GREEN URBAN INFRASTRUCTURE

SPAIN

Facts and Perceptions
Multifunctional Urban Agriculture

Coordination: Julián Briz

European Green Market Report
EFB WGIN

PRONATUR · FUNDACIÓN FORO AGRARIO · POLITÉCNICA · itd UPM · Fundación Juan XXIII · ACTUAL research · Bilendi & respondi

GREEN URBAN INFRASTRUCTURE SPAIN

Facts and Perceptions
Multifunctional Urban Agriculture

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INDEX

Madrid. I. de Felipe

Zaragoza.
J. Sicilia

PROLOGUE 1
EVOLUTION AND CHALLENGES OF GREEN INFRASTRUCTURE

Julián Briz
PRONATUR

Isabel de Felipe
itdUPM

The work is part of the European Green Market Research Initiative for Roofs and Walls, taking Nature-Based Solutions (SBN) as a reference.

The majority of the European population (75%) lives in urban areas, and we are aware that our habitat model is not sustainable due to climate issues, heat island effect, pollution, energy imbalance and natural resources, among other aspects. This forces the public and private sectors to take measures in the short, medium and long term.

There are numerous scientific studies that show the benefits of ecological technologies to solve the problems of European urbanisation, which requires us to call upon decision-makers to adopt affordable and sustainable measures, which include green infrastructure (https://greenmarketreport.eu/).

The European Green Market Report on green roofs and walls was carried out at the national level, following the guidelines of the European Federation of Green Roofs and Walls (EFB: https://efb-greenroof.eu) and the European chapter of the World Green Infrastructure Network (WGIN: Worldgreeninfrastructurenetwor.org), of which PRONATUR is a member of the Board of Directors (www.pronatur.es).

In April 2019, the UK Green Market Report was published by Living Roofs (www.livingroofs.org). In September 2019, the German Green Market Report was published by the German Green Infrastructure Association BUGG (https://gebaeudegruen.info/). In August 2020, the Austrian association VIB (https://gruenstattgrau.org) followed suit.

The idea of having greener cities in Europe continues to lead various European countries to prepare reports, sponsored by both public and private initiatives (https://greenmarketreport.eu/en/). It is in this context that we have established a platform for collaboration between institutions, universities, the private sector and the social sector in Spain to analyse the field of green infrastructure.

PRONATUR follows the EFB guidelines in Europe. Foro Agrario is conducting research projects with the Ministry of Ecological Transition, in coordination with the Innovation and Technology for Development Centre of the Universidad Politécnica de Madrid (itdUPM). The Juan XXIII Roncalli Foundation and the company Actual Research have carried out the field and research work.

There are some notable differences with respect to other European studies.

In Spain, there are certain barriers to obtaining statistical information, which is quite scarce in terms of green infrastructure projects, both locally and regionally. Data from the business sector is even more difficult to obtain, with limited access to information on market strategies. However, in recent decades there has been a tendency towards green projects in Spain, albeit somewhat behind compared to other European countries.

For all these reasons, we have prepared this report on green infrastructure in Spain, combining available information with the perceptions of the actors involved by requesting their opinions, including businesspeople, civil servants, scientists and experts.

We consider that the pilot analysis we have carried out must be complemented by more in-depth studies and with broader scenarios in terms of the time frame, type of research and location.

We hereby present the results, thanks to the effort and enthusiasm of the working group, with the aim of highlighting the important role that Nature-Based Solutions must play in response to the challenges of our environment.

Madrid. April 2022
***Julián Briz** / President of PRONATUR*
***Isabel de Felipe** / Researcher at itdUPM*

HEALTHY CITIES NEED OBJECTIVE AND FORWARD-LOOKING GREEN INFRASTRUCTURE STUDIES

PROLOGUE 2

GREEN INFRASTRUCTURE AND FORO AGRARIO FOUNDATION

José Abellán
Foro Agrario

Green infrastructure relies on nature for ecological advantages, and has demonstrated its ability to solve problems more efficiently than others when it comes to fostering synergies with the environment and social wellbeing.

The obvious impacts of the "unnatural" environment in cities are not mitigated if the 'green spaces', in the form of parks and gardens, are not accompanied by other green infrastructures that connect them. This is even more evident in large cities. For example, these green spaces allow biodiversity to flourish and promote inclusive spaces for the public. They can function as instruments to integrate and connect highly diverse spaces (urban, peri-urban, rural and natural) at different levels (local, metropolitan, regional, international, etc.). This in turn presents an opportunity to move towards land-use planning that transcends the administrative boundaries that have made us lose sight of the territory as a whole. Achieving the integrated development of cities and rural areas seems to be the prevailing concept in the EU. In this sense, we believe that it would be beneficial for Spain to facilitate this interconnection between green infrastructures to include old cattle tracks, networks of nature trails and water basins, among other elements.

Environment Project. I. de Felipe

Within this concept of green infrastructure that is so necessary for cities, we consider urban and peri-urban gardens to be an essential part of this infrastructure, and which can contribute to mitigating the environmental effects caused by urban agglomerations. It can also help to reinforce food sovereignty in urban areas and provide continuity to the forms of production and consumption based on the principles of agroecology, maintaining and/or re-introducing traditional crops and varieties.

ENVIRONMENTAL PROJECTS MUST BE DEVELOPED FOR THE WELL-BEING OF CITIZENS

That is why in 2021, with the support of the Ministry for the Ecological Transition and the Demographic Challenge, the Fundación Foro Agrario carried out two projects for the recovery and characterisation of fruit tree seeds, with the technical and scientific assistance of the itdUPM. It is worth mentioning that the same initiative had already been carried out with the stone fruit tree species in 2019. In addition, a third project had previously been carried out with the technical assistance of CEIGRAM (UPM) to characterise the urban gardens of the Network of Cities for Agroecology, in order to host the varieties of stone fruit trees of particular agroecological interest that had been identified in the work carried out before the COVID-19 pandemic.

The final results of the research are currently in the editing process, and the provisional versions can be found the website created by Foro Agrario: https://www.flavoresdeespaña.com/

José Abellán Gómez */ Foro Agrario President*

Madrid.
I. de Felipe

PROLOGUE 3

CITIES, GREEN INFRASTRUCTURE, AND AGROECOLOGY

Carlos G. Hernández
itdUPM

The COVID-19 pandemic has highlighted the need for today's society to be in contact with nature, to have open spaces and green areas. Cities are increasingly complex in their social, urban and technological aspects, as well as their biotic and abiotic aspects. The Mediterranean climate, which is prevalent in most of the country, along with climate change and the availability of water are all factors that have shaped the design of urban green infrastructure, even more so than in other humid areas with more stable environments. These conditions call for innovation, or sometimes 'retro-innovation', that is, looking to the past to find the designs and resource management that has traditionally been used in many cities in the south of Spain, with a highly particular culture of water; or on the contrary, looking to the traditional designs of the humid northern regions.

The design and management of green urban infrastructure must be carried out based on the principles of ecology, agronomy and landscaping. In this regard, the new organic farming regulation [Regulation (EU) 2018/848 of the European Parliament and of the Council of 30 May 2018 on organic production and labelling of organic products and repealing Council Regulation (EC) No 834/2007], applicable as of January 1, 2022, provides the possibility for groups of small producers to be accredited in this category, and could provide a space for the recognition of urban and ecological agriculture. In any case, urban green infrastructure must be designed based on the principles of agroecology, essentially promoting the responsible use of resources, fostering biodiversity and minimising the use of phytosanitary products. The European Action Plan for Organic Farming aims to implement a fair, healthy and sustainable food system throughout the European Union, in which the participation of cities will be essential to achieving the proposed objectives.

Cuenca.
I. de Felipe

The interest shown in this type of green infrastructure throughout the country is based on the perspective that green spaces are living organisms (they are born, they grow, reproduce, and die, to be reborn). In this regard, the principles of ecosystem dynamics must be applied, promoting diversity and adaptation to the microclimatic conditions of the urban environment, in which each environment is unique and requires multidisciplinary teams to understand it.

The Milan Urban Food Policy Pact, signed by various cities during the World Food Expo, held in Milan in 2015 and to which many other cities have since adhered, is leading the way on Urban Food Policies. There is already talk of 'edible parks' or simply holding discussions on agriculture in the urban environment, policies with significant international impact. In that same year, the United Nations approved the 2030 Agenda and its 17 Sustainable Development Goals. There are two objectives that, without a doubt, will have a relevant impact on cities and on the progress of green infrastructure: SDG 11 on sustainable cities and communities, and perhaps, to a greater extent, SDG 12 on responsible production and consumption, given that cities are already the main centres of consumption. Both of these SDGs aim for progress towards sustainable, inclusive, resilient, equitable, safe, and diversified food systems to ensure healthy and accessible food, reduce food waste and preserve biodiversity.

The Network of Cities for Agroecology is comprised of many Spanish cities, which understand and appreciate the multifunctionality of green space within the city. Green infrastructure contributes to making cities more environmentally friendly, reducing pollution, and improving the microclimate and overall health.

GREEN INFRASTRUCTURE MUST FOLLOW THE PRINCIPLES OF ECOLOGY, AGRONOMY AND THE LANDSCAPE

Recently, the European Green Deal has presented specific measures for biodiversity regeneration between now and 2030, paying special attention to cities. Some of the actions include increasing flora and fauna, and the recovery of degraded soils or green spaces on facades or rooftops. The Universidad Politécnica de Madrid (UPM), through the Innovation and Technology for Development Centre (itdUPM), and the Madrid Deep Demonstration of Healthy and Clean Cities initiative has led Madrid and other cities to be chosen by the main European initiative for innovation, the Climate Change Demonstrator of Sustainable and Healthy Cities (EIT- Climate-KIC). This initiative recognises the efforts to increase green infrastructure and its environmental adaptation. The Cities Platform has also been created as a space for collaboration and the co-design of solutions, together with citizens, which contributes to addressing the social and environmental challenges posed by large cities, especially climate change.

Green infrastructure, serving as a link between nature and the city, has the capacity to mitigate greenhouse gas emissions, thus forming one more piece of this complex puzzle that we call cities. This study presents the state of the art of this sector and the perceptions of green infrastructure in Spain. Finally, it demonstrates the potential for the future, in which rural and urban areas merge together without a defined border.

Carlos Gregorio Hernández */ itdUPM Secretary*

Aranjuez. I. de Felipe

Cuenca. I. de Felipe

INTRODUCTION

THE MULTIFUNCTIONAL ANALYSIS OF GREEN INFRASTRUCTURE MUST COMBINE AGRO-ENVIRONMENTAL REALITIES AND SOCIAL PERCEPTIONS

Urban green infrastructure (UGI) is multifunctional in nature, allowing us to adapt it the specific place and time, or to existing needs, which explains why this sector has had to evolve throughout history. The agroclimatic conditions shape the UGI model. Therefore, in rainy, dry or extremely wet climates, water management is essential to reduce flooding, or maintain the water supply and humidity. If there is air or noise pollution, the substrate and type of plants must be adapted to it. Water management is also necessary for the production of food, ornamental plants or to facilitate recreational spaces with landscaping.

For this reason, UGIs have been identified as one-dimensional elements that have subsequently been expanded to include urban agriculture and bioclimatic architecture, among others. Today, it is seen as a helpful instrument to achieve the objectives of urban sustainability and resilience, fostering wellbeing and improving citizens' lives. A more complete vision is provided by authors such as Timon McPhearson (Cary Institute of Ecosystem Studies), who considers UTIs to be a system of interconnected ecosystems through technological and ecological integration and the construction of infrastructures that provide socioeconomic and environmental benefits.

The work has been carried out based on a broad understanding of UGIs, taking into account the difficulties in the availability of reliable comprehensive data, since there is no national reference source, and projects are carried out at the local level. Municipalities are the primary source of data, together with professional associations of architects and engineers.

There are interesting studies and publications addressing how large cities are mobilising resources to undertake large-scale projects, along with those focused on agroecological aspects (Network of Cities for Agroecology: https://www.ciudadesagroecologicas.eu/).

Another aspect that we address is the social perception of the role of UGIs, for which we have carried out an analysis by consulting groups involved in the sector at the national level. We have also interviewed urban garden managers, municipal officials and university campus officials.

The work continues with an analysis of a case study on the city of Madrid, with several remarks on lessons learnt, followed by complementary studies, and concludes with some reflections and recommendations.

Santander. I. de Felipe

Madrid. itdUPM

CHAPTER 1
THE GREEN URBAN INFRASTRUCTURE SECTOR

1.1. HISTORICAL EVOLUTION

Spain is a mosaic of climates, cultures and traditions, and the evolution of urban development is very diverse. Spain has an Atlantic climate in the north, continental in the centre and a Mediterranean climate in the southern and eastern coasts. There is a wide variety of biodiversity, linked to traditional crops, water and natural resources use and management, which requires regional and local analyses to learn about these environments.

As several authors point out, countries such as Spain and Italy have chosen to use gardens for culinary purposes, in contrast to the United Kingdom, which has opted for gardening for ornamental purposes. With few exceptions, this can be seen in the policies, habits and customs of Spain, which tend to place less importance on green infrastructure.

Most of the country experiences high temperatures, a dry climate and a long and sunny summer season. Therefore, the local flora is quite different from rainy countries, where green landscapes are common, while the Mediterranean "green landscape" is usually yellow or brown in colour. However, the principles for including nature in urban centres are similar, which we refer to "urban greening."

