INTERNATIONAL STANDARD

ISO 37123

First edition
2019-12

Sustainable cities and communities — Indicators for resilient cities

Villes et communautés territoriales durables — Indicateurs de performance pour les villes résilientes

Reference number
ISO 37123:2019(E)

ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Fax: +41 22 749 09 47
Email: copyright@iso.org
Website: www.iso.org

Published in Switzerland

Contents

Page

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 268, *Sustainable cities and communities*.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

Cities need indicators to establish their baseline, and measure and evaluate their performance. However, existing indicators are often not standardized, consistent or comparable over time or across cities. To address these challenges, a new series of International Standards is being developed to provide standardized indicators that enable a uniform approach to what is measured, and how that measurement is to be undertaken.

The first standard in this series, ISO 37120, has quickly become the international reference point for sustainable city indicators. While ISO 37120 contains a number of indicators of relevance to a city's resilience planning and assessment, the need for additional indicators for resilient cities has been identified, reflected in this document, as has the need for additional indicators for smart cities, developed in ISO 37122.

A resilient city is able to prepare for, recover from and adapt to shocks and stresses. Cities are increasingly confronted by shocks, including extreme natural or human-made events which result in loss of life and injury, material, economic, and/or environmental losses and impacts. These shocks can include but are not limited to floods, earthquakes, hurricanes, wildfires, volcanic eruptions, pandemics, chemical spills and explosions, terrorism, power outages, financial crises, cyber-attacks and conflicts. A resilient city is also able to manage and mitigate ongoing human and natural stresses in a city relating to environmental degradation (e.g. poor air and water quality), social inequality (e.g. chronic poverty and housing shortages) and economic instability (e.g. rapid inflation and persistent unemployment) that cause persistent negative impacts in a city.

A city's preparedness can be characterized by developing a detailed understanding of the risks to the city, by taking action to reduce vulnerability and exposure, and by enhancing the awareness and participation of individuals, households and businesses.

A resilient city is able to recover from shocks and stresses in a timely and efficient manner, with a focus on ensuring the continuity or rapid restoration of city services such as electricity, water, telecommunications, waste management, sanitation, food distribution, financial services and access to emergency services.

A resilient city is also a city that understands the necessity to adapt its systems and processes to ensure that they are as robust as possible in the face of shocks and stresses, building back better following extreme events, while focusing on the goal of restoring and ensuring long-term prosperity.

Resilience is both a core component and an essential enabler of sustainable development. This document is focused on resilience measurement as a major contribution to the sustainability of a city. The structure of the family of city indicators standards for sustainable cities and communities reflects this relationship between sustainable development, resilient development and smart development (see Figure 1).

Progress and transformation towards sustainable development through maintaining and improving city services and quality of life in the face of shocks and stresses is a core component of a resilient city. This document is therefore intended to be implemented in conjunction with ISO 37120.

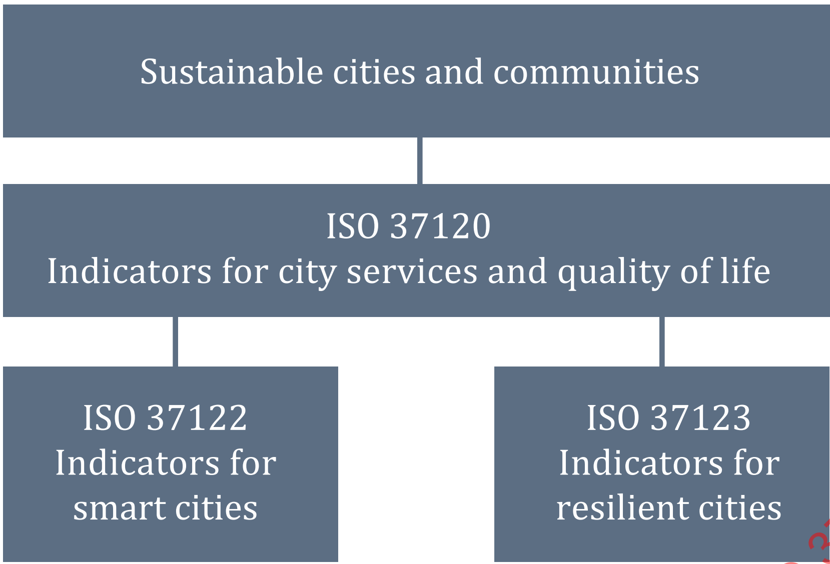

Figure 1 — Sustainable cities and communities — Relationships within the family of city indicators standards

The indicators in this document have been selected to make reporting as simple and inexpensive as possible, and therefore reflect an initial platform for reporting. The indicators have been developed to help cities:

a) prepare for, recover from and adapt to shocks and stresses;

b) learn from one another by allowing comparison across a wide range of performance measures, and by sharing good practices.

The indicators in this document can be used to track and monitor progress towards a resilient city, through the development of a city resilience strategy or when applying a city management system such as ISO 37101. While the indicators are structured around ISO themes that correspond to different sectors and services provided by cities, it is noted that the indicators can also be organized according to the risk management process (Annex B), the disaster management process (Annex C), the Sustainable Development Goals and the Sendai Framework for Disaster Risk Reduction (Annex D) and the ISO 37101 issues and purposes (Annex E). Furthermore, the typologies of hazards (Annex A) can assist cities in identifying the potential hazards that they face, which is relevant to many of the indicators contained in this document. It is also provided as a guide for helping identify peer cities facing similar hazards.

This document will support any and all global agreements that support sustainability and resilience. Agreements currently in place include, but are not limited to: the Sendai Framework for Disaster Risk Reduction[22], the New Urban Agenda, the 2030 Agenda (i.e. the United Nations Sustainable Development Goals[27]) and the Paris Agreement.

A city which conforms to this document does so in regard to measurement of indicators for city resilience in conformity with the definitions and methodologies as set out in this document, and may only claim conformity to that effect. This document does not provide a value judgement, threshold or target numerical value for the indicators, therefore conformity with this document does not confer a status in this regard.

It is acknowledged that cities may not have direct influence or control over factors governing some of these indicators, but the reporting is important for meaningful comparison and provides a general indication of resilience.

In this document, the following verbal forms are used:

— “shall” indicates a requirement;

— "should" indicates a recommendation;

— "may" indicates a permission;

— "can" indicates a possibility or a capability.

The terminology used within this document is outlined in the United Nations General Assembly (UNGA) Terminology Document, available at https://www.preventionweb.net/files/50683_oiewgreportenglish.pdf

Sustainable cities and communities — Indicators for resilient cities

1 Scope

This document defines and establishes definitions and methodologies for a set of indicators on resilience in cities.

This document is applicable to any city, municipality or local government that undertakes to measure its performance in a comparable and verifiable manner, irrespective of size or location. Maintaining, enhancing and accelerating progress towards improved city services and quality of life is fundamental to the definition of a resilient city, so this document is intended to be implemented in conjunction with ISO 37120.

This document follows the principles set out in ISO 37101, and can be used in conjunction with this and other strategic frameworks.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 37101, *Sustainable development in communities — Management system for sustainable development — Requirements with guidance for use*

ISO 37120, *Sustainable cities and communities — Indicators for city services and quality of life*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 37101 and ISO 37120 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1
critical infrastructure
physical structures, facilities, networks and other assets which provide services that are essential to the social and economic functioning of a community or society

Note 1 to entry: Examples of critical infrastructure can include, but are not limited to, power generation, transmission and distribution, water treatment, distribution and drainage, wastewater and storm water infrastructure, transportation, gas supply and distribution, telecommunications infrastructure, educational facilities, hospitals and other health facilities.

3.2
disaster
serious disruption to a city or community due to hazardous events interacting with conditions of exposure, vulnerability and capacity, leading to human, material, economic and/or environmental losses and impacts

Note 1 to entry: Disasters can be frequent or infrequent, depending on the probability of occurrence and the return period of the relevant hazard. A slow-onset disaster is one that emerges gradually over time, for example through drought, desertification, sea level rise, subsidence or epidemic disease. A sudden-onset disaster is one triggered by a hazardous event that emerges quickly or unexpectedly, often associated with earthquakes, volcanic eruptions, flash floods, chemical explosions, critical infrastructure failures or transport accidents.

3.3
hazard
phenomenon, human activity or process that can cause loss of life, injury or other health impacts, property damage, social and economic disruption or environmental degradation

Note 1 to entry: Hazards include biological, environmental, geological, hydro-meteorological and technological processes and phenomena. Biological hazards include pathogenic microorganisms, toxins and bioactive substances (e.g. bacteria, viruses, parasites, venomous wildlife and insects, poisonous plants, mosquitoes carrying disease-causing agents). Environmental hazards can be chemical, natural, radiological or biological, and are created by environmental degradation, physical or chemical pollution in the air, water and soil. However, many of the processes and phenomena that fall into this category can be “drivers” of hazard and risk rather than hazards themselves (e.g. soil degradation, deforestation, biodiversity loss, sea level rise). With respect to drinking water, ‘hazard’ can be understood as a microbiological, chemical, physical or radiological agent that causes harm to human health. Geological or geophysical hazards originate from internal earth processes (e.g. earthquakes, volcanic activity, landslides, rockslides, mud flows). Hydro-meteorological hazards are of atmospheric, hydrological or oceanographic origin (e.g. cyclones, typhoons, hurricanes, floods, drought, heatwaves, cold spells, coastal storm surges). Hydro-meteorological conditions can also be a factor in other hazards such as landslides, wildland fires and epidemics. Technological hazards originate from industrial or technological conditions, dangerous procedures, infrastructure failures or specific human activities (e.g. industrial pollution, nuclear radiation, toxic waste, dam failures, transport accidents, factory explosions, fires, chemical spills).

3.4
hazard map
map developed to illuminate areas that are affected or vulnerable to a particular hazard (e.g. earthquakes, landslides, rockslides)

3.5
drinking water
water intended for human consumption

Note 1 to entry: The term potable water is used instead of drinking water in ISO 37120 because this document was published before ISO 24513. Both terms can be used interchangeably but potable water is deprecated according to ISO 24513.

[SOURCE: ISO 24513:2019, 3.2.2.1, modified — Note 1 to entry replaced.]

3.6
resilience
adaptive capacity of an organization in a complex and changing environment

Note 1 to entry: The Intergovernmental Panel on Climate Change (IPCC) defines resilience as “the ability of a system and its component parts to anticipate, absorb, accommodate, or recover from the effects of a hazardous event in a timely and efficient manner, including through ensuring the preservation, restoration, or improvement of its essential basic structures and functions.”[21]

Note 2 to entry: Resilience is the ability of an organization to resist being affected by an event or the ability to return to an acceptable level of performance in an acceptable period of time after being affected by an event.

Note 3 to entry: Resilience is the capability of a system to maintain its functions and structure in the face of internal and external change and to degrade gracefully when this is necessary.

[SOURCE: ISO Guide 73:2009, 3.8.1.7, modified — Notes 1, 2 and 3 to entry have been added.]

3.7
resilient city
city able to prepare for, recover from and adapt to shocks and stresses

Note 1 to entry: A resilient city can resist, absorb, accommodate, adapt to, transform and recover from the effects of disasters and shocks in a timely and efficient manner, including through the preservation and restoration of essential basic structures and services in a sustainable way, and through risk-management practices. It involves stakeholders and especially citizens in disaster risk reduction through co-creation processes; reduces vulnerability and exposure to natural and human-made disasters; and increases its capacity to respond to disasters, shocks and other unforeseen chronic stresses through enhanced preparedness.

Note 2 to entry: A resilient city is still able to thrive regardless of the hazards, shocks and stresses it faces. It has a focus on lesson learning, continuous improvement and building back better after disasters.

3.8
shock
natural or human-made event that causes a disaster

EXAMPLE Flood, earthquake, volcanic eruption, hurricane, wildfire, pandemic, chemical spill or explosion, terrorism, power outage, financial crisis, cyber-attack and conflict.

3.9
stress
underlying human and natural pressure or tension that causes persistent negative impacts in a city relating to environmental degradation (e.g. poor air and water quality), social inequality (e.g. chronic poverty and housing shortages) and economic instability (e.g. rapid inflation and persistent unemployment)

3.10
vulnerability
susceptibility of individuals, households, businesses, assets or systems in a city to the impacts of hazards, as determined by physical, social, economic and environmental factors, processes and conditions

3.11
risk
effect of uncertainty on objectives

Note 1 to entry: An effect is a deviation from the expected — positive or negative.

Note 2 to entry: Uncertainty is the state, even partial, of deficiency of information related to understanding or knowledge of an event, its consequence or likelihood.

Note 3 to entry: Risk is often characterized by reference to potential "events" (as defined in ISO Guide 73:2009, 3.5.1.3) and "consequences" (as defined in ISO Guide 73:2009, 3.6.1.3), or a combination of these.

Note 4 to entry: Risk is often expressed in terms of a combination of the consequences of an event (including changes in circumstances) and the associated "likelihood" (as defined in ISO Guide 73:2009, 3.6.1.1) of occurrence.

[SOURCE: ISO 37100:2016, 3.4.12]

3.12
high-risk hazard
hazard for which there is a likelihood of extreme event(s) based on hazard maps created by the city that could significantly affect many properties in the city and/or have a major impact on the city

4 City indicators

This document contains indicators designed to assist cities in preparing for, recovering from and adapting to shocks and stresses.

To reduce vulnerability to shocks and stresses, these indicators will support cities in engaging all sectors, stakeholders and populations; apply collaborative leadership models and methods; work across disciplines and city systems; and use data information and appropriate technologies. The indicators can improve resilience in cities by promoting and enabling inclusive and collaborative approaches to governance at all levels (neighbourhood, district, city, metropolitan area, region, state/province, country). This involves long-term risk management of critical networks and their interactions and potential failures.

This document shall be implemented in conjunction with ISO 37120. The indicators are classified into themes according to the different sectors and services provided by a city, in alignment with ISO 37120. The classification structure is used solely to denote the services and area of application of each type of indicator when reported on by a city. This classification has no hierarchical significance and is organized alphabetically according to themes. All indicators shall be compiled and reported on an annual basis.

In some cases, it is difficult to define simple, quantitative metrics to measure the performance of systems and processes that are in place for managing resilience at the city level. However, it has been agreed that these systems and processes are core components of city resilience, and thus warrant inclusion in the document. Some indicators are thus defined so as to reflect the minimum characteristics or performance requirements for these systems and processes, which can then be objectively verified.

It is important to review the results of multiple types of indicators across themes; to focus on a single indicator can lead to a distorted or incomplete conclusion. Elements of aspiration shall also be taken into consideration in the analysis. Furthermore, it is also important to acknowledge potential antagonistic effects of the outcome of particular indicators, either positive or negative, when analysing results.

For data interpretation purposes, cities shall take into consideration contextual analysis when interpreting results. The local institutional environment may affect the capacity to apply indicators. Furthermore, it is important also to note that each city will face a unique set of shocks and stresses, as well as having a unique set of assets and resources to manage and address these shocks and stresses. In this context, it is important that caution is taken in applying these indicators to make comparison between cities to ensure a full understanding of these relevant contextual factors, including, for example, risk profiles. Some aspects of resilience may also be the responsibility of the private sector, other levels of government or individuals themselves.

5 Economy

5.1 Historical disaster losses as a percentage of city product

5.1.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 Historical losses reflect direct economic losses (in monetary terms) of disasters.

NOTE 2 This indicator reflects the “Economy and sustainable production and consumption” issue as defined in ISO 37101. It can allow an evaluation of the contribution to the “Resilience” purpose of the city as defined in ISO 37101.

5.1.2 Indicator requirements

Historical disaster losses as a percentage of city product shall be calculated as the direct economic losses from disaster(s) within the city summed over a period of five years (numerator) divided by the total city product summed over the same time period (denominator). The result shall be multiplied by 100 and expressed as historical disaster losses as a percentage of city product.

City product can be obtained from ISO 37120:2018, 5.9.3.

Direct economic losses shall refer to losses (in monetary terms) that result from disasters. Such losses are associated with damage or destruction to physical, social and critical infrastructure within the city's administrative boundary (even if not under the city's jurisdiction). Physical infrastructure refers to the built structures, systems and assets required for a city's economy to function, including transportation networks, telecommunication services, energy grids, sewerage and waste disposal systems, water supplies, city buildings and facilities, and housing. Social infrastructure is an important subset of physical infrastructure and includes structures that accommodate social services, such as schools, universities, hospitals and prisons. Critical infrastructure refers to systems, services or assets (physical or virtual) that are vital for the welfare of society (see 3.1).

5.1.3 Data sources

The data for this indicator should be sourced from damage and economic loss assessments prepared after disasters. Data may also be available from insurance industry sources.

5.2 Average annual disaster loss as a percentage of city product

5.2.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 Historical loss data does not provide a full picture of the potential economic losses that a city faces from disasters. Potential economic losses can only be appropriately assessed through modelling of potential future events (catastrophe modelling), which considers major hazards and their likelihood of occurrence, the vulnerability of the city to damage from the hazard and the economic consequence of this damage. Average annual loss is calculated from a large number of modelled scenarios considering these factors. Average annual loss is a widely used parameter in quantitative risk assessment and management, and allows estimation of the benefits of investing in risk reduction.

