.

Resilience…*the bamboo that bends is stronger than the oak that resists.*

Garner support and build a team

A very important part of step one is garnering support and building a team. Each community will need to engage stakeholders and raise awareness. There are often many different viewpoints of a problem. Understanding the different stakeholder perspectives is crucial towards recognizing how all the players can contribute to the solutions. Information sharing among stakeholders and gathering stakeholder input can raise awareness around the issue. Raising awareness is especially important when stakeholders are coming together from different backgrounds, sectors or organizational departments.

Key lesson from PREP:

Inventory what is being done in your community that is already building resilience. Use this exploration as an opportunity to work with others and garner support for your efforts.

Compile and track these efforts to include in your community resilience plan, where applicable. For instance, you may find storm water management initiatives already underway or an effort to strengthen neighborhood associations.

(Kristin Baja, City of Baltimore, PREP webinar 2014)

Select a leader to champion resilience

- As with all municipal initiatives you will want to build internal government and external community support.
- Most successful resilience initiatives have a leader, champion or a couple of champions who will continually learn about climate change and likely impacts for your community. They take the responsibility for ensuring that difficult decisions are informed. This person is ideally someone respected across political and social sectors and who has the courage to lead efforts that may look different than the status quo or "business as usual."

Know your audience

- Identify where and to whom (community leaders, nonprofit groups, demographic areas) outreach should be targeted in your community.
- Learn what is already going on in local emergency management agencies in the community. Often times, resiliency is a final step in the Respond & Recovery sequence.
- Seek to understand their concerns, motivations and influential people within these targeted social circles.
- Listen, be flexible and be prepared to research and share information from varying trusted sources.

Develop and share the preparedness message

- Share climate change already witnessed in your community. Use scientific sources to the extent possible and acknowledge natural variability while describing change that is beyond more typical variability.
- Explain what climate change impacts are projected for your area and how this may affect your community. Be open to discussion on this point because you may learn of helpful future resilience team members.
- Stress the need for preparation and the co-benefits of being proactive.
- Reveal other communities that are developing or have developed resilience plans and proactive initiatives.
- Share a flexible outline for a plan while acknowledging it is a work in progress and encourage other's engagement in the process.

- Climate change can still be controversial in our society even though the scientific evidence is overwhelming. You may find it best to begin resilience planning in terms of extreme weather events, which can be even more effective in some communities.

Here are some suggestions for approaches to sharing the message found in *"A Guidebook for Local, Regional, and State Governments*," from the Climate Impact Group:

Brown bag seminars, department meetings, scientific briefings to councils and executive staff, newsletters, fact sheets, utility inserts, brochures, websites, public meetings, press releases and public statements.

For more see:
www.cses.washington.edu/db/pdf/snoveretalgb574.pdf, pages 51-54

Build your resilience team

- Climate change is projected to have cross-sector implications namely economic, planning, environmental, public health, sociological, water and erosion management, emergency management and others. Therefore, it is important to have members on your resilience team from the relevant internal and external sectors.
- How much power does your team have? Do you have the power you need to make real change in your community? If not, how can you obtain it? Is your community taking a regional approach and therefore pooling resources with other local communities? Generally it is advisable to include planning leaders and technical experts from the community sectors namely natural, built, managed and social systems.
- The team will need a planning leader or group of leaders who have good communication skills and can work with people of varying backgrounds, interests and skill sets. Having climate impact knowledge is preferred, but can also be gained during the process. This person may also be your outreach champion if you have a small community.

Understanding the mission of the resilience team

Of note: Climate resilience plans are strongest when they are flexible.

- Assessing the vulnerability, adaptive capacity and projected climate impacts for your community.
- Prioritizing, developing goals and an implementation plan
- Implementation
- Measuring progress and updating as needed.

Ancient history?

Throughout geologic and human history there has been climate variability. Ancient and current cultures throughout the world have employed adaptive strategies to climate change.

One example of this is through various methods of rain water catchment when the climate has shifted toward more arid patterns that have created intermittent and even entrenched drought conditions. Examples of rain water catchment as a climate adaptation strategy can be seen in the archeological record throughout North (the Clovis around 11,500 bc) and South America (the Mayan around AD 800-900), the Arabian peninsula (in the Wadi Sana and Wadi Shumlya tributaries), and extensive systems throughout India and South Asia's history.

Many believe that rain water catchment systems may have more relevance today than at any other time during the Holocene.

Water and climate policymakers and planners would do well to learn from ancient cultures and possibly give more credence to rain water catchment systems as a modern response to climate change where applicable.

