



STRONGER THAN THE STORM

APPLYING THE URBAN COMMUNITY RESILIENCE ASSESSMENT TO EXTREME CLIMATE EVENTS

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EXECUTIVE SUMMARY

Highlights

- Climate change is a global phenomenon, but its impacts are distributed locally and unevenly in cities. The urban poor are disproportionately affected because of existing social vulnerabilities, a lack of access to urban services and basic infrastructure, political exclusion, and poor representation, among other factors.
- Effective urban climate-resilience strategies should reflect the specific needs of vulnerable communities and ensure that communities and their residents are included in planning processes that aim to reduce climate-change risks.
- This paper introduces the Urban Community Resilience Assessment (UCRA), a tool developed by WRI that was piloted in two Brazilian cities in 2016. UCRA develops a three-level resilience scorecard for cities, communities, and individuals with the aim of informing urban resilience planning by integrating different resilience needs.
- The pilot project results indicate that in order for cities to increase resilience in vulnerable urban communities, efforts should reflect communities' specific needs and engage individuals both in the identification and implementation of climate-resilience measures on the ground.

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Background

Climate change is a global phenomenon, but impacts are distributed locally and unevenly in cities. Among communities affected by climate change, the urban poor are the most affected, are more likely to live in areas that lack sufficient infrastructure and service provision, and are often exposed to higher climate risks. Research by the World Bank has established that without action, climate change could result in a further 100 million people living in poverty by 2030 (Hallegatte et al. 2016). Given rapid urban growth and climate change, how can cities ensure that their most vulnerable citizens are protected from and prepared for climate change? How can cities account for the varying impacts of climate change across diverse neighborhoods and social groups?

This paper introduces the Urban Community Resilience Assessment (UCRA) as a tool for city planners to measure differentiated needs for climate resilience through a territorial approach in cities. UCRA was developed by WRI in collaboration with the Brazilian municipal governments of Porto Alegre and Rio de Janeiro. The premise is that measuring how communities and individuals have responded to potential climate risks can help identify needs for resilience and inform effective urban resilience planning. Brazil has a high urbanization rate, where 85 percent of the population currently lives in cities (IBGE 2011). UCRA was piloted in low-income and vulnerable communities in both cities, and this paper describes the pilot project results, insights, and the potential for UCRA to be applied in other cities. This publication is part of WRI's wider work *Urban Community Resilience*. In addition to the pilots described in this paper, UCRA is currently being applied in the cities of Surat (India) and Semarang (Indonesia) as part of a wider effort to improve the UCRA framework, render it more operational, and deepen our understanding of how to strengthen urban community resilience (Rangwala et al. forthcoming).

How UCRA Measures Resilience

In recent years, there has been a proliferation in the development of tools that measure urban resilience. This development has come in response to the rise of urban climate resilience on international policy agendas such as the UN New Urban Agenda and the Paris Agreement. The first Brazilian cities to be part of the 100 Resilient Cities network—Porto Alegre and Rio de Janeiro—expressed their interest in understanding

how resilience can differ between and within neighborhoods. Both cities partnered with WRI to develop a tool that could capture resilience elements at multiple levels: the wider urban area, key social aspects of communities, and the capacities of individuals. The UCRA framework was developed to assess differential needs and risks at the neighborhood level. To pilot the tool, it was implemented in vulnerable communities at risk of climate change in both cities through participatory processes (which are detailed in the methodology). Data were collected through 400 household surveys in each city. The aim was to provide a snapshot of community and individual resilience and explore whether the framework could provide insights that would be useful to urban planners. Figure ES-1 provides an overview of the three aspects of the framework—vulnerability context, community resilience, and individual capacity—and the indicators developed to measure resilience within those aspects.

Findings

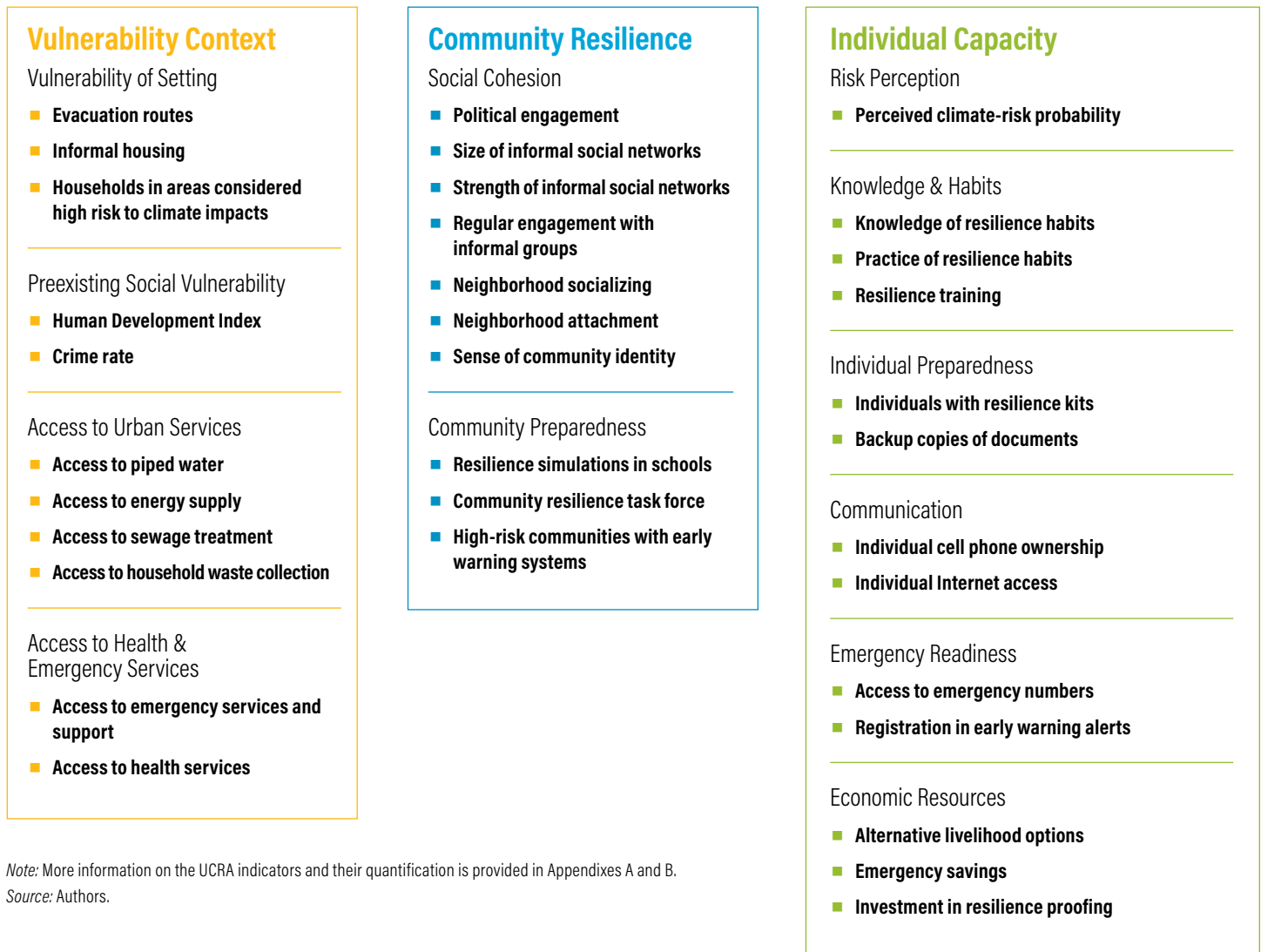
The results from the pilot projects highlighted differential returns on resilience actions on the ground, as well as new opportunities for resilience building by urban planners.

- For example, in Rio de Janeiro the results revealed impacts likely attributable to the work of the civil defense: The community in which more residents participated in resilience training offered by the civil defense scored more highly on indicators of individual resilience concerning resilience habits and knowledge.
- In Porto Alegre, the lowest scores were concentrated in community resilience regarding poor political engagement, early warning systems not being installed in high-risk communities, and a lack of community resilience task forces. These are potential opportunities for urban planners to prioritize when looking to build community resilience.

Engaging residents in urban resilience planning is necessary to identify differential resilience needs and reduce vulnerability to climate change.

- When cities do not include and engage residents in identifying resilience solutions and developing plans, they risk implementing urban climate resilience plans that do not effectively reduce vulnerability and, in some cases, can exacerbate existing vulnerability.

Figure ES-1 | **The Urban Community Resilience Assessment Framework**



- Cities can engage residents through participatory workshops, local community hearings, or direct communications channels.

Investing in the wider city and in community infrastructure does not necessarily translate into resilient individuals.

- In Rio, we found that installing early warning systems does not necessarily translate into the kind of behavior change in individuals that promotes resilience or mitigates risk from climate change.

- In the city of Rio de Janeiro, both communities attained medium to high scores with respect to vulnerability context and community resilience. This, however, did not reflect positively in the scores for individual capacity, which presented the lowest scores overall. This project assumes that building resilience requires not only investing in physical infrastructure and service provision, but ensuring that communities have access to and can develop their social capital and that individuals are engaged in the resilience-building process on the ground.

Recommendations

Cities should seize opportunities to support positive behavior change by encouraging residents to develop habits that increase their resilience to extreme climate events.

- Examples that support positive behavior change include developing awareness-raising campaigns to encourage residents to create authentic copies of important documents and to safeguard these in a location other than their home, preparing resilience kits, not disposing of waste in the streets that can block urban drainage, and creating stronger ties with their neighbors.

City governments should support communities to foster stronger social cohesion and engage with residents in participatory planning.

- City governments should work on developing strong relationships with communities and foster social cohesion within communities. For example, they should prioritize investment in community centers that serve communities' needs, engage local leadership in decision-making, and strengthen government programs like the civil defense that actively work together with communities.
- Resilience needs and potential measures should be identified through participatory workshops, regular community meetings, or focus groups.
- Cities should work closely with communities when implementing the resilience measures and regularly engage citizens in recognizing the need for resilience through training programs in schools, by organizing regular disaster simulations, and by creating stronger relationships with the community.

Next Steps

To ensure that UCRA can function as a tool to support urban resilience planning that reflects the differential needs of vulnerable communities, WRI should consider the following approaches for further development:

List of Abbreviations

EWS	early warning system
FAO	Food and Agriculture Organization of the United Nations
NUDEC	Núcleo Comunitário de Defesa Civil (Community Civil Defense Group)
HDI	Human Development Index
IIED	International Institute for Environment and Development
IPCC	Intergovernmental Panel on Climate Change
IPP	Instituto Pereira Passos
IRIs	Individual Resilience Indicators
ISSET	Institute for Social and Environmental Transition
NAACP	National Association for the Advancement of Colored People
SDGs	Sustainable Development Goals
UCRA	Urban Community Resilience Assessment
UNFCCC	United Nations Framework Convention on Climate Change
WRI	World Resources Institute

- The UCRA tool should seek to provide options for collecting data to measure resilience, such as the use of proxy indicators, community self-assessments, or household surveys. This will allow cities and urban planners to develop resilience diagnostics more rapidly and render UCRA more cost-effective.
- There is an opportunity to explore the causal links between the indicators in UCRA and test whether the selected indicators contribute to increasing urban resilience to climate change over time; this would also ground truth the tool's features and results.
- Enhancing UCRA's spatial analysis capacities is essential to inform and support urban planning. The tool could link to existing data and spatial analysis in capacities to produce maps that cross-analyze different indicators, such as gender and climate-risk perception. This could potentially reveal new insights into community resilience.

INTRODUCTION

Climate change is expected to increase the intensity and frequency of existing climate hazards, such as sea level rise, droughts, heat waves, and storms, as well as usher in new climate-related risks (World Bank Group 2016). The world is urbanizing rapidly. By 2030, the world urban population is forecast to grow to 5 billion and to 6.4 billion in 2050 (Angel et al. 2011). Ensuring that cities, their residents, assets, and infrastructure are prepared for and can withstand climate-change impacts is integral to achieving and maintaining sustainable development.

While climate change is a global phenomenon, impacts are distributed locally and unevenly in cities. The different features of cities, such as their geographic location, structure, density, topography, climate, and socioeconomic traits determine how their residents, assets, and infrastructure are vulnerable to current hazards and future climate change (Gasper et al. 2011).

Today, there are still 700 million people living in extreme poverty, and the World Bank has estimated that a further 100 million people could be living in poverty by 2030 if no action on climate change is taken (Hallegatte et al. 2016). In cities, the urban poor already face a multitude of risks and are disproportionately exposed to risk from climate change. Almost one in four of today's urban residents lacks one or more of the following amenities: access to improved water and sanitation, durable housing, or sufficient living space (UN-Habitat 2016; Colenbrander and Archer 2016). Under future climate-change scenarios, the urban poor will have even less access to these services (Colenbrander and Archer 2016; Hallegatte et al. 2016). As a result of poverty, the urban poor are more vulnerable to climate impacts and have a lower capacity to adapt to climate change (such as adjusting to potential damage or responding to consequences). For example, researchers documented a rise of 40 percent in mortality from extreme heat in a Philadelphia neighborhood when the share of vacant properties rose by 10 percent (Baussan 2015).