As mentioned, green infrastructure is more widespread in northern countries, with basic research and projects. However, the Mediterranean countries have attempted to capture some of the main ideas and recover some of the old traditions. Therefore, it is especially useful to exchange experiences, ideas and encourage basic research in Mediterranean conditions. Several factors have shaped the current situation in Spain, related to meteorological, political, socioeconomic, environmental and urban conditions. Historical trends reveal that certain barriers can be overcome due to favourable circumstances. In recent decades, a new horizon has emerged: a group of actors in urban design have laid the foundations for an evolving trend.

Córdoba.
A. Sanz

We can identify several stages in the evolution of urban nature in Spain: traditional, renaissance, and expansion or consolidation.

Traditional period

This includes all the spontaneous actions of urban greening carried out by institutions or individuals. As a Mediterranean country, the soil and climatic conditions determine the type of vegetation that is able to grow. However, there have been examples of concentrated green areas, even with exotic plants. In rural areas, old buildings were technically overrun by weeds. Detailed information on this period is not available, but generally speaking, the majority of the population lived in rural areas where urban 'green infrastructure' was not appreciated, and the buildings were considered old and abandoned when they were full of weeds. Only potted plants and those in "patios" have a longstanding tradition, mainly in Andalusia, where prizes are given through annual competitions to the most beautiful patios full of seasonal flowers.

The Green Renaissance period

This period was characterised by socioeconomic changes in the 20th century, which began when there was a demand for green areas in the new urban centres. The great migration from the countryside to the cities led to agglomerations of people, and green areas thus

THE EVOLUTION OF GREEN INFRASTRUCTURE IN SPAIN INCLUDES A TRADITIONAL PERIOD, A RENAISSANCE PERIOD AND A THIRD PERIOD OF GROWTH

became scarce. This was primarily due to urban planning, speculative plans and the lack of social and environmental principles. While the Mediterranean countries, and Spain in particular, have had a somewhat delayed response to this situation compared to other countries (mainly those of northern and central Europe), we should keep in mind that if we 'steal' the land from nature to build, we must return it to nature in the same manner. The migration of people from city centres to suburban residential areas has also changed the landscape in urban areas. Traditional neighbours have welcomed new immigrants into their neighbourhoods, sometimes with a mix of cultures, as is the case in the Lavapiés neighbourhood in Madrid, incorporating new green horticultural and gardening traditions.

In Spain, following the models of other countries (Germany, the Netherlands, the United States), an "ecological" movement began in the 1990s. Professors, researchers, officials, the business sector and citizens in general began to call for collaboration to install more green areas within cities, with calls for "urban nature". In 1989, the non-profit organization PRONATUR (Promotion of Urban and Rural Nature) was founded in the former E.T.S.I. Agronomos (School of Agricultural Engineering, today known as ETSIAAB, or by its Spanish name, 'Escuela Técnica Superior de Ingeniería Agronómica, Alimentaria y de Biosistemas (School of Agronomy, Food and Biosystems Engineering - ETSIAAB)' at the Universidad Politécnica de Madrid (UPM). It was an intense, vibrant period, with new experimental green infrastructure initiatives, research programmes, national and international seminars, doctoral theses, publications, etc. Society and the media responded (television, newspapers), showing interest, and even the Spanish Nobel Prize winner, Camilo José Cela, wrote an article about the "idealistic people of the green roofs" (Cela C.J., ABC, 1995).

Santander Bank

Institutions such as city halls, universities, banks, markets and others are now including green roofs and walls in their new construction projects. Simultaneously, a group of experts from the university, research centres, entrepreneurs and community neighbourhoods agree that having more green areas make cities more liveable. Bilateral contact with foreign European institutions has also set the stage for "greening" to truly take-off. The Berlin City Council and Humboldt University sponsored the "first experimental green roof in the Mediterranean area," located at the ETSIAAB in Madrid.

THE SUSTAINABLE CITY REQUIRES THE CO-RESPONSIBILITY OF SOCIAL ACTORS

The period of consolidation and expansion

This period began in the early 21st century, in order to consolidate the objectives achieved in recent years and expand activities based on the needs of society. The challenge was how to continue promoting the coordination between research, regulation and reconstruction. Academics, professional entrepreneurs and the government itself must be involved through incentives, through direct or indirect subsidies in research programmes (energy saving, landscaping, pollution reduction), and sustainable green and solar buildings. New advertising and promotion campaigns can encourage citizens to move towards environmentally friendly cities. The connection with international organisations (WGIN, EFB, and others) is also a source for new ideas and serves as an open discussion forum. Through Corporate Social Responsibility, companies can dedicate resources to improving the environment in urban areas. Within this period, we must also mention the concern about climate change, which in turn led to the call for an ecological transition.

In recent years, following a global trend, we can observe that the current urban model is unsustainable. Academics, experts and citizens have all denounced the situation, and there are a number of initiatives to promote urban greening, with projects in numerous Spanish cities. Barcelona, Valencia and Madrid (especially Madrid Rio and Madrid Nuevo Norte) are some of the participants in this new movement.

1.2. MUNICIPAL SCENARIOS OF GREEN URBAN INFRASTRUCTURES

In Spain, it is necessary to rethink the existing urban model. Starting with a purely regulatory approach to growth in order to provide housing and offices for an overcrowded population facing a deteriorating, unsustainable scenario, an environment is sought where the grey colours of cement and glass must be replaced by blue and green (green infrastructure and efficient water management).

In the 1980s, with the aim of revitalising neighbourhoods, expansion was promoted by creating a real estate-based model of urban

Zaragoza.
J. Sicilia

Barcelona. J. Elias

Estepona. J. Elias

development, which had a negative impact on further development, leaving behind homes that were unfinished or unoccupied in many cases. In the opinion of Professor José Fariña of the UPM, it is necessary to promote local, medium sized and small cities, where sustainable living follows a participatory community model, in line with the neighbourhood, where public services are provided simultaneously with the construction of residential buildings.

At the same time, we must think about the regeneration of existing urban spaces, where saving energy, everyday pedestrian mobility, responsible consumption and supply prevail, adopting Nature-Based Solutions as a guiding principle and in which green infrastructure has a key role to play.

The city of Vitoria is an example of such work, and was nominated as a European Green City in 2012, having successfully promoted and urban green infrastructure and agriculture, leading to an improvement in the urban environment and quality of life for residents.

Large cities such as Barcelona, Madrid, Valencia and Seville, among others, are also taking action in this regard. These cities have recently become a pioneering group within the 100 European Cities 2030, with the aim of achieving climate neutrality by the end of this decade. In the case of Madrid, this commitment is part of the ecological transition at the local level within the Madrid Deep Demonstration project.

Among the Spanish cities with successful UGI management programmes, the following are worth highlighting: Vitoria (green ring), Valencia (landscape policy), Barcelona (promoting UGI), Madrid (UGI and biodiversity), Santander (green ring of Santander bay), and Zaragoza (natural LIFE).

The Spanish green infrastructure strategy (www.miteco.gob.es/es/biodiversidad), framed within target 11.7 of SDG 11, considers that universal access to green areas must be provided in an inclusive manner from now until 2030, while also being accessible to women, children, disabled persons and the elderly.

The SDGs (Sustainable Development Goals) make reference to the UGIs in several of its goals: SDG 11 addresses sustainable cities and communities, 13 addresses climate action and 15 deals with life in terrestrial ecosystems. In the regulatory framework of the EU, Environmental Policy is framed within the 7th Environment Action Programme (EAP), as well as in the Communication on Green Infrastructure: the improvement of Europe's natural capital. In Spain, Law 33/2015 addresses this issue, among others.

Barcelona. J. Elias

WE NEED A GLOBAL ECO-SYSTEMIC VISION THAT MEASURES EVALUATIVE INDICES

In order to get a sense of the UGI of a city and its functions, such as photosynthesis and other services provided, a Vegetation Index is recommended, which would make it possible to raise awareness among citizens and city officials when prioritising the policies to be followed.

The informative green guide for Spain considers four elements of UGI: green areas (parks, gardens, facades and roofs), ecological corridors (connections between green areas), priority conservation areas (protection of flora and fauna) and buffer zones (transition between rural and urban areas). (See: Dissemination guide of the IV municipality, 2015, https:/www.mitaco.gob.es).

The data obtained in the guide was collected through surveys on the management of green areas, the resources allocated to them and their incentives, revealing relevant information due to the scope of the surveys. However, it is somewhat limited due to the lack of parameters on the quantification of green mass that some municipalities are beginning to identify, such as the volumes of tree biomass. Regarding the proportion of the municipal budget allocated to green areas, as can be expected, small cities have small populations and large areas featuring UGIs.

The average municipal budget dedicated to conserving UGIs is 2.7%, in which Getafe stands out at 8%. Regarding the average conservation cost per inhabitant, Madrid leads among the large cities, Getafe and Logroño among the medium-sized cities, and Ciudad Real among the small cities.

According to the mentioned report, 65% of the cities have a mixed UGI conservation system, with municipal and external bodies, with an average value of 2.6 euros/m^2. Although 65% of municipalities have a Geographic Information System, only 47% have an updated system.

Regarding the green areas maintained by the parks and gardens department per inhabitant in the municipality, the average is 12.46 m^2. Small cities rank higher, with six of the larger cities well above the average. Madrid stands out among the large cities with 20.52 m^2/inhabitant, and Vitoria among the medium-sized cities with 34 m^2/inhabitant, while among the small cities, Huesca stands out with 26.20 m^2/ inhabitant.

In relation to the conservation model for parks and gardens, of the 54 municipalities, 35 manage these areas through a combination of 60% external management and 40% municipal management. In 19 municipalities, these services are fully outsourced. In any case, all of the municipalities use gardening and maintenance services for street trees. The average number of street trees per area is 4.5 trees per hectare.

There has been difficulty in obtaining UGI information, even though it is necessary for its management and the adequate use of resources. It

is necessary to have a global ecosystemic vision with a measurement of the evaluation indices, both in number and quality of the UGIs.

1.3. ANALYSIS FRAMEWORK OF THE GREEN URBAN INFRASTRUCTURE SECTOR

The urban greening movement is linked to the latest trends in energy saving, the conservation of natural resources, sustainability and a healthy environment. The university, as a social catalyst, must direct its efforts towards social demands, opening up new frontiers, where there are jobs for new experts in the field. Institutions and companies, in addition to responding to the demands of a new market with the corresponding benefits, can organise the appropriate activities in this field within their Corporate Social Responsibility guidelines, since, in essence, nature and social well-being go hand-in-hand, thus integrating society and nature (Briz, J. and De Felipe, I. 2009).

Following the general trend, academia has been focusing its attention on two aspects of nature, food production and gardening. Urban agriculture has played a secondary role in academic studies in relation to rural agriculture, while gardening has been seen as an ornamental aspect, merely an improvement of the landscape.

More recently, universities and research centres are recognising other functions of UGIs, such as mitigating climate change, improving the environment, health and hygiene, recreation, saving energy and the conservation of natural resources.

Due to space and time constraints, we hereby present the experiences in Madrid, considering that cities such as Barcelona, Valencia, Seville and Zaragoza, among others, also have similar experiences in this field.

The following participants were involved in this work within the broader field of the sector:

- ***Universidad Politécnica de Madrid (UPM).*** There are several schools of this university involved in the analysis of green infrastructure, including the Higher Technical School of Agricultural Engineers (ETSIA, currently known as ETSIAAB), and the Higher Technical School of Architecture, among others. The Innovation and Technology for Development Centre (itdUPM) deserves special mention, (www.itdupm.es) as an interdisciplinary centre where researchers, professors and students come together to address the Sustainable Development Goals, collaborating with the government, private sector and civil society organizations. The centre offers face-to-face and virtual courses (MOOC on green cities), publications

Burgos. Contriz

(integrated urban agriculture, positive impacts of urban gardens in Madrid), as well as participating in international (ACT on NBS, EIT Climate KIC 2019-2021) and national research projects. It also carries out work on social innovation platforms, including the sustainable transformation of cities, created in 2018 together with the Madrid City Council. It serves as a multi-stakeholder collaborative project to address social and environmental challenges, featuring public-private collaboration through co-creative testing of prototypes and combined processes.

- ***Fundación Foro Agrario (Agrarian Forum Foundation) (https://foroagrario.es).*** Since 1989, the Foundation has been a leading think tank on agriculture, food and the environment. Together with PRONATUR, it holds the annual National Urban Nature and Agriculture Awards, in the academic and professional categories. Worth noting among the recently developed projects are the following: "Urban agriculture as an environmental improvement in cities (2016)", "Recycling of boiler gases in urban garden greenhouses (2021)", and "Urban and peri-urban orchards in the Network of cities for agroecology (2021)".

- ***PRONATUR (https://pronatur.chil.me)***. The Spanish Society for the Promotion of Urban and Rural Nature, founded in 1992, is a participatory forum for researchers, businesspeople, civil servants, university students and experts in agriculture and urban nature for green cities. As the founder of the Urban Agriculture Observatory, it offers courses, conferences, research projects and publications, and is a member of the Board of Directors of the World Green Infrastructure Network (www.wgin.org) and the Federation of European Green Infrastructure Associations (https://efb-greenroof.eu/)

- ***Juan XXIII Roncalli Foundation:*** The Foundation's objective is to foster social inclusion and job placement initiatives primarily for people with intellectual disabilities, promoting their autonomy and quality of life; developing quality employment and continuous improvement. Its line of green activities integrates design and environmental sustainability with comprehensive ecological solutions in urban areas of the Community of Madrid. It operates in the urban green infrastructure sector, from organic gardens to roof and wall gardening. It carries out projects with university entities (Universidad Politécnica de Madrid and Universidad Rey Juan Carlos of Madrid), as well as public and private entities. The circular economy is addressed in the "Madrid Mas Verde Center for Circular Economy" project. More recently, the Foundation has participated as part of the team, together with Foro Agrario, PRONATUR and itdUPM.