NOTE 2 This indicator reflects the "Economy and sustainable production and consumption" issue as defined in ISO 37101. It can allow an evaluation of the contribution to the "Resilience" purpose of the city as defined in ISO 37101.

5.2.2 Indicator requirements

Average annual disaster loss as a percentage of city product shall be calculated as the average direct economic losses from disaster(s) estimated from city-wide catastrophe modelling scenarios (numerator) divided by the total city product (denominator). The result shall be multiplied by 100 and expressed as average annual disaster loss as a percentage of city product.

Direct economic losses shall refer to losses (in monetary terms) that result from disasters. Such losses are associated with damage or destruction to physical, social and critical infrastructure within the city's administrative boundary (even if not under the city's jurisdiction). Physical infrastructure refers to the built structures, systems and assets required for a city's economy to function, including transportation networks, telecommunication services, energy grids, sewerage and waste disposal systems, water supplies, city buildings and facilities, and housing. Social infrastructure is an important subset of physical infrastructure and includes structures that accommodate social services, such as schools, universities, hospitals and prisons. Critical infrastructure refers to systems, services or assets (physical or virtual) that are vital for the welfare of society (see 3.1).

5.2.3 Data sources

Catastrophe modelling is a complex modelling activity typically undertaken by specialist risk consulting and advisory firms. Insurance companies also undertake catastrophe modelling.

5.2.4 Data interpretation

Over time, average annual loss data can be used to quantify the expected benefits of investing in disaster risk-reduction measures.

5.3 Percentage of properties with insurance coverage for high-risk hazards

5.3.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 Widespread insurance coverage within cities represents a crucial component of resilience due to the critical role that insurance plays in a city to rapidly recover from shocks and stresses. Insurance improves economic and fiscal outcomes through several channels. Before a disaster strikes, the pricing of insurance gives policyholders incentives to reduce their exposures through risk mitigation measures. In the aftermath of disaster, insurance transfers the fiscal burden away from taxpayers onto the private sector and into capital markets. It also limits financial contagion by restoring supply chains and stalled business operations faster, while providing needed liquidity and certainty in business and financial planning.

NOTE 2 This indicator reflects the "Living together, interdependence and mutuality" as defined in ISO 37101. It can allow an evaluation of the contribution to the "Resilience" purpose of the city as defined in ISO 37101.

5.3.2 Indicator requirements

The percentage of properties with insurance coverage for high-risk hazards shall be calculated as the total number of properties (residential and non-residential) within the city with insurance coverage for high-risk hazards affecting the city (numerator) divided by the total number of properties (households and businesses) in the city (denominator). The result shall be multiplied by 100 and expressed as the percentage of properties with insurance coverage for high-risk hazards.

Residential properties shall refer to dwellings (or structures) classified for residential use. Examples of residential properties should include, but are not limited to, single-family dwellings, mobile dwellings, semi-detached dwellings, row houses, condominiums and apartment buildings.

Non-residential properties shall refer to structures classified for non-residential use. Examples of non-residential properties should include, but are not limited to, office buildings/private business buildings, hotels, restaurants, government buildings, institutional buildings (e.g. educational and health facilities), factories and other special exempt properties (e.g. non-commercial recreational spaces, places of worship, funeral homes and cemeteries).

Where possible, insurance coverage data for each sector (i.e. residential and non-residential) and the hazards being insured against should be reported and listed in tables.

For the purposes of this indicator, high-risk hazards shall refer to hazards for which there is a likelihood of extreme event(s) based on hazard maps created by the city that could significantly affect many properties in the city and/or have a major impact on the city.

This indicator covers property insurance and excludes personal or life coverage. Insurance may come from multiple public or private providers.

5.3.3 Data sources

Aggregate insurance data should be sourced from public and private insurance entities and/or insurance industry associations.

5.3.4 Data interpretation

It should be noted that not all residential and non-residential properties in a city may require insurance for all high-risk hazards, for example if they are located outside a flood zone (given that proper mapping and identification of flood zones exists). The affordability of insurance will also be a major influence on uptake of insurance within the city for residential and non-residential properties. Two key elements when considering insurance coverage for resilience are the amount of damage sustained and the speed of recovery.

5.4 Percentage of total insured value to total value at risk within the city

5.4.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 An aggregate assessment of insurance levels relative to the value at risk from high-risk hazards helps to reveal potential instances of underinsurance. It also helps to educate the community, incentivise action to mitigate risks and prepare for disasters, and enhance city risk analysis and management processes.

NOTE 2 This indicator reflects the “Economy and sustainable production and consumption” issue as defined in ISO 37101. It can allow an evaluation of the contribution to the “Resilience” purpose of the city as defined in ISO 37101.

5.4.2 Indicator requirements

The percentage of total insured value to total value at risk within the city shall be calculated as the total insured value of all residential and non-residential properties within the city (numerator) divided by the total value of all residential and non-residential properties in the city (denominator). The result shall be multiplied by 100 and expressed as the percentage of total insured value to total value at risk within the city.

Residential properties shall refer to dwellings (or structures) classified for residential use. Examples of residential properties should include, but are not limited to, single-family dwellings, mobile dwellings, semi-detached dwellings, row houses, condominiums and apartment buildings.

Non-residential properties shall refer to structures classified for non-residential use. Examples of non-residential properties should include, but are not limited to, office buildings/private business buildings, hotels, restaurants, government buildings, institutional buildings (e.g. educational and health facilities), factories and other special exempt properties (e.g. non-commercial recreational spaces, places of worship, funeral homes and cemeteries). Where possible, insurance coverage data for each sector (i.e. residential and non-residential) and the hazards being insured against should be reported and listed in tables.

5.4.3 Data sources

Aggregate insurance data should be sourced from public and private insurance entities and/or insurance industry associations.

5.4.4 Data interpretation

It should be noted that not all properties in a city may require insurance for all hazards (e.g. if they are located outside a flood zone). The affordability of insurance will also be a major influence on the uptake and level of insurance within the city.

5.5 Employment concentration

5.5.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 A diverse local economy is a key component of city resilience. Some communities can be dependent on a small number of industries for providing employment and/or local taxation revenue, rendering these communities vulnerable to chronic stresses associated with economic downturns and structural, industrial and technological changes.

NOTE 2 This indicator reflects the "Economy and sustainable production and consumption" issue as defined in ISO 37101. It can allow an evaluation of the contribution to the "Resilience" purpose of the city as defined in ISO 37101.

5.5.2 Indicator requirements

Employment concentration shall be calculated as the number of people in the city employed in the three largest sectors of the local economy (as measured by total employment) (numerator) divided by the city's total labour force (denominator). The result shall be multiplied by 100 and expressed as a percentage.

Labour force shall refer to the sum of the total persons employed and unemployed who are legally eligible to work and who are primary residents of the city. This typically includes all working-age adults between the ages of 15 and 64, but the specific age will vary by country.

The sectors used for the calculation of this indicator should be defined as per the International Standard Industrial Classification of All Economic Activities, Rev.4[8] or an equivalent classification.

5.5.3 Data sources

Data on employment concentration should be obtained through labour force surveys or city employment assessments administered by local, regional or national authorities/statistical bodies, or the ministry or department of labour and employment.

5.5.4 Data interpretation

This indicator should be considered in the broader context of the economic wealth and prosperity of the city.

5.6 Percentage of the workforce in informal employment

5.6.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 Informal employment often comes with lower benefits and poorer working conditions, and poverty and informality are often found to be strongly correlated. Therefore, it is important that cities monitor informal employment to formulate effective development policies that help people transition from informal to formal employment[9].

NOTE 2 This indicator reflects the "Economy and sustainable production and consumption" issue as defined in ISO 37101. It can allow an evaluation of the contribution to the "Resilience" purpose of the city as defined in ISO 37101.

5.6.2 Indicator requirements

The percentage of the workforce in informal employment shall be calculated as the number of people working in informal employment (numerator) divided by the city's total workforce (denominator). This result shall be multiplied by 100 and expressed as the percentage of the workforce in informal employment.

Informal employment shall refer to employment where the employment relationship is, in law or in practice, not subject to national labour legislation, income taxation, social protection or entitlement to certain employment benefits (e.g. advance notice of dismissal, severance pay, paid annual or sick leave). The reasons may be non-declaration of the jobs or the employees; casual jobs or jobs of a limited short duration; jobs with hours of work or wages below a specified threshold (e.g. for social security contributions); employment by unincorporated enterprises or by persons in households; jobs where the employee's place of work is outside the premises of the employer's enterprise (e.g. outworkers without employment contract); or jobs for which labour regulations are not applied, not enforced or not complied with for any other reason. The operational criteria for defining informal jobs of employees are to be determined in accordance with national circumstances and data availability[10].

Informal employment should include own-account workers employed in their own informal sector enterprises, employers employed in their own informal sector enterprises, contributing family workers, irrespective of whether they work in formal or informal sector enterprises, members of informal producers' cooperatives, employees holding informal jobs in formal sector enterprises, informal sector enterprises or as paid domestic workers employed by households; and own-account workers engaged in the production of goods exclusively for own final use by their household[10].

Workforce shall refer to the sum of the total persons employed and unemployed who are legally eligible to work.

5.6.3 Data sources

Data on employment should be obtained through labour force surveys or city employment assessments administered by local, regional or national authorities/statistical bodies, or the ministry or department of labour and employment.

5.6.4 Data interpretation

Care is to be used in evaluating this indicator, as a low or high percentage of the workforce in informal employment may not necessarily be indicative of a more resilient city.

5.7 Average household disposable income

5.7.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE Average household disposable income is an important determinant of consumption and an indicator to measure people's economic well-being. In addition, average household disposable income is an indicator that can be used to set a baseline measuring the disposable income residents have to support their local retailers and engage with community organizations. That said, average household disposable income can also be used to measure the ability of households to support the local economy during economic downturns, ultimately serving as an indicator of a city's economic resiliency.

5.7.2 Indicator requirements

Average household disposable income shall be calculated as the total amount of income available for spending and saving after subtracting income taxes and pension contributions during the calendar year by all households within city boundaries (numerator) divided by the total number of households within city boundaries (denominator). The result shall be expressed as the average household disposable income in USD.

Household disposable income shall include the disposable income of all household members who are 15 years of age or older.

To make the conversion from local currency, cities should use the rates posted by the US Federal Reserve Bank: https://www.newyorkfed.org/markets/international-market-operations/foreign-exchange-operations. Cities should also make note of the rate and date of conversion.

5.7.3 Data sources

Data should be gathered from the national census or a regional or local ministry, department or organization responsible for monitoring income statistics

6 Education

6.1 Percentage of schools that teach emergency preparedness and disaster risk reduction

6.1.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 Teaching emergency preparedness and risk reduction in schools increases the coping capacity of society. It helps school administrators, instructors, students and staff to prepare for emergencies and reduce risks by protecting themselves, their property and their assets from the effects of a disaster.

NOTE 2 This indicator reflects the “Education and capacity building” and “Safety and security” issues as defined in ISO 37101. It can allow an evaluation of the contribution to the “Resilience” purpose of the city as defined in ISO 37101.

6.1.2 Indicator requirements

The percentage of schools that teach emergency preparedness and disaster risk reduction shall be calculated as the number of schools within the city that teach emergency preparedness and disaster risk reduction (numerator) divided by the total number of schools in the city (denominator). The result shall be multiplied by 100 and expressed as a percentage of schools that teach emergency preparedness and disaster risk reduction.

Schools shall refer to primary and secondary educational institutions.

Emergency preparedness and disaster risk reduction activities shall refer to training drills and awareness programmes, for example, but not limited to, evacuation simulations, practicing/rehearsing emergency protocols, testing the carrying capacity of potential evacuation routes and evaluating the response times for emergency services.

6.1.3 Data sources

The data from this indicator should be obtained from educational authorities, individual schools and educational institutions.

6.2 Percentage of population trained in emergency preparedness and disaster risk reduction

6.2.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 Training in emergency preparedness and disaster risk reduction enhances the response capacity of city populations. Regular and repeated training drills help to assimilate disaster awareness and responsiveness into the city population and to refresh and update emergency training and disaster protocols.

NOTE 2 This indicator reflects the “Education and capacity building” and” Safety and security” issues as defined in ISO 37101. It can allow an evaluation of the contribution to the “Resilience” purpose of the city as defined in ISO 37101.

6.2.2 Indicator requirements

The percentage of population trained in emergency preparedness and disaster risk reduction shall be calculated as the total number of people within the city trained by responsible authorities in emergency preparedness and disaster risk reduction activities in the previous 12 months (numerator) divided by the city’s total population (denominator). The result shall be multiplied by 100 and expressed as a percentage of population trained in emergency preparedness and disaster risk reduction.

Emergency preparedness and disaster risk reduction activities shall refer to training drills and awareness programmes, for example, but not limited to, evacuation simulations, practicing/rehearsing emergency protocols, testing the carrying capacity of potential evacuation routes and evaluating the response times for emergency services.

6.2.3 Data sources

The data for this indicator should be sourced from emergency management authorities.

6.3 Percentage of emergency preparedness publications provided in alternative languages

6.3.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 Multilingual education and training activities in emergency preparedness and risk mitigation help to ensure that learning opportunities are available to all individuals, regardless of linguistic differences. It is important to distribute such publications in alternative languages in tourism centres in order to inform tourists/ non-permanent citizens.

NOTE 2 This indicator reflects the” Safety and security” and “Living together, interdependence and mutuality” issues as defined in ISO 37101. It can allow an evaluation of the contribution to the “Resilience” and “Social cohesion” purposes of the city as defined in ISO 37101.

6.3.2 Indicator requirements

The percentage of emergency preparedness publications provided in alternative languages shall be calculated as the number of emergency preparedness publications provided in alternative languages within the city (numerator) divided by the total number of emergency preparedness publications published by the city (denominator). The result shall be multiplied by 100 and expressed as the percentage of emergency preparedness publications provided in alternative languages.

Alternative languages shall refer to other languages other than the official language spoken in the city, including those not having official or legal status with the local government.

Publications shall refer to official printed materials and digital materials produced by the city government for emergency preparedness.

6.3.3 Data sources

The data for this indicator should be sourced from emergency management authorities.

6.4 Educational disruption

6.4.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 It is important that educational institutions minimize disruption and ensure continuity of education for all children. Monitoring educational disruption as the number of lost teaching days due to extreme events can help to assess the effectiveness of minimizing disruption in educational institutions[11].

NOTE 2 This indicator reflects the "Education and capacity building" issue as defined in ISO 37101. It can allow an evaluation of the contribution to the "Resilience" and "Attractiveness" purposes of the city as defined in ISO 37101.

6.4.2 Indicator requirements

Educational disruption shall be calculated as the number of teaching hours lost annually due to shocks or stresses.

Teaching hours lost shall refer to hours when educational institutions are not operational during regular hours of teaching.

Any closure of an education facility in the city shall be counted. Multiple educational facilities closed on the same calendar date shall be counted as one in order to avoid double counting. For example, if there are multiple educational facilities closed for 8 h on the same day, only 8 hours will be counted for that day and not multiplied by the number of facilities affected.

6.4.3 Data sources

Data on the number of teaching days lost due to shocks or stresses should be sourced from local or regional school boards or a ministry/department of education.

7 Energy

7.1 Number of different electricity sources providing at least 5 % of total energy supply capacity

7.1.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 A diverse electricity supply mix helps ensure that alternative electricity provisions are available to the city in the event of a system failure, resulting in no or reduced power delivery or supply capacity. A diverse electricity supply system or infrastructure protects cities from generation and capacity disruption resulting from fuel or energy source disruption, and thus helps cities to mitigate and prepare for disasters and shocks. It is, however, noted that other system elements, such as the design and state of repair of transmission and distribution systems, will also influence the reliability of electricity supply and are not directly covered by this indicator.

NOTE 2 This indicator reflects the "Community infrastructures" issue as defined in ISO 37101. It can allow an evaluation of the contribution to the "Resilience" purpose of the city as defined in ISO 37101.

7.1.2 Indicator requirements

The number of different electricity supply sources providing at least 5 % of total energy supply capacity shall refer to the number of different, or separate, electricity supply sources to the city each providing at least 5 % of total energy supply capacity.

NOTE The 5 % threshold is used by international organizations such as the World Bank to ease calculations and to capture the major supply sources.

When the number of different electricity supply sources exceed two, the percentage of electricity supply capacity of each supply source should be reported.

In addition to providing the number of different electricity supply sources and supply capacity of each supply source, the number of different electricity supply sources and the total amount of electricity supplied to the city (GJ) by these electricity sources should be reported in Table 1.

Table 1

	Fossil fuels (e.g. coal, natural gas and petroleum)	**Mineral fuels (e.g. uranium and thorium)**	**Renewables (e.g. wind, solar, hydro, geothermal, tidal and biomass)**
Number of different electricity supply sources			
Total amount of electricity supplied to the city (GJ)			

A different (or separate) electricity supply source shall refer to electricity supplies that are not disrupted or directly influenced by other sources. This includes electricity supplies that are sourced from fossil fuels (e.g. coal, natural gas, petroleum), mineral fuels (e.g. uranium, thorium) and renewables (e.g. wind, solar, hydro, geothermal, tidal, biomass). These sources are converted to electricity at thermal and hydroelectric power stations, PV power plants, wind farms and wave farms, tidal power stations and solar power towers.