Given rapid urban growth and climate change's uneven impacts on different communities and residents, how can cities ensure that their most vulnerable citizens are protected from and prepared for climate change? How can cities account for the varying impacts of climate change across diverse neighborhoods?

In order to answer these questions, there is a need to better understand how communities and individuals respond to climate impacts (Bené 2013). This means understanding how resilience develops at various scales in a city, from the macro scale of whole cities, through communities, to the micro scale of individuals. Understanding is achieved through measurement, as Bené (2013) argues: "Without being able to measure and/or monitor resilience, policy-makers and societies more broadly will not be in a position to identify and support interventions that have more effect on people's ability to respond to and accommodate adverse events." Building urban resilience is thus a matter of intervening at various scales and appropriately reflecting the scales' varying features, which can be identified and achieved through resilience measurement.

Recent research shows that many cities' urban adaptation plans promote inequity and exclusion and reinforce existing vulnerabilities (Anguelovski et al. 2016). In New Orleans, for example, the city's proposed adaptation initiatives after Hurricane Katrina included converting low-lying residential areas into parks and green spaces for ecological functions and storm water management. These plans were withdrawn in the face of strong residential opposition because the plans would have displaced families from predominantly low-income and black communities that were not included in the planning process (Nelson et al. 2007). As global climate change affects local communities differently, it is important to develop a culture of local and participatory planning that can reflect communities' different needs and contribute to more effective resilience outcomes. Effective and equitable resilience and adaptation plans should aim to reflect each community's unique, preexisting vulnerabilities (Patterson 2015).

This paper introduces the Urban Community Resilience Assessment (UCRA) framework, a tool to measure resilience through a place-based approach to collect data and identify differential needs that can inform urban resilience and adaptation planning. UCRA was developed in collaboration with Porto Alegre Resiliente and Rio Resiliente in Rio de Janeiro, which belong to the 100 Resilient Cities network (100RC) and approached WRI to develop a tool that measures resilience at the informal, community, and

Box 1 | Overview of Common Terms Used to Characterize Urban Resilience

REFLECTIVE: Accepting of inherent and ever-increasing uncertainty.

ROBUST: Physical assets that are well-conceived, constructed, and managed so that they can withstand the impacts of hazard events without significant damage or loss of function.

REDUNDANT: The spare capacity purposely created within systems so that they can accommodate disruption, extreme pressures, or surges in demand. The term includes diversity: the presence of multiple ways to achieve a given need or fulfill a particular function. Redundancy can help enable safe failure, which implies that the system is able to absorb sudden shocks, including those that exceed system design or thresholds.

RESOURCEFUL: A term applied to people and institutions that are able to rapidly find different ways to achieve their goals or meet their needs during a shock or when under stress.

INCLUSIVE: Emphasizes the need for broad consultation and engagement of communities, including the most vulnerable groups.

INTEGRATED: Integration and alignment between city systems promotes consistency in decision-making and ensures that all investments are mutually supportive of a common outcome.

FLEXIBLE: Flexibility implies that systems can change, evolve, and adapt in response to changing circumstances. This may favor decentralized and modular approaches to infrastructure or ecosystem management. A resilient system has key assets and functions that are physically distributed so that they are not all affected by a given event at any one time (spatial diversity) and has multiple ways of meeting a given need (functional diversity).

Source: Silva, Jo da. 2014. *City Resilience Framework: City Resilience Index*. The Rockefeller Foundation; Tyler, S., and M. Moench. 2012. "A Framework for Climate Resilience." *Climate and Development* 4 (4): 311–26.

neighborhood level. The tool takes into account individual resilience capacities influenced by the context of the community and the wider physical urban environment.

This paper introduces the concept of resilience by acknowledging different definitions and the existing body of literature and work that aims to measure resilience. The authors describe the participatory approach taken to develop, validate, and implement UCRA before presenting the pilot project application and discussing its results. The paper concludes by outlining current gaps, limitations, and opportunities for further development of UCRA.

Defining Urban Resilience

For the purpose of this paper, resilience is defined as “the capacity of social, economic, and environmental systems to cope with a hazardous event or trend or disturbance, responding or reorganizing in ways that maintain their essential function, identity, and structure, while also maintaining the capacity for adaptation, learning, and transformation” (IPCC 2014).

The concept of resilience has risen rapidly up the urban development policy agenda and is considered a strategy to respond to and prepare for climate change by city managers, academics, and development and disaster relief practitioners alike. Its recent prominence is the result of two urgent issues: the growing global urban population and an increasingly uncertain future in relation to climate change (Friend 2017). Key international agreements and policy commitments, such as the Sendai Framework for Disaster Risk Reduction, the UN Sustainable Development Goals (SDGs), the United Nations Conference on Housing and Sustainable Urban Development (Habitat III), and the Paris Agreement of the United Nations Framework Convention on Climate Change (UNFCCC), include urban resilience as a priority (Friend 2017).

Resilience thinking provides a useful framework to analyze the urban environment, framing cities as systems made up of complex relationships with dynamic feedback loops that are able to absorb, adapt, and learn from disturbances (Friend 2017; Jabareen 2013). Several terms describe urban resilience characteristics, which are summarized in Box 1. These characteristics were compiled using the Institute for Social and Environmental Transition’s (ISET’s) Urban Climate Resilience Planning Framework and Arup’s City Resilience Framework. These terms

and other frameworks and indicators used to describe urban resilience are subject to continuous revision and improvement by researchers and practitioners.

For urban climate resilience actions to achieve effective results, cities first need to understand the current and future climate risks to which they are exposed and how structures, communities, and people respond to these climate impacts. Baussan (2015) emphasizes that resilience plans are most effective and equitable when they are designed in response to a community's unique vulnerabilities and characteristics. It is critical that a neighborhood's and a community's characteristics are considered and reflected in resilience planning as "each may be indicative of the need for a different design for adaptation planning, to accommodate differential preexisting vulnerabilities" (Patterson 2015). Thus, the first step is measuring urban resilience.

Measuring Urban Resilience

There are many ways in which resilience can be measured, and despite a plethora of existing tools and methodologies, practitioners and academics have yet to achieve a consensus (Vaitla et al. 2012). In part, this is explained by the fact that resilience is being applied to a range of fields, requiring resilience to be measured with different approaches. Additionally, the dynamic and continuous process of creating resilience is difficult to measure over time (FAO et al. 2014). Particularly for cities, the sheer complexity of urban systems renders it difficult to narrow resilience measurement down to a definite list of variables. Despite these challenges, efforts are under way to identify the most effective ways to measure resilience because such efforts help to validate the assumption that resilient communities are less vulnerable to hazards (Cutter et al. 2008).

UCRA focuses on urban community and individual resilience in the context of vulnerability to climate hazards. The paper analyzes UCRA's pilot application in two cities to demonstrate the insights the framework can provide regarding differential climate impacts and resilience among different communities and individuals. The following sections describe UCRA in more detail and outline the methodology and approach used to develop the tool.

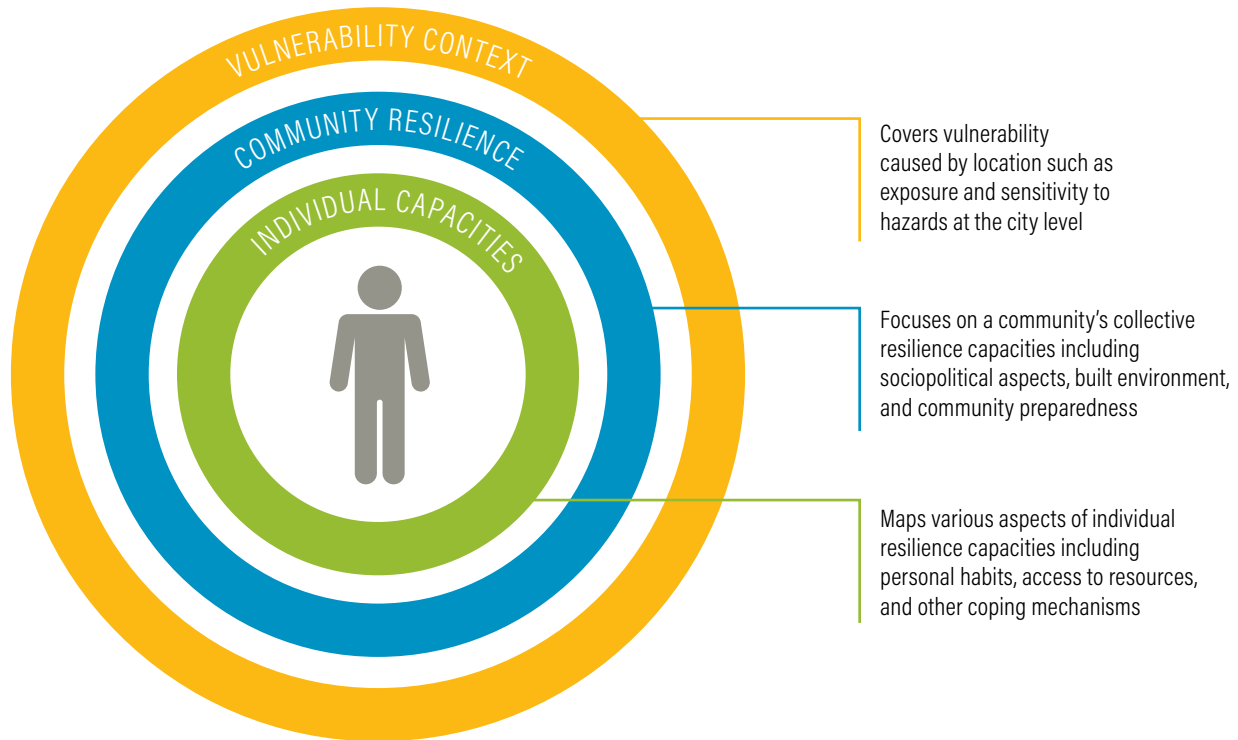
THE URBAN COMMUNITY RESILIENCE ASSESSMENT FRAMEWORK

UCRA, developed by WRI with support from Cities Alliance and 100RC, is a tool that identifies differentiated needs for resilience planning in poor urban communities. It focuses on current and future climate risks and the identification of resilience solutions based on local knowledge. The tool helps cities prepare for climate shocks, such as flooding or drought, by developing a three-level resilience scorecard for whole cities, communities, and individuals. UCRA defines resilience as **the capacity of individuals, communities, or cities to prepare for and cope with a hazardous event or trend or disturbance in ways that maintain their essential functioning, including health, without diminishing their ability to adapt, develop, and flourish.**

UCRA measures resilience by assessing indicators like access to municipal urban services, social cohesion, familiarity with local risks, warning systems, and disaster readiness. Our premise is that increased community and individual resilience helps strengthen the first response to a climate event and can help communities become better prepared and socially networked. The tool is organized into three aspects that are helpful to understand resilience as a dynamic process: Vulnerability Context, Community Resilience, and Individual Capacity (Figure 1). UCRA measures resilience using 33 indicators across 12 categories in these three aspects. The selection process of the indicators is explained in the methodology, and the following section briefly describes and explains the rationale for each aspect.

UCRA allows for analysis to be disaggregated by sex, age, income, and other socioeconomic variables, which enhances a city's understanding of the various dynamics that can influence a person's ability to secure a livelihood and prepare for an oncoming climate risk. The UCRA data collection method includes community members throughout the process, in focus group discussions and household and individual surveys. Through public participation, cities can work with communities and apply UCRA to identify actions that can increase resilience, including district-level emergency guides, community training, shelter maps and evacuation routes, community warning systems and apps, resilience task forces, and community garbage collection services. Engaging directly with communities through participatory processes can also deliver

Figure 1 | Overview of UCRA's Three Aspects



Source: Authors.

co-benefits such as revealing more localized information and raising awareness of climate resilience.

The UCRA indicators draw on community-level data to provide new evidence to inform resilience investment, leverage community resources, and contribute to building the social cohesion that studies show is a foundation for resilience. Key features of the UCRA approach are inspired by the terms used to characterize resilience in Box 1 and include the following attributes:

- **Responsive:** The UCRA indicators can be disaggregated by age, sex, education, income level, and other demographic variables to identify key individuals' and groups' specific needs. This enables UCRA to be more inclusive and gender-responsive.
- **Inclusive:** UCRA combines official secondary data sources with data collected on the ground, including residents' knowledge, skills, and perceptions of risk.