Establish decision-making criteria

Once all the stakeholders have been able to share information and raise awareness of their issues, the decision criteria should be established. The decision criteria serves as general guidelines to follow and may include certain outcomes that should be achieved or avoided, such as "do no harm" or known budget constraints. It's important to understand the decision criteria early on so that all the stakeholders are comfortable with moving forward towards taking action.
For a thorough analysis and theoretical methodology for integrative, trans-disciplinary decision making consider: Ciumasu, I.M., 2014, Dynamic decision trees for building resilience into future eco-cities, *Technological Forecasting and Social Change, 80,* 1804-1814. Retrieved from: http://www.researchgate.net/publication/268207133_Dynamic_decision_trees_for_building_resilience_into_future_eco-cities

Step Two: Assess your vulnerabilities

Vulnerability is when a system is unable to cope with a change brought about by a climate stressor. Vulnerability is a term often used to describe susceptibility or exposure to harm. In the context of climate-related impacts and resilience, the vulnerability of a population, resource or service is determined by two elements, its sensitivity to climate and the adaptive capacity. Building resilience will focus on these two aspects of vulnerability. In this step you will have to start thinking about critical assets in your community, which is often not easy to do. When considering vulnerability it is important to understand the concepts of *sensitivity* and *adaptive capacity*. Sensitivity involves exposure to potential impacts. Exposure refers to the presence of resources or people that could be affected by an extreme weather event or other hazard. Think of impacts as the potential effects on people, resources, services, or assets due to climate and non-climate stressors. Adaptive capacity is the ability of a system like a person, organization or community to cope with impacts and stressors or adjust to change.

Social vulnerability examines the demographic and socioeconomic factors in a community that mitigate or exacerbate the impacts of disasters on the population. Measuring social vulnerability allows policy makers, planners and resilience leaders to determine the risk level to various groups in the community. These metrics can be used to develop policies and programs to mitigate risk in advance of an extreme weather event or other disaster, as well as, target response efforts in a disaster. There are a number of indices available for measuring social vulnerability. While consensus on the most valid and reliable measure has not been attained, the Social Vulnerability Index, developed by Dr. Susan Cutter and colleagues from the University of South Carolina is widely used in the United States. US Social Vulnerability Index data can be found at: http://svi.cdc.gov/

Climate Sensitivity

In climate resilience planning, climate sensitivity refers to the degree to which a population or resource is affected by current climate and extreme weather impacts and may be affected by projected impacts and changing climate conditions. In step one, you began to evaluate how resources and services in your community are affected based on past experiences and understanding of impacts from climate and extreme weather events. Evaluating what resources and services are affected is the basis for decision making. This step allows identification of community assets likely to be exposed to hazards and impacts. Qualitative and quantitative data will inform your asset inventory so you can begin determining which assets are most sensitive to impacts. See Appendix A for example sensitivity analysis tables along with descriptions of how they were created.

Adaptive Capacity

As stated earlier, adaptive capacity is the ability of a resource, system or organization to cope with impacts and stressors or adjust to change. In other words, given the sensitivity certain resources have to current and projected climate impacts, what is their ability to cope with or accommodate these impacts with minimal disruption to their functions? Populations and resources often have different abilities to adapt. Some resources that have high climate sensitivity may also have a high adaptive capacity, meaning the resource was able to "bounce back" or maintain its functions after a climate impact and making it less vulnerable. As mentioned earlier, understanding social vulnerability is an important consideration because vulnerable populations may have less capacity to absorb climate stressors.

Understanding cause and effect

It is important to draw from a variety of resources (such as the climate resilience toolkit: https://toolkit.climate.gov/get-started/step-2-determine-vulnerabilities) and stakeholder input in assessing vulnerability throughout the resilence planning process. The stressors, climate and non-climate, and resources or services that are affected should be identified by understanding the cause and effect relationships surrounding impacts from climate change and extreme weather. It is also important for stakeholders to work together in order to understand these relationships. It may be helpful for stakeholders to work through a group conceptual model or mind mapping exercise. See Appendix B for example conceptual models. Mind maps or conceptual models are graphical representations of systems or processes and are great ways of communicating how resources are affected. This type of exercise can also allow a stakeholder group to begin identifying actions that are currently taking place or that could potentially be taken to increase adaptive capacity.

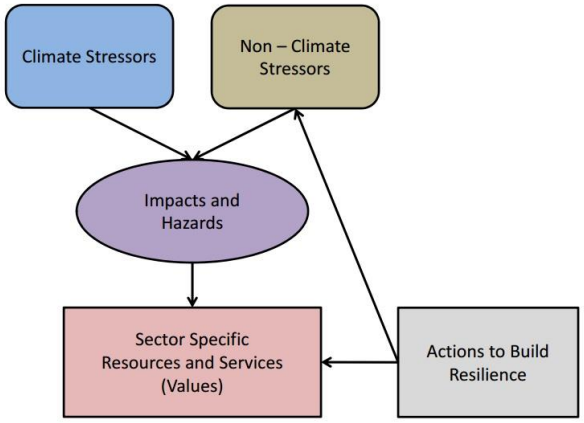


Figure 3. A conceptual model template for understanding relationships and building resilience

Step Three: Investigate options to reduce vulnerability and build resilience

- Options can be categorized into the following categories, according to how they reduce vulnerability:
  - Reducing exposure (reducing the presence of assets in harm's way, such as, property buyouts in a floodplain.)
  - Reducing sensitivity (changing the way an asset is potentially affected)
  - Increasing adaptive capacity (enhancing the ability to cope or withstand)