7.1.3 Data sources

The data for this indicator should be sourced from energy system regulators or management authorities, individual energy providers, electric utilities and electricity supply or service providers.

7.1.4 Data interpretation

While multiple, different, electricity sources contribute to city resilience in the event of a system failure, this is not necessarily indicative of city resilience in all cases.

7.2 Electricity supply capacity as a percentage of peak electricity demand

7.2.1 General

Those implementing this document shall report on this indicator in accordance with the following requirements.

NOTE 1 Having sufficient capacity in electricity supply allows cities to cope with predicted future growth in demand and shorter-term (temporary) demand surges stemming from shocks and stresses. Managing the supply and demand of electricity is thus critical in the continuity of essential utility services, to ensure that built systems are not overloaded and that they can maintain sufficient redundancy to absorb surges in demand. It is important that cities monitor peak electricity demand relative to available supply capacity (i.e. the reserve margin) to assess the vulnerability and robustness of their electrical supply systems.

NOTE 2 This indicator reflects the “Community infrastructures” issue as defined in ISO 37101. It can allow an evaluation of the contribution to the “Resilience” purpose of the city as defined in ISO 37101.

7.2.2 Indicator requirements

Electricity supply capacity as a percentage of peak electricity demand shall be calculated as the electricity supply capacity available to the city (numerator) divided by the city’s monthly peak electricity demand averaged over the calendar year (denominator). The result shall be multiplied by 100 and expressed as the electricity supply capacity as a percentage of peak electricity demand.

Electricity supply capacity shall refer to the expected maximum available supply of electricity to meet projected peak demands, including reserve supplies to meet unexpected losses, interruptions or surges in demand.

Peak electricity demand shall refer to the highest level of electricity needs from consumers across a specified period. Peak demand fluctuates with human activity cycles, the time of the day, the season of the year, weather extremes and industrial activity.

7.2.3 Data sources

Data should be gathered from electricity distributors, city energy or environment offices and international sources such as the International Energy Agency (IEA) or the World Bank.

7.3 Percentage of critical facilities served by off-grid energy services

7.3.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE Power outages of any duration are especially problematic for critical facilities, such as hospitals, fire stations, police stations, emergency services call centres, wastewater treatment plants or storage facilities for critical records. If a power outage occurs in a critical facility, this can further exacerbate the negative impacts of shocks and stress. For example, hospitals can lose heating or air-conditioning, water pressure, the ability to sterilize equipment and the use of elevators to transport patients to different floors during a power outage. Therefore, power reliability is essential to critical facility operations. Off-grid energy services can help critical facilities avoid power outages and continue their operations even when the primary energy grid of the city is experiencing planned and unplanned outages, ultimately allowing critical facilities to maintain a high level of energy independence from the centralised energy grid.

7.3.2 Indicator requirements

The percentage of critical facilities served by off-grid energy services shall be calculated as the number of critical facilities in the city served by off-grid energy services (numerator) divided by the total number of critical facilities in the city (denominator). The result shall be multiplied by 100 and expressed as the percentage of critical facilities served by off-grid energy services.

A critical facility shall refer to a facility that provides services and functions essential to a city, especially during and after a disaster. Categories of critical facilities include, but are not limited to, emergency response (e.g. fire, rescue and police stations), medical (e.g. hospitals, critical care facilities and outpatient clinics), emergency shelters (e.g. public school buildings and school bus facilities being used as shelters in the event of an emergency), lifelines (e.g. distributive systems and related facilities necessary to provide electric power), transportation (e.g. roads, bridges, tunnels, rail lines and stations), telecommunications (e.g. telephone and cellular telephone switching centres, and antenna or relay towers), data centres (e.g. facilities and systems providing local and internet computer capability and facilities for the storage of critical information), financial institutions (e.g. central and commercial banks), major industrial/commercial organizations (e.g. major employers without whom the community would not be able to sustain itself), and other related facilities and services that are essential to the well-being of the community served by these systems. Where possible, the types of critical facilities included should be indicated. This indicator shall only include those critical facilities located within the city's administrative boundary.

Off-grid energy services shall refer to both standalone energy systems and mini-energy grids that are not connected to the primary centralised energy grid for large-scale generation of energy at centralised facilities, and usually utilize battery and/or fuel cells as an energy source. Standalone energy systems shall refer to energy systems often used to power individual appliances and to users that are not connected to the primary centralised energy grid outside of the user's premises. A mini-energy grid shall refer to a small energy grid system providing energy to users who are not connected to the primary centralised energy grid. Also, off-grid energy production includes a wide range of technologies such as, but not limited to, wind turbines or plants, photovoltaic (solar) panels, microturbines and modular internal combustion engines. Examples of off-grid energy services include, but are not limited to, mini-energy grids providing power to communities (e.g. the Brooklyn Microgrid), critical facilities and institutional buildings, and solar photovoltaic power generation utilizing solar panels providing energy to residential households, critical facilities and institutional buildings.

Cities should account for critical facilities that have the capability to operate in "island mode" in the calculation of this indicator. Island mode shall refer to the capability of a critical facility to switch from operating on the local energy grid to operating in isolation from the local energy grid. The proportion of critical facilities that are solely served by off-grid energy services and have the capability to operate in island mode should be reported, and cities should note if critical facilities that have the capability to operate in island mode data are included.

7.3.3 Data sources

Data should be gathered from emergency management authorities and other authorities responsible for critical facilities.

8 Environment and climate change

8.1 Magnitude of urban heat island effects (atmospheric)

8.1.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 At city scale, urban areas are warmer, on average, than their rural surroundings. This applies to the city surface and the urban atmosphere, and it defines a phenomenon known as the "urban heat island" effect. Heat islands are caused by retention of heat in city construction materials, reduction of wind speeds in street "canyons," diminished evaporative cooling over impervious surfaces, and release of combustive heat from fuel use in buildings, industry and vehicles. In cities with a hot climate, or with a hot season, the heat island effect can convey serious health implications for human morbidity and mortality during prolonged heatwave events or extremely hot days or nights. The heat island effect also increases (decreases) energy demand for building cooling (heating) in hot (cold) cities or seasons. The measured magnitude of the heat island effect fluctuates with time of day, season of the year, geographic location, urban form and function, and prevailing weather conditions.

NOTE 2 City governments have direct control or influence over many planning and policy instruments that can influence or reduce urban heat island effects. These include urban planning policies, building codes and the designation and maintenance of green spaces.

NOTE 3 This indicator reflects the "Biodiversity and Ecosystem Services" and "Living and working environment" issues as defined in ISO 37101. It can allow an evaluation of the contribution to the "Preservation and improvement of the environment" and "Well-being" purposes of the city as defined in ISO 37101.

8.1.2 Indicator requirements

The urban heat island effect shall be calculated as the difference between mean daily air temperatures recorded simultaneously in one urban area and one non-urban area, averaged over a 12-month period.

Urban area shall refer to a central part of the city in the order of several hectares, with close-set buildings, paved roads, heavy traffic flow and high population density.

Non-urban area shall refer to a peripheral part of the city in the order of several hectares, with few buildings and roads, abundant natural land cover and low population density.

Cities should describe the two locations of the temperature sensors (or climate stations) used to measure the heat island magnitude (e.g. park, airport, city centre, agricultural area). This is necessary to convey the local representativeness of the measured values, the physical, demographic and human activities representative of the area surrounding the two instruments (or stations) and their influence on the recorded temperatures. References to "urban climate zones" (UCZ) are helpful in this regard. World Meteorological Organization (WMO) guidelines for temperature observations in urban and non-urban areas should be followed[12].

If available, cities should note the location of sensors or add a map to indicate the locations.

8.1.3 Data sources

Data for this indicator should be sourced from government agencies or research institutions that operate and maintain meteorological observatories, climate stations or environmental monitoring sites in cities and their surrounding rural areas.

8.1.4 Data interpretation

Care should be taken when interpreting data relating to the urban heat island effect, as the magnitude is sensitive to measurement height, measurement location, measurement interval, instrument type and instrument placement. Location is especially important because the heat island effect at city scale comprises many smaller local and micro-scale climates (e.g. hot and cool spots associated with small parks, water bodies, heat-emitting factories) throughout the city that may not be representative of the broader climate.

8.2 Percentage of natural areas within the city that have undergone ecological evaluation for their protective services

8.2.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 Ecological assets such as forests, mangroves and floodplains give protection to human settlements from hazards such as floods, heatwaves and tropical storms. Protective services are direct benefits provided by ecological assets to prevent or reduce the negative impacts of hazards on cities and their citizens. Examples of protective services include the reduction of peak storm water runoff by natural ground cover in river catchments and the attenuation of storm surges by coastal mangroves. To help a city identify and enhance the protective value of its ecological assets, the city's natural areas can be formally evaluated for the protective services they provide.

NOTE 2 This indicator reflects the "Biodiversity and Ecosystem Services" issue as defined in ISO 37101. It can allow an evaluation of the contribution to the "Preservation and improvement of environment" and "Resilience" purposes of the city as defined in ISO 37101.

8.2.2 Indicator requirements

The percentage of natural areas within the city that have undergone ecological evaluation for their protective services shall be calculated as the total area of publicly owned natural areas within the city that have undergone ecological evaluation for their protective services (numerator) divided by the total area of all publicly owned natural areas in the city (denominator). The result shall be multiplied by 100 and expressed as the percentage of natural areas within the city that have undergone ecological evaluation for their protective services.

Natural areas shall refer to geographic spaces or zones whose distinguishing characteristics have arisen naturally, or whose predominant land cover and landscape features are otherwise natural (i.e. soil, sand, water or vegetation) rather than built (i.e. impermeable construction materials).

Protective services are direct benefits provided by ecological assets to prevent or reduce the negative impacts of hazards on cities and their citizens. Ecological evaluation shall refer to a formal assessment or classification of the protective services provided by the ecological assets and systems in the defined area.

Although outside the scope for this indicator, assessments should ideally also be undertaken to evaluate ecosystems that lie beyond the city boundary but that provide important ecological services to the city (e.g. upstream watersheds). This may require transboundary collaboration with other city governments, regulatory authorities and other stakeholders. Also outside this document's scope are ecological evaluations by private landowners using their own resources. Although privately owned ecological assets provide the same protective service as public land, they may be difficult to evaluate.

8.2.3 Data sources

Ecological evaluations should be sourced from city environmental departments, external environment agencies or a combination of these and similar agencies.

8.3 Territory undergoing ecosystem restoration as a percentage of total city area

8.3.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 Ecosystem restoration is an effective way to strengthen ecological resilience and to mitigate the impacts of natural hazards. It has multiple benefits such as improved storm water management, water pollution control and reduced flooding and soil erosion.

NOTE 2 This indicator reflects the “Biodiversity and Ecosystem Services” and” Living and working environment” issues as defined in ISO 37101. It can allow an evaluation of the contribution to the “Preservation and improvement of the environment” and “Resilience” purposes of the city as defined in ISO 37101.

8.3.2 Indicator requirements

The territory undergoing ecosystem restoration as a percentage of total city area shall be calculated as the territory undergoing ecosystem restoration within the city boundary in square kilometres (numerator) divided by the total city area in square kilometres (denominator). The result shall be multiplied by 100 and expressed as a percentage.

Ecosystem restoration shall refer to the process of recovering natural and semi-natural landscape elements (i.e. related to soil, water bodies and vegetation) that have been degraded, damaged or destroyed.

Vegetation elements for restoration vary in spatial scale from individual rows of trees to entire valley systems; water elements vary from single ponds to entire watercourses. Examples of ecosystem restoration work include reconditioning of embankments or brownfields to parks or other recreational uses.

8.3.3 Data sources

Data on ecosystem restoration should be sourced from the city’s capital and public works budget. Other sources include city parks and environmental departments.

8.3.4 Data interpretation

Many ecosystems around the world have undergone significant degradation and change due to unnatural (e.g. changes in the environment due to human population growth and migration) and natural (e.g. changes in the environment due to natural disasters) impacts. Ecosystem restoration is often referred to as the act of returning an ecosystem back to its original state after degradation has occurred, and is important for conserving the environment and sustainable development. That said, a city should make efforts to restore its ecosystems in order to conserve its environment and to ensure the sustainable development of the city for current and future generations, and a high value for this indicator may indicate that a city is making significant efforts to restore its ecosystems.

However, there may be instances in which a large proportion of city land area does not require ecosystem restoration for a given year, perhaps because of significant ecosystem restoration efforts that have already been made in previous years and/or a large proportion of city land area does not require ecosystem restoration. Therefore, a low value for this indicator may not necessarily indicate that a city is not making an effort to restore its ecosystems, and the indicator value should be contextualized alongside a number of factors including, but not limited to, a city’s location, natural environment, and historical efforts and policies made with regard to ecosystem restoration.

8.4 Annual frequency of extreme rainfall events

8.4.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE Extreme rainfall events can cause flooding of low-lying areas (including residences, infrastructure and roads); overwhelm water sanitation systems; and damage urban lands dedicated to agriculture and forests within the city. Monitoring extreme rainfall events enables cities to anticipate probable changes in extreme weather, and to make sound investment and budgetary decisions regarding infrastructure and service-provision responsibilities. This monitoring of these extreme rainfall events can lead to better planning, preparation for and response to these events.

8.4.2 Indicator requirements

Annual frequency of extreme rainfall events shall be calculated as the number of extreme rainfall events in a given year.

Extreme rainfall events shall refer to precipitation events in which 50 mm or more of rain has fallen within the city over a 24-h period.

When relevant and available, more precise data at a subdivision level should be reported.

8.4.3 Data sources

Data on extreme rainfall events should be sourced from local or regional meteorological organizations or departments monitoring the environment and climate change.

8.5 Annual frequency of extreme heat events

8.5.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE During extreme heatwaves, mortality and morbidity increase among the general population, especially among vulnerable groups. This monitoring of these extreme heat events can lead to better planning, preparation for and response to these events.

8.5.2 Indicator requirements

Annual frequency of extreme heat events shall be calculated as the number of extreme heat events in a given year.

Extreme heat events shall refer to an extended period of time (at least 72 hours) with unusually hot weather conditions that put human health and well-being at risk. Country-specific air temperature thresholds for defining extreme heat events vary. For example, in Canada an extreme heat event may be defined as 72 hours or more with air temperatures above 30 °C/86 °F (or a specific community-based threshold), while in the USA it may be defined as temperatures above 32 °C/90 °F (or a specific community-based threshold).

Those reporting on this indicator shall use their country-specific method and temperature threshold.

Cities should consider the location of the air temperature measurements to convey the local representativeness of the reported values (e.g. airport, city centre).

When relevant and available, more precise data at a subdivision level should be reported.

8.5.3 Data sources

Data on extreme heat events should be sourced from local or regional meteorological organizations or departments monitoring the environment and climate change.

8.6 Annual frequency of extreme cold events

8.6.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE During extreme cold events, mortality and morbidity increase among the general population, especially among vulnerable groups. This monitoring of these extreme cold events can lead to better planning, preparation for and response to these events.

8.6.2 Indicator requirements

The annual frequency of cold events shall be calculated as the number of extreme cold events in a given year.

Extreme cold events shall refer to an extended period of time (at least 72 hours) with unusually cold weather conditions that put human health and well-being at risk. Country-specific air temperature thresholds for defining extreme cold events vary. For example, in Canada an extreme cold event may be defined as air temperatures or wind chills below −30 °C/−22 °F (or a specific community-based threshold) for at least 72 hours, while in the USA it may be defined as temperatures or wind chills below −29 °C/−20 °F (or a specific community-based threshold).

Those reporting on this indicator shall use their country-specific method and temperature threshold.

Cities should consider the location of the air temperature measurements to convey the local representativeness of the reported values (e.g. airport, city centre).

When relevant and available, more precise data at a subdivision level should be reported.

8.6.3 Data sources

Data on extreme cold events should be sourced from local or regional meteorological organizations or departments monitoring the environment and climate change.

8.7 Annual frequency of flood events

8.7.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE Floods are the most common natural disaster and the leading cause of natural disaster fatalities worldwide. With the increasing frequency of climatic extremes, the occurrence and severity of urban flood events is intensifying. Cities can use annual flood frequency data to improve flood warning systems and to monitor and forecast flood disasters and water resources. This monitoring of these flood events can lead to better planning, preparation for and response to these events.

8.7.2 Indicator requirements

The annual frequency of flood events shall be calculated as the number of flood events in the city in a given year.

A flood event shall refer to an overflow of water onto normally dry land, and may include the inundation of a normally dry area caused by a significant rise in the water level of a stream, lake, reservoir or coastal region. A flood event may also include pooling of water at or near the point of rainfall. Flooding is a longer-term event than flash flooding, lasting at least 72 hours[13].

8.7.3 Data sources

Data on flood events should be sourced from local or regional meteorological organizations or departments monitoring the environment and climate change.

8.8 Percentage of city land area covered by tree canopy

8.8.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 A city's tree canopy coverage can have numerous benefits, including reduction of daytime air temperatures in hot seasons, improving air quality and strengthening social ties among neighbours. These factors can strengthen resilience while also helping to attract businesses and residents[14].

NOTE 2 This indicator reflects the "Biodiversity and Ecosystem services" issue as defined in ISO 37101. It can allow an evaluation of the contribution to the "Preservation and improvement of environment", "Well-being" and "Resilience" purposes of the city as defined in ISO 37101.

