Mitsuru Tanaka · Kenshi Baba *Editors*

Resilient Policies in Asian Cities

Adaptation to Climate Change and Natural Disasters

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Preface

Japan suffered severe damage due to the Great East Japan Earthquake in March 2011, which was the largest earthquake and tsunami on record. This disaster led to a widespread focus on the prevention and minimization of damage from disasters and on keyword such as "resilience" and "resilient" from post-damage reconstruction perspective. These concepts refer to the ability of the citizens or the existence of social systems that would allow society to appropriately deal with and recover from external impacts (external forces) of severe natural disasters, such as earthquakes, volcanic eruptions, typhoons, and floods. These terms also refer to a social structure that will permit the protection of citizens' safety, lives, and health once society has obtained these abilities. Resilience could be said to be one of the most essential factors of modern society.

Indeed, after the Great East Japan Earthquake, the term "resilience" was adopted in Japan from the perspective of the ability to develop a strong resistance to, quickly recover from, and adapt to the damage from disasters. Resilience formed the basis of the keyword "national resilience," which was established in 2013 via the *Basic Law for National Resilience that Contributes to Disaster Prevention and Reduction*.

The international community has also adopted the concept of resilience as it relates to the abovementioned natural disasters, and there are more than a few discussions about information networks, energy supply, ecology/biodiversity, and climate change from a broad standpoint. For example, in 1970, Holling stated that resilience within an ecological context was "system resilience, the ability to absorb change and disturbance, and the ability to maintain the relationships between system components." Furthermore, the general public defines resilience as the strength of resistance to strong shocks and stresses and the speed of mental and physical recovery. It is thus used in the psychological and medical fields.

Regarding the concepts of "resilient" and "resilience," which have many meanings, this book will focus on the environmental/energy context and will discuss the application of resilience in regional societies and cities in particular.

In Part I, the concept of resilience will be systematically organized per previous studies, and, while discussing the meaning of resilience, the types of indices for

grasping and measuring resilience will be developed and proposed, and the results of the trial implementation in large Japanese cities will be summarized.

In Part II, a case study will be conducted based upon an analysis of individual applications of the concept of resilience in Asian cities, including those of Japan, the Philippines, and Thailand, and a methodology for constructing a resilient regional and local society will be proposed.

In Part III, we will refer to the mayor's initiative to establish and spread the concept of resilience as a summary of this book, and we will summarize the results and proposals developed by this research.

Although Asian countries, including Japan, are home to many diverse regions with unique features, they also have delicate and fragile natural environments, as well as areas that are at risk of large-scale disasters. Additionally, as we entered the twenty-first century, the effects of climate change have been actualized in various locations globally. As identified in the IPCC Fifth Assessment Report, disaster risks accompanying abnormal weather are predicted to increase and accelerate. The risks associated with climate change, and large-scale disasters that are expected to bring, take many forms over a broad range. These include enormous typhoons and hurricanes, sea level rise, the intensification of storm surges along the shore, heavy rain and floods, increased frequency of landslides in inland areas, the effects of rising temperatures on agriculture and lowered food production, increased heat stress and health hazards, the spread of infectious diseases, and the progression of water shortages and desertification. Regarding the expansion of climate change risks, the creation of responsive, resilient regional communities is being pursued, and this is thought to be the primary factor in the recent major focus on "adaptation" for climate change issues.

Thus, this book reanalyzes and reorganizes the concept of resilience, proposes paths to implement resilient regional societies that can adapt to risks per said concepts, and facilitates understanding of today's concerns. We sincerely hope that this book will be used to spread practical initiatives everywhere and that as many readers as possible will be able to use this book.

In conclusion, this book is based upon research results from studies implemented via support from the Ministry of the Environment's Environment Research and Technology Development Fund (1–1304) and the Ministry of Education, Culture, Sports, Science and Technology's research fund "Social Implementation Program on Climate Change Adaptation Technology (SI-CAT)," and it summarizes the knowledge obtained by the said studies. We would like to express once again our gratitude for all of the support our research received.

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Part I
Perspectives

Chapter 1
A Framework and Indicators of Resilience

Kenshi Baba, Yu Nagata, Shun Kawakubo, and Mitsuru Tanaka

Abstract As an introduction of this book, we first examine the definitions and scopes of resilience and concepts of a resilient city using an extensive literature review. We then employ the concept and framework of assessing a resilient city and develop its indicators. Consequently, we define a resilient city as being capable of responding to multiple environmental risks, and we assume that a combination of precautionary, adaptive, and transformative measures is required according to the degree of external forces (risks or stresses). We introduce the policy model based on the assumption that the state of implementation and preparation of resilience measures is governed by three major elements: risks of external forces, vulnerabilities, and situations to be avoided. The policy model also includes three types of indicators—urban, citizen, and administrative indicators—which measure the state of each element of the policy model.

