Diagramming Climate Change-Related Vulnerability-Consequence Adaptation Planning Scenarios (VCAPS)

A facilitation guide and tutorial

July, 2011

OVERVIEW

Climate related hazards and management actions

Evidence shows that coastal areas face a number of stresses that are likely related to climate change. Most of these problems are not unfamiliar. What is different is their likely future severity or frequency. For instance, estimates are that the number of hurricanes will decrease, but the severity of the storms will increase. Other problems, such as tidal flooding, are gradually going to be exaggerated by the slow but steady rate of sea level rise. Warmer temperatures are likely to change the ecology of some areas, perhaps leading to the presence of tropical diseases like Dengue fever or malaria. There may be new invasive plants or insects as well. Governments and universities contend that impacts of climate change are already being experienced and are likely to be worse, particularly on the coasts.

These hazards (or what we also call "climate stressors") produce a number of consequences that are mainly negative for coastal communities. But there are many things that municipalities can do to plan for and reduce these consequences. Knowledge is power. And having more knowledge about how climate-change related hazards influence a community can empower them to take preemptive actions. There are already many things that towns and states are doing all along the coast. These important activities need to be considered part of a larger strategy for managing these hazards.

Purpose of the VCAPS process and its importance for communities

The Vulnerability-Consequence Adaptation Planning Scenarios (VCAPS) process helps community decision-makers, staff, and planners clarify their understandings and assumptions about climate change adaptation challenges their communities will face in the future. As part of the process, they describe scenarios, or possible futures, for which a community should be prepared. There is no "right" or "wrong" scenario, just ones that are more or less likely to reflect what we know now as possible futures and more or less helpful when thinking about how to meet future challenges. Predicting the future means accepting uncertainty, even as we seek to minimize it. The scenarios that are meaningful for a particular community should be arrived at via careful consideration of community members' experience, knowledge, as well as the latest scientific knowledge. A "good" scenario is one that will help communities think and inform their decision-making, not necessarily one that will prove – in the future – to have been accurate.

The goals of the VCAPS process are to:

- Effectively gather and summarize the wealth of information, knowledge, and experience that exists within a community.
- Stimulate thinking and conversation about how to manage consequences by taking upstream or downstream actions.
- Aid in future decision making.

The diagrams made as part of a VCAPS session can serve as a library of what a community knows about the unique and special ways that it is vulnerable and resilient to different kinds of climate stressors. Such diagrams can summarize a tremendous amount of experience and knowledge in one place. The scenarios developed with the VCAPS process can reach across departmental or disciplinary boundaries to depict an integrated picture of a community's vulnerability and management responses. They can include expertise and knowledge from many aspects of community management, including water and sewer authorities, building and public works departments, emergency management services, and public health and environmental organizations. They can also be used to review the adequacy of knowledge. Gaps in knowledge or planning should be easier to spot. The community can then come up with a plan for filling in those gaps, if they are important.

The process facilitates identification of actions that can be taken by the community to prevent or mitigate consequences, or to adapt to them. We call these "management actions." They can give a clear understanding of where, what, and how a community is already acting to address problems. The diagrams can also make transparent to people in different departments how they are working in a coordinated way – or not – to protect the town. For instance, a police department may not fully understand the needs of the water and sewer department. More complete understandings may improve the abilities of personnel in a community to work together effectively.

As action-planning strategies, the process is also helpful because participants can clarify where and when management actions are being taken. It is good advice to coordinate management actions so that they are not all upstream or all downstream of a particular hazard event, such as a hurricane. For example, a community probably should not put all its resources into flood mitigation without sufficiently funding evacuation plans. On the other hand, it is probably not a good idea for a community to put all its resources into handing emergency conditions and do no planning to reduce or prevent the problem next time. Communities should make certain that they have the ability to take different kinds of management actions to both prevent and cope with disasters.

The diagrams are also helpful as outreach and education tools. Community residents might want to better understand what their town is (or is not) doing to protect their property or safety and why (or why not). The scenario diagrams can serve as useful visual aids to help explain decisions to residents. Transparency can help to build the support necessary for taking action, including the raising and spending of funds.

Short-term and long-term planning

The timetables we are talking about here run the gambit from near term to very long-term. Good planning means planning for the storm next week *and* for the long-term changes that will happen over decades. For instance, any new infrastructure projects should consider the continual rise of sea levels and plan so that the systems are still working under worst-case future conditions. In some jurisdictions, municipalities and utilities are actually *required* to incorporate future conditions caused by climate change, such as sea level rise. Of course, communities have

limited financial resources, and immediate needs must come first, but it would be a mistake to lose sight of the changes that are occurring more gradually.

Purpose of this document

This document describes how to facilitate a Vulnerability-Consequence Adaptation Planning Scenarios (VCAPS) diagramming session. A tutorial starts by identifying a climate-related concern and then follows through with how it impacts a community, documenting each step in the process. Diagram can be fine tuned to the specifics of a particular community.

Summary of the chapters in this document

Chapter One is a guide to using VUE, a free, open source diagramming program, and how to set it up for a VCAPS session.

Chapter Two introduces the important ideas about vulnerability to help you organize your thoughts into a diagram.

Chapter Three explains the fundamentals of how to facilitate the VCAPS process.

Chapter Four is a tutorial on how to make a diagram, which represents a particular scenario linking climate stressor to consequences, using the program.

Comments and feedback

We would appreciate your comments and feedback on this document and on the VCAPS process itself. We will use your input to improve the materials, which we anticipate sharing with other communities.

Please send your comments to:

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Thank you.

CHAPTER 1: USING VUE FOR THE VCAPS PROCESS

One of the characteristic features of the VCAPS process is its use of a diagramming program to visually document a group's discussion in real time. Based on the mediated modeling technique, participants in a VCAPS session direct someone from the facilitation team (known as the "scribe") through the process of documenting the outcomes and consequences of climate stressors. This is somewhat like concept mapping or influence diagramming. However, where concept maps are often free form, the structure of a VCAPS map shows clear chains of cause and effect. This structure is very important in making sure that diagrams stay simple enough for planners and managers to remember what was discussed months after the session and to share the results with others. It also avoids the tendency to create "laundry lists" of ideas that are not clearly linked to particular problems and vulnerabilities. While VCAPS could be accomplished using sticky notes, this tends to be a messy process. A computer diagramming tool makes VCAPS run more smoothly than sticky notes by:

- Allowing all participants to see a large version of the diagram in real time.
- Enabling the facilitator to enforce the VCAPS diagram structure on the group.
- Accelerating the editing process by making changes or additions to the diagram without having to move entire chains of sticky notes.

The Visual Understanding Environment (VUE) software and VCAPS

There are a number of free diagramming software tools available, but the VCAPS team recommends the Visual Understanding Environment (VUE) freeware, developed by Tufts University (http://vue.tufts.edu/index.cfm). VUE is simple to use. It is free. It has a very readable online help manual (https://wikis.uit.tufts.edu/confluence/display/VUEUserGuide/ENGLISH+USER+GUIDE).

Finally, an active user community online provides an online forum for users to ask questions of each other and get help easily. VUE is open source and licensed under the Education Community License v2 (http://www.opensource.org/licenses/ecl2.php). VUE is available for Windows XP, Vista, and 7, Mac OS X 10.4+, and Linux Sun Java 1.6+. To download the software you will need to set up a free account.

Before starting a VCAPS diagramming session the facilitators should become familiar with using VUE.

Because the VUE help files are comprehensive, we do not repeat basic software use here. However, we do provide a few tips for using VUE during a VCAPS session.

The "building blocks" of VCAPS diagrams

As you will read below, VCAPS is based on a particular framework of understanding how climate stressors (hazards) lead to consequences and how communities and individuals may prevent or mitigate those consequences (more detail is provided in Appendix C as well). In other words, VCAPS comes with a particular structure and conventions. We use these conventions throughout this document, and encourage you to also adopt them because they help to maintain a clear understanding of different elements in *causal chains*. Causal chains are pathways of cause and effect that link climate stressors with consequences, the local conditions that influence vulnerabilities, and the opportunities for mitigation and adaptation. By leading VCAPS participants through the process of building simple causal chain diagrams, you will help them to document the impacts of climate change and the consequences for their communities in a diagram that is easy to follow and to share with others in their communities.

To help you get started quickly, your companion CD has a *.vue* file that includes information the program needs about some of these conventions – the elements that will be used for constructing the diagrams. These are described in greater detail in Chapter 2. Right now, we are just concerned with making the shapes (nodes) for each of them available in a VUE diagramming session. We call these the VCAPS "building blocks" (and VUE refers to these as "nodes").

We recommend keeping this basic structure as-is in a corner of the diagram. This not only helps the participants remember the VCAPS structure, but also makes it easier for the scribe to cut and paste VCAPS nodes quickly without having to reformat shapes each time.

To use the VCAPS template:

1. Open the file VCAPS_template.vue.
2. Save the file with a new name to keep your template pristine. Click "File -> Save As," or use the keyboard shortcut "Cntl+Shift+S," and choose a new name for the file that will help you remember the time and place your VCAPS session took place.
3. By copying and pasting nodes of the basic VCAPS structure, you can make diagramming quick and easy. With the Selection Tool activated, draw a box around the template to select all nodes and links, then drag and drop them. You'll want to move them somewhere in the page where they will be out of the way of the active diagram but still convenient for you to click on to copy and paste nodes.
4. To copy and paste nodes and change them for use in your diagram during a VCAPS session, use the Selection Tool to click on a node with the shape and color you need. We suggest using the shortcuts "Cntl+C" to copy a node faster, but you can also right click on the selected node and select "Copy." Move the selection tool to the area where you want the new node, then left click once and enter "Cntl+V" to paste the copied node at that location. You can always select the node and move it later. Click on the text in the box to change it – for example, you may start a diagram by replacing "*Management Concern*" with "*Stormwater Management*."

