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Sustainable cities and communities — Indicators for resilient cities

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National foreword

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

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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.

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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.

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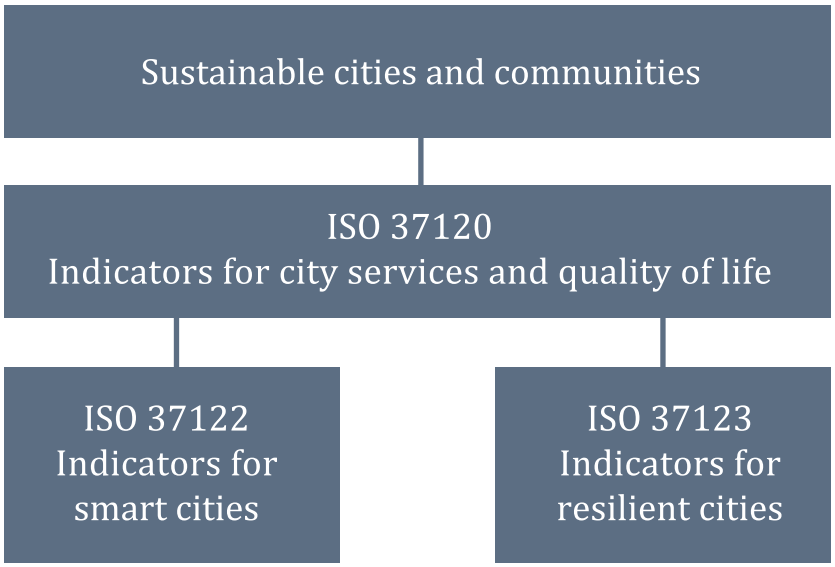

Figure 1 — Sustainable cities and communities — Relationships within the family of city indicators standards

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;

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— “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

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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.

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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.

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[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.

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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.

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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.

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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

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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.

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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.

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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

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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.

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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.

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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.

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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.

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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.

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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.

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