8.8.2 Indicator requirements

The percentage of city area covered by tree canopy shall be calculated as the city land area covered by tree canopy (numerator) divided by the city's total land area (denominator). The result shall be multiplied by 100 and expressed as the percentage of city land area covered by tree canopy.

Tree canopy shall refer to the layered biomass of tree leaves, branches and stems that obscures the underlying ground surface when viewed from above.

8.8.3 Data sources

Data on tree canopy coverage should be sourced from local or regional conservation organizations or a ministry/department of environment, land use or urban planning. In addition, data should be sourced using geographic information system (GIS) tools and methods.

8.9 Percentage of city surface area covered with high-albedo materials contributing to the mitigation of urban heat islands

8.9.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 Urban heat islands (defined in 8.1) affect the health and well-being of their occupants, especially sensitive people such as children or the elderly. Urban heat islands influence the local climate of the city, aggravate atmospheric pollution or have consequences on energy consumption.

To mitigate urban heat islands, and thus limit the health and economic consequences of urban heat islands, cities could provide the use of highly reflective materials/high-albedo materials (e.g. white or light-coloured walls, roofs and roads) on urban surfaces such as rooftops, streets, sidewalks, schoolyards and the exposed surfaces of parking lots.

Albedo describes the proportion of incident radiation reflected by a system. A perfect reflector would have an albedo of 1, whereas a perfect absorber would have an albedo of 0.

High-albedo materials have a positive impact on the localized ambient temperature and can reduce cooling energy consumption.

They can allow city dwellers to limit the impact of high temperatures, searing heat or extreme heat events on their health and well-being.

NOTE 2 The use of high-albedo materials completes the other ways to reduce heat islands, such as planting of trees, green areas, green infrastructure/green roofs, as considered in ISO 37120, as well as shading devices and permeable pavements.

NOTE 3 This indicator reflects the “Health and care in the community”, “Living and working environment”, “Smart community infrastructures” and “Economy and sustainable production and consumption” issues as defined in ISO 37101. It can allow an evaluation of the contribution to the “Resilience” and “Well-being” purposes of the city as defined in ISO 37101.

8.9.2 Indicator requirements

The percentage of city surface area covered with high-albedo materials contributing to the mitigation of urban heat islands shall be calculated as the total surface area of a city (such as rooftops, streets, sidewalks, schoolyards and the exposed surfaces of parking lots), excluding green spaces, built with cool pavements, clear colour permeable/draining materials with a high albedo (numerator) divided by the total surface area of the city excluding green spaces (denominator). The result shall be multiplied by 100 and expressed as the percentage of city surface area covered with high-albedo materials contributing to the mitigation of urban heat islands.

NOTE Green roofs are covered in ISO 37120:2018, 21.1.

8.9.3 Data sources

Information should be obtained from building owners and managers.

9 Finance

9.1 Annual expenditure on upgrades and maintenance of city service assets as a percentage of total city budget

9.1.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 Upgrading and maintenance of city services helps to ensure a more resilient city. If the assets to provide these services are not maintained and/or upgraded, the level of service over time is likely to decline and to be more vulnerable to disruption during shocks and stresses. Proactively maintaining and upgrading basic services ensures public safety and provides adequacy for the future.

NOTE 2 This indicator reflects the “Governance, empowerment and engagement” and “Community infrastructures” issues as defined in ISO 37101. It can allow an evaluation of the contribution to the “Resilience” and “Responsible resource use” purposes of the city as defined in ISO 37101.

9.1.2 Indicator requirements

Annual expenditure on maintenance and upgrades of city service assets as a percentage of total city budget shall be calculated as the annual total of all funds spent on maintenance and upgrades of assets for the provision of city services (numerator) divided by the total annual budget of the city (denominator). The result shall be multiplied by 100 and expressed as the annual expenditure on maintenance and upgrades of city service assets as a percentage of total city budget.

Where possible, expenditure data by service type (e.g. water, waste, transport) should be included as percentage values and included separately as a table.

City services will vary in each city, but usually include, though are not limited to, sanitation, water supply, waste collection, public transport, electricity and gas supply, street lighting and road maintenance.

9.1.3 Data sources

Information on expenditures should be sourced from capital and maintenance budget documents which are approved annually.

9.2 Annual expenditure on upgrades and maintenance of storm water infrastructure as a percentage of total city budget

9.2.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 Protective storm water infrastructure is critical to mitigate hazards and potential impacts of extreme precipitation events. When proactively maintained, upgraded, and managed helps to ensure public safety, and adequacy for the future.

NOTE 2 This indicator reflects the "Community infrastructures" issue as defined in ISO 37101. It can allow an evaluation of the contribution to the "Resilience" and "Responsible resource use" purposes of the city as defined in ISO 37101.

9.2.2 Indicator requirements

Annual expenditure on upgrades and maintenance of storm water infrastructure as a percentage of total city budget shall be calculated as the annual total of all funds spent on upgrades and maintenance of storm water physical and management infrastructure (numerator) divided by the total annual budget of the city (denominator). The result shall be multiplied by 100 and expressed as the expenditure on upgrades and maintenance of storm water infrastructure as a percentage of total city budget.

Storm water infrastructure shall refer to facilities and technical and organizational structures that are designed, installed and/or maintained to mitigate the effects of rainwater and snowmelt hazards in urban areas. Examples of storm water infrastructure include levees and flood barriers; flood basins; sea walls; storm drains and storm water holding tanks; storm water ditches, culverts and catchment basins.

9.2.3 Data sources

Information on expenditures should be sourced from capital and maintenance budget documents which are approved annually.

9.3 Annual expenditure allocated to ecosystem restoration in the city's territory as a percentage of total city budget

9.3.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 Ecosystem restoration is an effective way to strengthen ecological resilience and to mitigate hazards. It has multiple benefits such as improved storm water management, water pollution control and reduced flooding and soil erosion.

NOTE 2 This indicator reflects the "Biodiversity and ecosystem services" and "Living and working environment" issues as defined in ISO 37101. It can allow an evaluation of the contribution to the "Preservation and improvement of environment" and "Responsible resource use" purposes of the city as defined in ISO 37101.

9.3.2 Indicator requirements

Annual expenditure on ecosystem restoration as a percentage of total city budget shall be calculated as the total of all funds spent annually on ecosystem restoration assets for the specific purpose of enhancing the protective and other ecosystem services that enhance the resilience of the city (numerator) divided by the total city budget (denominator). The result shall be multiplied by 100 and expressed as the expenditure on ecosystem restoration as a percentage of total city capital budget.

Ecosystem restoration shall refer to the process of recovering natural and semi-natural landscape elements (i.e. related to soil, water bodies and vegetation) that have been degraded, damaged or destroyed.

9.3.3 Data sources

Data on ecosystem restoration should be sourced from the city's capital and public works budget. Some elements of expenditure can also be sourced from the city's parks and conservation budgets. The total city budget used in this calculation should be sourced from the city's audited financial statements without amendment or variation.

9.3.4 Data interpretation

This indicator measures specific city expenditure to support and enhance the ecosystem services.

9.4 Annual expenditure on green and blue infrastructure as a percentage of total city budget

9.4.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 Embedding green and blue infrastructure into the urban fabric is an effective way to strengthen ecological resilience and to mitigate the impacts of many hazards. These infrastructures have multiple benefits such as improved storm water management, water pollution control, and reduced flooding and soil erosion.

NOTE 2 This indicator reflects the "Biodiversity and ecosystem services" and "Living and working environment" issues as defined in ISO 37101. It can allow an evaluation of the contribution to the "Preservation and improvement of environment" and "Responsible resource use" purposes of the city as defined in ISO 37101.

9.4.2 Indicator requirements

Annual expenditure on green and blue infrastructure as a percentage of total budget shall be calculated as the total of all funds spent on creating, maintaining or enhancing green and blue infrastructure assets for the specific purpose of providing infrastructure-related services for the city (numerator) divided by the total city budget (denominator). The result shall be multiplied by 100 and expressed as the expenditure on green and blue infrastructure as a percentage of total city budget.

Green and blue infrastructure shall refer to all natural and semi-natural landscape elements that can be broadly defined as a strategically planned network of high-quality natural and semi-natural areas with other environmental features, which is designed and managed to deliver a wide range of infrastructure and ecosystem services and protect biodiversity[15]. Green elements are related to vegetation and vary in spatial scale from individual rows of trees to entire valley systems, and may include, but are not limited to, the following actions: greening streets, squares and roadsides; greening roofs and facades; developing urban agriculture; creating urban green corridors; replacing impermeable surfaces; implementing natural water filtration; daylighting urban rivers; and restoring embankments. Blue elements are related to water and vary from single ponds to entire watercourses, and may include, but are not limited to, river corridors, wetlands and other waterways[16].

9.4.3 Data sources

Data on green and blue infrastructure should be sourced from the city's capital and public works budget. Some elements of expenditure can also be included in the city's budget for parks and legally protected areas. The total city budget used in this calculation should be sourced directly from the city's audited financial statements without amendment or variation.

9.4.4 Data interpretation

Interpretation of this indicator has to be made carefully because the impact of these infrastructures on biodiversity protection depends also on the connectivity between the different infrastructures.

9.5 Annual expenditure on emergency management planning as a percentage of total city budget

9.5.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 Budgeting for emergency management planning helps cities to create a detailed plan of action so that the city can adequately respond to shocks and stresses.

NOTE 2 This indicator reflects the "Governance, empowerment and engagement" and "Safety and security" issues as defined in ISO 37101. It can allow an evaluation of the contribution to the "Resilience" and "Responsible resource use" purposes of the city as defined in ISO 37101.

9.5.2 Indicator requirements

Annual expenditure on emergency management planning as a percentage of total city budget shall be calculated as the total annual expenditure on emergency management planning (numerator) divided by the total annual city budget (denominator). The result shall be multiplied by 100 and expressed as the annual expenditure on emergency management planning as a percentage of total city budget.

Emergency management planning shall refer to the process of assessing a city's goals for disaster risk reduction and emergency preparedness, and creating a detailed plan of action to meet those goals so that the city can respond to shocks and stresses. Elements of emergency management planning include determining potential emergency situations and consequences of those situations (i.e. through risk assessments, hazard mapping, vulnerability analysis), and identifying the necessary and appropriate responses and procedures for each emergency situation (e.g. warning systems, evacuation routes, service conduits). Emergency management planning shall exclude ongoing operational emergency service budgets for police, fire or ambulance services.

9.5.3 Data sources

Information on expenditures should be sourced from budget documents which are approved annually or from the relevant city service departments.

9.6 Annual expenditure on social and community services as a percentage of total city budget

9.6.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 Social and community services are widely recognized as contributing to the development of social cohesion, which is widely recognized as being fundamental to resilience.

NOTE 2 This indicator reflects the "Governance, empowerment and engagement" and "Living together, interdependence and mutuality" issues as defined in ISO 37101. It can allow an evaluation of the contribution to the "Social cohesion and "Resilience" purposes of the city as defined in ISO 37101.

9.6.2 Indicator requirements

Annual expenditure on social and community services as a percentage of total city budget shall be calculated as the total annual expenditure on social and community services by the city (numerator) divided by the total annual budget of the city (denominator). The result shall be multiplied by 100 and expressed as the expenditure on social and community services as a percentage of total city budget.

Social and community services shall be defined as services directly provided or supported by the city with the goal of promoting or supporting individual and community resilience and well-being. This may include, but is not limited to, programmes and funding for community groups and associations, public health awareness, libraries, emergency shelters, homeless shelters, drop-in centres, community centres, civic events, community outreach, food programmes, health and human services, seniors programmes, services and outreach, and support and assistance for disadvantaged and vulnerable groups.

9.6.3 Data sources

Information on expenditures on social and community services should be sourced from the annual city budget.

9.6.4 Data interpretation

The provision of social and community services may also be the responsibility of other levels of government (e.g. local, regional, national) and other stakeholders, such as charities and not-for-profit groups. The expenditure by the city government on these services should be interpreted in this broader context.

9.7 Total allocation of disaster reserve funds as a percentage of total city budget

9.7.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 A disaster reserve fund is managed by the city government specifically to meet the unanticipated expenses of emergency response, recovery and reconstruction from a disaster event. The disaster reserve fund elevates a city's preparedness for disasters. The additional benefit of disaster reserve funds held by the city allows for the dispersal of funds to support rapid resumption of services.

NOTE 2 This indicator reflects the "Safety and security" and "Governance, empowerment and engagement" issues as defined in ISO 37101. It can allow an evaluation of the contribution to the "Resilience" and "Responsible resource use" purposes of the city as defined in ISO 37101.

9.7.2 Indicator requirements

The total allocation of disaster reserve funds as a percentage of total city budget shall be calculated as the total allocation of disaster reserve funds (numerator) divided by the total city budget (denominator). The result shall be multiplied by 100 and expressed as the total allocation of disaster reserve funds as a percentage of total city budget.

Disaster reserve fund shall refer to budgets managed by the city government and allocated specifically for meeting the unanticipated expenses of emergency response, recovery and reconstruction from a disaster event.

9.7.3 Data sources

Information on disaster reserve funds should be sourced through the city budget.

9.7.4 Data interpretation

Different jurisdictions will have different models for covering the costs of dealing with disasters, which will need to be taken into account when interpreting this indicator.

10 Governance

10.1 Frequency with which disaster-management plans are updated

10.1.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 Cities need to regularly test and update the long-term adequacy of disaster-management plans to reflect relevant hazards and risks facing the community (based on current data or modelled hazard and demographic projections), and to effectively mitigate those risks. Disaster-management plans will change with urbanization and land use, shifting weather and climate patterns, and improved knowledge and technology.

NOTE 2 This indicator reflects the "Governance, empowerment and engagement" issue as defined in ISO 37101. It can allow an evaluation of the contribution to the "Resilience" purpose of the city as defined in ISO 37101.

10.1.2 Indicator requirements

The frequency with which disaster-management plans are updated shall be calculated as the total number of city-wide disaster-management plan updates that occurred in the previous 5 years (numerator) divided by five (denominator).

Disaster management shall refer to the long-term organization, planning and application of measures to prepare for, respond to and recover from disaster events. Disaster-management plans should be integrated with wider regional or national responses and should stipulate which agency assumes leadership in different emergency scenarios, the response roles of different agencies, and the human and non-human resources available. Key components of a disaster-management plan are command and control; evacuations (e.g. hospitals, jails); communication systems; critical asset management (e.g. likely "failure chains"); integration of private-sector utilities covering, for example, energy, water/sanitation, trash collection and communications; medical response; law and order response; fire and rescue response; public information; and triage policies.

10.1.3 Data sources

The data for this indicator should be available from the relevant emergency management authority(ies) with responsibility for emergency planning.

10.2 Percentage of essential city services covered by a documented continuity plan

10.2.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 Continuity plans can enhance a city's preparedness for, and recovery from, shocks. The benefits of a continuity plan include continued delivery of essential services, reduced disruption to city operations, and timely and rapid recovery from disruptions due to shocks. Cities therefore need to be proactive in developing and adopting continuity plans, based on relevant risks and the issues likely to arise.

NOTE 2 This indicator reflects the "Governance, empowerment and engagement" issue as defined in ISO 37101. It can allow an evaluation of the contribution to the "Resilience" purpose of the city as defined in ISO 37101.

10.2.2 Indicator requirements

The percentage of essential city services covered by a documented continuity plan shall be calculated as the total number of essential services that are covered by a documented continuity plan (numerator) divided by the total number of essential services provided in the city by government entities (denominator). The result shall be multiplied by 100 and expressed as the percentage of essential city services covered by a documented continuity plan.

Essential city services shall refer to services that are deemed vital to the well-being and functioning of the community. These can include, but are not limited to, transportation, electricity, gas, water, sanitation and wastewater treatment, waste management, food, health, police, fire and emergency services and ambulances. Cities should report which essential city services are included in the calculation.

A continuity plan shall refer to a documented strategy that identifies the threats and risks facing the city operations, and that helps to protect its assets and personnel from the negative effects of shocks. Continuity planning involves defining potential risks, determining how those risks will affect operations, implementing safeguards and procedures to mitigate those risks, and regularly reviewing risks to ensure their relevancy and currency. Continuity plans should be regularly updated.

NOTE ISO 22301 is the internationally recognized benchmark for organizational continuity. It specifies requirements to plan, establish, implement, operate, monitor, review, maintain and continually improve a documented management system to protect against, reduce the likelihood of occurrence of, prepare for, respond to, and recover from disruptive incidents when they arise.

10.2.3 Data sources

The data for this indicator should be sourced from the continuity plans of entities providing essential city services

10.2.4 Data interpretation

The presence of a business continuity plan does not in itself ensure that identified continuity measures have been implemented or guarantee that business continuity will be ensured in the case of a stress or shock.

10.3 Percentage of city electronic data with secure and remote back-up storage

10.3.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 Safe and efficient back-up, access, recovery and storage of data are critical to the functioning of city governments and their disaster mitigation and recovery strategies. Important data held by governments can be backed up at secure, offsite data centres to protect against disruptions and/or damage to primary storage.

NOTE 2 This indicator reflects the "Governance, empowerment and engagement", "Safety and security" and "Community infrastructure" issues as defined in ISO 37101. It can allow an evaluation of the contribution to the "Resilience" purpose of the city as defined in ISO 37101.