Linking nodes

The *Link Tool* within VUE allows you to link two nodes. You can link two nodes by selecting the *Link Tool*, then left clicking in one node and dragging the mouse into the second node. When

the second node turns green, release the mouse button and the nodes are linked. You may label them if you wish, but participants tend to prefer simpler diagrams and labeled links make the diagrams more cluttered.

There are three types of links: straight, curved, and S-curved. You will want to use straight links as often as possible. However, participants like to see as much of a diagram as possible at once, and sometimes zooming in and out makes the node text too small. In these cases, you may wish to use curved links or S-curved links to stack elements of a chain vertically without having links disappear behind nodes (for examples, see the tutorial in Chapter 4). To change a link type:

1. Using the Selection Tool, right click on a link and click on the "Link" option in the menu.
2. For a curved link, select the "Curved" option. A blue dot appears that will allow you to adjust the link so that it curves around nodes.
3. Sometimes, if you want to continue part of a chain beneath the existing chain, you will need an S-curved link. Select the "S-curved" option, and two blue dots appear. Adjust both dots until the link does not overlap with any of the nodes. Usually, during a group it is better to project a diagram on the wall and leave the chains as horizontal as possible, zooming in and out as needed for visibility. However, this "stacking" option is useful when you need to print a diagram or save it as a .jpeg file for sharing after the VCAPS session is over.

Selecting custom colors

The VCAPS development team chose a particular color scheme to make sure the colors were distinct with our projection equipment. You may wish to alter the color scheme to fit what works for your digital projector and computer.

1. If the Formatting Palette is not visible, right click on the node and select "Formatting Palette" to make it appear.
2. With a shape selected, click on the "Fill" button in the Formatting Palette.
3. Click "Other," then select the "RGB" tab.
4. Input the values for red, green, and blue, as desired, or use the original VCAPS color scheme as shown in the table.

Node	R	G	B
Management Concern	210	201	222
Climate Stressor	237	205	203
Outcome	255	238	187
Consequence	202	218	169
Management Actions	209	235	241
Individual Responses	175	194	218
Contextual Factors	217	217	217

5. Click "OK." When you return to the "Fill" button on the Formatting Palette, you will notice that your custom color has been added to the bottom of the available colors.

Sharing VCAPS diagrams created with VUE

VUE has several options for sharing your VCAPS diagrams. It has print functions; additionally, files may be saved as Adobe Acrobat *.PDFs*. It is also useful to save diagrams as image files (VUE gives you the option to save files as *.jpeg* and *.png* images). However, VUE saves images at 72 dpi (dots per inch) resolution, which means images imported into word processing files and presentations can be blurry. You can remedy this by opening a VUE *.jpeg* or *.png* in a photo editing software program and changing the resolution. Specific instructions for how to do this depend on your choice of photo editing software. In general, you will want use the photo editing software's option to resize *without constraining the image proportions* to change the resolution – 150 dpi is sufficient for most normal uses, but you will want your images to be 300 dpi or higher for high resolution printing, like for conference posters. This gives the image a higher resolution while maintaining its original height and width. Then, constrain the image proportions and resize the image to a new height and width to fit your needs.

CHAPTER 2: CONCEPTS

The ways that climate-related stressors might affect a community can be described with a handful of concepts. These concepts describe aspects of consequences and vulnerabilities to them. They are based in two conceptual frameworks related to the causes and consequences of hazards and to vulnerability. More detail about these frameworks is provided in Appendix C, for interested readers. The concepts relate to each other in a sequence of events that are causally linked, and we use the convention of showing them in a sequence that moves from left to right. At the left are the things that initiate a chain of events, which lead to concrete consequences for the community, developing to the right.

Figure 2-1 shows the concepts that go into a VCAPS diagram:

- Management Concerns
- Climate Stressors
- Outcomes
- Consequences
- Contextual Factors
- Management Actions
- Individual Actions
- Influence Arrows

The shapes that represent these concepts are called nodes in VUE and "building blocks" in our VCAPS terminology.

Figure 2-1 also shows the general way that the concepts representing the chain flow from stressors on the left to consequences on the right. For a more succinct guide to the meaning of each concept, refer to the guide in Appendix A. Notice how different concepts are shown with different shapes and colors. We will continue to use this particular convention in all diagrams.

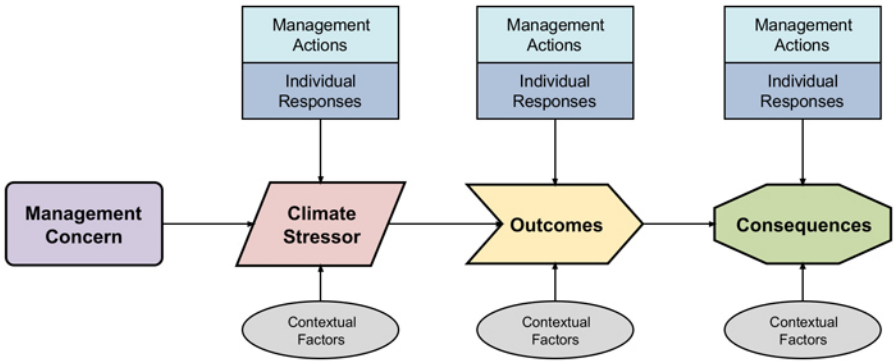


Figure 2-1. Building blocks of a vulnerability-consequence diagram.

In this section, VCAPS diagram concepts (i.e. management concerns) will be **bold** and colored to correspond with the diagram colors. When examples are given for the diagram concepts, they will be *italicized*.

Management Concern

Since there are many ways that climate change can impact a community, a diagram that depicts all consequences and vulnerabilities would be too complicated. To simplify things, we begin by focusing on a specific category of **management concerns.**

You can define a **management concern** to be whatever you want. It is a topic, or an area of focus. We suggest defining these in terms of the resource systems that you manage. For instance:

1. *Stormwater management*
2. *Wastewater management*
3. *Drinking and irrigation water management*
4. *Beach management*
5. *Shoreside infrastructure* (e.g., marinas, piers)
6. *Public health* (mosquitoes, rats, hurricanes, etc.)
7. *Building & zoning requirements* (erosion, elevation ordinances, wind shear ratings, street setbacks, etc.)
8. *Emergency management* (evacuation, fire, rescue, etc.)

Management concern icon:

Climate stressors

Each management concerns can be affected by **climate stressors**. These are events related to climate change that put some kind of stress on the community and its resource system. For instance, climate scientists are predicting that the southeastern USA will experience more rainfall in shorter time periods. We might identify this **climate stressor** as *heavy precipitation*. Heavier precipitation increases the demands on the urban drainage infrastructure. Consequently, *heavy precipitation* is a **stressor** under the management concern category *stormwater.*

List of a few **Climate Stressors** predicted along the Southeastern US Coast:

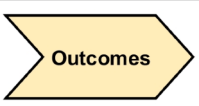
- Accelerating sea level rise (SLR)
- Increased temperature
- More frequent heavy rain events
- More powerful hurricanes
- Higher high tides

Climate Stressor node:

Outcomes

Climate stressors produce **outcomes.** These things happen in the community because of the climate stressor. Specifically, they can be either processes or events that occur in social or ecological systems because of the climate stressor. For example, *run-off* is an **outcome** of the stressor: *heavy precipitation*. Increased run-off also means that *more sediment will enter the stormwater system,* leading to some *drains becoming plugged*. These are more **outcomes**. The reason to distinguish among multiple outcomes is that they suggest different opportunities for intervening in the causal chain with management or individual actions (as defined below).

Outcomes icon:

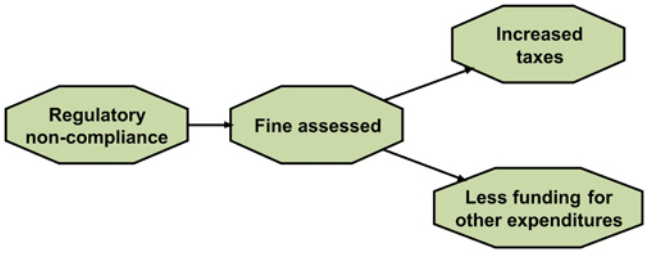


Consequences

Consequences are implications of the outcomes that affect individuals, communities, institutions, or ecosystems. Thus, they are a special kind of outcome. They reflect losses or costs to things that people care about. Examples include:

- *Death or injury*
- *Damage to structures*
- *Cost to town government*
- *Loss of income*

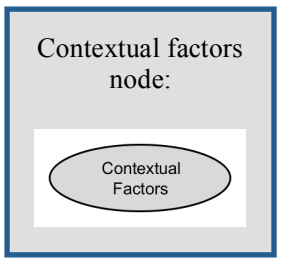
Consequences node:

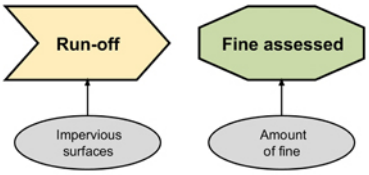


Harmful **consequences** can result from direct exposure to the event/condition or through indirect pathways, called secondary or tertiary **consequences** in this model (not shown in Figure 1). For instance, being in non-compliance with regulations can lead to a *fine*, which is a **consequence**. This cost to the town government can mean *increased taxes* or *less funding for other expenditures*, which are subsequent **consequences**. Attention to pathways of consequences is particularly important for coastal communities where impacts have repercussions beyond coastal hazard management to long term planning for land-use, community social services, transportation, insurance, and community bond ratings. Of course, there may also be beneficial **consequences**, such as economic benefits of job creation after a hazard or revised land-use plans that improve stormwater management.

