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ZARAGOZA IN 15 MINUTES: A STORY TOLD THROUGH MAPS

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Abstract: The development of many cities has been guided by the principles of petroleum urbanism, which have created urban areas primarily designed for motor vehicles, often neglecting the primary subject inhabiting them: people. The current challenges facing the modern city of the 21st century call into question the established urban system. Consequently, international programs such as the Sustainable Development Goals (SDGs) and the New Urban Agenda have been established, setting goals and initiatives to address these challenges.

In this context, the concept of the "15-Minute City" emerged in Paris, proposed as an urban model to address the economic, environmental, and social issues of our time. This article examines Zaragoza's situation regarding this chrono-urbanist model, analyzing three of its fundamental principles: the city must be compact, complex, and accessible, while also assessing citizen participation initiatives. The creation of a new index that combines these three urban indicators, along with the cartographic representation of the results, allows for the identification of the spatial distribution of this urban model in Zaragoza. Adapting the research in form and content to its StoryMap version has brought the results closer to a wider audience, revealing that Zaragoza is not entirely a 15-minute city, although there are areas where this model is observed. Therefore, it is necessary to analyze our cities to identify the lines of action that future comprehensive tactical urban planning should follow.

Keywords: 15-Minute City, Urban Indicators, Compactness, Complexity, Accessibility, StoryMap, Collaborative Mapping.

LA ZARAGOZA DE LOS 15 MINUTOS CONTADA EN MAPAS

Resumen: El desarrollo de muchas ciudades se ha guiado bajo las líneas del urbanismo del petróleo, aquel que ha creado urbes para el vehículo rodado, olvidando al principal sujeto que la habita: las personas. Los actuales retos a los que se enfrenta la ciudad moderna del siglo XXI ponen en entredicho el sistema urbano prestablecido. Por ello, en la actualidad existen programas internaciones como los ODS o la Nueva Agenda Urbana con los que se fijan metas e iniciativas para alcanzarlas.

En este contexto, nace en París el concepto de "Ciudad de 15 minutos", postulada como modelo urbano con el que resolver las problemáticas económicas, ambientales y sociales de nuestro tiempo. El presente artículo estudia la situación de Zaragoza respecto a este modelo cronourbanista, analizando tres de sus principios fundamentales: la ciudad debe ser compacta, compleja y accesible; además de valorar iniciativas de participación ciudadana. La creación de un nuevo índice que asocia estos tres indicadores urbanos junto con la representación cartográfica de los resultados permite identificar la distribución espacial de este modelo urbano en Zaragoza.

La adaptación de la investigación en forma y contenido a su versión *StoryMap* ha acercado los resultados a un amplio público. Dando a conocer el hecho de que no se trata de una ciudad de 15 minutos en su totalidad, si bien presenta zonas donde sí que se aprecia este modelo. Por tanto, resulta necesario analizar nuestras ciudades para identificar las líneas de acción que debe seguir el urbanismo táctico integral del futuro.

Palabras Clave: Ciudad de 15 minutos, Indicadores urbanos, Compacidad, Complejidad, Accesibilidad, StoryMap, Mapas colaborativos.

1. Introduction

Urban spaces have been, are, and will be one of the paramount expressions that define humanity. From the earliest settlements to the current megacities, different urban models have emerged in response to the demands of their respective historical moments (Jay *et al*., 2002; Diamond, 2016).

Since the mid-20th century, the process of urbanisation has surged, increasingly congregating more population in these spaces (United Nations, 2018). Urban design that has predominated in cities for the past century has been clearly influenced by the use of motor vehicles, thus facilitating the characteristic Urban sprawl seen in American cities, which has spread virtually worldwide (Delgado, 2011).

In the 21st century, often referred to as the century of cities (Rubiales, 2019), it is particularly necessary to improve life in urban spaces. Cities exhibit vulnerable areas due to economic models that favour imbalances and segregation (*Pueyo et al*., 2016), as well as the environmental, social, and economic consequences of climate change (López and Rodríguez, 2022).

Therefore, we are facing a paradigm shift that not only demonstrates the transformation of the productive model but also the way we experience the city.

Numerous designs and ideas have been proposed to address urban problems, with various national and international programs such as the Sustainable Development Goals or the New Urban Agenda of HABITAT III emphasising the urgency of action. These programs propose action plans and goals aimed at preventing economic, environmental, and social collapse.

Many of the organizations responsible for designing the recommended roadmap for cities agree on several fundamental urban requirements such as compactness, complexity, and accessibility for all citizens (Mardones *et al*., 2020).

The chrono-urbanist model of the "15-minute city" incorporates these three aspects (Moreno, 2023). Therefore, this article seeks to answer the question: Is actually Zaragoza a 15-minute city?

The main objective of this research is to analyse whether the city of Zaragoza adheres to the urban model known as the "15-minute city," where essential needs can be met within a fifteen-minute commute.

Since we live in a world of screens, with a society that values the immediacy of knowledge, the following StoryMap (https://arcg.is/G0LGu) has been created to summarise and facilitate the understanding of this research by presenting its various sections in a visual and intuitive manner.

The present paper maintains a classic structure of a scientific article. However, in its digital version, the sections of the StoryMap undergo necessary modifications to adapt the research to a coherent visual narrative, prioritising essential information.

2. Literature Review

2.1. The value of the urban

Cities, as "primary incubators of cultural, social, and political innovations" (Barber, 2013), have been facing a constant increase in population for decades. Currently, more than 55% of the population already lives in urban areas, which is 3.5 billion people, a number projected to reach 6.7 billion by 2050 according to the United Nations, implying that 70% of the world's population will live in urban areas (United Nations, 2018).

Since the onset of the Industrial Revolution and the expansion of the capitalist model, which prompted the massive exodus from rural to urban areas, cities have significantly increased their demographic weight (Diputació Barcelona, 2019).

In Europe, this demographic trend has accelerated compared to other regions, with 75% of the population already residing in urban areas, and Spain can be considered predominantly urban, as this percentage exceeds 80% (de la Cruz-Mera, 2019).

During the last years of the 20th century and the first two decades of the 21st century, urban spatial transformation has been framed within the Industrial and Post-Industrial phases, both governed by the capitalist system,

which has resulted in a significant spatial alteration of pre-existing models. Initially, there was an intensive development in the city centre, such as the emergence of financial districts, while simultaneously opting for extensive development in the periphery to meet the demand for urban land for new industries and transportation. Subsequently, there has been a real commitment to the growth of the periphery, which includes new mono and multi-functional centres, giving rise to true urban continuums (Escolano, 2018).

This dynamic of inhabiting the planet has generated transformations at all levels: economic, social, cultural, demographic, infrastructural,technological, and environmental. Therefore, there are many projects that adopt a global perspective from a local context, studying cities and seeking to solve the problems they generate, thus improving the quality of life of their inhabitants. Some examples include the Superblocks in Barcelona, Pontevedra, and Madrid; the Melbourne 2017 - 2050 plan; the renovation of the Nordhavn district in Copenhagen; or the Merwede district in Utrecht.

2.2. How should the cities of the 21st century be?

The cities of the 21st century adhere to significant urban planning guidelines. Various global initiatives, such as the United Nations Conference on Housing and Sustainable Urban Development, held in 2016, commonly referred to as UN-Habitat III, outline objectives at a global scale. The Sustainable Development Goals (2015) are another crucial framework to consider, with specific emphasis on Goal 11, focusing on "Sustainable Cities and Communities." At the European regional level, the New Charter of Athens from the European Council of Urbanists (2003) and the Urban Agenda for the European Union, ratified in Amsterdam in 2016, provide essential guidance. Additionally, in Spain, efforts towards urban planning were evident in the same year, with the development of the Spanish Urban Agenda roadmap.

In order to simplify, summarise, associate, and unify the different proposals, five general principles are proposed to interconnect the various programs:

- Improvement of social aspects.
- Increased local citizen awareness.
- Environmental sustainability.
- Enhanced accessibility and mobility.
- Connections with rural áreas.

2.3. The 15-Minute City: A Real Alternative?

Cities are facing a series of challenges that demand careful planning of projects and objectives, requiring swift action to prevent several of these difficulties from reaching a point of no return.

In this context, the concept of the 15-minute city (Moreno, 2023) emerged in Paris, pioneered by the scientist Carlos Moreno, director of the ETI Chair (Entrepreneurship, Territory, and Innovation), focused on the reflection of technological issues, cultural and social challenges, ecological constraints, urban spaces, and new economic and public management schemes (Chaire Entrepreneuriat Territoire Innovation, 2020).

This model of a city based on proximity and polycentrism began to see its immediate reality when in 2020 the mayor of Paris, Anne Hidalgo, included it in her electoral program. Since then, this urban policy has been widely accepted for proposing ideas contrary to petroleum urbanism, advocating for cities for their inhabitants.

One of the sources of inspiration for the design of the 15-minute city was the concept of the "living city" proposed by urbanist Jane Jacobs, whose interest in urban aspects was evident in her first book "The Death and Life of Great American Cities" (1961). In this book, she criticises the urban planning of the 1950s in the United States, a urban dynamic that has spread worldwide, promoting cities with a design opposite to the "Popular City", that is, cities where the segmentation of uses and private vehicles have been prioritised, fostering territorial dispersion and anonymity among its citizens, which has led to social segregation and insecurity. Jane Jacobs advocates for and defends the lively and popular city where the relationship between people and public space is essential to ensure safe and complex neighbourhoods thanks to the multiplicity of networks created by various uses (Jacobs, 1961).

A valuable lesson arising from Jacobs' thinking is a shift towards bottom-up urbanism, a planning approach based on the everyday experiences and real needs of citizens (Jacobs, 1961).