10.3.2 Indicator requirements

The percentage of city electronic data with secure and remote back-up storage shall be calculated as the volume of city electronic data with secure and remote back-up storage (numerator) divided by the total volume of electronic city data (denominator). The result shall be multiplied by 100 and expressed as the percentage of city data with secure and remote back up storage.

Back-up remote storage shall refer to the storage of data (held on servers, workstations and laptops) at a secure secondary (e.g. offsite) location.

Plans and mechanisms for the safe, long-term storage of city data should reflect the city's vulnerabilities to hazards and should be updated and tested regularly.

10.3.3 Data sources

Data for this indicator should be sourced from the city's IT department.

10.4 Percentage of public meetings dedicated to resilience in the city

10.4.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 Public meetings in cities help to promote and enable inclusive and collaborative approaches to resilience planning, enhancing citizen engagement and citizen-driven strategies in creating a more resilient city.

NOTE 2 This indicator reflects the "Governance, empowerment and engagement" and "Education and capacity building" issues as defined in ISO 37101. It can allow an evaluation of the contribution to the "Resilience" purpose of the city as defined in ISO 37101.

10.4.2 Indicator requirements

The percentage of public meetings dedicated to resilience in the city shall be calculated as the number of public meetings dedicated to resilience in the city (numerator) divided by the total number of public meetings in the city (denominator). The result shall be multiplied by 100 and expressed as the percentage of public meetings dedicated to resilience in the city.

Public meetings shall refer to meetings held by the city and open to all residents and stakeholders. Public meetings are meetings held to increase awareness of an issue or proposal, which may include, but are not limited to, meetings held by the urban planning department of the city regarding a development proposal for a new apartment building or public transport route. Public meetings dedicated to resilience in the city could cover a wide range of topics such as, but not limited to, the development of infrastructure to mitigate the impacts of potential shocks and stress, the development of environmental policies to mitigate the impacts of climate change and the funding of social programmes that increase social cohesion in the city. Therefore, cities should report the purpose of each public meeting in the numerator of the indicator calculation.

Cities should also report on who is facilitating the meeting and the minimum outreach and participation requirements for public meetings. In addition, cities should report the number of attendees at each meeting and the mode of attendance (e.g. online or in person), if possible.

10.4.3 Data sources

Data on public meetings should be sourced from a city’s public meeting registry.

10.5 Number of intergovernmental agreements dedicated to planning for shocks as percentage of total intergovernmental agreements

10.5.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 Intergovernmental agreements are a common and useful instrument serving a variety of purposes. With regards to resilience, intergovernmental agreements help to foster relationships across and between levels of government (e.g. city, state/province and national governments) and promote and entrench long-term collaborative planning for managing shocks.

NOTE 2 This indicator reflects the “Governance, empowerment and engagement” issue as defined in ISO 37101. It can allow an evaluation of the contribution to the “Resilience” purpose of the city as defined in ISO 37101.

10.5.2 Indicator requirements

The number of intergovernmental agreements dedicated to planning for shocks as a percentage of total intergovernmental agreements shall be calculated as the number of intergovernmental agreements involving the city that are dedicated to planning for shocks (numerator) divided by the total number of intergovernmental agreements (denominator). The result shall be multiplied by 100 and expressed as the number of intergovernmental agreements dedicated to planning for shocks as a percentage of total intergovernmental agreements.

An intergovernmental agreement shall refer to an agreement that is entered into by the city with at least one other level of government (e.g. state/provincial and national levels of government).

NOTE There are numerous transnational city networks, some of which have a general remit, while others work on individual aspects such as coping with the impacts of climate change. In the last few years, more and more city networks have been addressing the issue of city resilience, including preparedness for external shocks. In some instances, these existing city networks can be a source of intergovernmental agreements.

10.5.3 Data sources

Data on intergovernmental agreements should be sourced from city departments and ministries responsible for intergovernmental relations. If the city is member of a city network with relevance to the city’s sustainability and resilience this network can be counted as a data source.

10.6 Percentage of essential service providers that have a documented business continuity plan

10.6.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 Business continuity plans can enhance a city's preparedness for stresses and shocks, and enable rapid recovery. It is important to note that many private-sector entities provide essential or important goods and services relied upon by citizens. Cities therefore need to be proactive in encouraging private-sector entities to undertake business continuity plans, based on a shared view of the risks likely to arise.

NOTE 2 This indicator reflects the "Governance, empowerment and engagement" issue as defined in ISO 37101. It can allow an evaluation of the contribution to the "Resilience" purpose of the city as defined in ISO 37101.

10.6.2 Indicator requirements

The percentage of essential service providers that have a documented business continuity plan shall be calculated as the total number of essential service providers that have a documented business continuity plan (numerator) divided by the total number of essential service providers (denominator). The result shall be multiplied by 100 and expressed as the percentage of essential service providers that have a documented business continuity plan.

Essential service providers shall refer to entities outside of government that provide services that are vital to the functioning of the city. This includes private sector providers of infrastructure services, including electricity, gas, water, sanitation and wastewater treatment, and waste management. It should also include major food distributors and providers of retail banking services.

A business continuity plan shall refer to a documented strategy that identifies the threats and risks faced by a company or organization, and that helps to protect its assets and personnel from the negative effects of a stress or shock, thereby ensuring operational continuity. Business continuity planning shall involve identification of potential risks, determining how those risks will affect operations, implementing safeguards and procedures to mitigate those risks, and regularly reviewing risks to ensure their relevance and accuracy. Business continuity plans should be regularly updated.

NOTE ISO 22301 is the internationally recognized benchmark for business continuity. It specifies requirements to plan, establish, implement, operate, monitor, review, maintain and continually improve a documented management system to protect against, reduce the likelihood of occurrence of, prepare for, respond to and recover from disruptive incidents when they arise.

10.6.3 Data sources

Information on business continuity planning should be obtained from essential service providers for the city.

10.6.4 Data interpretation

The presence of a business continuity plan does not in itself ensure that identified continuity measures have been implemented or guarantee that business continuity will be ensured in the case of a stress or shock.

11 Health

11.1 Percentage of hospitals equipped with back-up electricity supply

11.1.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 During shocks and stresses, hospitals play a critical role in providing emergency care. These facilities need to care for existing patients, while they also take on the role of treating disaster-related casualties and injuries. Healthcare facilities rely on electricity to maintain their essential functions and therefore require a reliable back-up electricity supply to maintain these functions in the case of power outages.

NOTE 2 This indicator reflects the "Health and care in the community" and "Community infrastructure" issues as defined in ISO 37101. It can allow an evaluation of the contribution to the "Resilience" purpose of the city as defined in ISO 37101.

11.1.2 Indicator requirements

The percentage of hospitals equipped with back-up electricity supply shall be calculated as the number of hospitals equipped with back-up electricity supply (numerator) divided by the total number of hospitals in the city (denominator). The result shall be multiplied by 100 and expressed as the percentage of healthcare facilities equipped with back-up electricity supply.

Back up electricity supply will include electrical energy sources (including generators and battery storage) protected from likely hazards and with sufficient energy or fuel supplies to provide sufficient power to run the essential functions of the hospital for a 72-h period.

11.1.3 Data sources

Data on the number of hospitals equipped with emergency energy supplies and generators should be sourced from health authorities.

11.2 Percentage of population with basic health insurance

11.2.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 The provision of basic health insurance supports people in maintaining good health and allows access to appropriate medical care when sick, injured or disabled. Health insurance can reduce the financial burden that persons and their family face when requiring essential medical services. Health insurance also plays a role in enabling communities to be less vulnerable to shocks and stresses.

NOTE 2 This indicator reflects the "Health and care in the community" issue as defined in ISO 37101. It can allow an evaluation of the contribution to the "Resilience" and "Social cohesion" purposes of the city as defined in ISO 37101.

11.2.2 Indicator requirements

The percentage of population with basic health insurance shall be calculated as the total number of residents within the city with basic health insurance coverage (numerator) divided by the city's total population (denominator). The result shall be multiplied by 100 and expressed as a percentage of population with basic health insurance.

Basic health insurance shall refer to a form of risk protection from incurred medical expenses, either through free or low-cost access to medical services or through payments of benefits as a result of sickness or injury to recover costs. Health insurance may be publicly or privately provided.

11.2.3 Data sources

Data on residents with unified health histories should be sourced through local, regional or provincial healthcare providers or insurers.

11.3 Percentage of population that is fully immunized

11.3.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 Immunization is one of the most cost-effective public health interventions to date, averting an estimated 2 million to 3 million deaths every year. Immunization programmes have been very successful in protecting people against specific infections, hence why it is important people receive all basic vaccinations.

NOTE 2 This indicator reflects the "Health and care in the community" issue as defined in ISO 37101. It can allow an evaluation of the contribution to the "Resilience" purpose of the city as defined in ISO 37101.

11.3.2 Indicator requirements

The percentage of population that is fully immunized shall be calculated as the number of residents that have been fully immunized in the city (numerator) divided by the total city population (denominator). The result shall be multiplied by 100 and expressed as the percentage of population that is fully immunized.

According to the World Health Organization, a person who is fully immunized shall refer to a person who has received all basic vaccinations before reaching one year of age. More specifically, a person is fully immunized with all basic vaccinations if the person has received Bacillus Calmette-Guerin (BCG) vaccine against tuberculosis at birth; three doses each of polio and pentavalent [diphtheria-tetanus-pertussis-hepatitis B (Hep), Haemophilus influenza type B (Hib)] vaccines at 6 weeks, 10 weeks and 14 weeks old; and a vaccination against measles at 9 months old[17].

11.3.3 Data sources

Data on people who are fully immunizated should be sourced from a relevant local or regional ministry, department or organization that is responsible for providing immunization health services.

11.4 Number of infectious disease outbreaks per year

11.4.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 An infectious disease outbreak is a major potential shock for a city. The ability of a city to prepare for, recover from and adapt to an infectious disease outbreak is indicative of resilience.

NOTE 2 This indicator reflects the "Health and care in the community" issue as defined in ISO 37101. It can allow an evaluation of the contribution to the "Resilience" purpose of the city as defined in ISO 37101.

11.4.2 Indicator requirements

The number of infectious disease outbreaks per year shall be calculated as the count of infectious disease outbreaks in a given year in the city.

An infectious disease shall refer to a disease caused by pathogenic microorganisms such as bacteria, viruses, parasites or fungi; the diseases can be spread, directly or indirectly, from one person to another.

As defined by the World Health Organization, an outbreak shall refer to an occurrence of cases of disease in excess of what would normally be expected in a defined community, geographical area or season. An outbreak may occur in a restricted geographical area or may extend over several countries. It may last for a few days or weeks, or for several years[18].

11.4.3 Data sources

Data on the number of infectious diseases should be sourced from relevant local or regional ministries, departments or organizations responsible for disease surveillance and epidemiology.

11.4.4 Data interpretation

Public health surveillance ensures an ongoing, systematic collection, analysis and interpretation of health-related data essential to the planning, implementation and evaluation of public health practice. Surveillance is undertaken to inform disease prevention and control measures, especially in the case of disease outbreaks. Furthermore, public health surveillance, such as the tracking of disease outbreaks, is an essential communication point in forecasting and responding to disease outbreaks and incidents of regional, national and international significance.

12 Housing

12.1 Capacity of designated emergency shelters per 100 000 population

12.1.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 Emergency shelters are places of rest, reprieve and recuperation for people displaced by shocks and stresses. They are essential to a city's capacity for disaster preparedness and response, and therefore resilience.

NOTE 2 This indicator reflects the "Health and care in the community", "Living and working together" and "Living together, interdependence and mutuality" issues as defined in ISO 37101. It can allow an evaluation of the contribution to the "Resilience" purpose of the city as defined in ISO 37101.

12.1.2 Indicator requirements

Capacity of designated emergency shelters per 100 000 population shall be calculated as the total capacity of all designated emergency shelters in the city (numerator) divided by 1/100 000 of the city's total population (denominator). The result shall be expressed as the capacity of designated emergency shelters per 100 000 population.

Capacity shall refer to the maximum, predetermined number of people who can be accommodated in an emergency shelter.

Emergency shelter shall refer to an existing structure that has been officially designated to be used for temporary housing for people whose previous housing is unsafe or unavailable during or after a disaster, or who are fleeing the effects of a disaster. Emergency shelters should be able to resist a disaster by virtue of their construction and/or location.

12.1.3 Data sources

Information on designated emergency shelters should be sourced from emergency management authorities.

12.2 Percentage of buildings structurally vulnerable to high-risk hazards

12.2.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 The vulnerability of a city's building stock to severe damage or collapse during a disaster is vital to overall resilience. Assessment and review of building vulnerability can help cities to identify structures in need of repair, retrofit or rebuilding so as to meet current codes and standards that are relevant to the current hazard-risk profile. This is especially true in cities prone to earthquakes, hurricanes, cyclones, floods, tsunamis and landslides.

NOTE 2 This indicator reflects the "Living and working environment" issues as defined in ISO 37101. It can allow an evaluation of the contribution to the "Resilience" purpose of the city as defined in ISO 37101.

12.2.2 Indicator requirements

The percentage of buildings structurally vulnerable to high-risk hazards shall be calculated as the total number of buildings in the city that are vulnerable to high-risk hazards (numerator) divided by the total number of buildings in the city (denominator). The result shall be multiplied by 100 and expressed as the percentage of buildings structurally vulnerable to high-risk hazards.

Buildings shall refer to all residential and non-residential structures that are designed for human occupancy (i.e. with roofs and walls) and that stand in permanent or semi-permanent locations. This includes public and private buildings used for residential, commercial, industrial, institutional, recreational or other purposes. Buildings that are structurally vulnerable to high-risk hazards (such as earthquakes, cyclones and floods) are at high risk of suffering collapse or significant damage due to the effects of hazards that can cause death or injury to the building's occupants.

12.2.3 Data sources

Data for this indicator should be obtained from city departments or local authorities responsible for ensuring compliance with building codes, standards and safety regulations.

12.3 Percentage of residential buildings not in conformity with building codes and standards

12.3.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 National and/or local building codes stipulate safety and performance standards for the design and construction of residential buildings. These codes and standards can be legally and actively enforced to ensure that buildings withstand the high-risk hazards that a community faces, and thereby reduce risk of building damage or collapse during a disaster.

NOTE 2 This indicator reflects the "Living and working environment" issues as defined in ISO 37101. It can allow an evaluation of the contribution to the "Resilience" purpose of the city as defined in ISO 37101.

12.3.2 Indicator requirements

The percentage of residential buildings not in conformity with building codes and standards shall be calculated as the total number of residential buildings in the city not in conformity with building codes and standards (numerator) divided by the total number of residential buildings in the city (denominator). The result shall be multiplied by 100 and expressed as the percentage of residential buildings not in conformity with building codes and standards.

This indicator relates to all building codes and standards, including (and especially) those that regulate the structural integrity of residential buildings and their resistance to severe damage or collapse during a disaster (e.g. earthquakes, floods, cyclones, landslides).

Residential buildings shall refer to all structures designed for long-term human occupancy (i.e. with roofs and walls) and that stand in permanent or semi-permanent locations.

Building codes shall refer to the ordinances, regulations and associated standards intended to regulate aspects of design, construction, material use, alteration and occupancy of built structures.

12.3.3 Data sources

Data for this indicator should be obtained from city departments or local authorities responsible for enforcing building codes, standards and safety regulations, and for the licensing of new residential buildings.

12.4 Percentage of damaged infrastructure that was "built back better" after a disaster

12.4.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 Post-disaster learning is an essential process in the reconstruction of stronger and enhanced communities. The process of "building back better" helps cities to mitigate existing risks and prepare for future disasters. Lessons learned from real disaster events can be integrated into a city's risk-management framework.

NOTE 2 This indicator reflects the "Governance, empowerment and engagement", "Community infrastructure", "Innovation, creativity and research" and "Living and working environment" issues as defined in ISO 37101. It can allow an evaluation of the contribution to the "Resilience" purpose of the city as defined in ISO 37101.

12.4.2 Indicator requirements

Percentage of damaged infrastructure that was "built back better" after a disaster shall be calculated as the total infrastructure within the city that was "built back better" after a disaster or extreme event (numerator) divided by the total quantity of infrastructures damaged at the last event within the city (denominator). The result shall be multiplied by 100 and expressed as the percentage of damaged infrastructure that was "built back better" after a disaster.

Quantity of infrastructures shall refer to square metres for point infrastructures or kilometres for linear infrastructures.

Quantities (and associated percentage) have to be reported separately for point and linear infrastructure in Table 2 and cannot be summed.

Table 2

	Area or length build back better	Total area or length of infrastructure damaged at the last event	Percentage %
Point infrastructure (area in m^2)			
Linear infrastructure (length in km)			

This indicator can only be assessed in instances where a disaster or extreme event has impacted the city resulting in damage to buildings and structures.

Infrastructure shall refer to point and linear assets (physical, built) that provide essential functions at single, identifiable sites or positions within the city, or along conduits, corridors, routes or lines within the city, and that stand in permanent or semi-permanent locations.

Point infrastructures shall include major buildings used for education (e.g. schools, universities, colleges) and healthcare (e.g. hospitals, health clinics), as well as stations, facilities, plants, installations or other point-source works used for solid waste disposal and treatment, water and wastewater treatment, and power generation, transmission and distribution.