Keywords Climate change · Natural disaster · External force · Vulnerability

1.1 Introduction

Today, the term "resilience" is prevalent when discussing a sustainable society. Particularly in Japan, following the Great East Japan Earthquake, related discussions have advanced rapidly in the Advisory Committee on National Resilience (Disaster Reduction and Mitigation), by the National Resilience Promotion Office

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of the Cabinet Secretariat, since spring 2013. However, as indicated by the title of the Basic Act for Building National Resilience (Disaster Reduction and Mitigation), which serves as the basis of national resilience policy, and by the deliberations of the Advisory Committee (National Resilience Promotion Office, Cabinet Secretariat 2014), the most attention is paid to disaster reduction and mitigation.

Examining resilience is a global trend that is not limited to Japan alone, and there has been a variety of proposals concerning the concept of a resilient city. However, it must be noted that, in more than a few cases worldwide, the concept of a resilient city is discussed in terms of major environmental policy issues, whereas the issues are almost restricted to disaster reduction and mitigation in Japan. Although it is one of the important aspects in discussion of resilience, globally recognized resilience is also discussed in the context of environmental policy (hereinafter "environmental resilience"), especially climate change, which covers a broad range of issues such as energy, ecosystems, wastes, green urbanism, and so on.

Accordingly, in this chapter, we first examine the definitions and scopes of resilience and concepts of a resilient city by a broad range of literature review and interviews with the officials of local governments. Then, based on the findings of the review, we employ the concept and framework of assessing resilient city and develop the indicators for it. Finally, we summarize the characteristics of the concept, framework, and indicators in several guidelines of resilience.

1.2 Methodology

A literature review was conducted as follows. We first used a search engine to find articles on resilience. By using the key word "resilience," we got more than approximately 32,000 articles; we then selected approximately 60 articles that have the top impact factors in the field of environmental sciences, biodiversity, engineering, water resources, public administration, geography sociology, and urban studies. In addition to that, we collected other articles derived from the above articles and Japanese articles and books.

While arranging the concept, we also conducted interviews with the local officials (the general affairs department, the environmental policy department of the city of Kawasaki, the environmental policy department and other departments of the city of Sendai, the planning and administration department and other departments of the city of Toyota, and the environmental policy department and other departments of the city of Nagoya). We also obtained feedbacks from the officials of the local governments and those of the National Resilience Promotion Office of the Cabinet Secretariat and the Global Environment Bureau of the Ministry of the Environment of Japan at the "Resilient City Workshop" that we hosted in Hosei University on February 20, 2014.

After clarifying the concept and framework of resilience by interviews and workshops, we scrutinize various administrative plans such as comprehensive plans, environment master plans, and community disaster-prevention plans in the above-

mentioned local governments to identify indicators for the assessment of resilience. At the same time, we referred to several guidelines of resilience to develop our understanding of the concepts, frameworks, and indicators. The common purpose of these guidelines is to make cities and communities more resilient, but the framework and indicators differ greatly from one another. The summary of the characteristics of each guideline on resilience will be given at the end of this chapter.

1.3 Framework of Resilience

1.3.1 Various Definitions of Resilience

First, we outline the concept of resilience based on the literature review. A large number of surveys has already been conducted in a variety of fields, such as Ishihara and Nakamaru (2007) at the psychological and individual level; Shiozaki and Kato (2012), Norris et al. (2008), Manyena (2006), and others at the disaster reduction and the local community levels; Mori (2010), Resilient Alliance (2002), and others in the field of ecology and social ecosystems; and Fujii et al. (2012) in the field of economics. Referring to these, Table 1.1 presents the definitions from a number of previous studies likely to be useful as references in considering the subjects of this book—resilient city and environmental resilience.

A frequently cited study that discussed the concept of resilience is Holling (1973), which holds that resilience is a concept expressing the properties of an ecosystem with regard to environmental changes. It has since been cited in a very large number of papers from a variety of fields. The above-mentioned Norris et al. (2008) identifies that the ability to adapt to turbulence, stress, and disaster is a point that has been stressed in many definitions of resilience and suggests that there is a consensus on the two points that resilience is better conceptualized as a process than a result and as a form of adaptability rather than stability. Next, it argues that between engineering resilience (returning systems to their previously designed states and functions after a disturbance) and ecological resilience (tolerating a variety of desirable conditions suited to the environment), the latter is better suited to human beings, communities, organizations, and society. It then offers its own definition, arguing that resilience is achieved when robustness, redundancy, and speed counteract stress factors, and that resilience is, in fact, a networked combination of adaptabilities. This definition includes some very broad-ranging aspects, formed by linking economic development, information and telecommunications, community abilities, and social capital.

