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Sustainable cities and communities — Descriptive framework for cities and communities

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National foreword

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Développement durable des collectivités — Cadre descriptif pour les villes et les collectivités

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Foreword

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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).

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

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Introduction

The descriptive framework for cities and communities detailed in this document helps city and community stakeholders define a common language to describe cities and communities. This framework can facilitate the sharing of ideas, data and solutions within, and also between, cities. The descriptive framework, which can also be referred to as the city anatomy, serves as a basic blueprint to facilitate the integration of operating systems and services within a city or community[4],[5]. Ultimately, the descriptive framework can be the basis of a formal ontology, or knowledge model, which can be useful for helping to plan and implement city operating solutions, particularly those that might require digital machine-readable information.

A city or community is a system of systems and interactions that foster and are fostered by emergent human behaviour[6]. It can be seen as an arrangement of, and set of relationships between, the multiple layers of a permanent human settlement, with an administrative and legal status supported by laws and generally recognized throughout the world. Rather than being static, discreet entities, cities or communities often have porous and sometimes ambiguous borders (politically, economically, environmentally and socially) and can thus often be difficult to describe. The structure, interactions and societal aspects of a city or community are also integral parts of all wider systems extending beyond the city borders. However, more than half the world's population now lives in cities or communities and many of humanity's chronic challenges are faced in cities or communities. A common descriptive framework for cities or communities is a useful tool to assist them in sharing knowledge and finding solutions to issues common to cities or communities all over the world.

Solutions to the issues cities face are intended to improve the quality of life for all city citizens and follow sustainable development principles. These principles dictate that the solutions to city issues implemented today do not compromise the ability of future generations to meet their own needs. The United Nations Sustainable Development Goals (UNSDG) issued in 2015 resolve this relatively abstract ideal into more tangible objectives. The UNSDG Goal 11[7] provides these objectives for cities, creating 10 targets for improving the quality of life for citizens and the city's resiliency, while also limiting the impact of human activity on the environment. Tools such as ISO standards, for example ISO 37101 and ISO 37120, help cities plan for, monitor and reach these objectives. The purpose of this document is to provide a common language for the description of cities that will enable those goals and support the sharing of city solutions.

The descriptive framework is based on work by the City Protocol Society. It uses an analogy to human anatomy and its dynamic physiology to describe any city or community, of any size, in a manner that is timeless, culturally agnostic, scalable and generic. The descriptive framework categorizes the components of the city into three major elemental systems: a set of physical structures (structure), the living entities that create a city's society (society) and the flow of interactions between them (interactions). These elemental systems are further resolved into, or described by, layers that capture all the activities of importance to a city, both within and outside the city boundaries, as well as all the natural and built domain components within a city.

ISO 37100 contains a list of relevant terms and definitions which are also useful in understanding the descriptive framework.

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Sustainable cities and communities — Descriptive framework for cities and communities

1 Scope

This document specifies a descriptive framework for a city including an associated foundational ontology of the anatomical structure of a city or community. The descriptive framework is intended to have the following qualities:

— *timeless*, i.e. compatible with any human settlement at any time in history;

— *acultural*, i.e. valid for any culture and any type of city;

— *scalable*, i.e. valid for a metropolis, a city, a small town or a village;

— *generic*, so that everything we could define as a "human settlement", such as a "smart city", has a place in this structure.

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 37100, *Sustainable cities and communities — Vocabulary*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 37100 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
descriptive framework
logical structure that describes how the key entities within a specific domain can be classified so as to show their relationship with each other

Note 1 to entry: "Entities" refers not only to tangible things, but also to anything important that has a separate and distinct existence, for instance elemental conventions, principles, practices, strategies, policies, decision-making structures and accountabilities.

3.2
ontology
specification of concrete or abstract things, and the relationships among them, in a prescribed domain of knowledge

[SOURCE: ISO/IEC TR 19763-9:2015, 3.1.3, modified — Note removed.]