Linear infrastructure shall include major pipelines used for delivery of water and gas or removal of wastewater; transmission lines for delivery of electricity; and major transportation routes and corridors for movement of people and goods over land and water (e.g. highways, roadways, railways, causeways, bridges).

In the context of this indicator, "built back better" shall refer to the recovery, rehabilitation and reconstruction of cities' physical infrastructure after disaster events to increase its resilience. Examples of "built back better" are:

— introducing disaster risk-reduction measures (including building codes and regulations) to increase the resilience of physical assets being reconstructed, such as earthquake-resistant;

— building designs or raised-floor elevation in flood-prone areas;

— introducing and enforcing appropriate land-use planning regulations, which curtail reconstruction in high-risk areas;

— reconstructing improved hazard-control infrastructure, such as flood embankments;

— replacing damaged assets with context-sensitive, technologically updated alternatives, for example modernizing damaged telecommunications equipment to keep up with technological advances;

— using recovery as an opportunity to right size infrastructure to better meet community needs, for example reconstructing hospitals with an adequate number of beds[19].

12.4.3 Data sources

Data for this indicator should be sourced from the planning and engineering departments of the city along with other public and private entities involved in the planning and construction of city infrastructure.

12.4.4 Data interpretation

Point infrastructures and linear infrastructures data have to be considered and interpreted separately and carefully as the impact of infrastructure damage on city services and infrastructure reconstruction issues may be different depending of the type of infrastructure. Certain types of infrastructure can more easily be "build back better" than others.

12.5 Annual number of residential properties flooded as a percentage of total residential properties in the city

12.5.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 With the increasing frequency of severe weather events, it is essential that homeowners take steps to protect their homes from flooding. Cities also play a critical role in mitigating residential flooding, for example, through planning controls and construction and maintenance of storm water infrastructure. Sources of flooding can include, but are not limited to, rainfall, storm surge, overflowing river banks, surface water run-off, groundwater rise and sewage back-up.

NOTE 2 This indicator reflects the "Safety and security" and "Living and working environment" issues as defined in ISO 37101. It can allow an evaluation of the contribution to the "Attractiveness", "Resilience" and "Well-Being" purposes of the city as defined in ISO 37101.

12.5.2 Indicator requirements

The annual number of residential properties flooded as a percentage of total residential properties in the city shall be calculated as the annual number of residential properties that have flooded in the city (numerator) divided by the total number of residential properties in the city (denominator). The result shall be multiplied by 100 and expressed as the annual number of residential properties flooded as a percentage of total residential properties in the city.

Residential properties shall refer to dwellings (or structures) classified for residential use. Examples of residential properties should include, but are not limited to, single-family dwellings, mobile dwellings, semi-detached dwellings, row houses, condominiums and apartment buildings.

12.5.3 Data sources

Data on the number of residential properties flooded should be sourced from local or regional ministries/departments responsible for public safety, water and/or environment services.

12.6 Percentage of residential properties located in high-risk zones

12.6.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 Properties located in high-risk zones are especially vulnerable to damage or destruction during disaster events. Controlling the type and location of property development is a key strategy for cities to avoid and reduce risks from natural hazards.

NOTE 2 This indicator reflects the "Safety and security" issue as defined in ISO 37101. It can allow an evaluation of the contribution to the "Resilience" and "Attractiveness" purposes of the city as defined in ISO 37101.

12.6.2 Indicator requirements

The percentage of residential properties located in high-risk zones shall be calculated as the number of residential properties located in high-risk zones within the city (numerator) divided by the total number of residential properties in the city (denominator). The result shall be multiplied by 100 and expressed as the percentage of residential properties located in high-risk zones.

Residential properties shall refer to dwellings (or structures) classified for residential use. Examples of residential properties should include, but are not limited to, single-family dwellings, mobile dwellings, semi-detached dwellings, row houses, condominiums and apartment buildings.

High-risk zones shall refer to those areas of the city that are particularly vulnerable to natural hazards, such as flood plains, hillsides prone to mudslides and low-lying coastal areas. Hazard maps created by the city should be used to identify such areas and indicate the probability of occurrence of a relevant hazard.

12.6.3 Data sources

Mapping/delineation of hazards within the city is often a key responsibility of city governments. Information on hazard maps and the location of risk zones should be obtained from several departments and stakeholders, including GIS departments, emergency planners and research institutions.

13 Population and social conditions

13.1 Vulnerable population as a percentage of city population

13.1.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 Vulnerable members of a community are often the people most at risk from shocks and stresses. For emergency planning purposes, ensuring the safety of vulnerable people often requires a disproportionately large quantity of time and resources of emergency services during shocks. Knowing the magnitude of a city's vulnerable population can help a city prepare for shocks and stresses.

NOTE 2 This indicator reflects the "Living together, interdependence and mutuality" issue as defined in ISO 37101. It can allow an evaluation of the contribution to the "Resilience" and "Social cohesion" purposes of the city as defined in ISO 37101.

13.1.2 Indicator requirements

The vulnerable population as a percentage of total city population shall be calculated as the total number of vulnerable people within the city (numerator) divided by the city's total population (denominator). The result shall be multiplied by 100 and expressed as the vulnerable population as a percentage of total city population.

Vulnerable people shall refer to individuals who have limited capacity to anticipate, cope with, resist and recover from the effects of a disaster, and can include the following segments of the population:

— persons with physical or mental impairments;

— pregnant women;

— ill or undernourished people;

— the homeless;

— people located in slums and informal housing;

— refugees and internally displaced people;

— transient or nomadic communities.

Other population segments in the city (i.e. children and the elderly) that may be vulnerable to hazards due to location or context-specific factors may also be considered in the interpretation of city population vulnerability. They are not reported here as they have already been considered in ISO 37120.

NOTE 1 Children and ederly people are always counted in ISO 37120:2018, 13.4.3.

NOTE 2 Due to privacy issues, this reporting will be based on voluntary information. For example, a city can propose a voluntary reporting for persons who consider themselves as vulnerable.

13.1.3 Data sources

Population and demographic data should be obtained from census and household survey data. However, measuring some categories of vulnerable persons may require additional or alternative data collection methods such as additional specific surveys (e.g. for homeless people).

13.1.4 Data interpretation

A person can have physical impairments and be pregnant or can be ill and homeless and thus be vulnerable for several reasons that may be counted separately.

It can be difficult to detect this overlap, so the vulnerable population can be statistically over-represented in comparison to the population as a whole.

13.2 Percentage of population enrolled in social assistance programmes

13.2.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 Providing social and financial assistance to disadvantaged and low-income persons helps ensure access to essential needs and maintenance of basic living standards. Social assistance can also help to reduce the vulnerability of recipient populations to shocks and stresses.

NOTE 2 This indicator reflects the “Health and care in the community” and “Living together, interdependence and mutuality” issues as defined in ISO 37101. It can allow an evaluation of the contribution to the “Resilience” and “Social cohesion” purposes of the city as defined in ISO 37101.

13.2.2 Indicator requirements

The percentage of population enrolled in social assistance programmes shall be calculated as the number of people within the city enrolled in social assistance programmes (numerator) divided by the total population of the city (denominator). The result shall be multiplied by 100 and expressed as the percentage of population enrolled in social assistance programmes.

Social assistance shall refer to government-funded financial aid that provides support to families and individuals who cannot meet their basic living costs due to illness, disability, low income or unemployment. For some recipients, the need for assistance is temporary, while for others it is long term.

NOTE Social assistance is also known as welfare, income assistance or social security.

13.2.3 Data sources

Data on access to social assistance programmes should be sourced from the government agencies (at all tiers of government) responsible for providing these programmes.

13.3 Percentage of population at high risk from natural hazards

13.3.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 Knowing the proportion of a city’s population that is exposed to hazards can help to educate the community, incentivise actions to mitigate risk, identify instances of underinsurance and enhance city risk analysis and management processes.

NOTE 2 This indicator reflects the “Health and care in the community”, “Living together, interdependence and mutuality” and “Living and working environment” issues as defined in ISO 37101. It can allow an evaluation of the contribution to the “Resilience”, “Well-being” and “Attractiveness” purposes of the city as defined in ISO 37101.

13.3.2 Indicator requirements

The percentage of population at high risk from natural hazards shall be calculated as the number of people in the city at high-risk of exposure to natural hazards (numerator) divided by the total city population (denominator). The result shall be multiplied by 100 and expressed as the percentage of population at high risk from natural hazards.

Delineating high-risk exposure requires detailed local risk assessment and up-to-date hazard and vulnerability maps. Assessments and maps should be publicly available and inclusive of entire urban areas. Up-to-date information is particularly important for hazards such as floods, because changes in urban development can affect the area of a community at risk.

Where possible, the percentage data for each relevant hazard type should be included and listed in a table.

13.3.3 Data sources

Mapping/delineation of hazards, vulnerabilities, risks and exposures in the city is often a key responsibility of city governments. Information on these maps should be obtained from several departments and stakeholders, including GIS departments, emergency planners and research institutions.

13.4 Percentage of neighbourhoods with regular and open neighbourhood association meetings

13.4.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 Neighbourhood groups increase sense of place and mobilization levels at the very local scale, while building social capital and local interpersonal ties.

NOTE 2 This indicator reflects the "Health and care in the community", "Living together, interdependence and mutuality" and "Safety and security" issues as defined in ISO 37101. It can allow an evaluation of the contribution to the "Resilience", "Well-being" and "Attractiveness" purposes of the city as defined in ISO 37101.

13.4.2 Indicator requirements

The percentage of neighbourhoods with regular and open neighbourhood association meetings shall be calculated as the number of neighbourhoods in the city with regular and open neighbourhood association meetings (numerator) divided by the total number of neighbourhoods in the city (denominator). The result shall be multiplied by 100 and expressed as the percentage of neighbourhoods with regular, open neighbourhood association meetings.

A neighbourhood shall refer to an administratively defined geographic area within the city.

Regular and open neighbourhood association meetings shall refer to neighbourhood association meetings that occur at least annually and there are no exclusions in regard to who is able to attend the meetings. A neighbourhood association shall refer to an association representing the residents of a specific neighbourhood.

13.4.3 Data sources

Data on the number of neighbourhoods with association meetings should be sourced from the relevant local or regional registration authority that collects information and data on the registration of official neighbourhood associations.

13.5 Annual percentage of the city population directly affected by natural hazards

13.5.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 The number of people directly affected (i.e. evacuated, relocated, injured or sickened) by natural hazards is a measure of a city's vulnerability. In some cases, it is a more relevant measure of disaster impact than the number of deaths.

NOTE 2 This indicator reflects the "Safety and security" issue as defined in ISO 37101. It can allow an evaluation of the contribution to the "Well-being" and "Resilience" purposes of the city as defined in ISO 37101.

13.5.2 Indicator requirements

The annual percentage of the city population directly affected by natural hazards shall be calculated as the annual number of people evacuated, relocated, injured or sickened due to natural hazards (numerator) divided by the total city population (denominator). The result shall be multiplied by 100 and expressed as the annual percentage of the city population directly affected by natural hazards.

Where possible, the data for each relevant hazard type should be included and listed as a table.

NOTE An indicator that measures annual disaster-related deaths is included in ISO 37120.

13.5.3 Data sources

The data for this indicator should be sourced from emergency management authorities and other agencies engaged in emergency response.

14 Recreation

For recreation indicators, please refer to ISO 37120.

15 Safety

15.1 Percentage of city population covered by multi-hazard early warning system

15.1.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 This indicator refers to the specific warning of an imminent threat. Early warnings of that threat are essential to reduce human and economic losses from disasters. Warning systems prevent loss of life and mitigate the economic and material impacts of disasters. It is the responsibility of city governments to ensure that its citizens are effectively covered by some form of early warning system, enabling better preparedness for (and response to) shocks.

NOTE 2 This indicator reflects the "Safety and security" issue as defined in ISO 37101. It can allow an evaluation of the contribution to the "Resilience" purpose of the city as defined in ISO 37101.

15.1.2 Indicator requirements

The percentage of city population covered by multi-hazard early warning systems shall be calculated as the total number of people within the city covered by multi-hazard early warning systems (numerator) divided by the city's total population (denominator). The result shall be multiplied by 100 and expressed as a percentage of population covered by multi-hazard early warning systems.

Early warning systems shall refer to an integrated and coordinated arrangement of hazard monitoring, forecasting and prediction, disaster risk assessment, and communication and preparedness activities that enable cities and residents to take action to reduce risks in advance of hazardous events.

Multi-hazard early warning systems cover a range of hazards and impacts, and are ideally designed to be used in multi-hazard contexts where hazardous events may occur as a singular event, simultaneously, in succession or cumulatively over time, leading to a number of interrelated and cascading effects within a city. Warnings should be delivered over the maximum possible notice period via multiple media, including, but not limited to, phone, TV, radio, web and sirens.

Warnings should be reliable and specific to hazard type and should allow ample time for preparation and response (as far as technology permits).

NOTE The technology of disaster warnings is rapidly evolving, both in the long-term assessment of risk (e.g. seasonal weather forecast) and the notification period and update frequency for a specific event (e.g. landslide risk, tornado warnings, movement of flood crest). However, meaningful earthquake warning systems do not currently exist for practical purposes.

15.1.3 Data sources

The data for this indicator should be sourced from emergency management authorities.

15.2 Percentage of emergency responders who have received disaster response training

15.2.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 Emergency responders are among the first people to arrive at the scene of an emergency related to a disaster event. Response training is therefore a critical element of disaster preparedness.

NOTE 2 This indicator reflects the “Safety and security” and “Education and capacity building” issue as defined in ISO 37101. It can allow an evaluation of the contribution to the “Resilience” purpose of the city as defined in ISO 37101.

15.2.2 Indicator requirements

Percentage of emergency responders who have received disaster response training shall be calculated as the total number of emergency responders who have received disaster response training in the city (numerator) divided by the total number of emergency responders in the city (denominator). The result shall be multiplied by 100 and expressed as a percentage of emergency responders who have received disaster response training.

Emergency responders shall refer to police officers, firefighters, paramedics and rescuers. They are among the first people to arrive at the scene of an emergency related to a disaster, and are trained to deal with an array of medical, security and safety issues that can arise immediately before, during or after a disaster.

Disaster training should cover worst-case scenarios.

15.2.3 Data sources

The data for this indicator should be sourced from emergency management authorities.

15.3 Percentage of local hazard warnings issued by national agencies annually that are received in a timely fashion by the city

15.3.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 Early warning mechanisms or arrangements between hazard monitoring agencies (e.g. weather offices) and local emergency responders are an essential component of disaster preparation. Warnings and forecasts from national offices can be disseminated in an accurate and timely fashion to emergency planning authorities, via well-understood information systems and management plans that correspond to the estimated return period (i.e. likelihood and severity) of a disaster event.

NOTE 2 This indicator reflects the “Safety and security” issue as defined in ISO 37101. It can allow an evaluation of the contribution to the “Resilience” purpose of the city as defined in ISO 37101.

15.3.2 Indicator requirements

The percentage of local hazard warnings issued by national agencies annually that are received in a timely fashion by the city shall be calculated as the number of local hazard warnings issued annually by national agencies that are received in a timely fashion by the city (numerator) divided by the annual total number of local hazard warnings issued by national agencies to the city (denominator). The result shall be multiplied by 100 and expressed as the percentage of local hazard warnings issued by national agencies that are received in a timely fashion by the city.

Hazard warning or forecast shall refer to a specific call, notice, projection, alert or alarm of a potential disaster event. Warnings should be delivered over the maximum possible notice period via multiple media, including phone, TV, radio and the Web.

Timely fashion shall refer to hazard warnings or forecasts received by city emergency responders with sufficient time to activate information systems and implement emergency plans (e.g. evacuation routes) to warn citizens. This allows time for responders to ask questions and obtain further information about the warning or forecast from representatives of the issuing authority.

Emergency responders shall refer to police officers, firefighters, paramedics and rescuers. They are among the first people to arrive at the scene of an emergency related to a disaster, and are trained to deal with an array of medical, security and safety issues that can arise immediately before, during or after a disaster.

NOTE The technology of disaster warnings is rapidly evolving, both in the long-term assessment of risk (e.g. seasonal weather forecast) and the notification period and update frequency for a specific event (e.g. landslide risk, tornado warnings, movement of flood crest). However, meaningful earthquake warning systems do not currently exist for practical purposes.

15.3.3 Data sources

The data for this indicator should be sourced from emergency management authorities.

15.4 Number of hospital beds in the city destroyed or damaged by natural hazards per 100 000 population

15.4.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 Damage or destruction to critical infrastructure assets such as hospitals have major negative consequences for cities and can seriously hamper disaster recovery efforts.

NOTE 2 This indicator reflects the”Health and care in the community” issue as defined in ISO 37101. It can allow an evaluation of the contribution to the “Resilience” purpose of the city as defined in ISO 37101.

15.4.2 Indicator requirements

The number of hospital beds in the city destroyed or damaged by natural hazards per 100 000 population shall be calculated as the total number of hospital beds destroyed or damaged by natural hazards within the city (numerator) divided by 1/100 000 of the city’s population (denominator). The result shall be expressed as the number of hospital beds in the city destroyed or damaged by natural hazards per 100 000 population.