- ***Current Research:*** Actual Research is a strategic consultancy firm specialising in guaranteeing business growth, using market research as a tool to make the best decisions.

In addition to the quantitative and qualitative aspects of the activities carried out, we should mention co-creation as an operative methodology used in recent years, with the participation of various types of institutions, where professionals from different sectors address specific problems and provide solutions, based on the availability of resources and the capacity to carry them out viably in the long-term. Institutions such as itdUPM have served as a melting pot of ideas to carry out national and international projects.

1.4. MULTIFUNCTIONAL URBAN AGRICULTURE

Urban agriculture is no longer on the periphery, with little institutional recognition. Today, it is a dynamic movement at the national level where, in addition to changes in food production, environmental degradation can be reduced and social ties strengthened (Briz, J., De Felipe, I. 2015).

According to the work of Ballesteros (Ballesteros G., 2018) https://www.agroecologia.net/ in the Google alert service in Spanish Urban Agriculture, during the 2013-2017 period there were 2,000 annual notifications. In 2017, 682 zones were registered with 28,865 gardens, covering more than 3 million m2 in 369 municipalities.

Among the Autonomous Regions, Andalusia had the highest percentage of gardens (18%), followed by Valencia (16), Madrid (15) and Catalonia (11).

Regarding the number of gardens, Andalusia (26%), Valencia (14%) and the Basque Country (9%) are worth noting. Regarding the surface used, 3,103,254 m2 of gardens are located in the main Autonomous Regions: Andalusia (25%), Valencia (15%), Castilla y León (10%), Catalonia (10%) and Madrid (8%).

In order to discover the perceptions of the key actors in the field on this issue, we have compiled their opinions, obtained through personal surveys on three different occasions in February 2022 (Foro Agrario and the Juan XXIII Foundation project).

Methodology and results of the studies: For this purpose, we worked with a survey format that included nine questions, which was carried out by telephone or, if requested, by e-mail, sent to a list of contacts involved in the gardens that were the subject of the study, within three lines of work:

SURVEY OF MUNICIPAL OFFICIALS OF THE CITIES FOR AGROECOLOGY NETWORK

The survey was carried out with 15 municipalities. In order to obtain the relevant contacts, we referred to the website of the Cities for Agroecology Network https://www.ciudadesagroecologicas.eu/. The Cities for Agroecology Network in Spain is made up of 20 cities of different sizes and environments. The purpose of this work is to find out the availability of urban and peri-urban gardens to accommodate the varieties of stone fruit trees (apricot, peach and plum), taking into account the conditions related to municipal regulations, the climate and the soil. The telephone survey shows that the majority of the

Madrid.
I. de Felipe

entities are administrative departments of the City Council, while others are administrative concessions or neighbourhood associations with agreements in place for the management of the gardens. In most cases (8), there are less than ten gardens, while others (5) have between ten and twenty, and only in three cases did they have more than twenty gardens. The location is heterogeneous, ranging from industrial parks (5 cases), municipal land (6) and unused plots (3), all of them located in urban green areas. The users of the gardens are typically comprised of groups of ten to fifty people, who in their vast majority are between 16 years and 65 years old, and sometimes older (6 cases). Regarding gender, both men and women participate in equal proportion.

URBAN AGRICULTURE IS NO LONGER IN THE BACKGROUND AND IS LEADING A SILENT REVOLUTION

In general, vegetables are grown, and in some cases, fruit trees (3), small fruits (4), almond trees (4), olive trees (2) and pomegranates (1) are grown. The majority (9) claim they would be willing to grow traditional varieties of fruit trees. Almost all (19) claim that municipal regulations are limiting the cultivation of fruit trees. The produce from the gardens is oriented towards local consumption.

SURVEY OF USERS OF URBAN AND PERI-URBAN GARDENS THAT BELONG TO THE CITIES NETWORK

It was possible to carry out 41 surveys of garden managers/users from 10 different Spanish provinces. The evolution of urban gardens over time has been analysed, along with the sociodemographic information of the users, the types of cultivated products and the availability to incorporate local varieties among the fruit trees. Municipal regulations and the destination of the produce obtained are other dimensions that have been analysed. All of this data provides basic information that can be used for planning urban agriculture in the coming years.

Regarding the evolution over time, the majority of the gardens (21) are between 5-10 years old, while a group of 11 are less than five years old, and a third group (8) is the oldest at more than a decade old.

A very high degree of satisfaction with urban farming was observed. The majority (29) were very satisfied, and the rest (11) were satisfied, with no dissatisfied respondents.

The demographic characteristics of the users show that the most frequent age bracket (41-65 years) is represented by 34 people, followed by those under 40 years of age (25 people), and those over 65 years of age (22 people). There is parity between men and women among users.

The type of crops in urban gardens is worth noting, which are predominantly vegetables (28 cases), followed by small fruits (23), fruit trees (19), olive trees (17) and fig trees (17) g at similar levels. Almond trees (12) and pomegranates (11) are less prominently featured.

Madrid. Fundación Juan XXIII Roncalli. I. de Felipe

The majority (20) consider that the regulations are somewhat limiting for fruit trees, however, 31 claim they would be willing to grow local varieties. As can be expected, urban agricultural produce is used for local consumption (32), although there are some cases (8) where they sell their produce at local markets, restaurants and in different neighbourhoods.

SURVEY OF THOSE RESPONSIBLE FOR THE RED DE UNIVERSIDADES CULTIVADAS (GREEN CULTIVATED UNIVERSITIES NETWORK) (http://universidadescultivadas.org/)

This Network is a space for cooperative work, the exchange of experiences and dissemination of information. It is a meeting place for people who promote respect for the environment, sustainable production models and healthy eating habits. A community to learn and teach through organic gardens. This third manner of carrying out surveys began in the final phase of the project, to support the study. Research was carried out on the group's website to prepare a list contacts of the member universities, and an email was sent to them, requesting completion of the survey.

In the case of gardens on university campuses, the majority (4) have been operative for between 5 and 10 years. The experience has been reported as very satisfactory (3) and satisfactory (2). The gardens are usually grown on their own plots or are assigned by association. They most often involve between 10 and 50 people, under 40 years of age, with some representation from other age groups and the participation of both men and women. The main crops are vegetables and small fruits, with the possibility of introducing native varieties of fruit trees.

Ibiza. I. Solano

CHAPTER 2

SOCIAL PERCEPTIONS OF GREEN URBAN INFRASTRUCTURE

The Urban Green Infrastructure (UGI) sector is complex due to its multifunctionality, and needs to be analysed from both a quantitative and qualitative perspective. In both cases, the availability of financial and human resources and the opportunity to employ a multidisciplinary approach and collaboration is a determining factor, for which we have carried out a number of surveys of groups of experts and people involved in the operation of the project.

The complexity of urban greening makes it difficult to understand for the urbanite who needs to be able to appreciate and value the resources allocated to improve his or her environment in a sustainable way. Technical, socioeconomic, and environmental evaluations should be proposed using consistent criteria, as well as expert opinions summarising the current situation and highlighting strengths and weaknesses, which are presented below.

This work offers a reflection on green infrastructure in Spain, with a comprehensive vision that takes into account the difficulties of statistical and documentary sources in a sector often neglected by society. The administrative fragmentation of the regulatory regulations and the variety of institutions and professions involved have led us to supplement the available documentation with qualitative information, by including the perceptions of some of the main actors in the sector. An online survey was carried out, focused on different profiles (actors in the sector, academics, businesspeople, civil servants, neighbourhoods), seeking their opinion on the role of urban green infrastructure. Their opinions provide a qualitative value that can be useful for more in-depth and extensive studies in the future, which would serve as guidance for the actions of leaders, investors and politicians in the field of urban green infrastructure.

GREEN URBAN INFRASTRUCTURE

Spain

Facts and perceptions
Multifunctional urban agriculture

FINAL REPORT. MARCH 2022

The perceptions of a group of experts and actors in the green infrastructure sector are presented below

KEY BUSINESS FACTORS

The growing interest in urban greening has led the Federation of European Green Infrastructure Associations (EFB) to carry out a study on citizens from various European countries regarding the green urban infrastructure market.

In Spain, this study was carried out by PRONATUR, in collaboration with the Universidad Politécnica de Madrid (UPM), with the group ACTUAL RESEARCH as the Technical Director of the BILENDI study, the online panel that carried out the field work.

In order to establish the framework of the study, the key actors were interviewed, including academics, researchers, suppliers of products and services, civil servants, experts, project designers, suppliers of materials and developers, guaranteeing the confidentiality of the data and the comprehensive and anonymised processing of the data.

The study was carried out in Spain in September 2021 in a single sampling of results.

ACTUAL RESEARCH, with extensive experience in market studies, has offered PRONATUR a solution, in collaboration with the UPM, that allows it to serve as a guide to explore the future and market potential of green urban infrastructure.

Marbella.
J. Elias

Madrid.
B. González

MAIN GOAL

The main goal has been to look for a solution for evaluate the Spanish market to the following issues.

1

ASSESS THE MARKET POTENTIAL AND PROVIDE EXPERT INSIGHTS ON THE DEVELOPMENT AND BENEFITS OF GREEN INFRASTRUCTURE:

- DEVELOPMENT OUTLOOK.
- BENEFITS.
- INTEREST.
- COMPETITION AND ANTICIPATED SERVICES.

2

CHALLENGES AND POTENTIAL OBSTACLES:

- CHALLENGES OF GREEN ROOFS.
- CHALLENGES OF GREEN WALLS.
- INTEREST.
- EXPANSION OF THE COMPANY'S COMPETENCE PROFILE.

3

VOLUME OF PROJECTS, TYPE OF CLIENTS AND MARKET DEVELOPMENT:

- LAST 3 YEARS.
- NEXT 3 YEARS.
- SEGMENT OF THE VALUE CHAIN IN WHICH IT OPERATES.
- ESTIMATED BUSINESS VOLUME.

4

PERCEPTIONS OF THE BENEFITS OFFERED BY GREENING:

- EFFECTS OBSERVED.
- RECOMMENDED MEASURES. EVOLUTION.
- RELEVANCE FOR THE SPANISH MARKET.
- QUALITY OF THE OFFER.
- ATTRACTIVENESS OF THE OFFER RECOMMENDATIONS AND REPUTATION.

METHODOLOGY

A QUANTITATIVE-PANEL methodology was used with the following characteristics:

POTENTIAL population in Spain of academic researchers, suppliers of products and service providers, experts, civil servants, project designers and nursery operators and developers.

SCOPE national level

110 EXPERTS (sample error +-9,00% for p=q=50% with a 95% confidence interval).

SAMPLE STRATIFICATION (I)

BASIC ACTIVITY

- Academic researchers = 41 interviews
- Project designers = 23 interviews
- Officials = 21 interviews
- Experts = 16 interviews
- Suppliers of products and service providers, nursery operators and developers = 9 interviews

ZONES

- Centre = 78 interviews
- Other representative regions = 32 interviews

QUESTIONNAIRE

Structured online questionnaire designed by PRONATUR, UNIVERSIDAD POLITÉCNICA DE MADRID and ACTUAL RESEARCH. 15 minutes per interview.

STATISTICAL PROCESSING AND ANALYSIS

Frequency analysis, cross tabulation and segmentation analysis were carried out.
A graphic report of results has been obtained with the main conclusions of the study

QUALITY CONTROL

According to the CCI/ESOMAR code of conduct

1

Madrid.
I. de Felipe

CAN THE MARKET POTENTIAL BE MEASURED AND CAN EXPERT INSIGHTS BE PROVIDED ON THE DEVELOPMENT AND BENEFITS OF GREEN INFRASTRUCTURE?

DEVELOPMENT OUTLOOK IN THE UPCOMING YEARS

"The EXPERTS have a predominantly positive view of the development of the green infrastructure sector."

PREDOMINANTLY POSITIVE 85%

And the most relevant benefits for them are ...