Resilience is the ability of a system (natural, human, built or economic) to cope with a stressor and still maintain its essential function or identity. Building climate resilience can reduce vulnerability to climate and extreme weather events by increasing adaptive capacity of the human and natural systems. Some organizations may refer to options as opportunities, alternatives, choices, and potential actions, among others. Sets of options are often referred to as strategies. At this point in the process, identifying options is like creating a "laundry list" and making sure that all feasible options are identified. This is a group exercise and the process benefits from multiple sessions. Also refer to the Climate Resilience Toolkit: https://toolkit.climate.gov/get-started/step-3-investigate-options)

Similar to the previous step, it is important to understand the cause and effect relationships between your options and stressors and impacts. Understanding these relationships allows you to articulate what change or influence you would expect potential actions to have on the problem at hand and how they would reduce vulnerability. This also provides a way of establishing expected outcomes and ideas to measure later for effectiveness. As mentioned in the previous step, one way of articulating the cause and effect relationships is by using a "mind mapping" technique also referred to as conceptual models. Options identified can be integrated into any conceptual model that may have been generated in the previous step (See Appendix B).

Step Four: Evaluate and choose the best options

- Identify the most relevant hazards, areas and populations most at risk
- List and prioritize adaptive needs
- Appraise your options – costs and valuation – What is the magnitude of the expected loss? Calculate the expected loss across multiple climate scenarios to assess uncertainty
- Evaluate the risk (the chance of a loss), uncertainties and probabilities
- Develop action plans
- Identify implementable strategies – How could we respond?
- Set targets and identify possible adaptation responses
- Build a balanced portfolio of responses with detailed cost/benefit assessments
- Prioritize options/actions
    - Evaluate and prioritize (make the decision)
    - Look at tradeoffs
    - Consider barriers and feasibility

Ask: What are our best options to address the identified vulnerabilities?

By the time you have arrived at this step you have considered your potential climate impacts and current vulnerabilities. You have also identified potential options that reduce your community's vulnerability. Now it is time to ask 'What are our best options to address the identified vulnerabilities?' https://toolkit.climate.gov/get-started/step-4-evaluate-risks-costs

Feasibility and co-benefits

One of the initial criterion that can be used for evaluating options is how realistic or feasible an option is compared to other alternatives. There are many potential barriers to feasibility, from funding to political perceptions.

Another consideration is co-benefits that options may have. These are options that may reduce vulnerability *and* satisfy other management goals. For example, the development of greenspace in a floodplain may reduce vulnerability by mitigating flood waters and provide the co-benefit of recreational opportunities for the community.

Evaluating risk

While vulnerability takes into account how a resource may be affected and its ability to cope in the event of a climate related impact or extreme weather, risk considers the likelihood and consequence of an impact or event occurring.

Evaluation of risk can be challenging because of uncertainty- no one can perfectly predict the future. Risk is often described as the probability or likelihood of an event occurring multiplied by the impacts if the event happened. It is recommended that evaluating risk should be done using cost-benefit analysis or a multi-criteria analysis that relies on data and not on expert advice alone.

Focus on vulnerable populations and areas at most risk

Extreme weather events are environmental justice issues because they have a disproportionate impact on people who are already socially vulnerable or disenfranchised in other ways. It may help to focus on the most relevant impacts and on the areas, resources, or populations at the greatest risk, or that are most likely to face the greatest consequences from a climate impact.

Prioritizing actions

Action plans identify implementable strategies with actions that are prioritized based on amount of vulnerability or risk. Even if a risk assessment does not take place, actions can be prioritized based on how well they reduce vulnerability and satisfy adaptive needs.

- Look at each stressor and determine **the probability** of the event, the severity of the impact, the ease of implementation, the cost and the value of action.
    - Considering **probability ranges** can be one way of evaluating risk, which reduces some uncertainty by looking at possible futures that have known levels of confidence.
    - Another method is to consider **multiple scenarios**. A scenario examines the future based on one or more possible outcomes. Scenarios can also combine potential outcomes of climate and non-climate issues. Options can then be identified that address each scenario or possible outcome. By looking at multiple scenarios, it may be evident that some options identified are the same regardless of the uncertainty or which scenario actually unfolds.
- For valuation discussions, we must ask the question – **"Who is paying the bill and who is benefiting?"** For example, many communities in our nation have transferred their risk to the federal government through flood insurance programs with very low premiums.
- **Identify synergies** across sectors and make sure chosen options don't have negative consequences for other sectors. Look for logical and synergistic partners, such as, the county, the state, nonprofit organizations etc.

Step Five: Take Action!

Implementing the decision

A common problem is viewing uncertainty as a barrier to taking action, but there is certainty in the existence of climate stressors and likely future impacts. Uncertainty can be understood and communicated and options can be identified that take uncertainty into account. A common approach to handling uncertainty is to consider options that have "no regrets" or "do no harm." Some uncertainty is inevitable, inaction is not.

