Green Areas, the Most Significant Indicator of the Sustainability of Cities: Research on Their Utility for Urban Planning

Francisco Gómez1; José Jabaloyes2; Luis Montero3; Vicente De Vicente4; and Manuel Valcuende5

Abstract: This work summarizes a very extensive study conducted in the city of Valencia, Spain, on the role of green areas in the comfort of the city. Previously, the environmental parameters that make up the urban environment were studied. With these values, a very large series of comfort indexes was analyzed and validated, and the indexes that exhibited the best behavior were determined. The role of green areas in public city spaces was also studied: the retention of solar radiation and pollution retention capability. This culminated in the formulation of the comfort indexes according to the amount of green areas, which, through statistical correlation, allowed the determination of the surface area of green areas required for the city to be considered theoretically comfortable. This work completes the analysis of these formulations for a wider spectrum of measurements in the city with a greater scope and greater variety of spaces and situations. The three comfort indexes that performed best, i.e., those with greatest statistical certainty, have been reformulated for Valencia. The work concludes with research from the previous experimentation applied to the green plan of Valencia. The final solution takes into account the proposals put forward by the Valencian Authority on the plan for protection of the Huerta, the natural market garden setting on which the city of Valencia stands, following the philosophy of the European Territorial Strategy and the European Landscape Convention. DOI: 10.1061/(ASCE)UP.1943-5444.0000060. © 2011 American Society of Civil Engineers.

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Introduction

The urbanization rate of the world population has grown significantly in recent years. This phenomenon is occurring primarily because cities provide a greater quality of life for the citizens and considerably increase their levels of freedom.

The reality is that urban areas are increasingly conflictive, unhealthy, unmanageable, and, above all, an enormous pressure on the environment. Therefore, it seems reasonable to think that the environmental problems must first and primarily be tackled and solved in cities.

In recent years, thousands of people rush each weekend to explore the habitats and natural spaces in their immediate surroundings that are not found in the city.

This is fundamentally because modern civilization, especially the Western world, has made a clear commitment to the “quality of life.” By referring to quality of life as a complex reference to well-being, this unfailingly results in the same definition of health as proposed by the World Health Organization (WHO): “Not only the absence of disease or infirmity, but also a state of physical, mental and social well-being.”

Some examples of the initiatives developed from the subject of the quality of life in urban environments include the Dobrf assessment [European Environment Agency (EEA) 1995], which considers the use of an experimental set of environmental indicators from a series of European cities; the Sustainable Seattle (1993) report, a volunteer network and civic forum committed to the long-term environmental health and vitality of its region; the Aalborg charter [European Sustainable Cities and Towns Campaign (ESCTC) 1994], a political commitment to the advance toward sustainability; the Lisbon action plan (ESCTC 1996), a commitment to action, promoting the use of sustainability indicators that enable the fulfillment of the Aalborg Charter; and an intervention framework for the sustainable urban development of the European Union (1998), which highlights the importance of the use of comparative indicators to evaluate urban performance and the need to explore methods for the monitoring of the advances. Since the year 2000, the initiative for the monitoring of sustainability on a European level has been developed through the application of a bottom-up strategy by a group of urban environment experts in close consultation with local authorities throughout Europe (Expert Group on the Urban Environment 2001).
In short, returning to a generalist standpoint, some of today’s important researchers—McHarg (1969), Hough (1984), Register (1987), Steiner (1991), Tjallingii (1995), and Girardet (2001)—clearly understand that the first issue brought up by sustainability, above all in cities, is the evidence of the environment and landscape’s limits and the realization that the city does not stand alone, the city-region concept is a reality.

This work presents the second part of a more extensive piece of research performed in the city of Valencia, Spain, on the role of green zones in city planning. The first part was published previously (Gómez et al. 2004). This second part ratifies with greater statistical certainty the conclusions of the first regarding the amount of green zone necessary in the city for it to be considered comfortable. It reaches a precise formulation of three of the comfort indexes used in the research for Valencia.

The second part of the research focuses on applying the first part’s knowledge to proposed green planning for the city. This second part starts by analyzing the updated international bibliography on city environment and sustainability, the present concept represented by green zones and comfort in today’s cities, the relationship of both concepts, and concludes by explaining the latest conclusions of research in these fields.

Role of Vegetation in the City

The green infrastructure of cities is the only infrastructure that responds to certain needs for the coexistence, gathering, and socialization of different human groups. It fulfills an important social function that is also of interest with regard to the reaffirmation of personal integrity because it helps to maintain ties with the past (historic gardens, green accompaniment in monumental areas), that is, it facilitates the positioning of people not only on a cultural level, but also on a natural level, as a result of the connection with the temporal succession of biological aspects (changing of the seasons, temperatures, amount of daylight) in these live spaces.