Contextual Factors

Many things in the local physical or social environment help shape the form or extent of a climate stressor, outcome, or consequence. We call these **contextual factors.** They can be anything that makes a climate stressor, outcome, or consequence bigger, smaller, better, worse, or simply different. For example, the size of the outcome *run-off* is determined by the *amount of impervious surface*, which is a **contextual factor**. The amount of impervious surface is a quality of the physical infrastructure. **Contextual factors** also apply to consequences. A **contextual factor** that helps shape the consequence of a fine is the actual amount of the fine. Therefore, *amount of fine* is one **contextual factor**.



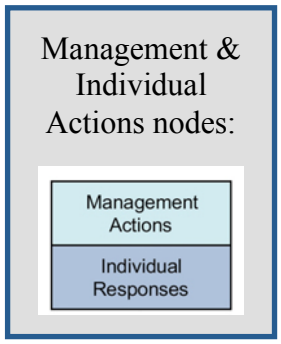


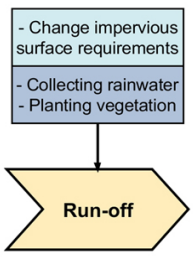
Management Actions & Individual Actions

Of course, leaders in a community care about all of these outcomes, and it is their job to take steps to alleviate or prevent them from happening. We refer to town planners, town administrators, wastewater system managers, etc. as "managers. Proactive or reactive actions of managers that are intended to mitigate climate stressors, outcomes, or consequences we call **management actions.** In the diagram, a **management action** appears as a node directly above a climate stressor, outcome, or consequence (with an arrow connecting the two nodes).

Individuals also take proactive or reactive actions to mitigate climate stressors, outcomes, or consequences. We call these **individual actions**. These are not necessarily actions required by law. While they maybe required, they can also be either spontaneous or planned actions that people take with the purpose of interrupting a chain of events that leads to an undesirable consequence.

Similar to management actions, **individual actions** appear in a diagram as a node directly above a climate stressor, outcome, or consequence (with an arrow connecting the two nodes).





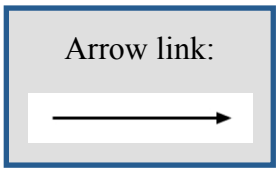
For example, the outcome *run-off* can be prevented or reduced by *increasing the amount of permeable surfaces*. A local ordinance that requires new development to maintain a certain amount of permeable surface is an example of a **management action**. Likewise, homeowners can make landscaping choices that minimize the outcome *run-off* by *planting certain plants, anchoring the soil, and collecting or absorbing rainwater*.

We want to emphasize that **management actions** and **individual actions** can be made at any point along the sequence that joins climate stressors, outcomes, or consequences,

as shown in Figure 2-1. Those that are meant to affect a climate stressor or outcome we call upstream actions, while those that are meant to affect consequences we call downstream actions. This means that there can be multiple opportunities to block or change the character of a consequence. While there are strong benefits associated with blocking the causal chain early on (i.e., upstream), there can also be significant costs to doing this. For instance, economic losses from coastal storms can be mitigated by moving housing further from unprotected shores, but this is costly and highly controversial. Likewise, allocating too many hazard management resources at the far right side of the diagram (i.e., downstream) is also unacceptable. Reimbursing people for economic damages does not adequately compensate people for all losses they might experience. In conclusion, hazard management strategies should be considered at multiple points in the causal chain.

Arrows

Arrows (referred to as "links" in VUE) connect management concerns, climate stressors, outcomes, or consequences, contextual factors, management actions, and individual actions. They link two elements of the diagram to represent what is being influenced.



When climate stressors, outcomes, or consequences are connected with **arrows**, the **arrows** represent cause-effect relationships. For example, sea level rise causes flooding. Erosion causes property damage.

Management actions and individual actions are linked to concepts such as climate stressors, outcomes, or consequences with **arrows** to show what the actions are intended to change.

CHAPTER 3: FACILITATING A VCAPS PROCESS

While a community could conceivably use VUE to create their own VCAPS diagrams, to date VCAPS participants have unanimously preferred to have an outside facilitator lead the process. Participants have cited many reasons for outside facilitation, but common explanations include that the facilitator is better able to keep the group to the diagram structure, that participants are better able to share conflicting opinions, and that the outside information members of a facilitation team provide on climate science are valuable for the discussion. The following chapter describes the key roles of a VCAPS facilitation team and gives you tips on conducting a diagramming session.

Planning a VCAPS session

VCAPS diagramming sessions that result in the development of possible scenarios are led by a facilitation team, and participants typically consist of 6-12 community decision-makers. The diagramming session is just one part of the VCAPS process. Elements of a typical VCAPS process include:

- Researching background information on the community
- Contacting key informants to identify participants and meeting logistics, including the number of diagramming sessions necessary
- Conducting the VCAPS diagramming session(s)
- Writing narrative descriptions of diagrams
- Validating diagrams and narratives

The VCAPS diagramming session is a meeting or series of meetings where the facilitation team guides participants through making a diagram of the consequences of climate change for an issue of local concern and the decisions that can be made in response. A VCAPS session includes:

- Introduction to VCAPS
- Presentation about locally relevant climate stressors
- Primer on VCAPS building blocks
- Interactive diagramming time
- Reflections and wrap-up

The VCAPS development team has found that it takes about two- to two-and-a-half-hours for participants to diagram one management concern, depending on the issue. There is a learning curve for participants, so the first diagrams a community makes tend to take longer. Add to this a typical hour for the introductory material, and time at the end to re-cap and get feedback, and it takes about four hours for a community to complete its first VCAPS diagram from start to finish. Subsequent management concern diagrams are typically faster, because participants are familiar with the VCAPS process. Depending on the complexity of the issues, another session may be enough for completing an additional diagram.

For a single management concern, the VCAPS development team generally conducted two two-hour VCAPS sessions, held over two days (see Appendix B). In the first meeting, all introductory material is presented, and the participants spend about 45 minutes to an hour to start

a diagram. On the second day, the participants finish the diagram, and then have time to reflect and wrap up. This two-day method gives the facilitation team more time overnight to review notes, make additions or subtractions to the diagram created, and rearrange VCAPS building blocks to make the diagram clearer. It also allows participants a chance to go home and consider what they have learned, getting a fresh start in the second meeting. One town that participated in VCAPS suggested that a single half-day session, with an hour break to allow the facilitation team to examine the diagram, might be easier to schedule in towns with a large volunteer staff. Careful consultation with VCAPS participants will help you determine which approach is appropriate in each place.

Who should a VCAPS session include?

A critical first step is to discuss the VCAPS process with a key informant. Town managers or administrators are often helpful in this role. This key informant will help you to identify local issues and potential participants. He or she will also help you to learn about local issues that are of concern; this will be help you tailor the climate information you present to these local contexts.

The sessions are most comprehensive when they are attended by key decision-makers for a town as opposed to general community residents without specific management expertise. If you know before the VCAPS session begins what management context the group needs to discuss, this narrows down the list of potential participants. For example, a town may come to you with a stormwater management project that they want to make more climate-resilient. In this case, you would assemble the key staff – such as stormwater managers, town administrators, planners, and engineering consultants – involved in making stormwater management decisions.

VCAPS facilitation teams

There are five roles that members of a VCAPS facilitation team must fill. Although it is possible to conduct a VCAPS session with two people filling all of these roles, we recommend at least a four-person team. Team roles and responsibilities are described below.

1. *FACILITATOR*: This person is responsible for guiding the group through the VCAPS diagram structure. The facilitator introduces the group, sets ground rules, and describes the VCAPS process and diagram elements. She guides the group through selecting a management context, getting group members to decide on applicable climate stressors, and soliciting the resulting outcomes and consequences to fill out the chains. She also leads the group through describing the management and individual actions that are applicable, as well as asking for contextual factors.

2. *SCRIBE*: The scribe is responsible for listening to the discussion and capturing ideas on the VCAPS diagram in real time. This person sits behind the laptop and works to add nodes and links while the participants discuss. Sometimes this is easy – a participant will give a clear indication that a node is needed. Other times, discussion may be more diffuse, requiring the scribe to add a node to the diagram and ask the participants to clarify if the node he has added captures what the participants were trying to describe.

3. *CLIMATE EXPERT*: In many cases, participants are not familiar with the impacts of climate change. After the facilitator gives the basic introduction, the climate expert gives a brief 20-minute presentation on potential local impacts of climate change. The presentation should also include discussion of the limitations of global and regional assessments for understanding potential local impacts. The VCAPS development team was fortunate to have a climate expert also trained in facilitation, so during the VCAPS sessions we conducted in McClellanville, SC, the facilitator doubled as the climate expert.

4. *ASSISTANT SCRIBE*: Once participants get the hang of the VCAPS structure, they may be very eager to provide their input. A good facilitator can reduce some of the pressure on the scribe to capture a lively discussion, but it helps to have someone sitting next to the scribe who can help keep track of participants' suggestions and clarify with the scribe where nodes and links should go.