Table 1.1 Examples of the concepts of resilience

Author, year of publication	Area	Definition
Holling 1973	Ecosystem	According to this definition, resilience is the property of the system; resilience determines the persistence of relationships within a system and is a measure of the ability of these systems to absorb changes of state variables, driving variables, and parameters and still persist
Adger 2000	Society	This article argues that social resilience is defined as the ability of communities to withstand external shocks to their social infrastructure
Resilient Alliance 2002	Social ecology	"Ecosystem resilience" is the capacity of an ecosystem to tolerate disturbance without collapsing into a qualitatively different state that is controlled by a different set of processes. A resilient ecosystem can withstand shocks and rebuild itself when necessary
		Resilience in social systems has the added capacity of humans to anticipate and plan for the future
		"Resilience" has three defining characteristics: The amount of change the system can undergo and still retain the same controls on function and structure; the degree to which the system is capable of self-organization; the ability to build and increase the capacity for learning and adaptation
Godschalk 2003	Urban	A resilient city is a sustainable network of physical systems and human communities. During a disaster, the physical systems must be able to survive and function under extreme stresses
UNISDR 2005	Urban	The capacity of a system, community, or society potentially exposed to hazards to adapt, by resisting or changing in order to reach and maintain an acceptable level of functioning and structure. This is determined by the degree to which the social system is capable of organizing itself to increase this capacity for learning from past disasters for better future protection and to improve risk reduction measures
Norris et al. 2008	Local community	Community resilience is a process linking a network of adaptive capacities (resources with dynamic attributes) to adaptation after a disturbance or adversity. Thus, in summary, we propose that resilience resources have three dynamic properties: robustness, redundancy, and rapidity
		Community resilience emerges from four primary sets of adaptive capacities—economic development, social capital, information and communication, and community competence—that together provide a strategy for disaster readiness

Source: Holling (1973), Adger (2000), Resilient Alliance (2002), Godschalk (2003), UNISDR (2005), Norris et al. (2008)

1.3.2 Various Definitions of Resilient City

One key international policy development regarding the resilient city is the "Making Cities Resilient Campaign" started in 2010 under the UNISDR (United Nations International Strategy for Disaster Reduction) (2005). Based on the Hyogo Framework for Action (HFA) 2005–2015, which was adopted at the second World Conference for Disaster Reduction held in Kobe in 2005 with the participation of 168 national governments, 78 regional and international agencies, and 161 NGOs, the campaign is intended to strengthen the understanding of and commitment to the mitigation of disaster risk and improvement of resilience, as well as increasing the priority of climate change policies among national and local governments. This would ensure that each national government's efforts are more likely to reduce the vulnerabilities and disaster risks that they need to address. It is expected that the cities participating in the campaign will improve their resilience through learning from each other and mutual technical assistance.

The UNISDR calls for developing disaster resilience as a factor in achieving sustainable development, and it provides an overview of key strategies and actions needed to build resilience to disasters, as part of an overall strategy to achieve sustainable development. Climate change and extreme weather events are likely to increase the city's exposure to hazards and risks. Here, risk is a function of the hazard (a cyclone, an earthquake, a flood, or a fire, for example), the exposure of people and assets to the hazard, and the conditions of vulnerability of the exposed population or assets. Outlining the specific details of the state of such disaster resilience, it is one: (1) where disasters are minimized because the population lives in homes and neighborhoods with organized services and infrastructure that adhere to sensible building codes, without informal settlements built on flood plains or steep slopes because no other land is available; (2) that has an inclusive, competent, and accountable local government that is concerned about sustainable urbanization and commits the necessary resources to develop capacities to manage and organize itself before, during, and after a natural hazard event; (3) where the local authorities and the population understand their risks and develop a shared, local information based on disaster losses, hazards, and risks, including who are exposed and who are vulnerable; (4) where people are empowered to participate, decide, and plan their city together with local authorities and value local and indigenous knowledge, capacities, and resources; (5) that has taken steps to anticipate and mitigate the impact of disasters by incorporating monitoring and early warning technologies to protect infrastructure, community assets, and individuals, including their homes and possessions, cultural heritage, and environmental and economic capital, and is able to minimize physical and social losses arising from extreme weather events, earthquakes, or other natural or human-induced hazards; and (6) that is able to respond, implement immediate recovery strategies, and quickly restore basic services to resume social, institutional, and economic activity after such an event.