Another conviction shared by Carlos Moreno, in line with Jacobs, is the notion of "useful time." To understand human activities, it is essential to incorporate the temporal dimension, as highlighted by Byung-Chul Han. We live in a society of work and performance, where productivity predominates (Han, 2017). This demand, which seems to turn us into slaves of time, can be reduced with "chosen mobility" or demobility, which aims to minimise wasted time during journeys by making use of the various functions of the same space.

This space-time relationship was already explored during the 1960s by the Swedish school of geography, in which Torsten Hagerstrand developed various models of spatial diffusion that included the temporal component. From these models, he concluded that an individual's movements are conditioned by three types of constraints:

- Individual Capacity Constraint: Such as biological limitations, income constraints, car availability, or access to public transportation.
- Coupling Constraint: This defines the place, time, and period of time required to carry out the action that motivates their displacement.
- Authority Constraint: This refers to conditions imposed by individuals or institutions, thereby regulating the behaviour of individuals (Garrocho, 1993) (Cerda, 2010).

Many of the limitations proposed by Hagerstrand have disappeared with the flexidimensionality of space brought about by the hybridization between the physical and digital worlds (Campos, 2020), thus redefining social behaviour patterns. The 15-minute city considers certain technological trends that have been accelerated by COVID-19, such as telecommuting, which has eliminated many daily commutes in cities, or the rediscovery of urban spaces as a result of mobility restrictions during quarantine.

The chrono-urban policy that will design the new "City of Light" aspires to consolidate "viable" spaces where economy and ecology converge; "equitable" spaces with an economy mindful of social actions; and "livable" spaces, meaning there is a close relationship between social impact and ecology (CICIM, 2020).

To achieve these urban ideals, Carlos Moreno (2023) discusses six activities (living, working, shopping, caring, learning, and enjoying) that should be possible within a 15-minute radius from home, through walking or cycling, known as active mobility (LA Network, 2020).

In conclusion, this 15-minute city aspires to an urbanism based on the traditional Mediterranean city, characterised by continuous, dense, and well-cohesive spaces, where the mixture of uses, proximity, and a good communication network facilitate a life full of social interactions (ETSAM, 2021).

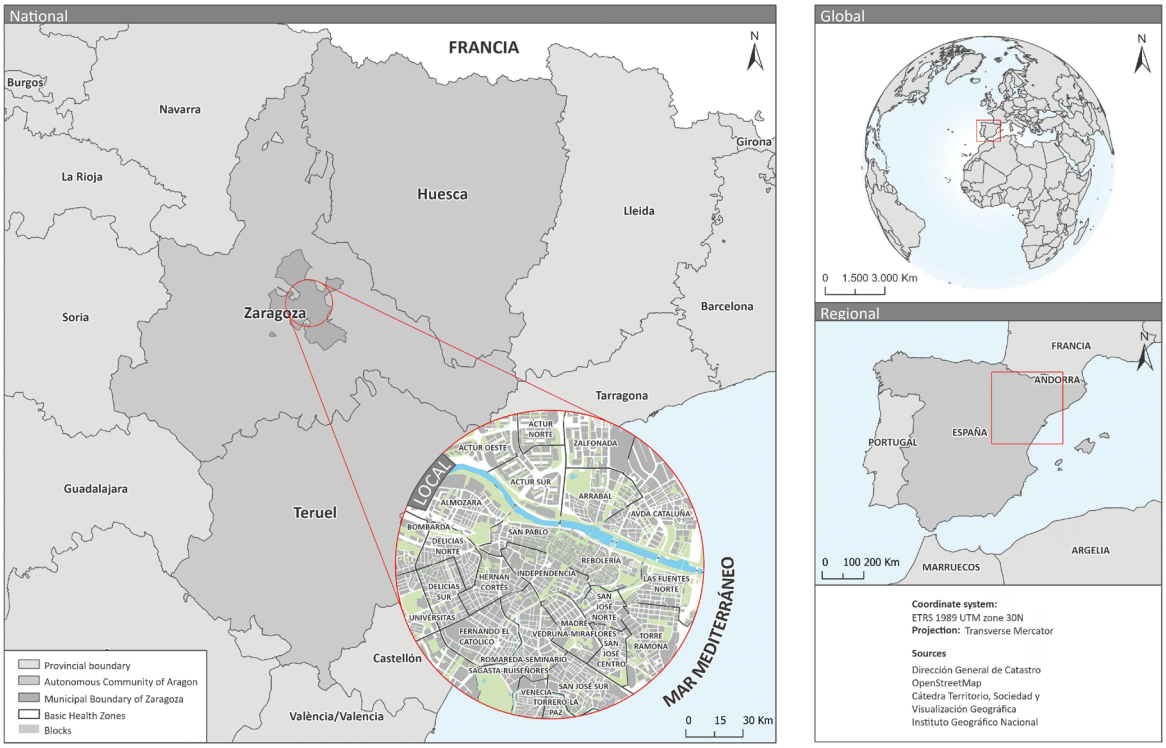
3. Methodology

3.1. Area of Study

The study area is Zaragoza, the fifth-largest city in Spain by population, with 682.513 habitants in 2023 (INE, 2023). It concentrates more than 51% of the population of the Aragon region, demonstrating the clear macrocephaly of this Autonomous Community. Zaragoza stands out for its optimal location, situated in the northwest quadrant of the Iberian Peninsula (Figure 1). It is halfway between Madrid and Barcelona, the two most dynamic cities in Spain, and maintains a similar distance from Bilbao, Valencia, and Toulouse, providing a geostrategic advantage as a node in the network of the most important cities in southern Europe.

The urban structure of Zaragoza reflects the different periods that have marked its design and expansion. The city grew from the Roman historical centres, initially with working-class neighbourhoods, mainly residential, boosted by the various railway stations that revitalised the city, such as Delicias, San José, or Torrero. Later, expansion occurred through urban extensions, where the city lost compactness influenced by hygienist theory, spacing out the streets and creating meeting places for citizens in districts like Centro, Miraflores, or Miralbueno (Adiego, 1995). During the last decades, according to the classification proposed by A. Champion's model, Zaragoza is in the stage of Suburbanization, characterised by the expansion of its periphery, based on the monumentality represented by urban projects (Ges, 2018) implemented on the urban fringe margin during the first eight years of the 21st century. This period saw excessive construction activity that ended with the financial crisis of 2007 due to the collapse of the real estate bubble (Bellet and Alonso, 2016) (Escolano *et al*., 2018).

FIGURE 1.
LOCATION MAP OF THE STUDY AREA - ZARAGOZA



The recent growth of urban space in Zaragoza has led to an increase in the urban land area, from 5,711 hectares in 2001 to 9,036 hectares in 2018 (De Miguel González, 2014). This expansion of the city of Zaragoza is characterised by residential development primarily located on the outskirts of the consolidated urban fabric. New neighbourhoods have been created, such as Valdespartera, Parque Venecia, or Arcosur. Another characteristic feature of Zaragoza's periphery is the presence of monofunctional centres, well-connected to the city centre through ring roads, which have not only served as mere communication routes but also acted as vectors of development and urban growth. Most of the new neighbourhoods and these monofunctional centre, such as Puerto Venecia and Plaza, are adjacent to the Z-30 and Z-40 roads (De Miguel González, 2014).

3.2. Urban indicators

For the evaluation of the 15-minute city model in the urban area of Zaragoza, four analyses are conducted to address the objectives outlined and ultimately obtain the necessary data to answer the question: "Is Zaragoza a 15-minute city?

1. Compactness

Compactness is one of the most commonly used variables to characterise the shape of the built urban space (Escolano, 2018), as it expresses the proximity of physical components. There are two complementary procedures to calculate this indicator:

- Absolute Compactness (CA): relates the built volume to the total land area in an urban area, thus expressing the pressure exerted by buildings on the urban fabric (Rueda, 2010).
- Corrected Compactness (CC): This "variant" of the calculation of absolute compactness allows the indicator to incorporate land uses by relating the built volume to the mitigating public spaces in an urban area, understood as places of gathering, coexistence, and interaction with nature.

A low compactness index expresses urban sprawl usually accompanied by greater fragmentation in land uses. Conversely, an urban area with excessively high compactness results in congested spaces with efficiency problems (Bosetti, 2016).

In summary, a city with good compactness implies proximity and accessibility, promoting the mix of land uses and efficiency.

***2.** Complexity*

As noted by Marín and Palomares (2020), complexity "is a measure of the organization of the urban system that informs about the degree of diversity of uses and services that characterise the city." Therefore, it is essential to understand the degree of multifunctionality of each space, as the 15-minute city entails high complexity (Bustos, 2015).

There are multiple indicators that allow calculating urban complexity from different perspectives that express the diversity of these spaces. According to the literature consulted, the most common method is the Shannon's Diversity Index derived from information theory (Rueda, 2010).

***3.** Accessibility*

In addition to sustainable mobility, there is another relevant term known as sustainable accessibility. This refers to enhancing access to goods and services by leveraging the human ability to travel on foot or by bicycle (Sanz, 1997). In other words, it refers to active mobility. A compact and complex city must also be accessible, meaning it should provide citizens with all the facilities necessary for their daily needs within a maximum radius of 15 minutes.

***4.** Citizen Participation*

The 15-minute city involves citizens in decision-making processes. This active participation of society is linked to bottom-up governance, where individual daily life is considered the main source of knowledge when implementing policies. Therefore, listening to the various urban proposals and demands of the inhabitants represents a first step towards this city model aimed at improving quality of life (Flanagin & Metzger, 2008).

One of the initiatives developed by the Chair of Territory, Society, and Geographic Visualization of the University and the City Council of Zaragoza is "My Maps, My Data" on the city council's website (https://www.zaragoza.es/sede/) in the Open Government section. This initiative reflects the transparency and interest in citizens' opinions. In addition to launching surveys and presenting public data, in November 2020, Collaborative Maps were created, a GIS tool that allows any citizen to digitise locations they consider relevant.