Monitor outcome and effectiveness

Strategies or actions to reduce vulnerability and risk is a long-term commitment and can take years to fully implement. The effectiveness of actions taken should be measured based on how successful they were in reducing vulnerability or risk. Monitoring the outcomes of actions taken can tell you whether you need to adjust your priorities, whether your vulnerabilities and risks have changed, and whether additional action is needed.

Learn Action Approaches from others and then tailor to meet the needs of your community. For instance, review case studies often, such as, at: https://toolkit.climate.gov/taking-action

PREP Summary:

PREP concluded with an online survey to evaluate the program from the perspective of the SSDN partner city Sustainability Directors. One of the primary goals of the program was to improve collaboration and communication in the SSDN network. By strengthening the SSDN network Sustainability Directors can continue to share ideas, information, brainstorm with one another, encourage each other and learn from one another how to overcome barriers in their respective community resilience efforts. To that end, building cohesion in the network will enhance the quality of current and future efforts and promote resilience not only in the network, but in each respective community.

Resilience Case Study: Reducing the impact of heavy rain events in Asheville, NC

Step 1: Identify the problem including stressors and impact:

In September 2004, Western North Carolina was significantly impacted by floods and landslides caused by two major hurricanes. The cost was high. Eleven lives were lost, 140 homes were destroyed and more than 16,000 homes were damaged in the Asheville area and surrounding counties. In total, there were $200 million in damages and freshwater supply was lost to Asheville for several days due to erosion and a break in the water main. These types of severe storms are not unusual in Western North Carolina. In Asheville alone, nine major floods have occurred in the past 100 years, two of the most serious in 1916 and 2004. Damaging floods occur every 20 years on average. Future storms and flooding events have the potential to cause more property, infrastructure damage and loss of life.

Garnering support and building the team:

After the 2004 floods, a Flood Damage Reduction Task Force (FDRTF) was formed which included the City of Asheville, Buncombe County, Universities, local businesses, non-profit organizations, and other local, county, and state agencies. A planning study was also conducted by the North Carolina Department of Environment and Natural Resources Division of Water Resources and stakeholders from Biltmore Village, the City of Asheville, and the Swannanoa Watershed with assistance of a project consultant.

Step 2: Assess your risks and vulnerabilities:

The FDRTF identified known risks and vulnerabilities in the Swannanoa watershed. One known risk was that the Swannanoa River was prone to flood during extreme rain events and the surrounding community including people, infrastructure and homes were vulnerable.

Step 3: Identify options to build resilience:

After assessing for risks and vulnerabilities the FDRTF identified 45 potential projects for building resilience by reducing the impacts from flooding in the Swannanoa River watershed.

Step 4: Evaluate the costs of action(s) vs inaction and choose the best option:

Potential projects for reducing flood damage were ranked according to their environmental impact, ability to implement and other factors. The ranking highlighted several options for increasing adaptive capacity of the storm water system, including:

- Property buyouts,
- Opening an alternative reservoir for flood mitigation,
- Reconstructing a critical bridge,
- Installing an early warning system
- A flood retention project to manage high water during flood events. We identified new building regulations in the floodplain to reduce exposure to future flood events.

Asheville case study continued:

Step 5: Implement– Take Action!

All of the projects listed above were implemented. The final flood retention project is still being implemented. Together, the projects are keeping flood waters away from pedestrians, vehicles and housing, which thereby lowers the vulnerability of the community.

Partnerships had a crucial role in implementation:

An added benefit of the flood retention project is a partnership with the NC Department of Transportation to make improvements, including installation of a traffic signal and turn lane which will benefit users of the nearby Nature Center, Recreation Park and Soccer Complex. The location is also considered as part of an ongoing flood remediation study by the Army Corps of Engineers.

The FDRTF worked to raised awareness with the community and sought funding for building community support for the projects. The FDRTF partnered with the local University to provide GIS, education and outreach tools on flood mitigation.

Outcomes and monitoring effectiveness

A major storm event in the summer of 2013 showed how effective these measures have been to lower vulnerability. July, 2013 was the wettest July on record for Asheville, including three days in the first week of the month that set daily rainfall records. Despite the heavy rainfall events in the Asheville area in July, the Swannanoa River remained below flood stage. The flood retention project for Phase 1 was completed in December, 2014. The Federal Emergency Management Agency (FEMA) announced that the City's voluntary management activities exceeded the standards of the National Flood Insurance Program (NFIP). Therefore, the outcome is not only a safer community, but also a 10 percent reduction in flood insurance premiums. The NFIP report cites several positive steps taken by the City of Asheville to reduce flood damage, including education and outreach projects, floodplain mapping, preservation of open space in flood prone areas and storm water management, such as the Swannanoa River flood control project.