Since 2010, the International Council for Local Environmental Initiatives (ICLEI) also has held an annual international conference under the title "Resilient

Cities." The ICLEI's concept of the resilient city is as follows: For a city to be sustainable, it must be resilient to disasters, climate change, and unforeseeable events, and in order to improve its resilience, it must reduce its exposure and vulnerability to risks while also increasing its resistance and robustness and preparing for emergencies (ICLEI 2012). The ICLEI, founded in 1990 at the World Congress of Local Governments for a Sustainable Future held at the United Nations, is an international network of local governments and local government associations dedicated to sustainable development. At present, its membership consists of more than 1000 local governments from 84 countries. Every year Resilient Cities welcomes more than 500 attendees who mainly take part in broad-ranging discussions concerning resilient cities prepared for the external forces of climate change and natural disasters (Otto-Zimmermann 2011, 2012).

In addition, ResilientCity.org, which is an open Internet forum operated mainly by a group of architectural and urban planning researchers and practitioners in Canada, defines a resilient city as "one that has developed capacities to help absorb future shocks and stresses to its social, economic, and technical systems and infrastructures so as to still be able to maintain essentially the same functions, structures, systems, and identity." It advocates increasing resilience from the perspectives of architectural design and urban planning, mainly to address climate change and instability in energy supplies. It advocates six principles of resilient design, including diversity (of the various systems that comprise cities) and redundancy (of infrastructure, including electrical power, fuel supply, waste water processing, and most importantly, food and potable water supply) (Resilient City.org 2013).

While the concept of resilient city has been discussed mainly in the context of cities' resilience to natural disasters, Newman et al. (2009) expand the concept to include resilience to shortages of natural resources and the effects of human activities with regard to climate change. Specifically, in their definition of a resilient city, they include that a city can substantially reduce its dependence on petroleum fuels in a way that is socially and economically acceptable and feasible. For this reason, they argue that a resilient city has built-in systems that can adapt to change, such as a diversity of transport and land use systems, and multiple sources of renewable power that will allow a city to survive shortages in fuel supplies. Furthermore, they propose the following ten principles as strategies for realizing resilient cities: (1) Set the vision, prepare an implementation strategy; (2) learn on the job; (3) target public buildings, parking, and road structures as green icons; (4) build TOD (transit-oriented development), POD (pedestrian-oriented development), and GOD (green-oriented development) together; (5) transition to resilient infrastructure step by step; (6) use prices to drive change where possible; (7) rethink rural regions with reduced oil dependence; (8) regenerate households and neighborhoods; (9) facilitate localism; and (10) use approvals to regulate for the post-oil transition.

Much of the literature (e.g., Tobin 1999) uses both the terms "sustainable city" and/or "eco city" in a similar way as "resilient city." In Japan, among the concepts such as eco city or smart city, one typical example of a specific policy is the Eco-Model City Project promoted by the Regional Revitalization Bureau of the Cabinet Secretariat of Japan. It identifies Eco-Model Cities as cities that take leadership on

efforts to greatly reduce greenhouse gas emissions, as the first step toward a low-carbon society. The basic stance of these cities is one of reducing or mitigating environmental impact or external forces (risks or stresses). On the other hand, as discussed above, the concept of resilient city is mainly focused on responding to external forces. Accordingly, in this book, we consider a sustainable city to be an overarching, higher level concept, while a city that intends to mitigate external forces is referred to as eco city or smart city, in a complementary relationship with the resilient city.

1.3.3 The Risk in the Context of Environmental Policy in Japan

Looking at the context of environmental policy in Japan, risk is defined as the possibility that the use of a technology or attendant human actions or activities could have undesirable effects on human health or safety, property, or the environment (systems). Environmental risk is regarded as one of the risks as well as risk of natural disaster, risk of urban disaster, risk of food security, and others (Ikeda and Morioka 1993).

According to the (then-) Environment Agency of Japan, the term environmental risk was first used in Japan in the first Environment Master Plan, formulated in 1994. Later, "the report of the colloquium on environmental protection in the 21st century (1996)" established within the Environment Agency defined environmental risk as the possibility that the environmental burden of human activities could, under certain conditions and through processes within the environment, affect health or ecosystems.

While the environment master plan mainly considered the use of chemicals as an environmental risk factor, such factors can include any and all of the factors that could cause impediments to environmental protection, such as modifications to the environment and greenhouse gas emissions (Uchiyama 2006).

1.3.4 Definition and Scope of Resilience

Based on the findings of the above review, we assume that natural disasters and climate change, which influence each other, are among the major human-caused external forces (risks or stresses) and that these impact various facets of socio-ecosystems. Along with the premise, we define the resilient city and the scope of environmental resilience as following: resilient city is capable of responding to multiple environmental risks, taking into consideration the relationship between the external forces (risks or stresses) and socio-ecosystems.