In summary, the system of green spaces in the city and their planning interact with the urban microclimate system and with psychological environmental aspects of great importance for the inhabitants of the city, such as the urban environment, comfort, and quality of life (Sukopp and Werner 1982).

The vegetation in a city not only has a decorative function, but it also has a regulating role in environmental aggression: retaining atmospheric waters (Terjung and O’Rourke 1981), contributing to evapotranspiration, filtering out pollution, and representing an excellent regulator for the exchange of air, heat, and moisture with the urban environment (Miltner et al. 2004). City inhabitants also have a psychological need to be close to nature for its well-known therapeutic effects: decrease in stress, fatigue, and other aspects pointed out by the WHO and many other authors. Urban vegetation is especially beneficial because it improves urban comfort in hot climates (Givoni 1989) and reduces heat islands (Gómez et al. 1998).

Proof of the extremely important role of green areas in cities is the support from the European Union and the World Meteorological Organization to increase the green areas per inhabitant and the incentive to develop green plans in all cities.

Thermal Comfort in the City

Since ancient times, researchers have linked climatic conditions to well-being and the health of man. Throughout history, the different views and theories on these effects have done nothing but formulate hypotheses, more or less elaborate, attempting to explain the evolution or justify the development of different civilizations.

Nonetheless, during the twentieth century, systematic studies were undertaken regarding the relationships among man, the city, and climate. Perhaps it was the geographer Max Sorre who first and most accurately tackled the study of climatic comfort, and that which is of the most interest, who was the first to associate it with the microclimate of cities and artificial modifications (Sorre 1943). In addition, in the United States, geographers from the Department of Geography at the University of California (Terjung 1966) established a comfort index by using a graphic application similar to Olgyay’s bioclimatic chart, whose author was a professor of the School of Architecture at the University of Princeton. He also led, to a great extent, the important group of researchers from Berkeley, where different approaches were used in the studies of climate and urban comfort, significantly emphasizing the study of urban ecology (Register 1987).

Recent studies on bioclimatic comfort continue to use the two basic approaches pointed out by Morgan and Baskett (1974): the analytical or rational approach, which is based on the human energetic balance, and the synthetic or empirical approach, which is based on combinations of diverse meteorological variables. The empirical indexes ignore the decisive role of human physiology, activity, clothing, and other personal data (height, weight, age, sex). The rational indexes are more recent and tend to be developed through computer-aided techniques and depend on the human energy balance (Hoppe 1993).

At present, rational indexes are more related to urban planning interests and, on a worldwide level, highlight the work carried out during the Seville World Exhibition (Alvarez et al. 1991); the Rediscovering the Urban Realm and Open Spaces (RUROS) project, of special interest, developed for the European Union (Nikolopoulou et al. 2004); and the RayMan model, which has had a great impact, designed by meteorologists from the University of Freiburg (Matzarakis et al. 2006) based on the Association of German Engineers (VDI) Guideline 3787 (VDI 1998), published by VDI and the working group from the University of Sonora (Ochoa et al. 1999) on the basis of the work by Brown and Guilleseip (1995).

The International Society of Biometeorology has made a decisive contribution to this research with its publications and the creation of a special commission for the study of a universal thermal climate index (UTCI, http://www.utci.org/).

Recently, the evidence that psychological factors play an important role in the interpretation of individual comfort has been studied, especially in open city spaces, because it is important to take them into consideration for the design of these outdoor areas (Nikolopoulou and Steemers 2003; Sanesi et al. 2007; Van der Berg et al. 2007). Surveys administered to the citizens, inhabitants of these spaces, confirm the results from the empirical indexes (Gómez et al. 2004).

Comfort and Green Areas

There is a field that has been scarcely studied on a global level: the relationship between green areas and comfort (Salvador and Smith 1987; Kim 1989).

The first of these two works simply makes a comparative analysis of the cities of Valencia and Dayton, Ohio, in the performance of green zones in their relationship with the urban environment. Only the incidence of the green zones with the temperature existing in the spaces occupied by these was determined, establishing the
following equation: average annual \( T \ (°C) = -2.64486 \times \log \) ratio of green zones + 10.75701.

In the second work, Professor Kim (1989) established for the first time some relationships between comfort and green zones in a study with great impact on the whole city of Seoul. This is a more scientific work that uses climatological data, analyzes the existence of heat islands, and correlates green zones with comfort by means of the discomfort index (DI). Although the interaction of green zones with the meteorological parameters can be parsed, the results obtained have low statistical significance \( (R^2 = 0.35224) \). This is because of the low number of sampling points that had been taken in the study. The author nevertheless considers this type of study to be important for urban planning, although he points out that they should be done for each city, and the results may be very different for cities with different climatology.