3.3
urbanism
urban life and environment

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4 Descriptive framework of cities and communities

4.1 General description of a city

Figure 1 shows the three overarching logical elements of a city or community ecosystem as the holistic integration of the physical structure (structure), the people who live in it and occupy this physical space while carrying out functions (society) and the interactions through which the society engages with the structure.

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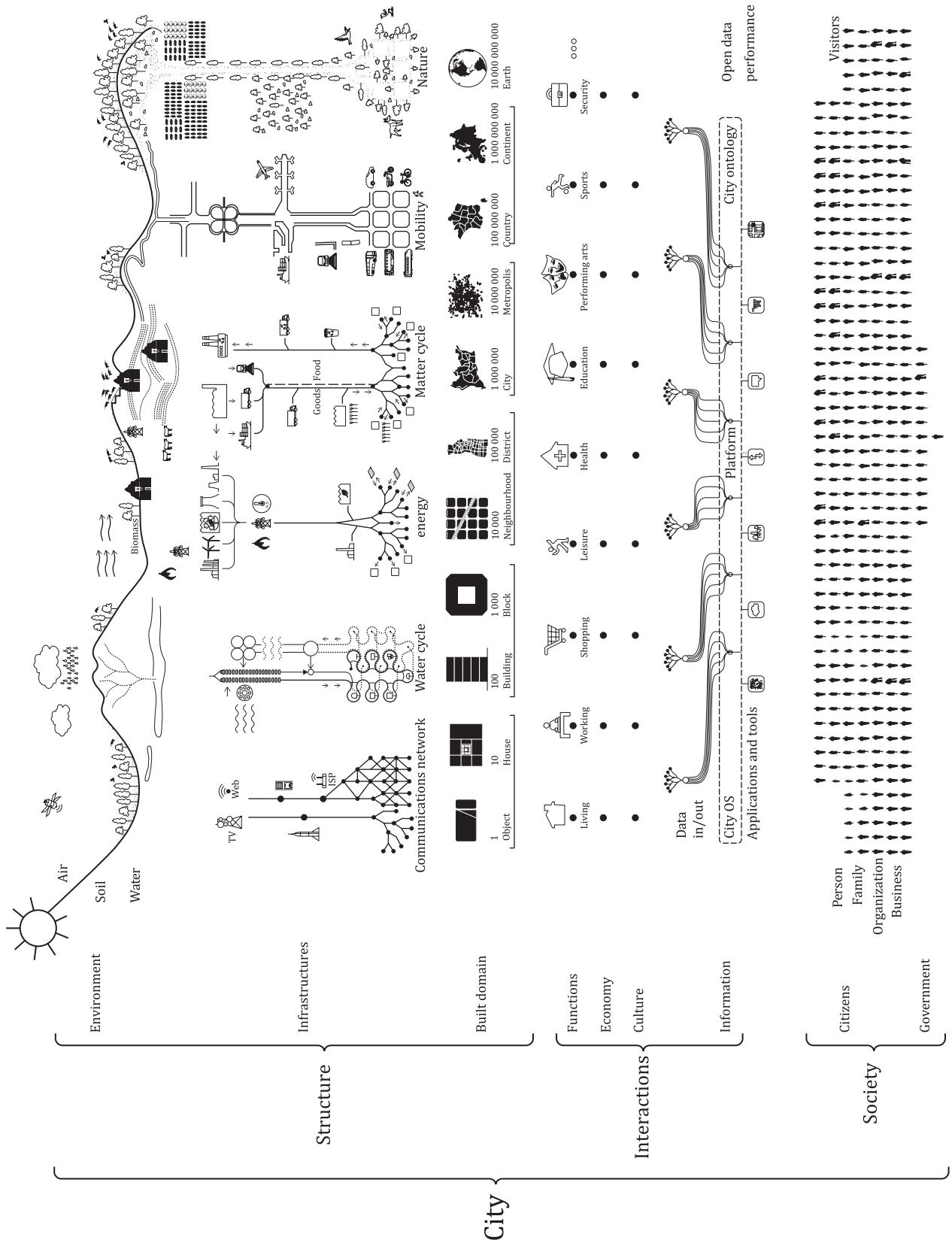

Figure 1 — A timeless, culturally agnostic, scalable, generic descriptive framework for any city or community

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4.2 Cities as ecosystems

A city can best be viewed and understood as an ecosystem, broken down into three elements:

1) the *physical structure* of that ecosystem;

2) the *living entities* that it contains;

3) the *flow of interactions and information*.