- **Actionable:** The indicators were designed with officials' and stakeholders' input to help identify resilience weak spots that can be addressed more rapidly.
- **Local:** Citizens have the best local knowledge, are the first affected, and are the first to react at the scene of an emergency. By focusing on citizens, UCRA helps cities leverage actors who can help cities save time in emergency response.
- **Multi-factorial:** UCRA recognizes that resilience is not only a factor of macro-level elements (economics, governance, access to services). It also captures relationships among individuals, organizations, and urban form.
- **Flexible:** When applying UCRA, cities and users must apply all 12 categories but needn't apply all indicators listed in the categories. Cities and users can pick and choose which indicators from the 12 different categories that they want to apply to measure resilience, in order to best reflect local reality and data availability.

The objective of this paper is not to present an exhaustive list of indicators that increase resilience. The indicators featured in UCRA have not been tested as a group to establish a definite list of indicators that are proven to increase resilience. As such, this paper does not claim that cities need to only focus on the UCRA indicators to increase resilience of vulnerable communities. The indicators featured in UCRA are a selection of hypothetical proxies based on literature reviews, focus groups, and expert evaluations (see methodology). The indicators require further testing and monitoring and evaluation of impact, which will be possible once resilience-building measures have been implemented in the pilot project locations.

Aspects

The first aspect is the vulnerability context, which includes indicators such as exposure to climate hazards, access to essential urban services, preexisting social vulnerability, and levels of informal housing. Data for the vulnerability context are gathered for the entire city. The literature review identified the importance of measuring vulnerability through a place-based approach, which includes analysis of physical, socioeconomic, development, and environmental perspectives and how they vary from location to location within a given city. Addressing issues of development is considered essential to reducing disaster and climate-risk vulnerability (Bahadur et al. 2015). Such an approach acknowledges that vulnerability is differentiated and that people and communities experience the same risks and impacts differently. A place-based approach to measuring resilience enables cities to engage in more effective and equitable resilience planning and avoids assuming a level of community homogeneity (Baussan 2015; Paton and Johnston 2001).

The second aspect is community resilience, which aims to capture community characteristics that collectively enhance resilience to climate-change impacts. In this paper, *neighborhood* is a spatial area defined by clear municipal boundaries. *Community* refers to people living in previously informal areas that have since been urban-

ized but are marked by social vulnerability and share a sense of identity and characteristics, such as race and income. When a community is referred to throughout the paper, the use and definition of this term is clarified. Community resilience can be strengthened through policies and best practices, such as equipping high-risk areas with early warning systems, and social cohesion, which is expressed as a sense of community among residents and is considered critical to increasing a community's capacity to respond to sudden changes (Paton and Johnston 2001; Cutter et al. 2010). Measuring resilience at the community level also reveals different capacities among communities, helping cities to develop and deliver better targeted actions and policies to residents. More resilient communities have the capacity to draw on internal strengths and the resources to deal with hazards and disasters (Paton and Johnston 2001).

The third aspect, individual capacities, measures the resilience of individuals, who are considered key agents of urban resilience. Individual citizens are the first to be affected and first to respond to climate impacts; encouraging and enabling a culture of resilience can help reduce damage and speed up recovery. This requires placing citizens at the heart of resilience strategies and planning and measuring individual citizens' capacities, such as their habits, knowledge, and perception of risk. Individuals with knowledge about risk may influence demands and political actions aimed at reducing risk (Oltedal et al. 2004), which in turn can increase community and urban climate resilience as a whole.

The three aspects are divided into 12 categories and 33 indicators, as displayed in Figure 2 below. The tool is flexible: Cities can use UCRA to develop their assessment by selecting applicable indicators from across the 12 different categories that reflect data availability and local reality. This flexibility enables cities to create an assessment based on local reality, needs, and data availability, which can result in more effective resilience planning (Baussan 2015).

Figure 2 | **Urban Community Resilience Assessment Framework: Aspects, Categories, and Indicators**



Note: More information on the UCRA indicators and their quantification is provided in Appendixes A and B.
Source: Authors.

Categories

This next section breaks down the UCRA framework into its categories, briefly describing them and providing justifications for why they contribute to increasing resilience. The full list of indicators can be found in Appendix A.

Vulnerability Context

Vulnerability of Setting focuses on the exposure to hazards in a given place, including both current and future climate risks, such as sea level rise, landslides, and floods.

Preexisting Social Vulnerability focuses on vulnerability arising from socioeconomic factors, such as illiteracy rate, the Human Development Index, and crime rate. According to the IPCC (2014), “Vulnerability encompasses a variety of concepts and elements including sensitivity or susceptibility to harm and lack of capacity to cope and adapt.”

Access to Urban Services focuses on the equity of access to basic public services, such as access to piped water in homes, access to waste collection, and access to energy supply. The IPCC (2001) argues that “equitable distribution of resources increases adaptive capacity” and that “both availability of, and entitlement to, resources is important.” Increasing access to basic services also contributes to development goals and can reduce poverty.

Access to Health and Emergency Services focuses on residents’ ability to access health services and shelters in emergency situations. The provision of and access to health services is a determining factor in the adaptive capacity of populations (IPCC 2001).

Community Resilience

Social Cohesion is a property of a society and not of individuals (Jenson 2010) and focuses on the social capital, relationships, and sense of community identity. Socially cohesive communities have been shown to respond better to external shocks before, during, and after a hazard event through planning, effective mobilization, and recovery (Baussan 2015). Building social cohesion includes targeting efforts not only at communities, but also at their individuals.

Community Preparedness is concerned with the extent to which a community has risk-management initiatives and structures in place, such as early warning systems. This category focuses on the governance, train-

ing, and infrastructure available in a community to support residents in planning for and responding to risks. The indicators are strongly informed by best practices carried out by civil defense officials in the city of Rio de Janeiro, who have implemented an extensive risk-management program in at-risk informal communities in the city.

Individual Capacity

Risk Perception deals with how individuals understand the potential impact of climate risks and the probability of the climate risk occurring. Local understanding of risk helps to reduce the impact of hazards, and risk perceptions affect people’s willingness to take steps to manage risks (O’Connor et al. 1999).

Knowledge and Skills focuses on the ability of individuals to understand, react to, and recover from disasters and adapt to climate hazards. The rationale for this category is that a “lack of informed, skilled, and trained personnel reduces adaptive capacity,” while “greater access to information increases likelihood of timely and appropriate adaptation” (Swanson et al. 2007).

Individual Preparedness involves key actions that individuals can take to increase their level of readiness to face climate risks. The indicators for this category were identified from the literature on disaster risk management and in working groups and stakeholder workshops in Rio de Janeiro and Porto Alegre.

Communication focuses on access to primary communications networks in order to understand the potential for isolation during an emergency event and the potential for information sharing to enable more effective organization. Communications technologies such as cell phones and the Internet can facilitate interaction among residents and increase their access to information on climate.

Emergency Readiness is a person’s minimum level of preparedness to face a sudden climate impact. Resilience is based on a culture of preparedness and individuals’ beliefs that actions can enhance preparedness and contribute to reducing the overall impact of a disaster (U.S. Department of Homeland Security 2011). Minimum actions that individuals can take include ensuring that they are able to access the correct government emergency services and are registered for early warning alerts.

Economic Resources measures the opportunity for alternative livelihoods and individuals' willingness to invest in their own resilience. Research strongly indicates that poverty is a significant driver of vulnerability. The more financial capital individuals have, the higher their ability to face and recover from climate impacts. When individuals can benefit from financial mechanisms like insurance, social safety nets, and entitlement programs, their overall resilience is increased (Cutter et al. 2003). Economic resources are thus a determining factor building resilience and adaptive capacity (IPCC 2001).

METHODOLOGY

WRI developed and piloted UCRA in a collaborative and participatory effort with a range of stakeholders spanning city authorities, community leaders, civil society organizations, and academia. The framework and indicators for UCRA were selected and validated through a literature review, working groups, and stakeholder workshops. This process is described below. UCRA was initially developed and implemented in Rio de Janeiro and Porto Alegre; both cities belonged to the 10ORC network, a key implementing partner of UCRA, and had demonstrated an interest in measuring resilience at the informal and neighborhood levels.

Defining the Objective of UCRA

WRI held three initial meetings with Rio de Janeiro's and Porto Alegre's resilience teams to identify the need for measuring resilience at the community and individual levels and how such measurement could enhance urban resilience planning. Together, we defined the objective of UCRA as developing a set of indicators to help municipalities evaluate the resilience of citizens and communities to climate change over time and to help identify measures that can specifically address key resilience weak spots. Both cities emphasized the key role of individuals and communities in increasing urban resilience and noted a gap in the availability of user-friendly tools that could help them focus on multiple levels and could rapidly provide a snapshot of local resilience. The cities stressed that the measurement tool should capture differentiated needs, address issues of equity, and place people and communities at the center of urban resilience planning.

Selecting Indicators for UCRA

The WRI team conducted a review of the literature on social vulnerability to climate change, disaster risk management, and resilience indicators. The review afforded an overview of indicators and indexes that various groups have used to quantify vulnerability or resilience and suggested an initial starting framework of categories and example indicators related to resilience.

To evaluate this first draft of the individual resilience indicators (IRIs), the project team organized two expert meetings with groups of specialists from *Instituto Pereira Passos* (IPP) (Rio's data collection department), civil defense, *Pensa* (the city's big data office, since closed), and the city's resilience team *Rio Resiliente* (also since closed). The two working group meetings helped narrow the initial list and identify missing indicators and key categories, which resulted in the second draft of the indicators.

This second draft of the IRIs was evaluated in three rounds of stakeholder engagement: a high-level workshop with participants including policymakers, city managers, and technical specialists, and two community-level workshops involving community leaders from vulnerable and at-risk communities. In total, 52 participants from 36 different organizations and community associations participated in the three workshops. All workshops followed the same agenda and structure, allowing participants to vote on the most and least important indicators through a simple voting method. With the voting session complete, WRI facilitated a discussion summarizing which indicators had been prioritized, which marked as nonpriorities, and what further suggestions for indicators had been made. Analyzing the results, it was possible to identify which indicators were considered more or less important to measuring individual and community resilience. Feedback was collected and analyzed to produce a third and final draft of the IRIs. This version of the IRIs was applied in a pilot project in two urban communities in Brazil and eventually renamed the Urban Community Resilience Assessment.

The method described above to select the indicators has its limitations. For example, the final list of indicators relies on expert input and opinion, and the indicators chosen were not tested to determine whether they measurably enhance resilience overall.

Developing Scores

To measure resilience, WRI and the city authorities jointly developed a scoring range. Each indicator received a resilience score on a scale of 1 to 5, 1 being *Not Resilient*, and 5 being *Very Resilient* (Figure 3).

Figure 3 | Resilience Scoring Scale Developed for UCRA



Source: Authors.

Thresholds for each indicator were developed, based on international references, research, and specialists' experience. For instance, for the indicator *Crime Rate* in Vulnerability Context, UCRA draws upon the scoring bands from the Global Peace Index developed by the Institute for Economics and Peace. The index scores violent crime into five bands according to the number of homicides per 100,000 people; these parameters are used as a suggestion to measure *Crime Rate* in UCRA. Where such international references or scoring bands for indicators were not found, the scoring bands were determined by WRI and validated by the city authorities. All scoring bands for the indicators are listed in Appendix B.

Piloting UCRA

To identify pilot communities for UCRA, WRI worked with the municipalities and civil defense in both cities to select pilot project sites. In Rio de Janeiro, two vulnerable communities were chosen. In Porto Alegre, five low-income and at-risk neighborhoods were selected, which are not considered informal settlements. Table 1 depicts the criteria used to select the communities in each city.

By selecting communities that are classified as high risk and that are equipped with early warning systems, it was possible to work in locations that presently face climate risks officially identified and classified by the city authorities in the municipal resilience plans for Rio de Janeiro and Porto Alegre. These climate risks are intense rains, intense winds,

increased temperatures, flooding, drought, and sea level rise in the case of Rio de Janeiro (Prefeitura Rio de Janeiro 2016), and flooding and landslides in Porto Alegre (Prefeitura Porto Alegre 2016).

The support and agreement of local community leaders was important for local buy-in. To achieve this, the project team worked with civil defense and its established network of locally established community leaders of the neighborhood associations in Rio de Janeiro and directly with the local leaders of the selected region in Porto Alegre with whom contact was maintained over the course of the project. As a result, the project team were able to develop a harmonious relationship with the community members, and attendance at workshops was high.