This indicator is only applicable in the instance when a disaster or extreme event has occurred in the last 12 months.

15.4.3 Data sources

The data for this indicator should be sourced from emergency management authorities as well as health and educational authorities.

16 Solid waste

16.1 Number of active and temporary waste management sites available for debris and rubble per square kilometre

16.1.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 Debris removal and processing can be critical to helping a city recover from a disaster. It is essential to dispose of debris that is blocking rescue and emergency response activities. Safe and well-managed waste management sites are key to debris removal if they are established in suitable locations, follow national safety rules and meet capacity requirements.

NOTE 2 This indicator reflects the "Community infrastructure" issue as defined in ISO 37101. It can allow an evaluation of the contribution to the "Resilience" and "Preservation and improvement of environment" purpose of the city as defined in ISO 37101.

16.1.2 Indicator requirements

The number of active and temporary waste management sites available for debris and rubble per square kilometre shall be calculated as the number of active and temporary waste management sites accessible to the city where debris and rubble can be disposed of (numerator) divided by the total land area of the city in square kilometres (denominator). The result shall then be expressed as the number of active and temporary waste management sites available for debris and rubble per square kilometre.

A waste management site shall refer to a site used for the accumulation of waste with the purpose of disposing or treatment of such waste. A waste management site may include vacuum pyrolysis plants, incinerators, compost plants, transfer stations, storage facilities, recycling plants and disposal sites. These facilities are seen as waste management sites because they allow for "continuous" storage of waste on their premises before the treatment, disposal, removal or handling thereof. An active waste management site shall include any site that is currently in use, is fully functioning and is accessible to the city. A temporary waste management site is a site that can be built temporarily to manage for a limited period of time debris and rubble in a safe manner for health and the environment.

Debris and rubble should include building and construction materials (e.g. wall coverings, plaster, drywall, plumbing fixtures, roofing shingles and other roof coverings) and other loose solid waste such as desks, chairs, sheet metals, PVC pipes and paper.

16.1.3 Data sources

Data on active and temporary waste management sites for debris and rubble should be sourced from local or regional solid waste management departments, ministries or organizations.

17 Sport and culture

For sport and culture indicators, please refer to ISO 37120.

18 Telecommunication

18.1 Percentage of emergency responders in the city equipped with specialized communication technologies able to operate reliably during a disaster event

18.1.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 Mobile telecommunications networks (e.g. terrestrial cell antennae) can be damaged or overly congested during a disaster event. Having a privileged-access subscriber identity module (SIM) installed in handsets can help emergency responders to avoid such problems and safely connect to their networks during and after a disaster event. Satellite telephones, which connect to orbiting satellites rather than terrestrial cell towers, can avoid such problems when terrestrial cellular services are unavailable. Professional mode radio (PMR) is designed for specific use by organizations such as police forces and fire brigades to allow point-to-multipoint communication across large areas.

NOTE 2 This indicator reflects the "Safety and security" and "Community infrastructure" issues as defined in ISO 37101. It can allow an evaluation of the contribution to the "Resilience" purpose of the city as defined in ISO 37101.

18.1.2 Indicator requirements

The percentage of emergency responders in the city equipped with specialized communication technologies able to operate reliably during a disaster event shall be calculated as the number of emergency responders within the city having access to PMR, satellite telephony or privileged-access mobile communications networks (numerator) divided by the total number of emergency responders in the city (denominator). The result shall be multiplied by 100 and expressed as a percentage of emergency responders in the city equipped with specialized communication technologies able to operate reliably during a disaster event.

Emergency responders shall refer to police officers, firefighters, paramedics and rescuers. They are among the first people to arrive at the scene of an emergency related to a disaster and are trained to deal with an array of medical, security and safety issues that can arise immediately before, during or after a disaster.

PMR shall refer to field radio communication systems that are designed for specific use by organizations such as police forces and fire brigades. These radio systems allow point-to-multipoint communication across large areas.

NOTE PMR is also known as private mobile radio and land mobile radio.

Satellite telephony shall refer to the technology associated with mobile phones that are connected to orbiting satellites rather than terrestrial cell sites.

Privileged-access mobile communication shall refer to the exchange of information across mobile telephone networks that have prioritized access for persons such as members of emergency services and emergency response teams.

18.1.3 Data sources

The data for this indicator should be sourced from emergency management authorities.

19 Transportation

19.1 Number of evacuation routes available per 100 000 population

19.1.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 Accessible, well-documented and publicised evacuation routes and exit strategies are necessary to ensure mass movement of people safely and quickly away from a disaster. Evacuation routes are therefore an important response measure to help cities deal with the immediate effects of a disaster.

NOTE 2 This indicator reflects the "Mobility" issue as defined in ISO 37101. It can allow an evaluation of the contribution to the "Resilience" purpose of the city as defined in ISO 37101.

19.1.2 Indicator requirements

The number of evacuation routes available per 100 000 population shall be calculated as the total number of evacuation routes (numerator) divided by 1/100 000 of the city's total population (denominator). The result shall be expressed as the number of evacuation routes available per 100 000 population.

Evacuation routes shall refer to highways, roadways, waterways and railways and that are officially designated for urgent removal and temporary relocation of people and their assets away from imminent or ongoing danger associated with a disaster. A single evacuation route may not be suitable for all emergencies.

19.1.3 Data sources

The data for this indicator should be sourced from emergency management authorities.

20 Urban/local agriculture and food security

20.1 Percentage of city population that can be served by city food reserves for 72 hours in an emergency

20.1.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 Mechanisms can be put in place to ensure continuity of essential food supplies during an emergency or due to shocks, when city supply chains are disrupted or stopped. The first three days after a disaster or shock event – and before external help might be available – are critical to the recovery effort. This indicator focuses on availability and supply for building resilience under emergency situations.

NOTE 2 This indicator reflects the "Health and care in the community" and "Governance, empowerment and engagement" issues as defined in ISO 37101. It can allow an evaluation of the contribution to the "Resilience" purpose of the city as defined in ISO 37101

20.1.2 Indicator requirements

The percentage of city population that can be served by city food reserves for 72 hours in an emergency shall be calculated as the number of people within the city that can be served by city food reserves for 72 hours (numerator) divided by the total city population (denominator). The result shall be multiplied by 100 and expressed as the percentage of population that could be served by intra-city food reserves for 72 hours.

City food reserves shall refer to essential food supplies from city emergency stores, arrangements with local supermarkets and other contingency plans that secure food stocks for households.

NOTE Cities can refer to the "Sphere Project" and its *Humanitarian Charter and Minimum Standards in Disaster Response.* The project was launched in 1997 by a group of humanitarian NGOs, who established minimum standards to be attained in disaster assistance in each of five key sectors: water supply and sanitation, nutrition, food aid, shelter and health services[20].

20.1.3 Data sources

The data for this indicator should be sourced from the emergency management department in the city.

20.2 Percentage of the city's population living within one kilometre of a grocery store

20.2.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 Proximity to good quality and affordable food is a challenge for many city residents. Nearby grocery stores can provide access to good quality and affordable food, which improves the health, productivity and general prosperity of city residents, as well as the overall resilience of a city.

NOTE 2 In addition, residents living in close proximity to grocery stores tend to have greater food security relative to those residents living further away from grocery stores, as these residents living in close proximity to grocery stores can travel to obtain food more efficiently. In addition, establishing grocery stores in closer proximity to residents decentralizes food supply, providing more grocery shopping options for residents across a city and ultimately ensuring the ease of access to food options for residents in a city.

NOTE 3 This indicator reflects the "Health and care in the community" and "Mobility" issues as defined in ISO 37101. It can allow an evaluation of the contribution to the "Resilience" purpose of the city as defined in ISO 37101.

20.2.2 Indicator requirements

The percentage of the city's population living within one kilometre of a grocery store shall be calculated as the number of people in the city that live within one kilometre of a grocery store (numerator) divided by the city's total population (denominator). The result shall be multiplied by 100 and expressed as the percentage of the city's population living more than one kilometre from a grocery store.

A grocery store shall refer to a retail shop that primarily sells food.

20.2.3 Data sources

Data on the number of people living within one kilometre of a grocery store should be sourced from surveys and by the use of GIS mapping tools.

21 Urban planning

21.1 Percentage of city area covered by publicly available hazard maps

21.1.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 A hazard map is a key tool for a city to plan for resilience. Up-to-date hazard maps are particularly important for hazards like flooding, where changing development patterns can significantly affect the area of the community potentially at risk. Urban plans are informed with, and influenced by, up-to-date risk information. Publicly available information is important for community awareness and can also be important for insurers seeking to improve the accuracy of risk pricing.

NOTE 2 This indicator reflects the “Governance, empowerment and engagement” issue as defined in ISO 37101. It can allow an evaluation of the contribution to the “Resilience” purpose of the city as defined in ISO 37101.

21.1.2 Indicator requirements

The percentage of city area covered by publicly available hazard maps shall be calculated as the area of the city covered by publicly available hazard maps in square kilometres (numerator) divided by the total city area in square kilometres (denominator). The result shall be multiplied by 100 and expressed as the percentage of total city area covered by publicly available hazard maps.

These maps should be publicly available and cover the whole city.

21.1.3 Data sources

Information on hazard maps should be sourced from several departments and stakeholders, including GIS departments, emergency planners and research institutions.

21.2 Pervious land areas and public space and pavement built with porous, draining materials as a percentage of city land area

21.2.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 Pervious (or permeable) land areas perform important environmental functions in urban settings, such as improving the urban climate and easing storm runoff from rainfall or snowmelt. Pervious areas are therefore considered natural assets that can reduce physical vulnerability to hazards such as floods, heatwaves and tropical storms, while strengthening ecological resilience within the city. Cities can directly influence the quantity and distribution of pervious surfaces through planning policies and other mechanisms. In addition, smart cities can use porous, draining materials to build public spaces and pavements to reduce the severity and consequences of floods, to allow water from urban surfaces to infiltrate through the surface or to be stored below ground.

NOTE 2 This indicator reflects “Smart community infrastructures”, “Safety and security”, “Well-being”, “Biodiversity and ecosystem services” issues as defined in ISO 37101. It can allow an evaluation of the contribution to the “Resilience” and “Preservation and improvement of environment” purposes of the city as defined in ISO 37101.

21.2.2 Indicator requirements

The percentage of pervious land areas and public space and pavement built with porous and draining materials as a percentage of city land area shall be calculated as the total surface area of pervious land areas, public space and pavement built with porous and draining materials (numerator) divided by the total city land area (denominator). The result shall be multiplied by 100 and expressed as the percentage of pervious land areas and public space and pavement built with porous and draining materials as a percentage of city land area.

Pervious land area shall refer to all permeable surfaces in the city that enable water absorption and drainage. Permeable surfaces include areas of vegetation (e.g. grasses and forest), bare soil (e.g. gardens, agricultural plots), sand (e.g. beaches, desert) and water (e.g. lakes, rivers). Pervious areas also include green roofs on buildings. Areas that are without permeable cover are assumed to be sealed (i.e. paved or impervious).

Pervious land area and surface of public space or pavement built with porous and draining materials shall be reported separately in Table 3.

Table 3

	Percentage of area/city land area	**Percentage of area/public space and pavement area (porous, draining and impervious)**
Pervious land area (km^2)		NA
Public space and pavement built with porous and draining material (km^2)		
Total pervious land and public space and pavement build with porous and draining material (%)		NA
Key		
NA not applicable		

21.2.3 Data sources

Information on pervious areas should be obtained from city recreation and parks departments, planning departments, forestry departments and census data. Pervious areas can be delineated using aerial photography and/or land use/land cover maps.

Information on public spaces or pavement built with porous and draining materials should be obtained from city managers.

21.2.4 Data interpretation

Depending on the issues and purposes of interest, pervious land area and public space and pavement built with porous and draining materials can be interpreted jointly or independently. In particular, when considering only total pervious land area, this reflects the “Biodiversity and ecosystem services” issue as defined in ISO 37101, thus contributing to the “Preservation and improvement of environment” purpose as defined in ISO 37101. However, considering total pervious land area and public space and pavement built with porous and draining materials together contributes to and reflects the “Resilience” purpose as defined in ISO 37101. Furthermore, when considering only the affect of public space and pavement on flooding, it may be interesting to complete the interpretation by considering the amount of public space and pavement built with porous and draining materials as a percentage of total public space and pavement area (i.e. porous, draining and impervious) (Table 3, second column). This will be necessary to assess city flood mitigation measures.

21.3 Percentage of city land area in high-risk zones where risk-reduction measures have been implemented

21.3.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 Property and people located in high-risk zones are vulnerable to the damaging, destructive and deadly effects of disasters. Risk-reduction measures, such as the provision of additional protective infrastructure, are needed to reduce the risk of hazard exposure for populations inside these zones.

NOTE 2 This indicator reflects the "Governance, empowerment and engagement" issue as defined in ISO 37101. It can allow an evaluation of the contribution to the "Resilience" purpose of the city as defined in ISO 37101.

21.3.2 Indicator requirements

Percentage of city land area in high-risk zones where risk-reduction measures have been implemented shall be calculated as the city land area in high-risk hazard zones where relevant risk-reduction measures have been implemented in square kilometres (numerator) divided by the city land area in high-risk zones in square kilometres (denominator). The result shall be multiplied by 100 and expressed as the percentage of city land area in high-risk zones where risk-reduction measures have been implemented.

Risk-reduction measures shall refer to activities designed to either directly enforce or empower local actors to contain local human vulnerability and hazard, and enhance adaptive capacity and actions in the long and short term.

Risk-reduction measures include, but are not limited to, protective works. Protective infrastructure shall refer to physical structures and natural buffers that minimize the physical, humanitarian and economic impacts of hazards (e.g. levees and flood barriers; flood basins; sea walls; storm shelters; storm drains and storm water holding tanks; wetlands and mangroves; and shock absorption capabilities fitted to infrastructure to deal with earthquakes).

21.3.3 Data sources

Information on risk assessments and hazard maps should be sourced from several departments and stakeholders, including GIS departments, emergency planners, planning departments and research institutions.

21.4 Percentage of city departments and utility services that conduct risk assessment in their planning and investment

21.4.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 Risk assessments are an integral and regular feature of urban planning and investment. They are an effective way to integrate hazard impacts into long-term city plans for urbanizing areas, and are therefore essential to risk mitigation. It is important that results from risk assessments are readily available and accessible to city departments and utility services, in order to inform the planning and implementation of risk-reduction measures and strategies.

NOTE 2 This indicator reflects the "Governance, empowerment and engagement" issue as defined in ISO 37101. It can allow an evaluation of the contribution to the "Resilience" purpose of the city as defined in ISO 37101.

21.4.2 Indicator requirements

The percentage of city departments and utility services that conduct risk assessment in their planning and investment shall be calculated as the number of city departments and utility services that conduct risk assessments in their planning and investment (numerator) divided by the total number of city departments and utility services within the city (denominator). The result shall be multiplied by 100 and expressed as the percentage of city departments and utility services that conduct risk assessment in their planning and investment.

Utility services shall refer to all public and private companies providing basic provisions and facilities related to electricity, natural gas, water, sewage, waste management and telecommunications.

Risk assessment shall refer to the systematic process of evaluating potential risks of hazards and disasters to individuals, groups, organizations, critical assets and protective infrastructure within the city. The purpose of a regular risk assessment is to (i) ensure resilience-building activities are relevant to the city context; (ii) ensure appropriate and proportionate investment of resources according to risks, hazards, shocks and stresses; (iii) enable the different risk exposures and vulnerabilities of the city to be understood; and (iv) enable common consequences to be identified so that capabilities can be developed that will address the impact of many risks in combination (ISO 31000:2018, Annex C). The results of a risk assessment should be conveyed partly through maps, whether these are hazard, vulnerability, exposure, evacuation or risk.

21.4.3 Data sources

The data for this indicator should be sourced from city departments and utilities.

21.5 Annual number of critical infrastructures flooded as a percentage of critical infrastructure in the city

21.5.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE With the increasing frequency of severe weather events, it is essential that critical infrastructure is protected from flooding. Cities also play a critical role in mitigating flooding, for example through planning controls and construction and maintenance of storm water infrastructure. Sources of flooding can include, but are not limited to, rainfall, storm surge, overflowing river banks, surface water run-off, groundwater rise and sewage back-up.

21.5.2 Indicator requirements

The annual number of critical infrastructures flooded as a percentage of total critical infrastructure in the city shall be calculated as the annual number of critical infrastructures that have flooded in the city (numerator) divided by the total number of critical infrastructures in the city (denominator). The result shall be multiplied by 100 and expressed as the annual number of critical infrastructures flooded as a percentage of total critical infrastructure in the city.

Critical infrastructure shall refer to physical structures, facilities, networks and other assets which provide services that are essential to the social and economic functioning of a community or society.

Critical infrastructure can include, but is not limited to, power generation, transmission and distribution, water treatment, distribution and drainage, wastewater and storm water infrastructure, transportation, gas supply and distribution, telecommunications infrastructure, educational facilities, hospitals and other health facilities.

21.5.3 Data sources

Data on the number of critical infrastructures flooded should be sourced from local or regional ministries/departments responsible for critical infrastructure.