The descriptive framework offers a common language to describe the city ecosystem as a set of physical structures, the living entities that make up a city's society and the flow of interactions between them. In so doing, it suggests an analogy to the human anatomy and its dynamic physiology.

4.3 How the descriptive framework supports governance and transformation

Ultimately, the descriptive framework aims to help enable effective governance, evaluation and transformation by providing city officials and other stakeholders with:

— a way to describe their aims and objectives, existing or proposed city initiatives, and services in a manner that is consistent across cities, vendors, service providers and standards developers;

— a comprehensive checklist of key city aspects and domains.

By providing a framework for describing projects and objectives in a way that is consistent with other cities, city solution providers and standards organisations will enable them to more easily:

a) identify opportunities and potential areas for innovation and collaboration within or between cities;

b) improve communications between different city service owners and/or operators within the city;

c) communicate their objectives and priorities clearly to citizens and service providers;

d) frame and support emerging processes and citizen demands; and

e) identify the standards that are most relevant to the needs they are seeking to address.

The checklist can help them:

1) review their city in a comprehensive way to evaluate areas of strength and weakness and set priorities for future action;

2) review potential projects to understand the areas of city life they are likely to impact and the city stakeholders that need to be consulted or involved; and

3) develop comprehensive sets of evaluation criteria to judge the success of projects.

See Annex A for a more detailed description of applying the descriptive framework for cities: governance, evaluation and transformation.

4.4 Basic elements of the descriptive framework for cities and communities

4.4.1 Structure (system)

The first layer within the structure system element is the *environment*, which is the physical and geographic setting of the city, including the natural environment ("nature"). It is formed by nature (plant and animals) and by the three basic components – air, earth and water – interacting dynamically in a seasonally variable way, and increasingly subject to the impacts of climate fluctuations linked to anthropogenic greenhouse gas pollution.[1)] The second layer of the structure system element is

1) Anthropogenic sources are those caused or produced by humans, such as the carbon emitted through power generation or transport.

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infrastructures, the connective structures that enable resource gathering and extraction from the environment, transporting resources to the city, and the material and energy cycles within the city itself. These infrastructures include those that support *communications*, the *water and energy cycles*, the *matter cycle* that supports the movement of goods and food as well as the resultant waste, the *mobility networks*, and *nature* or green infrastructure of the city. The third layer is the *built domain*, which can best be organized according to the approximate number of people that it can accommodate on a physical basis. Thus, within the *built domain*, an *object* corresponds to a *single person*, *house*, *building*, *block*, *neighbourhood, district, city,* and *metropolis* or *region,* each increasing the scale by an order of magnitude. Private and public spaces are contained within each level of scale.

4.4.2 Interactions (system)

The first layer within the interactions system element comprises urban *functions* including *living*, *working*, *education*, *shopping*, caring for *health*, the *performing arts* and many more. The second layer is the *economy*, which influences urban innovation and the everyday operation of the city, as well as the life cycles of services provided by cities. The third layer is *culture* – the languages, traditions, beliefs, values and ways in which people organize their conceptions of the world around them (i.e. the non-material assets of the city). The fourth and final layer is *information*. It includes the *city operating system* (city OS), *city performance indicators and indexes*, *tools and applications, city ontology* and an *information portal* for open data and specific learning protocols and related resources.