One of the proposed themes are "I'm Moving". In this, the areas of the city most attractive for changing residence are located, thus selecting those locations where citizens see their needs met.

3.3. Work scale

The different geographic analyses have been conducted at the working scale that best represents each phenomenon, meaning the most appropriate for making the study object comprehensible and manageable for the observer (Reboratti, 2001) (Valenzuela, 2006). Thus, analyses, where methodologically feasible, are presented at various scales to avoid a limited view and establish relationships between elements, thereby creating a summarised and direct view of reality.

Therefore, the analysis entities that have been used are:

- Basic Health Zones: These are the most basic geographic and demographic delineations for the planning and organization of primary care teams (Ministry of Health, Consumer Affairs, and Social Welfare). There are 35 BHZ in the municipality of Zaragoza.
- Census Tracts: This administrative division is created based on demographic statistics and comprises a population of between 500 and 2,000 inhabitants. Zaragoza has 491 census tracts.
- City Blocks: Identified by the cadastre as "MASA," these constitute the most basic unit of work. The Royal Spanish Academy (RAE) defines them as "urban space, generally quadrangular, delimited by streets on all sides."

3.4. Cartographic Design

In this work, the cartographic component constitutes a fundamental contribution to explain the different variables under study.

Since Claudius Ptolemy laid the foundations of modern cartography in his work "Geography," cartographic production, i.e., maps, have accompanied us for almost everything. "Not only as analytical tools, but also as a form of expressive visual art" (Pickles, and Cooke, 2015).

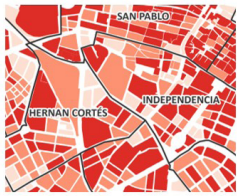
The paradox proposed by Jerry Brotton, "we can never know the world without a map, nor can we definitively represent it with one," underscores the paramount importance of maps. These graphic productions "facilitate the spatial understanding of things, concepts, conditions, processes, or events concerning the human world" (Harley, *et al*., 1987). Thus, maps depict the spatial distribution of the various indicators studied to answer how and where the 15-minute city urban model is located in Zaragoza.

The maps have been created following the design and elaboration phases of the cartographic process proposed by (Zúñiga, 2009).

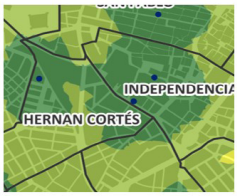
Two types of maps have been created (Figure 2): univariate maps (Complexity, Accessibility, The 15-Minute City in Zaragoza, and I'm moving house) and multivariate maps (Compactness and Intersection of Compactness with Complexity).

FIGURE 2.
CARTOGRAPHIC MODELS

Univariable Maps: Complexity, Accessibility, The 15-Minute Zaragoza, and I'm Changing Houses

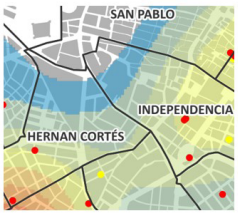


Real Variable: Complexity
Visual Variable: Value
Legend: Sequential



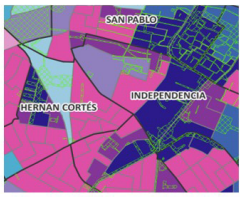
Real Variable: Accesibility
Visual Variable: Value
Legend: Sequential

Real Variable: 15-Minute City Index
Visual Variable: Value
Legend: Diverging



Real Variable: Preferences for Moving
Visual Variable: Colour - Value
Legend: Diverging

Multivariable Maps: Compactness, Compactness Cross, and Complexity



Real Variable: Absolute Compactness and Corrected Compactness
Visual Variable: Colour - Value
Legend: Sequential: Double Entry

Real Variable: Compactness and Complexity
Visual Variable: Colour - Value
Legend: Sequential: Double Entry

Source: Prepared by the author

3.5. Design and Structure of StoryMap

As previously mentioned, the content of this article undergoes a significant yet appropriate adaptation in its StoryMap version. The introduction utilises a horizontal slideshow with lateral scrolling, summarising the state of the art. The 7 slides comprising it use photographs, texts, demographic graphics, timelapse, and infographics to convey to the audience the current relevance of urban studies.

In order to generate a solid narrative structure, the final slide introduces the urban indicators that will be developed in the following sections.

The following figure is a timeline in which the different urban indicators are ordered, thus exposing the study's objectives and the script that will be followed in the simultaneous explanation of the methodology and results.

At the same level of relevance as the Introduction, the next section is titled "15-Minute City". In this case, the reader becomes familiar with this chrono-urbanist model by navigating through a vertical sidecar where text messages emerge.

3.6. Absolute and Adjusted Compactness

1. *Absolute Compactness: Built volume (m^3) / Surface area (m^2)*

For the calculation of this index, it was necessary to download the Building_part_GML file provided by the Electronic Headquarters of the Cadastre in Shapefile format. Vector layers related to different administrative units over which absolute and adjusted compactness will be calculated have also been obtained, namely, districts, basic health zones, and census sections downloaded from Zaragoza.es, IDEAragon, and IGN.

Upon the building layer of the municipality of Zaragoza, several of its fields have been calculated to orderly display information regarding the number of floors, height, surface area, and volume of each building.

With the restructuring of the building layer, which originally had polygonal representation, it has been converted to points by calculating their centroids. This is done to avoid issues with building geometries that span across two administrative units simultaneously, as it could lead to duplicated values.

Finally, after a series of vector geoprocessing steps, the necessary data has been obtained for the calculation of absolute compactness (built volume and surface area) for the different administrative units at the three scales of analysis.

2. *Corrected Compactness: Built volume (m^3) / Habitable area (m^2)*

Starting from the absolute compactness, for which the built volume has already been calculated, obtaining the values of surface area representing habitable spaces is necessary for this corrected compactness.

For obtaining this type of spaces, information has been consulted and extracted from the platform based on open-source software technologies, OpenStreetMap (OSM), which was subsequently supplemented with files provided by the Chair of Territory, Society, and Geographic Visualization.

First, the entities that can be considered habitable spaces were studied by consulting the OSM Wiki, and then the relevant features were extracted using the QuickOSM plugin in QGIS.

The objects that will be part of the habitable spaces are:

- Highway / Pedestrian: These are streets exclusively for pedestrians and areas where motorised vehicles may access during very limited periods of the day.
- Highway / Living_Street: These are streets and residential areas where pedestrians have legal priority over cars, maintaining very low speed limits.
- Leisure / Park: Parks
- Landuse / Forest: Forests
- Natural / Scrub: Scrubland

It is worth noting the measurement of the width of fourteen hundred streets using the most up-to-date orthophotos from the PNOA (Plan Nacional de Ortofotografía Aérea) and overlaying the cadastral building layer, thereby avoiding the distortion caused by the tilt of the camera axis and/or relief displacement in the aerial images.

Next, a series of geoprocessing tasks were implemented using ArcMap and the SAGA library in QGIS, allowing the extraction of surface area values for each of the administrative units studied.

3.7. Calculation of building use complexity

Developed from the mathematical theory of information, the Shannon index expresses, through the calculation of H, the number of information carriers capable of contact, in terms of quantity and diversity.

$$H = (-\sum_{i=0}^{n} P_i \, Log_2 \, P_i)$$

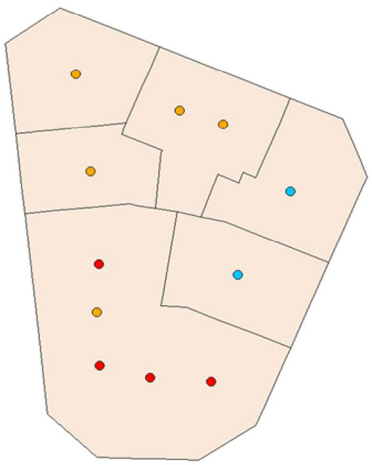
For the study of urban complexity, buildings with their different uses provided by the cadastre in its .CAT files will be considered as information carriers.

Once the property uses for each of the administrative units of study have been obtained, the data is exported for the calculation of H, of which it is necessary to understand its different elements.

$$P_i = \frac{N_i \ (nº \ properties \ with \ the \ same \ use)}{N \ (nº \ total \ uses)}$$
$$= Relative \ abundance \ of \ each \ property \ use$$

FIGURE 3.
CALCULATION OF THE SHANNON INDEX

Classes of property uses	N_i
C-Commercial	4
E-Cultural	2
V-Residential	5
N	11



$$P_i \, C = \frac{4}{11} = 0,36$$
$$Log_2 \, P_i = Log_2 \, (0,36) = -1,45$$
$$-\sum P_i \, Log_2 \, P_i = (0,36) * (-1,45) = 0,53$$

$$P_i \, E = \frac{2}{11} = 0,18$$
$$Log_2 \, P_i = Log_2 \, (0,18) = -2,45$$
$$-\sum P_i \, Log_2 \, P_i = (0,18) * (-2,45) = 0,45$$

$$P_i \, V = \frac{5}{11} = 0,45$$
$$Log_2 \, P_i = Log_2 \, (0,45) = -1,13$$
$$-\sum P_i \, Log_2 \, P_i = (0,45) * (-1,13) = 0,52$$

$$H = \sum (0,53 + 0,45 + 0,52) = 1,49$$

Source: Prepared by the authors

3.8. Accessibility Analysis

To measure urban accessibility to various key spaces and services in Zaragoza, a network analysis has been conducted, in which different service areas are calculated. These service areas encompass all streets accessible to each service, applying a temporal impedance of 5, 10, and 15 minutes.

To develop this analysis, it was necessary to obtain the street network of Zaragoza, acquired from *QGIS* using the *QuickOSM* plugin, selecting the *Highway* feature.