21.6 Annual expenditure on water retention measures as a percentage of city prevention measures budget

21.6.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 Floods can have serious consequences for people, economic activity, infrastructure and buildings, cultural heritage and the environment.

NOTE 2 This indicator reflects the "Smart community infrastructures", "Safety and security" and "Well-being" issues as defined in ISO 37101. It can allow an evaluation of the contribution to the "Resilience" purpose of the city as defined in ISO 37101

21.6.2 Indicator requirements

Annual expenditure on water retention measures as a percentage of the city prevention measures budget (numerator) shall be calculated as the total flood prevention measures budget divided by the total prevention measures budget of the city (denominator). The result shall be multiplied by 100 and expressed as a percentage.

Flood prevention measures shall refer to building of buffer tanks/flood control works to confine water, adaptation of existing underground infrastructures (e.g. car parks) as holding tanks for storm water and landscaping of public spaces (e.g. parks) to serve as flood plains in case of flooding.

21.6.3 Data requirements

Data for this indicator should be obtained from city managers.

22 Wastewater

For wastewater indicators, please refer to ISO 37120.

23 Water

23.1 Number of different sources providing at least 5 % of total water supply capacity

23.1.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 A diversity of water sources and distribution systems ensures that alternative water supplies are available during system failure or disruption from the effects of disasters and shocks. The main goal is the provision of safe drinking water that will safeguard the health of inhabitants. Therefore, risk management of water sources and distribution systems protect and safeguard public health, in particular from pathogenic and chemical hazards, water pollution and contamination, and industrial accidents. With diverse water sources, cities are able to mitigate the effects of dangers to health and improve response and recovery efforts during and immediately after a disaster event.

NOTE 2 This indicator reflects the “Health and care in the community” and “Community infrastructures” issues as defined in ISO 37101. It can allow an evaluation of the contribution to the “Resilience” purpose of the city as defined in ISO 37101.

23.1.2 Indicator requirements

The number of different sources providing at least 5 % of total water supply capacity shall refer to the number of different, or separate, water supply sources to the city each providing at least 5 % of water supply capacity.

NOTE The 5 % threshold is used by major international organizations such as the World Bank to ease calculations and to capture the major supply sources.

When the number of different water supply sources exceeds two, the percentage of water supply capacity of the two most significant sources should be reported in tables.

A different (or separate) water supply source shall refer to water supplies that are not disrupted or directly influenced by other sources. Water supply sources shall include dams, reservoirs, rivers, lakes, aquifers and desalination plants.

23.1.3 Data sources

The data for this indicator should be provided by the water system operator and/or appropriate regulatory authorities.

23.1.4 Data interpretation

While multiple, different, water sources contribute to city resilience, this is not necessarily indicative of city resilience in all cases.

23.2 Percentage of city population that can be supplied with drinking water by alternative methods for 72 hours

23.2.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 Providing drinking water is critically important to the response efforts for a disaster event. It is important that city water providers and local governments ensure effective planning for alternative (i.e. back-up) drinking water supply methods during and immediately after a disaster event or system disruption. It is important that contigency plans are established in order to identify how drinking water will be distributed in the case of such a disruption. Back-up supplies are especially important to serve vulnerable populations.

NOTE 2 This indicator reflects the “Health and care in the community” and “Community infrastructures” issues as defined in ISO 37101. It can allow an evaluation of the contribution to the “Resilience” purpose of the city as defined in ISO 37101.

23.2.2 Indicator requirements

The percentage of city population that can be supplied with drinking water by alternative methods for 72 hours shall be calculated as the number of people in the city who can be supplied with drinking water by alternative methods for 72 hours (numerator) divided by the total city population (denominator). The result shall be multiplied by 100 and expressed as the percentage of city population that can be supplied with drinking water by alternative methods for 72 hours.

Alternative methods of water supply shall include emergency water tankers, bottled water and rain water harvesting.

23.2.3 Data sources

The data for this indicator should be sourced from the emergency management department of the city, water system operators and/or appropriate regulatory authorities.

24 Reporting and record maintenance

Reports on city indicators shall compile the data required in the individual test methods used.

Annex A
(informative)

Typology of city hazards

Table A.1 presents a typology of hazards faced by cities. This typology and the associated definitions are informative only. Local typologies and definitions may be established by cities themselves or through local standards or regulations.

This typology is presented to assist cities in identifying the potential hazards that they face, which is relevant to many of the indicators contained in this document. It is also provided as a guide for helping identify peer cities facing similar hazards.

Table A.1 — Hazard categories

Geophysical
Hydrological
Meteorological
Climatological
Biological
Extraterrestrial
Technological
Environmental

[SOURCE: International Council for Science (ICSU). *Peril Classification and Hazard Glossary*.[26]]

Annex B
(informative)

Mapping ISO 37123 indicators to the risk-management process

A major focus of city resilience is the management of the risks facing cities. Table B.1 highlights how the indicators in this document relate to the key stages of the risk-management process as defined by ISO 31000:2018.

Table B.1 — Mapping of ISO 37123 indicators to the risk management process

Risk context	7.1 Number of different electricity sources providing at least 5 % of total energy supply capacity 8.1 Magnitude of urban heat island effects (atmospheric) 8.4 Annual frequency of extreme rainfall events 8.5 Annual frequency of extreme heat events 8.6 Annual frequency of extreme cold events 8.7 Annual frequency of flood events 8.8 Percentage of city land area covered by tree canopy 12.3 Percentage of residential buildings not in conformity with building codes and standards 21.2 Pervious land areas and public space and pavement built with porous, draining materials as a percentage of city land area 23.1 Number of different sources providing at least 5 % of total water supply capacity 20.1 Percentage of city population that can be served by city food reserves for 72 hours in an emergency
Risk assessment: — **Risk identification** — **Risk analysis** — **Risk evaluation**	10.1 Frequency with which disaster-management plans are updated 10.5 Number of intergovernmental agreements dedicated to planning for shocks as percentage of total intergovernmental agreements 12.2 Percentage of buildings structurally vulnerable to high-risk hazards 12.6 Percentage of residential properties located in high-risk zones 13.3 Percentage of population at high risk from natural hazards 21.1 Percentage of city area covered by publicly available hazard maps

Table B.1 *(continued)*

Risk treatment:	
— **Avoidance**	
— **Reduction**	6.1 Percentage of schools that teach emergency preparedness and disaster risk reduction 6.2 Percentage of population trained in emergency preparedness and disaster risk reduction 6.3 Percentage of emergency preparedness publications provided in alternative languages 8.2 Percentage of natural areas within the city that have undergone ecological evaluation for their protective services 8.3 Territory undergoing ecosystem restoration as a percentage of total city area 9.1 Annual expenditure on maintenance and upgrades of city service assets as a percentage of total city budget 9.2 Annual expenditure on upgrades and maintenance of storm water infrastructure as a percentage of total city budget 9.3 Annual expenditure allocated to ecosystem restoration in the city's territory as a percentage of total city budget 10.2 Percentage of essential city services covered by a documented continuity plan 10.3 Percentage of city electronic data with secure and remote backup storage 10.6 Percentage of essential service providers that have a documented business continuity plan 15.1 Percentage of city population covered by multi-hazard early warning system 15.2 Percentage of emergency responders who have received disaster response training 15.3 Percentage of local hazard warnings by national agencies that are received in a timely fashion by city 19.1 Number of evacuation routes available per 100 000 population 20.1 Percentage of city population that can be served by city food reserves for 72 h in an emergency 21.3 Percentage of city land area in high-risk zones where risk-reduction measures have been implemented 21.4 Percentage of city departments and utility services that integrate the results of risk assessment in their planning and investment 23.2 Percentage of population that can be supplied drinking water by alternative methods for 72 hours
— **Transfer**	5.3 Percentage of properties with insurance coverage for high-risk hazards 5.4 Percentage of total insured value to total value at risk within the city
— **Acceptance**	9.5 Annual expenditure on emergency management planning as a percentage of total city budget 9.7 Total allocation of disaster reserve funds as a percentage of total city budget 18.1 Percentage of emergency in the city equipped with specialized communication technologies able to operate reliably during a disaster event

Table B.1 *(continued)*

Communication and consultation	6.3 Percentage of emergency preparedness publications provided in alternative langages 10.4 Percentage of public meetings dedicated to resilience in the city 15.1 Percentage of city population covered by multi-hazard early warning system 15.2 Percentage of emergency responders who have received disaster response training 15.3 Percentage of local hazard warnings by national agencies that are received in a timely fashion by city 18.1 Percentage of emergency in the city equipped with specialized communication technologies able to operate reliably during a disaster event
Monitoring and review	5.1 Historical disaster losses as a percentage of city GDP 5.2 Average annual disaster loss as a percentage of city product 12.4 Percentage of damaged infrastructure that was "built back better" after a disaster 12.5 Annual number of residential properties flooded as a percentage of total residential properties in the city 13.5 Annual percentage of the city population directly affected by natural hazards 15.4 Number of hospital beds in the city destroyed or damaged by natural hazards per 100 000 population

Annex C
(informative)

Mapping ISO 37123 indicators to the disaster-management process

A resilient city seeks to resist, absorb, accommodate, adapt to, transform and recover from the effects of hazards and disasters in a timely and efficient manner, including through the preservation and restoration of essential basic structures and services in a sustainable way, and through risk-management practices. Table C.1 maps how the indicators in this document relate to the key elements of the disaster-management process.

Table C.1 — Mapping of ISO 37123 indicators to the disaster-management process

Mitigation	7.1 Number of different electricity sources providing at least 5 % of total energy supply capacity 8.2 Percentage of natural areas within the city that have undergone ecological evaluation for their protective services 8.3 Territory undergoing ecosystem restoration as a percentage of total city area 9.1 Annual expenditure on upgrades and maintenance of city service assets as a percentage of total city budget 9.2 Annual expenditure on upgrades and maintenance of storm water infrastructure as a percentage of total city budget 9.3 Annual expenditure allocated to ecosystem restoration in the city's territory as a percentage of total city budget 9.4 Annual expenditure on green and blue infrastructure as a percentage of total city budget 9.6 Annual expenditure on social and community services as a percentage of total city budget 21.2 Pervious land areas and public space and pavement built with porous, draining materials as a percentage of city land area 21.3 Percentage of city land area in high-risk zones where risk-reduction measures have been implemented 21.4 Percentage of city departments and utility services that integrate the results of risk assessment in their planning and investment 23.1 Number of different sources providing at least 5 % of total water supply capacity
Preparedness	5.3 Percentage of properties with insurance coverage for high-risk hazards 5.4 Percentage of total insured value to total value at risk within the city 6.1 Percentage of schools that teach emergency preparedness and disaster risk reduction 6.2 Percentage of population trained in emergency preparedness and disaster risk reduction 6.3 Percentage of emergency preparedness publications provided in alternative languages 9.5 Annual expenditure on emergency management planning as a percentage of total city budget 10.1 Frequency with which disaster-management plans are updated

Table C.1 *(continued)*

	10.6 Percentage of essential service providers that have a documented business continuity plan 10.3 Percentage of city electronic data with secure and remote back-up storage 10.4 Percentage of public meetings dedicated to resilience in the city 10.5 Number of intergovernmental agreements dedicated to planning for shocks as percentage of total intergovernmental agreements 11.1 Percentage of hospitals equipped with back-up electricity supply 11.3 Percentage of children that are fully immunized 13.4 Percentage of neighbourhoods with regular, open neighbourhood association meetings 15.1 Percentage of city population covered by multi-hazard early warning system 19.1 Number of evacuation routes available per 100 000 population 20.1 Percentage of city population that can served by city food reserves for 72 hours in an emergency 21.1 Percentage of city area covered by publicly available hazard maps 23.2 Percentage of population that can be supplied drinking water by alternative methods for 72 hours
Response	9.7 Allocation of disaster reserve funds as a percentage of total city budget 15.2 Percentage of emergency responders who have received disaster response training 15.3 Percentage of local hazard warnings by national agencies annually that are received in a timely fashion by city 18.1 Percentage of emergency in the city equipped with specialized communication technologies able to operate reliably during a disaster event
Recovery/ reconstruction	12.4 Percentage of damaged infrastructure that was “built back better” after a disaster

Annex D
(informative)

UN Sustainable Development Goals (SDGs) and the Sendai Framework for Disaster Risk Reduction

Table D.1 — Mapping of ISO 37123 indicators to the UN SDGs[27]

UN Sustainable Development Goal	ISO 37123 indicators
Goal 1: End poverty in all its forms everywhere Specifically noting: 1.3 Implement nationally appropriate social protection systems and measures for all, including floors, and by 2030 achieve substantial coverage of the poor and the vulnerable 1.5 By 2030, build the resilience of the poor and those in vulnerable situations and reduce their exposure and vulnerability to climate-related extreme events and other economic, social and environmental shocks and disasters: 1.5.1 Number of deaths, missing persons and persons affected by disaster per 100 000 people 1.5.2 Direct disaster economic loss in relation to global gross domestic product (GDP) 1.5.3 Number of countries with national and local disaster risk reduction strategies	5.1 Historical disaster losses as a percentage of city product 5.2 Average annual disaster loss as a percentage of city product 5.6 Percentage of the workforce in informal employment 10.1 Frequency with which disaster-management plans are updated 10.6 Percentage of essential service providers that have a documented business continuity plan 11.2 Percentage of population with basic health insurance 11.3 Percentage of children that are fully immunized 11.4 Number of infectious disease outbreaks per year 12.6 Percentage of residential properties located in high-risk zones 13.1 Vulnerable population as a percentage of city population 13.2 Percentage of population enrolled in social assistance programmes 13.3 Percentage of population at high risk from natural hazards 13.5 Annual percentage of the city population directly affected by natural hazards 15.1 Percentage of city population covered by multi-hazard early warning system 15.4 Number of hospital beds in the city destroyed or damaged by natural hazards per 100 000 population 21.1 Percentage of city area covered by publicly available hazard maps
Goal 2: End hunger, achieve food security and improved nutrition and promote sustainable agriculture	20.1 Percentage of city population that can be served by city food reserves for 72 hours in an emergency 20.2 Percentage of the city's population living within one kilometre of a grocery store
Goal 3: Ensure healthy lives and promote well-being for all at all ages Specifically noting: 3.8.2 Number of people covered by health insurance or a public health system per 1,000 population	11.1 Percentage of hospitals equipped with back-up electricity supply 11.2 Percentage of population with basic health insurance 11.3 Percentage of children that are fully immunized 11.4 Number of infectious disease outbreaks per year 15.4 Number of hospital beds in the city destroyed or damaged by natural hazards per 100 000 population

Table D.1 *(continued)*

UN Sustainable Development Goal	ISO 37123 indicators
Goal 4: Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all	6.1 Percentage of schools that teach emergency preparedness and disaster risk reduction 6.2 Percentage of population trained in emergency preparedness and disaster risk reduction 6.4 Educational disruption 15.4 Number of hospital beds in the city destroyed or damaged by natural hazards per 100 000 population
Goal 5: Achieve gender equality and empower all women and girls	
Goal 6: Ensure availability and sustainable management of water and sanitation for all	9.2 Annual expenditure on upgrades and maintenance of storm water infrastructure as a percentage of total city budget 21.2 Pervious land areas and public space and pavement built with porous, draining materials as a percentage of city land area 23.1 Number of different sources providing at least 5 % of total water supply capacity 23.2 Percentage of city population that can be supplied potable water by alternative methods for 72 hours
Goal 7: Ensure access to affordable, reliable, sustainable and modern energy for all	7.1 Number of different electricity sources providing at least 5 % of total energy supply capacity 7.2 Electricity supply capacity as a percentage of peak electricity demand 11.1 Percentage of hospitals equipped with back-up electricity supply
Goal 8: Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all	5.1 Historical disaster losses as a percentage of city product 5.2 Average annual disaster loss as a percentage of city product 5.3 Percentage of properties with insurance coverage for high-risk hazards 5.4 Percentage of total insured value to total value at risk within the city 5.6 Percentage of the workforce in informal employment 9.7 Total allocation of disaster reserve funds as a percentage of total city budget
Goal 9: Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation Specifically noting: 9.1 Develop quality, reliable, sustainable and resilient infrastructure, including regional and transborder infrastructure, to support economic development and human well-being, with a focus on affordable and equitable access for all	7.1 Number of different electricity sources providing at least 5 % of total energy supply capacity 7.2 Electricity supply capacity as a percentage of peak electricity demand 9.1 Annual expenditure on upgrades and maintenance of city service assets as a percentage of total city budget 9.2 Annual expenditure on upgrades and maintenance of storm water infrastructure as a percentage of total city budget 9.3 Annual expenditure allocated to ecosystem restoration in the city's territory as a percentage of total city budget 9.4 Annual expenditure on green and blue infrastructure as a percentage of total city budget 11.1 Percentage of hospitals equipped with back-up electricity supply 12.4 Percentage of damaged infrastructure that was "built back better" after a disaster 18.1 Percentage of emergency responders in the city equipped with specialized communication technologies able to operate reliably during a disaster event 19.1 Number of evacuation routes available per 100 000 population

Table D.1 *(continued)*

UN Sustainable Development Goal	ISO 37123 indicators
Goal 10: Reduce inequality within and among countries	6.3 Percentage of emergency preparedness publications provided in alternative languages 13.2 Percentage of population enrolled in social assistance programmes