4.4.3 Society (system)

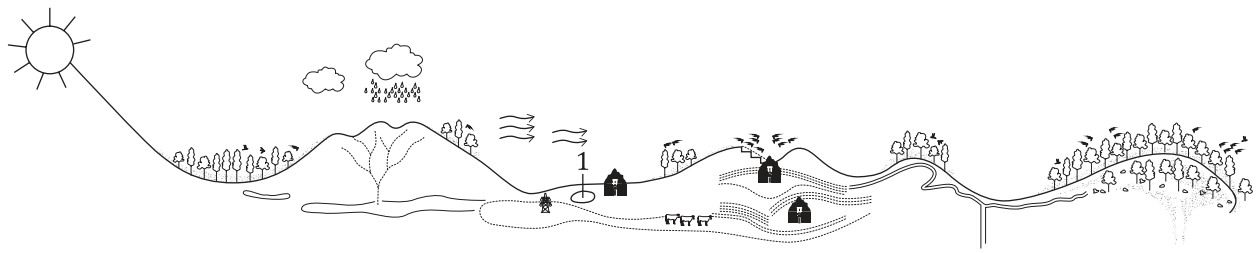
The society system element is composed of the living entities of the city. The first layer is *citizens*, which can be broken down into: *person (the individual), family*, *organizations* and *businesses.* The second layer is *government*, whose head is, typically, the mayor.

NOTE The term *governance* is used when the descriptive framework of a city is used for evaluation purposes. The term governance is the process of running a government and, as such, it focuses on its effectiveness.

4.5 Structure (system)

4.5.1 Environment

The first subsystem layer within the structure system element of the descriptive framework (see Figure 1) is the environment, the setting of the city, as shown in Figure 2.



Key

1 gas

Figure 2 — Environment

The environment existed well before the establishment of the city and includes the topography, morphology, living systems, and natural flows and cycles that form the city's physical setting. The environment is nature (plants and animals) and the three basic components – air, soil and water – which interact dynamically in seasonally variable ways. Each of these components has its own indicators to assess quality and other characteristics.

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Air quality can be assessed by measuring particulate concentration, ozone levels and other chemistry, as well as CO_2 levels, temperature and other measures related to global warming. The ground topography (*soil*) is fundamental for siting a city and serves as an important resource, supporting agriculture, plants and animals. It is also an important source of minerals and energy. *Soil* too has physical and chemical properties, which can be measured. Finally, *water* cycles through the environment – atmosphere to surface water to groundwater to oceans. Both water quality and water quantity can be measured in a number of ways.

These are the components which interact to form the environment layer and are critical in the functioning of a city.

4.5.2 Infrastructures

4.5.2.1 Introduction

The second subsystem layer within the structure system element is the Infrastructures, the connective structures that enable resource extraction and use, as well as enabling city life. The infrastructure layer includes the networks that support communications and mobility, as well as those that support cycles for water, energy and matter. It also includes the natural – or green – infrastructure that plays an important role in many communities.

4.5.2.2 Communications network

The first infrastructure depicted in Figure 1 is the communications network shown in detail in Figure 3. The communications component is composed of all the technologies that carry information, such as information communication technologies (ICT) (wire and cellular telephone technologies, radio, television) and the Internet. Centralized models of communication with one emitter and many receivers (i.e. radio and television) have evolved into a more distributed arrangement of information with many emitters and many receivers of information (i.e. the Internet). Telecommunications networks transporting information through copper and/or fibre optic cables, as well as through the electromagnetic spectrum, are all examples of communication infrastructure.

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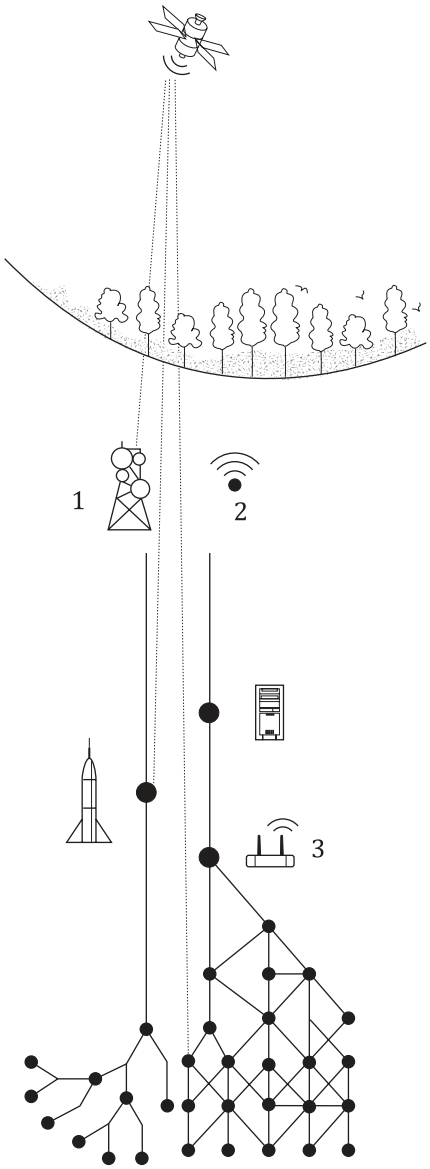