The street network obtained, labelled as "*Highway*" includes a variety of road typologies such as pedestrian streets, highways, bike lanes, etc. In conclusion, it is not the sidewalk network through which any citizen can walk, but it does serve to generate an approximation of the current service areas. This is because the alternative analysis by buffer generation is insufficient, as pedestrian mobility seldom occurs in a straight line.

Given that the concept of the 15-minute city involves active mobility, which extends beyond walking and includes cycling as a primary alternative, another network analysis has been conducted using the bike lanes for calculating service areas.

Both the bike lane network and the key structural facilities under study have been provided by the Chair of Territory, Society, and Geographic Visualization.

Before creating the *Network Dataset* and employing the *Network Analyst* extension, both the *Highway* (pedestrian accessibility) and bike lane (bicycle accessibility) layers were edited using the *Planarize Lines* tool, which divides lines at all their intersections. The following fields were included:

- Speed: 5 km/h as the average walking speed (Walkable Cities, n.d.), and 12 km/h for cycling (Self-experience-derived average).
- Length: Distance measured in metres for each of the arcs in the network.
- Minutes: 0.06 * [Length] / [Speed].

Once the two layers of linear entities, which function as the network, have been corrected, the Network Dataset is created to calculate the different service areas.

The maximum distance between the key structural facilities and the pedestrian accessibility network is 50 metres. Some of the facilities have been modified to meet this distance requirement.

However, for the service areas with the bike lane, a distance of 200 metres is established, which should be covered on foot (2.4 minutes on foot = 17.4 minutes maximum travel time) by the cyclist to reach their destination. In this case, no location has been edited to accurately represent facilities with poor accessibility.

Finally, since the 15-minute city concept implies sustainable accessibility to all facilities, areas with better accessibility have been calculated through vector geoprocessing. These areas are where all classes of facilities are accessible, both on foot and by bicycle. This approach aims to identify urban spaces that meet the criteria of the chrono-urbanist model.

3.9. Intersection of Compactness with Complexity

In order to relate these first two indicators, a classification of their results has been necessary, which allows for the calculation of a common index.

- Compactness Classification: According to the consulted literature, the categories used to classify compactness are:

Table 1 y 2.
COMPACTNESS CLASSIFICATION.

Absolute Compactness		
Class	**Ranges**	**Assessment**
1	<=3	Bad
2	>3 y <=5	Average
3	>5	Good

Corrected Compactness		
Class	**Ranges**	**Assessment**
1	<=5 y >100	Bad
2	(>5 y <10) o (>50 y <= 100)	Average
3	>=10 y <=50	Good

TABLE 3.
CALCULATION OF COMPACTNESS INDEX

Absolute Compactness Class * Corrected Compactness Class.

Compactness		
Class	**Ranges**	**Assessment**
1	<=3	Bad
2	>3 y <=6	Average
3	>6	Good

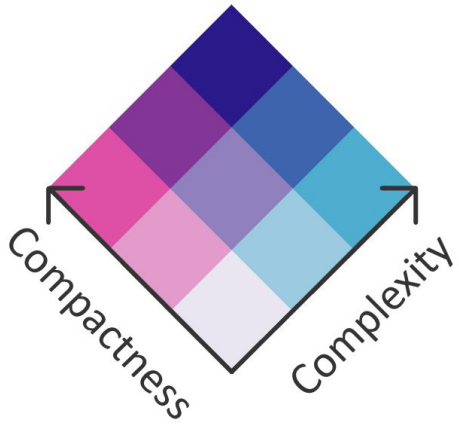
- Complexity Classification: Utilising the Natural Jenks method, which groups similar values and maximises differences between classes, the following classification has been created:

TABLE 4.
COMPLEXITY CLASSIFICATION

Complexity		
Class	**Ranges**	**Assessment**
1	<0,43	Bad
2	0,43 a 1,08	Average
3	>1,08	Good

For a better interpretation of the results through cartography, a dual-entry legend has been created (Figure 4). This allows for the perception of the existing relationships between the two variables, as the axis of pink tones represents the two classes of compactness (Table 3) and the blue axis repeats the process for complexity (Table 4), while also maintaining the pre-established ranges.

FIGURE 4.
DUAL-ENTRY LEGEND COMPACTNESS - COMPLEXITY



Source: Prepared by the authors

3.10. Intersection of Compactness with Complexity and Accessibility

As a final result, the aim is to provide a clear overview of the situation in Zaragoza, considering all three indicators simultaneously. For this purpose, a 15-minute City Index has been created, classifying the different categories of the three indicators that compose it. The classification of Compactness and Complexity corresponds to Tables 3 and 4, while Accessibility has been classified based on the 5, 10, and 15-minute service areas.

Table 5.
ACCESSIBILITY CLASSIFICATION

Accesibilidad	
Class	**Service areas**
1	15 minutes
2	10 minutes
3	5 minutes

As previously explained, the adaptation of this methodological section in the StoryMap is carried out jointly with the results. Thus, the "Methodology and Results" section consists of a vertical sidecar that begins by contextualising the reader in the study area. For this purpose, an animated aerial view of Zaragoza and its metropolitan area is presented alongside an expandable text highlighting the demographic and economic significance of this capital.

Next, following the timeline of the introduction, the different indicators are presented homogeneously, with the same distribution of elements: a left sidebar for methodology and presentation of results on the rest of the screen through interactive thematic mapping (option to vary the scale, unlimited scrolling, and data querying on entities).

The redundancy in the spatial layout of the content precisely aims to capture the reader's attention. Since this section is the most interesting and presents higher complexity compared to the other sections of the StoryMap, the methodological load has been balanced to make the study more accessible to a broader audience. With its 17 maps, 8 tables, and 2 graphs, this section becomes the focal point of the narrative.

4. Results

The results are structured into six sections: the first three evaluate the results of compactness, complexity, and accessibility. The next two sections relate these indicators, first by cross-referencing compactness with complexity, and then adding accessibility to this relationship. Finally, the results extracted from collaborative maps are presented.

4.1. Compactness

The results of compactness are divided between those obtained in the study of absolute compactness and corrected compactness.

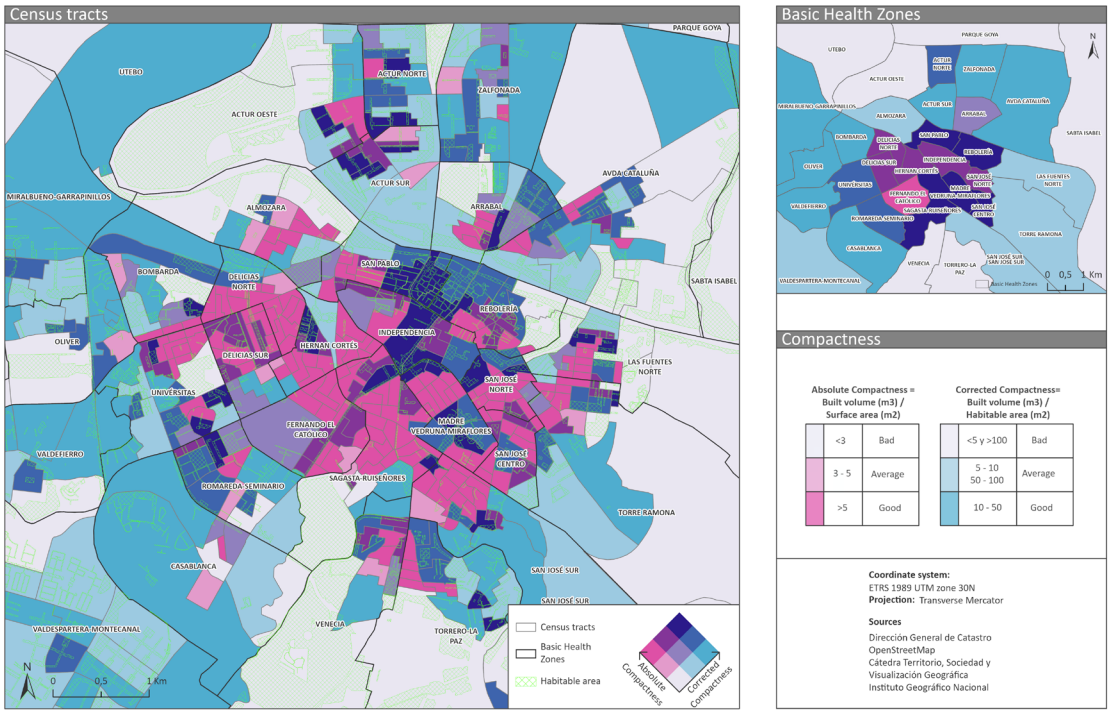
Absolute Compactness: The results obtained from the calculation of absolute compactness clearly show that the census sections located in the city centre exhibit higher values, as the building pressure is greater there. Notable are the BHZ (Basic Health Zones) of San José Norte and Centro, Independencia, Madre Vedruna – Miraflores, Hernán Cortés, San Pablo, Delicias Sur, and Norte, all of which record absolute compactness values exceeding 6.

These results need to be qualified because this indicator is clearly influenced by the urban area of reference. In Figure 5, it can be observed that the census sections of the aforementioned BHZ have a smaller surface area compared to those further from the centre, such as Utebo, Torrero la Paz, or Miralbueno – Garrapinillos, whose values are below 1.

Therefore, Figure 5 presents compactness at two scales, allowing for a detailed observation of census sections with absolute compactness values that differ from those recorded by the corresponding BHZ. In this regard, it is worth noting the high absolute compactness values shown by the census sections in the northern parts of the Venecia and Torrero la Paz BHZ, a situation mirrored in the western sections of Las Fuentes Norte or the southern sections of Almozara.