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Appendix A – Climate Sensitivity Examples and terms:

Sensitivity Analysis Overview: The tables below show examples of a sensitivity analysis for one planning area in each sector of built, economic, social and natural systems. While this is not an exhaustive analysis, it shows how climate and non-climate stressors could be assessed for stormwater management, food security and local agriculture, public health and social vulnerability, and coastal erosion management planning areas. Some of the examples were taken from themes and content developed by the SSDN PREP participants in November, 2014. The degree of sensitivity should be determined for the specific municipality or planning entity. Once the planning areas that are affected by climate and weather have been indentified, a senstivity analysis can help examine how the planning areas are directly and indirectly affected by climate and extreme weather.

Current and Expected Stressors (Climate and Non-climate): The sensitivity analysis first identifies what stressors (climate and non-climate) that each of the planning areas face. Many of these are likely stressors that the planning areas already have to deal with and manage. It is important to include both climate and non-climate stressors in system-based resilience planning. Understanding the non-climate stressors can be important to help identify opportunities for co-benefits in climate adaptation and resilience activities.

Conditions that Contribute to Stressors: In some cases the non-climate stressors will have greater potential impacts than climate stressors and may be determined a higher funding priority. For each stressor, identify the conditions that contribute to each one. For the climate stressors, the contributing conditions will include climate and weather-related factors or variables.

Potential Impact or Consequence to Planning Area: Stressors have an impact on planning areas due to the consequences they have on people, assets, or values. For each stressor begin to identify potential impacts—how resources, services, or people may be affected by a stressor . This step can lead to thinking about and identifying other aspects of vulnerabilty and risk, such as exposure—the presence of resources or people that could be affected, and the potential consequeneces of the loss of resources or services.

Projected Change in Stressors and Contributing Conditions: Also, it is important to identify how the stressors identified and contributing conditions are expected to change. For climate related stressors, information resources such as climate assessments can be used to understand what changes are projected for certain time scales of interest.

Degree of Sensitivity: Finally, a degree or level of senstivity can be determined and compared relatively across planning areas within a municiplaity or organization. Determining this degree of sensitivity can be done qualitatively or quantitatively, but it is important that this is determined by the organization or planning area that is conducting the assessment.

1. Sector and/or Planning Area	**2. Current and Expected Stressors (Climate and Non-climate)**	**3. Conditions that Contribute to Stressors**	**4. Potential Impact or Consequence to Planning Area (Resources and Services Affected)**	**5. Projected Change in Stressors and Contributing Conditions**	**6. Degree of Sensitivity**
Built: Storm water Management	Flooding	Heavy precipitation, amount and timing of precipitation, tropical storms, and sea level rise and storm surge	Damage to property and infrastructure in floodplain, impassable roadways, threat to human safety, and business interruption	Recent increase in heavy precipitation in the region is already a concern, trend can be expected to continue	High [only an example-sensitivity degree must be determined by each community team]
	Erosion and/or Landslides	Runoff from heavy precipitation events, steep slopes	Damage to property and infrastructure, impassable roadways, threat to human safety, and business interruption	Recent increase in heavy precipitation in the region is already a concern, trend can be expected to continue	
	Impervious surfaces	Land use and use of best practices in developments	More storm water contributing to runoff and flooding	Increased development into the future can be expected	
	Less funding for storm water infrastructure upgrades	Storm water fees and funding levels	Lack of infrastructure for managing storm water	Funding will likely continue to be a challenge	

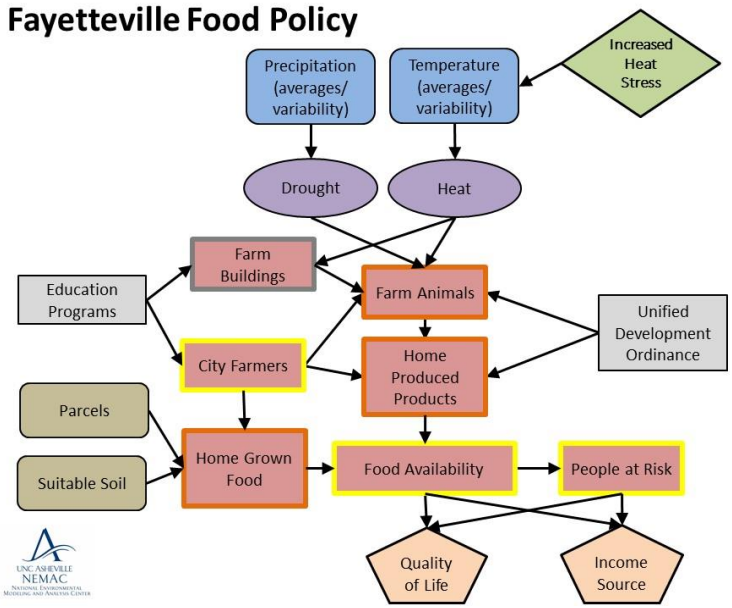
1. Sector and/or Planning Area	**2. Current and Expected Stressors (Climate and Non-climate)**	**3. Conditions that Contribute to Stressors**	**4. Potential Impact or Consequence to Planning Area**	**5. Projected Change in Stressors and Contributing Conditions**	**6. Degree of Sensitivity**
Economic: Food Security and Local Agriculture	Drought	Amount and timing of precipitation	Loss or damage to crops due to water availability	Precipitation variability is increasing with more exceptionally wet and dry summers. Decreased water availability, exacerbated by population growth and land use change, will continue to increase water competition.	Moderate [only an example-sensitivity degree must be determined by each community team]
	Flooding	Heavy precipitation, amount and timing of precipitation, tropical storms, and sea level rise and storm surge	Loss or damage to crops in floodplain, loss of property, loss of transportation and mobility (for people and goods) and access to food	Recent increase in heavy precipitation in the region is already a concern, trend can be expected to continue	
	Heat stress	Temperature and extreme heat days	Loss or damage to crops, livestock and property, increased energy cost and/or need for cooling	Increases to the number of consecutive hot days and temperature variability are projected	
	Changes in length of growing season	Temperature	Changes in suitable crops and animals for home production, increased water demand	Increase in the length of growing season is projected	
	Suitable land and soil	Land use and land availability	Increased cost of land and less opportunity for suitable land	Population growth and development has potential to compete for land	
	Limited access to healthy food	Economic factors, transportation and mobility	Planning initiative to create a “food city,” where as much space as is practical is used to grow food.	Food insecurity is an ongoing stressor due to increased population growth and increasing prices in the food system.	
	Limited ability to grow and sell home produced products	Zoning, ordinances, rules and policies, education, climate	Less potential income, decreased food security for vulnerable populations		