In Rio, the decision to focus on communities that already collaborate with civil defense was made to facilitate an entry point for the application of the survey. Informal communities, known as *comunidades* and *favelas* in Brazil, are often characterized by high levels of organized crime, which can render access to the communities difficult due to territorial disputes. By working with civil defense, it was possible to

Table 1 | Selection Criteria Used to Identify Pilot Project Locations

CRITERIA FOR RIO DE JANEIRO
<ul style="list-style-type: none"> Communities classified as high-risk from landslides Communities equipped with early warning systems Communities work in collaboration with the civil defense Communities with lower levels of violence Local community leaders agree and engage in applying the survey
CRITERIA FOR PORTO ALEGRE
<ul style="list-style-type: none"> Neighborhoods contain areas classified as at high risk from flooding Local community leaders agree and engage in applying the survey Communities work in collaboration with civil defense

Source: Authors.

negotiate entry into the informal communities and establish a minimum level of safety for the surveyors.

Two informal communities were selected in Rio de Janeiro: Morro da Formiga and Morro dos Macacos. In Porto Alegre, the wider Administrative Region of Partenon was identified as a suitable pilot project location. Partenon is made up of five neighborhoods: Coronel Aparício Borges, Partenon, Santo Antônio, São José, and Vila João Pessoa. Unlike in Rio de Janeiro, these neighborhoods are classified as formal, and not all are considered low-income.

Data Collection

Data were collected for the indicators using both primary and secondary methods. Primary data collection involved surveys of residents; secondary data sources included open databases, reports, and data hosted online by the cities. Data for the vulnerability context indicators were mainly collected through secondary sources, such as online reports, the cities' online open databases, and through official government census data (using the latest census data from the Brazilian Institute of Geography and Statistics [IBGE 2011]). The data for the Community Resilience and Individual Capacity aspects were collected through a survey that was conducted in the pilot project locations in both cities.

It was possible to collect data for all indicators, except for the following:

- Access to emergency shelters (Rio de Janeiro and Porto Alegre): Due to lack of data and human resources within the cities, it was not possible to calculate the score for this indicator.
- Access to health centers (Rio de Janeiro): It was not possible to access georeferenced data for all health centers in Rio.
- Resilience simulations in schools (Porto Alegre): There are currently no data for this indicator.

To develop the survey, WRI worked with local community leaders, the city teams responsible for climate resilience in both cities, and civil defense to develop a first outline of the survey. The questions were validated with the city representatives, after which WRI hired surveying companies in both Porto Alegre and Rio de Janeiro to refine and conduct the survey. The last version was checked by the local community leaders and civil defense for language, accessibility, and cultural sensitivity. As a result, adjustments were made to language and the order of questions before finalization.

In total, 400 surveys consisting of 43 questions were conducted in each city. In Rio de Janeiro, 200 surveys were carried out in each of the two informal communities during July 2016. In Porto Alegre, 400 surveys were conducted proportionately to the population of each neighborhood during July 2016. The surveys were implemented in collaboration with the project's local partners and in close collaboration with civil defense officials of both cities. Copies of the survey for both cities are provided in Appendix D. Both surveys were implemented during the dry season in Brazil, which might have altered the risk perception of residents as no recent extreme rain events had taken place.

Data Analysis and Scoring

The raw data were analyzed in Excel, and each indicator was scored according to the five-point scale depicted in Figure 3. The scores were aggregated at the category level to get a mean score for the category. These mean scores were again aggregated to develop a mean aspect score. The main results and conclusions are presented in the following sections.

When interpreting the results, users should note that the indicators were not weighted. Users should not interpret the results from the category and aspect scores alone, but should also regard the indicator scores. Indicators that scored low even in categories that scored high should not be dismissed. In sum, users should analyze the scores at the indicator level first.

RESULTS OF THE PILOT PROJECTS

Rio de Janeiro

Data collection in the two vulnerable communities in Rio de Janeiro was carried out during July 2016. Emerging originally as informal communities, the two communities are now categorized as urban settlements by the city of Rio de Janeiro.

Located in the Vila Isabel neighborhood, Morro dos Macacos is part of Terreininho, a region formed by the union of the communities of Pau da Bandeira and Vila Isabel Park. With a population of 5,072 inhabitants divided into 1,384 households, the community has been categorized by civil defense as a vulnerable, high-risk settlement (IPP 2016).

Morro dos Macacos is part of the program Resilient Communities, run by civil defense. The region is also home to the 13th Pacifying Police Unit (UPP) installed by the State of Rio de Janeiro on November 30, 2010. This UPP covers both the community of Morro dos Macacos and Vila Isabel Park. Figure 4 shows the community boundaries (red).

Morro da Formiga (Figure 5) is located in the neighborhood of Tijuca in the North Zone of Rio de Janeiro. It is home to 4,312 residents and 1,279 households and spans an area of 199,991 m² (IPP 2017). Like Morro dos Macacos, the community is also categorized as a vulnerable and high-risk area according to civil defense. The community has a higher population density of 215.6 people per hectare than the municipal average of 110.7 (IPP 2017).

Figure 4 | Morro dos Macacos Territory



Source: IPP 2016.

Figure 5 | Morro da Formiga Territory



Source: IPP 2017.

Table 2 summarizes the results of the pilot application of UCRA in these two communities in Rio de Janeiro. The results are similar, both scoring resilient for the Vulnerability Context aspect and for Community Resilience (using a regular rounding system). However, for the aspect Individual Capacity, Morro dos Macacos received a considerably lower score of 2.6, which is addressed further on in this chapter.

Table 2 | Summary of Pilot Project Results in Rio de Janeiro

ASPECTS	MORRO DA FORMIGA	MORRO DOS MACACOS
Vulnerability Context	3.5	3.6
Community Resilience	4.0	3.9
Individual Capacity	3.1	2.6

Source: Authors' own elaboration based on findings from the UCRA survey.

Vulnerability Context

Both communities received scores in the *moderately resilient to resilient* range. The results for Morro da Formiga indicate that potential resilience weak spots or issues for consideration are informal housing and access to piped water (Table 3). The indicator for Informal Housing received a scoring of 2, since 18 percent of the households in the community are considered informal, according to data from Rio+Social. In terms of access to piped water, only 48 percent of households, roughly 612 households, are connected to the water distribution system, earning the indicator a score of 2 (*weak resilience*). The results for Morro dos Macacos were marginally better in the category Vulnerability of Setting, and somewhat poorer in the category Access to Utility Services. A potential resilience weak spot highlighted by the results concerns Access to Energy. In total, 26 percent of households (360 households), are not connected to the energy grid. Results in this aspect demonstrate the different contextual needs for both communities and how the resilience in Formiga is informed by different needs than in Macacos. Vulnerable communities are not homogenous, which should be reflected in policy

Table 3 | Summary of Results for Vulnerability Context in Rio de Janeiro

VULNERABILITY CONTEXT	CATEGORY	FORMIGA	MACACOS	INDICATOR	FORMIGA	MACACOS
	Vulnerability of Setting	3.5	4.0	Evacuation routes	5.0	5.0
				Informal housing	2.0	3.0
				High-risk areas	—	—
	Preexisting Social Vulnerability	3.0	3.0	Socio-economic characteristics	3.0	3.0
				Crime rate	3.0	3.0
	Access to Utility Services	4.0	3.8	Access to piped water supply	2.0	5.0
				Adequate sewage treatment	5.0	4.0
				Access to energy supply	4.0	2.0
				Household waste collection	5.0	4.0
Access to Health and Emergency Services	—	—	Access to emergency shelter	—	—	
			Access to hospitals and health centers	—	—	

Source: Authors' own elaboration based on findings from the UCRA survey.

responses aimed at reducing vulnerability, although this is often not the case.

Community Resilience

Community preparedness stands out in both communities for their *very resilient* scores (Table 4). This can be attributed to the work and presence of municipal civil defense in Rio de Janeiro, which runs resilience simulations in schools, helps coordinate community resilience task forces, and is responsible for installing and managing early warning systems (EWSs) that alert residents in high-risk areas to evacuate in case of strong rains and potential risk of landslides.

In terms of social cohesion, both communities attained scores of *moderately resilient*. The results show that, despite scoring well on size of social networks, neighborhood attachment, and sense of community identity, scores were significantly poorer for all other indicators relating to neighborhood socializing and regular engagement with neighbors. The results indicate that residents in both communities feel strongly attached to their neighborhoods and know a lot of neighbors but that regular engagement and contact with neighbors is not common. This might leave more vulnerable residents, such as elderly people, at risk of isolation during extreme events.

Another key insight is that both communities in Rio de Janeiro scored poorly on the Political Engagement aspect. This can suggest several things, including lack of knowledge of local community meetings or public consultations, lack of trust in participatory processes, lack of trust in government, or lack of interest in political engagement. The results for this indicator need to be better explored and understood. When residents are more politically engaged with local governance, this can influence their ability to inform local decisions regarding access to services or urban upgrading. This ability, on the whole, contributes to a community's resilience as it can hold authorities more accountable to address communities' needs.

The results from this aspect provide insights into a neighborhood's social capital and level of engagement with local governance, as well as the existing infrastructure that helps communities to prepare, react to, and recover from climate impacts. Encouraging the strengthening of community resilience through local governance, social cohesion, or task force groups is important to building a community's capacity to organize.

Table 4 | Summary of Results for Community Resilience in Rio de Janeiro

	CATEGORY	FORMIGA	MACACOS	INDICATOR	FORMIGA	MACACOS
COMMUNITY RESILIENCE	Social Cohesion	3.0	2.8	Political engagement	1.9	1.3
				Size of informal social networks	4.1	3.8
				Strength of informal social networks	2.3	2.6
				Regular engagement with informal groups	2.4	2.1
				Neighborhood socializing	2.1	2.0
				Neighborhood attachment	3.9	3.9
				Sense of community identity	4.6	4.1
	Community Preparedness	5.0	5.0	Resilience simulations in schools	5.0	5.0
				Community resilience task force	5.0	5.0
				High-risk communities with EWSs	5.0	5.0

Source: Authors' own elaboration based on findings from the UCRA survey.

Individual Capacity

The poorest scores of the Rio de Janeiro pilot project are found in the Individual Capacity aspect (Table 5). Despite both communities achieving *moderately resilient* to *resilient* scores in Risk Perception (which indicates a relatively satisfactory understanding of the local climate risks), this did not translate into better scores for indicators of other categories such as Knowledge and Habits, Individual Preparedness, Emergency Readiness, and Economic Resources. While both communities are covered by an EWS and have received training by civil defense, few respondents indicated they were registered in mobile warning alerts or had certified backup copies of identity documents.¹ For residents living in a high-risk and low-income community, such actions can help reduce vulnerability and increase individual resilience. The results are somewhat unexpected, highlighting that despite understanding the local climate risks, respondents had not taken key actions that could increase their resilience and mitigate risks. This is a potential barrier to increasing the resilience of a vulnerable population and should be further understood through more research, interviews, and focus groups.

Morro da Formiga scored better than Morro dos Macacos. This might reflect the fact that more residents in Morro da Formiga had participated in resilience training delivered by municipal civil defense officials than in Morro dos Macacos. In Morro da Formiga, 30 percent of residents had participated in resilience training, compared to 4 percent in Morro dos Macacos.

UCRA helps city authorities and resilience managers understand key resilience behaviors at the individual level, which is important to take into account when designing policy responses to reduce climate vulnerability. Ultimately, resilient communities are made up of resilient individuals. Identifying key drivers for individual resilience behavior can help with successful policy implementation and outcomes aimed at increasing the resilience of communities and their residents.

¹ Documents such as the Cadastro de Pessoas Físicas (Registry of Individuals, abbreviated as CPF) are mandatory for Brazilian citizens who pay income tax, own bank accounts, or own property as established by Normative Ruling No. 1548 of February 13, 2015.

Table 5 | Summary of Results for Individual Capacity in Rio de Janeiro

INDIVIDUAL CAPACITY	CATEGORY	FORMIGA	MACACOS	INDICATOR	FORMIGA	MACACOS
	Risk Perception	4.2	3.4	Climate risk perception	4.2	3.4
	Knowledge and Habits	2.4	1.8	Knowledge of resilience habits	1.3	1.0
				Practice of resilience habits	2.4	1.5
				Resilience training	2.2	1.2
				Weather forecast awareness	3.5	3.3
	Individual Preparedness	2.2	2.0	Resilience kits	2.8	1.7
				Backup copies of documents	1.6	2.2
	Communication	4.1	4.1	Individual cell phone ownership	4.3	4.3
				Individual Internet access	3.9	3.9
Emergency Readiness	3.1	2.0	Knowledge of correct emergency number	3.6	2.5	
			Access to emergency numbers	3.6	2.4	
			Early warning alerts	2.2	1.2	
Economic Resources	2.8	2.2	Alternative livelihood options	3.0	3.1	
			Emergency savings	2.3	1.3	
			Investment in resilience proofing	3.0	2.3	

Source: Authors' own elaboration based on findings from the UCRA survey.