Corrected Compactness: The result representing a correct relationship between built volume and public space for leisure falls between 10 and 50. Census sections or BHZ showing average or poor corrected compactness can be the result of two inverse situations: one where there is a large amount of public leisure space with very little built volume, as observed in the section of Parque Grande José Antonio Labordeta; or, conversely, where built volume significantly outweighs mitigating public spaces, as seen in many sections of Sagasta – Ruiseñores.

FIGURE 5.
ABSOLUTE AND CORRECTED COMPACTNESS IN ZARAGOZA.



In general, the sections located on the outskirts of the city exhibit good corrected compactness due to a better balance between built volume and leisure spaces, largely owing to their open urban design with more green spaces and wide sidewalks, as observed in Valdefierro, Valdespartera – Montecanal, Casablanca, and several sections of Actur Norte and Sur.

Sections adjacent to Plaza Paraíso and Plaza España, located in the heart of the city, also demonstrate good corrected compactness, showcasing a commitment to wide sidewalks and pedestrianisation of surrounding streets. Similarly, in Madre Vedruna, the building pressure is softened by the presence of Miraflores Park, contributing to a good corrected compactness.

4.2. Complexity

The values obtained with the Shannon index by building use for each block demonstrate the complexity of the city of Zaragoza. Figure 6 represents this complexity by blocks, but in order to explain the results and draw certain conclusions, the average by Basic Health Zones (Zonas Básicas de Salud) has been calculated.

Casablanca, San Pablo, Independencia, Madre Vedruna – Miraflores, and Sagasta – Ruiseñores all exhibit the highest average complexities, exceeding a value of 0.9. Conversely, some areas showing lower complexity, with values below 0.4, include Torrero – La Paz, Las Fuentes Norte, and Valdespartera – Montecanal.

This categorization by Basic Health Zones (BHZ) provides a representative summary of the actual complexity of each urban area. However, the representation by city blocks is the most reliable, as it allows for distinguishing the most and least complex blocks within each BHZ.

In this regard, the BHZ that stand out for the differences in complexity among their blocks are Utebo, Avda Cataluña, Casablanca, and Parque Goya, where a higher standard deviation is recorded, exceeding 0.6. However, in the opposite situation, that is, the BHZ where complexity maintains a more homogeneous distribution across their blocks, are Sagasta – Ruiseñores and Madre Vedruna – Miraflores, both with a standard deviation below 0.4.

4.3. Compactness and Complexity

In this section, the results obtained from the intersection of the compactness and complexity indicators are presented.

In Figure 7, it is evident at a glance that the blocks in the historic centre and Paseo Independencia exhibit darker colours, which indicate higher compactness and complexity. Other isolated blocks with good results can also be recognized in Arrabal, Actur Norte and Sur, and San José Norte.

The map shows a bluer tonality because the compactness index is calculated based on the two previously mentioned classes (Absolute and Corrected Compactness). Therefore, it is difficult for blocks to achieve the maximum compactness rating, which has already been represented in Figure 5 with the darkest tones.

When averaging the blocks contained within each BHZ, a reality evident in the map is confirmed, where San Pablo obtains the highest average with 5.43, followed by Independencia with 4.84, and Rebolería with a result of 4 (Low values considering the perfect situation is 9). The remaining BHZ can be classified into two groups: those with slightly higher values above 3, indicating a slight intersection of these two indices, as observed in San José Norte, Madre Vedruna – Miraflores, Actur Norte, Delicias Sur, Arrabal, and San José Centro. On the other hand, there are areas where the result is below 3, indicating a lack of overlap between compactness and complexity sought by the 15-minute city concept, once again coinciding with the BHZ on the periphery such as Torrero La Paz, Miralbueno – Garrapinillos, Parque Goya, and Valdespatera – Montecanal, which obtain the worst results.

4.4. Overall Accessibility

Once the information from the different service areas to healthcare facilities, shopping establishments, educational centres, cultural spaces, and sports centres has been processed, Figure 8 shows the areas of the city with the highest sustainable accessibility for 5, 10, and 15-minute travel distances. The result for the entire population of Zaragoza is positive because 92% are located in 15-minute service areas. This percentage decreases to 80% if the maximum travel time is reduced to 10 minutes. Finally, in areas with the best accessibility, where access to all types of facilities is possible within a maximum of 5 minutes, 22% of the population of the Aragonese capital resides.

FIGURE 6.
COMPLEXITY IN ZARAGOZA.

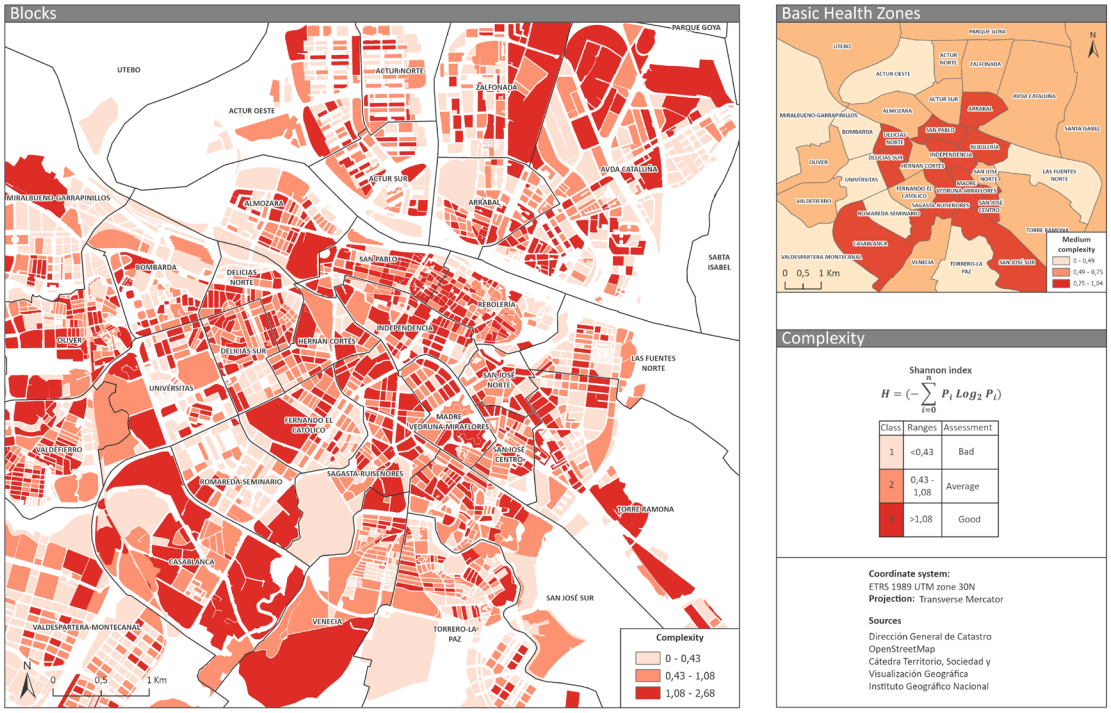
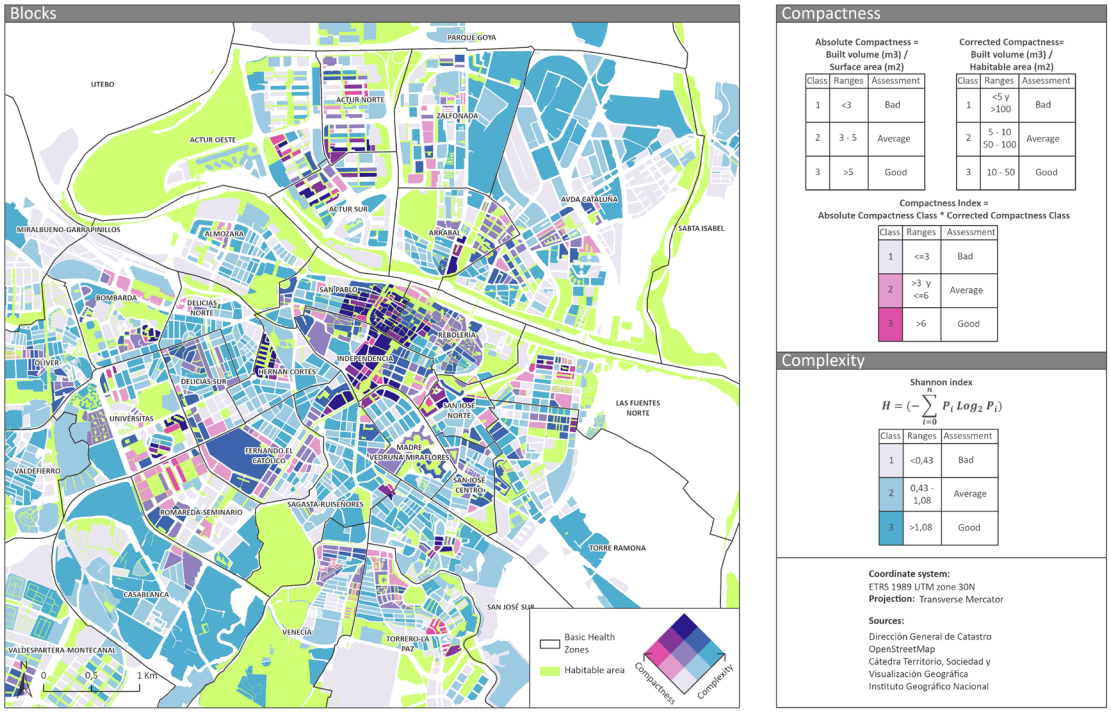


FIGURE 7.
COMPACTNESS AND COMPLEXITY IN ZARAGOZA.