The work presented in this article was started several years ago, and part of the results obtained have already been published (Gómez et al. 1997). On that occasion, comfort indexes were formulated according to the green area in each district in the city and the most appropriate type of vegetation for the city: radiation retention, pollution retention, or others.

This research has expanded statistically and geographically in the city of Valencia, thus confirming a clear path and solution for those responsible for urban planning.

Following active collaboration in the drafting of the green plan for the city of Valencia, the culmination of this study has been undertaken: the zoning and planning of green areas, that is, observing the quantity and quality of the green areas that should be implemented in each district to study the accessibility criteria that make them correctly usable by the citizens.

**Methodology**

In this work, meteorological variables were applied to numerous comfort indexes sampled in the city districts chosen for the study.

A statistical analysis using least significant difference (LSD) intervals obtained by ANOVA was performed on all of the indexes. The indexes that gave the most significant results, in accordance with a previous bioclimatic characterization of the city (Gómez et al. 1999), are presented in Table 1.

In Table 1, \( T_D \) = dry bulb temperature (°C); \( T_W \) = wet bulb temperature (°C); \( T_G \) = globe temperature (°C); and \( V \) = wind velocity (m/s).

The areas sampled for the meteorological analysis of the city of Valencia were the eight most important districts (Fig. 1).

For this study, eight districts in the city of Valencia were chosen in such a way that all of the urban and environmental characteristics...
Table 2. Formulation of the DI and WBGT Indexes according to the Surface Area of Green Areas Relative to Each District of the City

<table>
<thead>
<tr>
<th>Index formulation</th>
<th>Correlation coefficient (r) and coefficient of determination ($R^2$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>DI</td>
<td>Linear equation: $68.3513 - 32.1545$ (m$^2$ green area/land)  $r = -0.8262$ $R^2 = 0.6827$</td>
</tr>
<tr>
<td></td>
<td>Exponential equation: $e^{(2.246 - 0.48)}$ (m$^2$ green area/land) $r = -0.6901$</td>
</tr>
<tr>
<td>WBGT</td>
<td>Linear equation: $72.5075 - 47.1822$ (m$^2$ green area/land) $r = 0.8337$ $R^2 = 0.6952$</td>
</tr>
<tr>
<td></td>
<td>Exponential equation: $e^{(2.837 - 0.6693)}$ (m$^2$ green area/land) $r = -0.8401$ $R^2 = 0.7059$</td>
</tr>
</tbody>
</table>

Note: m$^2$ green area/land = m$^2$ green area/1,000 m$^2$ land in each district.

Table 3. DI Values Based on the Green Spaces (Data from Kim 1989)

<table>
<thead>
<tr>
<th>Year</th>
<th>Green spaces (km$^2$)</th>
<th>Summer DI</th>
<th>Decrease (-) or increase (+)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1986</td>
<td>360.52</td>
<td>73.83957098</td>
<td>+0.99999909</td>
</tr>
<tr>
<td>2001</td>
<td>359.79</td>
<td>72.83957189</td>
<td></td>
</tr>
</tbody>
</table>

The meteorological parameters measured were the following: air temperature, ambient temperature (globe), wind velocity, relative humidity, and solar radiation on a horizontal surface. These parameters were required for the indexes chosen; for the Olgyay chart, some of the data needed were requested from the Valencia Meteorological Service.

The need to increase the number of measurements at each sampling point was because attempts were made to formulate two of the indexes with the first series of five measurements (Table 2).

This formulation was satisfactory because the coefficients of determination were considerably better than those obtained by other authors (Kim 1989) (Table 3).

These formulations were obtained by using the following statistical conditions:

$$DI\text{(summer, Seoul)} = (-1.19 \times 10^{-6} \times \text{green spaces}) + 72.84$$

Standard error = 1.21363

$$R^2 = 0.35224$$

Signif. $F = 0.0419$

This formulation was very important because it allowed expression of the comfort and well-being of a space, district, or city according to its green areas. The confirmation of this hypothesis would be, on a district level, for the comfort calculated to increase as the surface area of green area increases.

The data obtained from this study are shown in Fig. 2.

This chart shows that the values obtained for each district did not coincide with a greater amount of green area [taking into account the maximum values for each index: DI = 20.5 and wet bulb globe temperature (WBGT) = 73.58]. Specifically, the DI comfort value of the Pla del Real district, which had the greatest amount of green area, is furthest from the maximum index value of 20.5.

To clear up any doubt caused by this apparent incoherence, the generic behavior of “soft” and “hard” ground was analyzed to confirm the hypothesis on the relation between well-being and green areas (in this case, in one way or another, in soft areas). Soft areas were considered to be sandy soils or grass, tree-lined or shrub-lined streets, with good orientation for breezes, and generally areas with lower reflection. Hard areas were those with concrete or stone pavement, hard ground, poorly oriented streets, or treeless streets. (Figs. 3 and 4).