Porto Alegre

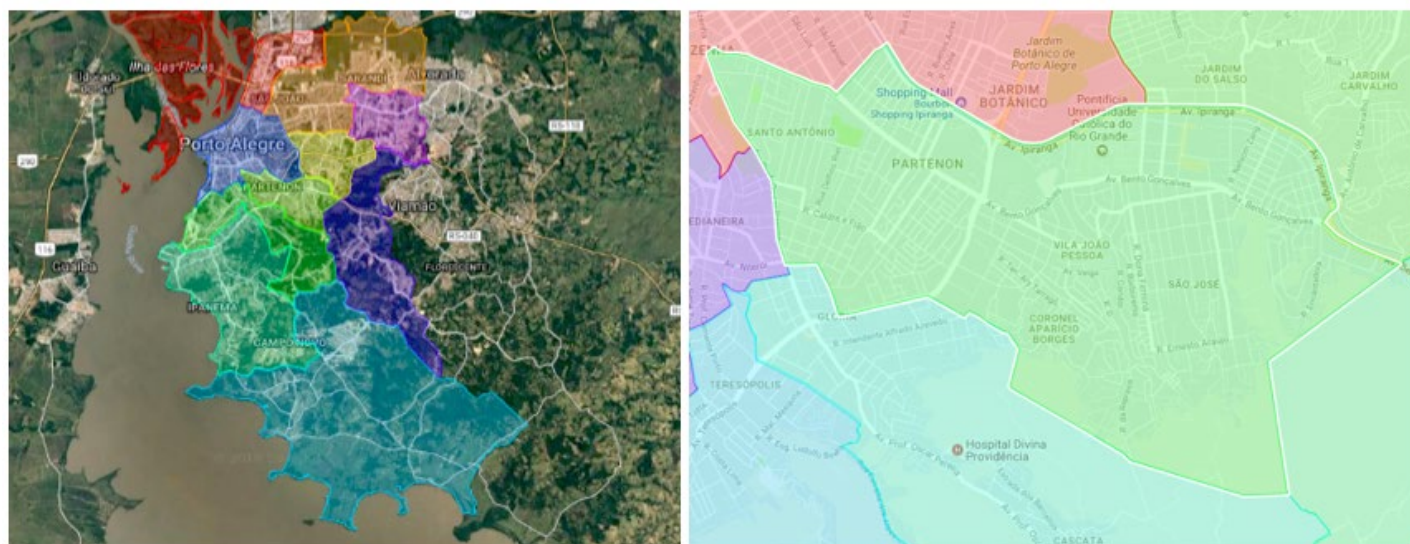
In Porto Alegre, 400 surveys were implemented during July 2016 in five communities within the administrative region of the city called Partenon, which is home to 120,000 residents. Partenon is made up of five neighborhoods: São José, Vila João Pessoa, Cel Aparício Borges, Santo Antônio, and Partenon (Figure 6). The surveys were implemented in proportion to the population of each neighborhood.

Over the years the region has developed a diversified commercial network, and a broad number of educational institutions have opened in Partenon, including one of the largest university campuses of Porto Alegre. Of the 17 administrative regions of the city, Partenon has the fourth largest percentage of households living in informal housing and is the fourth most densely populated region. The five neighborhoods have varying socioeconomic contexts, rendering Partenon a good region to pilot UCRA.

Table 6 summarizes the results by aspect for the pilot application of UCRA in the Partenon region of Porto Alegre. The scores for the five neighborhoods varied somewhat within each aspect. For vulnerability context, scores ranged from 3.0 (*moderately resilient*) in Coronel Aparício Borges (CAB) to 3.9 (*resilient*) in Santo Antônio. Community Resilience stands out as the weakest aspect for all neighborhoods, each attaining similar scores of 1.9–2.0. Regarding Individual Capacity, all five neighborhoods were classified as *moderately resilient*, attaining scores between 2.6 and 3.0.

Scores for Individual Capacity were better than scores for Community Resilience. This might indicate that individuals are able to enhance their own resilience using their own resources. Urban planners should seek to understand these drivers in order to better leverage them when looking to develop and invest in community resilience.

Figure 6 | The City of Porto Alegre's Administrative Regions and Partenon's Five Neighborhoods



Source: ObservaPOA. Available at: http://observapoa.com.br/default.php?reg=272&p_secao=46 Accessed: 02.20.2018.

Table 6 | Summary of Results for Porto Alegre

ASPECTS	CEL. APARÍCIO BORGES	PARTENON	SANTO ANTÔNIO	SÃO JOSÉ	VILA JOÃO PESSOA
Vulnerability Context	3.0	3.8	3.9	3.3	3.6
Community Resilience	2.0	1.9	2.0	1.9	2.0
Individual Capacity	2.7	2.8	3.0	2.7	2.6

Source: Authors' own elaboration based on findings from the UCRA survey.

Vulnerability Context

The neighborhoods attained similar scores for most categories, except for Vulnerability of Setting. The scores for this category ranged widely across the five neighborhoods, from 2.3 (*weak resilience*) to 5.0 (*very resilient*) (Table 7). In comparison, more people live in high-risk areas in Coronel Aparício Borges and São José, and more people live in informal housing areas in São José.

Key resilience weak spots concern Evacuation Routes and Crime Rate across all neighborhoods. Porto Alegre has not developed designated evacuation routes, despite having identified and mapped 118 high-risk areas. This decreases the overall resilience of communities, individuals, and the city in terms of risk management. Regarding crime, overall the homicide rate varies between 7 and 64 homicides per

100,000 inhabitants in the city of Porto Alegre. The crime rate of the five neighborhoods together stands at 36.2 homicides per 100,000 inhabitants, earning the poorest score (*not resilient*).

Regarding the category Access to Utility Services, most neighborhoods scored well, being classified as *resilient* or *very resilient*. This reflects the fact that the majority of the neighborhoods have access to basic municipal infrastructure and services such as piped water, sewage treatment, access to energy, and household waste collection services. Potential resilience weak spots and opportunities for improvement concern access to adequate sewage treatment in the Coronel Aparício Borges (score of 2) and São José (score of 3) neighborhoods.

Table 7 | Summary of Results for Vulnerability Context in Porto Alegre

CONTEXTUAL VULNERABILITY	CATEGORY	CEL. APARÍCIO BORGES	PARTENON	SANTO ANTÔNIO	SÃO JOSÉ	VILA JOÃO PESSOA	INDICATOR	CEL. APARÍCIO BORGES	PARTENON	SANTO ANTÔNIO	SÃO JOSÉ	VILA JOÃO PESSOA
	CONTEXTUAL VULNERABILITY	Vulnerability of Setting	2.3	3.7	5.0	2.3	3.3	Evacuation routes	1.0	1.0	–	1.0
Informal housing								4.0	5.0	5.0	3.0	4.0
High risk areas								2.0	5.0	5.0	3.0	5.0
Preexisting Social Vulnerability		2.3	2.5	2.8	2.3	2.5	Socioeconomic characteristics (Human Development Index)	4.0	4.0	5.0	4.0	4.0
							Crime rate	1.0	1.0	1.0	1.0	1.0
Access to Utility Services		4.3	5.0	5.0	4.5	4.8	Access to piped water supply	5.0	5.0	5.0	5.0	5.0
							Adquate sewage treatment	2.0	5.0	5.0	3.0	4.0
							Access to energy supply	5.0	5.0	5.0	5.0	5.0
							Household waste collection	5.0	5.0	5.0	5.0	5.0
Access to Health and Emergency Services		3.0	4.0	3.0	4.0	4.0	Access to emergency shelter	–	–	–	–	–
	Access to hospitals and health centers						3.0	4.0	3.0	4.0	–	

Source: Authors' own elaboration based on findings from the UCRA survey.

Community Resilience

In all neighborhoods, Community Resilience was the aspect with the poorest resilience scores. Regarding category scores, all neighborhoods were categorized as *moderately resilient* for Social Cohesion and as *not resilient* for Community Preparedness. Once again, the scores for the indicators differed little among the neighborhoods (Table 8).

Scores for Political Engagement were particularly poor across all neighborhoods, where 65 to 95 percent of the population had not engaged in a political event (participatory budgeting, protest, public consultation, etc.) over the previous six months.

In general, about 70 to 80 percent of respondents indicated that they intend to continue living in their neighborhoods for the next five years. (The exception is Vila João Pessoa, where the rate for Place Attachment is 57 percent.) Scores for Sense of Community Identity were high, averaging 4 (*resilient*). A strong sense of community identity contributes to social cohesion in the neighborhood as a whole; studies have demonstrated that this can contribute positively to community resilience because it indicates

that residents are invested in the overall improvement of their neighborhood (Baussan 2015).

Despite respondents indicating that they knew many of their neighbors, the bonds tended to be loose. Table 8 shows that while respondents scored better on knowing neighbors, they scored poorly on indicators of stronger bonds between neighbors, such as Strength of Informal Social Networks, Regular Engagement with Informal Groups, and Neighborhood Socializing. Isolation or low socializing among neighborhoods are forms of vulnerabilities that can lead to less resilient communities (Baussan 2015). In this particular case, the UCRA diagnostic helped reveal that there is potential to strengthen social bonds, which could be useful to city officials looking to strengthen community cohesion by investing in local governance or strengthening the local neighborhood association.

All neighborhoods received the poorest score of 1 (*not resilient*) on the indicator Community Preparedness, due to the fact that the city doesn't employ community civil defense units, engage in resilience simulations, or install early warning systems in high-risk areas. Because the city doesn't organize resilience simulations, there were no available data.

Table 8 | Summary of Results for Community Resilience in Porto Alegre

CATEGORY	CEL. APARÍCIO BORGES	PARTENON	SANTO ANTÔNIO	SÃO JOSÉ	VILA JOÃO PESSOA	INDICATOR	CEL. APARÍCIO BORGES	PARTENON	SANTO ANTÔNIO	SÃO JOSÉ	VILA JOÃO PESSOA	
COMMUNITY RESILIENCE	Social Cohesion	3.0	2.9	3.0	2.9	3.0	Political engagement	1.2	1.3	1.8	1.2	1.6
							Size of informal social networks	4.4	4.2	4.5	4.3	4.7
							Strength of informal social networks	2.4	2.7	3.0	2.6	3.3
							Regular engagement with informal groups	1.9	1.6	1.5	2.0	1.8
							Neighborhood socializing	2.6	2.4	1.8	2.3	2.6
							Neighborhood attachment	4.3	4.0	4.1	3.9	3.3
							Sense of community identity	3.9	3.9	3.8	3.9	3.9
Community Preparedness	1.0	1.0	1.0	1.0	1.0	Resilience simulations in schools	-	-	-	-	-	
						Community resilience task force	1.0	1.0	1.0	1.0	1.0	
						High-risk communities with early warning systems	1.0	1.0	1.0	1.0	1.0	

Source: Authors' own elaboration based on findings from the UCRA survey.

Individual Capacity

In general, the neighborhoods assessed in the pilot UCRA application in Porto Alegre are *moderately resilient* in terms of their individual capacity. Table 9 shows a good level of Risk Perception in the neighborhoods (with the exception of Coronel Aparício Borges), in addition to *moderately resilient* to *resilient* scores for the Communication indicators. This is driven by rising levels of access to the Internet and smartphones in recent years, particularly in Santo Antônio, the most economically affluent neighborhood. The results for the indicator Access to Weather Forecasts stand out as Very Resilient, scoring above 4.8 for all neighborhoods.

Individual Preparedness scored poorly overall, attaining scores from 1.7 to 2.1 across the five neighborhoods (*not resilient* and *weak resilience*). Residents don't own resilience kits, don't have authenticated copies of their ID, don't know the telephone numbers for emergency services, aren't registered in EWSs (because they aren't installed in the city), and don't tend to set aside emergency savings, even in the more affluent of the surveyed neighborhoods. As in the case of the Rio neighborhoods discussed earlier, the application of UCRA revealed that high levels of risk perception did not necessarily translate into individual preparedness, particularly regarding key habits and actions that can mitigate and lower risks.