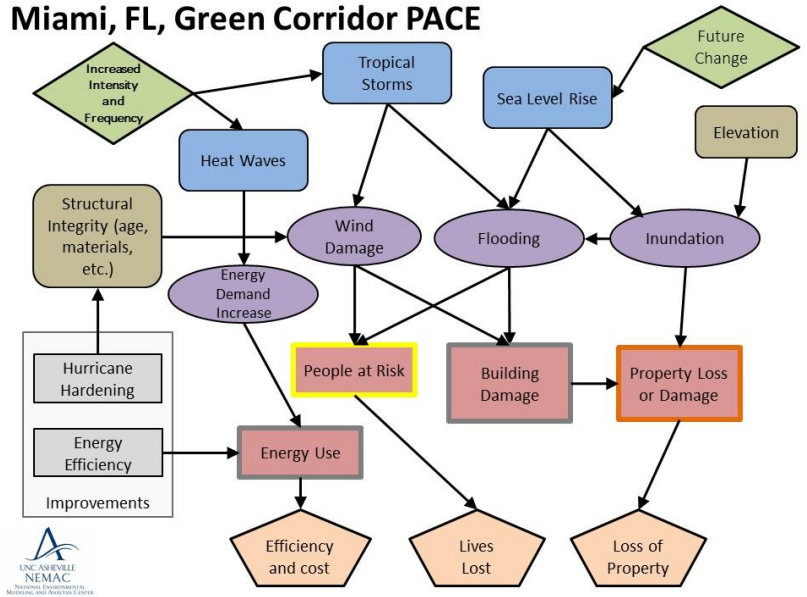
1. Sector and/or Planning Area	2. Current and Expected Stressors (Climate and Non-climate)	3. Conditions that Contribute to Stressors	4. Potential Impact or Consequence to Planning Area	5. Projected Change in Stressors and Contributing Conditions	6. Degree of Sensitivity
Social vulnerability	Flooding	Heavy precipitation, amount and timing of precipitation, tropical storms, and sea level rise and storm surge	Loss or damage to crops in floodplain, loss of property, loss of transportation and mobility (for people and goods) and access to food	Recent increase in heavy precipitation in the region is already a concern, trend can be expected to continue	Moderate [only an example-sensitivity degree must be determined by each community team]
	Decreased affordable housing stock	Immigration, higher end development and land use constraints	Increased homelessness, decreased discretionary spending for the local economy	Increasing low income population due to climatic and economic migrations	
	Heat stress	Temperature and extreme heat days	Loss or damage to crops, livestock and property, increased energy cost and/or need for cooling, dehydration risk to vulnerable populations, such as, elderly and children	Increases to the number of consecutive hot days and temperature variability are projected	
	Change in agricultural growing seasons	Changing climate variability	Unpredictable changes in suitable crops and animals for home production, increased water demand	Increasing variability	
	Electricity cost increases	Change in heating/cooling days, increased demand/enhanced regulatory standards	Increased economic pressure on vulnerable populations	Changes to heating and cooling degree days expected, increasing demand due to rising temperatures and population growth	
	Limited access to healthy food	Economic factors, transportation and mobility, impacts to agriculture including changing climate variability, drought, and flooding	Decreased food security for vulnerable populations	Population growth, rising food prices, strained job market	

