



**CLIMATE  
RESILIENCE  
FRAMEWORK**  
ISET-INTERNATIONAL

# CLIMATE RESILIENCE FRAMEWORK: TRAINING MATERIALS

Series 2: Understanding Vulnerability & Risk





## TRAINING.I-S-E-T.ORG

### The Training Materials Consist of:

- Participant Guides
- Activities
- Supporting Materials: case studies, working papers, tools, and resource links

**Series 1: Establishing Resilience Principles** introduces the Climate Resilience Framework and shared learning dialogue process, and gets lead partners started in the climate resilience planning process.

**Series 2: Understanding Vulnerability** systematically walks lead partners through the steps involved in conceptualizing, designing, and implementing initial vulnerability and climate risk study.

**Series 3: Building Resilience** describes the steps required to identify, prioritize, implement and evaluate actions designed to build climate resilience and provides focused materials on key topics.

### ISET-INTERNATIONAL'S MISSION

To catalyze transformative change toward a more resilient and equitable future. Through research, training, and implementation activities we improve understanding and elevate the level of dialog and practice as society responds to natural resource, environmental, and social challenges. We serve as a framework for equal collaboration among individuals and organizations in the North and South.

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## WHAT IS THE CLIMATE RESILIENCE FRAMEWORK: TRAINING MATERIALS?

The CRF:TM is a set of tools designed to be utilized by a leadership team to help communities and partner organization assess and strengthen their climate resilience.

## OUR APPROACH

The materials provide a roadmap for gathering a team, assessing your vulnerability to climate change, and identifying key actions to take to building resilience in your community. We believe that what matters most in a sustainable process is establishing good working relationships with key stakeholders and decision-makers, and employing the appropriate data to inform your communities decisions.

## EFFECTIVE USE OF THESE MATERIALS

The CRF:TM is intended to be delivered in a workshop format by a trained facilitator. Additional support for facilitators and trainers is available. If you would like to conduct a training based on these materials and require assistance or support please contact [training@i-s-e-t.org](mailto:training@i-s-e-t.org)

## WHERE TO FIND MORE INFORMATION

[Training.i-s-e-t.org](http://Training.i-s-e-t.org)

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# Overview

The Climate Resilience Framework is a conceptual framework for simplifying and analyzing complex relationships between people, systems, institutions, and climate change. The framework helps clarify factors that must be included in the diagnosis of climate vulnerability; it structures the systematic analysis of vulnerability in ways that clearly identify entry points for response; and it supports strategic planning to build climate resilience.

The framework has been synthesized from a wide range of related fields, including ecology, engineering, disaster risk reduction, complex systems theory and planning with the goal of prompting new and practical ways of thinking about the challenge of adaptation to climate change.

ISET-International's approach to teaching trainers and communities to use this framework at the community, or city level is delivered in three series in the Climate Resilience Framework: Training Materials (CRF:TM), described below.

The training materials assume stakeholders have no prior experience—that climate change is a new concept—and begins by building the capacity to understand and address climate change from the ground up. The CRF:TM are intentionally iterative, support and rely on collaboration, and require personal and group reflection and the creative engagement of everyone involved.

## Series 1: Establishing Resilience Principles

Series 1 is designed to get the lead partners in a local climate resilience planning process started. Participants are first introduced to the conceptual framework behind ISET-International's engagement approach, the Climate Resilience Framework, and to the key tool used for engagement, the Shared Learning Dialogue. Following this introduction, participants are led through identifying resilience planning goals, reviewing existing policies, identifying the stakeholders needed to support and engage in

the climate resilience building process and from this group assembling a “climate working group”, and assembling core data. These initial steps are the foundation for Series 2, and Series 3.

### Series 2: Understanding Vulnerability and Risk

Series 2 systematically walks the newly formed climate working group through some of the steps involved in conceptualizing, compiling, analyzing and utilizing an initial city-wide vulnerability and climate risk study. This series is designed for a community and/or working group with little previous experience conducting climate vulnerability and risk assessments. However, communities that have conducted vulnerability and risk assessments previously will find that this series contains tips that help re-evaluate previously collected data in a more systematic manner, allowing clear identification of gaps.

### Series 3: Building Resilience

The concluding module series, Series 3, reviews the steps required to:

**Identify Actions:** how to take the information generated in the vulnerability assessment and use it to develop initial actions to address identified vulnerabilities;

**Prioritize Actions:** introduces a variety of tools that can be used to assess the potential for proposed actions to address identified vulnerabilities under possible future conditions;

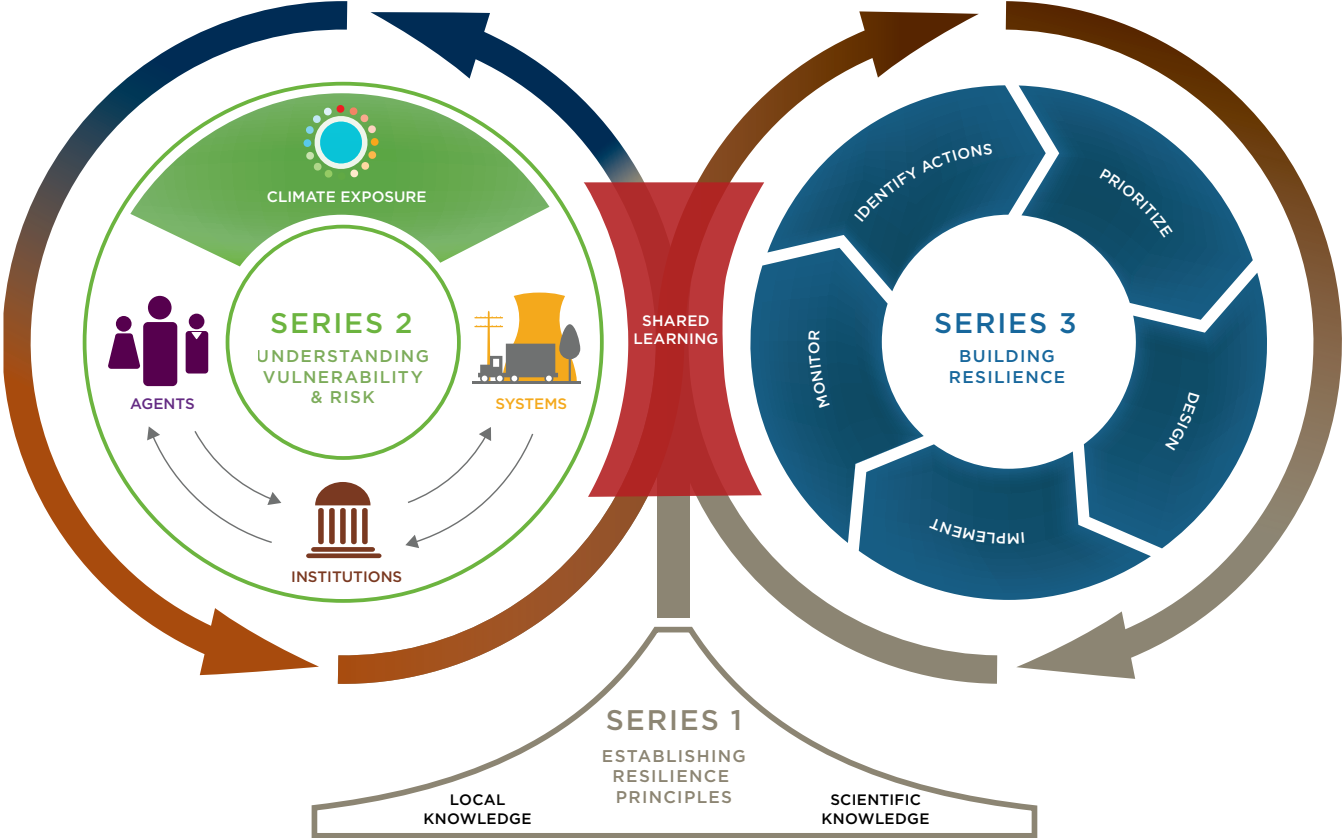
**Design Your Resilience Strategy:** how to develop a broad, local level guidance document (a Climate Resilience Strategy) that provides the context, evidence and analysis justifying actions to strengthen resilience to climate change, and identifies high priority resilience actions that can be linked and coordinated with other local initiatives;

**Implement Actions:** begin implementation of priority actions; and

**Monitor Results:** why you need to develop resilience indicators to monitor whether the activities and actions being taken to “build resilience” are succeeding.

The Series 3 materials do not address all of these steps in detail. For some steps, there are many tools already available—for example, for evaluating, ranking and prioritizing implementation actions. For other steps, such as implementation, tools are highly context dependent. The materials included in Series 3 are those that ISET has developed to supplement materials available elsewhere. They are designed to fill gaps and/or address topics in unique ways. You will need to determine whether they are useful for your city’s resilience process.

# The Climate Resilience Framework



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## About the Authors



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Dr. MacClune received a PhD in Earth Sciences from the University of Colorado where she studied glacial hydrology and did field work in Greenland and Antarctica. Prior to her work with ISET-International Karen was a groundwater hydrologist at S.S. Popodopolous & Associates where she worked with multiple and diverse stakeholders in addressing water resource issues in the Southwestern US. With ISET-International Karen has extended her stakeholder outreach, leading the development the Climate Resilience Framework: Training Materials.



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Dr. Sarah Opitz-Stapleton is a Senior associate Scientist with ISET-International and independent research scientist. Her work lies at the intersection of generating and appropriately communicating climate, vulnerability, and risk information for various disaster risk reduction and urban climate resilience initiatives, and decision-making contexts. Dr. Opitz-Stapleton's work spans community-level to provincial-level assessments in Asia, Latin America, and the Caribbean.



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Ms. Kari Hansen Tyler is an instructional designer and researcher. She specializes in the design of educational experiences that engage analysis of complex systems in support of creative problem solving. She received a Masters Degree in Adult Education and Community Development from the Ontario Institute for Studies in Education (OISE) and the University of Toronto. Her research has explored holistic learning in an intercultural context, with a focus on a First Nations culturally integrated curriculum.

# Acknowledgements



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Support and training of these city partners has been delivered by ISET-International staff in country and regional offices, and by national partners. Without their committed effort in the field and ongoing discussion about impacts and results, these materials would remain entirely conceptual. We are deeply indebted to them for pushing us to rewrite and revise materials to reflect the needs and reality on the ground.

Finally, while acknowledging these vital contributions to the publication, the authors take responsibility for its contents, including any errors or omissions therein.



## **SERIES 2: Understanding Vulnerability & Risk**



**FOR MORE INFORMATION: [TRAINING.I-S-E-T.ORG](http://TRAINING.I-S-E-T.ORG)**

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# 2.0.0

## SERIES 2

Understanding  
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### Contents of Set

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2.0.1: Activity

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# INTRODUCTION TO VULNERABILITY & RISK ASSESSMENTS

Series 2 of the Training Materials systematically walks you through some of the steps involved in conceptualizing, compiling, analyzing and utilizing an initial citywide vulnerability and climate risk study. This series is designed for a city and/or working group with little previous experience conducting climate vulnerability and risk assessments. Even if your city has conducted vulnerability and risk assessments previously, this series contains tips that might help you re-evaluate the data you've collected in a more systematic manner and identify remaining gaps.

Series 2 assumes that your city has either completed Series 1: Getting Started, or has completed some of the exercises covered in Series 1 under previous programs and that you therefore have certain types of information readily available, including: a Policy Review; Agent Mapping; and consensus on your city's guiding climate resilience principles. If your city has never done any of these exercises, we highly recommend that you complete the exercises in Series 1. Information

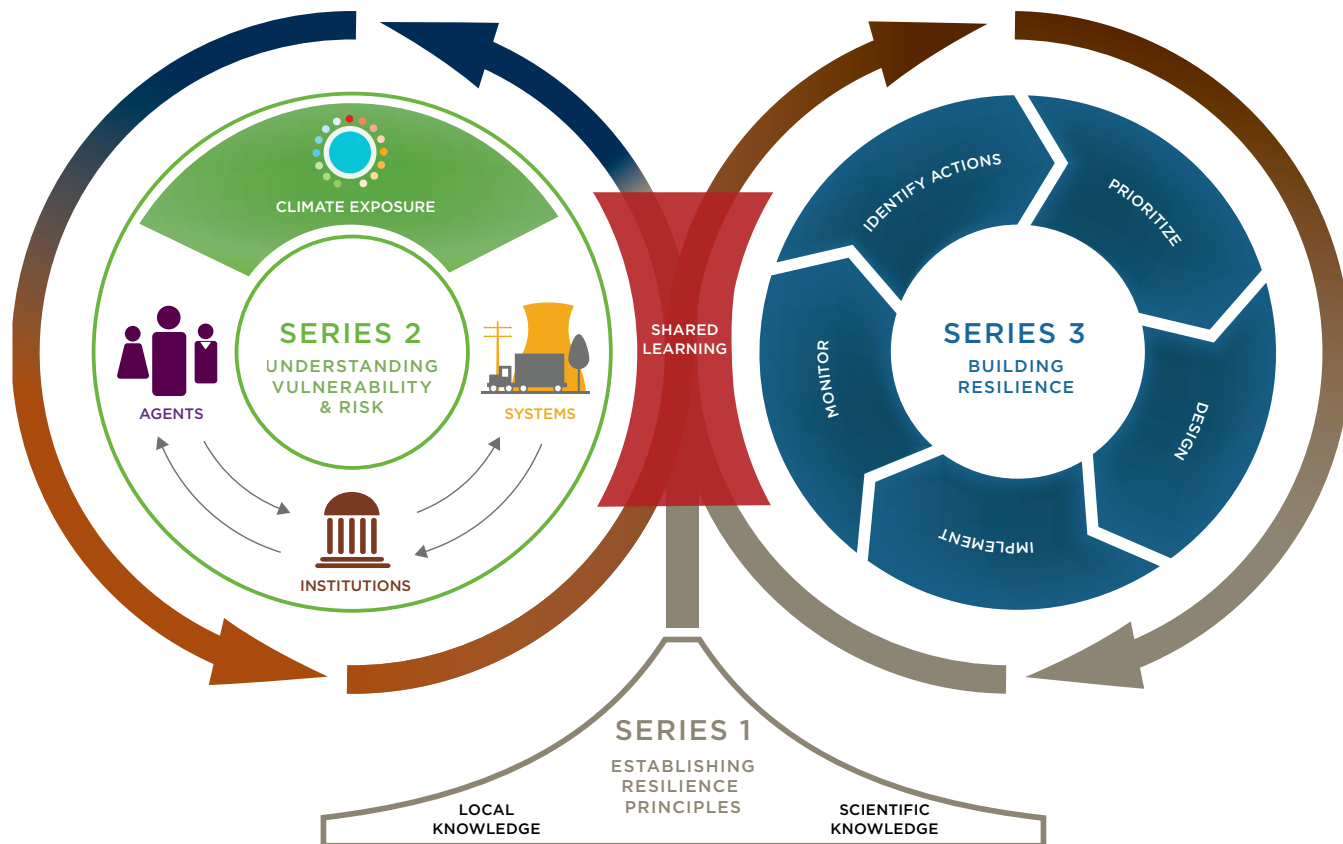
collected during Series 1 will help you through all stages of your resilience planning process and help you identify who (particularly government departments, universities, community-based groups, NGOs, etc.) should be involved.

### IN THIS SET YOU WILL:

- ✓ Review the steps covered in Series 1. If some or all of these steps have already been completed, you will be particularly well prepared for the Series 2 training, but the training can be undertaken prior to completing all of these steps if needed.

**FIGURE 2.0.1**  
**The Climate Resilience Framework**

Urban Climate Resilience Planning graphic. Series 2 of the Training Materials walks you through the left-hand loop of the diagram, the Vulnerability and Risk Assessments.



## WHY UNDERTAKE A VULNERABILITY ASSESSMENT

Climate change vulnerability assessments are key inputs to climate change resilience planning. They help you:

- Assess the vulnerability of your city's human, natural, and physical infrastructure to existing climatic hazards, to climate variability, and to future climatic changes;
- Help you identify why those people, natural systems, or physical infrastructure are vulnerable;
- Identify existing capacity to adapt to current and future climate stresses; and,
- Identify the actions or entry points for reducing those vulnerabilities.

This engagement is represented by the left-hand loop of the resilience planning diagram, shown in Figure 2.0.1.

### AS PART OF YOUR VULNERABILITY ASSESSMENT, YOU WILL:

- Document and describe your city's current climate hazards and what impact those hazards have on your city;
- Use your understanding of current climate hazards and impacts to identify potential impacts of future climate change;

- Identify the groups, areas of your city, and city services and functions that are most vulnerable to current climate hazards;
- Explore why these groups, areas and services are vulnerable;
- Explore how this vulnerability may change in the future because of climate change;
- Assess both the need and the capacity to adapt; and
- Broadly identify appropriate strategies and interventions to enhance the resilience of these vulnerable groups, areas and services, in ways that will also enhance city-wide resilience.

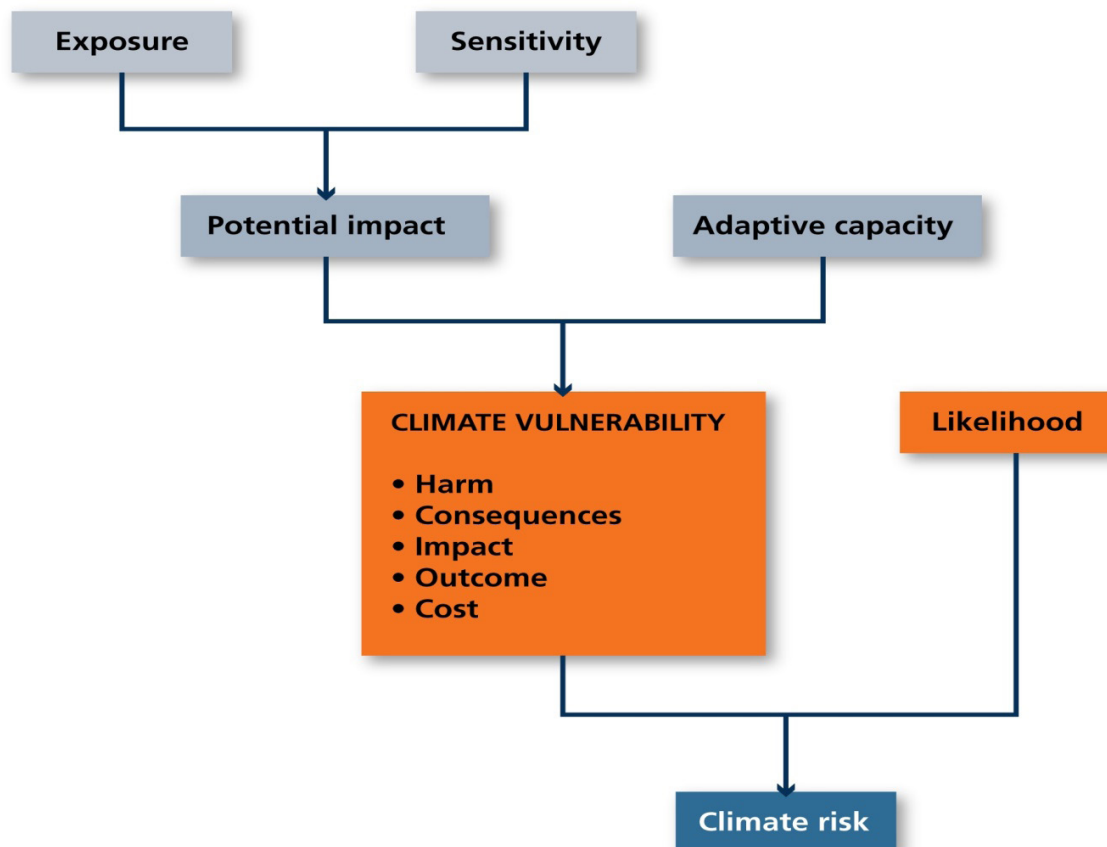
## Why Undertake a Risk Assessment

Risk is the likelihood that particular consequences might happen based on the vulnerability of a system and as a result of the likelihood of particular hazards. For example, a community may be vulnerable to flooding, but if improvements in drainage make it highly unlikely that a flood will occur, then the community's flood risk is very low.