Table 9 | Summary of Results for Individual Capacity in Porto Alegre

CATEGORY	CEL. APARÍCIO BORGES	PARTENON	SANTO ANTÔNIO	SÃO JOSÉ	VILA JOÃO PESSOA	INDICATOR	CEL. APARÍCIO BORGES	PARTENON	SANTO ANTÔNIO	SÃO JOSÉ	VILA JOÃO PESSOA
	Risk Perception	2.9	3.5	4.0	3.7		3.7	Perceived climate-risk probability	2.9	3.5	4.0
Knowledge and Habits	2.9	3.0	3.3	2.6	2.8	Knowledge of resilience habits	3.1	2.6	3.1	2.0	2.2
						Practice of resilience habits	2.2	3.1	3.6	2.2	2.6
						Resilience training	1.5	1.5	1.6	1.4	1.5
						Access to weather forecast	4.9	4.8	4.9	4.9	4.9
Individual Preparedness	1.7	2.1	1.9	1.9	2.1	Resilience kits	1.4	2.2	1.7	1.9	1.7
						Backup copies of documents	1.9	2.2	2.0	1.9	2.5
Communication	3.8	3.9	4.2	3.4	3.6	Individual cell phone ownership	3.7	3.9	4.6	3.5	3.8
						Individual Internet access	3.9	3.8	3.8	3.4	3.5
Emergency Readiness	2.3	2.0	1.8	2.2	1.5	Emergency number	2.1	1.5	1.1	2.7	1.1
						Access to emergency numbers	3.8	3.3	3.2	3.0	2.4
						Early warning alerts	1.0	1.0	1.0	1.0	1.0
Economic Resources	2.6	2.2	2.7	2.0	1.8	Alternative livelihood options	3.2	2.6	2.9	2.5	2.1
						Emergency savings	2.4	2.1	2.7	2.0	2.2
						Investment in resilience proofing	2.1	1.8	2.6	1.6	1.2

Source: Authors' own elaboration based on findings from the UCRA survey.

CONCLUSIONS AND RECOMMENDATIONS

This section outlines the key findings of the pilot projects and their relevance to city planners and other potential users of UCRA. It also describes some limitations of the tool and opportunities for its further development.

The UCRA results shed light on the access to key urban services and sociopolitical factors that affect resilience at the community and individual levels. The data brought to light new information for both cities, particularly regarding individual capacities such as the risk perception of individuals, their resilience habits, and how prepared individuals are to face climate risks.

Key Findings

The data offer potential guidance on priorities when cities are deciding where and how to enhance resilience in vulnerable and low-income settlements.

Vulnerability Context

Based on our findings for Rio de Janeiro, key resilience concerns include the presence of informal housing and lack of piped water in Morro da Formiga, and energy security in Morro dos Macacos. In Porto Alegre, results were less homogenous, which demonstrates that the city needs to adapt and target specific interventions in different communities. For instance, scores on informal housing and access to sewage treatment varied between two and five for the five different neighborhoods, despite their being part of the same administrative region.

Community Resilience

The lack of early warning systems or evacuation routes undermines community resilience in Porto Alegre, as does the lack of political engagement in all communities surveyed. In the latter case, the city could opt to focus on strengthening public engagement and participation in local governance. What stood out in both cities is that residents have a strong sense of place and attachment to place but that this does not translate into strong or regular engagement with neighbors or local governance. This is a potential barrier to building community and individual resilience that needs further exploration. More understanding could also help identify drivers and opportunities to overcome this barrier to strengthen social cohesion. If cities are able to focus on strengthening community bonds and citizen engagement, this might have a positive impact on individual habits and the preparedness of citizens.

Individual Capacity

Communities in both cities demonstrate that individual residents are aware of their climate risks, but perform poorly in terms of knowledge or habits that increase their resilience. As mentioned above, this is a barrier that requires further understanding, which could potentially lead to changes in policymaking and resilience planning. The survey also shows that few residents have participated in resilience training. Lack of training affects the ability of residents to access information and services or act in ways that can increase their resilience.

For example, in Rio de Janeiro, the results for both communities highlight that few residents had authenticated backup copies of their documents of identification. In the case of Porto Alegre, only a small number of residents had resilience kits or knew the correct emergency services telephone numbers to call. It is possible to interpret the poorer individual capacity scores as an indication that more attention and resources need to be targeted at the individual level. Despite investments in community resilience infrastructure, such as EWSs in Rio de Janeiro or improved access to urban services, these urban development programs need to be coupled with training and improved access to information targeted at individuals, in order to affect behavior change on the ground.

For instance, the results for the Rio pilot project reveal *moderately resilient* to *resilient* scores for both the Vulnerability of Context and Community Resilience aspects. These scores, however, did not translate into similar scores at the Individual Capacity aspect. If part of cities' resilience goals is to enhance the resilience of vulnerable individuals, those individuals need to be engaged in the planning process and ensure that their needs are addressed. Investing in public services and community infrastructure may not be enough to create a culture of resilience and preparedness among individuals. What is needed is more engagement and training, better targeted communications, and visible actions on the ground.

Limitations

The results highlight limitations regarding data collection and analysis. In the case of Rio de Janeiro, it was not possible to fully develop all indicators for Vulnerability Context due to lack of data available at the community level. Data were available only at the neighborhood level, which does not appropriately reflect the reality in the vulnerable

and low-income settlements. Using neighborhood-level data can limit the validity of the information and distort the results, as is the case for household waste collection, where waste collection is measured by whether the community has a public waste collection point. In many of Rio's vulnerable and formerly informal settlements, these public waste collection points are at the entrance to the communities and are in areas where garbage trucks have enough space to maneuver. Many residents who live farther away from the collection point or in areas accessible only by foot are out of reach of the truck or must walk long distances to dispose of their household waste.

Several indicators for Porto Alegre, such as the crime rate, received the same score across all five neighborhoods. This is due to a lack of data disaggregated to smaller neighborhood units. As a consequence, a comparative analysis of differential resilience was not possible. On the other hand, the lack of data also reveals a valuable insight and data gap for cities to generate data that are needed to effectively address neighborhood and community resilience.

In some instances—for example, with respect to the categories for access to emergency shelter and high-risk areas—data were not available in either city, so the indicators were not scored. Missing data hinder the development of robust composite indicators, so the indicators where data were either not available or missing will be reviewed to identify proxy indicators and to establish whether the methodology to measure the indicators needs to be simplified.

A further limitation was the geographical scope of data collection. Data were collected on the ground by an outsourced survey company, and whose movements and coverage of the area were limited for security reasons. In Rio, territorial disputes between drug gangs caused the surveyors to stay closer to the community center, rather than walk around the community. Data were collected at one location near the entrance to the favela, and the surveys most likely did not access residents who tend to move in and out of the favela infrequently, such as elderly residents.

Regarding the scoring methodology, weights were not assigned to the different indicators. Because the number of indicators is not evenly distributed in the various categories, this can result in an unbalanced structure in the composite index, giving more weight to categories that feature fewer indicators. For example, if category A features only three indicators and category B features six,

then the indicators from category A will carry more weight than those in category B.

In terms of interpretation and analysis of results, due to time and resource constraints it was not possible to cross-analyze the data and produce an intersectional analysis; that is, to identify whether findings differed based on gender or age. Such an analysis would provide useful insights into equity and social inclusion and help inform more targeted and effective policies that aim to build community and individual resilience. Effective resilience planning is participatory and must address the equity and vulnerability needs of a community (Patterson 2015). Consequently, this paper falls short in addressing how social inclusion and equity contribute to building community and individual resilience.

Finally, applying UCRA in a city does not guarantee that urban adaptation and resilience planning will take differentiated needs of vulnerable communities into account. Such differentiation is led by political will. Where such will exists, UCRA is a tool that can facilitate more participatory processes in urban resilience planning because cities have the option to engage communities in data collection and analysis. As such, implementing UCRA should be demand-driven by cities.

Opportunities for Improving UCRA

We have identified opportunities for improvement that will help develop UCRA into a more robust composite index and urban-resilience planning tool.

The composite index methodology of the tool needs to be improved to enhance the ability to analyze causal relationships among indicators. This can help better measure the sociopolitical and community capacities that influence resilience in vulnerable and informal urban settlements. Consequently, UCRA could yield more accurate insights and analysis into what creates or undermines resilience in such communities, whether it is the strength of social bonds between women, perception of risk of parents, or resilience habits of children.

Data collection for UCRA indicators needs to be improved and the resulting datasets made more accessible to city stakeholders. This would allow for quick scaling and reduce the time- and resource-intensive process of collecting data through household surveys. Some of the indicators, especially in the individual capacity aspect, require review by WRI and city partners to help identify whether

proxy indicators should be established. The UCRA tool should also consider leveraging mobile technology and other digital platforms to collect data.

The spatial analysis function of the tool should be advanced to help cities map resilience for all three aspects. Ideally, the results should be disaggregated by factors such as sex, age, employment status, migration status, and so on. This would facilitate more granular analysis of vulnerability and resilience. The UCRA tool should focus on improving its GIS functions and include features such as the ability to overlay UCRA results with future climate impacts, such as flooding or increased urban heat. Such analysis will enable cities to better plan for future development and allocate resources more effectively. It will also help cities to prioritize and invest in specific resilience-building actions and improve their resilience scores over time.

Solutions should be informed by residents' demands and needs expressed through workshops and, potentially, focus groups. This would strengthen UCRA's function as both a resilience diagnostic and a participatory planning tool to develop long-term community plans that respond to climate change impacts and focus on building community and individual climate resilience.

For UCRA to be effective and increase urban community resilience, it needs to deliver policy outcomes (that is, on-the-ground adaptation and resilience measures) and not just policy outputs (that is, strategies and plans). The tool should help policymakers rapidly identify effective and implementable urban community resilience solutions. Second, the tool needs to demonstrate that community resilience measurably increases over time when cities apply the UCRA methodology. Monitoring and evaluation of resilience can be achieved by applying UCRA over the long term and analyzing how scores change. In Porto Alegre and Rio de Janeiro, the pilot projects did not reach the stage of implementing resilience measures. Therefore, this paper cannot yet comment on the effectiveness of UCRA in enabling cities to address differentiated needs of vulnerable communities.

Further, in order to affect policy, urban planners and city managers need to be aware of the benefits of pro-poor urban resilience planning. This working paper is part of ongoing work which seeks to engage policymakers at the municipal and national level in three cities: Rio de Janeiro (Brazil), Surat (India), and Semarang (Indonesia). The results from the application in all three cities will be presented to policymakers in municipal and national governments, as well as to the communities who participated in the three pilot projects (Rangwala et al. forthcoming). The results to date have been presented at key urban-focused conferences, such as ICLEI Resilient Cities in Bonn, Germany, and the World Urban Forum in Kuala Lumpur, Malaysia.

APPENDIX A: SCORING PARAMETERS FOR THE URBAN COMMUNITY RESILIENCE ASSESSMENT

		1	2	3	4	5	NO SCORE
Indicator Name	Indicator Definition	Not Resilient	Weak Resilience	Moderately Resilient	Resilient	Very Resilient	Comments
Evacuation Routes	Number of officially designated evacuation routes in high-risk area	No designated evacuation route	—	—	—	Designated evacuation route	
Informal Housing	% of households living in informal housing in the area	25.1–100%	15.1–25%	10.1–15%	5.1–10%	0–5%	
High-Risk Areas	% of households in area which are subject to city's identified risks	25.1–100%	15.1–25%	10.1–15%	5.1–10%	0–5%	
Socioeconomic Characteristics	HDI for neighborhood	—	0–0.54	0.55–0.699	0.7–0.799	0.8–1%	
Crime Rate	Incidents of violent crime per 100,000 residents	20–5,000	10–19.99	6–9.99	2–5.99	0–1.99	
Access to Piped Water Supply	% of households connected to water distribution network	0–40%	40.1–80%	80.1–90%	90.1–95%	95.1–100%	
Adequate Sewage Treatment	% of households linked to wastewater collection and treatment network	0–40%	40.1–80%	80.1–90%	90.1–95%	95.1–100%	
Access to Energy Supply	% of households connected to the electricity grid	0–40%	40.1–80%	80.1–90%	90.1–95%	95.1–100%	
Household Waste Collection	% of households served by municipal waste collection	0–19.9%	20–30.9%	31–74.9%	75–90%	90.1–100%	
Access to Emergency Shelter	% of households within 500m distance of either a school, police station, or civil defense unit	—	—	—	—	—	Unable to score due to difficulty in data collection
Access to Hospitals and Health Centers	% of households within 500m distance of a hospital or health center	—	—	—	—	—	Unable to score due to difficulty in data collection
Political Engagement	Number of engagements with political activity in the last 6 months (community meeting, protest, or public hearing)	0 engagements	1–2 engagements	3–4 engagements	5–6 engagements	7+ engagements	
Size of Informal Social Networks	Number of neighbors known by first name	0 neighbors	1–2 neighbors	3–4 neighbors	5–6 neighbors	7+ neighbors	
Strength of Informal Social Networks	Number of neighbors' phone numbers saved	0 neighbors	1–2 neighbors	3–4 neighbors	5–6 neighbors	7+ neighbors	