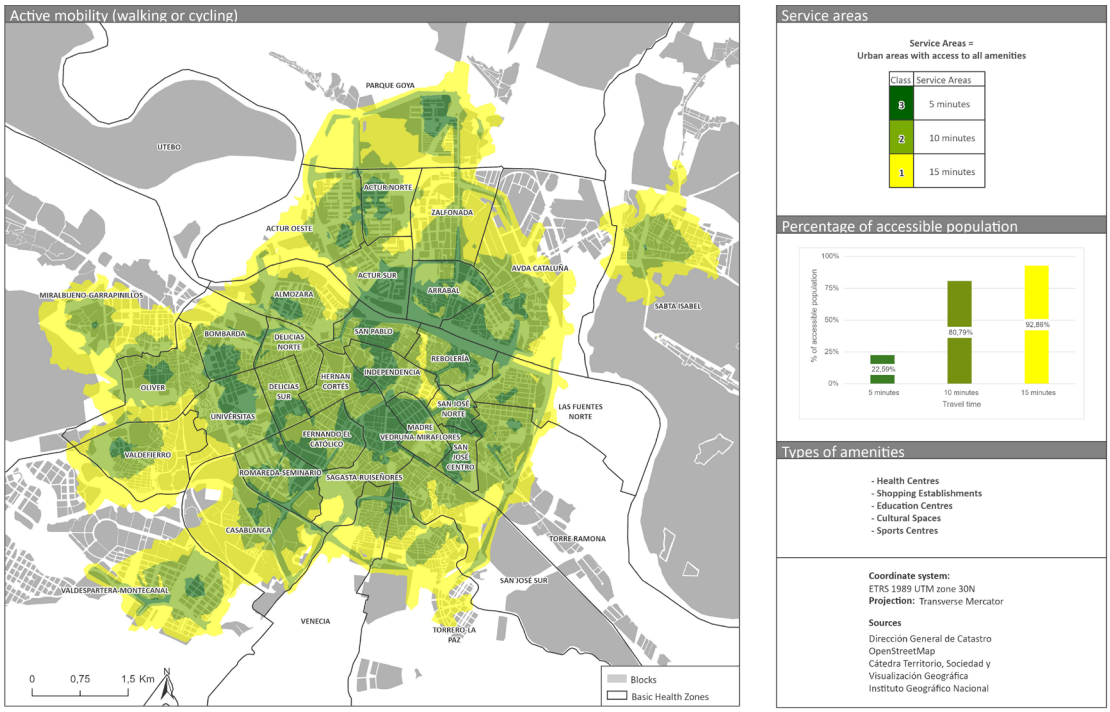


Considering the BHZ with the lowest percentage of accessible population and according to the results already outlined in the previous sections, it is the outskirts of Zaragoza that obtain the worst results. Thus, with less than 60% of its population accessible within 15-minute areas, we find Valdespartera – Montecanal (57%) and Santa Isabel (58%). The next BHZ are Parque Goya and Miralbueno, with 62% and 65% respectively.

It is also important to highlight those urban areas with high percentages of population in 5-minute service areas, or in other words, the Basic Health Zones with the best sustainable accessibility. Arrabal stands out remarkably with 70% of its population in these areas of maximum accessibility.

Following Arrabal, San José Centro, Independencia, Madre Vedruna – Miraflores, and Sagasta – Ruiseñores have population percentages close to 50%.

FIGURE 8.
OVERALL ACCESSIBILITY IN ZARAGOZA



4.5. 15-Minute City Index

Finally, it is in this section where the results are discussed, allowing us to answer the question of whether Zaragoza is a 15-minute city.

As previously evidenced by the results presented, the outskirts of Zaragoza deviate from this chrono-urbanist city model. This reality is evident in Figure 9, where several blocks in these urban areas are represented in grey, indicating that they do not meet one of the requirements, such as sustainable accessibility to all types of facilities.

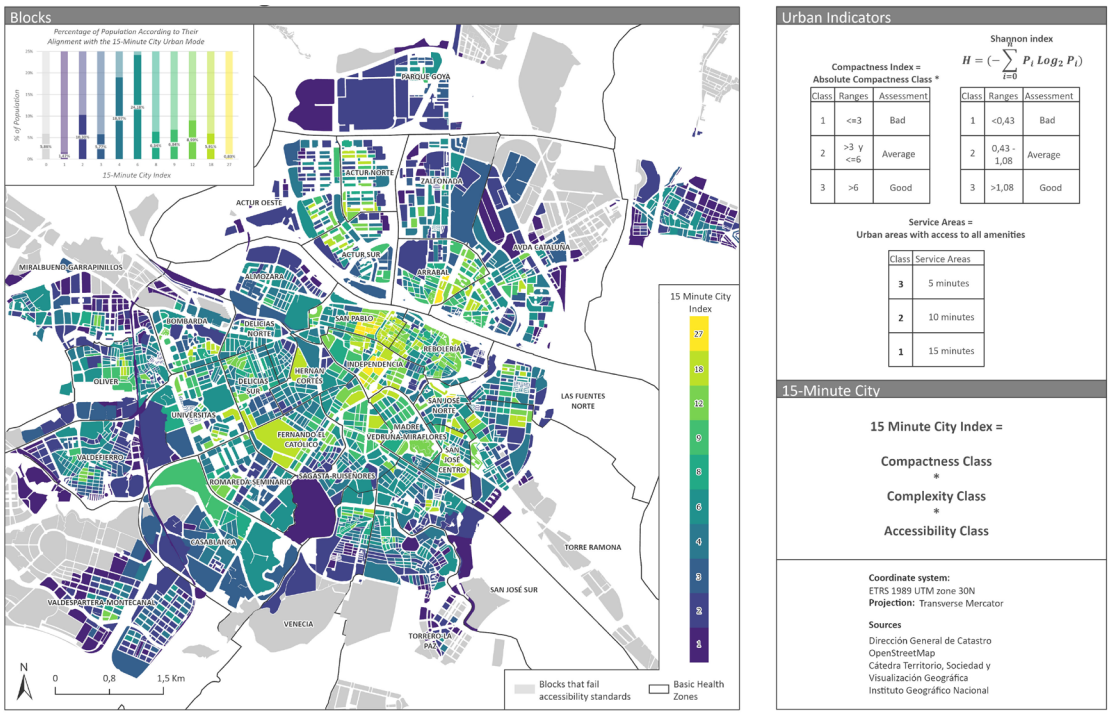
On the other hand, summarising the results presented from blocks to BHZ, a clear centrality of the chrono-urbanist model of the 15-minute city is observed in Zaragoza. These are the urban areas with the highest average index, such as San Pablo (12.5), Independencia (11.1), San José Norte (8.4), Rebolería (8.29), and Arrabal (8.1).

Specifying the location of the urban areas where all conditions are met, i.e., those that obtain the maximum score of 27, they are:

- Independencia Sector: The blocks between Paseo Independencia and Avda. de César Augusto surrounding Plaza Ntra. Sra. del Carmen; the block between Paseo Pamplona and Calle Canfranc facing Puerta del Carmen; the block between Paseo Independencia and Constitución that opens towards Plaza Paraíso.
- San Pablo Sector: Quadrant of blocks located between Avda. de César Augusto and Calle Mariano de Cerezo, closer to Calle de Conde Aranda.
- San José Norte Sector: Block located between Camino de las Torres and the streets of Miguel Servet and Roger de Tur.
- Arrabal Sector: Blocks southeast of this BHZ, between Calle Sobrabe and Matilde Sanguesa Castañosa.
- Actur Norte Sector: Block between Calle de José Luis Borau and Julio García Condoy.

The bulk of Zaragoza's population (24%) resides in areas with a rating of 6. The percentage for ratings below 6 represents 42% of the population, while in the opposite situation, i.e., the population living in areas with ratings between 6 and 27, represents 28%. Thus, as shown by the various graphs for the BHZ, there are significant differences between the areas of Zaragoza.

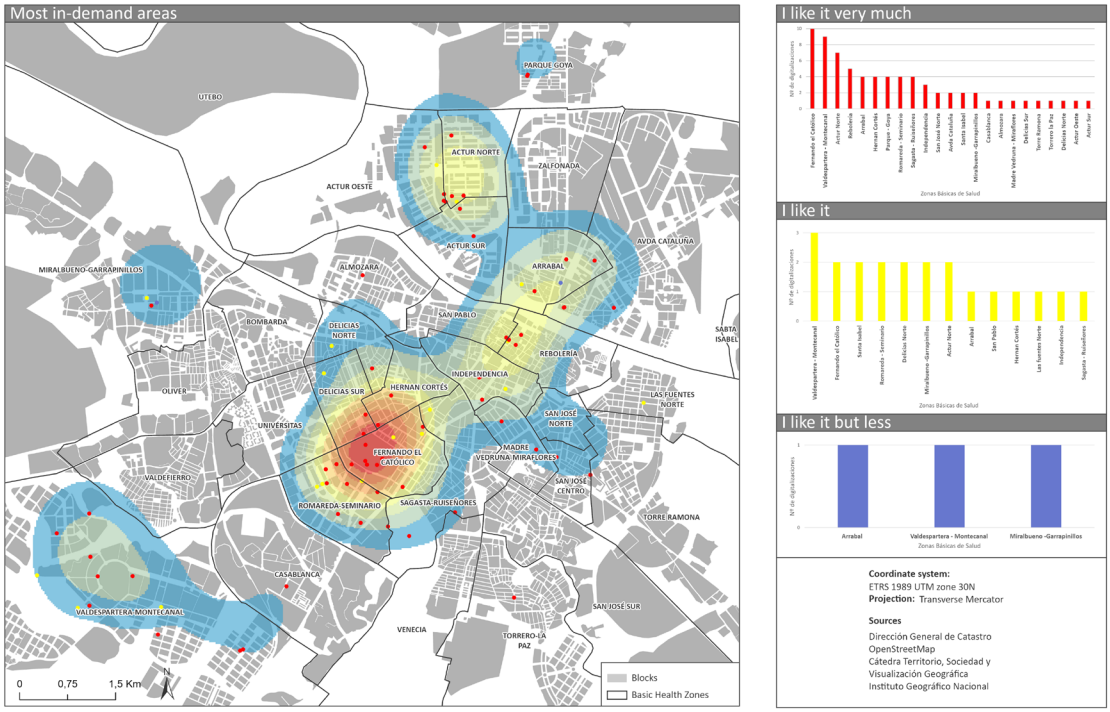
FIGURE 9.
THE 15-MINUTE ZARAGOZA.