Risk assessments include a review of the direct impacts of climate change on the most vulnerable groups, areas, and city services and functions, an exploration of how direct

**FIGURE 2.0.2**  
**Climate Risk Assessment**

A climate risk assessment can be the next step after a vulnerability assessment in which you try to describe, to the best of your existing knowledge, how likely it is that climate change will cause certain outcomes or impacts for your city. Source (UKCIP 2007).



impact to one element might cause indirect impacts for other elements, and an exploration of how direct impacts of climate change somewhere else in the world can indirectly affect your city (for example, through food security, raw materials availability, markets, etc.). Assessments of current risk are based on current vulnerability to particular hazard events combined with the historical likelihood of those particular hazard events and an examination of the resulting impacts. Forward-looking climate risk assessments take the range of potential changes in rainfall, temperature, or storms to develop future hazard likelihoods. These future hazard likelihoods are combined either with current vulnerability levels (most simple analysis) or with the scenarios of future vulnerability (more complex analysis) to develop scenarios of future risk.

Both vulnerability and climate risk can and will change.

Climate risk can change as a result of changes in likelihood of a climate hazard and/or changes in vulnerability.

Vulnerability can be reduced if proactive measures to reduce sensitivity and exposure or increase adaptive capacity are taken because risk is recognized. Vulnerability can increase if system fragility increases, if constraining rules, policies or laws are enacted that limit people's access to support or resources, or if people lose previous adaptive capacities. Vulnerability can also change after a disaster or similar high impact event occurs and your city and citizens respond, or fail to respond, to the consequences.

Vulnerability and risk assessments are crucial elements of the resilience planning process and are closely tied to shared learning dialogues (SLDs). As discussed in Set 1.3, SLDs are the iterative platforms that enable joint dialogue, reflection, and understanding of climate challenges, vulnerabilities, risks and potential resilience strategies within the cities. The process and outputs of these activities enable discussion, reflection, and collaborative planning on approaches and activities that can enhance a city's resilience to climate change impacts. Vulnerability and risk assessments are a key part of this process, providing critical bottom-up community information, top-down expert analysis of local climate hazards and climate change projections, and synthesis of the two. This information is then fed back to the SLDs for discussion and decision regarding further action.

## Training Materials: Series 2 Contents

There are many ways to conduct vulnerability and risk assessments, depending on information available, timelines, and the goals of the resilience process. The steps and methods introduced in this series are designed to help you select a methodology that works for your city—a methodology that you are comfortable with, you have the data to complete, and that will provide the information you want from the assessment. This series will also begin guiding you toward

thinking about how information from your vulnerability and risk assessments will help you identify and prioritize your resilience options, as well as adhere to your guiding resilience principles that you developed in Series 1. Series 2 is composed of 8 sets, which are listed and briefly described below. These represent the left-hand loop in the resilience planning diagram (Figure 2.0.1).

### **SET 2.1: DEFINING VULNERABILITY & RISK**

There are many definitions of vulnerability and risk in use in both the climate adaptation literature and in practice. There is no one single definition that is more ‘correct’ than the others. However, it’s important to make sure that everyone involved in the resilience planning process is using the same definition. Doing so will result in less confusion among participants and stakeholders, help guide your vulnerability assessment approach, methodology, and framework, and simplify communicating results when you’re done.

### **SET 2.2: CLARIFYING YOUR VULNERABILITY FRAMEWORK**

The vulnerability framework provides a starting point for determining the units of analysis—specific populations, sectors/systems or geographic areas, and timescales for historic and future analysis—that should initially be studied. At the same time, it can help identify important links between the initial units of analysis and other units of analysis that will

need to be investigated. Once a vulnerability framework has been selected, it will become easier to decide which methods for conducting a vulnerability assessment for your city are appropriate at each step.

### **SET 2.3: TREND ANALYSIS: PAST, PRESENT AND FUTURE**

Cities are constantly evolving, and as those changes take place the nature of vulnerability shifts over time. In this set, you will examine historic development trends from the last 20 to 50 years to understand how certain forces—such as economic development, urban planning, and rural-to-urban migration—have affected the way your city is structured, operates, and is vulnerable today. In addition to a changing climate, those social and economic forces of change will continue to impact your city and help shape its future vulnerability.

### **SET 2.4: CLIMATE CHANGE, EXPOSURE & RISK**

One component of vulnerability to climate hazards is exposure, literally putting people, infrastructure and assets in areas where hazards occur. Climate change is affecting the intensity, frequency, and in some cases location or nature of climate hazards. This set introduces climate change and its potential future impacts, examines current climate exposure, and explores potential future climate exposure and hazards.

### **SET 2.5: POVERTY & VULNERABILITY**

Vulnerability is often equated with poverty—“vulnerable” populations are identified by per capita or household income. Yet, this is often an oversimplification and may overlook many highly vulnerable groups and households because they have slightly more, or even significantly more, income than the poverty cutoff. In this set, you will explore the concept of vulnerability and the factors that contribute to creating and maintaining vulnerability.

### **SET 2.6: SYSTEM FRAGILITY**

In Set 2.3 you explored your city’s development trends, the types of historical climate hazards that have occurred in your city, and you mapped current hazard exposure for one hazard. In this set, you will build on this by completing a simple, qualitative baseline vulnerability assessment for one city system. You will examine that system’s strengths and fragilities, will consider how it has functioned in past disasters or crises, and will propose ways that system resilience could be improved, taking into account the characteristics of resilient systems presented in Set 1.1.

### **SET 2.7: VULNERABILITY AND GOVERNANCE**

Vulnerability is often perpetuated through institutional constraints, either cultural norms and expectations, or governance. Yet, efforts to build climate resilience must be mainstreamed into everyday governance if they are to lead to effective and sustainable interventions in the form of policy, budgeting, programs and projects. In this set, you will explore how to steer your resilience effort such that it can maximally leverage areas that align with positive governance, while brainstorming ways that you can use your process to begin influencing areas of negative governance.

### **SET 2.8: PUTTING IT ALL TOGETHER**

Over the course of this series we have presented a number of ideas, some of which may be new, and had you complete a variety of activities. All of the information and activities were designed to introduce techniques and ways of thinking that, with the addition of quantitative data regarding population, socio-economic factors, and climate, can be used directly to frame and populate your vulnerability assessment. In this final set of Series 2 we explore “top-down” and “bottom-up” information generation, and describe how you can combine this type of information generation with the approaches used in the other activities to produce a vulnerability assessment.

## 2.0.1

### SERIES 2

Understanding  
Vulnerability & Risk



### Activity 2.0.1

## Checklist of Required Foundation Material for Series 2

As you work through Series 2: Understanding Vulnerability & Risk, it will become increasingly clear why these steps are necessary before proceeding further. If some or all of these steps have already been completed, you will be particularly well prepared for the Series 2 training, but the training can be undertaken prior to completing all of these steps if needed.

### IN THIS ACTIVITY YOU WILL:

- ✓ Complete a checklist of information and actions that it is best to complete prior to undertaking your Vulnerability Assessment.

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## ACTIVITY 2.0.1 : CHECKLIST OF REQUIRED FOUNDATION MATERIAL

### INSTRUCTIONS

In the questionnaire below, though most of the questions could be answered as yes/no questions, please take the time to note down additional details if they are available. For example, “several calls have been made to the national climatology office, but so far we have been unable to locate anyone to discuss available climate projections for our region.” Though simple, the act of combining information from all members of the group and noting it down may provide significant clarity about gaps and next steps.

### RESILIENCE STAKEHOLDERS

Have you identified and engaged a range of stakeholders—from government departments, community groups, NGOs, etc.—that are key to the resilience process (Set 1.2)?

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Have you formed a city working group and/or steering committee that will oversee and direct the city vulnerability and risk assessments, and be able to later identify and implement resilience activities and strategies (Sets 1.2 and 1.6)?

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**RESILIENCE PRINCIPLES AND PROCESS**

Have you reviewed the urban climate resilience framework and decided how it will guide your city’s resilience process (Set 1.1)?

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Have key stakeholders and the city working group developed and agreed upon a set of resilience principles and goals (Set 1.4)?

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Have the key stakeholders and city working group begun developing a common set of terminology (Set 1.6 and Lexicons)?

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Have the key stakeholders and city working group decided upon an initial and flexible timeline for various stages of the resilience process (Set 1.6)?

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Have you reviewed policies, laws, and plans at various government administrative levels that might impact your city's resilience process (Set 1.5)?

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## 2.0.2

### SERIES 2

Understanding  
Vulnerability & Risk

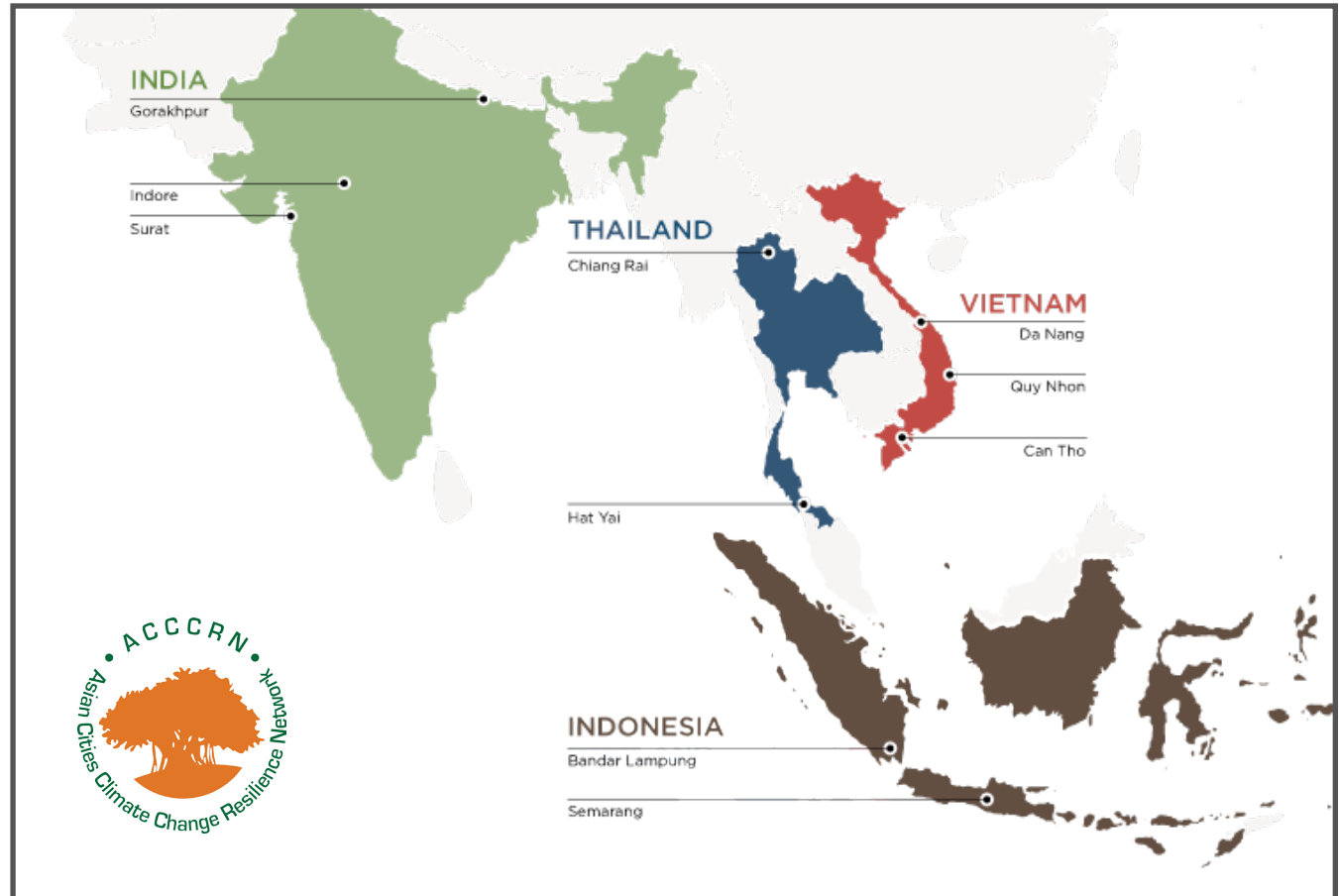


### Case Study 2.0.2

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## Vulnerability and Risk Assessments in the ACCCRN Cities



In the Asian Cities Climate Change Resilience Network (ACCCRN) project, though there were common elements in all ten ACCCRN cities, each city implemented vulnerability assessments in a slightly different way. Nonetheless, there were enough similarities to identify key factors that contributed to successful completion of the vulnerability assessments and application of the assessment findings to ongoing resilience planning.

The most critical element of the ACCCRN vulnerability assessments were that the findings, and the process of undertaking the assessment itself, were linked to adaptation planning aimed at reducing vulnerability and enhancing resilience. In the ACCCRN cities, the vulnerability assessments were reviewed as soon as they were completed with the goal of identifying next steps, gaps, and policy and planning implications. Without this translation into action, a vulnerability assessment alone will do nothing to reduce city vulnerability.

Beyond that, the primary goals in vulnerability assessment implementation in all of the ACCCRN cities were:

- To select methods for the vulnerability assessment with which the team was comfortable and that were feasible given the human, financial, and time resources available;

- To create a process that was flexible and iterative in order to enable the cities to pursue priority issues that emerged; and
- To help city officials, stakeholders, and residents get a preliminary understanding of climate change implications in their cities, identify additional areas for more intensive analysis, and provide some basis for considering how interventions could target vulnerable groups and areas in order to enhance resilience both of vulnerable groups and the overall city.

All ten cities completed vulnerability assessments and all but one city, where the assessment was poorly structured and consequently generated no new knowledge, generated new information that was subsequently used in developing their city resilience strategies.

Shared learning dialogues, described in Set 1.3 were central to building urban climate resilience in the ACCCRN cities. On one hand, designing and undertaking the vulnerability assessment required interaction between climate scientists, local experts knowledgeable in the function of urban systems, decision-making actors, and marginalized agents whose vulnerability might not be recognized by others. The iterative interaction among these groups and their different knowledge sets was crucial to building a common

understanding of potential urban vulnerabilities to climate change. On the other hand, design of resilience-building actions also required iterative engagement between technical experts, system users, and marginalized groups who need access to those systems to build their capacities. The SLDs allowed stakeholders to expand on issues that arose in both the design phase and assessment process, facilitating the iterative process of planning for resilience.

None of the ACCCRN cities other than Bandar Lampung and Semarang, in Indonesia, attempted to conduct risk assessments, and in Indonesia the risk assessments ultimately were only partially used in developing the city resilience strategies. The story behind why the risk assessments were only partially used is quite useful in thinking about how to set up the process in other cities.

In Indonesia, the risk assessments were conducted by CCROM, a research center at the Bogor Agriculture University. CCROM developed a series of indices, applied at the district level, to assess vulnerability, adaptive capacity, and climate exposure. These indices were assessed both for current and projected future vulnerability and climate risk. Though this analysis was very quantitative and well thought out, in application its value to the Indonesian cities was mixed. Some of the issues the city partners flagged were:

- The cities didn't like the indicators that were selected for analysis. In part, this was because they felt some of the indicators were misleading, such as the number of educational facilities in an area, rather than the average level of education. Because the indicators were not made transparent in the document, the city team spent considerable effort to discover what was actually being measured, leading them to further lose confidence in the analysis;
- Analyses were based on national datasets, some of which the cities did not consider reliable;
- Areas currently unexposed to flooding were identified as vulnerable to future flooding, but the city team was not convinced this was realistic;
- CCCROM only minimally consulted with partners, which exacerbated confusion;
- The report writing style was academic which made it difficult for many of the city partners to understand and increased the challenges in giving feedback to CCROM; and
- Overall the results were not practical because they aggregated hazards and referred to a hazard index rather than specific hazards.

These concerns about the analysis spurred the working group to review and discuss the CCROM assessment in great detail, and as a result working group members learned a lot about what should not be done in future vulnerability assessments. Semarang and Bandar Lampung ultimately supplemented the CCROM report with other secondary sources with which they felt more comfortable, and explored development trajectories under different climate scenarios via scenario development.

This experience is described here to illustrate that thoughtful selection of working partners (in particular partners who are willing and able to work closely with city stakeholders to understand their concerns and interests), careful attention to communication, and clearly laying out expectations and definitions is necessary to assure successful results. Climate change can feel daunting to those for whom it is new, particularly when faced with technical experts who seem to fully understand all the issues. However, those technical experts are unlikely to fully understand issues of importance to individual communities, city departments, and city leaders. **It is critical that city stakeholders stay engaged and actively working with technical experts if study results are to be useful to your city.**

# 2.1.0

## SERIES 2

### Understanding Vulnerability & Risk



#### Contents of Set

##### 2.1.0: Guide

##### 2.1.1: Activity

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# DEFINING VULNERABILITY & RISK

You were just introduced to the concepts of vulnerability and risk assessments, what role they play in city resilience building, and how they were applied in various ACCCRN contexts in Series 2.0: Overview. In this set we present a short overview of some of the commonly used definitions of vulnerability and risk and ask you to select or develop a set of definitions that you will use throughout the rest of your resilience planning.

There are many definitions of vulnerability and risk in use in both the climate adaptation literature and in practice. It is important that everyone involved in the resilience planning process is using the same definition for the following reasons:

- You will have a lot less confusion among stakeholders in the process if you have a shared definition of vulnerability and risk upon which everyone agrees.

- Your definitions can help guide your approach to how you conduct your vulnerability and risk assessments, the methods you use, and your overall vulnerability and risk framework (discussed in the Set 2.2).
- Your definitions are clear and understandable to policy makers and can be used in your city's planning processes.

#### IN THIS SET YOU WILL:

- ✓ Work with your team to develop shared definitions of vulnerability and risk that you can refer back to throughout your resilience planning process.

## Common Definitions: Vulnerability & Risk

There are many definitions of vulnerability and risk, each arising from a different perspective —disaster risk reduction, sustainable development, poverty alleviation, and climate science, to name a few. The disaster risk reduction definitions keep vulnerability and risk separate (UNDP 2005):

- Vulnerability is a measure of human welfare that integrates environmental, social, economic and political exposure to a range of harmful perturbations.
- Risk is the likelihood of a climate hazard event and/or its consequences (impacts) to a particular system or agent as a result of that system's or agent's vulnerability.

### DEFINITIONS OF SYSTEMS AND AGENTS

SYSTEMS in a city include infrastructure, services, and functions (e.g. water supply and wastewater treatment systems, roads, power lines, food distribution, health, education, finance) and ecosystems (e.g. agricultural land, parks, wetlands, fishing grounds). Systems are designed and managed by people, but their performance depends on a multitude of factors that are difficult to manage, including human behavior and institutional context, which often lead to unintended side effects like pollution. Systems are fragile if they are easily disrupted or broken, though their basic functioning may look very stable.

Systems are linked and dependent on each other. The strengths or weakness of the links between systems can enhance adaptive capacity or increase the

vulnerability of other systems. A system's climate risk depends on how likely a particular climate hazard is and what its consequences might be as a result of that system's vulnerability.