		1	2	3	4	5	NO SCORE
Regular Neighborhood Socializing	Number of regular meetups with informal groups for leisure, hobbies, civic engagement per month	0 meetups	1-2 meetups	3-4 meetups	5-6 meetups	7+ meetups	
Spontaneous Neighborhood Socializing	Number of irregular meetups in the neighborhoods (meet friends, church engagements, relax, shop) per month	0 meetups	1-2 meetups	3-4 meetups	5-6 meetups	7+ meetups	
Neighborhood Attachment	Number of residents who indicated they intend to live in the neighborhood for the next five years	Doesn't know/ no	—	—	—	Yes	
Sense of Community Identity	Number of residents who indicated they feel part of their neighborhood community	No	—	Somewhat	—	Yes	
Resilience Simulations in Schools	Number of neighborhood schools in high-risk area that have undertaken a resilience simulation	No	—	—	—	Yes	
Community Resilience Task Force	Community resilience task force established in neighborhood (NUDECs)	No	—	—	—	Yes	
High-Risk Communities with Early Warning Systems	For areas identified as high risk, is it covered by an early warning system?	No	—	—	—	Yes	
Perceived Climate-Risk Probability	% of climate risks correctly identified by residents	Correctly identified up to 20% of risks	Correctly identified up to 40% of risks	Correctly identified up to 60% of risks	Correctly identified up to 80% of risks	Correctly identified more than 80% of risks	
Knowledge of Resilience Habits	Number of resilience habits residents were able to name	Identified 1 habit correctly	Identified 2 habits correctly	Identified 3 habits correctly	Identified 4 habits correctly	Identified at least 5 habits correctly	
Practice of Resilience Habits	Number of resilience habits residents said they practiced	Practiced 1 resilience habit	Practiced 2 resilience habits	Practiced 3 resilience habits	Practiced 4 resilience habits	Practiced 5 or more resilience habits	
Resilience Training	Number of residents trained in emergency response and resilience	Resident not trained/ resident who doesn't know	-	-	-	Residents who have received training	
Resilience Kits	Number of resilience kit items correctly identified	Correctly identified 1 item	Correctly identified 2 items	Correctly identified 3 items	Correctly identified 4 items	Correctly identified 5 items	The score for resilient kits is calculated as the average between both indicators

		1	2	3	4	5	NO SCORE
		Resident does not have resilience kit / Doesn't know	—	—	—	Resident has resilience kit	
Individual Resilience Preparation	Number of residents with backup copies of documents	No backup copies/doesn't know	1 non-authentic copy	2 non-authentic copies	At least 1 authenticated copy	2 authenticated copies	The score for resilient kits is calculated as the average between both indicators
	Storage of backup copies of documents	Documents kept at home/ doesn't know	—	—	—	Documents stored outside home	
Individual Cell Phone Ownership	Number of residents who own a cell phone	Doesn't own cell phone/ doesn't know	—	Owens a cell phone without Internet	—	Smartphone with Internet	
Individual Internet Access	Number of residents with access to the Internet	Doesn't access the Internet/ doesn't know	Via LAN House	Home computer	Tablet	Smartphone	
Emergency Number	Number of residents who can correctly name the civil defense emergency number	Mentions numbers other than 193 or 199/ doesn't know	—	—	—	193/199	Not for scoring For analysis only
Access to Emergency Numbers	Number of residents who have saved emergency numbers	Hasn't saved numbers/ doesn't know	Hasn't saved numbers, but knows by heart	Saved and stored at home	Saved and carries them	Saved numbers onto cell phone	
Early Warning Alerts	Number of residents registered in early warning system	Not registered/ doesn't know	—	—	—	Is registered in an EWS	
Early Warning Alerts	Number and type of information sources residents use to access weather information	Does not access weather information/ doesn't know	Social media sites, word of mouth, or interpreting local conditions	Access to weather information using one traditional media source	Access to weather information using several traditional media sources	Access to weather information using a combination of smartphone apps and city apps	
Alternative Livelihood Options	Average number of residents who indicated likelihood of alternative livelihoods	Very unlikely/ doesn't know	Unlikely	—	Likely	Very likely	
Emergency Savings	Average number of residents with emergency savings	0-1/2 of minimum salary/doesn't know	1/2-1 minimum salary	1.1-3 minimum salaries	3-6 minimum salaries	6+ minimum salaries	
Investment in Resilience Proofing	Average number of residents who indicated willingness to invest in resilience proofing strategies	No/doesn't know	—	—	—	Yes	

APPENDIX B: SCORING SOURCES FOR THE INDICATORS

ASPECT	CATEGORY	INDICATOR	SOURCE
Vulnerability Context	Vulnerability of setting	Evacuation routes	Civil Defense Rio de Janeiro
Vulnerability Context	Vulnerability of setting	Informal housing	Informal Settlement Vulnerability Index - Provincial Government of the Western Cape
Vulnerability Context	Vulnerability of setting	High-risk areas	UN Habitat
Vulnerability Context	Preexisting social vulnerability	Socioeconomic characteristics	HDI
Vulnerability Context	Preexisting social vulnerability	Crime rate	Global Peace Index. Institute for Economics and Peace
Vulnerability Context	Access to utility services	Access to piped water supply	Informal Settlement Vulnerability Index - Provincial Government of the Western Cape, 2012
Vulnerability Context	Access to utility services	Adequate sewage treatment	Informal Settlement Vulnerability Index - Provincial Government of the Western Cape, 2012
Vulnerability Context	Access to utility services	Access to energy supply	Informal Settlement Vulnerability Index - Provincial Government of the Western Cape, 2012
Vulnerability Context	Access to utility services	Household waste collection	Informal Settlement Vulnerability Index - Provincial Government of the Western Cape, 2012
Vulnerability Context	Access to health and emergency services	Access to emergency shelter	WRI Brasil
Vulnerability Context	Access to health and emergency services	Access to hospitals and health centres	WRI Brasil
Community Resilience	Social cohesion	Political Engagement	WRI Brasil
Community Resilience	Social cohesion	Size of informal social networks	WRI Brasil
Community Resilience	Social cohesion	Strength of informal social networks	WRI Brasil
Community Resilience	Social cohesion	Regular engagement with informal groups	WRI Brasil
Community Resilience	Social cohesion	Neighborhood socializing	WRI Brasil
Community Resilience	Social cohesion	Neighborhood attachment	WRI Brasil
Community Resilience	Social cohesion	Sense of community identity	WRI Brasil
Community Resilience	Community preparedness	Resilience simulations in schools	WRI Brasil
Community Resilience	Community preparedness	Community resilience taskforce	WRI Brasil
Community Resilience	Community preparedness	High-risk communities with early warning systems	WRI Brasil

ASPECT	CATEGORY	INDICATOR	SOURCE
Individual Capacity	Risk perception	Perceived climate risk probability	WRI Brasil
Individual Capacity	Knowledge and habits	Knowledge of resilience habits	WRI Brasil
Individual Capacity	Knowledge and habits	Practice of resilience habits	WRI Brasil
Individual Capacity	Knowledge and habits	Resilience training	WRI Brasil
Individual Capacity	Individual preparedness	Resilience kits	WRI Brasil
Individual Capacity	Individual preparedness	Backup copies of documents	WRI Brasil
Individual Capacity	Communication	Individual cell phone ownership	WRI Brasil
Individual Capacity	Communication	Individual Internet access	WRI Brasil
Individual Capacity	Emergency readiness	Emergency number	WRI Brasil
Individual Capacity	Emergency readiness	Access to emergency numbers	WRI Brasil
Individual Capacity	Emergency readiness	Early warning alerts	WRI Brasil
Individual Capacity	Economic resources	Alternative livelihood options	WRI Brasil
Individual Capacity	Economic resources	Emergency savings	WRI Brasil
Individual Capacity	Economic resources	Investment in resilience proofing	WRI Brasil

APPENDIX C: GENERIC SURVEY

A) Do you live in [community]? (Open answer)

1) Yes

→ NEXT QUESTION

2) No

→ END SURVEY

SOCIAL COHESION

(A CARD WITH THE DEFINITION OF INDIVIDUAL CLIMATE RESILIENCE IS HANDED TO THE RESIDENT. THE SURVEYOR READS THE DEFINITION TOGETHER WITH THE RESIDENT.)

1) Having read the definition, on a scale from 1 to 5, where 1 is not resilient and 5 is very resilient, how resilient do you consider yourself? **(Tick one)**

1) Not resilient

3) Moderately resilient

5) Very resilient

2) Weak resilient

4) Resilient

2) In the past 6 months, how many times have you participated in public consultations, community meetings, or protests? **(Tick one)**

1) 0 times

3) 3-4 times

5) 7 or more times

2) 1-2 times

4) 5-6 times

3) How many neighbors do you know by first name? **(Tick one)**

1) 0 neighbors

3) 3-4 neighbors

5) 7+ neighbors

2) 1-2 neighbors

4) 5-6 neighbors

4) Do you have your neighbors' cell phone numbers saved? If so, how many? **(Tick one)**

1) 0 neighbors

3) 3-4 neighbors

5) 7+ neighbors

2) 1-2 neighbors

4) 5-6 neighbors

5) How often per month do you meet with neighbors in the community for regular socialization, for example to play sports regularly, practice music together, dance, prepare for carnival, meet at the local community center, go to the parents' club, take part in religious group activities? **(Tick one)**

1) 0 times

3) 3-4 times per month

5) 7+ times per month

2) 1-2 times per month

4) 5-6 times per month

6) How often per month do you meet with neighbors in the community for informal, irregular socialization like watching TV, eating together, having a barbecue, shopping, drinking, etc. **(Tick one)**

1) 0 times

3) 3-4 times per month

5) 7+ times per month

2) 1-2 times per month

4) 5-6 times per month

7) Do you intend on living in the community in the next five years? **(Tick one)**

1) Yes

2) No

3) Don't know

8) Do you feel part of your local community? **(Tick one)**

1) Yes

2) Somewhat

3) No

RISK PERCEPTION

9) Do you think that climate change, which is change in the planet's climate caused by human activity, which is increasing extreme weather events, is a risk to your neighborhood? **(Tick one)**

- 1) Yes 2) No 3) Don't know

10) I'm going to read some climate risks and would like if you could please let me know which could happen in your neighborhood? **(Tick one)**

11) And of these climate events, which do you consider to be the most dangerous? **(Tick one)**

Climate Events	Q.10	Q.11
Strong winds	1	1
Sea level rise	2	2
Hurricanes	3	3
Earthquakes	4	4
Extreme heat	5	5
Strong rains	6	6
Prolonged drought	7	7
Hail	8	8
Landslides	9	9
Floods	10	10

12) Would you be interested in investing in, for example, insurance to reduce your own risk to these climate impacts? **(Tick one)**

- 1) Yes [→ GO TO QUESTION 13](#) 2) No [→ GO TO QUESTION 14](#)

13) How much would you be willing to invest monthly? **(Tick one)**

- 1) Up to R\$ 20,00 4) R\$ 76,00 to R\$ 100,00
 2) R\$ 21,00 to R\$ 50,00 5) More than R\$ 100,00
 3) R\$ 51,00 to R\$ 75,00

14) If you could choose one type of insurance product to reduce your risk from climate change, which type from the list below would you choose? **(Tick one)**

- 1) Government insurance
 2) Private insurance
 3) Would not invest in insurance. Prefer to invest in home improvements.
 4) Other. Detail: _____
 5) Don't know
 6) Not applicable

PREPAREDNESS AND EMERGENCIES

- 15) In case one of the climate risks we just read happened in your neighborhood, which public service would you call? Which telephone number would you dial? **(Open answer)**
- 16) Do you know the telephone number for civil defense, in case you had to call? Which number would you call? **(Tick all that apply)**
1) 193 2) 199 3) Don't know Other: _____
- 17) Have you saved on your cell phone, or written down somewhere, the telephone numbers for the police, the fire brigade, the ambulance, and/or civil defense? **(Tick one)**
1) Yes, have them saved on my cell phone
2) Yes, have them written down and carry them
3) Yes, have them written down at home
4) Don't have them written down but know them by heart
5) Don't have them written down and don't know them by heart
- 18) Are you registered in an early warning system by cell phone, telephone, or through any other platform? **(Tick one)**
1) No, am not registered
2) Yes, am registered with the following platform (define):
- 19) How do you access the weather forecast? **(Tick all the apply)**
1) Social media 5) Smartphone/app
2) Newspaper 6) City's operations center
3) Radio 7) Interpreting weather patterns
4) TV 8) Through word of mouth
Other: _____