Figure 1.1 organizes the concept to give a practical form to environmental resilience. Here, up to a certain level of risk exposure (scale of environmental changes),

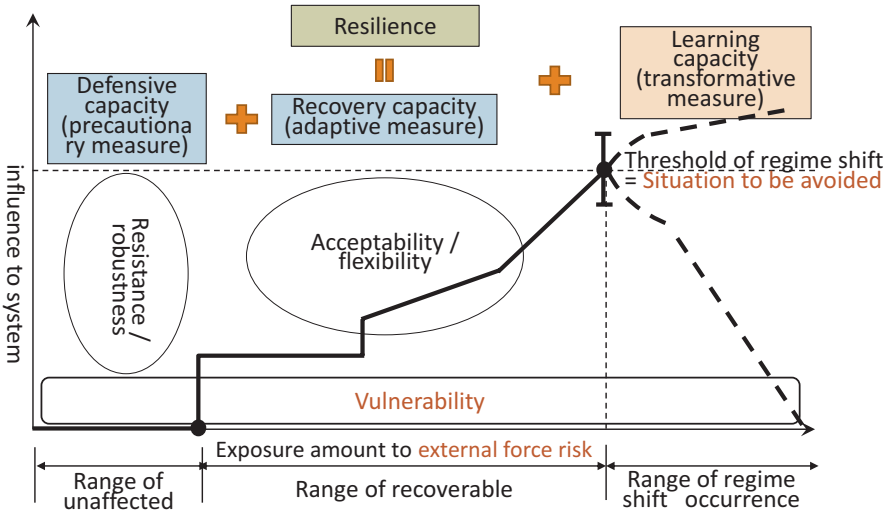

Fig. 1.1 A concept of three measures of resilient policy. (Altered from Mens et al. 2011)

urban systems will remain completely unaffected and systems will be maintained in their prior forms due to their resistance and robustness. However, when risk exposure (scale of environmental changes) exceeds one level, the impacts on urban systems will begin to appear in a discontinuous manner. Still, even at this stage, the urban systems will continue to maintain their prior forms due to their acceptability and flexibility. Measures that can be taken at this stage include precautionary measures and adaptive measures to draw out the defensive capacity and recovery capacity of the systems. Based on this understanding, there is a need to implement both these types of measures before and after such events. Furthermore, when risk exposure (scale of environmental changes) surpasses a certain threshold, a regime shift (or revolutionary phenomenon) will take place, breaking down the existing framework of urban systems. Therefore, transformative measures need to draw out learning capacity to create fundamentally new systems over a very long term. Accordingly, to make cities and communities more resilient, a combination of precautionary, adaptive, and transformative measures is required.

1.3.5 Policy Model, Status Report, and Scenario

We developed a framework that employs the terms of policy model, status report, and scenario for a resilient city, using analysis and implementation by identifying the corresponding measured assessment indicators (Fig. 1.2).

A policy model is a hypothetical flow expressing the overall process of developing policy, based on the assumption that the state of preparation and implementation of resilience measures are governed by three major elements; risks of external

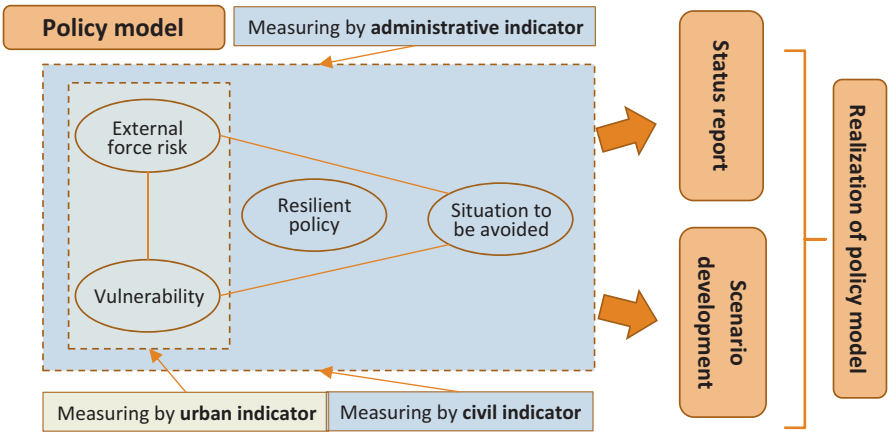

Fig. 1.2 A framework and indicators of resilient policy

forces, vulnerabilities, and situations to be avoided. It also provides the three types of indicators: urban, civil, and administrative indicators, which measure the state of each element of the policy model.

A status report is used to diagnose the resilience of each city, together with the results of measurement by the indicators. Policy scenario refers to the scenario developed in venues such as internal workshops within local government agencies and citizen conferences to implement policy, using the status report.