Key

1 TV

2 Web

3 Internet service provider

Figure 3 — Communications network

4.5.2.3 Water cycle

The second infrastructure is the water cycle component, which includes water supply, treatment and management of wastewater, surface water runoff and floodwaters (see Figure 4). Cities draw water from the environment, perform treatment processes and consume it. Grey water[2)] and wastewater is discharged back into receiving bodies, often after treatment, and sometimes recycled directly back into the community's own water supply. Water infrastructure describes all of the physical elements that form the water cycle – from its extraction to its disposal or reuse – and that operate it in a structured way to serve a city or community.

2) Grey water is wastewater from sinks, baths, washing machines, and other sources that can be used or recycled for other purposes where potable water is not required, like toilet flushing.

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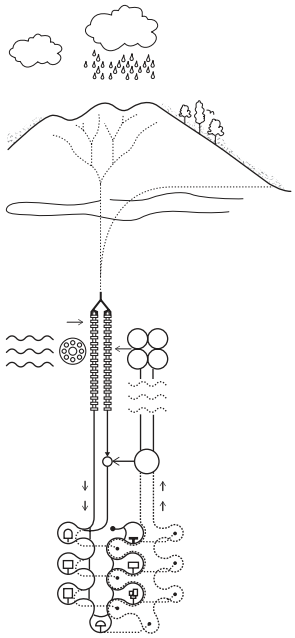

Figure 4 — Water cycle

4.5.2.4 Energy

The third infrastructure is the energy cycle component (see Figure 5), composed of the entire power system, including functional nodes producing power (e.g. nuclear and fossil fuel power plants, wind farms, biomass/bioenergy power plants, hydroelectric plants, solar generating plants) often located outside of the city; the networks needed to transmit electricity or convey fuel – like natural gas – into the city; as well as other networks of pipelines, ships, rail and trucks needed for the transport of fossil fuels and chemicals as raw or refined products. In addition, smaller production nodes, like district-level generating plants, bio-energy systems and steam generation, often operate in cities, as do distributed energy nodes, like rooftop solar for thermal energy or electricity.