AGENTS are individuals, households, communities, the private sector, businesses, and government entities – they are people functioning either alone or in groups. People, unlike systems, are capable of careful thought, independent analysis, voluntary interaction, and strategic choice in the face of new information. This makes agent behavior more difficult to predict than system behavior. People's thinking, analysis, interaction and choice often reflects their location and structure within society, their preferences, and the opportunities and constraints they perceive.

The Intergovernmental Panel on Climate Change (IPCC) definition of vulnerability is widely referred to in climate adaptation and resilience programs, but doesn't define risk because it includes likelihood in the definitions of exposure and sensitivity.

- Vulnerability is the degree to which a system is susceptible to, and unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate change and variation to which a system is exposed, its sensitivity, and its adaptive capacity (IPCC 2001: 388).

In this set, we have chosen an approach and associated definitions that keep vulnerability and risk separate. We find this often makes it easier to understand the underlying causes of vulnerability for your city, to create scenarios of potential future impacts and the consequent risks, and to identify different resilience options. We also find that using very simple definitions makes the work easier. These definitions, for all that they are simple, are equally technically rigorous and are supported by a strong conceptual framework.

*Vulnerability: Who/what (e.g. individuals, neighborhoods, businesses, livelihoods) might suffer harm because of what (e.g. extreme climate event, indirect event like landslide, slow-onset change) and why (e.g. low education, live in poorly constructed housing, no access to health clinics).*

*Risk: The likelihood (how frequently a climate hazard might occur in the future due to climate change) that who/what might suffer harm because of what and why.*

#### **IN THIS DEFINITION, *EXPOSURE*, *SENSITIVITY* AND *ADAPTIVE CAPACITY* ARE DEFINED AS:**

**Exposure:** The nature and degree to which a system experiences climate events, such as temperature increases, rainfall variability and change (including extremes), or changes in the frequency or intensity of tropical cyclones and storms.

**Sensitivity:** The degree to which a system is affected, either adversely or beneficially, by climate-related stimuli. It is often measured by the system's response to what has happened during past events.

**Adaptive Capacity:** The ability of a system to adjust to climate—including climate variability and extremes, to moderate potential damages, to take advantage of opportunities, or to cope with the consequences.

In the end, it doesn't matter which definition of vulnerability and risk that you use. It is simply important that everyone involved in the resilience process agrees on the same working definition to avoid confusion throughout the process. As with every step of the resilience process, it is likely that you will return to your definitions and ask yourself if they are still relevant to what you are finding in the process or if they need to be modified.

## 2.1.1

### SERIES 2

#### Understanding Vulnerability & Risk



### Activity 2.1.1

## Developing Vulnerability and Risk Definitions

In this activity you will develop initial definitions of vulnerability and risk. Following the training, these definitions should be refined by the full working group and a set of working definitions selected and introduced to the steering committee and key stakeholders during SLDs or other engagement efforts. However, we encourage you to allow your understanding and definition of these terms to change over time, influenced by stakeholder input and experience conducting your vulnerability and risk assessments.

### IN THIS ACTIVITY YOU WILL:

- ✓ Work with your team to develop shared definitions of vulnerability and risk that you can refer back to throughout your resilience planning process.

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### ACTIVITY 2.1.1: DEVELOPING VULNERABILITY AND RISK DEFINITIONS

**INSTRUCTIONS:** You are now going to spend time coming up with working definitions of vulnerability and risk that you will use throughout your resilience process.

1. In the space provided below each word, write down the definitions your working group proposes. You can have multiple definitions listed below each word.
2. It is also ok for you or members of the working group to draw images or pictures that come to mind when talking about vulnerability and risk. These pictures or images might help in choosing your city's definition of vulnerability and risk.
3. As a group, take some time to review all the proposed definitions one more time and then decide which definition is the one you like best and will use as you begin your vulnerability and risk assessment. Circle this definition.

#### VULNERABILITY

#### RISK

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# 2.2.0

## SERIES 2

Understanding  
Vulnerability & Risk



### Contents of Set

2.2.0: Guide

2.2.1: Activity

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# CLARIFYING YOUR VULNERABILITY FRAMEWORK

Clarifying the vulnerability framework that will guide your research effort is the critical first step to conducting vulnerability and risk assessments. The framework provides a starting point for determining the units of analysis—specific populations, sectors or geographic areas—that you will initially study. At the same time, it can help you identify important links between the initial units of analysis and other units of analysis that will need to be investigated at a later point. Once you have developed your vulnerability framework, it will become easier for you to decide which methods for conducting the assessment are appropriate, to identify who will conduct the vulnerability assessment, and to establish a timeframe and budget for the work.

### IN THIS SET YOU WILL:

- ✓ Answer a series of questions that will help you focus and frame your vulnerability assessment

## Overview

There is no single standard approach to conducting vulnerability and climate risk assessments. Rather, there are a range of frameworks, tools and methods that draw on knowledge from a variety of fields—climate change adaptation, disaster risk reduction, sustainable development, and food security—that can be adapted and used for urban vulnerability and climate risk assessments. In particular, climate vulnerability and risk assessments in urban areas are still relatively recent, especially in developing countries. The vulnerability framework you will develop in this set, and the approaches outlined in the following five sets, will have to be tailored by your city working group to meet your resilience process needs. This is because to be locally useful, a vulnerability assessment must be tailored to your local conditions, must leverage locally available data and existing studies, must address local at-risk populations and sectors, and must address local enabling or restricting institutions (rules, regulations, social and cultural norms and expectations, and government policies).

### A BASIC VULNERABILITY FRAMEWORK IDENTIFIES:

- Why the vulnerability assessment is being undertaken;
- What information the finished assessment should produce or include, and how that information will subsequently be used;
- Units of analysis—people, neighborhoods or districts, city systems, services or functions, specific sectors such as the water sector, etc.;
- Timescale of analysis—how far into the past you want to go to establish trends in population, urbanization, economic development, migration, climate, AND at what point or points in the future you will assess future conditions, like 2030 and/or 2050;
- Geographic scope of study—current city administrative limits, city center plus surrounding peri-urban areas, a specific sub-district;
- Who will do the vulnerability and risk assessments. Members of the city working group should assist in conducting the vulnerability and risk assessments, but you may need additional expertise or help from a university, research institution, or NGO. The

stakeholder review (Set 1.2) and policy review (Set 1.5) can help you identify who can assist with your vulnerability and risk assessments;

- An initial review of who has or might have various types of data needed, including historical climate data;
- Financial resources and time available for conducting the vulnerability and climate risk assessments; and
- A draft workplan outlining how many, what type, and when Shared Learning Dialogue or other types of meetings will be held so that all important stakeholders (Sets 1.2 and 1.3) can review the city working group's progress and results, and make sure the analysis is still on track.

## 2.2.1

### SERIES 2

Understanding  
Vulnerability & Risk



### Activity 2.2.1

## Developing a Draft Vulnerability Framework

In this activity, you will begin outlining the basic elements of your vulnerability assessment **if you have already determined what those elements should be**. If you have not already identified some of the units of analysis, such as the timeframes of concern or the most vulnerable populations, please skip these questions for now. The rest of the sets in Series 2 will explore these components of your vulnerability assessment in more detail. This initial activity is simply to begin focussing you on the questions that will need to be answered before you begin your formal vulnerability and risk assessment.

### IN THIS ACTIVITY YOU WILL:

- ✓ Begin to frame your city's vulnerability assessment by exploring three separate areas relevant to the assessment.
- ✓ Answer a series of questions that will help you focus and frame your vulnerability assessment

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## ACTIVITY 2.2.1: DEVELOPING A DRAFT VULNERABILITY FRAMEWORK

### INSTRUCTIONS

For this activity, you will divide into small groups. If you need more room than is available in the table below to answer each question, do not hesitate to write your answers on additional sheets of paper, on a white board, or on a flip chart.

1. The first step in framing your vulnerability assessment is to decide why you are undertaking the assessment. Answer the questions listed under Step 1.
2. The second step is identifying the geographic area and the units of analysis—which groups of people, city services, sectors, or functions, and over what time periods—you will study to determine who or what in your city currently suffers harm (is vulnerable) and how that vulnerability and climate risk might change in the future under different climate scenarios. Answer the questions listed under Step 2.
3. Finally, the scope of your vulnerability and risk assessment and the methodology you select for analysis will be strongly influenced by the resources you have available for the work. Answer the questions in the space provided under Step 3.

**STEP 1: WHY YOU ARE UNDERTAKING A VULNERABILITY ASSESSMENT**

What do you want to learn from your vulnerability assessment?

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How are you planning to use the results of the completed assessment?

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Who will use the results of the assessment?

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For successful use of the results, what format do the results need to be in?

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**STEP 2: WHO AND WHAT, WHERE, AND WHEN**

What geographic area do you plan to study? If maps are available, mark the boundaries of the study area. If maps are not available, sketch the area of planned study.

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Will you study everything within your marked area in equal detail, or will you focus on a particular set of sub-areas?

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Why do you plan on studying these areas?

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Who or what is currently most vulnerable within your study area? Indicate on maps or hand drawn sketches of the city areas that are particularly vulnerable, and note groups and systems that are particularly susceptible to harm.

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What particular groups of people are vulnerable to current climate hazards? For example, is there a community whose sole source of income is rice farming and this community's income is very vulnerable to drought at certain times of the year?

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What areas of the city are currently most exposed to what climate hazards? Mark on the maps where flooding, landslides, drought, etc. occur.

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What city systems, services or functions are particularly fragile? For example, are there poorly functioning drainage systems that, when there is rain, put particular neighborhoods or groups at risk of flooding?

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What time periods will your vulnerability and risk assessments cover? Consider both current vulnerability & risk, and future vulnerability & climate risk.

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Will you establish historical trends in population, urbanization, economic development, migration and climate based on 10 years of data? 25 years? The availability of data may influence possible timescales of analysis. However, just because you have data extending back 200 years does not mean that full period is relevant to current challenges. Again, pick a timeframe that is relevant to the questions you are trying to address. Though future climate projections are often available through 2100, 2100 is generally too far out to be meaningful to current planning challenges.

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How far into the future do the city development plans cover? 10 years? 20 years?

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Is your city currently planning on developing any lands or building any major infrastructure? These types of things have lifetimes of 60+ years, will change your city’s current and future vulnerability and climate risk, and need to be considered.

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**STEP 3: RESOURCES AVAILABLE FOR THE ASSESSMENT**

What financial resources do you have to devote to your vulnerability and risk assessment?

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How long do you have to conduct the vulnerability and risk assessment? When do you need results to begin the next steps of your resilience process?

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What individuals on the city working group and/or outside experts can undertake the data collection, select the appropriate vulnerability and risk assessment techniques, and analyze the data? What are their capacities and areas of expertise?

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How far into the future will your scenarios of future vulnerability and climate risk cover—2030 to 2050? The policy review you completed in Set 1.5 may influence the future time periods you wish to include.

This image shows a single sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

# 2.3.0

## SERIES 2

Understanding  
Vulnerability & Risk



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- 2.3.3: Activity 3

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# TRENDS ANALYSIS

## Past, Present, and Future

Cities are constantly evolving, and as those changes take place, the nature of vulnerability also shifts. It is useful to examine historic development trends from the last 20 to 50 years to understand how certain forces, such as economic development, urban planning, and rural-to-urban migration have affected the way your city is structured, operates, and is vulnerable today. In addition to a changing climate, social and economic forces of change will continue to impact your city and help shape its future vulnerability.

### IN THIS SET YOU WILL:

- ✓ Review historical photographs or stories about your city and use this as a starting point to explore, in small groups, how your city has changed over the past several decades;
- ✓ Discuss what the future city could look like if current trends continue;
- ✓ Imagine the best possible future for your city;
- ✓ Discuss the difference between these two futures, and what it will take to get from the extrapolation of trends to the best possible future; and
- ✓ Map your city's development trends over the past few decades.

## Overview

Cities grow in response to population growth and economic growth. This growth results in changes to city infrastructure and land use, changes in available natural resources, and changes in social structure. However, even in the most rapidly developing cities we can forget the scope of changes that have occurred even during our lifetimes. Systematically reflecting on these changes is the fundamental basis for any vulnerability assessment. It is only by assessing the factors that have brought us to where we are today, and the rate at which that has occurred, that we can fully understand both how we have arrived at our current vulnerabilities and what future vulnerabilities might look like.

However, where we have come from is clearly only half the problem at best. We also need to assess where current conditions are likely to take us if we take no action, where we would like to be, and what is required to get from one to the other. This requires a realistic examination of what the future would look like if past trends continue, particularly if elements of those past trends include poor governance, poor urban planning, highly restrictive policies or laws, social or political conflict or unrest, or poor economic conditions. It also requires hope and the ability to envision the best possible future in spite of current limitations and challenges. You will be best equipped to build resilience armed with a clear picture

of where you are currently headed, coupled with a solid vision of where you want to be. Resilience actions are the individual activities that will begin moving your city and its citizens from the trends to the vision.

There are a number of ideal city models developed over the past century (e.g. Garden Cities, Sir Ebenezer Howard 1898; The Contemporary City, Le Corbusier 1922). Although interesting and useful in terms of generating thinking about alternative ways to structure cities, it is important to remember that these remain theoretical models. It is neither feasible nor sensible to try to erase our current cities and redo them. What we have to do is to make improvements and build resilience with what we already have. The activities that follow are designed to begin the exploration of what it will take to get from where you are to something more resilient, fully acknowledging current limitations and challenges.



### ABOUT THE AUTHOR

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Dr. Friend's work at ISET-International is focused on urban climate resilience. He has a PhD in social anthropology and development studies based on extensive fieldwork in southern Thailand. He has been working in the Mekong Region for 20 years in areas related to human development, governance, and natural resource management, with particular interest in sustainable livelihoods, climate change, water resources, and fisheries. He has led regional implementation and capacity building programs

as well as research networks, working for international NGOs, donors, inter-governmental organizations, and independent think tanks. He speaks Thai, Lao, and English.

## 2.3.1

### SERIES 2

Understanding  
Vulnerability & Risk



### Activity 2.3.1

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## Development Trends: Past and Present Exploration

How has your city evolved to look as it does today? How quickly has the city changed? What are key trends? In this activity, you will explore why your city looks the way it does. The information generated in this activity will be used in the next activities, exploring future trends and future vision. It will also form the basis of your vulnerability assessment.

### IN THIS ACTIVITY YOU WILL:

- ✓ Review historical photographs or stories about your city;
- ✓ Explore, in small groups, how your city has changed over the past several decades; and
- ✓ Compare group responses and discuss the changes you have noticed.

## ACTIVITY 2.3.1: DEVELOPMENT TRENDS – PAST AND PRESENT EXPLORATION

### INSTRUCTIONS

#### Step 1: Overview of Past History

If historical pictures of the city or area of interest are available, begin with a slideshow, from oldest to most recent. This can be done with discussion, if time allows, or simply as a quick presentation. Pictures can be drawn from a broad range of areas—landscape images of the city and its surroundings, pictures of typical inhabitants, pictures of politicians, royalty or officials, social gatherings, transportation, etc. There is no “right” set of imagery; imagery can cover any aspect of and period of the past that seems relevant.

If imagery is unavailable, you can alternately begin with a short presentation by a local elder who has watched the city transform over time, or with a group discussion of changes you and your friends and relatives have seen over time. Again, this discussion can cover whatever period in the past your group finds easy to address.

One of the goals of this introductory engagement is to notice both key trends and also how fast things have changed. These changes can be easy to forget if you are living in and are a part of the change.

#### Step 2: Document past changes

Based on the overview of your city’s history, and taking into consideration the issues of concern in your city, discuss and select several points in the past, for example 30 years ago, 20 years ago, 10 years ago, and now, and 4 or 5 key categories that you will examine at each of those points in time. Categories could include population, water resources, waste management, transportation, natural resources, economy, urban infrastructure, land use, or social issues.

The time periods you select should relate to the age of the city, the rate of change of the city, the period over which participants can best document change, and the period of future change you will eventually want to evaluate. Even if your city is 1000 years old, if you are concerned with planning for the next 30 to 50 years you want to go back no further than 50 years in documenting the past. Conversely, if you are a new city or community with only a 10-year history at your current location, and in the last 5 years there has been exponential growth, then you might want to look at 10 years ago, 5 years ago, 3 years ago, and the present.



Hue, Vietnam 1950



Hue, Vietnam 1992



Hue , Vietnam 2012

The categories selected for exploration should include, but do not need to be limited to, issues of concern in your city. For example, access to drinking water, shelter, and livelihoods might be the primary areas of interest. Or, it might be urban flooding, waste management and land use. For both of these, you might also want to include population growth and economy. Do not worry about picking the “right” categories—the goal is to document a range of areas in which your city is changing.

Once you have selected time periods and categories, split into small groups of 4-8 people each. Each group will work together to explore in more detail the condition or status of each of the selected categories at each of the selected points in time. Everyone in the group is encouraged to contribute—there are no right or wrong answers, just what you remember from the past and notice about the present. The focus here is

on what you perceive about the past and how it has changed, not on collecting or analyzing data about the past. Results should be recorded as a matrix on big sheets of paper, with time across the top, each category listed down the left hand side, and discussion results filled in in the resulting grid. See Table 2.3.1 for an example.

Once all the groups have had a chance to fill in their charts, present your results to the full group. Subsequent groups can highlight additions or areas where their results differ from those already presented. Once all the groups have presented, discuss your results. Are there areas of change that other groups documented that yours did not? Do you agree with the things other groups have documented? Did your group or any other group come up with something that surprised you?

Table 2.3.1:

An example of the described exercise, as completed by the Climate Change Working Group in Lao Cai, Vietnam in May 2012.

CATEGORY	1980–1990	1990–Present
ECONOMY	Agriculture accounts for most of economy. Mostly people do farming within small scale.	Industry, services, and agriculture. Mining and processing. Agricultural production applies more scientific management. Con Minh and Hai Phong corridor, lots of development. Traffic infrastructure, railway system is expanded and increased quality. Before they got power from China but now they get power from here. Agriculture declining, focus is on industry, services, and trade.
POPULATION	Low density. Population < 10,000 Ethnic minority groups account for large percentage of local population.	Increased density. Population 120,000 in 2010 and growing quickly. Kinh people (national ethnic majority) accounts for majority of the local population (76%).
NATURAL RESOURCES	Land resource mainly used for agricultural production. Land cleared via slash and burn. People just used the land around them.	Shift in economic structure has shifted use of natural resources and the forest area. Forest has been reduced to about 40% of total area. Increasing use of natural resources such as minerals – iron, water resources (hydropower). Increased urbanization and growth of urban area. Land is more organized. Climate is a major resource because it helps attract people to the city.
URBAN INFRASTRUCTURE	2 highways – traffic was difficult. Infrastructure not very developed.	New roads (280 KM), railway. City up to standard of grade 3 city, urban areas. Expect to become a grade 2 city in 2015. Compared to the first period, comprehensive system of transportation. System of dikes for flood control developed to prevent flood.
SOCIAL ISSUES	80% illiteracy rate > 30% malnutrition rate 70% poverty rate	Forest area has decreased, so people face difficulties in changing livelihood. Systems of health, education, traffic, and other services meet the needs of 90% of the population, but 10% still lacking access. Colleges in the city – system of education. Reduction in poverty – less than 14%. Emerging issue of rich-poverty gap – inequality, more people are becoming severely poor, leading to social evils.

## 2.3.2

### SERIES 2

Understanding  
Vulnerability & Risk



### Activity 2.3.2

## Future Trends, Future Vision

In the previous activity, you explored past development trends in your city. It was sort of like a car journey—you set off from the past going in a direction that has got us to the present. In this activity, you will continue the journey in the same line and see where you end up. What will the future of your city look like if these trends continue? This information will help you further frame your vulnerability assessment, and will eventually support the development of your resilience strategy.