The details of three indicators are as following. The background of providing the three types of indicators is that the integration of expert knowledge, local knowledge, and living wisdom collected in these ways can increase environmental resilience effectively. The way of thinking about this coincides with community-based adaptation such as Allen (2006) and van Aalst et al. (2008).

- Urban indicators: These involve ascertaining and evaluation, by local government officials and experts, of resilience related to the state of factors such as the city's physical infrastructure, its economic activities, and environmental factors. They employ statistical data such as population census.
- Civil indicators: These involve ascertaining and evaluation, by stakeholders and citizens as well as experts, of resilience related to the state of the lives of citizens, including knowledge and awareness, learning and training, and social capital as well as environmental factors. They employ data from questionnaire surveys of citizens, supplemented by statistical data such as those from a public opinion poll.
- Administrative indicators: These involve local government officials and experts checking whether any relevant measures have been implemented in the past, their extent and progress, and ascertaining and evaluating whether they led to improvements in the resilience of the city. They employ data from questionnaire surveys of administrators supplemented by administrative plans and other information.

1.4 Indicators of Measuring Resilience

1.4.1 Administrative Indicators/Civil Indicators

After the above preparation and comprehensive consideration, we identified 41 indicators concerning risks from natural and social external forces anticipated in past measures, 28 indicators concerning vulnerabilities inherent to local communities and within the local government, 24 indicators concerning anticipated situations to be avoided, and 44 indicators concerning the state of preparation and implementation of resilience measures capable of addressing these. Forty-four administrative indicators consist of three types measures, that is, precautionary measures (19 indicators), adaptive measures (14 indicators), and transformative measures (11 indicators). For the civil indicators concerning acceptability of resilience measures, 44 indicators are reduced to 16 by integrating indicators similar to each other to facilitate understanding of the citizens. The administrative indicators will be described in detail in Chap. 5, and the civil indicators will be described in detail in Chap. 3 and 4 (Table 1.2).

1.4.2 Urban Indicators

Urban indicators were developed specifically for assessing resilience by the following steps: Many indicators for measuring resilience were proposed at first. The proposed indicators were then validated and carefully selected for data availability, simplicity, comparability, representativeness, and balance. Data availability is one of the most important criteria for selecting indicators, because even a theoretically sound indicator is useless if its value cannot be calculated because of the lack of data. Simplicity is also important as it helps indicator users to understand the actual condition of the target city. Comparability must be considered as well because it is difficult to understand the strengths and weaknesses of a target city in comparison with other cities if the accuracy and definition of the data vary from area to area.

Consideration of representativeness and balance is also essential when there are many candidate indicators for a single assessment factor. After developing the set of urban indicators considering the above, the urban indicators were incorporated into three comprehensive resilience indicators for assessing a city's (1) defensive capacity, which evaluates the capacity to prevent the occurrence of damage with precautionary measures; (2) recovery capacity, which evaluates the capacity to minimize damage after a disaster with adaptive measures; and (3) learning capacity, which evaluates the capacity to recover quickly from the disaster with transformative measures. Finally, the Tokyo metropolitan area and other selected cities were assessed by using the developed indicators. Over 30 indicators were initially proposed, and 18 were carefully selected according to the aforementioned criteria. Table 1.3 lists

Table 1.2 Administrative/civil indicators to assess a resilient city

41 Indicators of risk perception		28 Iindicators of vulnerability	24 Indicators of situation to be avoided
Noise, vibration	Animal damage	Presence of lowland or land at 0 m elevation	Direct damage to human life
Soil pollution	Harmful insects	Presence of steep terrain	Long-term physical or mental health damage
Land subsidence	Increase in invasive species	Presence of rapidly flowing rivers	Cut-off of food or lifeline supply
Air pollution, odor	Decrease in/loss of biodiversity	Presence of coastlines subject to erosion	Long-term worsening of food conditions
Water contamination	Forest depletion	Presence of active volcanoes	Long-term worsening of water resources
Drought, depletion of water sources (water resources)	Decrease in food and agriculture production capacity	Presence of earthquake zones or fault lines	Worsening of living environment
Acid rain	Infectious diseases, viruses	Lack of usable water resources	Loss of ease of living/ comfort
Torrential rainfall	Factory explosions, accidents	Presence of rare or endangered species	Full or partial collapse of buildings, or building damage
Heat waves, fierce heat	Chemical pollution, accidents	Single-crop farming	Cut-off or interruption of transportation and telecommunications functions
Cold waves, blizzards	Transportation accidents	Vulnerable infrastructure	Deteriorating (aged) urban infrastructure
Ocean pollution	Energy-infrastructure accidents	Presence of industrial zones	Cut-off of energy supply
Rising sea levels	Accidents at nuclear power facilities	Concentration of housing in areas prone to disaster	Long-term instability in energy supply
High tides	Accidents in information and telecommunications infrastructure	High number or density of wooden homes	Cut-off of financial service functions
Red tides	Increasing greenhouse gas emissions	High number of vacant homes	Suspension of industrial activities or supply chains
Tornadoes, strong winds	Rapid population increases	Lack of open space	Long-term decline in economic activity
Typhoons	Population decreases, low birth rates	Lack of evacuation sites	Suspension of administrative activities
Mudslides, landslides	Aging of population	Lack of medical services	Long-term decrease in the level of administrative services