- **Better quality of life**
- **Improvements in the microclimate**
- **Ecological impact**

"THIS IDEA THAT WE CAN IMPROVE QUALITY OF LIFE THROUGH GREEN INFRASTRUCTURE, IMPROVE THE CLIMATE AND ECOLOGICAL EFFECTS, IS NOT A FIGMENT OF OUR IMAGINATION OR A HOPE FOR THE FUTURE... IT IS ACTUALLY POSSIBLE ACCORDING TO EXPERT INSIGHTS"

LEVEL OF IMPORTANCE OF THE BENEFITS OF GREEN INFRASTRUCTURE FOR CITIES AND BUILDINGS IN THE NEAR FUTURE

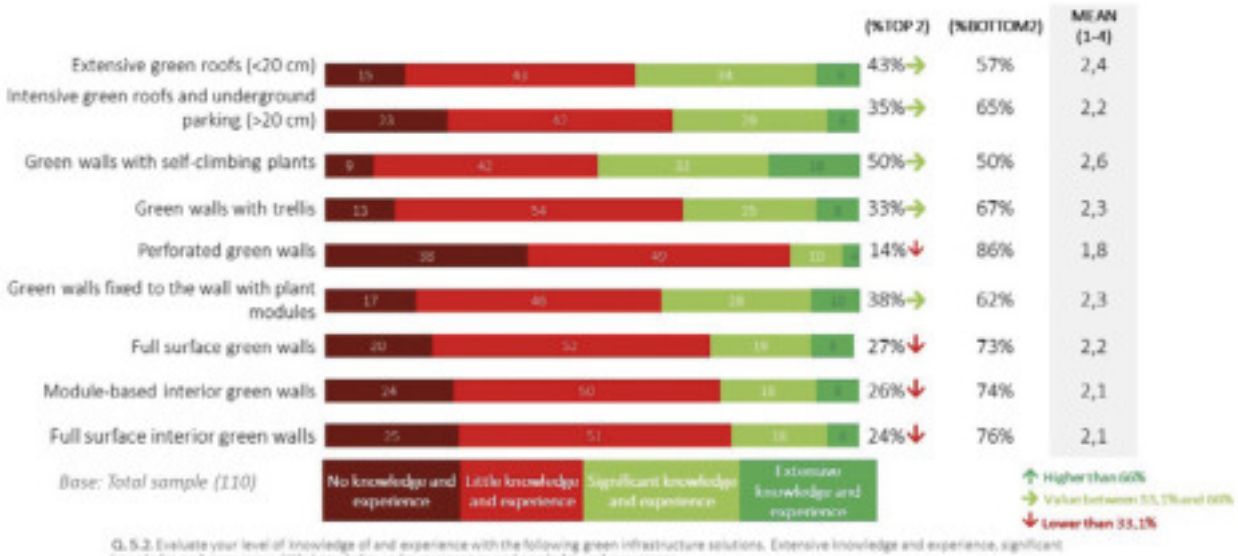
A high level of importance was given to all the aspects measured, with ratings above 3 on a scale of 1-4. However, the improvements in the microclimate and the increase in quality of life are especially worth noting.

Madrid.
I. de Felipe

Estepona.
J. Elias

LEVEL OF KNOWLEDGE AND EXPERIENCE OF GREEN INFRASTRUCTURE SOLUTIONS

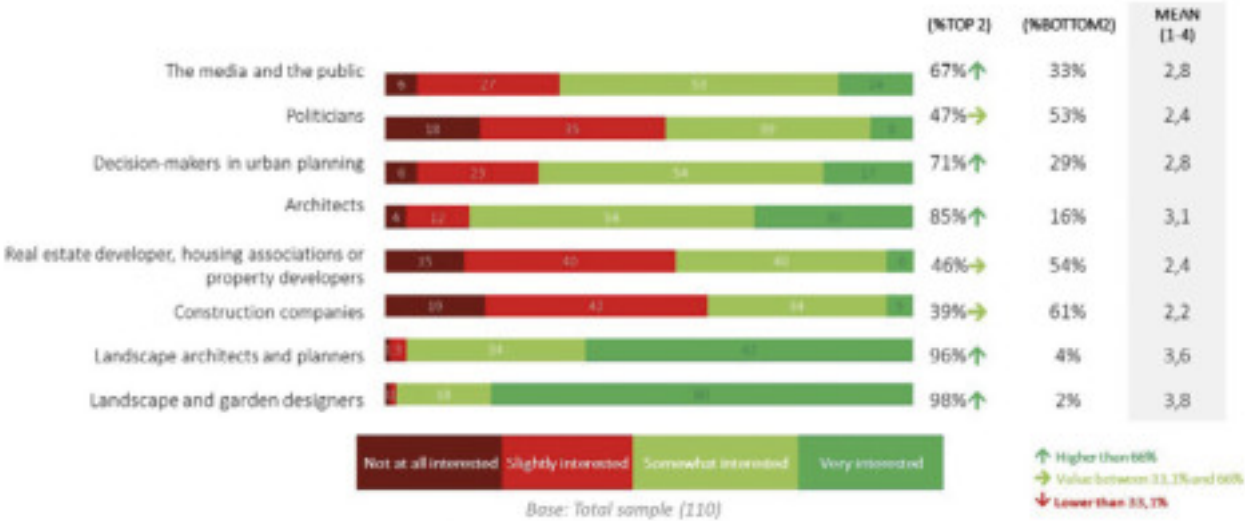
The greening of walls with climbing plants is what green infrastructure experts have the greatest knowledge of and experience in. However, there was a notable lack of knowledge on perforated green walls



Q. 5.2. Evaluate your level of knowledge of and experience with the following green infrastructure solutions. Extensive knowledge and experience, significant knowledge and experience, little knowledge and experience or no knowledge and experience.

DEGREE OF INTEREST IN GREEN INFRASTRUCTURE

Landscape and garden designers, together with landscape architects and designers, are the groups that are perceived as the most interested in green infrastructure. However, it is the construction companies and real estate developers who are perceived as the least interested.



Q1. 6.1 To what extent do you consider the following groups interested in green infrastructure? Very interested, somewhat interested, slightly interested or not at all interested

Málaga. J. Elias

2

WHAT OBSTACLES ARE ENCOUNTERED WHEN INSTALLING GREEN ROOFS, GREEN FACADES AND GREEN INTERIOR FACADES?

- **The main obstacles that businesses encounter when installing green roofs are difficulties in maintenance and problems during implementation.**
- **When installing green walls, obtaining building permits is an obstacle.**
- **And when installing the green interior walls, obtaining building permits is an obstacle.**

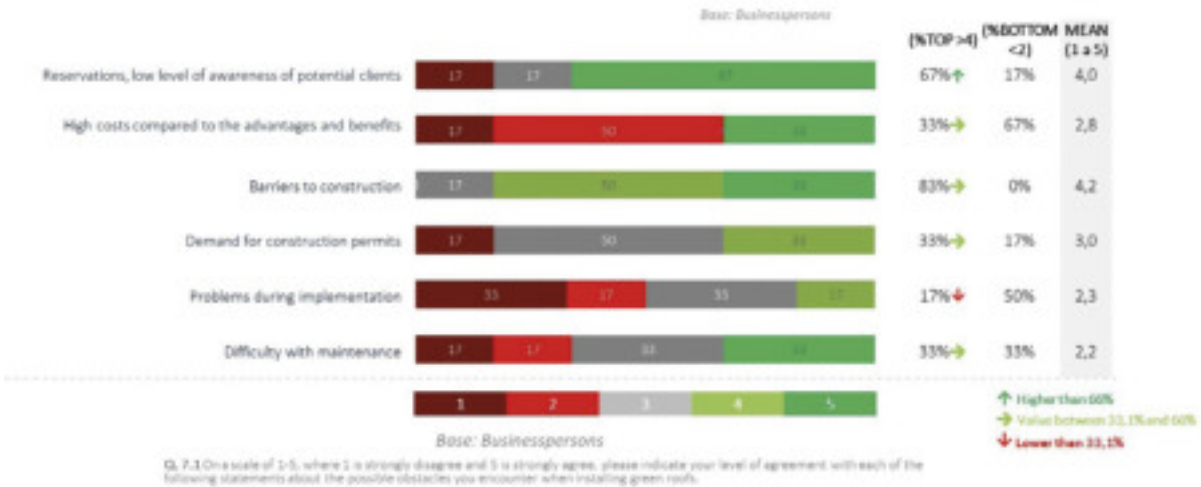
"BUILDING PERMITS HAVE BECOME MAJOR CONSTRAINTS"

Valencia.
J. Elias

Madrid.
I. de Felipe

CHALLENGES OF GREEN ROOFS

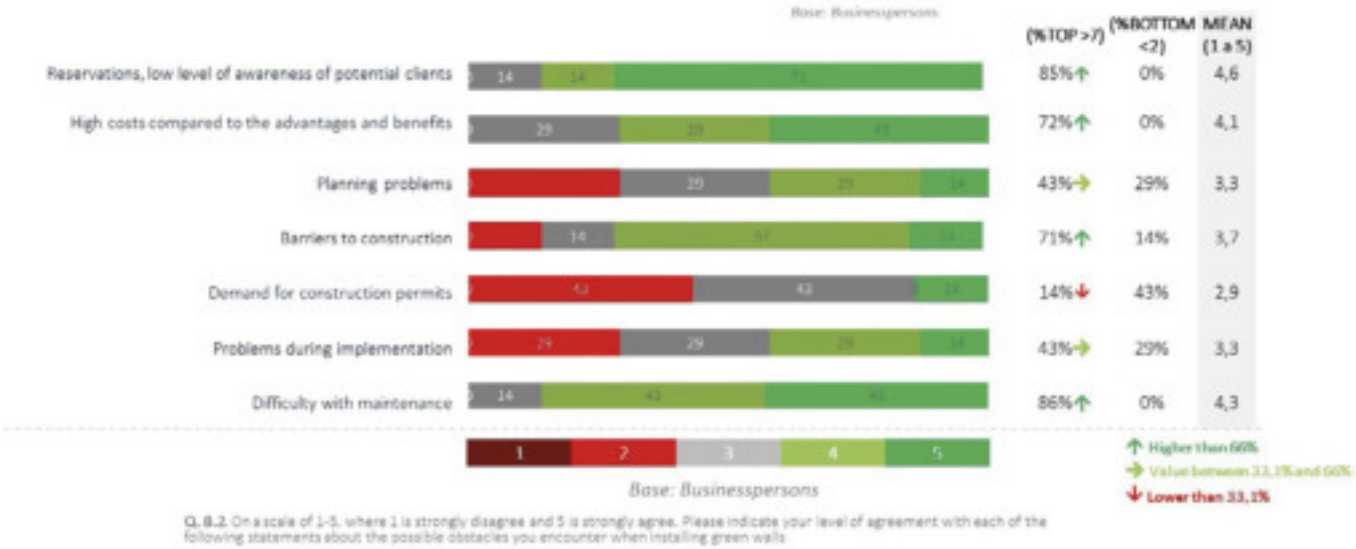
The main obstacle that businesses encounter when installing green roofs are the barriers to construction and the low level of awareness of potential clients.



Barcelona.
J. Elias

CHALLENGES OF GREEN WALLS

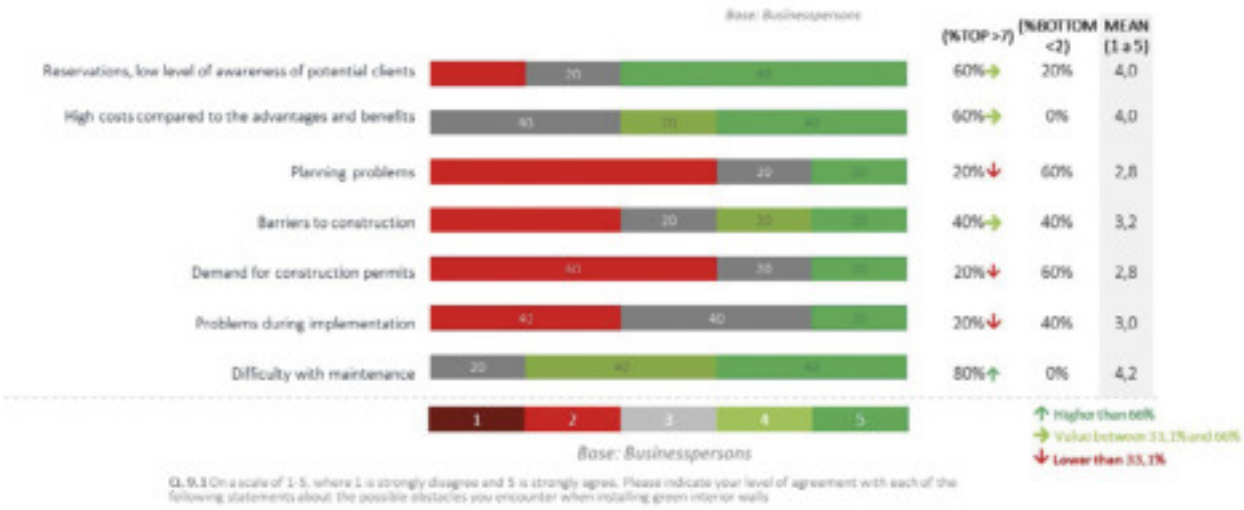
The main obstacle that businesses encounter when installing green walls is the low level of awareness of potential clients and the difficulty of maintenance.



Q. 8.2. On a scale of 1-5, where 1 is strongly disagree and 5 is strongly agree. Please indicate your level of agreement with each of the following statements about the possible obstacles you encounter when installing green walls

CHALLENGES OF GREEN INTERIOR WALLS

The main obstacle that businesses encounter when installing green walls is the difficulty in maintenance, the low level of knowledge of potential clients and the high costs compared to the advantages and benefits.