### IN THIS ACTIVITY YOU WILL:

- ✓ Discuss what the future city could look like if current trends that were explored in activity 2.3.1 continue;
- ✓ Imagine, and have everyone briefly present, their vision of the best possible future for your city; and,
- ✓ Discuss the difference between these two futures, and what it will take to get from the extrapolation of trends to the best possible future.

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## ACTIVITY 2.3.2: FUTURE TRENDS, FUTURE VISION

### INSTRUCTIONS: FUTURE TRENDS

**Part 1: To begin, you should discuss and select as a group a point in the future to focus on.**

It should be far enough out that there are likely to be significant changes, both in development and possibly in climate, but not so far out that the scope of changes is beyond imagining. It may be similar to or shorter than the period of time explored in the first activity, but probably should not be longer.

**Part 2: Working individually, consider what the trends have been and think about what the city will look like if those continue.** How big will the city be? Where will people live? What will they do to make a living? How will they get around? Who will be vulnerable and why? As you do this, think about where current systems are fragile, and whether existing laws or policies are helping or hindering improvement. Think about how past disasters have impacted the city and whether the size and nature of disasters and disaster response are getting better or worse. Think about whether livelihood

options are increasing or decreasing, whether there is in-migration or out-migration, whether there are a few livelihoods on which much of the city is dependent and what the future of those livelihoods might be.

You can write or draw if this helps you think. There are no right or wrong answers.

**Part 3: Following this individual reflection time, take turns describing your future city to the group.** If others have shared many aspects of your future city already, focus on the aspects that have not been discussed. Is there general agreement within the group about what the future will look like if trends continue? Is this a future you want to live in? What are some positive aspects of this future and what are some negative aspects?

## INSTRUCTIONS: FUTURE VISION

**Part 1: Imagine the best possible future for your city.** In the Future Trends exercise, you imagined the future of your city if current trends continue. However, in many cities, continuing current trends of poorly planned development, explosive growth of marginal or migrant communities, increasing demand and stress on basic services, etc. will likely lead to greater risks and less resilience in the future. The goal of this exercise is to begin to identify where the leverage points are for building a more optimistic, resilient future.

Begin by closing your eyes and imagining, or writing or sketching on paper, your vision of the best possible future for your city. Use the same point in time as was used for the future trend assessment. How would this future be different than that future? Imagine that your children and grandchildren are living in this ideal future city. How do they make a living? What do they do in their free time? Where do they live, and what do they eat? How do they get around? What does their city look like—is it skyscrapers and bumper-to-bumper cars on the roads or are there trains and buses, space for pedestrians and parks?

**Part 2: After everyone has taken a few minutes to develop their future vision, briefly share your vision, or aspects of your vision that are new or different from other shared visions, with the full group.** If time allows, your facilitator

may note whether your visions address all four aspects of the Climate Resilience Framework. If not, brainstorm as a group the missing elements. For example:

- What has happened to currently vulnerable populations within the city? Are they still vulnerable?
- Have weak systems been improved? Have they been replaced? Are the replacements just improvements on the old system (i.e. raised dikes) or completely new systems (i.e. living with floods, stilt housing, or extensive, connected parks that double as drainage to route water through the city)?
- How have constraining institutions been overcome?
- What happens when climate hazards—floods, typhoons, droughts, etc.—occur? How are they dealt with? How have people, systems, and institutions adapted to handle these hazards?

**Part 3: Finally, briefly discuss what could be done to begin moving from where current trends are leading to the best possible future you have envisioned.**

## 2.3.3

### SERIES 2

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Vulnerability & Risk



### Activity 2.3.3

## Mapping City Development Trends

Different aspects of a problem often come to light when the problem is represented in a different way. In this exercise, you will draw many of the trends you have been discussing on maps. If, by moving from words to spatial/ visual representation of trends, you find yourself highlighting or emphasizing different aspects of city growth or vulnerability, add these to your earlier tables.

### IN THIS ACTIVITY YOU WILL:

- ✓ Map your city's development trends over the past few decades;
- ✓ Map the informal settlement growth in your city over the past few decades; and
- ✓ Map how the coverage of services – drinking water, electricity, sewage, and solid waste management – has changed over the past few decades.

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### ACTIVITY 2.3.3: MAPPING CITY DEVELOPMENT PLANS

**INSTRUCTIONS:** Begin by either drawing a map of your area of interest or using an existing map that you are comfortable drawing on. Outline the main urban boundary for the time periods you evaluated in Activity 2.3.1. Use a different color for each time period.

Using the same colors for the same time periods, draw in slum or informal settlements and zones of major economic focus. As you work, consider:

- How are the city boundaries changing? Has the city expanded in ways that will put it more at risk or less at risk of climate hazards?
- Are the slum or informal settlement areas changing over time? Are there areas that were slums or informal settlements in the past, but have been converted to other uses? Note where those people are now living.
- Are the economic zones growing? Are new economic zones in different parts of the city being created?

Now, map how the coverage of services has changed over your time periods. Again, use different colors for each time period.

- Do slums and informal settlements receive services now? Did they in the past? How has this affected, or not affected the vulnerability of the inhabitants?
- Are services spreading? If so, how is this impacting transportation and development? How does this affect urban land use and density?

Discuss, first in your small group and then in plenary, what you have mapped and what the implications are for current and future vulnerability. Is there anything else that should be added to these maps to help convey those vulnerabilities?

# 2.4.0

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# CLIMATE CHANGE, EXPOSURE & RISK

One component of vulnerability to climate hazards is exposure, literally putting people, infrastructure, and assets in areas where hazards occur. Climate change is affecting the intensity, frequency, and in some cases, location or nature of climate hazards. This set introduces climate change and its potential future impacts, examines current climate exposure, and explores potential future climate risk. The set assumes a basic understanding of the causes of climate change, global climate models, and the sources of uncertainty in model results.

### IN THIS SET YOU WILL:

- ✓ Be introduced to climate change and its potential future impacts;
- ✓ Examine your historic climate exposure; and
- ✓ Explore potential future climate exposure and hazards and how they combine to form climate risk.

# Climate Change

The Intergovernmental Panel on Climate Change (IPCC) has significant evidence that the use of fossil fuels, deforestation, and changes in land use have led to an increase in greenhouse gases (GHGs) in the atmosphere, causing the Earth's surface temperature to rise. This has already and will continue to result in:

**Increased temperatures:** temperatures are increasing globally. Temperatures on land, particularly in inland locations, are likely to increase more than temperatures over the oceans or near coasts. Cold season and nighttime temperatures may increase more than warm season and daytime temperatures.

**Rising sea levels:** sea levels are rising in response to increased temperatures. Higher temperatures cause the oceans to expand as they warm and melt land-based ice, increasing the amount of water in the oceans. Sea level rise is likely to accelerate over the next 100 years regardless of greenhouse gas emissions.

**Changes in precipitation timing and intensity:** in general, dry regions and dry times of the year are likely to get drier, and wet regions and wet times of the year

are likely to get wetter. When rain falls, it is likely to fall as more intense rainstorms.

**Increased melting of snow and ice:** in areas that experience freezing, precipitation will fall increasingly as rain rather than snow, snowpack will melt earlier, and glaciers will melt faster and at increasingly higher elevations.

**Weather will become more variable:** climate hazards (typhoons, flooding events, extended droughts, and heat waves) are likely to occur more often and may be more intense than past events.

The impacts of these changes in the climate system are likely to include:

- Increasing energy demand for cooling during hot weather events;
- Increased difficulty in meeting water demand during dry periods;
- Increased salinization in estuaries and near river mouths, and possible increases in salinization of near-coastal groundwater reserves;
- Changes in agriculture and fisheries;
- Inundation of coastal and delta areas;

- Spread of respiratory, vector, and water-borne diseases; and,
- Population displacement.

These events will dramatically alter ecosystems and the lives and livelihoods of women, men, and children. Countries such as Indonesia, Vietnam, and Bangladesh, with heavy concentrations of population and economic activity in fragile and vulnerable regions such as coasts, deltas and low-lying areas, are especially threatened by climate change.

Urban areas, already stressed by disasters such as storms and flooding, are particularly vulnerable to climate impacts. Climate impacts will stress physical, built-infrastructure such as transportation, communication, and water delivery systems, increase energy demand, and affect economic sectors such as agriculture, fisheries, and tourism. Impacts may be exacerbated by inadequate infrastructure and housing, limited access to services, limited urban planning and land-use management, and limited preparedness among city populations and emergency services. Urban poor are especially at risk due to location of settlements in areas vulnerable to floods and landslides, limited access to services such as water, energy supply and health, and few assets or safety nets that enable them to manage loss. Women, who often have less access to services or economic resources, are particularly vulnerable. Already urban governments are strained to deliver services and manage impacts of disasters.

Rapid urbanization and population increase, as is occurring in much of the developing world, places additional stresses on urban infrastructure and ecological systems and on the ability of cities to manage climate change impacts.

## Climate Exposure

Disaster risk reduction practitioners often note “natural hazards happen, but natural disasters are created”. This is because it is only when groups of people, systems, and infrastructure in our cities are put in places where natural hazards occur, and when they are left vulnerable to those hazards in those places, that they suffer harm. Historically, cities have grown and developed next to rivers or along coastlines because water is necessary for sustaining a city and integral to economic activities. However, by situating our cities in these locations and altering waterways and ecosystems through land use development, we expose ourselves to numerous climate hazards, including flooding, drought, typhoons, storm surge, and high tides.

How much harm we suffer from a particular climate hazard is determined by our vulnerabilities and our capacities and to a lesser extent, by the intensity and frequency of hazard events to which we are exposed. For example, the poor and socially marginalized often lack the money or social

resources to secure good housing and instead are often left to live in slums or migrant housing communities in low lying areas. The buildings they live in are poorly constructed and easily damaged by wind or water and the location itself often floods. In cases such as this, the “exposure” of these groups is due more to social constraints and resource access than the climate hazards, which, with adequate resources, could be significantly avoided. Similarly, the least expensive land is often located in hazard-impacted areas like floodplains. Governments, seeking to save money on public infrastructure projects, may be tempted to locate critical infrastructure such as schools, water treatment plants, hospitals, and major transportation routes in these areas. However, building in these areas comes with a higher risk due to the high exposure.

Climate hazard mapping is a simple way to explore your climate exposure. Mapping areas historically impacted by climate hazards provides a quick means of visualizing which groups of people, critical infrastructure such as hospitals or electricity generation plants, or areas of your city are more likely to experience hazards. Climate hazard mapping can help you identify flood plains, areas where landslides or wildfires are more likely to occur, and areas of likely storm surge. This knowledge can be used in city planning efforts. Ideally, people and infrastructure will not be situated in the highest-hazard areas; either hazards will be mitigated, or

multiple resilience measures will be incorporated into the development plans. For example, in Thailand a new hospital for the elderly near Bangkok is being constructed on 400 stilts to raise it 15 feet above ground level, mitigating floodrisk.

## Climate Risk

The Bangkok exposure mapping case study—see text box—highlights one of the challenges that climate change is going to pose; the location and nature of climate exposure will change as climate changes. This means that climate risk will change.

Climate risk is an estimate of the likelihood of a climate hazard exceeding a critical threshold and causing an impact to a particular group of people, an area of your city, or a city system as a result of that group’s, area’s, or system’s underlying vulnerability or fragility.

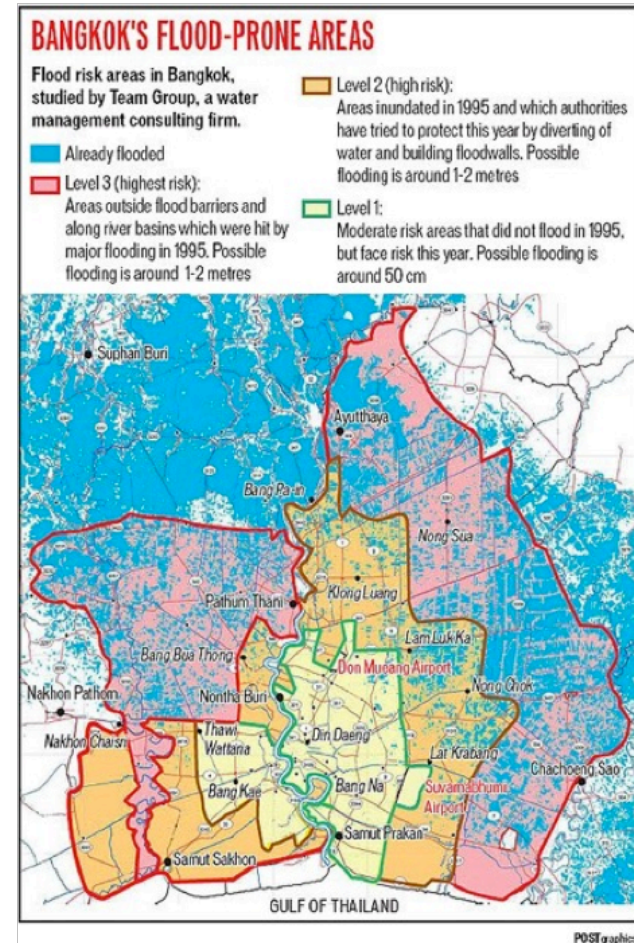
Current and historical climate risk can be quantified with sufficient data. To assess current climate risk, we can use historical data about the hazard—its intensity and how frequently it occurs—to calculate the likelihood of future events of that size. Next, we describe how confident we are in the historical data (how much we believe the data). This



## CASE STUDY

### Climate Hazard Mapping

Bangkok is a low-lying city located in the Chao Phraya river delta, at the bottom of a 160,400 km<sup>2</sup> drainage basin. Much of the city lies only slightly above sea level. Average flow in the Chao Phraya is 718 m<sup>3</sup>/s, but during and following the summer monsoons, flows can reach 6000 m<sup>3</sup>/s. Large areas of the city are exposed to flooding during heavy precipitation events, during peak river flows, and particularly when high flows coincide with high tides. Figure 2.4.1 is a flood risk hazard map for the city showing the relative exposure of various areas of the city to flood. Many of the industrial areas, a World Heritage site that is a significant tourism draw (Ayuttaya) and the domestic airport, are all located to the north and north-east of central Bangkok, areas which fall in the Level 2 (high) and Level 3 (highest) flood risk zones. In 2011, Bangkok was subject to major flooding due to record high flows coupled with high tides. During the floods, the northern sections of the city were underwater for over a month, closing down the domestic airport and many industrial factories. This had enormous impacts not only on the Thai economy, but also on the global economy. Future sea level rise of 30 cm, which is projected to occur by 2050, will significantly increase inundation depth and duration in the city and expand the size of the Level 2 and Level 3 risk zones unless significant actions are taken by the Thai.



**Figure 2.4.1** Flood hazard map of Bangkok, Thailand published during the 2011 flooding.

will depend, in part, on whether we have a long record of past data, or a very short record, and on how accurate we think the data itself is. Finally, we combine the likelihood of hazard occurrence with the severity of impacts, and a description of our confidence in the data, and then use this to describe the level of current risk associated with that hazard for a particular group of people or city system. Once hazard risk is described (qualitatively or quantitatively), it can be used to test out various resilience plans and options to see if the risk is reduced or increased by a particular option or development trajectory. Risk estimates are also used, for example, by city planners to determine zoning, building codes, and other safety measures, and by insurance companies to determine whether, and if so at what cost, they will insure various assets.

Climate change, however, is already changing the type of climate hazard events that occur, their frequency, and their magnitude. This means that identifying the risk of future climate hazard events is going to become increasingly uncertain. Climate change may also result in new climate hazard events. For example, already in various global locations we are seeing impacts of extreme heat events such as road damage due to heat-melting or expansion, railway damage due to rail expansion and buckling, and foundation damage due to extreme soil heating and drying. Similarly, climate change is anticipated to have an impact on concrete

structures through increasing rates of deterioration as well as through the impacts of extreme weather events (Wang et al., 2010).

This is why we focus on building resilience rather than addressing individual climate hazards. It is going to become increasingly difficult to provide the climate information necessary to support design specifications for dams, dikes, flood control channels, and so forth. There are techniques that allow more precise identification of potential climate changes at a given location, such as downscaling global results to provide information at a much smaller, more local scale. Clearly, for major infrastructure development, this is necessary to quantify, as best we can, the nature and magnitude of potential climate changes. In some cases, however, unresolvable uncertainty may lead planners and engineers to find alternative design approaches that are less dependent on climate specifics. And, for most planning and non-structural resilience actions, the broad climate change information available from global circulation models is enough to begin to act. By building resilience, rather than attempting to engineer solutions to a rapidly changing climate, your city will also far better prepare itself for the unexpected.

## How to Use Climate Projections in Your Resilience Building Process

First, try to obtain the best future climate data available for your location. There is a great deal of information available about climate both globally and regionally, and the more accurate picture you can get about possible climate changes at your location, the better. You and your facilitator should look, at the national and regional level, for climate modeling organizations and begin a dialogue with them about how they can support your process. In many cases, donor agencies, climate or disaster focused NGOs, and local or national meteorological offices may also be able to provide suggestions for where to look for future climate data.

As you look for future climate data, there are three key things to remember about what you need and how you should use it:

First, the data you obtain are not predictions. The data do not tell you what the future climate will be like. Instead, what you have obtained are “projections,” a statement about what might happen in the future. So, even if the data indicate a 2°C increase in winter temperature in 2040, that doesn’t make it a planning target.

Second, climate scientists cannot project future climate accurately. There are currently about 30 global circulation models producing results for 6 different possible future conditions (called “scenarios”). Each model produces slightly different results for each scenario, and we have no reason to believe one model or scenario is more likely than any other model or scenario. Ideally, when you are given climate data, it will be based on results for several models, will provide results for two or more scenarios, and will give a range of possible future conditions for each scenario (e.g. temperature increases of 2.3 to 3.5 °C by 2050 for the A2 scenario). If you are just given a single number, be aware that the values you are looking at represent the mid-point of what may be a fairly large range. Although the data you receive might project an increase in wet season rainfall in 2040 of 3%, the full range of models and scenarios might actually project changes ranging from an increase of 20% to a decrease of 10%.

Third, whatever data you are given will not reflect the increase in variability that future climate is likely to have. For example, even if you are given a range of possible rainfall changes, only very specialized climate data would address how intense the rainstorms will be that deliver that rain. You will probably be given, at best, monthly future climate information

for a particular point in time, such as 2040. This provides little guidance about how daily high or low temperatures could change or what individual storms might look like.

Ideally, when you obtain your climate data, you will obtain it from a source that you can have an ongoing discussion with. If this is the case, begin building a relationship with your climate data provider. Ask what scenarios the data represent, and whether it is from multiple models or just one. And, see if they will engage directly with your resilience building effort. Climate scientists typically distribute climate information in ways that are easy for them to produce, and this is rarely in a form that is particularly useful for city resilience planning. If you can teach your climate data provider about the types of climate data you need to support building resilience on the ground in your city, both you and they will benefit.

## 2.4.1

### SERIES 2

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### Activity 2.4.1

## Mapping Hazard Exposure

One component of vulnerability is exposure—putting people, infrastructure, and assets in areas where hazards occur. In this activity, you will explore the types of climate hazards that currently affect your city, map the areas of the city impacted by each type of hazard, and note the severity of impact in each area. For this activity, you will focus on climate hazards, such as flooding, storm surge and tidal damage, erosion, landslides, forest fires, and drought. Geological hazards such as earthquakes, volcanoes, and tsunamis do not need to be mapped.

### IN THIS ACTIVITY YOU WILL:

- ✓ Explore the types of climate hazards that impact your city;
- ✓ Sketch a map of your city and identify areas of the city that are exposed to or repeatedly affected by climate hazards; and
- ✓ Indicate the severity of these climate impacts using a qualitative scale of Low, Medium, High, and Severe.