5. *NOTETAKER*: This person documents the conversation as much as possible, helping the group to recall previously discussed material as needed. Having a notetaker relieves the facilitator from the need to take more than cursory notes, allowing her to focus on managing the session instead. Careful notes can also be useful for the scribe while cleaning up a diagram after the session to be sure nothing was missed. The notetaker could also function as the assistant scribe. However, an assistant scribe playing this dual role must be careful about getting absorbed in note taking, because it is easy to miss facial expressions or other visual cues that may help clarify the diagramming needs for the scribe.

Facilitation tips

Ultimately, how you facilitate a VCAPS process depends on your facilitation team and the participants. Appendix B includes a sample participant agenda, as used by the VCAPS development team in McClellanville, SC. Chapter 4 will lead you through an example of how to solicit information for a VCAPS diagram. The VCAPS development team has several tips that you may find helpful:

- Providing coffee and possibly food is a nice gesture. One participant suggested healthier foods (rather than your standard bagels and muffins) might be better in case your participants need to be conscious of diets.

- Make sure that the scribe and the computer/projector set up do not interfere with the facilitator's line of sight with the participants or the participants' view of the projected VCAPS diagram. Seat the assistant scribe next to the scribe, but if you have a notetaker, arrange to have him sit closer to the participants.

- Make sure the climate expert is aware of the audience's backgrounds and presents without jargon. Explaining the difference between climate and weather is a good starting point – this clarifies confusion and helps them use something they mostly understand as a foundation on which to scaffold the new information presented. Discussions of *observed local* changes are more relevant to town management than impacts in remote parts of the globe; this also helps diffuse side debates on whether

climate change is occurring. There is little need to explain scientific concepts like the greenhouse effect or radiative transfer – the impacts matter most to communities. When discussing climate scenario projections, near-term impacts (climate variability over the next 20 years) are easier for participants to relate to than projections for 2100. Ensure that the expert is brutally honest about uncertainty in projections, i.e., how confident scientists are in what the impacts will be. To date, VCAPS participants have appreciated candor about uncertainty while still understanding that climate variability and change pose a risk to their communities.

- If you have not already worked with your key informant to define the first management concern you will have the group diagram during the VCAPS, you will need to solicit it from the group. Ask the participants what their top concerns are for their town given the climate information they have just learned about. Many times consensus jumps out immediately about the first issue to diagram. If consensus is not emerging, multi-voting (writing the issues on a pad of paper and giving sticky dots to participants to select their top three choices) may help. If they need advice on what types of issues to diagram, suggest starting with a clear-cut issue that draws on the expertise of as many people in the VCAPS group as possible.

- Judge the group dynamic carefully in the first few minutes of diagramming to determine participants' learning curves with the VCAPS structure and their comfort with each other. In the VCAPS development team's Sullivan's Island sessions, the facilitator stuck to questions that filled out the causal chain structure, as described in Chapter 4. However, in McClellanville, participants needed more clarification on the process. In that case, the facilitator adjusted her tactic to allow slightly more free form brainstorming for the first session. During the second session, she held the group more tightly to questions that followed the VCAPS structure.

- Encourage the group to identify outcomes and consequences first, and then return to contextual factors and management actions later.

- Do not allow the participants to skip too many intermediate outcomes or consequences. You do not want to risk missing the opportunities to document management actions that come with these intermediate steps. If the participants seem to be skipping from outcomes to consequences quickly, probe for the intermediate steps (see Chapter 4 for an example of this).

- Make sure the scribe saves the diagram early and often. In VUE, you can save quickly during a pause in the conversation by using the keyboard shortcut "Cntl+S." If using the multi-day format for sessions, you may wish to make a copy of the file for the second session and edit from there – this allows you to compare the progress made in the diagram at the end of each diagramming session with the final product.

- Do not worry about getting the node sizing, formatting, or spelling correct as the scribe is diagramming. Participants tend to be forgiving of typos while the diagram is in process, so it is a higher priority to capture everything the group is saying than to have the diagram look perfect. Correct mistakes during lulls in the conversation or after the diagramming session is over.

CHAPTER 4: TUTORIAL

This chapter will lead you through the process of creating a diagram. The example we use is for the **management category** of *stormwater.* We lead you through the process of making a relatively simple diagram. After grasping the basic process, you can make more complicated diagrams that better suit your needs and situation.

The goal of a diagram is to:

- Effectively gather and summarize the wealth of information, knowledge, and experience that exists within the town.
- Stimulate thinking and conversation about how to manage consequences by taking upstream or downstream actions.
- Aid in future decision making.

One of the challenges of making useful diagrams is to figure out what **climate stressors, outcomes, consequences, management actions, individual actions, and contextual factors** to put in the diagram. We provide some advice on how to do this, but experience is the best teacher.

> *Make everything as simple as possible, but no simpler.*
>
> Albert Einstein

The best piece of advice is that famous statement by Einstein: that everything should be as simple as it can be, but no simpler than it needs to be. We recommend that you:

- Start simple; make the diagram more complex gradually.
- Begin with a **management category** and a **climate stressor**.
- Start with the **outcome** that follows most immediately from the **climate stressor**.
- Include only **outcomes** and **consequence**s that can be modified by **management actions** or **individual actions**

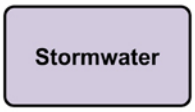
This tutorial is organized in several sections. We will start by defining a **management concern** and a **climate stressor**. Then **outcomes** and **consequences** will be added. To "localize" the diagram, **contextual factors** will then be defined and added to the diagram. Finally, **management** and **individual actions** that can be taken to mitigate adverse consequences from the climate change stressor will be added to the diagram, thus "completing" a diagram to represent a vulnerability-consequence scenario.

In this section, VCAPS diagram building blocks (i.e. management concerns) will be **bold** and colored to correspond with the diagram colors. Examples that are given to build the sample diagram will be *italicized*.

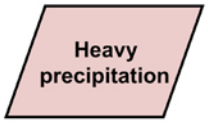
Start with the management concern and the climate stressor

For the following steps, you will need to be familiar with how VUE works. Begin by opening the VUE program.

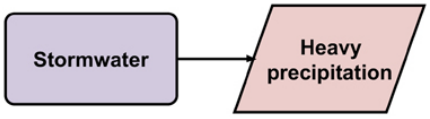
- First, create a node for the group's chosen **management concern**. One way to do this is by pre-loading the different "building block" nodes, as described in Chapter 1. If you did this, then select, copy, and paste the **management concern** node in the template. To change the text, click on the node, select the text, and type over it. For this example, enter *stormwater.*



- Then, add a **climate stressor**. Ask the group which of the climate stressors they learned about are applicable to the management concern. Here, you may want to allow the climate expert to interject to be sure the group stays within the bounds of reasonable expectations of impacts. For this example, we are going to begin with the stressor *heavy precipitation.* To insert this, move the cursor back to the template nodes, select the **climate stressor** node, copy, and paste it into the workspace where you want it – just to the right of the *stormwater* node. Click on the text to change it from "label" to "*Heavy Precipitation*."



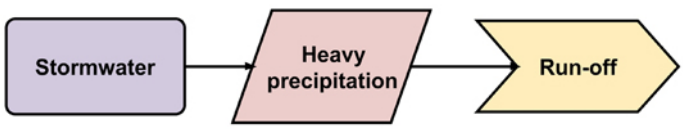
- Finally, connect the **management concern** node to the **climate stressor** node by drawing an arrow link between them. Do this with the Link Tool within VUE. You can link two nodes by selecting the Link Tool, then left clicking in one node and dragging the mouse into the second node. When the second node turns green, release the mouse button and the nodes are linked.



Add Outcomes

After the **management concern** and the **climate stressor**, it is time to add **outcomes**. There are many **outcomes** associated with *heavy precipitation*, but ask the participants, "Why do you care about heavy precipitation?"

- Ask the group to think about things that are going to cause problems for the town. *Run-off* is one of the most immediate outcomes of heavy precipitation. Add an object representing this outcome, change the text, and connect the previous shape by following the same procedure as with the previous two objects.



TIP

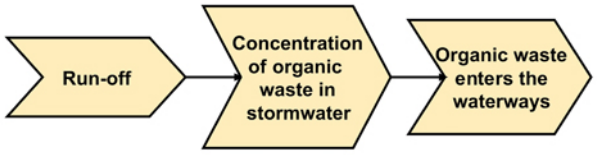
To figure out what node to put next, ask the group, *"Why does the community care about X?"* Follow this up with the question: *"How does this happen?"* And: *"Are there opportunities to control or manage X?"* Then, cross-examine the participants to make certain there are no intermediary steps missing.

Other outcomes result from *heavy precipitation* too. Participants may bring up *flooding* or *erosion*, for example. While both of these are important outcomes, they need to be preceded by the outcome of *run-off* because managing *run-off* is an important way to avoid *flooding* or *erosion*. If we simply drew a diagram that went from *precipitation* to *flooding*, we would be ignoring the opportunities the community has to manage floodwater.

At this point, the diagram could take several different directions. Ask, "Why should we care about *run-off*?" They may answer that *run-off* can lead to: *flooding of roadways; erosion; increased treatment volume for wastewater treatment plant*; or *movement of organic waste into waterways*. Now we need to choose which of these problems the group to focus on. The overall goal is to build a diagram that includes all the important pieces, but it is helpful to focus on one pathway of the diagram at a time. If the group is unsure of which to pick first, the facilitator can make an executive decision which pathway to pursue.