Q. 9.1 On a scale of 1-5, where 1 is strongly disagree and 5 is strongly agree. Please indicate your level of agreement with each of the following statements about the possible obstacles you encounter when installing green interior walls

Sevilla.
J. Elias

3

Madrid.
I. de Felipe

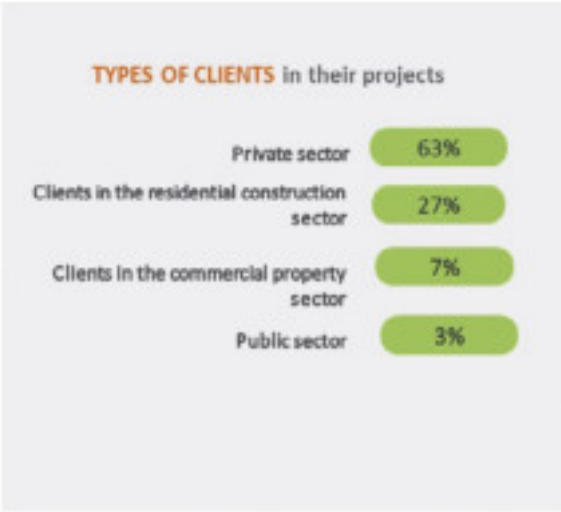
WHAT HAS THE VOLUME OF PROJECTS, m², TYPE OF CLIENTS AND MARKET DEVELOPMENT BEEN LIKE IN THE LAST THREE YEARS?

- **Intensive green roofs: moderate number of projects, most of them private and with a slight growth in recent years.**
- **Green facades: moderate number of projects, most of them private and with a slight growth in recent years.**
- **Interior facades: moderate number of projects.**
- **The future expansion of the competence profile to include green buildings is based on actions related to attending meetings of experts.**
- **The forecast in the development of the service portfolio in the near future is oriented towards planning services and consultants / project development.**

"WE ARE TALKING ABOUT SLIGHT GROWTH AND MODERATE EXPANSION IN THE FUTURE"

WHEN WE REFER TO INTENSIVE GREEN ROOFS,

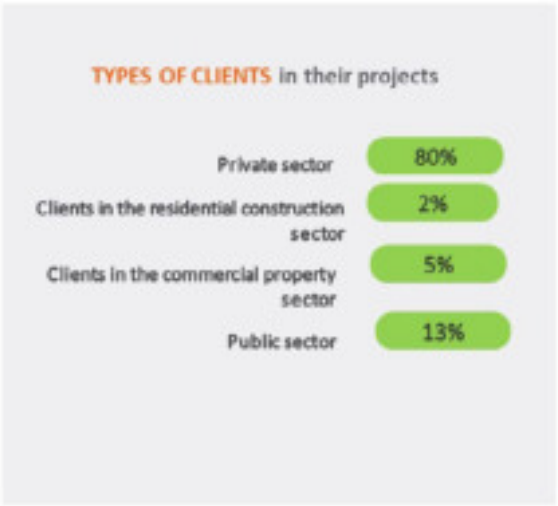
the average number of projects supported by businesses is very moderate. These are mostly private sector projects, and a slight growth is estimated.



Q. 10 Intensive and extensive green roofs (in m^2) in 2018, 2019 and 2020.
Q. 11 Estimate the distribution, in percentage, so that they add up to 100% of the clients of your green roof projects.
Q. 12. In your opinion, how will the green roof market develop over the next 3 years (in % per year, compared to 2019).

WHEN WE REFER TO GREEN WALLS,

the average number of projects supported by businesses is very moderate. These are mostly private sector projects, and a slight growth is expected.



Q. 13 Green facades (in m^2) in 2018, 2019 and 2020. How many green facade projects have you supported with your services in 2018? How many green facade projects have you supported with your services in 2019? How many green facade projects have you supported with your services in 2020?
Q. 14 Estimate the distribution, in percentage, so that they add up to 100% of the clients of your green facade projects.
Q. 15. In your opinion, how will the green facade market develop over the next 3 years (in % per year, compared to 2019).

Madrid.
I. de Felipe

WHEN WE REFER TO INTERIOR WALLS,

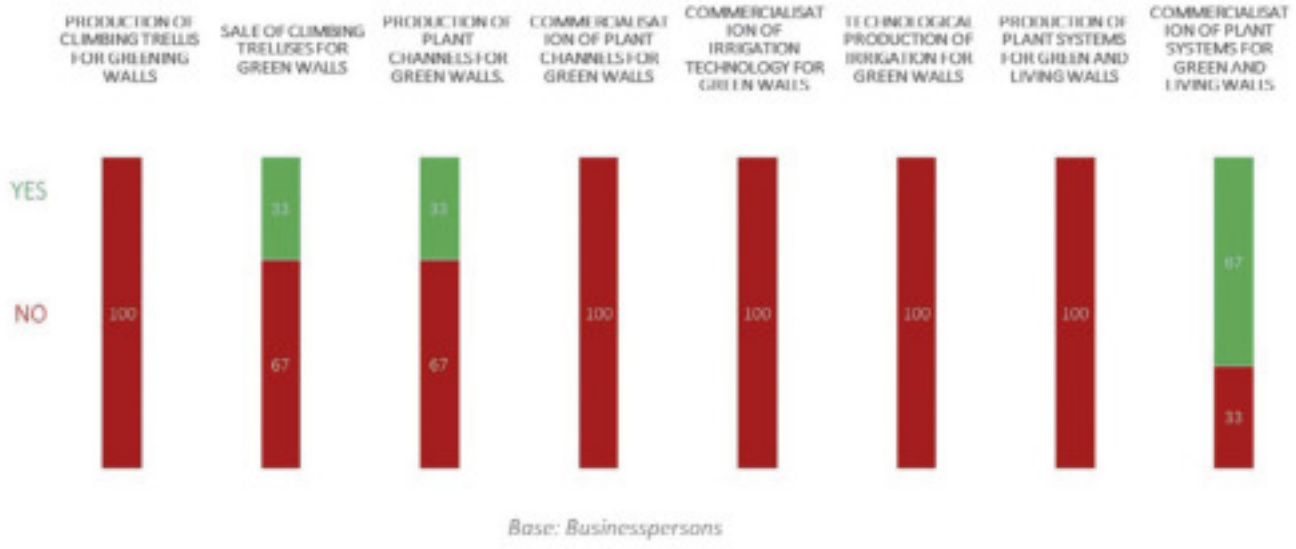
the average number of projects supported by businesses is very moderate.

Base: Businesspersons

Girona.
J. Elias

SEGMENTS OF THE GREEN AND LIVING WALL VALUE CHAIN

The main segment of the value chain in which it operates is the commercialisation of plant systems for green and living walls.



Base: Businesspersons

Q. 24. *In which segment of the green and living walls value chain does it operate?*

FUTURE EXPANSION OF THE BUSINESSPERSON'S COMPETENCY PROFILE TO INCLUDE GREEN BUILDINGS

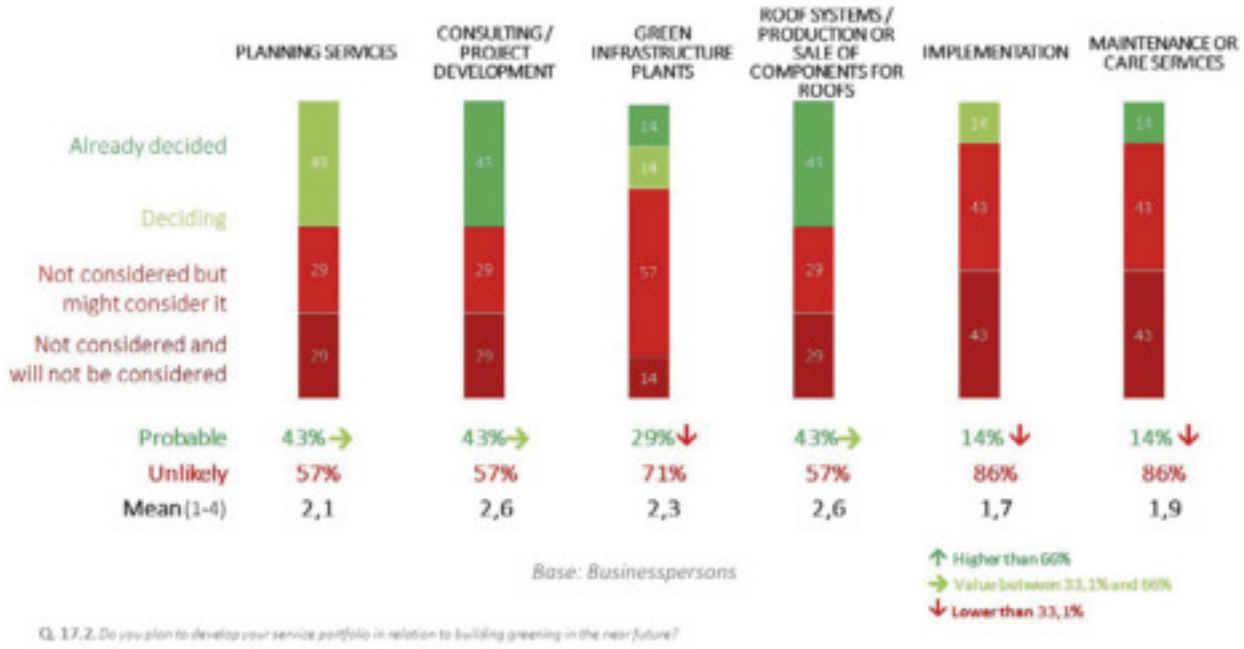
The future expansion of the competence profile to include green buildings is based on actions related to attending specialist meetings. The rest of the proposed competencies demonstrated a very low level of intentions.

Q. 17.1. *Which of the following options best expresses your situation and opinion regarding expanding your skills profile to include green buildings in the near future*

Puigcerda. J. Elias

FUTURE DEVELOPMENT OF SERVICE PORTFOLIO IN THE GREENING OF BUILDINGS

The forecast in the development of the service portfolio in the near future is oriented towards planning services and consultancies/development of projects and roof systems.



Q. 17.2. *Do you plan to develop your service portfolio in relation to building greening in the near future?*

Marbella.
J. Elias

4

WHAT ARE THE PERCEPTIONS REGARDING THE BENEFITS OFFERED BY GREENING?

- **Effects produced**
- **Recommended measures**
- **Evolution of urban greening**
- **Importance for the Spanish market**
- **Quality of the offer**
- **Market attractiveness**
- **Recommendation and reputation**

"LANDSCAPES AND FILTERING POLLUTION ARE KEY BENEFITS. MEASURES SUCH AS CITIZEN AWARENESS AND INCLUSION IN URBAN PLANS ARE ESSENTIAL"

Valencia. J. Elias

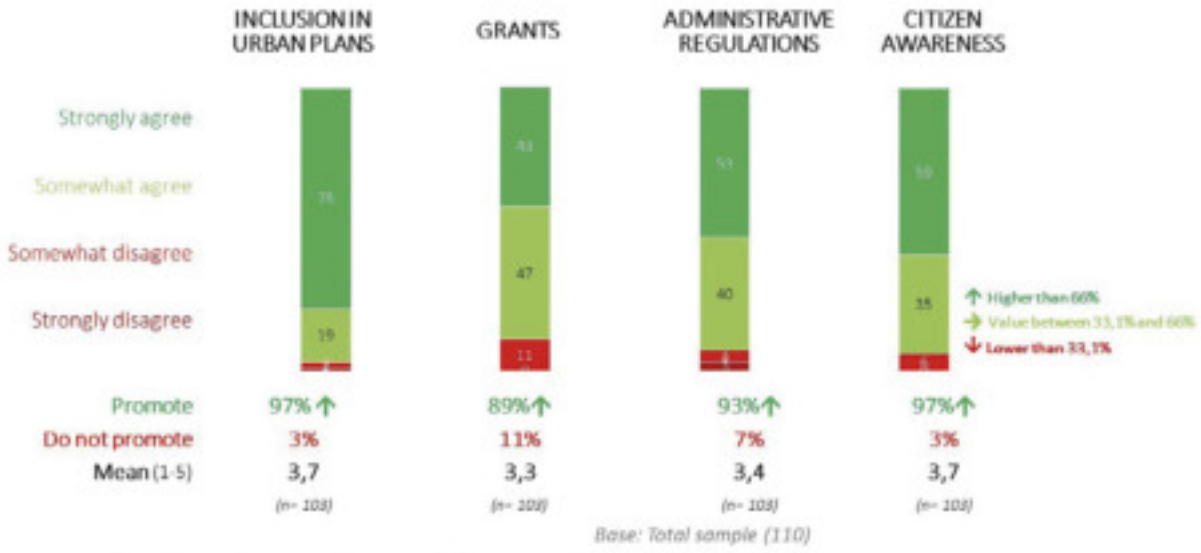
EFFECTS PRODUCED BY URBAN GREENING

Academics, experts, designers and promoters consider that the main effects produced by urban greening are landscapes, filtering pollution, biodiversity, improving the work environment...

Cabrera. J. Elias

MEASURES TO PROMOTE URBAN GREENING

Academics, officials, experts and designers consider that the main measures to promote urban greening would be its inclusion in urban plans, followed by citizen awareness, administrative regulations and subsidies.