## ACTIVITY 2.4.1: MAPPING HAZARD EXPOSURE

### INSTRUCTIONS

For this activity, you will begin by discussing the hazards that impact your city and recording the key points from your discussion in the table provided. The first line has been filled in as an example. Note: you may want to address things like annual flooding, flooding caused by intense individual rainstorms, and catastrophic monsoon-induced flooding as different hazards, particularly if the types of damages, areas affected, or duration of the events is significantly different.

1. Discuss as a group the types of climate hazards that impact your city. Write down the hazards you identify. These could include, but are not limited to: annual floods, major floods, typhoons, drought, forest fires, intense rainfall events, heat waves, cold snaps, early monsoon, late monsoon, landslides, etc.
2. How frequently does each of these hazards occur? Are they annual events? Every decade? Every hundred years?
3. What areas are impacted? Are hazard impacts broadly distributed or generally concentrated in small areas? Are all impacted areas affected equally?
4. What are the impacts of each hazard? Are damages economically large? Can the hazard impacts result in loss of life? Do impacts disrupt city life and the lives of citizens for extended periods of time? Are a high number of people impacted in a given event?
5. How would you prioritize this hazard? Is it of major concern in your city? Is there city planning around responding to the impacts of this type of hazard (e.g. a Disaster Risk Response plan or similar)? Is there an early warning system in place to warn of the potential arrival of this hazard? Rate the priority as Low, Medium, High, or Severe.
6. Finally, note anything else that comes up in your discussions in the Additional Notes column.

Part 1: Complete the matrix below

Hazard	Frequency	Area impacted	Impacts	Hazard priority	Additional notes
Annual flooding	2-3 times per year during rainy season	Rice fields, areas near lagoon, areas along river that are not dike-protected.	Inconvenient to those living in flooded areas, sometimes crop loss, impacts to transportation on smaller roads.	Low	Priority can be medium if flooding coincides with high tides. Severity increases because damage to homes and crops increase, length of inundation increases, impacts to transportation and transportation infrastructure increase.

**Part 2: Next, locate the areas impacted by each of the hazards you have discussed on a map of your city.**

1. Begin by sketching a map of your city (if city maps are available, and you are comfortable writing and drawing on them, feel free to use them).
2. On your map, outline the areas impacted by the climate hazards you identified above. Start with the hazards you identified as the highest priority. If the map is getting too crowded by the time you have added two or three hazards, but there are other hazards that are still high or severe priority, start a second map.
  - If you can, use a different color for each hazard type.
  - Within each hazard area you have outlined, write down approximately how often that hazard occurs and note the priority level you assigned that hazard.
3. Review your map – which areas of your city are most exposed to climate hazards? Where do the highest priority hazards occur? Do these overlap with the areas of highest impact? Discuss your results briefly.
4. Mark critical infrastructure on your map. Make particular note of facilities that are in areas that have been repeatedly exposed to a particular hazard, whether they were damaged or not.

- Hospitals, schools
- Electricity generating plants
- Waste water treatment plants
- Drinking water treatment plants or community wells
- Airports
- Bus terminals, train stations
- Markets
- Roads, railroads, or other transportation lines
- Ports

Share and discuss your results with the full group. Have you learned or noticed anything about your city's climate exposure that you hadn't been aware of prior to this activity?

Are there specific locations within the city, specific groups of people, or specific city systems that are more susceptible to hazards than others?

Are there climate hazards you did not discuss or map, such as drought-related food shortages resulting from droughts occurring elsewhere in your country or even in another country? Or closure of major transportation routes due to landslides that occur well outside city boundaries but nonetheless impact commerce in the city? Because cities are dependent on goods and services drawn from a much

larger area than the city boundaries, even climate events in far-distant locations can have significant or even devastating impacts on your city. If you have not already, briefly discuss how national, regional, or even global climate events impact your city. Add additional hazards to your table or maps if appropriate.

Save the maps and table you have produced; you will refer back to them in future activities in this Series.

## 2.4.2

### SERIES 2

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### Activity 2.4.2

## Exploration of Historic Climate Event Impacts

In this activity, you will explore one or two recent, significant climate events for your city. These can include events such as droughts, floods, typhoons, or heat waves. The goal of this exploration is to understand the roles that agents, systems and institutions played in exacerbating or mitigating impacts of past events.

### IN THIS ACTIVITY YOU WILL:

- ✓ Select one or two significant climate events for your city to explore in detail;
- ✓ Identify people and systems impacted by the events;
- ✓ Discuss the role of agents, system fragility, and institutions in mitigating or exacerbating the impacts of the event; and
- ✓ Consider how recently implemented or planned development or policies might change the impacts of similar events in the future.

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## ACTIVITY 2.4.2: EXPLORATION OF HISTORIC CLIMATE EVENT IMPACTS

### INSTRUCTIONS

In the full group, select one or two significant climate events that have impacted your city. At least one event should have occurred within the past 5 or 10 years. Then, divide into small groups (5-8 people each). In each small group, discuss the questions posed in the following table and record your answers in the space provided.

When all groups have completed their tables, reconvene and share your answers. Did all groups answer the questions similarly, or were there significant differences between groups?

If there were significant differences, spend some time exploring why. Are there different understandings of the Climate Resilience Framework and how agents, systems and institutions are used, or different perspectives on the past climate events you were exploring? There is no “right” way to answer these questions. If there are widely differing understandings of past disasters, this should be carefully explored. Understanding the reasons for the different responses will provide valuable input for the resilience building process.

If there were not significant differences, briefly consider as a group whether the inclusion of members of a vulnerable group, or from different organizations or departments would change the answers in any way.

## ACTIVITY 2.4.2: EXPLORATION OF HISTORIC CLIMATE EVENT IMPACTS

### INSTRUCTIONS

This exercise will be completed as small group discussions. Please have someone record the discussion on the following matrix.

Event:		Date:
Systems	What systems or aspects of systems were affected?	
	Why were those systems affected (underlying fragilities)?	
	Were these expected failures? Were there unexpected failures?	
	What was the role of organizational or agent response in improving or failing to improve the situation?	

City residents (Who)	Who was affected?	
	Why were they affected (underlying vulnerability)?	
	What were the impacts on those people, and were those impacts expected or unexpected?	
	What was the role of organizational or agent response in improving or failing to improve the situation?	
Institutions	Was government or organization response effective or ineffective?	
	Were there rules, laws, or policies that constrained or enabled effective responses?	
	Are there new rules, laws, or policies that, if enacted, would mitigate impacts of a future event?	
Exposure	Are there development plans currently underway that will affect the areas or systems impacted by this climate disaster?	
	Once completed, how will this development interact with similar climate events?	

## 2.4.3

### SERIES 2

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### Activity 2.4.3

## Exploring Climate Change and Climate Risk

Climate change will change the severity and duration of current climate hazards and will cause new climate hazards in your city. In this activity, you will explore how climate change could alter existing climate hazards or create new hazards.

### IN THIS ACTIVITY YOU WILL:

- ✓ Explore how climate change could intensify or reduce current climate hazards;
- ✓ Discuss recent climate events that seem to be different from past climate events and the problems or benefits these changes are posing to your city and citizens;
- ✓ Discuss new hazards that climate change may pose for your city; and
- ✓ Brainstorm ways that future problems related to climate change could be reduced or future benefits leveraged.

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## ACTIVITY 2.4.3: EXPLORING CLIMATE CHANGE AND CLIMATE RISK

### INSTRUCTIONS

#### PART 1: “CLIMATE IDOL”

This activity will begin with a game, “Climate Idol”. Divide the trainee group into smaller groups of 4–5 people each. Each group should select a climate hazard from the table you created in Activity 2.4.1. You are unlikely to be able to address all the climate hazards listed; try to work with a range of hazard types and severities.

Each team will refer to the information presented on climate change and the types of changes we expect to see. Using this information, decide how you think your climate hazard will change in the next 30 to 50 years. Will your hazard become more severe or less severe? If your future hazard impacted your city today, would it affect a larger portion of the city or a smaller portion? Which groups of people or systems will be most impacted?

Once you have a clear picture of your future hazard, brainstorm actions that could be taken that would make the city or its inhabitants more resilient to that future hazard. Pick the action that you think could be most effective and also the most realistic to implement.

When all groups are ready, groups take turns presenting your hazard, what you think it will look like in the future, and potential resilience action to address that hazard. Members from other groups can ask questions or point out aspects of the hazard that might have been missed, ways that impacts might be different from those presented, and ways that the proposed action might not work or could be improved upon. Once all the groups have presented, all participants vote on which group they think did the best job of identifying: a) their future hazard; b) the potential impacts of that future hazard; and, 3) potential resilience actions.

#### PART 2: IS CLIMATE CHANGE ALREADY HAPPENING?

For this section of the activity, rearrange into slightly larger groups of 6–8 people. In each group, discuss the following questions and note down your answers. Once all the groups have explored the questions, briefly report back to the plenary the key indicators you see that climate change is already happening in your city.

1. When you think about climate events that have occurred in the past several years, are there things that seem to be different from past climate events?

For this discussion, consider not just the major climate events you explored in Activity 2.4.1 but also smaller scale climate events like heat waves, wet periods that have led to disease outbreaks, intense rainfalls that have caused localized flooding, wet season rains arriving early or late, etc.

2. What new problems are these changes causing?
  - Who or what is impacted?
  - How are they impacted?
  - How long do impacts last?
  - What could be done to make these events less of a problem?
3. Are there recent shifts in climate that are primarily beneficial? For example, fewer periods of deep cold during the winter, and milder winters in general, so there are fewer cold-related winter deaths and winter heating demand is lower city-wide.
  - If so, how do these events benefit people or systems?
  - Who is benefitting? Everyone? Specific communities or people? Are there people who are not benefitting or are even being harmed?
  - Are their ways to make better or wider use of these benefits?

4. Are the impacts of these events entirely due to climate or climate change (e.g. your city has always had trouble with flooding, or, the monsoon seems to be arriving later) or they are a combination of climate and development (e.g. flood patterns are changing, both because rainfall seems to be changing and because how floodwaters move through the city has been changed by building dikes and roads and other structures)? Often events such as floods can be intensified by development in low-lying areas or lack of city-wide drainage networks. Could the “climate” events you identify be caused by development rather than changes in climate?

### PART 3: NEW HAZARDS

Finally, reconvene as one large group and discuss what new hazards climate change might pose to your city. For example:

- Vietnam is currently a net exporter of rice. However, much of that rice is grown in the Mekong Delta, which is projected to be heavily impacted by sea level rise. Will national food security increasingly become an issue in Vietnam?
- In many developing countries, there is a growing lower-middle class that is highly dependent on physical assets for their livelihoods, such as a motorcycle, which supports working as a delivery person, or a sewing machine for a tailoring business.

Could this create a generally secure segment of the population that is nonetheless highly vulnerable to disasters that could damage their physical assets, such as a large flood or severe typhoon?

# 2.5.0

## SERIES 2

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### Contents of Set

2.5.0: Guide

2.5.1: Activity 1

2.5.2: Activity 2

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# POVERTY AND VULNERABILITY

Vulnerability is often equated with poverty; “vulnerable” populations are identified by per capita or household income. Yet, this is often an oversimplification and may overlook many highly vulnerable groups and households because they have slightly more, or even significantly more, income than the poverty cutoff. This is particularly true in urban environments, where the factors contributing to and maintaining vulnerability can be complex. In this set, you will explore the concept of vulnerability and the factors that contribute to creating and maintaining vulnerability, such as lack of supporting systems, or institutions which limit access to systems or livelihoods or otherwise limit the agency of those who are vulnerable, constraining their ability to act on their own behalf.

### IN THIS SET YOU WILL:

- ✓ Explore the relationship between poverty and vulnerability;
- ✓ Consider how urban vulnerabilities differ from rural vulnerabilities and what this means for entry points for building resilience; and
- ✓ Unpack the underlying vulnerabilities—such as little access to medical care or lack of land tenure—that make a particular group of agents more susceptible to suffering harm during a climate hazard event.

## Vulnerability

Vulnerability is the degree to which someone or something (agents and the systems on which they depend) can be affected by exposure (e.g. short-term climate hazards such as storms or long-term changes such as sea level rise) and their ability to anticipate, prepare for, and/or respond to the impacts of that exposure. Vulnerability depends on a range of physical, social, human, economic, and environmental factors that increase susceptibility to climate change impacts and that affect adaptive capacity.

Vulnerability assessments are about understanding people and systems, to what they are vulnerable, the factors contributing to vulnerability, and their capacity to adapt.

Women and men of different social groups have different vulnerabilities to climate impacts and different adaptive capacities for addressing those impacts. This is in part due to differing roles, opportunities, and access to resources. Lack of access to services, economic poverty, and cultural norms often further exacerbate social and gender differentiated vulnerability. Compounding these factors, socially marginalized groups and poor populations are seldom involved or given voice in decision-making processes related

to short or long-term planning for climate change. As a result, their concerns are less likely to be known by decision-makers or addressed in relevant policies and practice.

The most poor are almost always among the most vulnerable populations in a given area. They lack the resources to prepare for or recover from climate disasters, have limited livelihood options, often lack access to basic services and systems, and their ability to implement adaptive strategies (e.g. growing their own food, building more secure housing, etc.) are often limited by institutional constraints (e.g. lack of land for agriculture, lack of secure tenure to support investment in more secure housing, etc.). However, while all poor may be vulnerable, not all the vulnerable are poor. Those engaged in climate-sensitive economies (for example, agriculture or fishing), or on economies reliant on climate-sensitive inputs (for example, clothing manufacturers reliant on a steady supply of cotton), may be heavily impacted by climate change though they have not traditionally been seen as “vulnerable”. Age may also place certain populations more at risk, such as children and the elderly, who may be more susceptible to health impacts. Even within poor populations, there will be those who are more vulnerable than others. Two households with the same number of people and the same household incomes may have very different vulnerabilities if one household has access to credit and the other does not.

Analyzing how different social groups, including women and men, may be vulnerable to climate impacts and assessing their differing adaptive capacities is critical to develop strategies to reach these groups, reduce their vulnerability, and strengthen their resilience. Those likely to be vulnerable to climate impacts include, but are not limited to:

- Slum, squatter, and migrant populations resident in informal settlements. These settlements are often located in physically vulnerable locations. Economic poverty, limited access to services such as water, energy, health and finance, and insecure tenure exacerbate vulnerabilities. Shelter may be limited or of poor quality and unable to withstand or function well during extreme climate events;
- Those engaged in climate sensitive livelihoods such as agriculture, livestock, aquaculture, and fisheries, which are key livelihoods in urban, peri-urban, and rural areas;
- Industrial and informal sector workers, whose occupations place them at significant risk to natural hazards or poor working conditions;
- Children, the elderly, and the physically handicapped who may lack the mobility, resources, or physical stamina to prepare for or cope during climate hazard events; and

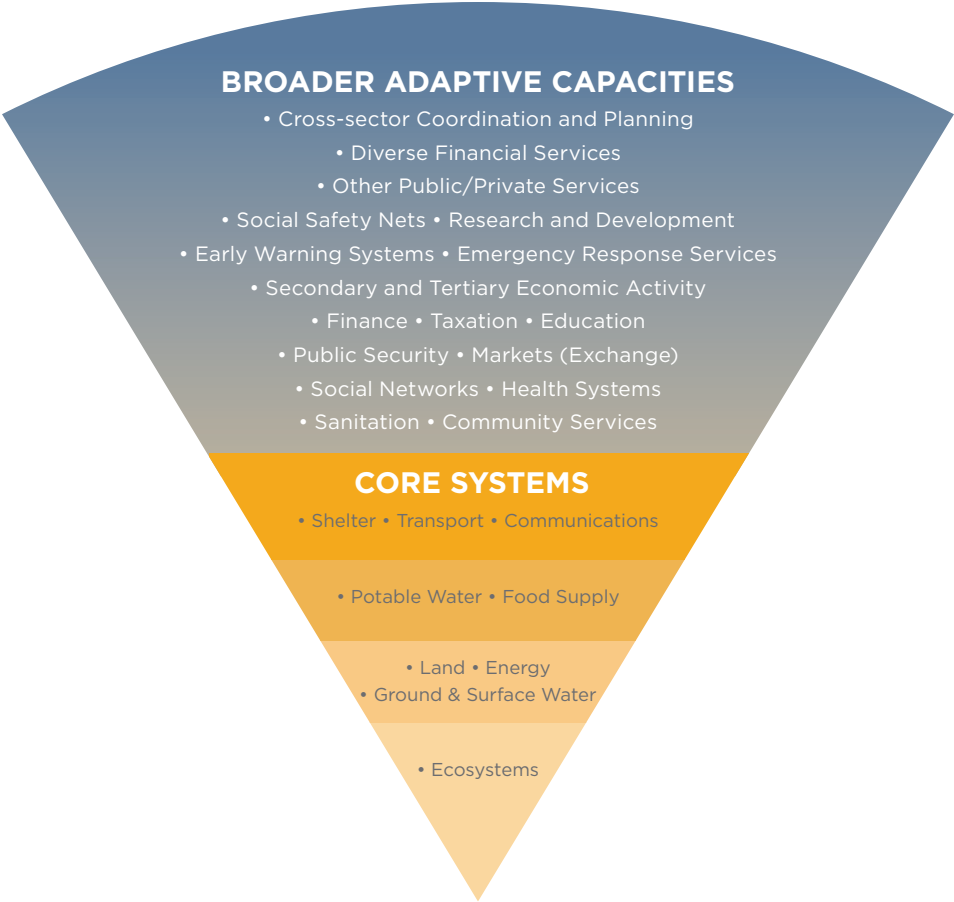
- Women, due to limited economic assets and cultural barriers around access to knowledge, education, or financial services that would otherwise support them to adapt.

## Vulnerability in Urban Contexts

A critical element of vulnerability in urban environments is access to core systems. If core systems are fragile, and fail during climate hazard events, or if institutions limit access to those systems, the people dependent on those systems will be highly vulnerable. Figure 2.5.1 illustrates core and higher systems. Only when core systems are in place can higher systems begin to be developed and/or used. Consequently, a key element of assessing vulnerability is understanding how vulnerable groups access core systems, the types of factors that constrain or limit that access, and whether the core systems themselves are fragile to climate exposure (system fragility is addressed in Set 2.6).

Moving beyond poverty in identifying vulnerability, particularly in an urban environment, can be complicated. Vulnerability may depend on places people live (e.g. exposed floodplains), the strength of their houses, or the functioning of communication and transportation systems at times of

FIGURE 2.5.1: Systems graphic, illustrating core and broader adaptive capacity systems



floods. It may depend on social dimensions such as age and gender, low caste or ethnic groups, levels of family and social networks, access to health and other services, or political stability. It may also depend on the level of disaster preparedness. Levels of education, literacy, and even attitudes of helplessness may also affect vulnerability. Low incomes or loss of financial assets may inhibit people's opportunity to recover. Similarly, economies lacking a diverse productive base may be more vulnerable. Environmental factors such as obstruction of natural drainage systems, unstable slopes due to deforestation, limited fish stocks, and limited availability of water affect the ability of social and ecological systems to respond to climate changes. These factors contributing to vulnerability are inherently connected. For example, changes in environmental factors, such as lack of water availability or reduced water quality during a drought can directly affect the food security and health of populations, rendering them even more vulnerable. Simultaneously, built infrastructure such as water treatment or cell phone towers could be impacted by low flows and associated reduction in hydroelectric power. Rolling blackouts and reduced reliability of the communications network would place additional stress on vulnerable groups.