- For this example, the group elects to focus on the *movement of organic waste into waterways* (like pet waste, petroleum products, and fertilizer). Strong rain events can push a large amount of organic material into the drainage system and waterways. Create a new node to represent this outcome, but do not have the scribe connect it to run-off yet.

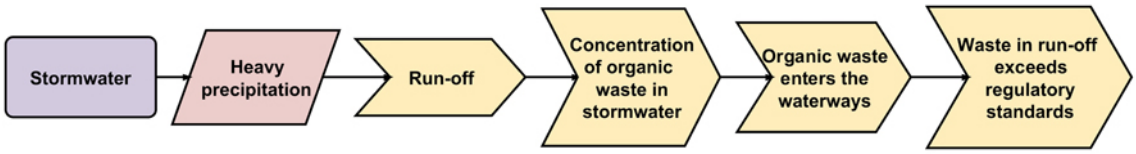
- Now ask them, "How does this happen?" How does run-off move pollutants into the waterways? They respond that first, it gathers pollutants into the stormwater, so in the diagram this outcome, *concentration of organic waste in stormwater*, actually precedes the outcome, *organic waste enters the waterways*. Have the scribe create a new node to represent the new outcome and place in between the other two outcomes to reflect the order of events. Now connect these three outcomes into a causal sequence using arrows.



The reason for distinguishing these two steps is because the more refined the causal the chain is, the easier it will be to envision and insert **individual** and **management actions**. There is more discussion about inserting individual and management actions later in this tutorial.

- After concentrated waste enters the waterways, there is one more outcome that is important to include. Ask, "Why care about concentrated organic wastes in waterways?" Environmental regulators will care about this outcome. One participant responds that is possible that the *organic waste levels in the run-off exceed regulatory levels*. Add this outcome to the diagram and link it with an arrow.

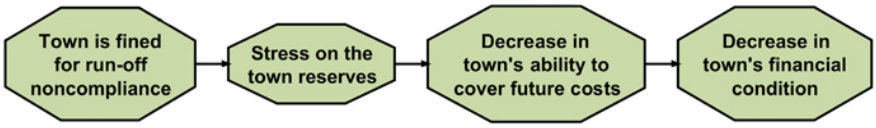
With this final node, we have completed the chain of **outcomes** that need to be included in this diagram. The four **outcomes** mark significant moments in the series of events starting with the **climate stressor**, *heavy precipitation*. So far, the entire diagram looks like this:



Continue by adding Consequences

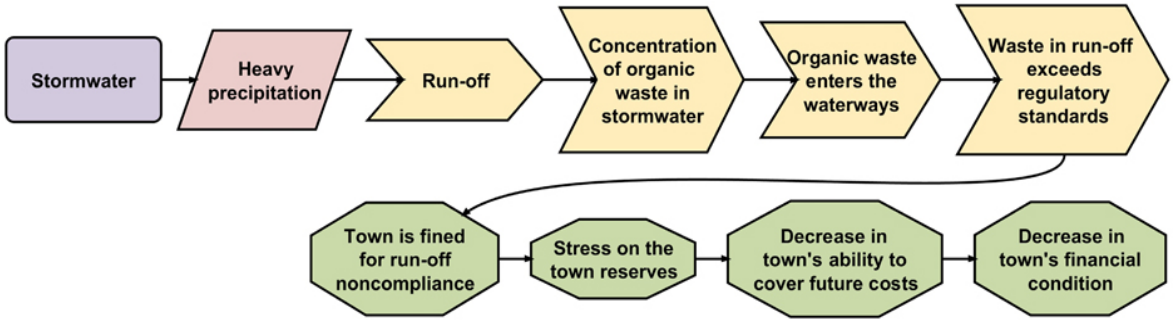
Consequences are special types of **outcomes**. To decide if something is a **consequence**, ask, "Why does the community care about this?" **Consequences** are implications of the **outcomes** that affect individuals, communities, institutions, or ecosystems. They exert some sort of loss or cost to things that people value. In making this tutorial, we are assuming that the people creating a VCAPS diagram will be mainly concerned with things like public safety and costs to a municipality. Most of the **consequences** we address here can be fundamentally traced to these values.

- Why care if the run-off contains levels of organic wastes that are over regulatory limits? The participants state that an individual might care out of concern for the natural environment and a municipal authority may be worried that exceeding regulatory limits may lead to *fines for non-compliance*. The fine assessed to the town is not the final **consequence**. Now the town must find a way to pay for the fines, which will further put a *stress on the town's reserves*. This stress then *decreases the town's ability to cover future costs*, which then *decreases the town's financial condition*. Add each of these **consequences** to your diagram, and arrange the nodes so that the series of consequences looks like this:



While this may seem overly detailed, the more refined the diagram is with each **outcome** and **consequence**, the easier it will be to determine **individual** and **management options** and the **contextual factors** that matter.

The entire diagram should now look like this diagram (note: your diagram may progress straight across the screen; we have added a curved arrow and stacked our diagram for viewing in this guide):



Localize the diagram with Contextual Factors

After detailing the general sequences linking a **climate stressor** to **outcomes** and **consequences** it is helpful to start asking: "What about this place makes us more or less vulnerable to these outcomes and consequences?" Another way of asking this question is, "What makes this (**climate stressor, outcome,** or **consequence**) better, worse, stronger, larger...?" In the terminology of VCAPS, a **contextual factor** is any quality of a place, person, or thing that shapes the way a particular node is affecting downstream objects in the diagram. **Contextual factors** influence the cause-effect relationship.

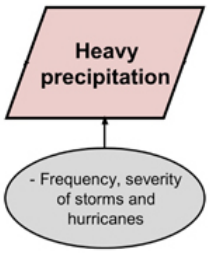
This stage of building a diagram transforms it from depicting a causal chain to representing a particular future scenario. We are getting participants to identify all the qualities of the community or geography that contribute to making **climate stressors, outcomes** or **consequences** worse or better. For example, a town that is at a very low elevation is much more susceptible to all the **outcomes** associated with flooding and high tides than a town on a hill. Towns with a vibrant, diverse economy are less susceptible to economic woes of interruption in business.

It is worthwhile to identify **contextual factors** because they often affect the character of a cause-effect relationship or how well **management** or **individual actions** will work to avoid certain **outcomes** and **consequences**. Sometimes **contextual factors** are something that can be changed, which gives a community some control and help focus and direct management response actions. This will become clearer as we work through this example.

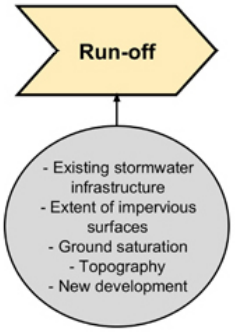
Ask the participants to return to the beginning of the pathway, and work across the diagram from left to right to have them suggest **contextual factors** that shape each **climate stressor**, **outcome**,

or **consequence** along the way. For each node, ask, "What could make this better, worse, stronger, larger...?" For this example, participants tell you:

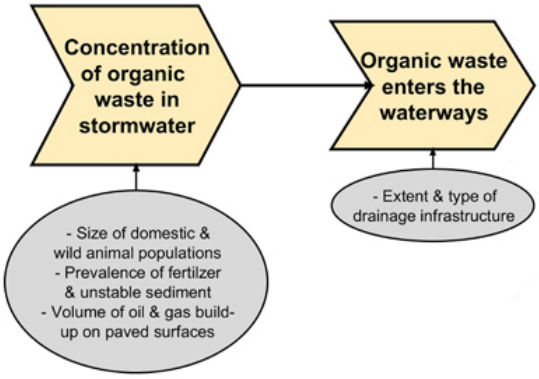
- To begin, the **climate stressor** *heavy precipitation* is shaped by changes in weather. For example, the *frequency and severity of storms and hurricanes* is estimated to increase for the southeastern US. Even if this is something we have no direct or immediate control over, taking note of these conditions helps clarify what contributes to shaping this stressor. To add this to the diagram, the scribe inserts the **contextual factor** node as was done for the other nodes, changing the text and using an arrow to connect it to *heavy precipitation*. As a matter of convention (and to keep the diagrams from being too cluttered), we place **contextual factors** directly below the node that is being influenced.



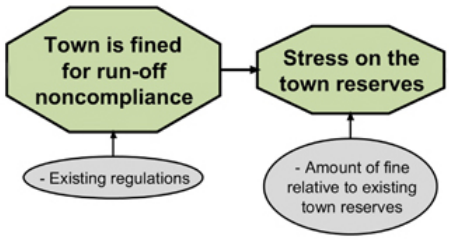
- Moving to the next node in the causal diagram, the outcome *run-off* is strongly shaped by local conditions. There are many possible attributes that shape run-off, including; *topology of the land, permeability of the surfaces, saturation of the ground, and existing infrastructure like roads and stormwater*. The final **contextual factor** that we include in this tutorial is *new development***.** This is a vague factor, more meant as a placeholder for a number of variables that would influence run-off. The participants' logic here is that new construction may disrupt historic patterns of run-off, creating novel conditions. Add these **contextual factors** as described above.