(continued)

Table 1.2 (continued)

41 Indicators of risk perception		28 Iindicators of vulnerability	24 Indicators of situation to be avoided
Flooding	Poverty, disparities in living standards	High percentage of low-income earners, poor employment conditions	Temporary loss of order in society
Earthquakes	Financial bankruptcy	High number of single-person households	Chronic worsening of public safety
Tsunamis	War, disputes, terrorism	High percentage of elderly population, depopulation	Degeneration of local culture/traditions
Volcanic eruptions		Weak ties within communities	Sudden, localized worsening of natural environment
		Frequent relocation of residents into and out of the community (low retention)	Loss of shores, rural land, green land, etc.
		Lack of activities by citizens' groups, nonprofits, etc.	Long-term negative impact on ecosystems
		Weak ties between government and citizens	Increase in global warming
		Presence of political conflict	
		Lack of resources for drafting and promoting policies	
		Conservativeness of organizations in government agencies	
		Lack of tax revenue	

19 Indicators of precautionary measures	14 Indicators of adaptive measures	11 Indicators of transformative measures
Development of buildings and infrastructure compliant with current standards	Strengthening of lifeline backup functions	Resettlement from high-risk areas
Development of various disaster prevention functions and facilities compliant with current standards	Rapid provision of shelters and temporary housing, etc.	Construction regulations and land use control in high-risk areas
Promotion of renewable energy	Strengthening of firefighting and emergency medical services	Building and infrastructure improvements exceeding current standards

(continued)

Table 1.2 (continued)

19 Indicators of precautionary measures	14 Indicators of adaptive measures	11 Indicators of transformative measures
Promotion of energy conservation	Support for those who require it	Condensation of urban functions (creation of compact cities)
Nature conservation and promotion of forestation	Prompt restoration support for transportation, communication, and energy supply functions	Transfer of urban functions
Preventive measures for health maintenance	Expanding methods of gathering and providing damage information	Development of and support for next-generation telecommunications infrastructures
Support during government shutdowns	Operation of government data backup systems	Development of and support for next-generation energy infrastructures
Disaster prevention training and public awareness	Prompt transitions to emergency structures by government organizations	Establishment of and support for local energy companies
Stimulation of self-assistance, cooperative assistance, and community functions	Activity to maintain public order	Deregulation via the special ward system, etc.
Dissemination of risk information	Enhancement of public self-assistance and cooperative assistance support capacity during disasters	Implementation of and support for next-generation technical research and development
Expansion and revision of disaster hazard areas, etc.	Engagement of recovery specialists and advisors	Promotion of green infrastructures
Strengthening of various monitoring functions	Prompt establishment of support reception structures	
Accumulation of government data and coordination with policies	Various measures to prevent expansion of secondary damage and injuries	
Collection and application of scientific prediction information	Protection of traditional cultural assets	
Strengthening through penalties and various disaster prevention regulations		
Public recognition and commendation of exemplary disaster prevention initiatives		
Engagement of disaster prevention specialists and advisors		
Formation of disaster agreements		
Promotion of preservation of tradition and culture		

Table 1.3 Assessment items and corresponding urban indicators

No.	Assessment item	Urban indicator	Unit
01	Prevention of fire breakout in density area	Number of fires/ population of densely-inhabited districts	Number/ 1,000,000 people
02	Prevention of deterioration of industry production	Value of industry production/ amount of water consumption	1,000,000 yen/ m^3/day
03	Prevention of evacuation route cutoff	Total length of roads with width less than 5.5 m/ total length of all type of roads	%
04	Prevention of accidents in an emergency situation	Number of traffic accidents/ total population	Number/ 1,000,000 people
05	Prevention of delay in evacuation	Number of people requiring long-term care or support/ total population	%
06	Prevention of collapse of houses	Number of houses built before 1980/ total number of houses	%
07	Prevention of housing vacancies	Number of housing vacancies/ total number of houses	%
08	Prevention of uncomfortable room temperature	Number of houses with double-sash windows/ total number of houses	%
09	Adequacy of area for evacuation	Number of schools that can be used for evacuation/ total population	Number/ 1,000,000 people
10	Adequacy of medical professionals	Number of doctors/ total population	Number/ 1,000,000 people
11	Adequacy of medical facilities	Number of hospital beds/ total population	Number/ 1,000,000 people
12	Adequacy of communication equipment	Number of public telephone booths/ total population	Number/ 1,000,000 people
13	Adequacy of fire protection equipment	Number of fire apparatuses/ total population	Number/ 1,000,000 people
14	Adequacy of patient transportation equipment	Number of ambulances and heliambulances/ total population	Number/ 1,000,000 people
15	Capacity of local government finances	Financial ability **index** (standardized revenues/ standardized necessary expenditure of local government)	–
16	Capacity of local employment	Number of new job offers/ number of new job applications	%
17	Capacity of household budgets	Average saving rate (= savings/household income)	%
18	Capacity of labor force	Size of labor force/ total population	%