1. Sector and/or Planning Area	**2. Current and Expected Stressors (Climate and Non-climate)**	**3. Conditions that Contribute to Stressors**	**4. Potential Impact or Consequence to Planning Area**	**5. Projected Change in Stressors and Contributing Conditions**	**6. Degree of Sensitivity**
Natural: Coastal erosion management	Inundation	Degree and speed of sea level rise	Increased storm surge, damage to property and infrastructure, loss of ecosystems, loss of property	Sea level rise poses widespread and continuing threats	High [only an example-sensitivity degree must be determined by each community team]
	Erosion	Sea level rise, storm surge, condition of wetlands and dunes	Reduced buffer and mitigation of future storm surge	Sea level rise poses widespread and continuing threats and leading to greater storm surge	
	Salt water intrusion	Degree and spread of sea level rise and amount of storm surge	Loss of species and ecosystems	Sea level rise poses widespread and continuing threats and leading to greater storm surge	
	Coastal development	Increased population	Loss of undeveloped land and ecosystem services in coastal zone	Continued population growth	

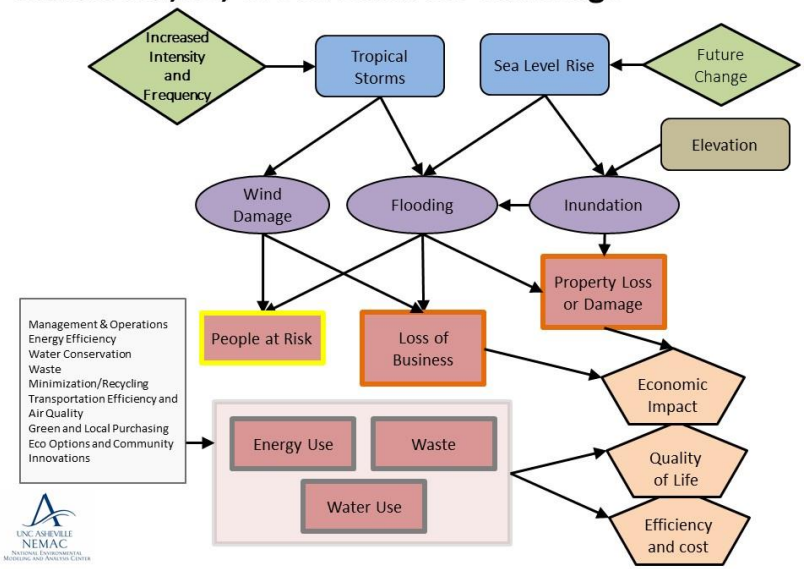
Appendix B – Example Conceptual Models

Below are example conceptual models that were created and used in the PREP workshop in November, 2014. The conceptual models were used as a tool for understanding the relationships between climate and non-climate conditions (blue and tan boxes) that contribute to stressors and impacts (purple ovals) to resources and services in the community (red boxes). The conceptual model also starts to identify potential options or activities (gray boxes) that could reduce exposure or increase adaptive capacity of the system.