4.6. Collaborative Maps

Analysing the data from the collaborative maps, shown in the following Figure 10, confirm the need to handle the data with caution and not draw hasty conclusions, as some results may contradict each other. For example, while Fernando el Católico is the second BHZ with the most demands for facilities, it is also the most demanded in the "I move house" map. This apparent contradiction can be explained by studying the surveyed population. If the majority of respondents are university students who spend a significant part of their day on the San Francisco campus, this can justify the relative importance given to this BHZ and consequently the "neglect" of other urban areas.

FIGURE 10.
COLLABORATIVE MAP "I MOVE HOUSE".



5. StoryMap

Stories or narratives have been the most effective means of communication for transmitting knowledge" (Marta and Osso, 2015). "And cartography, as a fundamental tool for encoding, modelling, and representing what happens, successfully complements these narratives" (Roth, 2013).

If to these two essential pieces of evidence for geographic dissemination the transmission of information is introduced digitally, it acquires a powerful tool for effective communication.

In a society where the immediacy of knowledge is paramount, where the flexidimensionality of space spreads with the generalisation of screens and the beginning of the AI era, it is undeniable how geographic visualisation tools such as ESRI's StoryMap facilitate geographical storytelling" (Cope, *et al*., 2018).

The StoryMap of the present article (https://arcg.is/G0LGu) visually represents urban concepts and a dense database through a clear, organised, and intuitive interface that promotes audience interaction with the tool during the visualisation and reading process.

The structure of this StoryMap does not follow the classical canons presented in the article; instead, its reading is planned and organised towards specific comprehension goals by presenting concepts in divergent visual patterns that emphasise their relationships (Reutzel, 1985). It is worth highlighting the joint presentation of methodology with results, exposing each urban indicator with its cartographic representation.

The combination of multimedia such as images and videos with interactive maps and three-dimensional representation, as well as the inclusion of graphics, pop-ups, tables, and text, constructs an engaging narrative thread for the general audience (Caquard and Cartwright, 2014).

Therefore, the StoryMap is a flexible GIS tool that allows adapting its content to a broad audience without losing the detail or essence of those fundamental sections (Roth, 2021).

6. Discussion

In this article, a series of urban indicators (Compactness, Complexity, and Accessibility) have been calculated, allowing the assessment of Zaragoza's suitability with respect to the 15-minute city model.

As the methodology section justifies and the results confirm, the nature of this work is predominantly geographical, where the scale of analysis poses a fundamental issue in obtaining and representing the data.

As a result, the working scale has been the most methodologically accessible and manageable, represented by blocks, census sections, or Basic Health Zones, depending on the condition of each indicator.

According to this scaling issue, several limitations have arisen, hindering a homogeneous representation of the different indicators. This limitation has been mainly encountered in the complexity indicator, as it is calculated based on the buildings within each block. Therefore, obtaining and presenting the results of this section with another scale would entail a complexity that poorly represents reality. Consequently, the complexity data for Basic Health Zones (BHZ) have been calculated with the average of each of these primary care units.

Another aspect to consider is the level of aggregation used to calculate the absolute compactness indicator, as it involves relating administrative units with varying surface areas (for example, census sections in the centre of Zaragoza are smaller than those near the municipality's boundary). This methodological "restriction" is addressed in other studies, such as those by the Urban Ecology Agency of Barcelona in their analyses of cities like Lugo or Vitoria, where reference units are created for calculating compactness using a raster grid.

Another methodological limitation was encountered for the corrected compactness indicator due to the lack of publicly available layers (provided by Spatial Data Infrastructures) such as street widths. This required valuable digitization of spaces classified by OpenStreetMap as pedestrian streets. This absence of layers also posed another limitation for accessibility analyses, as the indicator was calculated using lines identified as highways by OpenStreetMap.

As a result of the disadvantages encountered, the future lines of work to expand and improve the analyses of this study are evident:

- Calculation of Absolute Compactness using reference units defined by a raster grid.
- Update complexity with new building use data registered by the land registry.
- Creation of a database with the width of all sidewalks and crosswalks in Zaragoza.
- Expansion of bicycle accessibility analysis by incorporating shared lanes with other vehicles and adding direction impedances and speed limits to the Network Dataset.

However, these limitations have led to the discovery of new avenues to achieve the set objectives. Thus, the main advantage of the methodology used is that it can be applied in other cities, comparing results and drawing new conclusions.

The fact that Zaragoza is considered a medium-sized city allows for its comparison with other cities that have already been analysed for compactness and complexity, such as Lugo and Vitoria by the Agència d'Ecologia Urbana de Barcelona, or the case of Loja in Ecuador (Muñoz, 2013).

When comparing the findings from various studies with the situation observed in Zaragoza, it is evident that in these medium-sized cities, there is a clear factor of centrality for both absolute compactness and complexity. These urban areas tend to achieve better results. Meanwhile, corrected compactness exhibits a more dispersed spatial distribution, with suitable values found in areas ranging from the historical centre (including Zaragoza) to the urban periphery.

This chrono-urban model, which will shape the city of Paris in the coming years, is highly attractive to other cities because it addresses many of the goals and proposals outlined by the Sustainable Development Goals (SDGs) or the New Urban Agenda of Habitat III.

However, Pedro B. Ortiz's reflection on the "loss of international competitiveness and economies of scale" that could result from the fragmentation of the city into small 15-minute urban areas is very interesting.

Far from fostering spatial fragmentation, the 15-minute city model is fundamentally oriented toward advancing territorial equity. By enhancing local accessibility, it reinforces urban cohesion and mitigates socio-spatial inequalities, all while maintaining the functional efficiency of the broader metropolitan system.

Furthermore, it is essential to consider the social dynamics, as not all 15-minute divisions of a city currently have the same services, as demonstrated by this study. These physical differences can translate into human injustices in the form of social disparities.

Therefore, the 15-minute city must be analysed from an interdisciplinary perspective, due to the numerous implications it entails. The presentation of this research through the StoryMap tool may initially present certain limitations such as prior unfamiliarity or being fully digital. However, the ArcGIS Online environment with which it is created is simple and intuitive, and its digital presentation, far from being a limitation, has become its main virtue.

This urban analysis of the city of Zaragoza, with over 2,800 views, has been highly relevant, being published in the press, shared on social media, and even shared by Carlos Moreno himself, the pioneer of the 15-minute city concept.

For this Discussion section in the StoryMap, a vertical sidecar is again utilised, incorporating images, infographics, a map, and direct links to websites with pop-up text, aiming to showcase the main methodological limitations encountered.

7. Conclusions

This research has concluded with the design of a 15-minute city index, which has enabled the evaluation of this urban model in the city of Zaragoza. Based on the analysis of the different aspects it encompasses (compactness, complexity, and accessibility), the following conclusions have been drawn:

- The spatial distribution of both types of compactness (absolute and corrected) shows a clear centrality, with urban areas closer to the historic centre achieving the best results for both types of compactness. Meanwhile, the immediate outskirts surrounding this urban centre stand out for higher absolute compactness at the expense of corrected compactness. Conversely, in the outermost urban outskirts, the opposite situation is observed, with areas standing out for their high corrected compactness.
- That centrality is repeated in the complexity analysis, where once again those more central areas of the city obtain higher complexity values, while also exhibiting less variability in their results, making them more homogeneous than the urban areas on the outskirts, where greater diversity of complexity among their blocks is observed.
- When analysing all the service areas of the studied facilities together, Zaragoza shows good sustainable accessibility, as 92.86% of its population has their needs covered within a maximum time of 15 minutes.
- In a preliminary approach to citizen participation methodologies such as collaborative mapping, there is a correspondence between areas with higher ratings on the 15-minute City Index and the most demanded urban areas for changing residence, demonstrating the enormous potential of these techniques.

After conducting the various analyses, it is concluded that Zaragoza exhibits differences among its urban areas, although the distribution of the three variables comprising the index shows a clear centrality, with the historic centre and adjacent spaces standing out as the most representative of this 15-minute city concept in Zaragoza.

Therefore, it is considered interesting to expand and cross-reference the results with sociodemographic information to create a rich database from which to strategically and comprehensively plan the city of Zaragoza.

The presentation of the research in StoryMap has demonstrated the power of this format as an indispensable resource in the fundamental task of communicating geographical knowledge.

Declaration of conflict of interest

The authors of this article declare that they have no financial, professional, or personal conflicts of interest that could have inappropriately influenced this work.

Declaration of authorship contribution

Nacho Quílez Aznar: Conceptualisation, Data Curation, Formal Analysis, Research, Methodology, Validation, Visualisation, Drafting – original draft, Writing – proofreading and editing.

María Zúñiga Antón: Conceptualisation, Formal Analysis, Methodology, Monitoring, Visualisation, Drafting – original draft, Writing – proofreading and editing.

Carmen Bentué Martínez: Conceptualisation, Formal Analysis, Methodology, Monitoring, Visualisation, Drafting – original draft, Writing – proofreading and editing.

Bibliography

Adiego, E. (1995) "La estructura de Zaragoza", en: Escolano, S. (ed.): *Atlas de geografía de Aragón,* Zaragoza, IFC-CAI.