KNOWLEDGE & HABITS

- 20) What behavior/habits do you think could reduce the risks from strong rains? **(Open answer)**
- 21) **(Hand card with a list of resilience habits to resident)** I will now read a list of habits and I'd like you to tell me which you practice in the case of strong rains? **(Tick all the apply)**
1) Leave the house with the family 9) Avoid using cell phones/telephones during storms
2) Prepare emergency bag 10) Avoid traveling during strong rains
3) Release/free pets 11) Search for a shelter
4) Observe the flood surge level 12) Keep a lantern close at night
5) Avoid walking barefoot
6) Turn off the electricity, the gas, close the doors and windows in case of strong water surge
7) Lie on flat terrain or on the beach to avoid lightning
8) Avoid standing close to large trees, metal gates, or electrical wires
- 22) Have you participated in resilience training or an emergency drill in your neighborhood? **(Tick one)**
1) Yes [→ GO TO QUESTION 23](#) 2) No [→ GO TO QUESTION 26](#)
- 23) Which training sessions have you participated in? **(Open answer)**
- 24) Who organized the training? **(Open answer)**
- 25) Did the training help you become better prepared for strong rains? **(Open answer)**
1) Yes 2) Somewhat 3) No

INDIVIDUAL PREPAREDNESS

26) (Hand card with a list of resilience items to resident) I will read a list of items, and I would like you to please indicate which you think are important to keep in an emergency backpack? **(Tick all that apply)**

- | | |
|--------------------------|------------------|
| 1) Torch or candle | 7) Extra clothes |
| 2) Water bottle | 8) ID documents |
| 3) First aid kit | 9) Cell phone |
| 4) Prescription medicine | 10) Batteries |
| 5) Money | 11) Other |
| 6) Personal hygiene kit | |

27) (Hand image of emergency backpack to resident) Do you have an emergency backpack like the one depicted ready at home? **(Tick one)**

- 1) Yes 2) No

28) Do you have backup copies of your ID? If yes, are these copies authenticated? **(Tick all that apply)**

- 1) Don't have copy of ID
2) Yes, have authenticated copy of ID
3) Yes, have a copy of ID but not authenticated

29) Do you keep the copy/copies of your ID in a safe location outside your home? If yes, where do you keep the copy/copies **(Tick one)**

- 1) No, only at home
2) Yes, I keep them stored outside of my home. Note the locations: _____

30) Do you have a cell phone? If yes, does the cell phone have access to the Internet? **(Tick one)**

- 1) Don't own a cell phone 2) Yes, have a cell phone with Internet
3) Yes, have a cell phone but without Internet

31) How do you usually access the Internet? **(Tick one)**

- 1) Don't access the Internet
2) Smartphone
3) Home computer
4) In a LAN house/Internet café
5) Tablet
Other: _____

ECONOMIC RESOURCES

32) In case you lost your main source of income, how likely would you be able to access a second source of income or an alternative form of livelihood? **(Tick one)**

- | | |
|----------------|------------------|
| 1) Very likely | 4) Unlikely |
| 2) Likely | 5) Very unlikely |
| 3) Not sure | |

33) Do you have savings you can access in case of an emergency? For example, money saved in a bank, at home, etc.? **(Tick one)**

- 1) Yes → GO TO QUESTION 34 2) No → GO TO QUESTION 35 2) Don't Know → GO TO QUESTION 35

34) How much do you have in savings (either in a bank or saved at home) to use in case of an emergency? **(Tick one)**

- 1) Up to R\$ 440,00
- 2) R\$ 441,00 to R\$ 880,00
- 3) R\$ 881,00 to R\$ 2.640,00
- 4) R\$ 2.641,00 to R\$ 5.280,00
- 5) More than R\$ 5.280,00
- 6) Don't know

DATA

35) Sex 1) Male 2) Female

36) Age _____ years

- 1) 16–19 years
- 2) 20–29 years
- 3) 30–39 years
- 4) 40–49 years
- 5) 50–59 years
- 6) 60+ years

37) What is your personal monthly income? **(Open answer)**

38) What is your family monthly income? **(Open answer)**

RENDA MENSAL	Q,37	Q,38
Up to R\$ 440,00	1	1
R\$ 441,00 to R\$ 880,00	2	2
R\$ 881,00 to R\$ 2.640,00	3	3
R\$ 2.641,00 to R\$ 5.280,00	4	4
More than R\$ 5.280,00	5	5

39) What is your property status? **(Tick one)**

- 1) Homeowner
- 2) Renter
- 3) The home is borrowed

40) How many people live in your household including you? **(Open answer)**

41) What is your level of education? **(Tick one)**

- 1) Illiterate/no education
- 2) Primary school
- 3) Secondary school
- 4) High school
- 5) College graduate
- 6) Vocational degree
- 7) Master's
- 8) Doctorate

42) What is your employment status? **(Tick one)**

- 1) Housewife/househusband
- 2) Retired
- 3) Student
- 4) Public servant
- 5) Farmer
- 6) Full-time employment with contract
- 7) Full-time employment w/o contract
- 8) Self-employed
- 9) Business owner
- 10) Freelancer
- 11) Looking for work
- 12) Unemployed
- 13) Intern
- Other: _____

43) Having reached the end of the survey, on a scale from 1 to 5, where 1 is not resilient at all and 5 is very resilient, how resilient do you consider yourself? **(Tick one)**

- 1) Not resilient
- 2) Weak resilient
- 3) Moderately resilient
- 4) Resilient
- 5) Very resilient

GLOSSARY

Adaptation: “The process of adjustment to actual or expected climate change and its effects. In human systems, adaptation seeks to moderate or avoid harm or exploit beneficial opportunities. In some natural systems, human intervention may facilitate adjustment to expected climate change and its effects” (IPCC 2014).

Adaptive capacity: “The ability of systems, institutions, humans, and other organisms to adjust to potential damage, to take advantage of opportunities, or to respond to consequences” (IPCC 2014).

Civil Defense: A government agency instructed to protect citizens from natural disasters and aid with response before, during, and after a natural disaster.

Climate change: “Climate change refers to a change in the state of the climate that can be identified (for example, by using statistical tests) by changes in the mean and/or the variability of its properties and that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes or external forces such as modulations of the solar cycles, volcanic eruptions, and persistent anthropogenic changes in the composition of the atmosphere or in land use” (IPCC 2014).

Disaster: “Severe alterations in the normal functioning of a community or a society due to hazardous physical events interacting with vulnerable social conditions, leading to widespread adverse human, material, economic, or environmental effects that require immediate emergency response to satisfy critical human needs and that may require external support for recovery” (IPCC 2014).

Disaster Risk Management (DRM): “Processes for designing, implementing, and evaluating strategies, policies, and measures to improve the understanding of disaster risk, foster disaster risk reduction and transfer, and promote continuous improvement in disaster preparedness, response, and recovery practices, with the explicit purpose of increasing human security, well-being, quality of life, and sustainable development” (IPCC 2014).

Disaster Risk Reduction (DRR): “Denotes both a policy goal or objective, and the strategic and instrumental measures employed for anticipating future disaster risk; reducing existing exposure, hazard, or vulnerability; and improving resilience” (IPCC 2014).

Early Warning System: “The set of capacities needed to generate and disseminate timely and meaningful warning information to enable individuals, communities, and organizations threatened by a hazard to prepare to act promptly and appropriately to reduce the possibility of harm or loss” (IPCC 2014).

Equality: “The state of being equal, especially in status, rights, or opportunities” (Oxford Living Dictionaries 2018).

Equity: “Equity is based on the idea of moral equality, the principle that people should be treated as equals. This is the idea that, despite many differences, all people share a common humanity or human dignity and, as a result of this, we must consider how each of them should be treated” (Jones 2009).

Exposure: “The presence of people, livelihoods, species or ecosystems, environmental functions, services, and resources, infrastructure, or economic, social, or cultural assets in places and settings that could be adversely affected” (IPCC 2014).

Gender: Refers to the social attributes and opportunities associated with being male and female and the relationships between women and men and girls and boys, as well as the relationships between women and those between men. These attributes, opportunities, and relationships are socially constructed and are learned through socialization processes. (UN Women 2018).

Hazard: “The potential occurrence of a natural or human-induced physical event or trend or physical impact that may cause loss of life, injury, or other health impacts, as well as damage and loss to property, infrastructure, livelihoods, service provision, ecosystems, and environmental resources. In this report, the term *hazard* usually refers to climate-related physical events or trends or their physical impacts” (IPCC 2014).

Impacts: “In this report, the term *impacts* is used primarily to refer to the effects on natural and human systems of extreme weather and climate events and of climate change. Impacts generally refer to effects on lives, livelihoods, health, ecosystems, economies, societies, cultures, services, and infrastructure due to the interaction of climate changes or hazardous climate events occurring within a specific time period and the vulnerability of an exposed society or system. Impacts are also referred to as consequences and outcomes. The impacts of climate change on geophysical systems, including floods, droughts, and sea level rise, are a subset of impacts called physical impacts” (IPCC 2014).

Informal Settlement: “A term given to settlements or residential areas that, by at least one criterion, fall outside official rules and regulations. Most informal settlements have poor housing (with widespread use of temporary materials) and are developed on land that is occupied illegally with high levels of overcrowding. In most such settlements, provision for safe water, sanitation, drainage, paved roads, and basic services is inadequate or lacking. The term *slum* is often used for informal settlements, although it is misleading as many informal settlements develop into good quality residential areas, especially where governments support such development” (IPCC 2014).

Livelihood: “The resources used and the activities undertaken in order to live. Livelihoods are usually determined by the entitlements and assets to which people have access. Such assets can be categorized as human, social, natural, physical, or financial” (IPCC 2014).

Poverty: Poverty is a complex concept with several definitions stemming from different schools of thought. It can refer to material circumstances (such as need, pattern of deprivation, or limited resources), economic conditions (such as standard of living, inequality, or economic position), and/or social relationships (such as social class, dependency, exclusion, lack of basic security, or lack of entitlement)" (IPCC 2014).

Probability: "A statement about the odds of whether an event will happen, based on knowledge of the constraints surrounding that event. For example, what are the odds of rolling a four on a six-sided die? Because there is some knowledge about the constraints and past experience about how the event works, there is some certainty about the event and the odds can be verified" (ISET 2011).

Resilience: "The capacity of social, economic, and environmental systems to cope with a hazardous event or trend or disturbance, responding or reorganizing in ways that maintain their essential function, identity, and structure, while also maintaining the capacity for adaptation, learning, and transformation" (IPCC 2014).

Risk: "The potential for consequences where something of value is at stake and where the outcome is uncertain, recognizing the diversity of values. Risk is often represented as probability of occurrence of hazardous events or trends multiplied by the impacts if these events or trends occur. Risk results from the interaction of vulnerability, exposure, and hazard. In this report, the term risk is used primarily to refer to the risks of climate-change impacts" (IPCC 2014).

Sensitivity: "The degree to which a system or species is affected, either adversely or beneficially, by climate variability or change. The effect may be direct (for example, a change in crop yield in response to a change in the mean, range, or variability of temperature) or indirect (for example, damages caused by an increase in the frequency of coastal flooding due to sea level rise)" (IPCC 2014).

Sex: "Sex refers to the biological characteristics that define humans as female or male. While these sets of biological characteristics are not mutually exclusive, as there are individuals who possess both, they tend to differentiate humans as males and females. In general use in many languages, the term *sex* is often used to mean 'sexual activity,' but for technical purposes in the context of sexuality and sexual health discussions, the above definition is preferred" (WHO 2018).

Vulnerability: "The propensity or predisposition to be adversely affected. Vulnerability encompasses a variety of concepts and elements, including sensitivity or susceptibility to harm and lack of capacity to cope and adapt (IPCC 2014).

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World Resources Institute is a global research organization that turns big ideas into action at the nexus of environment, economic opportunity and human well-being.

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Natural resources are at the foundation of economic opportunity and human well-being. But today, we are depleting Earth's resources at rates that are not sustainable, endangering economies and people's lives. People depend on clean water, fertile land, healthy forests, and a stable climate. Livable cities and clean energy are essential for a sustainable planet. We must address these urgent, global challenges this decade.

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We envision an equitable and prosperous planet driven by the wise management of natural resources. We aspire to create a world where the actions of government, business, and communities combine to eliminate poverty and sustain the natural environment for all people.

Our Approach

COUNT IT

We start with data. We conduct independent research and draw on the latest technology to develop new insights and recommendations. Our rigorous analysis identifies risks, unveils opportunities, and informs smart strategies. We focus our efforts on influential and emerging economies where the future of sustainability will be determined.

CHANGE IT

We use our research to influence government policies, business strategies, and civil society action. We test projects with communities, companies, and government agencies to build a strong evidence base. Then, we work with partners to deliver change on the ground that alleviates poverty and strengthens society. We hold ourselves accountable to ensure our outcomes will be bold and enduring.

SCALE IT

We don't think small. Once tested, we work with partners to adopt and expand our efforts regionally and globally. We engage with decision-makers to carry out our ideas and elevate our impact. We measure success through government and business actions that improve people's lives and sustain a healthy environment.

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