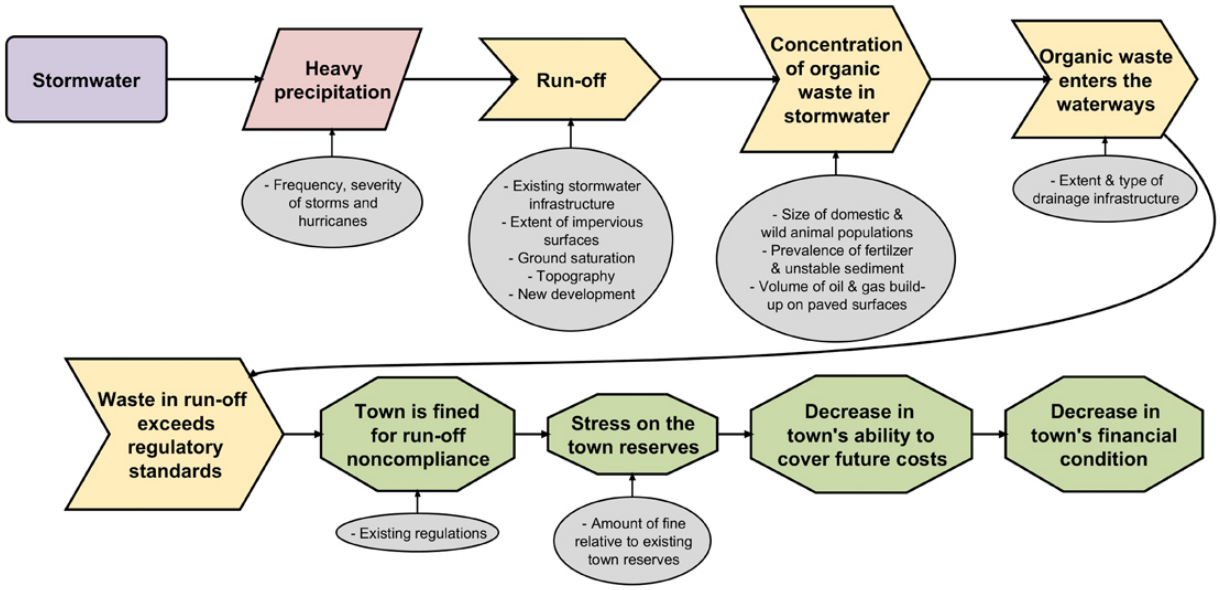
- The next **outcome** describes the *concentration of organic waste in stormwater*. The concentration is dependent on the amount of waste, which is related to the *size of animal populations*. It is also important to consider other inputs of organic waste such as *sediments, fertilizers and the oil and gas that builds up on roadways and is mobilized in a heavy rain*. The following **outcome** is *organic waste enters the waterways*. This is shaped by the *location and type of drainage discharge points*. Add these **contextual factors** to your diagram too.



- There are **contextual factors** that also shape the **consequences**. Whether or not a town is fined depends on the *existing regulations* and the impact of the cost to the town depends on the *size of the fines relative to existing financial reserves*. To complete the addition of **contextual factors**, add these too.



Your diagram should now look like this:



Complete the diagram by adding Management and Individual Actions

The final step in making a diagram is to highlight actions that can be taken to prevent or change **climate stressors, outcomes, or consequences**. After you have thought about how **climate stressors** lead to **outcomes** and **consequences**, as well as how local conditions affect these relationships, you will be in a better position to ask participants, "What can the municipality or others do to prevent or mitigate these outcomes and consequences?" Of course, participants may have had some ideas along the way of constructing the diagram – the scribe may have chosen to add these immediately, or the facilitator may have taken note of these ideas on a pad or whiteboard to return to later. Now that **contextual factors** have been added to "localize" the diagram, we will complete the remainder of the diagram.

Not every node in the chain of events can be modified by someone's actions, but some have very important possible actions. Some of the **management actions** are less obvious than others. For instance, regulatory non-compliance could be modified by changing the regulations even though this may take years and the time and effort may well be beyond the ability of any single municipality. This also illustrates the benefit of thinking about both the short-term and the long-term. We only mention it in order to stimulate your thinking. Allow participants to be creative and brainstorm. You can throw out unusable ideas later on. If a long-term strategy is important to their community, make sure that you include it in the

TIP

Remind the group to think about long-term and short-term actions. For each node in the diagram, have them brainstorm a number of different possibilities. You can always throw away the less helpful ideas later.

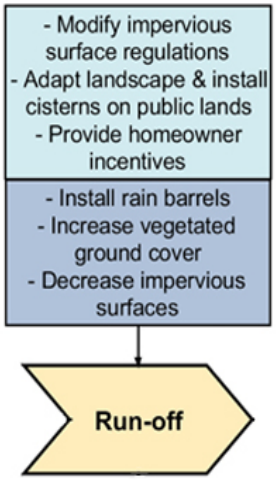
diagram. However, the participants might decide that it is more productive to focus on near-term actions they can take to manage climate-related hazards that are more under their control.

For each node in the diagram, ask the group:

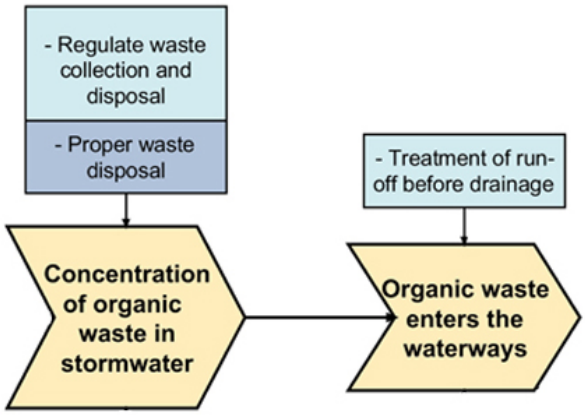
- What IS government doing to prevent or mitigate this?
- What COULD government do to prevent or mitigate this?
- What ARE individuals doing to prevent or mitigate this?
- What COULD individuals do to prevent or mitigate this?

As a matter of convention, we place **management action** and **individual action** nodes above the **outcome** or **consequence** that they seek to address, and we link them with arrows. The light-blue boxes contain the management activities that institutions do. The dark-blue box is an activity that individuals can do.

- For example, there are many things that can be done to mitigate run-off. A municipality can: *pass regulations mandating that properties limit their impervious surfaces to a certain percentage of the total lot size; require property developers to install cisterns to hold run-of; or provide incentives for homeowners to take actions to collect and hold stormwater on site*. There are also actions that individual homeowners can take. They can: *install rain barrels; increase their vegetative cover; or decrease the impervious surfaces on their lots.* Take a minute to add these to the diagram in the light and dark blue shapes, using dashes to make it into a list if preferred.

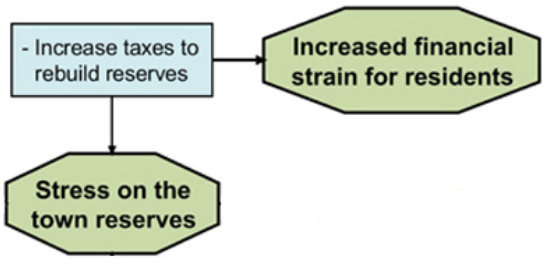


- Now go on to the next **outcomes**. In the section on **outcomes,** we explained that it is important to distinguish between different **outcomes** because, as more steps are elaborated, there is more opportunity to see what **management actions** and **individual actions** are possible options. Have the group consider the **outcomes** *concentration of organic waste in stormwater* and *concentrated waste enters waterways*. The reason for distinguishing these two steps is that there are many different sources of organic waste. For example, a participant may consider pet waste on the ground. In a *heavy precipitation* event, pet waste can be transported by the run-off into a waterway. It is possible to intervene in two places here. First, the waste could be better controlled in the first place so that it is not on the ground near waterways. You can add this to your diagram as both a **management action** called *regulate waste collection and disposal* and an **individual action** called *proper waste disposal.* Second, there are landscape management designs that can help slow run-off and prevent suspended materials from entering the waterway.