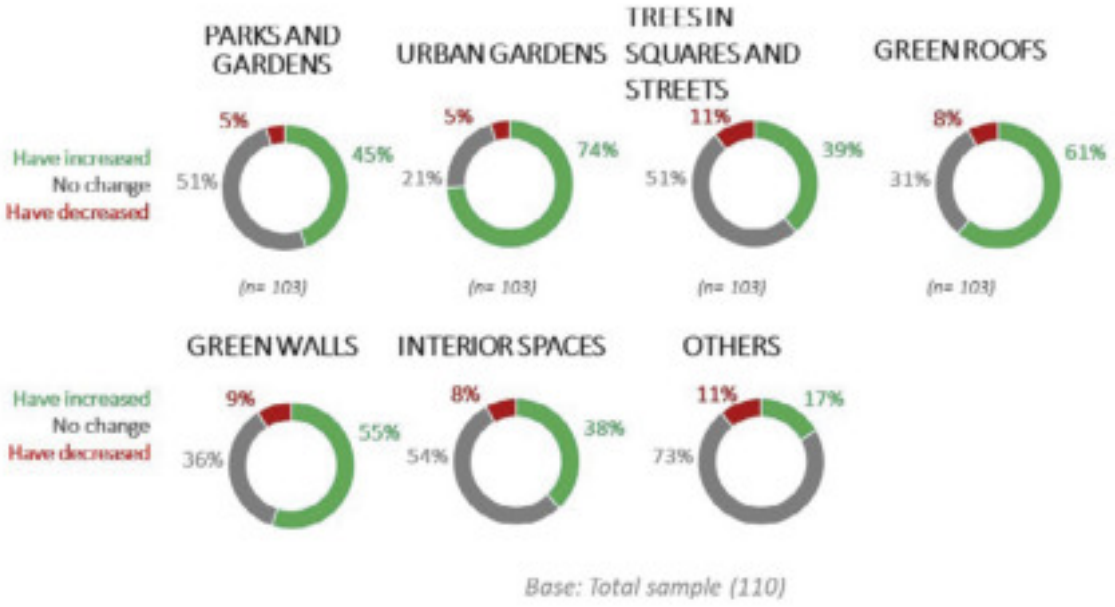
Q. 28. Measures to promote urban greening. Strongly agree, somewhat agree, somewhat disagree, or strongly disagree

Sevilla.
J. Elias

Sevilla.
J. Elias

EVOLUTION OF URBAN GREENING

The evolution of urban greening has been very positive: urban gardens, green roofs and green walls have increased the most. However, trees in squares and streets and trees in interior spaces have increased the least.

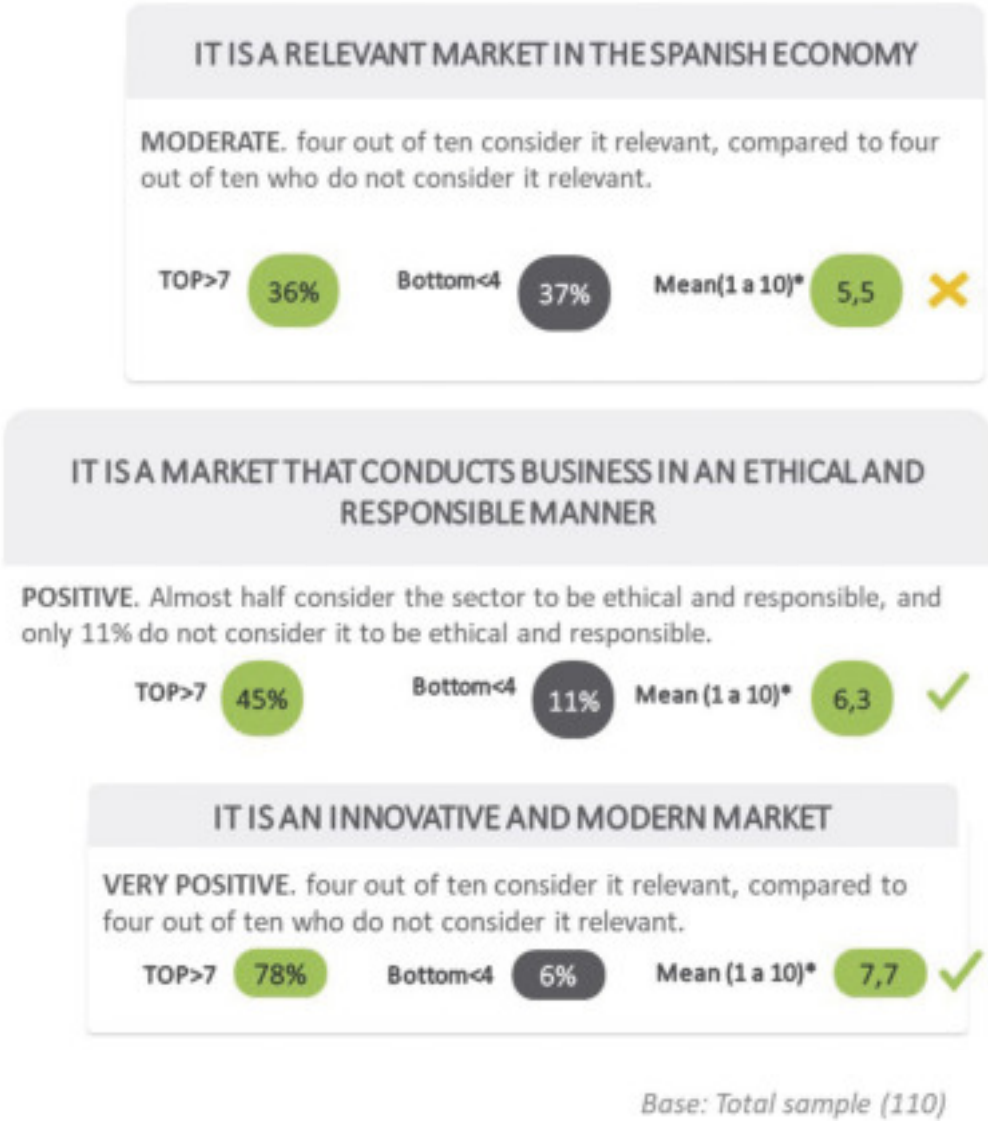


Base: Total sample (110)

Q. 29. Evolution of urban greening. Which of the following options best expresses your opinion on the different aspects of the evolution of urban greening? Have increased, remained the same or decreased.

IT IS CONSIDERED SOMEWHAT RELEVANT IN TERMS OF IMPORTANCE FOR THE SPANISH MARKET

When it is positioned as an innovative and modern market, its value increases considerably.

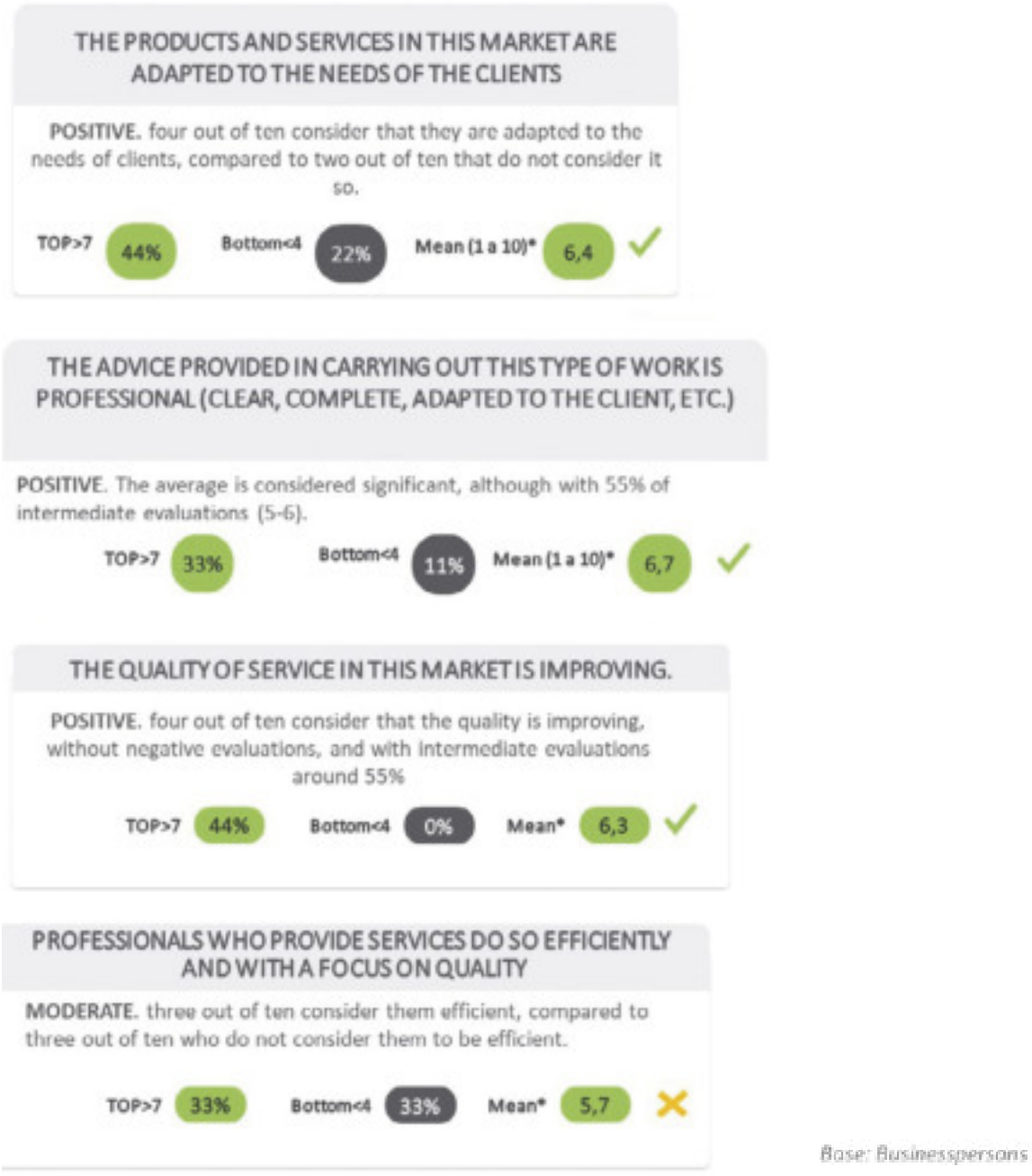


Base: Total sample (110)

Q. 30. Importance of the urban green infrastructure market in terms of management and leadership. I am going to ask you for your level of disagreement with the following statements, taking into account that 1 means that you do not agree at all and 10 means that you totally agree. We are going to analyse the importance of the urban green infrastructure market in terms of management and leadership.

IT IS CONSIDERED A QUALITY MARKET

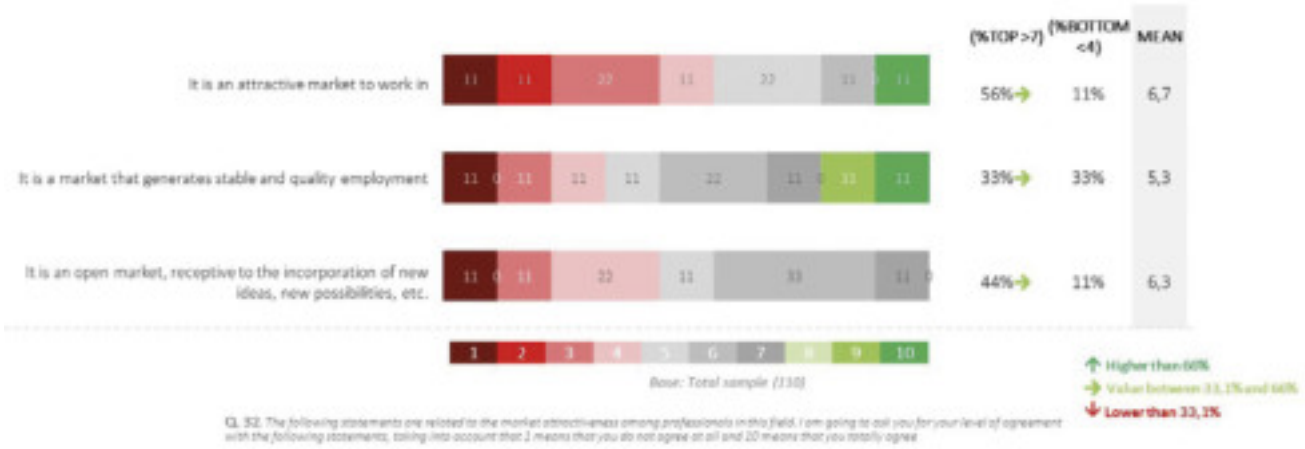
When it is positioned as an innovative and modern market, its value increases considerably.



Q. 31. The aspects that I am going to ask you to evaluate next are those related to the quality of the green infrastructure market offer. I am going to ask you for your level of agreement with the following statements, taking into account that 1 means that you do not agree at all and 10 means that you totally agree.

DEGREE OF MARKET ATTRACTIVENESS

It is an attractive market. It is not clear whether it generates stable and quality employment. It is an open market, receptive to the incorporation of new ideas, new possibilities.



Barcelona. J. Elias

Valencia.
J. Elias

DEGREE OF RECOMMENDATION AND REPUTATION

The urban greening market is recommended for business collaboration, from the point of view of the profiles interviewed. It demonstrates an optimal average, with a 7.2 on a scale of 1-10.
The reputation and market image of green infrastructure are very positive, with a score of 7.4.