Identifying core vulnerabilities among populations, particularly in urban environments, requires engagement with the populations themselves. Tools such as Vulnerability

and Capacity Assessments, household surveys, household histories and narratives, key informant or focus group interviews and other similar techniques are required here to gain a solid "bottom-up" understanding of the issues. As you conduct your bottom-up analysis, you will want to note, in particular, existing resilience capacities and strategies exhibited by your target groups. Table 2.5.1 provides an example of what capacities and vulnerabilities might look like in practice.

**TABLE 2.5.1: QUALITATIVE VULNERABILITY AND CAPACITY MATRIX FOR WOMAN-HEADED BUSINESSES AT A CITY MARKET.**

Who or What	FLOOD HAZARD (TO WHAT)		
	Capacities/ Vulnerabilities (Why)		
	Agents	Access to Systems	Institutions
Women-headed Businesses at the City Market (Agents)	<p>Capacities:</p> <ul style="list-style-type: none"> <li>• Formation of a women micro-finance support group</li> <li>• Informal support group of women-owned small business</li> </ul> <p>Vulnerabilities:</p> <ul style="list-style-type: none"> <li>• No connections to city government</li> <li>• No representation on the formal business and economic development board</li> </ul>	<p>Capacities:</p> <ul style="list-style-type: none"> <li>• Good roads and bus system to allow women to move goods to market</li> <li>• Electricity and piped water at the market for small manufacturing.</li> </ul> <p>Vulnerabilities:</p> <ul style="list-style-type: none"> <li>• Semi-permanent stalls are easily damaged during floods.</li> <li>• No formal insurance to recover losses from floods.</li> <li>• No solid waste pickup at market. Waste clogs the paths and increases flood depths.</li> <li>• Low incomes and little economic diversity</li> </ul>	<p>Capacities:</p> <ul style="list-style-type: none"> <li>• New laws to help women start businesses</li> </ul> <p>Vulnerabilities:</p> <ul style="list-style-type: none"> <li>• Strong cultural discrimination against women doing business</li> </ul>
			<ul style="list-style-type: none"> <li>• The women-owned businesses at the market are confined to the low-lying area of the market. Consequently, their stalls flood first during heavy rainstorms.</li> </ul>

## Building Resilience Among Vulnerable Groups

Within the framework, building resilience of agents means building the capacities of social agents to access and maintain urban systems and to develop adaptive responses. Key capacities that contribute to agent resilience and adaptation include the following:

- **Responsiveness:** capacity to organize and re-organize in response to opportunity; ability to establish function, structure, and basic order in a

timely manner in response to a disaster event. For example, household emergency preparedness.

- **Resourcefulness:** capacity to identify and anticipate problems, establish priorities, and mobilize resources for action. This includes the capacity to visualize and plan, which may require collaboration. It also includes the ability to access financial and other resources, including those of other agents and systems in order to take action.

- **Capacity to learn:** ability to learn from past experiences in ways that avoid repeated failures and improve performance, as well as to learn new skills.

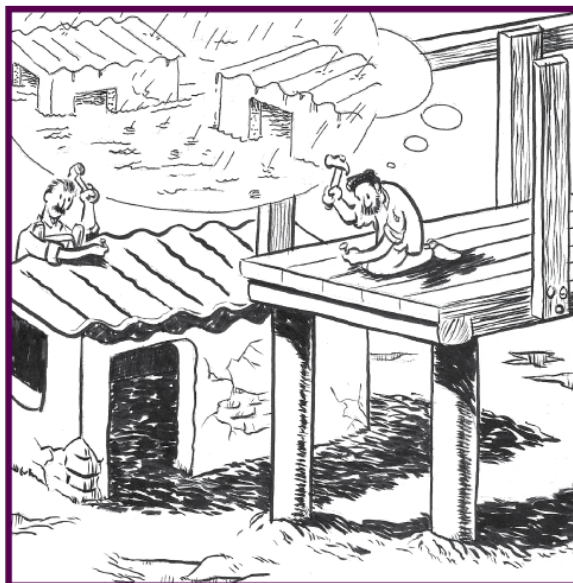
Often interventions to reduce vulnerability to disasters focus on reducing sensitivity to climate hazards, such as building higher dikes along flood prone rivers or sea walls as coastal defense mechanisms, rather than strengthening resilience and adaptive capacity of those being impacted. However, current approaches to disaster management and infrastructure engineering may be less appropriate when climate becomes more variable. The issues may be not simply engineering standards, but the whole approach to engineering (e.g. safe fail designs instead of fail-safe); this is discussed further in Set 2.6. Supporting autonomous adaptation by systematically building the resilience of vulnerable groups, rather than very costly high standard infrastructure that cannot be feasibly protected from extreme events, is likely to prove increasingly cost-effective.

Activities 2.5.1 and 2.5.2 will lead you through an initial exploration of vulnerability and resilience. As you engage in these activities, keep in mind the definition of vulnerability:

Who might suffer harm, **because of what** and **why**.

As you explore vulnerability, look beyond just who is vulnerable. Deeply explore the **because of what** and **why** elements of vulnerability. If they are vulnerable “because”

they have to rebuild their housing every year and it keeps them in poverty, then explore **why** they have to rebuild their housing. What keeps them in poor housing? What keeps them located where they are? What prevents them from being responsive? What resources would they need to better respond? What have they learned from past events and what keeps them from adapting more effectively to future events? This deeper understanding will build the foundation on which resilience actions can be identified, prioritized, and implemented.



**AGENTS**  
Capacity to Learn

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Illustration by Jamie Stroud

## 2.5.1

### SERIES 2

Understanding  
Vulnerability & Risk



## Responding to Crises



### Activity 2.5.1

Different people have different strategies and resources for responding to a crisis. What are yours? In this activity, we will explore what you and the other members of this training would do to respond during a crisis.

#### IN THIS ACTIVITY YOU WILL:

- ✓ Explore the types of strategies and resources you and your colleagues use to respond to crisis situations.

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## ACTIVITY 2.5.1: RESPONDING TO CRISES

### INSTRUCTIONS

Consider what types of events would be a shock or crisis for your family. This could include natural disasters (droughts, floods), epidemics, inflation, loss of land due to planning, damages to your home or the home of an extended family member, death or major illness of a family member, loss of job, etc. Choose one shock or crisis that could realistically happen to you or your extended family. If you or your extended family have recently experienced a shock or crisis, you are welcome to use that experience for this exercise if you would like to.

Now, find one person to work with. Work as a pair to answer the questions:

- How do you respond if you experience a shock or crisis? What resources would you call on?
- Are there strategies you do employ, or could employ, to avoid this type of crisis in the future?

For example, if you suffered a health crisis, do you have access to medical care? Would you use savings to go to the doctor? Would family members help out, either financially or

by looking after children or providing food? What kind of daily support might you need and where would you go to get it? What types of activities do you do now that you might have to give up, at least temporarily?

If your crisis is the primary wage earner in the family losing their job, would that wage earner move to a new city for work, or ask influential friends to help them obtain a new job? If the primary wage earner moved to another city, how much of the family would move with them? No one? Just the immediate family? The entire extended family? If some of the family did not move, how would the daily routine of the family be impacted? Would they need to rely on extended family and friends for additional support?

Spend some time to explore your crisis, what it would mean for your life, and all the resources you can tap into to respond to that crisis. Consider city or national systems, such as health care, job boards, or access to loans that could help you respond. Consider personal resources, such as education, connections through family or professional or social groups, or financial savings that you might take advantage of.

Consider the network of family and friends you might rely on and what sort of support they would or could provide.

Take turns with your partner discussing and questioning one another regarding your selected crisis and the resources and strategies you would use to address it. Then, reconvene in the full group and briefly report back the results of your discussions.

Discuss in the full group how this exercise illustrates a step of the analysis required in a vulnerability assessment: looking at the needs that different crises pose and identifying the resources needed to meet all those needs.

Keep this exercise in mind as you move to the second activity in this set. In activity 2.5.2, you will explore vulnerability. As you do this, consider the resources the people in this training group have access to. What types of resources could poor or vulnerable groups access if faced by a similar crisis? If you don't know, where could you look, or what type of study could you undertake, that could provide answers to these questions?

## 2.5.2

### SERIES 2

Understanding  
Vulnerability & Risk



### Activity 2.5.2

## Exploring Vulnerability

Every person living and working in your city or the city periphery, including you, is exposed to climate hazards. Different groups of people suffer different levels of harm during climate hazards, economic crises, or other difficult times because they have different strengths (capacities, including access to systems and supporting institutions), weaknesses (vulnerability, including lack of access to systems and constraining institutions), and degree of exposure to the particular disruptive event. In this activity, you will select a particular vulnerable group in your city and explore that group's capacities and vulnerabilities, including: the laws, policies, and customs that limit or help this group of people; the types of resources they have available; and their access to city services, functions, and ecosystems.

### IN THIS ACTIVITY YOU WILL:

- ✓ Discuss whether poverty and vulnerability are different ideas in your context;
- ✓ Explore “what is poverty” and “what is vulnerability;” and
- ✓ Identify existing information about or representation of poverty and vulnerability in your city.

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## ACTIVITY 2.5.2 : EXPLORING VULNERABILITY

### INSTRUCTIONS

#### PART 1: POVERTY VS. VULNERABILITY

Are poverty and vulnerability the same or different? Start by discussing whether poverty and vulnerability convey different information in the context in which you are working. What does “poverty” mean? What does “vulnerability” mean? If you are working in a language other than English, when you translate these words, do they both translate to the same word in your language? If you cannot distinguish between these, then do this exercise just for the one poverty/vulnerability concept you have.

Discuss as a group, ‘what is poverty?’ Some questions you might want to consider are:

- Is there an official ‘poverty line’ in your city, a level of income below which a person or family is considered to be “poor”?
- Is poverty solely dependent on income?
- If someone in your city and someone in the countryside have the same income, are they equally poor?
- Is there a measure of poverty that is not tied to income?

Next, explore ‘vulnerability’. Again, questions you might want to consider are:

- Who are the vulnerable people in your city?
- Where do they live?
- What do they do for work?
- What resources do they have that they can use or rely on during disasters or crises?
- What sort of events are “crises” for these people?
- What happens to them during economic downturns or climate disasters?

#### PART 2: WHO IS VULNERABLE?

Often, city residents have an image of “those people”—the slum dwellers, the migrant workers, the female headed-households, the boat-people—as the vulnerable people in a community. However, there are often other groups, those that are not quite as desperately poor or vulnerable, who are overlooked. In this section, we want to identify those

vulnerable but not quite as desperate groups. These are the groups that can be *unexpectedly* at risk from sudden shocks or crises. For example, barbers can be particularly impacted by economic downturn, because people choose to skip haircuts or cut their own hair.

Some of the questions you might want to explore as you consider this idea are:

- If you have an official “poverty line”, who are the people who lie just above the poverty line? Are they really less vulnerable than those below the poverty line?
- What groups are particularly dependent on weather or climate? This could include those involved in farming, aquaculture and fishing, but also small-scale tourism, the elderly, handicapped or children who might be disproportionately impacted by extreme weather events, migrant workers who depend on climate related employment, etc.
- Are there other groups of people that are not generally considered vulnerable that nonetheless could become vulnerable if conditions shift only slightly?

### PART 3: EXISTING INFORMATION

This third section is designed to deepen the discussion around vulnerability by beginning a dialogue around poverty and vulnerability issues and seeing where it goes. If the first question or two take you off in an interesting and useful direction, there is no need to return to the rest of the questions.

- What kinds of information about poverty are there in the city?
- Is there statistical information regarding the distribution of poor people?
- Are there services or safety nets for people living below the poverty line? If so, are the same safety nets or services available for the near-poor?
- Can people be poor because they cannot access social networks?
- Are migrants and people who are not registered considered members or residents of the city? What services and systems do they have access to? Are there laws, policies; or social expectations that limit their access to services that other community members have?
- Is your city an expensive place to live?

- How do people with very little money manage to live in your city? What are their adaptation strategies to compensate for being poor?

## PART IV: MAPPING VULNERABLE GROUPS

In Activities 2.3.3 and 2.4.1 you mapped City Development Trends and Hazard Exposure. As part of these exercises, you considered vulnerable groups and areas of the city. If you have access to those maps, work with the first set of questions below. If you don't, work with the second set of questions. Once you have finished either the first or second set of questions (Maps or No Maps), complete the third set of questions (Climate Change).

Divide into small groups of 4–6 people.

**Maps:** Review your maps from Activities 2.3.3 and 2.4.1:

- Are the vulnerable groups and areas you discussed in this activity represented on those maps? If not, add them, or start a new Poverty and Vulnerability map.
- Do the maps from Activity 2.4.3 indicate high hazard areas that you have not considered in your discussions in this activity?

- If you combine the information from your previous mapping activities with what you discussed in this activity, do you find new areas, groups, or classes of vulnerable peoples that you haven't yet discussed?
- Are there things you have discussed—vulnerable groups or geographic areas, fragile systems, or other information—that are core information about your city's vulnerability that are not represented on your maps? Add them to one of your maps.

**No Maps:** If you do not have maps from Activities 2.3.3 and/or 2.4.1:

- Draw a map of your city.
- On the map, identify vulnerable areas or groups.
- Add areas that are heavily impacted by climate hazards. Ideally, sketch in different climate hazards (typhoons, annual flooding, intense rainfall flooding, drought, windstorms, landslides, erosion, etc.) in different colors.
- Add other information that helps explain vulnerability in your city. This might include: sources of water or food; major transportation routes; service coverage such as areas with piped water, electricity, solid waste disposal, sewers; areas with rapid urbanization; etc.

- Is there anything else from your discussions in this activity that should be added to your map? If so, add it now.

**Climate Change:** On your maps, identify areas, systems, or groups that would be more vulnerable as a result of climate change. For example (this list is not comprehensive—this is just the type of question you might want to consider):

- Are there secondary areas that might flood or be subject to high erosion or landslides if flooding got worse?
- Are there areas that would be impacted by longer or more frequent droughts?
- Are there specific areas/systems/people that would be impacted by heat waves?
- Are there areas that are heavily dependent on tourism that might be impacted by climate-related tourism reductions?

Each small group should share their maps with the full group, with subsequent groups noting just information not included on previous maps.

# 2.6.0

## SERIES 2

Understanding  
Vulnerability & Risk



### Contents of Set

2.6.0: Guide  
2.6.1: Activity  
2.6.2: Case Study

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# SYSTEM FRAGILITY

Urban systems include infrastructure and ecosystems that support the high density of human occupation and economic activity in cities. They are essential in creating the productive opportunities central to urban life. When these systems are fragile—when their functioning is easily disrupted—the people reliant on them are put at risk. Resilience of vulnerable groups can frequently be increased by improving the resilience of the systems on which they depend.

### IN THIS SET YOU WILL:

- ✓ Be introduced to the idea of fragile and resilient systems;
- ✓ Consider how urban systems differ from rural systems and what this means for vulnerability and entry points for building resilience; and
- ✓ Explore the underlying fragilities and exposure—such as dependence on only one avenue for delivering a service, construction in a floodplain, or ecosystem degradation—that might make a particular system, service or function susceptible to suffering harm from climate hazards.

## What is System Fragility?



Urban systems include infrastructure and ecosystems that support the high density of human occupation and economic activity in cities. They are essential in creating the productive opportunities central to urban life. Urban systems include infrastructure, services, and functions (such as water supply and wastewater treatment systems, roads, power lines, food distribution, health, education, finance) and ecosystems (such as agricultural land, parks, wetlands, fishing grounds). Systems are designed and/or managed by people, but their performance depends on a multitude of factors that are difficult to manage, including human behavior and institutional context. Systems are fragile if they are easily disrupted or broken, though their basic functioning may look very stable.

City systems are susceptible to harm from past and current climate hazards in a different manner than people simply because systems cannot make decisions or take actions. Ecosystems are reactive. They respond to changes caused by people or the climate, but do not think about their responses or actively choose to evolve the way they do. Other systems, like water management, roads, electricity production and distribution, or food production and distribution, depend on people for their maintenance and functioning.

City systems, services, functions and infrastructure are vulnerable because we make them vulnerable in how we conceive of, build, and maintain them. Systems suffer harm because of:

- Exposure, or location in hazard prone areas;
- Inappropriate construction materials and techniques and/or lack of maintenance;
- Construction and location of surrounding infrastructure, which if improperly placed or constructed can increase the hazard intensity. For instance, road construction often changes drainage patterns, creating new flooding hazards;
- Ecosystem degradation; and
- Damage to one system causing damage to others. For example, failure of a dike causing flood damage to roads, homes and businesses.

Systems also suffer harm as a result of constraining and/or weak institutions:

- Laws, policies, and practices that encourage poor selection of systems (e.g. national construction mandates that are ill suited to the environment), poor construction, mismanagement or poor maintenance; and
- Cultural practices that shape the way systems, city services or functions are created and delivered. For instance, planning and constructing schools only for boys, or limiting access to food, jobs or housing based on ethnicity or religion.

Vulnerability and institutions are discussed further in set 2.7

When conducting an assessment of current vulnerability, you need to assess these factors in a qualitative or quantitative manner, or some combination of the two, depending on how your working group has set up your vulnerability framework. Capacities and fragilities are often measured or described as opposites—a river basin that has been damaged by people cannot adequately supply city water needs or filter city wastes; we would describe this as a fragile ecosystem. A healthy river ecosystem, however, might be able to supply city water, maintain a strong, health fishery, and filter waste; we would describe this as a resilient ecosystem.



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The photo above shows fragile systems—drainage and roadways—during extreme rainfall in Gorakhpur, India.

## Characteristics of Resilient Systems

Within the framework, building system resilience means strengthening systems to reduce their fragility in the face of climate impacts and to reduce the risk of cascading failures. Resilient systems differ from engineered, robust systems. Robust engineered systems rely primarily on hard protective structures (e.g. sea walls) or are designed in ways that emphasize the strength of specific individual components to ensure functionality. Resilient systems, in contrast, ensure that functionality is retained and can be rapidly re-instated through system linkages despite localized failures or operational disruptions.

Rather than relying on the strength of individual components, resilient systems retain functionality through:

- **Flexibility and diversity:** the ability to perform essential tasks under a wide range of conditions, and to convert assets or modify structures to introduce new ways of achieving essential tasks. A resilient system has key assets and functions physically distributed so that the entire system is not affected by a given event at any one time (spatial diversity) and so that the system has multiple ways of meeting a given need (functional diversity).

- **Redundancy, modularity:** spare capacity for contingency situations or to accommodate increasing or extreme surge pressures or demand; multiple pathways and a variety of options for service delivery; and/or interacting components composed of similar parts that can replace each other if one, or even many, fail. Redundancy is also supported by the presence of buffer stocks within systems that can compensate if flows are disrupted (e.g. local water or food supplies to supplement or replace imported food or water).
- **Safe failure:** designed to fail in predictable and/or planned ways that will minimize damage. Safe failure also refers to the interdependence of various systems that support each other; failures in one structure or linkage being unlikely to result in cascading impacts across other systems.