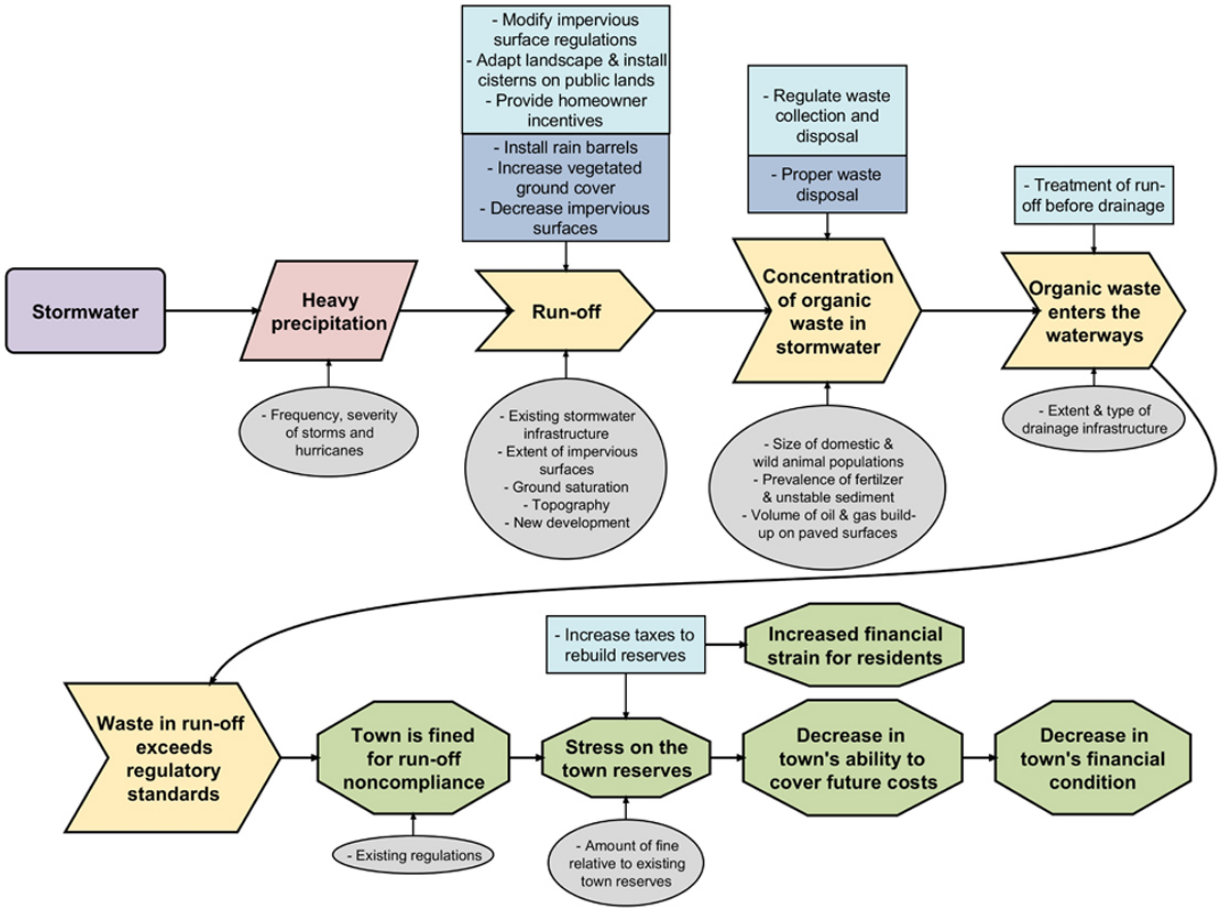


For instance, plants can impede the movement of materials in run-off. You can add this to your diagram as a **mangement action** called *treatment of run-off before drainage.*

- Another action that could be inserted into the diagram relates to the **consequence**, *stress on the town reserves.* The town could *increase taxes to rebuild its reserves* so insert this into the diagram. Now, there are cases when a **management action** or **individual action** can create new **outcomes** or **consequences**. This can be represented in the diagram by placing an **outcome** or **consequence** object to the right of the **management action** or **individual action** and connecting it with an arrow. The **management action**, *increase taxes to rebuild reserves*, is an example of an action that will create additional **consequence**. If taxes are increased to rebuild reserves then the residents will be paying the price, resulting in *increased financial strain for residents*. This could lead to another chain of events, but for the sake of this tutorial, we will stop here.



The complete diagram is shown on the following page. The actions listed are limited only by the scope with which the prompting questions above are approached. This tutorial only serves to make suggestions and create an example.


- Modify impervious surface regulations
- Adapt landscape & install cisterns on public lands
- Provide homeowner incentives
- Install rain barrels
- Increase vegetated ground cover
- Decrease impervious surfaces
- Regulate waste collection and disposal
- Proper waste disposal
- Treatment of run-off before drainage
Stormwater
Heavy precipitation
Run-off
Concentration of organic waste in stormwater
Organic waste enters the waterways
- Frequency, severity of storms and hurricanes
- Existing stormwater infrastructure
- Extent of impervious surfaces
- Ground saturation
- Topography
- New development
- Size of domestic & wild animal populations
- Prevalence of fertilzer & unstable sediment
- Volume of oil & gas build-up on paved surfaces
- Extent & type of drainage infrastructure
- Increase taxes to rebuild reserves
Increased financial strain for residents
Waste in run-off exceeds regulatory standards
Town is fined for run-off noncompliance
Stress on the town reserves
Decrease in town's ability to cover future costs
Decrease in town's financial condition
- Existing regulations
- Amount of fine relative to existing town reserves

Conclusions

The examples that we used in this tutorial were meant to be simple and perhaps obvious. Our purpose has been to clarify how to think through helping a group make a VCAPS diagram during a session.

The goal of a diagram is to:

- Effectively gather and summarize the wealth of information, knowledge, and experience that exists within the town.
- Stimulate thinking and conversation about how to manage consequences by taking upstream or downstream actions.
- Aid in future decision making.

Diagrams should be thought of as living documents. The diagrams are representations of scenarios, or possible futures, developed by the participants in a VCAPS session. There is no "right" or "wrong" scenario, just ones that are more or less likely to reflect what we know now as possible futures and more or less helpful when thinking about how to meet future challenges. A "good" diagram and the scenario which it represents is one that will help communities think and inform their decision-making, not necessarily one that will prove – in the future – to have been accurate.

As a community changes, conditions change, or new collaborators add their expertise, the diagram can be changed or updated to reflect new information. In a way, the diagrams can serve as a picture of how a community works. They highlight the main problems and the capabilities of a community to manage these problems.

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SERI Project webpage: www.seri-us.org/content/coastal-adaptation-planning

NOAA SARP webpage: www.climate.noaa.gov/cpo_pa/sarp

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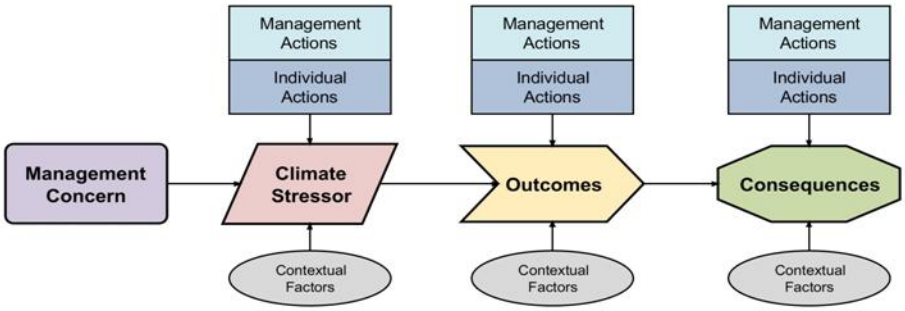
Appendix A

Building Blocks of VCAPS Diagrams



Element	Definition	Purpose	Examples
Management Concern	An issue or topic of concern for managers & decision makers.	Organize diagrams based on issues of common concern.	Stormwater Wastewater Erosion
Climate Stressor	An event or process that may be aggravated by climate change.	Identify the dominant physical event(s) or process(es) affected by climate change that impact the management concern.	Heavy precipitation Abnormally high tides Sea level rise (SLR)
Outcomes	An additional process(es) or event(s) that occurs in socio-logical systems as a result of the climate stressor.	Identify the process(es) & event (s) that occurs as a result of the climate stressor & lead to consequences.	Runoff (outcome) occurs as a result of heavy precipitation (climate stressor).
Consequences	Implications of the outcome(s) that affect individuals, communities, institutions or ecosystems.	Identify the point in which the outcome(s) affect individuals, communities, institutions, or ecosystems.	Harmful algal blooms (outcome) lead to contaminated shellfish beds (outcome), consumer illnesses (consequences) & loss of sales (consequences).
Management Actions	Protective or reactive actions of managers that are intended to mitigate climate stressors, outcomes or consequences.	Identify the actions that can be taken by managers to reduce or eliminate the consequences of the stressor(s).	Modify impervious surface regulations (management action) to minimize runoff (outcome).
Individual Actions	Protective or reactive actions of individuals that are intended to mitigate climate stressors, outcomes or consequences.	Identify the actions that can be taken by individuals to reduce or eliminate the consequences of the stressor(s)	Homeowners plant vegetation in strategic places on their property to help absorb rainwater & anchor the soil.
Contextual Factors	Characteristics of the social or physical environment that affect the magnitude of the climate stressors, outcomes, or consequences.	Identify the site specific characteristics that affect the magnitude of the climate stressor, outcome or consequence.	Severity of runoff is influenced by topography, impervious surfaces & existing stormwater infrastructure.

Appendix B: Sample Participant Agenda

Schedule of meetings with McClellanville for project on

"*Informing coastal management adaptation planning and decision-making for climate change using an interactive risk-based vulnerability assessment tool*"

A focus on McClellanville

In this project we will work with the coastal community of McClellanville, South Carolina to characterize the community's vulnerability to natural hazards that may be related to climate change. Such knowledge is more useful to local planners when it is created with input from residents and community leaders. Modeling and scenario-building efforts work best when they are focused on the information needs of decision makers.

Two meetings are being held to introduce local government officials and staff in McClellanville to a computer-based diagramming tool and to produce vulnerability and consequence scenarios related to coastal management for climate change and associated hazards. These scenarios will be used to identify strategies to mitigate social, economic, and environmental impacts.

The dates and purposes of the two two-hour meetings are:

31 March, 10am – noon: In the first meeting we will introduce the project goals, the meeting goals, and the benefits of the computer-based diagramming tool for building scenarios of climate change and adaptation. This will be followed by a brief overview of the state of the science on climate change in the region. During the second hour we will develop a scenario about consequences, vulnerabilities, and adaptation strategies to a climate stressor that is selected by the meeting participants.

1 April, 1 – 3 pm: During the second meeting we will revise the scenario developed in the previous meeting. If time permits, we will develop a second scenario that interests meeting participants. We will conclude with a discussion of how the tool may be used in the future in McClellanville and gather of feedback from the participants about the scenario building process.

Appendix C: Conceptual foundations of VCAPS

The causal structure of hazards

A causal model – or framework – of risks encourages people to conceptualize and examine threats and their consequences as a causal sequence resulting from a stream of choices and activities (Kates, Hohenemser, and Kasperson 1985, Bowonder, Kasperson, and Kasperson 1985, Clark et al. 1998). The stream of choices and activities that culminate in undesirable consequences can be interrupted and blocked at various stages by management activities. *The purpose of using the causal model as part VCAPS is to focus people's attention on decision-relevant variables or concepts (e.g., driving forces of vulnerability) related to adaptation.*

A simple causal chain is represented as a flowchart of boxes with arrows showing how one thing causes another, as shown in Figure 1.