Q. 33. *Business attitude. I am going to ask you for your level of agreement with the following statements, taking into account that 1 means that you do not agree at all and 10 means that you totally agree. 34. Reputation / image of the greening market, and finally, I am going to ask you for your level of agreement with the following statement:*

REPORT ON URBAN GREEN INFRASTRUCTURE IN SPAIN

ASSESSMENT	STRATEGIC INVOLVEMENT
POSITIVE ASSESSMENT OF THE EXPERTS ON THE DEVELOPMENT AND BENEFIT OF GREEN INFRASTRUCTURE, WITH GREATER INVOLVEMENT OF DESIGNERS AND ARCHITECTS THAN OF CONSTRUCTION COMPANIES AND DEVELOPERS	• The level of importance of the benefits offered is very high. Particularly noteworthy is an improvement of the microclimate and an increase in quality of life. • The greening of walls with self-climbing plants is what green infrastructure experts have the greatest knowledge of and experience in. Landscape and garden designers, along with landscape architects and designers, are the groups most interested in green infrastructure. Construction companies and property developers are the least interested.
CHALLENGES AND POSSIBLE OBSTACLES, BASED ON BARRIERS TO CONSTRUCTION, LOW LEVEL OF AWARENESS, MAINTENANCE DIFFICULTIES AND COSTS	• The main obstacle that businesspersons encounter when installing green roofs, green walls and green interior walls are the barriers to construction, the low level of knowledge of potential clients, the difficulty in maintenance and the high costs compared to the advantages and benefits.
VOLUME OF PROJECTS m2, VERY MODERATE TYPOLOGY OF PRIVATE CLIENTS AND MARKET DEVELOPMENT WITH MODERATE GROWTH	• Intensive green roofs, green walls and interior walls have a very moderate average number of projects supported by businesspersons, and these are primarily private projects with an estimated slight growth. The main segment of the value chain is the commercialisation of plant systems for green and living walls. Future expansion is based on actions related to attending expert meetings. The rest of the proposed competencies demonstrated very low intentions. The forecast in the development of the portfolio of services in the near future is oriented towards planning services and consultancies / project development.

REPORT ON URBAN GREEN INFRASTRUCTURE IN SPAIN

ASSESSMENT

PERCEPTION OF THE BENEFITS OFFERED BY GREENING, VERY POSITIVE WITH LANDSCAPES, FILTERING POLLUTION... DEMAND FOR INCLUSION IN URBAN PLANS HAS EVOLVED POSITIVELY AND IS CLEARLY APPEALING

STRATEGIC INVOLVEMENT

- Academic officials, experts, designers and promoters consider that the main effects produced by urban nature are improvements in the landscape, filtering pollution, biodiversity and improvements of the work environment
- The main measures to promote urban nature would be its inclusion in urban plans, followed by citizen awareness, administrative regulations and subsidies
- The evolution of urban nature is very positive: what has increased most are urban gardens, green roofs and green walls. However, what has increased the least are trees in squares and streets and trees in interior spaces.
- In terms of importance for the Spanish market, it is considered relevant. But when it is positioned as an innovative and modern market, the value increases considerably. There is quality in the offer.
- It is an attractive market, but it is not clear whether it generates stable and quality employment. It is an open market, flexible to the incorporation of new ideas and new possibilities.
- The urban nature market is recommended for business collaboration, from the point of view of the experts interviewed. The perceptions are an optimal average with a 7.2 on a scale of 1-10. The reputation and market image of green infrastructure are very positive, with an impact of 7.4.

CHAPTER 3
EVOLUTION AND TRENDS

3.1 URBAN GREENING AS A DYNAMIC APPROACH

The coexistence of humankind with nature has been a constant process throughout history, with triumphs and difficulties, depending on socioeconomic and environmental factors. In its early years, the human species was fully integrated into the natural environment, dedicated to hunting and gathering wild fruits. The arrival of agriculture enabled a sedentary lifestyle and the beginning of the urban nucleus, allowing certain groups of people to devote themselves to other activities, such as crafts or liberal arts, which was restricted among nomadic peoples.

For defensive and fiscal reasons, cities were located behind walled enclosures, which limited the available space dedicated exclusively to housing. However, there are several examples of green areas, in gardens such as Babylon, or orchards such as those just outside of Cuzco. On speculative grounds, among other reasons, nature has been pushed out from urban centres, although attempts have been made in recent decades to reclaim green spaces.

In the twentieth century, a hygienic-sanitary concern led to new approaches in the management of green areas, quantifying the proportion of the area to be dedicated to parks and gardens (15%), in addition to a perimeter forest reserve (minimum 10km).

The Athens Charter of 1933 laid down the principles of modern urbanism, including nature in planning, as well as free spaces (Reyes-Paecke S., available at www.ecosistemasurbanos.cl). However, the focus was solely on parks and gardens, with the Conference on the Human Environment (Stockholm 1972) having a broader view of the ecosystem. A broader approach to urban greening, such as green infrastructure, (Briz J, Kohler M, De Felipe I., 2019) recognizes the variety of services, direct or indirect, that natural spaces provide to society.

GREENING IS NECESSARY FOR PLANNING IN LINE WITH THE SUSTAINABLE DEVELOPMENT GOALS

In addition to recreation, landscape, food or hygienic-sanitary improvements, there are dimensions that are not directly visible in the market, such as biodiversity, social relations, rainwater management, carbon sequestration and others. Greening and green infrastructures therefore extend beyond the initial idea of planned green areas to include the nature, vegetation and fauna in an interconnected way.

The classification of UGI, depending on its management, is done by establishing the foundations for quantitative and qualitative information, with 21 different typologies in the Spanish municipalities (Green infrastructure, Ministry for the Ecological Transition and the Demographic Challenge).

In 2013, the European Commission adopted strategies to promote the implementation and support of green infrastructure, taking into account:

- Physical components, green and blue spaces that maintain vegetation and water spaces.

- Projects, interventions to establish, improve or restore nature. Planning and integrating nature into urban and territorial planning in a sustainable way.

- Methodologies and techniques that allow for analysing and understanding the multifunctionality of greening and the benefits it provides to society.

The achievement of green urbanism is not an easy task, but given the evolution of our environment, its application is inevitable (Lopez J., 2021).

The restrictions applied during the pandemic have had negative impacts on many socio-economic aspects, but the levels of pollution, energy consumption and CO2 emissions in the environment decreased, with an improvement in air and noise quality. It is worth asking whether the measures imposed for health reasons, such as COVID-19, could be gradually extrapolated and with less radical objectives to save planet Earth and our own survival, shaping the planet our descendants will one day inherit.

The interaction between urbanism and greening on health, socio-economics and the environment has faced a key problem throughout history. Cities with narrow streets and no ventilation were breeding grounds for epidemics such as the bubonic plague, cholera or the flu. Its health and socio-economic effects were devastating.

There have been extensive urban actions in terms of hygienic-sanitary improvements. From installing sewers to the expansion of the city outside the walls, once the defensive needs were overcome, only the fiscal or ornamental aspects were left.

Galicia.
I. de Felipe

At the heart of the controversy is the search for priority between the economy, mobility, health, or social relations, with greening as a pending issue. There is talk of green urbanism vs climate containment, interlinking ecosystems with biological aspects within a global approach.

Large cities have always had a conflictive urban history, with natural disasters such as earthquakes or fires (in the case of London or Lisbon), socio-political turmoil (in the case of Madrid or Paris), sporting events or fairs (Barcelona, Seville) prompting the cities to undertake urban reforms.

On other occasions, urban plans have overlapped, such as the cases of Barcelona (Planes Rovira i Torras of 1816 and Cerda) and Madrid (Planes del Conde de Aranda, Arturo Soria, Plan Castro 1857-1898, Marqués de Salamanca, Cesar Manrique). Underlying all of them is the role of greening and recreation areas, environmental quality vs. economic interests or mobility density. This is the recent case of Madrid, with the issue of Madrid Central, Madrid 360º, the Metropolitan Forest and the repairs to be made in the wake of the storm Filomena.

Urban greening does not imply a clash with progressive or conservative urban plans, but is rather a necessary complement to them, compatible with the objectives of each plan to achieve citizens' well-being, where the right to housing includes a dignified, healthy and sustainable environment.

3.2 FURTHER STUDIES AND LESSONS LEARNT

In Spain, there is a lack of statistical and documentary information on green infrastructure (GI), which is reflected in the lack of relevant studies. Unlike other developed countries, urban agriculture and the environment are often left out of urban plans.

However, more recently, there has been a strong citizen movement in favour of fostering healthy environments. City councils, academia and civil society are developing projects, studies and conferences to raise awareness among citizens. It is necessary that at the national level, the Government, through the National Institute of Statistics, along with the relevant Ministries, such as Agriculture, Housing or Environment, as well as professional organisations of Colleges of Engineers, Architects and others, incorporates in their activities the collection of information to provide a comprehensive and reliable database.

Madrid.
I. de Felipe

GREEN AREAS MULTIFUNCTION GIVES A GLOBAL UTILITY TO URBAN SOCIETY

The above-mentioned activities and remarks must be complemented by the appropriate studies that provide new information, as well as the correction of errors that may be detected in greening as a dynamic process of adaptation to existing needs. The subsequent contributions will identify the characteristics of urban green infrastructure in Spain, evaluating the impact of the successive measures applied. The interdisciplinary collaboration of professions and the multifunctionality of urban greening (Briz J., Köhler M., De Felipe I., 2019) will provide a global vision, highlighting its importance in the sustainability of urban well-being.

The current city model is not sustainable, which requires making decisions for the urban community to achieve quality of life. Useful instruments to carry out this task include green infrastructure, which must be promoted by both the public and private sectors and endorsed by citizens. This requires training and objective information on its effects, cost and benefits, as well as information on the degree of implementation.

We will address the elements that must be incorporated into future studies and proposals on UGI, so that they may be undertaken by citizens in the long-term.

The use of information must be considered, and the green space factor (GSF) should be configured as a basic element of this. It involves identifying the green spaces that are currently implemented through urban programmes. The use of indices or elements that are easy to understand and apply includes the so-called “green space factor”. It was first applied in Berlin and has subsequently been continued in other cities, such as London, Helsinki, Malmo and Washington DC.

The calculation for a given area is based on the identification, in an initial phase, of the existing green surface, which is weighted by a coefficient (green space factor). The sum of the total weighted green areas is compared (divided) by the total area and the result is the overall Green Space Factor of the district, neighbourhood or city, as follows:

Unitary Green Space (UGS) = S x FEV
Global Green Space (GGS): ΣS x UGS
Relative Green Space (RGS): GGS/S

Where:
S=surface
GSF= Green Space Factor

The GSF varies between 0 and 1, a range that represents the minimum and maximum. It should be noted that this factor must be adapted to the characteristics of the environment analysed and the priorities of the urban community where it is applied.

The method is complementary and compatible with other assessments, such as energy saving, biodiversity, pollution, health, recreation, or landscaping. The green space is three-dimensional, therefore, although only the horizontal green surface is considered in the initial phase, the vertical surface is also considered in the case of facades or walls, as well as interior spaces or greenhouses, with several levels of green surface. All this can be reflected in the aforementioned coefficient, which can have a range greater than one.

Another option to consider is the multifunctionality of green spaces and their particular usefulness for the urban community where it will be applied. Among other aspects, we can highlight the management of rainwater to reduce flooding, energy conservation, reduce air and noise pollution, leisure and recreation space for human interaction, the production of food, ornamental plants and the landscape, whose assessment and priorities must be reflected in the urban plan on green infrastructure.

The above mechanism has several limitations, depending on the time and the human and financial resources available. The geographical location is also a determining factor, according to whether these are areas of high geographical density or peri-urban, protected areas in terms of the heritage of the buildings, property system and others.

In any case, the tool is easy to use and understand between the various actors involved in decision-making, and allows for solid arguments to be established in the presentation of the projects to be carried out.

The sustainability of the actions to be developed is another point of interest. Sometimes, green infrastructure is temporary, with an ornamental purpose (even with plastic material), only for use in inaugurations, fairs, and exhibitions, or to obtain assistance or assessment in projects. That is why we must consider aspects of sustainability and maintenance, as well as the type of substrate, plant varieties, their distribution and compatibility between the different plant species, water infiltration capacity and polluting particles, fertilization, and maintenance. All of this entails complementary assessments, as well as the approach of a "Green Urban Integration Coefficient" factor, where the functions and the preferences offered to the community where they are going to be implemented are recorded.

Its range is also from 0 to 1, and would be obtained through interviews to obtain the opinions of the actors participating in the project.

In short, the use of a series of evaluation indices or factors simplifies the decision-making process and should be applied in future developments in Spain.

ERRORS IN THE GREEN VALUE CHAIN CAN ARISE IN ANY OF THE LINKS, RANGING FROM DEVELOPERS, PROPERTY OWNERS, GOVERNMENT, TECHNICIANS OR USERS

ERRORS IN THE GREEN URBAN CHAIN

Urban greening is structured through a value chain that interacts with the different factors that comprise it individually or institutionally. There are basic links that are altered by other external factors.

Links:

- Supplier link (producer): Real estate park, nurseries, construction materials.
- Industrial link-services: Builders, architects, engineers, designers.
- User-consumer link: offices-factories-homes.

External factors

- Government: Regulation, aid, taxes
- Professional associations, advisory services
- NGOs, civil society, support.

There are a number of errors that may occur in the different links and their interactions.

In the supplier group, residential owners may experience disagreements in the supply of spaces to be greened for economic or social reasons. Urban communities face many problems and decisions, making this a social barrier.

In the industrial and service group, errors can be technical and design-related. The selection of suitable plants and substrates, their maintenance, or the project itself affect its viability. Therefore, professionalism is necessary in the sector since the mistakes that are made may discourage future investments and achievements.

Professional associations of architects, agronomists and other professions must provide clear and acceptable UGI guidelines and quality controls.