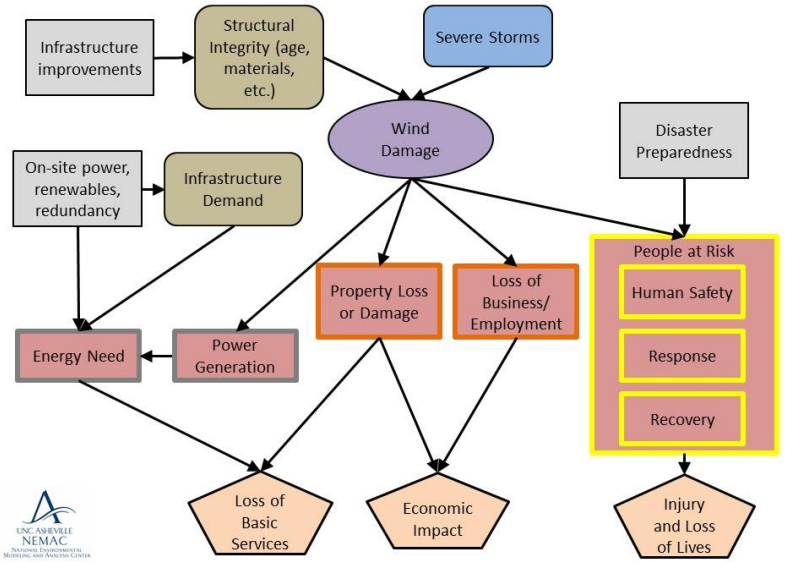




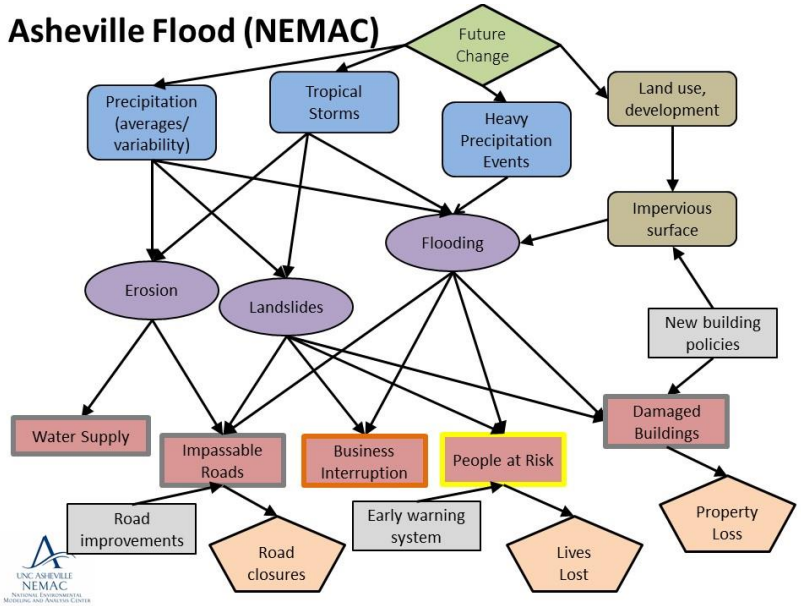
Charleston, SC, Green Business Challenge



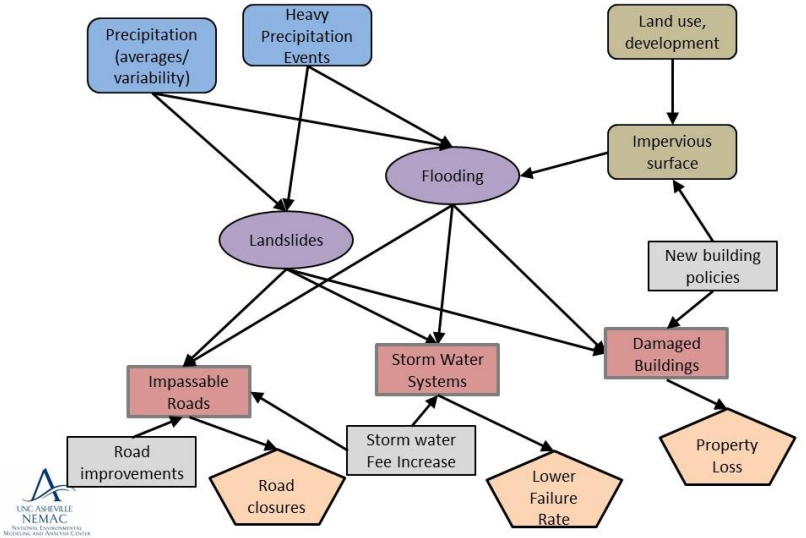
Huntsville, AL, Tornado Impacts to Critical Infrastructure

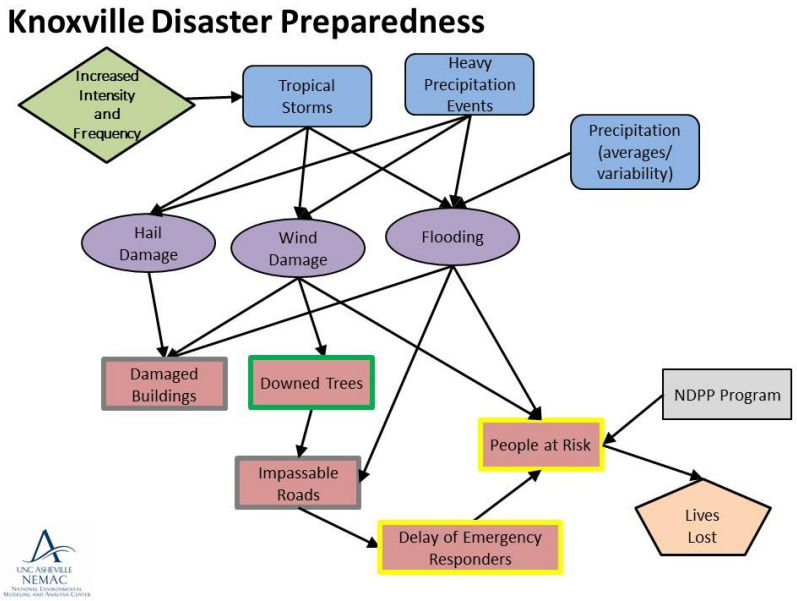


Asheville Flood (NEMAC)



Asheville Storm water (City of Asheville)




Knoxville Disaster Preparedness
Increased Intensity and Frequency
Tropical Storms
Heavy Precipitation Events
Precipitation (averages/ variability)
Hail Damage
Wind Damage
Flooding
Damaged Buildings
Downed Trees
NDPP Program
People at Risk
Impassable Roads
Lives Lost
Delay of Emergency Responders
UNC ASHEVILLE NEMAC

M. Hutchins, and J. Pollock. (Team). (2015). *Partnerships for Resilience and Empowered Planning, Community Resilience Planning Handbook.* Produced by the National Environmental Modeling & Analysis Center and the University of Arkansas. Southeast Sustainability Directors Network.