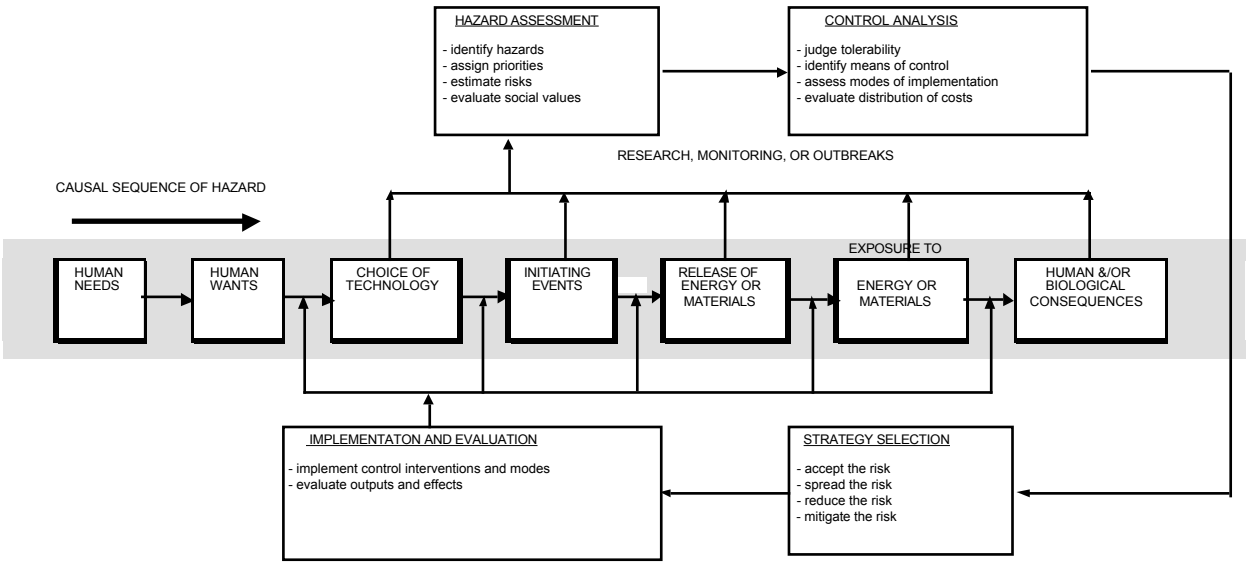


Figure 6: Flow Chart of Hazard Management (Source: Kasperson, Kates, and Hohenemser 1985)

In the context of VCAPS, a causal chain starts with a concern or stressor on the left side, as shown in Figure 2. At the end of the diagram, on the far right side, are consequences we seek to avoid, for example, loss of life, economic costs, decline of trust in government, and so on. To avoid these outcomes, hazard managers seek to interfere by blocking intermediary outcomes in the causal chain. These management actions are captured in the boxes along the top of Figure 2.

While there are strong benefits associated with blocking the causal chain early on, there can also be significant costs to doing this. For instance, economic losses from coastal storms can be mitigated by moving housing further from unprotected shores, but this is costly and highly controversial. Likewise, allocating too many hazard management resources at the far right side

of the diagram is also unacceptable. Reimbursing people for economic damages does not adequately compensate people for the losses they experienced. In conclusion, a good hazard management strategy includes actions at multiple points in the causal chain.

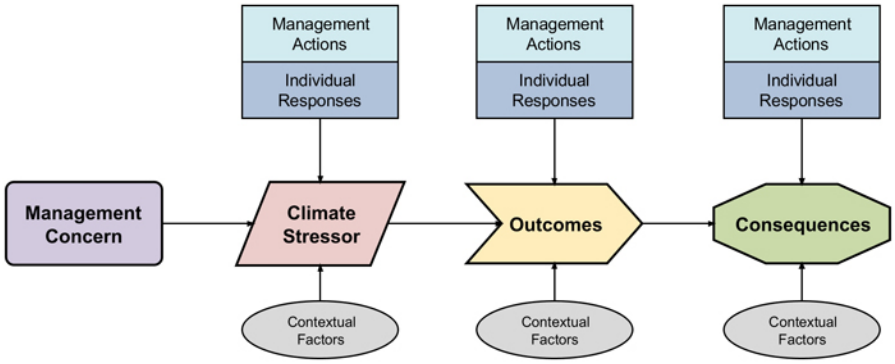


Figure C.1: Basic structure of the VCAPS causal model

The causal model framework we present here has been widely used. For example, It has been used previously to explore differences in understandings of risks among laypeople and technical experts by one of the project participants (Webler et al. 1995), by Tuler and colleagues in studies of visitor and employee safety in national parks (Tuler and Golding 2002, Golding and Tuler 2002, Golding et al. 2002, Machlis et al. 1990), and by other researchers to assess vulnerabilities to methylmercury contamination (Ratick et al. 2004) and coastal storms (Clark et al. 1998).

Vulnerability of coupled human-environment systems

VCAPS supplements the causal chain with information about *vulnerability*. Scholarship on this has developed rapidly over the last quarter century (Dow 1992, Turner et al. 2003). Vulnerability can be defined as the "differential susceptibility to loss from a given insult" (Kasperson et al. 2001: 24). It depends on exposure to a hazard, the sensitivity to harm from the exposure, and the resilience to plan for or cope with the harm. Exposure information is implicit to the original causal model. VCAPS adds information on sensitivity and resilience. Sensitivity information is included as contextual conditions along the bottom of the diagram. There are many things in the physical or social environment help shape the form or extent of a climate stressor, outcome, or consequence. They can be anything that makes a climate stressor, outcome, or consequence bigger, smaller, better, worse, or simply different. That is, they mediate the causal relationships between these different elements in the causal chain. Resilience information is included in VCAPS diagrams by adding data about individual actions (along with management actions) in the boxes along the top of the diagram. These are actions taken to alter the causal sequence so that harmful consequences are minimized.

Integrating vulnerability into the causal chain of hazards improves the ability to characterize and manage impacts in two ways. First, it clarifies that different entities are affected differently by the same exposure. For example, summer tourism businesses have a low susceptibility to

harm from a coastal storm in winter, but retail businesses that serve the permanent population are susceptible anytime during the year. Second, it adds the notion of coping (also called adaptive capacity or resilience). Resilience actions are taken by the affected entities before or during the hazard event intended to mitigate harm. For example, people evacuate town before the storm hits; or they build their homes to withstand expected levels of wind stress.

References

Bowonder, B., Kasperson, J.X., and Kasperson, R.E. 1985. Avoiding future Bhopals, *Environment* 27(7):6-13, 31-37.

Clark, G.E., S.C. Moser, S.J. Ratick, K. Dow, W.B. Meyer, S. Emani, W.Jin, J.X. Kasperson, R.E. Kasperson, and H.E. Schwarz. 1998. Assessing the Vulnerability of Coastal Communities to Extreme Storms: The Case of Revere, MA, USA, *Mitigation and Adaptation Strategies for Global Change* 3:59-82.

Dow, K. 1992. Exploring differences in our common future(s): the meaning of vulnerability to global environmental change. *Geoforum* 23(3), 417-436.

Golding, D. and Tuler, S. 2002. *A Comprehensive Study of Visitor Safety in the National Park System: Final Report*. Prepared for the National Park Service Under subcontract (#GNK756) to the University of Idaho, Cooperative Park Studies Unit, Moscow, ID.

Golding, D., Tuler, S., Krueger, R., and Duda, M. 2002. *An Analysis of Visitor Accident Risk in the National Park System*. Prepared for the National Park Service Under subcontract (# GNK756) to the University of Idaho, Cooperative Park Studies Unit, Moscow, ID.

Kasperson, J. X., & Kasperson, R. E. (Eds.). 2001. *Global environmental risk*. London: Earthscan.

Kates, R, et al. (eds.) 1985. *Perilous progress.* Boulder, CO: Westview Press.

Machlis, G. E., Kasperson, R. E., and Tuler, S. 1990. *A social risk analysis of the Olympic National Park Mountain Goat Removal Project*. Report prepared for Olympic National Park, Port Angeles, WA by the Cooperative Park Studies Unit, University of Idaho, Moscow, Idaho. National Park Service Reference #D-173. 74 pgs.

Ratick, S., Capoccia, S., Dichter, A., Goble, R., Golding, D., Hattis, D., and Tanguay, J. 2004. *Determining the vulnerability of populations to mercury*. Prepared for the US EPA, contract no. XA – 83067901-0. February 9, 2004. Clark University. Worcester, MA.

Tuler, S. and Golding, D. 2002. *A Review of the Literature for a Comprehensive Study of Visitor Safety in the National Park System*. Prepared for the National Park Service Under subcontract (# GNK756) to the University of Idaho, Cooperative Park Studies Unit, Moscow, ID.

Turner, B. I., Kasperson, R., Matson, P., McCarthy, J. J., Corell, R., Christensen, L., et al. 2003. Science and Technology for Sustainable Development Special Feature: A framework for vulnerability analysis in sustainability science. *PNAS* 100(14), 8074-8079.

Webler, T., Rakel, H., Renn, O., and Johnson, B. 1995. A Comparative Analysis of Concerns About Land Application of Municipal Sewage Sludge, *Risk Analysis* 15(3):421-436.