These characteristics of resilient systems are guidelines for thinking about complex urban systems, not technical prescriptions. Each technical context and system will be different. It is impossible to provide specific guidelines for all conditions. However, there is a growing body of research looking at the resilience of specific systems and the wider consequences and costs of disruption or failure due to climate change. Table 2.6.1 provides examples of

**Table 2.6.1: Characteristics of Resilient Systems**

SYSTEM CHARACTERISTIC	PERFORMANCE DESCRIPTION	EXAMPLES (FOR WATER SUPPLY)	OTHER EXAMPLES
Flexibility and Diversity	The system can meet service needs under a wide range of climate conditions. Key elements are spatially distributed and can substitute for each other but are functionally linked.	<p>Multiple, geographically distributed water sources (ground and surface water).</p> <p>Pumping stations in multiple sites with overlapping service.</p> <p>Demand side management to ensure water is used efficiently.</p> <p>Expandable fleet of water tankers.</p>	<p>Transportation: multiple modes and capacities for transporting key goods and people.</p> <p>Food supply sourced from diverse geographic areas.</p>
Redundancy and Modularity	Spare capacity to accommodate unexpected service demand or extreme climate events. System components and pathways provide multiple options or substitutable components for service delivery.	<p>Reservoir storage capacity exceeds demand under drought conditions.</p> <p>Groundwater recharge exceeds withdrawal rate.</p> <p>Storage to buffer annual variability or other supply disruptions.</p> <p>Backup systems for water pumping.</p> <p>Rainwater harvesting systems to supplement water supply.</p>	<p>Transportation: multiple access routes.</p> <p>Communications: redundant transmission towers.</p> <p>Energy: backup generators for crucial services.</p> <p>Food and medicines: maintain high stock/flow balance in case of disruption.</p>
Safe Failure	Failure in one part of the system will not lead to cascading failures of other elements or related systems. Key service delivery can be maintained even under failures.	<p>Protection and monitoring of source quality under conditions of climate stress.</p> <p>Failure of one pumping station does not lead to distribution system failure.</p> <p>Distribution network interlinked so local failure will not cause major service interruptions.</p>	<p>Dikes can be opened to flood retention zones outside city, if threatened.</p>

what resilience characteristics might look like for a series of water supply examples. From these examples, it can be seen that the resilience characteristics of a system are not mutually exclusive. In any given system, a particular desired service might be addressed under more than one resilience characteristic (in some systems, for example, modularity is similar to diversity, e.g. multiple water pumping stations in various locations).

## SYSTEM FAILURE

Core or “critical” systems are essential to urban function (Figure 2.6.1). The failure of core systems puts human well-being at risk, and precludes higher order economic activity until core function is restored. Core systems include water supply, food supply and the ecosystems that support these, as well as energy, transport, shelter and communications.

Other urban systems support broader adaptive capacity of city residents. Markets, financial services, education, health care – these are the systems that differentiate the urban environment. They are the systems that enable greater prosperity and well-being. Systems such as early warning systems, emergency response services, and social safety nets provide security. Failure of these systems, or failure to

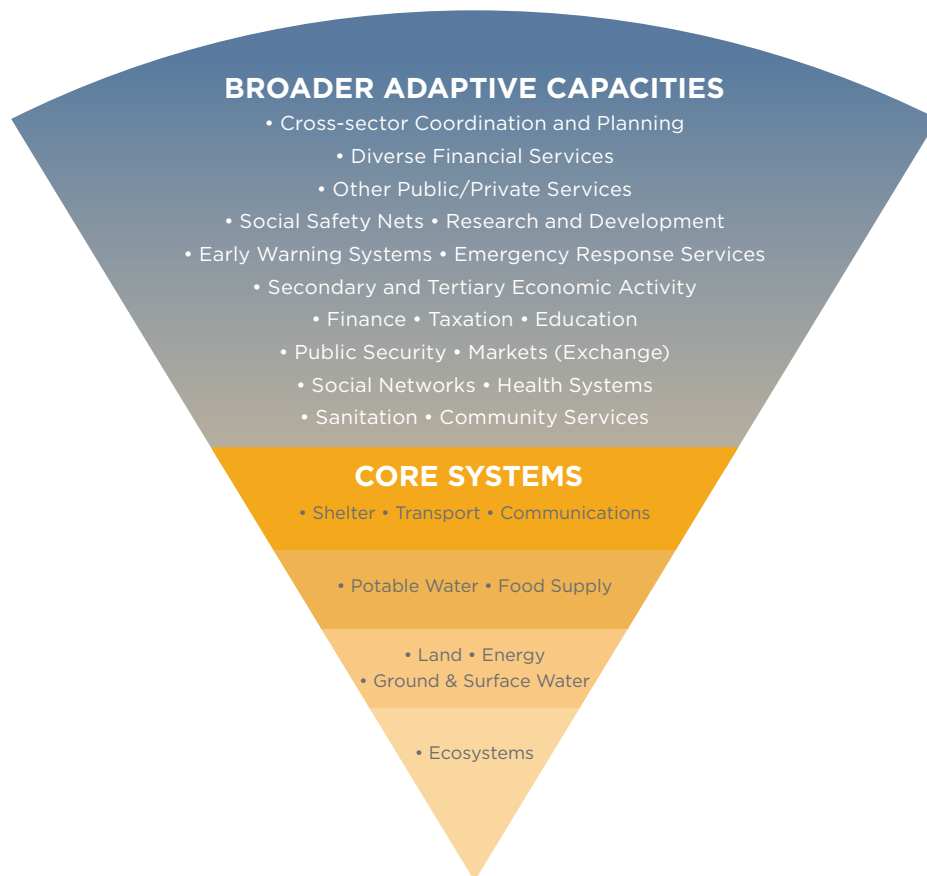
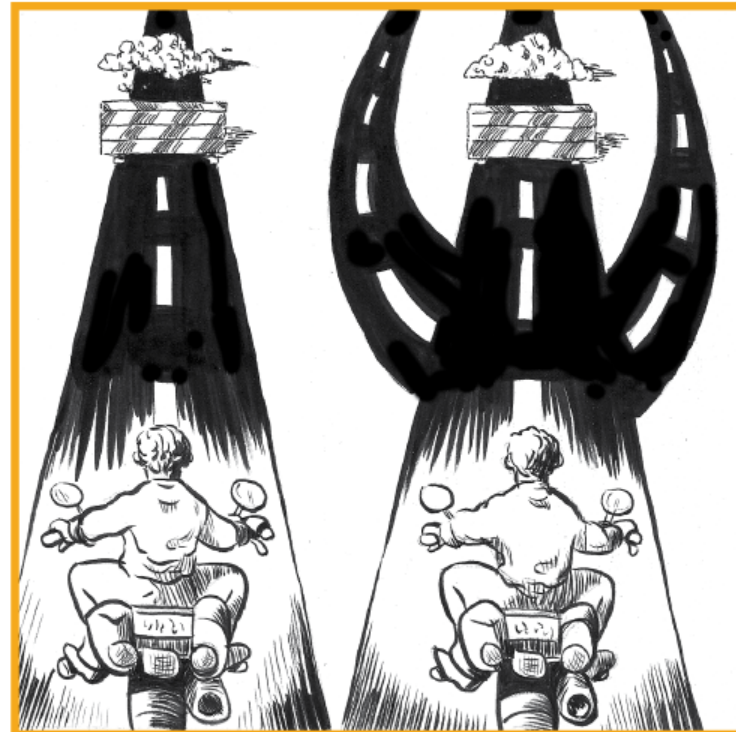


FIGURE 2.6.1 CRITICAL SYSTEMS DIAGRAM

access them, results in greater vulnerability and negates many of the expected benefits of urban residence.

The potential for any one of these urban systems to fail under climate-induced stress can be relatively easily assessed. However, more critical in an urban environment is to identify the interdependencies between systems. Unlike in rural environments, where systems can be relatively simple and straightforward, systems in urban environments are frequently complex and interlinked. As a result, the failure of one system often lead to failures in linked systems. The New York City Blackout case study presented in Section 2.6.2 illustrates the potential for cascading failures in systems.

Analyzing the potential for cascading failures is challenging. Scenario construction and “What if...” games are two ways to begin exploring the complexities of linked systems.



 **SYSTEMS**  
Flexibility & Diversity

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Illustration by Jamie Stroud

## 2.6.1

### SERIES 2

Understanding  
Vulnerability & Risk



## Exploring System Vulnerability



### Activity 2.6.1

Every city system, function, service or infrastructure is vulnerable to climate hazards. Systems are vulnerable because of their fragilities, which are a function of agent decisions in designing the systems, on institutions governing system operation and maintenance, and on the location and construction of the systems themselves (exposure). In Set 2.5, you explored the vulnerability of one group of people in your city. You can use information from that Set and from Sets 1.2 and 1.5 to help answer some of the questions in this activity.

#### IN THIS ACTIVITY YOU WILL:

- ✓ Explore the underlying fragilities and capacities that made a particular city system, service or function more susceptible to suffering harm during recent climate hazards (i.e., weak building codes or ecosystem degradation that you identified in the city development activity); and
- ✓ Map where this system is located in your city on the hazard exposure maps you created in Activity 2.4.1.

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### ACTIVITY 2.6.1: EXPLORING SYSTEM VULNERABILITY

1. Pick one city service, function or system from the list below. If you want to explore a different system than what is listed here, you can.

- Drinking water
- Electricity generation
- Transportation networks: roads, railroads, etc.
- Wastewater and storm water
- Solid waste management
- Health services
- Urban Agriculture
- City food supply
- Urban planning and land use development
- City and peri-urban ecosystems
- Construction

2. Draw on the hazard exposure maps from Activity 2.4.1 where this system is located in your city (or start a new map if you did not do Activity 2.4.1).

3. Answer the following questions about this system.

While you are answering each question, decide whether your answer represents a capacity or a fragility. If it is a capacity, mark it with a +. If it is a fragility, mark it with a - .



## AGENTS

WHAT SYSTEM: _____		WHAT FUNCTION(S) THIS SYSTEM PROVIDES:
	[ + / - ]	COMMENTS
Is this system formally managed by some city agency, organization, or department?		
Who—government agency, city council, mayor, etc.—makes the laws and policies determining how this system is managed and how it should function?		
Who is officially in charge of taking care of this system?		
Who—community group, NGOs, households, etc.—manages this system for different areas of the city?		
If this system is damaged, how long does it take for repairs to happen? Who makes the repairs?		
Who—community groups, economic sectors, households, etc.—depends on this system for business or domestic needs?		
Who does not have regular access to this system, but could benefit from better access?		



## SYSTEMS

WHAT SYSTEM: _____		WHAT FUNCTION(S) THIS SYSTEM PROVIDES:
WHAT SYSTEM:	[ + / - ]	COMMENTS
What areas of the city have good access to this system?		
Which areas of the city are not served by this system?		
Do city residents and businesses have to pay for access to this system? If so, how much?		
Does the revenue collected cover the costs of maintaining this system?		
If this system is disrupted or fails—such as an electricity outage—what other city systems, services or infrastructure are negatively impacted?		
If this system is disrupted or fails, what do city residents and businesses do in order to keep working or meeting household needs? For example, households have back-up generators if city electricity fails; households purchase water from tankers if water pressure is too low.		
What infrastructure increase the hazard exposure of this system? For instance, paved and raised roads can increase flood depths in the surrounding areas and damage other systems.		



## INSTITUTIONS

WHAT SYSTEM: _____		WHAT FUNCTION(S) THIS SYSTEM PROVIDES:
WHAT SYSTEM:	[ + / - ]	COMMENTS
What laws and policies govern how this system is formally or informally managed and taken care of?		
Do these laws and policies require different building techniques and materials if the system is located in a hazard-prone area? For instance, no buildings within 100 metres of a river must be elevated 1 metre above the ground.		
Do these laws and policies encourage flexibility and redundancy within the system, so that if it fails in one part of the city, it will not fail in other parts? For example, supporting household rainwater harvesting as supplemental water supply.		
Does the city have disaster risk reduction or emergency management plans? If so, do these plans influence land use planning, building codes, and environmental protection standards?		
What kinds of laws, policies or programs exist to build disaster resilient infrastructure and improve the quality of life for residents and businesses in informal settlements?		
What kinds of laws, policies or cultural practices prevent certain residents or businesses from accessing this system?		

## 2.6.2

### SERIES 2

Understanding  
Vulnerability & Risk



### Case Study 2.6.2

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## Case Study: New York City Summer 2003 Blackout

At 4pm on August 14, 2003, the grid that distributes electricity to the eastern United States became overloaded, resulting in a series of power failures and electrical system shutdowns that left parts of eight states in the northeast and mid-western United States and Canada without electricity. Millions of people were instantly caught up in the largest blackout in American history.

The blackout began just as thousands of workers were about to head home. Soon hospitals and government buildings were switching on backup generators to keep essential equipment operating, and the police were evacuating people trapped in elevators. Nine nuclear plants in the affected area shut down automatically, decreasing available power. Airports suffered serious disruptions, including the three major airports in New York City, and regional airports closed as they couldn't perform security screenings. Flight delays and cancellations rippled all the way to San Francisco on the west coast of the United States, 3000 miles away.

Thousands of subway passengers in New York City had to be evacuated from tunnels, and 600 commuter and subway trains were stalled between stations, unable to run. People who would normally have taken buses and trains home from work walked miles instead. Sidewalks were crowded, and many pedestrians ended up in the streets. While some commuters were able to find alternate sleeping arrangements, many were left stranded in New York and slept in parks and on the steps of public buildings. Cars were basically immobile due to gridlock caused by lack of traffic lights. Many gas stations were unable to operate their electric pumps, leading to long lines at functioning stations and an immediate, dramatic rise in gas prices. Oil refineries shut down, causing a rise in fuel prices following the blackout and prompting some governments to consider fuel rationing.

Many hospitals saw increased admissions. The first wave consisted of minor injuries such as broken bones and cuts as people tried to get out of the city, minor traffic injuries

from pedestrians hit by cars, and people who suffered heart attacks from walking down stairs of high-rise buildings because the elevators weren't working. The next wave was people who got too hot, who had respiratory problems triggered by heat and stress, or who had been trapped in underground subways. In some areas, the elderly and ill were moved to emergency medical centers to keep them from suffering heat illnesses or running out of water; without this advance planning hospital admissions would no doubt have been higher. Nonetheless, heat-related deaths were unusually high.

Water treatment and pumping was shut down in many areas. For those that did retain water service, loss of pressure in the lines led to contamination and people were instructed to boil their water for several days following resumption of power service. Wastewater treatment plants shut down, resulting in discharge of raw sewage into waterways. Computer shutdowns caused lost business productivity; businesses with backup power for computers but not for cooling lost computers entirely as they overheated and catastrophically failed. Main telephone networks and major cellular providers continued to operate on standby generator power, but increased demand overwhelmed available circuits. Verizon, one of the primary land and cellular phone networks, had their emergency generators fail several times, leaving the emergency services number 911 out of service for several



People walking home during the 2003 blackout. Street lights were not functioning, so vehicle traffic came to a halt.

periods of about a quarter hour each. Several television and radio stations were knocked off the air for periods ranging from several hours to the length of the entire blackout. Lack of official communications increased confusion, but people responded in innovative ways to deal with the situation as individuals and self-organizing groups.

Large numbers of factories were closed in the affected area and others outside the area were forced to close or slow work because of supply problems and the need to conserve energy while the grid was being stabilized. At one point, a 7-hour wait developed for trucks crossing one of the US-Canada border crossings due to the lack of electronic border check systems. Freeway congestion in affected areas affected the “just-in-time” supply system. Some industries (including the auto industry) did not return to full production until August 22, eight days later.

Many countries are far more experienced with power blackouts than the United States and the widespread system failure seen here may seem surprising. However, the point is that until a key system fails, we may be unaware of the related systems that will be impacted or how people will respond in such situations. As you reflect on the exercises in this section, we encourage you to explore how your systems and communities are interrelated.

# 2.7.0

## SERIES 2

Understanding  
Vulnerability & Risk



### Contents of Set

2.7.0: Guide  
2.7.1: Activity

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# VULNERABILITY AND INSTITUTIONS

Vulnerability is often perpetuated through institutional constraints, either cultural norms and expectations, or governance. Identifying and addressing these constraints is critical to successfully building resilience.

### IN THIS SET YOU WILL:

- ✓ Explore the role institutions play in maintaining vulnerability in your city.

## Institutions

Institutions are the rules, laws, customs, social norms and conventions that guide, enable, and constrain people's behavior. Institutions define the range of perceived possible responses or actions in a given situation. Institutions can be formal or informal, overt or implicit. They are created to reduce uncertainty, to maintain continuity of social patterns and social order, and to make our interactions more stable and predictable.

Institutions link agents and systems, thereby mitigating or exacerbating vulnerability, by constraining or enabling access by agents to those systems. This can be seen in overt ways – who has access to education, health services, clean water supplies, labor markets. However, institutions also structure things such as:

- Who is enabled or constrained to play a role in decision-making (i.e. who is viewed as a legitimate “stakeholder”). This influences whose interests are considered in political decisions;
- The standards to which systems are designed and managed (i.e. building codes, engineering standards),

which strongly influences whether those systems will meet the needs of users;

- Pricing structures for urban services, which influences access to those services, particularly for the poor;
- Slum clearance and resettlement, which can be positive or negative based on whether it incorporates just compensation, participatory planning and governing rights; and
- Social marginalization or entitlement.

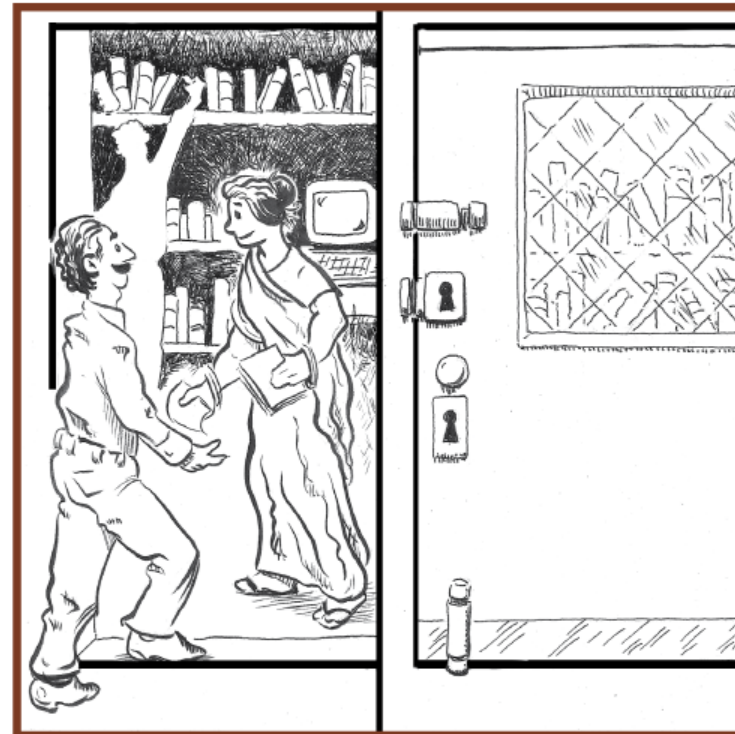
Cultural exclusion of women, the disabled, migrants and inadequate representation of the young and elderly tend to leave them more vulnerable than others, and put them particularly at risk. In assessing institutional enabling or constraining of populations, these groups should be called out explicitly.

## Characteristics of Resilient Institutions

The attributes of resilient institutions are:

- **Access:** Rights and entitlements to use key resources or access urban systems are clear and are equitably distributed;
- **Decision-making:** Decision-making processes, particularly in relation to urban development and urban system management, follow widely accepted principles of good governance, chiefly: transparency, accountability, and responsiveness (United Nations Development Program, 1997 #292); and
- **Information:** Private households, businesses, and other decision-making agents have ready access to accurate and meaningful information to enable judgments about risk and vulnerability and for assessing adaptation options.

In the following exercise you will consider vulnerable groups in your city and the institutions that contribute to perpetuating that vulnerability. Using these resilience characteristics will help identify entry points for institutional change.



 **INSTITUTIONS**  
Information

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Illustration by Jamie Stroud

## 2.7.1

### SERIES 2

Understanding  
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### Activity 2.7.1

## Exploring Vulnerability and Institutions

Institutions—rules, laws, customs, social norms and conventions—guide, enable, and constrain people’s behavior. Institutions define the range of perceived possible responses or actions in a given situation. Consequently, institutions play a large role in constraining or enabling agent response to shocks and crises. Resilience requires strong institutions that enable agent response and support access to needed systems.