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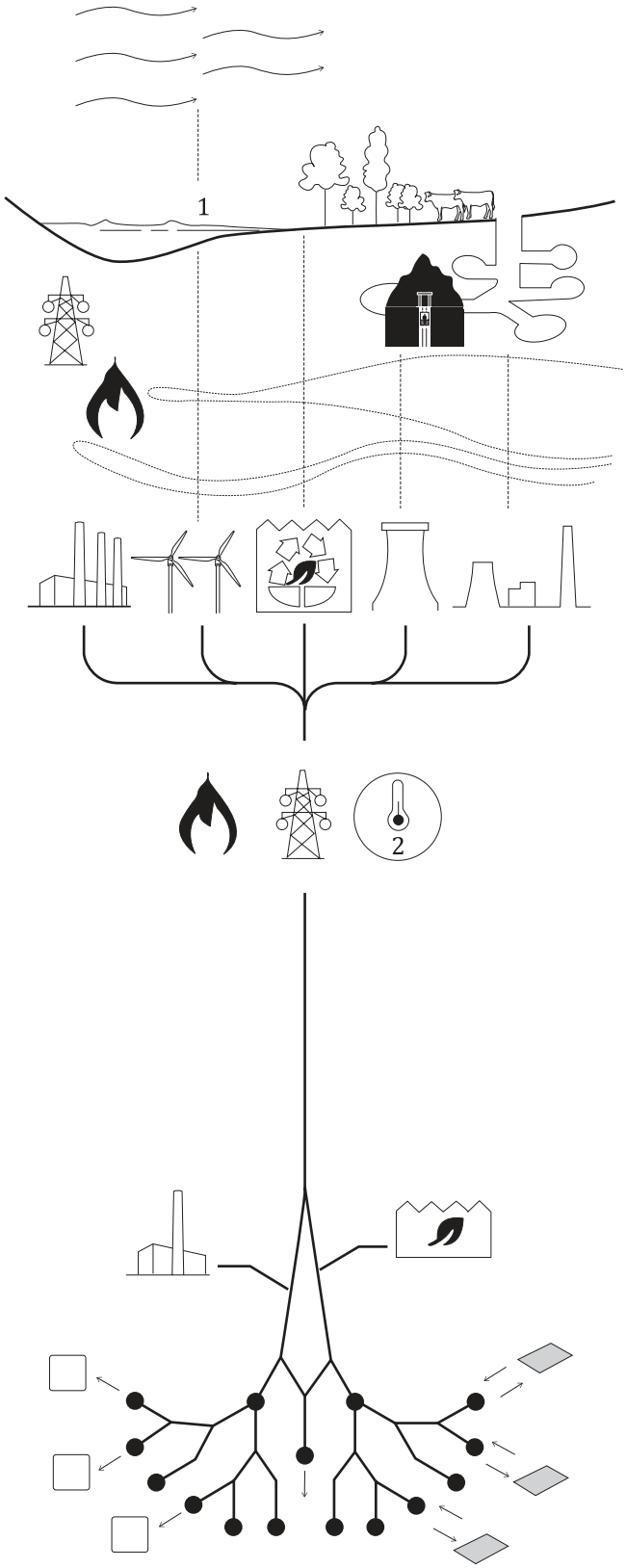

Key

1 biomass

2 H_2O

Figure 5 — Energy

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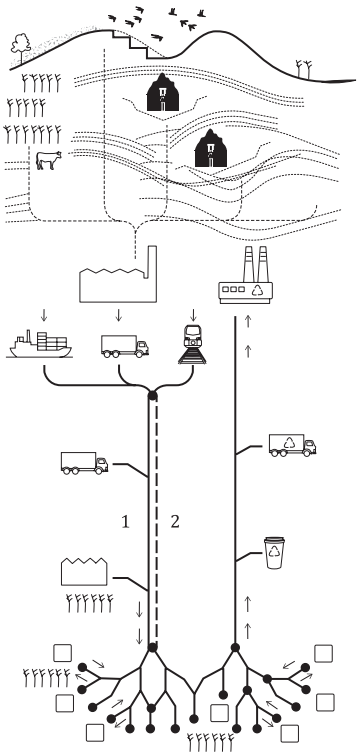
4.5.2.5 Matter cycle

The fourth infrastructure is the materials or matter cycle (see Figure 6). This infrastructure component includes the extraction of material resources from nature (including food), their industrial level or small-scale manipulation to create products, the transportation and logistics infrastructures to reach consumers and the management of waste materials. Stated another way, the matter cycle includes: (i) everything involved in the extraction of resources from the environment and the transport of those resources to factories or production centres; (ii) the distribution of resources and products around the world enabled by logistics platforms, containers and other means; (iii) deliveries within cities; (iv) consumption within cities; (v) waste generation; (vi) transport of waste to landfills; and (vii) waste recycling and/or waste-to-energy production.

Figure 6 depicts two main types of materials: (i) the matter incorporated into consumer goods and construction materials within the city, shown as a solid line, and (ii) food – both plant-based and livestock – shown as a dotted line.