Among users, errors are derived from a lack of awareness of the advantages and disadvantages of greening, a lack of maintenance or the lack of technical and financial resources.

In the government sector, errors occur when there are false contracts awarded, and in the control and monitoring of economic resources, not to mention the misalignment between objectives and the resources facilitated, corruption in the process of contracting and monitoring projects.

Caixa Forum.
Madrid.
I. de Felipe

CHAPTER 4

CASE STUDY: GREEN URBAN INFRASTRUCTURE IN MADRID

Madrid is a city with green areas that have a great artistic value and heritage (Zarate A., 2015), and which have become popular, as seen in the new expansions in the upcoming urban plans.

Historically, many of the green spaces were inherited from the monarchy, among which we can mention the Monte de El Pardo (16 thousand ha) old hunting ground, a Mediterranean forest featuring holm oak. The Casa de Campo (1,700 ha) was once the estate of the monarch Felipe II, which was ceded to the City Council in 1931. The Palace of the Buen Retiro of the seventeenth century has been reduced to the Park of El Retiro (118 ha), and there are also historical places such as Fuente del Berro, El Capricho and the Botanical Garden.

More recently, parks such as Berlin, Oeste, Tierno Galván and Madrid Rio have been added to provide the city with new green areas that will be expanded with new projects and urban plans.

As an example, we present an evaluation of Madrid's green infrastructure to improve sociological resilience (Suarez M., Riveiro A., Alba D., 2020). Plans, projects and programmes are evaluated using a resilience index ranging from -10 to +10, with positive, neutral or negative impacts. The average value of the policies implemented is positive +4.3. Among the most promising aspects are innovation and learning, the duration over time and social justice. Self-sufficiency, autonomy and polycentric governance appear marginalised.

We provide a brief description of the green infrastructure in Madrid, which demonstrates the dynamics in recent decades:

- Regulations at the national, regional or local level are affected.
- The Ministry of Ecological Transition has published a National Strategy for Green Infrastructure and Ecological Restoration, approved by Ministerial Order of July 13, 2021.
- The Spain 2050 Strategy (May 6, 2021) on the need for green spaces to improve health and sustainability.
- Law on Climate Change and Ecological Transition (Law 7/2021) with articles (17 and 24) on the importance of green infrastructure and connectivity.
- In large cities, such as Madrid, the decrease in the absorption capacity of pollutant gases and particulate matter is evident in the reduction of green areas, and therefore it is necessary to promote and connect them.
- During the period 2000-2019, direct emissions from the Residential, Commercial and Industrial (RCI) complex in Madrid have decreased by around 12%, due to investment in combustion technology and equipment, the removal of more polluting fuels and the improvement of transport routes and logistics.
- In 2017, Plan A for Air Quality and Climate Change was established in Madrid, through the Madrid+Natural Programme.

Madrid Rio.
I. de Felipe

MADRID HAS GREEN AREAS WITH A GREAT ARTISTIC HERITAGE AND VALUE, AND HAS EXPERIENCED A STRONG BUSINESS AND INSTITUTIONAL REVITALISATION IN RECENT YEARS

- In 2018, the Madrid Recupera Plan was proposed for the regeneration of existing areas, prioritising them over the new areas in expansion, where greening already played a strategic role.
- The EU initiative in 2020, through the EIT Climate KIC aimed at climate mitigation, created the Deep Demonstration platform that seeks Nature-Based Solutions within the LIFE-PACT Project (LIFE H 2020).
- Simultaneously, during 2020, the Madrid City Council launched the Green Infrastructure and Biodiversity Plan with 180 specific actions, including the ARCE Network to connect green areas through corridors, where vertical agriculture must be an essential element.
- Madrid 360 is a sustainability plan, reducing pollution emissions, especially NOx, and increasing gas immission factors, dust particles and heat, through the Metropolitan Forest as a 600 ha green belt, and the planting of one-hundred thousand trees of native species, and other green infrastructure such as orchards, gardens and recreation areas.
- In 2021, the Roadmap towards climate neutrality in 2030 of the city of Madrid was presented, expecting to reduce emissions by 65% in 2030 compared to 1990, and reach climate neutrality in 2050.

Madrid.
I. de Felipe

Some of the most significant regulations are presented in more detail below.

Among the policies analysed, the main strategic plans are: Green Infrastructure and Biodiversity Plan, Green Zones Master Plan, Plan A and Strategic Plan for Municipal Decentralization. The 620 actions of the policies developed are classified into 92 categories, which are evaluated with the Resilience Index, identifying a divergence between Northwest-Southeast inequality.

GREEN POLICIES ARE EVALUATED WITH THE RESILIENCE INDEX WITH A DIAGONAL NORTHWEST-SOUTHWEST

More specifically, the Green Infrastructure and Biodiversity Plan carries out an assessment of the natural heritage, with the support of a multidisciplinary team of businesspersons, politicians, technicians and citizen organisations. It is worth highlighting that Madrid complies with the recommendations proposed by the World Health Organization (WHO), with parameters of approximately 0.5 trees and 18.6 square meters of green area per inhabitant, with a heterogeneous distribution between districts. Therefore, it is recommended to take advantage of the different modalities of urban greening to use all the available spaces, both on the ground and at height (facades, roofs, interiors) within a decade.

The "Madrid recupera" plan aims to regenerate green spaces, promoting new opportunities through habitable itineraries, connecting markets, schools, cultural centres and parks, which serve as a meeting place for citizens, where there is an attractive environment in both temperature and humidity, surrounded by nature, and with special attention paid to the most vulnerable neighbourhoods.

The "Plan A for air quality and climate change" is another of the instruments that includes actions such as the "Madrid + natural" programme, focusing on three levels: buildings, neighbourhood and city. At the first level, special attention is paid to green roofs and facades in municipal buildings, and a census is kept of these and of the achievements achieved.

At the neighbourhood level, action is taken through environmental corridors that connect existing or future natural spaces, creating the appropriate green spaces through roofs and facades, which until now have been marginalised. On a greater scale, the greening of the river Manzanares is worth highlighting, as part of the blue-green project "Madrid Rio."

With this comprehensive vision, we can include the subsequent high-impact projects such as "Madrid Nuevo Norte" (the largest urban regeneration project in Europe, with an investment of 25 billion euro and more than four-hundred thousand m^2 of green areas (https://distritocastellananorte.com/), and the "Metropolitan Forest" (75 km greenring and 100,000 new trees, available at https://estrategiaurbana.madrid.es). These initiatives aim to address the many urban issues through Nature-Based Solutions. Another series of actions address

specific issues such as food supply in “Madrid Alimenta”, which is based on existing infrastructure, such as the Network of Community Urban Gardens, taking into account the guidelines set out in the Milan Pact and the Network of Cities for Agroecology. The “Madrid City of Care” plan boosts community cohesion and environmental health with projects to improve schoolyards (MICO).

Madrid.
I. de Felipe

Milan.
Spanish Pavilion.
I. de Felipe

CHAPTER 5
REFLECTIONS AND RECOMMENDATIONS

The work of Urban Green Infrastructure in Spain (UGI) collects information and opinions that can serve as the basis for further studies. It aims to be inclusive by contemplating very diverse aspects that go beyond greening, to include well-being or new social trends and the media.

Rurban well-being relies to a large extent on quality indicators recommended by institutions such as the World Health Organization, integrating human life with the flora and fauna of the location, with the parameters of surface (10-15 m^2 person) and distance (such as "Paris, the 15-minute city" as proposed by Mayor Anne Hidalgo, see http://ethic.es).

Other recommendations (Ministry of Development, Urban Ecological Agency. Barcelona 2021. "Certification of Ecological Urbanism") indicate that residents must have access to a green space of 1000m2 within 200 meters As we can see, the recycling of green roofs and facades in buildings is an essential contribution in terms of proximity and accessibility, although they are usually marginalised (Briz J., De Felipe I. 2022)

We must learn from these mistakes by avoiding and correcting them when they occur. To this end, we would need a historical record of our environment and others like it. Greater transparency would also allow us to know the causes and effects and the flexibility and opportunity to redirect actions when the environmental conditions change.

The COVID-19 pandemic has shown us the importance of the natural environment:

- A model of home-office housing in the same location, made possible by teleworking, with priority given to the natural environment:
- Socio-political loyalty. Ensure that a change in the current government does not affect the previous ongoing projects if they are efficient and improve the well-being of the community.
- Training and providing information to citizens is essential to implement viable and sustained nature-based models.

It must be recognised through the news media and publications of various kinds that a social movement is taking place, regarding greening in the *rurban* world. However, there are a lack of in-depth studies and research that adequately assess the positive impact and its need for implementation.

Natural disasters with the corresponding floods, snowstorms such as Filomena (in 2021) in the central regions or the volcanic eruption of the island of La Palma (September, 2021) occupy the headlines of the news, but the continuous phenomena of pollution, drought and desertification or the inadequate management of natural resources go unnoticed or are not given due attention.

It is therefore a priority to raise awareness among the population about the need to adopt measures to achieve a sustainable future. The participation of foundations and civil society is increasingly significant.

Fundación Biodiversidad (Biodiversity Foundation) is oriented towards a change of lifestyle, with improvements in nature promoting change at three levels: a change of behaviour in people towards sustainability; in public policies and perceptions, and values to inspire society. Urban problems are heterogeneous, for which UGI are multifaceted and must be coordinated at the local, regional, national, and international levels, seeking a change of mentality among the actors.

We can affirm that in Spain, the tendency towards greening has traditionally been conceptualised through private initiatives, both individually and collectively. However, in recent decades, local institutions such as municipalities are the new catalysts of initiatives with universities, companies and civil society, which have been expanded through national and transnational policies, under the principles of climate change, global warming and decarbonization. It is time to join all of these initiatives together in a coordinated manner, following the Sustainable Development Goals.

***RURBAN* WELL-BEING IS BASED ON QUALITY INDICATORS WHERE GREENING IS A KEY ELEMENT**

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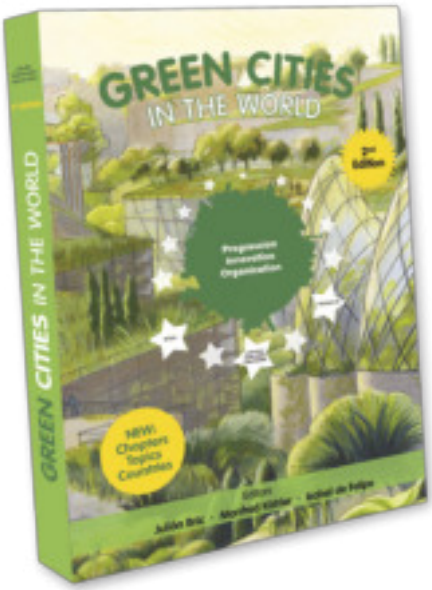

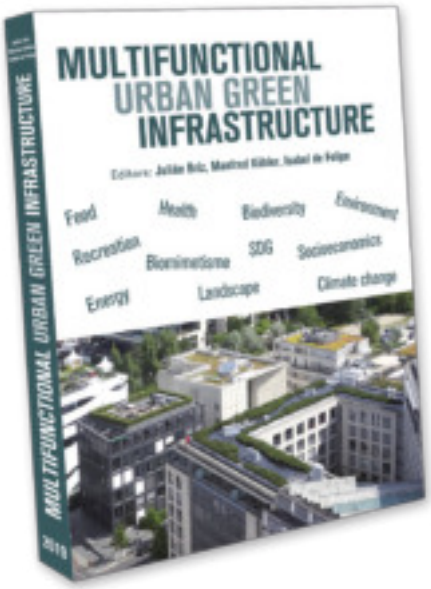

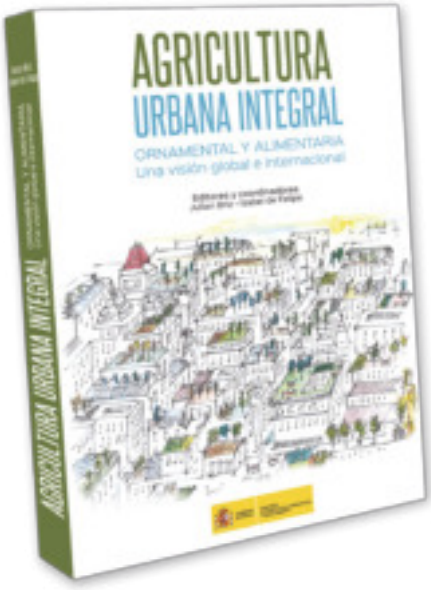

Urban green infrastructure in Spain aims to address the evolution of a sector with a deep-rooted tradition in Spain, but that has traditionally been forgotten in urban designs and socioeconomic policies. The lack of a national database and the lack of global studies on this topic has led to the proposal of a hybrid model of analysis: facts and perceptions.

Regarding facts, different documents prepared by professionals in urban agriculture and gardening have been included, and in terms of perceptions, the prevailing ideas in society are addressed through nationwide surveys of professionals and users. Academics, scientists, entrepreneurs, civil servants and civil society in general acknowledge that it is a sector on the rise with a very positive outlook, but it requires social acceptance and real support for future projects.

The dynamic approach of this book can be highlighted, with the urgent need for further studies. Some of the most frequent errors in the management of urban green infrastructure are also noted. Finally, a number of reflections and recommendations are made on Nature-Based Solutions, a key instrument for the sustainability of the urban environment.

Entidades colaboradoras

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