※ No. 01-08: prevention, No. 09-14: adaptation, No. 15-18: transformation

the names of the selected indicators and their associated assessment items. The urban indicators will be described in detail in Chap. 2.

1.5 Characteristics of This Book's "Resilience"

Let us introduce the summary of the characteristics of each guideline of resilience in terms of the above-mentioned concepts, frameworks, indicators, and so on. We reviewed some guidelines from UNISDR; United Nations University Institute of Advanced Studies (UNU-IAS); Resilient Alliance; World Bank; Arup, RPA and Siemens; Rockefeller Foundation and ARUP; Rockefeller Foundation; and Asian Cities Climate Change Resilience Network (ACCCRN) to make cities and communities resilient. The key points are summarized in Table 1.4.

Table 1.4 Characteristics of a variety of guidelines of resilience

	UNISDR	Bioversity International and UNU-IAS	Resilient Alliance	World Bank	Rockefeller Foundation and ARUP International Development	IIED and ACCCRN	This book
Name of guideline, year of publication	How to make cities more resilient A handbook for local governments leaders, 2012 (UNISDR 2012)	Indicators of Resilience in Socio-ecological Production Landscapes (SEPLs), 2013 (Bergamini et al. 2013)	Assessing Resilience in Social-ecological Systems Workbook for Practitioners Revised Version 2.0, 2010 (Resilient Alliance 2010)	Building Urban Resilience Principles, Tools, and Practice, 2013 (Jha et al. 2013)	City Resilience Framework, 2014 (The Rockefeller Foundation and ARUP International Development 2014)	Urban climate resilience: A review of the methodologies adopted under the ACCCRN initiative in Indian cities, 2013 (Sharma et al. 2013)	MRMR (Making cities and communities more resilient to multiple risks), 2018
Purpose	To make cities more resilient	Because of the dynamic nature and the complexity of interrelations between the elements of SEPLs, the indicators, jointly developed by Bioversity International and UNU-IAS, are designed to capture the different aspects that are entailed and essential for sustaining a resilient landscape (e.g., cultural, social, ecological, and agricultural)	Designed to assist in resolving specific resource issues and in developing and implementing management goals without compromising the resilience and integrity of the system as a whole	It summarizes the guiding principles, tools, and practices in key economic sectors that can facilitate incorporation of resilience concepts into the decisions about infrastructure investments and general urban management that are integral to reducing disaster and climate risks	This report presents the inclusive framework for articulating city resilience that the foundation was looking for, to underpin the City Resilience Index	This Working Paper aims to document and analyze the several methodologies adopted in the seven Indian ACCCRN cities: Surat, Indore, Gorakhpur, Shimla, Bhubaneswar, Mysore, Guwahati.	To make cities and communities more resilient to multiple risks for short and long term

(continued)

Table 1.4 (continued)

	UNISDR	Bioversity International and UNU-IAS	Resilient Alliance	World Bank	Rockefeller Foundation and ARUP International Development	IIED and ACCCRN	This book
				This handbook provides guidance on how to build urban resilience into critical infrastructure and the social realm by taking advantage of available methodologies, tools, and resources	This framework will form the basis of a tool that should enable all of us interested in city resilience to convene around a common understanding of that idea, and begin to "baseline" what matters most for making cities more resilient	The paper analyzes these methodologies and the overall process adopted in each of these cities for its potential for replication in other cities in India, and brings out the inherent challenges, gaps, and opportunities in achieving this	

						Drawing from these experiences, and with the aim of overcoming these challenges, this paper contributes recommendations on various stages of resilience planning exercises which would be beneficial to cities that plan to undertake such planning in the future	
Targets	Primarily for local government leaders and policy makers to support public policy, decision making, and organization as they implement disaster risk reduction and resilience activities	-	Practitioners	Urban planner	–	–	Mainly local government officials, but also the stakeholders and general citizens to develop policy collaboratively

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