Key

1 goods

2 food

Figure 6 — Matter cycle

4.5.2.6 Mobility

The fifth type of Infrastructure is mobility (see Figure 7). Mobility chiefly refers to transportation for people, though often the same facilities, networks and means of conveyance transport goods as well, like airports and ports, and other facilities devoted to shipping and logistics. Mobility networks include large systems, such as railways, airports and highways, as well as road systems, including city streets. City streets, used by pedestrians, bicyclists, vehicles and public transportation, are not only important for mobility, but also form an integral part of a city's public space, which is important for many aspects of city life.

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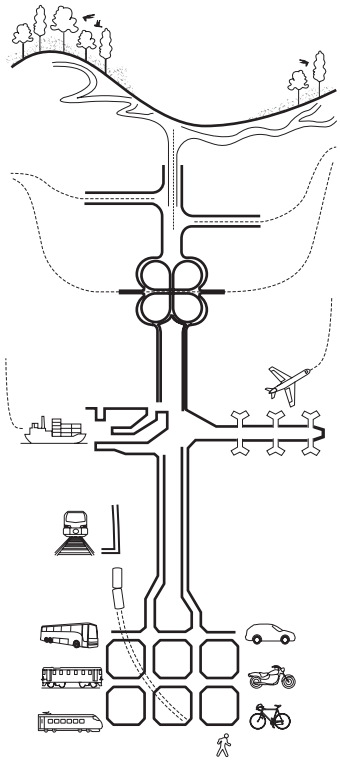

Figure 7 — Mobility

4.5.2.7 Green infrastructure

The final infrastructure is the green infrastructure (see Figure 8), i.e. the infrastructure provided by the natural environment. It can be composed of natural elements used in a structured way, like rain gardens or bioswale[3)], or any other natural element, like trees and open space that has an effect on the quality of city life.

3) Bioswales are landscape elements designed to concentrate or remove silt and pollution from surface runoff water.

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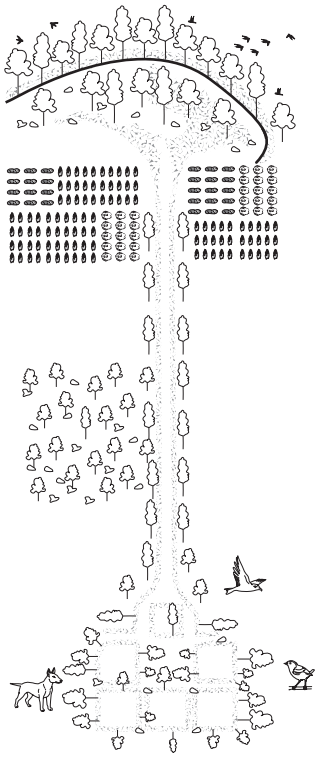

Figure 8 — Green infrastructure

4.5.3 Built domain

The third component of the city structure system element is the built domain, both public and private, and the surrounding public space. The built domain has two distinct and essential characteristics in relation to urbanism: (i) it is the main expression of the material culture of a city, and (ii) it is fundamentally multi-scale in nature (i.e. scale is an intrinsic characteristic of the built environment), as illustrated in Figure 9. At the highest level of resolution, the built environment supporting urban functions can be viewed as objects. Scaling up, the built domain is a collection of objects and the space that contains them. As illustrated in Figure 9, this scale can be represented as: houses, building, blocks, neighbourhoods, districts, the city, the metropolis, the country, the continent and ultimately the whole planet.

Figure 9 — Built domain

Objects are also those structures at the smallest scale that can ultimately have their own identity in a global network of the Internet of things (IoT). Most objects belong to a functional category since they support one or more functions for human life in cities. In many cases they become part of a larger scale network made up of other elements and systems (e.g. buildings or the city itself).

The built domain in both Figure 1 and Figure 9 is ordered according to the number of people that each level of scale approximately relates to on a physical basis, for example 1 object; 10 house; 100 building; 1 000 block; 10 000 neighbourhood; 100 000 district; 1 000 000 city; 10 000 000 metropolis or region.

The built domain determines where the essential functions attached to human life in cities take place, both publicly and privately. Thus, it is typically buildings like apartments/flats, hospitals, offices and other places of employment, but it can also be the public space of streets and squares. These public

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