Zúñiga, M. (2009). *Propuesta cartográfica para la representación y análisis de la variable población mediante Sistemas de Información Geográfica: el caso español* (Doctoral dissertation, Universidad de Zaragoza).

Barber, B. R. (2013). *If mayors ruled the world*. Yale University Press.

Bellet, C. y Alonso, M. P. (2016). Proyectos urbanos incompletos. Vacíos urbanos en la Zaragoza post-AVE. Boletín de la Asociación de Geógrafos Españoles, nº 70, pp. 285-304.

Bosetti, M. Q. (2016). Compacidad Urbana: Estrategia Metodológica en pro de la Complejidad de las Ciudades. *Revista de Urbanismo*, (35), 4-26.

Brotton, J. (2014). *Historia del mundo en 12 mapas*. Debate.

Bustos, M. (2015). A*nálisis de la complejidad urbana en la ciudad turística: El caso de La Pineda (Vila-seca, Tarragona)*. International Conference on Regional Science: Innovation and geographical spillovers: New approaches and evidence.

Campos, Á. P. (2020). La inteligencia geográfica: construyendo conocimiento fidigital para la sociedad y sus espacios. In *Desafíos y oportunidades de un mundo en transición: Una interpretación desde la Geografía* (pp. 777-792). Servei de Publicacions

Caquard, S., & Cartwright, W. (2014). Narrative cartography: From mapping stories to the narrative of maps and mapping. *The Cartographic Journal*, 51(2), 101-106.

Chaire Entrepreneuriat Territoire Innovation. (2020) *Qui Somme-nous? https://chaire-eti.org/la-chaire/*

Cerda, J. (2010). Análisis crítico de la geografía del tiempo como base conceptual para el entendimiento de la funcionalidad espacio-temporal de las ciudades. *Report de recerca*, *7*.

CICIM oficial (2020). *Carlos Moreno: La Ciudad de los 15 minutos (Smart Cities). https://www.youtube.com/watch?v=hmlAnYm74n8&t=1300s*

Ciudades que caminan (s.f.) *Metrominuto: caminar no cuesta tanto https://ciudadesquecaminan.org/blog/repor/metrominuto-caminar-es-cool/*

Cope, M. P., Mikhailova, E. A., Post, C. J., Schlautman, M. A., & Carbajales-Dale, P. (2018). Developing and evaluating an ESRI story map as an educational tool. *Natural Sciences Education, 47(1)*, 1-9.

de la Cruz-Mera, Á. (2019). La Agenda Urbana Española.

de Urbanistas, C. E. (2003). Nueva Carta de Atenas. *La visión de las ciudades en el siglo XXI del Consejo Europeo de Urbanistas*.

Delgado, M. (2011). Prólogo del texto Muerte y vida de las grandes ciudades de Jacobs Jane. *Madrid: Capitán Swing*.

De Miguel González, R. (2014). Metamorfosis urbana en Zaragoza. *Biblio3W Revista Bibliográfica de Geografía y Ciencias Sociales*.

Diamond, J. (2016). *Sociedades comparadas: Un pequeño libro sobre grandes temas*. Debate.

Diputació Barcelona. (2019). *Planificación urbana integral, aprendiendo de Europa*. Serie Administración Local

Escolano, S. (2018). Los espacios urbanos: procesos y organización territorial. *Zaragoza: Universidad de Zaragoza. Recuperado de https://geografia. unizar. es/sites/geografia. unizar. es/files/archivos/Documentos/sescolano_urbana_tema_2. pdf*.

Escolano-Utrilla, S., López-Escolano, C., & Pueyo-Campos, Á. (2018). Urbanismo neoliberal y fragmentación urbana: el caso de Zaragoza (España) en los primeros quince años del siglo XXI. *EURE (Santiago)*, *44*(132), 185-212.

ETSAM [Escuela Técnica Superior de Arquitectura de Madrid (UPM)]. (7 de julio de 2021). 15-Minute City and Health [Archivo de Vídeo]. YouTube *https://www.youtube.com/watch?v=S5hNJ_HyRZ4*

Federación Española de Municipios y provincias. (2020) *Guía Divulgativa. Agenda Urbana Española.*

Flanagin, A. J., & Metzger, M. J. (2008). The credibility of volunteered geographic information. *GeoJournal*, *72*(3-4), 137-148.

Garrocho, C. (1993). De la casa al hospital: un enfoque espacio-temporal. *Estudios sociológicos*, *11*(32), 547-554.

Ges, A. F. (2018). Análisis de los proyectos urbanos estratégicos en el contexto europeo, 1997-2017. El caso de Zaragoza. In *Ciudad y formas urbanas: perspectivas transversales: Libro de resúmenes* (p. 147). Institución Fernando el Católico.

Han, B. C. (2017). *La sociedad del cansancio: Segunda edición ampliada*. Herder Editorial.

Harley, J. B., Woodward, D., & Lewis, G. M. (Eds.). (1987). *The history of cartography* (Vol. 1, p. 622). Chicago: University of Chicago Press.

INE. (2023) Cifras oficiales de población de los municipios españoles: Revisión del Padrón Municipal. https://www.ine.es/jaxiT3/Datos.htm?t=2907

Jacobs, J. (1961). *Muerte y vida de las grandes ciudades*. Capitán Swing Libros.

Jay, P., García, L. B., & Gómez, D. L. (2002). *La riqueza del hombre: una historia económica de la humanidad*. Crítica.

LA Network. (2020). *Ciudad de los 15 minutos: ¿en qué consiste la propuesta de Anne Hidalgo para su segundo mandato.* https://la.network/ciudad-de-los-15-minutos-en-que-consiste-la-propuesta-de-anne-hidalgo-para-su-segundo-mandato/

López, C. y Rodríguez, M.M. (2022). Un caso de análisis para la planificación urbana en el contexto del COVID-19: el Acuerdo por el Futuro de Zaragoza (España). Revista de Urbanismo, (46), 3-21.

Luis Buezo. (3 de octubre de 2020). La Ciudad de los 15 minutos VS La Metrópoli de 30 minutos – Entrevista a Pedro Ortiz. [Archivo de Vídeo]. YouTube. https://www.youtube.com/watch?v=2MvDSUt9B3Y&t=3s

Marín-Cots, P., & Palomares-Pastor, M. (2020). En un entorno de 15 minutos. Hacia la Ciudad de Proximidad, y su relación con el Covid-19 y la Crisis Climática: el caso de Málaga.

Mardones-Fernández-de-Valderrama, N., Luque-Valdivia, J., & Aseguinolaza-Braga, I. (2020). La ciudad del cuarto de hora,¿ una solución sostenible para la ciudad post-COVID-19?.

Marta, M., & Osso, P. (2015). Story Maps at school: teaching and learning stories with maps. J-READING *Journal of reasearch and didatics in Geography, 2*.

Moreno, C. (2023) *La revolución de la proximidad.* Alianza Editorial.

Muñoz, V. (2013). *Cálculo de indicadores urbanos mediante sistemas de información geográfica. Caso de estudio: Loja, Ecuador.* Universidad de Salzburg

Naciones Unidas. (2015) *Objetivos de Desarrollo Sostenible*. https://www.un.org/sustainabledevelopment/es/

Ministerio de Sanidad, Consumo y Bienestar Social (s.f.) https://www.sanidad.gob.es/estadEstudios/estadisticas/sisInfSanSNS/ofertaRecursos/hospitales/home.htm

ONU III, H. (2016). Nueva Agenda Urbana

Pickles, R., & Cooke, T. (Eds.). (2015). *Mapas: explorando el mundo*. Phaidon.

Pueyo, Á., Kratochvíl, O., Postigo, V., López, C., Alonso, M.D.P., & Zúñiga, M. (2016). El análisis de la vulnerabilidad sociodemográfica en áreas urbanas mediante indicadores multi-escalares y herramientas cartográficas. *In XV Coloquio Ibérico de Geografía 2016. Retos y tendencias de la Geografía Ibérica: actas. Murcia, España, 7-9 noviembre 2016* (pp. 1177-1188). Asociación Española de Geografía.

Reboratti, C (2001). *Una cuestión de escala: sociedad, ambiente, tiempo y territorio.* Sociologias, núm. 5, enero-junio, 2001.

Reutzel, D. R. (1985). Story maps improve comprehension. *The Reading Teacher, 38(4)*, 400-404.

Roth, R. E. (2013). An empirically-derived taxonomy of interaction primitives for interactive cartography and geovisualization. *IEEE transactions on visualization and computer graphics, 19(12)*, 2356-2365.

Roth, R. E. (2021). Cartographic design as visual storytelling: synthesis and review of map-based narratives, genres, and tropes. *The Cartographic Journal*, 58(1), 83-114.

Rubiales, M. (2019) Ciudades del Futuro. [Podcast] No es un día cualquiera. Radio Nacional España

Rueda, S. (2010). Plan de indicadores de sostenibilidad urbana de Vitoria-Gasteiz. *Agencia de Ecología Urbana de Barcelona, Ayuntamiento Vitoria Gasteiz*.

Sanz, A. (1997). Movilidad y accesibilidad: un escollo para la sostenibilidad urbana. *Construcción de la Ciudad Sostenible, Documentos. Recuperado de http://habitat. aq. upm. es/cs/p3/a013. html*.

United Nations. (2018) *World Urbanization Prospects 2018*. Department of Economic and Social Affairs Population Division.

Urban Agenda for the UE. (2016). *Pact of Amsterdam.*

Valenzuela, C. O. (2006). Contribuciones al análisis del concepto de escala como instrumento clave en el contexto multiparadigmático de la Geografía contemporánea. *Investigaciones geográficas*, (59), 1.