Sometimes the role of institutions in creating vulnerability is obvious, such as when girls are not allowed to attend school through either formal policies or social convention. However, because institutions have the role of mediating access and response of agents, their impact on vulnerability can also be indirect. Here we provide two different activities that will allow you to explore how institutions enable or constrain agent response to stressors. Feel free to use either activity, both, or a combination of the two.

### IN THIS ACTIVITY YOU WILL:

- ✓ Use creativity and imagination to explore the complexity of vulnerability; and
- ✓ Explore the role institutions play in maintaining vulnerability in your city.

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## ACTIVITY 2.7.1: EXPLORING VULNERABILITY AND INSTITUTIONS

In Activity 2.5.2 we mapped community vulnerability. This activity may build on that one indirectly.

### ACTIVITY OPTION 1:

*Worst Humanitarian Or Community Development Agency EVER!*

For all the talk that we hear about best practices, we know that there are things that do happen that would fit into the category of worst practices. This activity is a chance to playfully develop worst practices, ones that would increase a community's vulnerability.

In small groups, with whatever area of specialty that you are most familiar with, imagine what you would do if you were part of the worst community development, community planning, or humanitarian agency ever. First identify the vulnerable community that you would be working with, possibly the one that was mapped in exercise 2.5.2 or another that the whole group is familiar with and can imagine easily. Then get creative about entrenching existing problems and making things worse!

This is an activity where you get to let your imagination run wild. If you were a team of mythical tricksters, or misguided fairy godmothers with the magic ability to wave a wand and make things happen, what would you do?

- What actions would you propose to increase vulnerability of the target community that you are working with?
- What things can you do or facilitate that would weaken agents and lead to fragile systems?
- How can you undermine the ability of key local ecosystems to adapt or bounce back?
- What role would institutions play in making things worse? Would there be discriminatory laws? Cultural or religious norms that prohibit certain activities?

Brainstorm your ideas of WORST practices on a large piece of flip chart or butcher paper on the table.

Examples that you might come up with are things like:

- You can change organizational mission objectives and organizational priorities and shuffle budgets so no one knows how long resources will last and long term planning is impossible.
- You can defer exclusively to outside experts about local problems, and avoid building local knowledge and capacity.
- You can discourage collaboration and encourage staff in different departments to work in isolation without coordinating with other teams or outside agencies.
- You could build only one road that allows access in and out of town.
- You could build dikes along rivers with the weakest, most likely to fail points right next to the most critical city infrastructure.
- You could insist on strict adherence to hygienic, dietary or dress standards even during disasters, and refuse aid to anyone not meeting those standards.

## ACTIVITY OPTION 1: DEBRIEF

*Returning to the real world & decreasing vulnerability*

After completing the brainstorm—or when you think you have enough examples to work with (and have laughed a bit):

Review what has been written down, some of the ideas might be so ridiculous that their opposite might highlight simple ways to reduce vulnerability. Write down what simple actions could be effective in *reducing* vulnerability.

- Which of these actions could you implement now?  
Which could you implement with the addition of limited resources or through strategic partnering?
- Are there existing organizations that would be natural allies in implementing these actions?

Now, pick two to five of these actions and identify institutions that would enable or constrain either implementation of the action, or the effectiveness of the action once it was implemented. Make two lists, one of enabling institutions, and one of constraining institutions.

- For the enabling institutions, are there ways you can further leverage potential institutional support for your action?
- For the constraining institutions, are there ways that

these institutions could be changed such that they would better address and reduce vulnerability? Are there smaller changes you could begin to act on? (e.g. education campaigns around vaccination or domestic violence, lobbying local government to change zoning, etc.)

## ACTIVITY OPTION 2:

### *Role Play*

This activity, a role-play with 2 to 4 roles, works best with a team of people who know and trust each other. If you have a very large group of people (more than 20) you might want to break into several smaller groups.

### **Roles:**

1. Individual experiencing a shock or stress. This character is a member of a vulnerable community that has relevance in your local context. This person could be a member of the community that you mapped in exercise 2.5.2.

### **Examples:**

- A single mother who earns money by preparing food at home to sell in the market, and lives in an area that floods regularly.

- A motorcycle taxi driver who has broken his leg.
- A youth who has to work to support his or her family and so can't go to school.

2. Representative of Social Services (or similar)
3. Representative of Community Development organization (or similar)
4. Representative of Community/Land Use/Urban Planning commission (or similar)

The two key roles to include are the individual from a vulnerable community and someone who can stand as a representative for key social institutions. To highlight power discrepancies, this activity is more effective when the vulnerable individual is outnumbered by representatives of the institutional systems that control their access to resources.

Once participants have decided on characters they should take a couple of minutes to imagine the role in greater depth.

## **PLAYING THE GAME:**

The person who takes the role of the vulnerable individual approaches each of the service of planning representatives in turn, trying to problem solve around their particular stressor or crisis. What services or supports might theoretically be available?

### **Round 1:**

The vulnerable individual requests support from each service representative/social institution. Each of the representative reply to a request for support with “No, because....”

### **For example:**

The motorcycle taxi driver could ask for temporary income support from the social service agency, and the representative would reply something like “No, because, you were self employed and you need to provide proof of employment from your previous employer to have access to any income support.”

### **Round 2:**

Each of the representatives reply to the same request for support in the positive with “Yes, and ....”. This gives the opportunity to imagine how to support AND build on the response requested.

### **For example:**

In response to the same request the response could now be something like “Yes we provide partial income replacement AND skills training so you have the option of finding different work when you are able to work again.”

At any point in the exchange if someone in a role is stuck they can ask for help from another member of the group in the audience. If someone else in the group has another idea for how the scene is played out they ask to replace someone currently playing a role or come in in a new role. The two rounds can also be repeated with different people to give more people the opportunity to participate and to build creative energy around the exchange.

Participants watching the role-play can be attentive to where there are institutions that would play a part enabling or constraining the responses of the characters.

## DEBRIEF CONVERSATION AND REFLECTION:

Once everyone interested in participating has had a chance to do so, have a large group discussion. As a starting point for conversation consider these questions:

- What did it feel like to participate in the first round of exchanges?
- What did it feel like to participate in the second round?
- What were the key differences?
- Which of the scenarios that came up are likely issues for your community? What could you do to start changing these dynamics?
- In the scenarios, were institutions involved, either overtly or indirectly, in enabling or constraining actions?
- What were features of institutional responses that helped to decrease vulnerability or build resilience?

**Note for Facilitators:** This activity will probably go a little more quickly if you take some time to develop examples of characters that are locally relevant. It might also go more smoothly, because you can predict questions and challenges in advance and be prepared to address them.

# 2.8.0

## SERIES 2

Understanding  
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2.8.0: Guide

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# CONDUCTING YOUR VULNERABILITY ASSESSMENT

Over the course of this series we have presented a number of ideas, some of which may be new, and had you complete a variety of exercises. All of the information and exercises were designed to introduce techniques and ways of thinking that can be used directly to frame and populate your vulnerability assessment. In this module we explore “top-down” and “bottom-up” information generation, and describe how you can combine this type of information generation with the approaches used in the Series 2 activities to produce a vulnerability assessment.

### IN THIS SET YOU WILL:

- ✓ Review what your vulnerability assessment should include; and
- ✓ Take away a sample vulnerability assessment outline.

## What Your Vulnerability Assessment Should Include

Your climate vulnerability assessment should consist of five main sections. It should:

1. Introduce the vulnerability assessment by reviewing why it is being conducted, the information it needs to produce, and how that information will be used.
2. Provide a snapshot of current vulnerability and help the reader understand how and why particular groups of people and city systems are more susceptible than others to suffering harm during climate hazard events.
3. Examine the development trends of your city to understand how your city got to where it is today and how these development choices contribute to vulnerability, and briefly describe what the city could look like in the future if current development trends continue (population, density, number of highly vulnerable inhabitants, etc.).
4. Describe the historical and future climate context of your city.
  - Describe the historical climate in your city or region.
  - Discuss past climate disasters in your city.

- Discuss climate projections for your city in terms of how current climate will change, so that the potential links to climate impacts are easy to extrapolate.
  - Discuss the challenges that future climate may pose for the city as a whole and for currently vulnerable people and systems.
  - Note whether climate may create new challenges for your city—for example, many cities are not currently significantly impacted by heat stress issues, but that may change over the next few decades.
5. Combine these three sets of information—current vulnerability, development trends, and historical and potential future climate—and review what you have learned from each set alone and from the three sets together. This information should then be used to identify key entry points for addressing current and potential future climate vulnerability.

The information and activities in Sets 2.2 through 2.7 can be used directly to frame the analysis and data needed to write the first four sections.

- Section 1 will use the information and exercises in Set 2.2: Clarifying Your Vulnerability Framework.

- Section 2 will be based on Sets 2.5: Vulnerability and Poverty, 2.6: System Fragility and 2.7: Vulnerability and Institutions.
- Section 3 will be based on Set 2.3: Past Present and Future.
- Section 4 will be based on Sets 2.4: Climate Change, Exposure & Risk, 2.5: Poverty & Vulnerability, 2.6: System Fragility, and 2.7: Vulnerability & Institutions.
- Section 5 will integrate the previous sections. It will include discussion about what becomes apparent when they are all put together and will identify starting points to address vulnerability in ways that build overall city resilience.

In undertaking your full vulnerability assessment, you will complement the information and activities in the sets with additional data and analysis. How to do this is discussed below.

## VULNERABILITY ASSESSMENT METHODOLOGY

Ultimately, the methods you use to conduct your Vulnerability Assessment should be methods you already have experience with. In selecting methods for conducting a vulnerability assessment, it is useful to couple 'bird's eye view' or top down information [e.g. maps, GIS data layers, global

climate projection data, socio-economic and meteorological data] with 'toad's eye view' or bottom up information [e.g. Vulnerability and Capacity Assessment information collected at the household level].

System analysis, which is a process of trying to get an overview picture of the situation, is an example of a bird's eye view method. The historical and future trend activities of Set 2.3 are the beginning of system analysis – learning about the existing data, how things are changing, and the implications of those changes both now and in the future. Those activities can be expanded on, using more detailed data, coupled with mapping or GIS analysis. In further expanding the activities, it is important to keep in mind that different systems are linked together and to look at systems in relation to other systems. For example, if transportation and roads are increasingly stressed and regularly damaged by climate events, and if increasing amounts of food are being imported, either improving transportation infrastructure or increasing local agriculture are needed to build food security resilience.

The next step is to combine the system analysis with a toad's eye view analysis, where the toad's eye view captures information about individuals and households, the actors.

This includes:

- What do people at the household level do to cope with disasters or big system shocks?

- If these shocks happen, what would it mean? How would people respond?

Trying to answer these types of questions is part of a vulnerability assessment—documenting what people do when they experience a shock or crisis. It is likely that, following the bottom-up analysis, you will want to return to your top-down toolset to assess the implications of your bottom-up information at the city scale.

By combining top-down and bottom-up information, you will achieve a simultaneously broad and detailed picture of your city vulnerability. By systematically assessing this information in terms the roles and capacities or strengths of agents, systems and institutions and how each contributes to or mitigates vulnerability, you will greatly facilitate the identification of entry points for addressing vulnerability and building resilience.

## SAMPLE TOOLS FOR VULNERABILITY ANALYSIS

When selecting tools and methods for conducting a vulnerability analysis, consider which provide a bottom-up analysis, and which provide a top-down analysis. Your vulnerability assessment will be stronger if you incorporate several types of analysis that capture a couple of different perspectives. The following table illustrates some of the tools and methods can be used to do a vulnerability assessment.



Tip: The right-hand loop of the Climate Resilience Framework describes the resilience characteristics of Agents, Systems, and Institutions for you.



# SYSTEMS

CHARACTERISTIC	FLEXIBILITY AND DIVERSITY	REDUNDANCY AND MODULARITY	SAFE FAILURE
Description	The system can meet service needs under a wide range of climate conditions. Key elements are spatially distributed but functionally linked.	There is spare capacity to accommodate unexpected service demand or extreme climate events. System components and pathways provide multiple options or substitutable components for service delivery.	Failure in one part of the system is unlikely to compromise the ability of the system as a whole to deliver service.
Tools and Methods	<ul style="list-style-type: none"> <li>• Engineering system performance measures</li> <li>• Simulation modeling</li> <li>• Ecosystem assessment</li> <li>• Biodiversity assessment</li> <li>• Demand forecasts</li> <li>• Resource mapping</li> <li>• System analysis tools</li> </ul>	<ul style="list-style-type: none"> <li>• System capacity assessment</li> <li>• Environmental Impact Assessment</li> <li>• Engineering Risk Assessment</li> <li>• Cost Benefit Analysis</li> <li>• System optimization analysis</li> <li>• Geospatial / GIS analysis</li> <li>• Cost Effectiveness analysis</li> <li>• Analytical Hierarchy process</li> </ul>	<ul style="list-style-type: none"> <li>• System reliability analysis</li> <li>• Threshold analysis</li> <li>• System failure analysis</li> <li>• Case studies of system failure</li> <li>• Fault tree analysis</li> </ul>



# AGENTS

CHARACTERISTIC	RESPONSIVENESS & RE-ORGANIZATION	RESOURCEFULNESS	CAPACITY TO LEARN
Description	Agents are motivated and able to take timely action when required, including changes in organization or structure. Key functions can be restored in a timely fashion after a climate related shock or extreme event	Priority actions for adaptation are identified and the necessary resources mobilized for implementation.	Capacity exists to identify and anticipate problems. Lessons from past failures and feedback from users are internalized and system improvements implemented. Potential future risks are assessed on an ongoing basis.
Tools and Methods	<ul style="list-style-type: none"> <li>• Agent Based Modeling and Simulation</li> <li>• Cultural Theory and agent roles</li> <li>• Organizational behaviour analysis</li> <li>• Hazard, Capacity and Vulnerability Analysis</li> <li>• Disaster Risk Assessment</li> <li>• Poverty studies</li> <li>• Socio-economic analysis</li> </ul>	<ul style="list-style-type: none"> <li>• Social networks analysis</li> <li>• Household histories and narratives</li> <li>• Case studies of past climate disasters</li> <li>• Organizational capacity analysis</li> <li>• Organizational needs assessment</li> <li>• Community transects</li> </ul>	<ul style="list-style-type: none"> <li>• Longitudinal studies of disaster response</li> <li>• Case study of learning mechanisms</li> <li>• Documentary assessment of reports, etc.</li> <li>• Key informant interviews</li> <li>• Focus group interviews</li> </ul>



## INSTITUTIONS

CHARACTERISTIC	ACCESS	DECISION MAKING	INFORMATION
Description	Rights and entitlements to use key resources or access urban systems are equitably distributed.	Decision-making processes, particularly in relation to urban development and urban systems management, follow widely accepted principles of good governance, chiefly: transparency, accountability and responsiveness.	Private households, businesses and other decision-making agents have ready access to accurate and meaningful information to enable judgments about risk and vulnerability and for assessing adaptation options.
Tools and Methods	<ul style="list-style-type: none"><li>• Social and gender analysis</li><li>• Institutional analysis</li><li>• Poverty studies</li><li>• Case studies at household level</li><li>• Participatory appraisal methods</li><li>• Timelines, seasonal calendars</li></ul>	<ul style="list-style-type: none"><li>• Governance analyses</li><li>• Stakeholder analysis</li><li>• Political economy</li><li>• Community-based assessment tools</li><li>• Conflict assessment</li></ul>	<ul style="list-style-type: none"><li>• Communications assessment</li><li>• Content analysis</li><li>• Case studies</li><li>• Focus group interviews</li></ul>

## NEXT STEPS

In framing your Vulnerability Assessment, if you haven't already, you will want to conduct a Shared Learning Dialogue to provide input on the focus and content of the assessment. This will assist in directing the analysis in ways that will truly generate new, relevant knowledge.

In selecting tools and approach for the analysis, it is important to think holistically and systematically, and not to forget to include agents and institutions and governance. There are many entry points to assessing systems, agents and institutions. In your city, there are likely to be a large collections of tools and methods familiar to practitioners such as civil or environmental engineers, land use planners, resource managers, development workers or researchers. If there are areas where the climate working group has limited or no experience, consider who you can partner with to address that portion of the assessment. A key element of resilience is in building strong, diverse networks of partners. Your vulnerability assessment is the perfect place to begin.

## 2.8.1

### SERIES 2

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## Vulnerability Assessment Outline



### Outline 2.8.1

Below is a example outline for a Climate Vulnerability Assessment based on the information and activities presented in Series 2 of the Climate Resilience Framework: Training Materials. There are many ways to structure a vulnerability assessment; this is not necessarily the best, and certainly not the only, way to set up your assessment. This is simply provided as one possible approach.

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## 1. INTRODUCTION

- Why this study is being undertaken
- What you hope to learn
- Who will use the study when it is complete, and what will they use it for
- What geographic area, what timeframe, and what people/communities/systems are included in the study and why
- Who did the analysis, what tools were used and why

## 2. CURRENT VULNERABILITY

- Identification of questions you wish to address around vulnerability and climate
- Review of existing reports and data, identification of gaps
- Summary of community surveys or other participatory techniques used to learn about people's actual experience and opinions (bottom-up information)
- Top-down analysis to explain distribution and relevance of bottom-up information at the city scale
- Summary of who or what is vulnerable, why they are vulnerable, and the implications of that vulnerability now and in the future

## 3. TREND ANALYSIS

- Based on the trend analysis in Set 2.3, but with additional data, more detail, and utilizing supporting tools such as GIS analysis and mapping to develop the top-down, big picture assessment of vulnerability
- Summary of how this has led to current vulnerabilities and what it would mean if current trends continue

## 4. CLIMATE

- Description of current climate—what are the seasons, how much rain the city typically receives and when does it fall, typical and extreme temperatures, etc.
- Description of historical climate trends: whether it has been warming, whether rainfall has changed, whether high tides or sea level have changed, etc.
- Description of current and past climate hazards. Describes both key hazard events—floods of record, significant droughts, heat waves—as well as what type of weather constitute a problem and how people respond to that problem (e.g. monsoon comes late, farmers lose crops, food prices go up, people switch to cheaper grains)

- Description of climate projections for the city, or at whatever scale is available. This should include information about where the climate data is from, what GCM models were used to produce it, what scenarios were modeled, how downscaling was done if the data was downscaled, and the results themselves, ideally with averages and ranges of uncertainty around that average.
- Discussion of what the climate projections mean. If climate changed in the ways projected, describe how this would change everyday life, how it would change disasters, who would be affected and how. In particular, note how it would impact existing vulnerable people and systems, and what new vulnerable groups or systems it might create. Include questions that need to be explored next if the impacts of climate change to your city are to be better understood.

that would reduce current vulnerability, would address potential future vulnerability, and would build resilience

- Overall, what this study has learned that is new
- What gaps does it identify for future study

## 5. SUMMARY AND CONCLUSIONS

- Summarize the previous sections and what was learned in each
- Discussion of what these mean when put together
- List key entry points that can be identified based on these findings—what actions could be taken



The Climate Resilience Framework is an analytical, systems-based approach to building resilience to climate change. The goal of this structured framework is to build networked resilience that is capable of addressing emerging, indirect and slow-onset climate impacts and hazards.

ISET-International is using this framework with cities across Asia to build local capacity for climate change resilience with funding provided by the Rockefeller Foundation as part of the Asian Cities Climate Change Resilience Network (ACCCRN), USAID as part of the Mekong-Building Climate Resilient Asian Cities (M-BRACE) program, the Climate & Development Knowledge Network and the American Red Cross.



We invite you to visit the  
Climate Resilience Framework: Training Materials online: **TRAINING.I-S-E-T.ORG**  
Contact us: [Training@I-S-E-T.org](mailto:Training@I-S-E-T.org)