The three indexes selected were reanalyzed with this criteria and confirmed that, in 100% of the seasons, better behavior was exhibited for the soft ground as a result of their proximity to the comfort area.

Therefore, some of these indexes were redefined by soft and hard ground and the time at which the measurements were taken...
and summer; green area (m²) was analyzed by season and district according to the amount of soft zones; district 12 in spring (Su) goes down, the spring comfort curve goes up slightly, and the autumn (A) and winter (W) comfort curves go up, toward to the range in all the seasons of the year. The four lines represent the comfort range values (Gómez et al. 2004); i.e., in all seasons of the year, the green zones have a smoothing effect on the thermal conditions (decreasing the temperature in the summer and increasing the temperature in the autumn and winter).

This diagram corroborates the new hypothesis of the correlation of comfort with the amount of green area because only the district with the greatest amount of green area leans toward the points of greatest comfort in all four seasons. Therefore, the rest of the 20 measurements were taken for each sampling point, as suggested by the statistical design. In this way, more exact data were obtained, which led to the reformulation of the three selected theoretical indexes: DI, WBGT, and cooling potential (PE) (Vinje) according to the new concept of soft ground.

The results are shown in Tables 5–7.

<p>| Table 4. Formulation of the DI and WBGT Comfort Indexes for the City of Valencia according to the Type of Ground: Soft (B) or Hard (D) and Time of Day (H) (Gómez et al. 2008) |</p>
<table>
<thead>
<tr>
<th>Season</th>
<th>Formulation of the comfort (DI and WBGT)</th>
<th>Coefficient of determination</th>
</tr>
</thead>
<tbody>
<tr>
<td>Winter</td>
<td>DI = 6.7809B + 6.938D + 0.648H</td>
<td>(R² = 0.993)</td>
</tr>
<tr>
<td>Summer</td>
<td>DI = 20.57B + 20.7277D + 0.33H</td>
<td>(R² = 0.997)</td>
</tr>
<tr>
<td>Spring</td>
<td>DI = 15.60B + 15.48D + 0.44H</td>
<td>(R² = 0.990)</td>
</tr>
<tr>
<td>Autumn</td>
<td>DI = 18.33B + 9.13D + 0.59H</td>
<td>(R² = 0.980)</td>
</tr>
<tr>
<td>Winter</td>
<td>WBGT = 36.66B + 37.39D + 1.73H</td>
<td>(R² = 0.992)</td>
</tr>
<tr>
<td>Summer</td>
<td>WBGT = 67.98B + 68.73D + 1.03H</td>
<td>(R² = 0.998)</td>
</tr>
<tr>
<td>Spring</td>
<td>WBGT = 59.07B + 58.99D + 1.16H</td>
<td>(R² = 0.992)</td>
</tr>
<tr>
<td>Autumn</td>
<td>WBGT = 38.29B + 39.07D + 1.81H</td>
<td>(R² = 0.990)</td>
</tr>
</tbody>
</table>

<p>| Table 5. Formulation of the DI Comfort Index (Adapted from Gómez et al. 2008) |</p>
<table>
<thead>
<tr>
<th>Type of ground</th>
<th>Hard (m² green /1,000 m² surface area)</th>
<th>Soft (m² green /1,000 m² surface area)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spring</td>
<td>0.3294; R² = 0.5465</td>
<td>0.3235; R² = 0.5250</td>
</tr>
<tr>
<td>Summer</td>
<td>0.3972; R² = 0.5528</td>
<td>0.3825; R² = 0.5285</td>
</tr>
<tr>
<td>Autumn</td>
<td>0.2699; R² = 0.5646</td>
<td>0.2579; R² = 0.5393</td>
</tr>
<tr>
<td>Winter</td>
<td>0.2402; R² = 0.5644</td>
<td>0.2307; R² = 0.5455</td>
</tr>
</tbody>
</table>

(this information was important because the meteorological parameters were taken in each district throughout the day between 9:30 a.m. and 2:30 p.m. and, logically, some of the parameters varied considerably depending on the time at which they were taken.

The results of this formulation are presented in Table 4.

In Table 4, B = 1 for soft zones; B = 0 for hard zones; D = 0 for soft zones; D = 1 for hard zones; H = h GMT + 2 in spring and summer; H = h GMT + 1 in autumn and winter.

To confirm the hypothesis, the behavior of one of the indexes (DI) was analyzed by season and district according to the amount of green area (m²/1,000 m² land in the district). This study is presented in Fig. 5.

In Fig. 5, District 6 Pla del Real, which has the greatest amount of green zone (108.3), is the district best positioned in the comfort range in all the seasons of the year. The four lines represent the seasons.

Fig. 5 also shows that in District 6, the summer comfort curve (Su) goes down, the spring comfort curve goes up slightly, and the autumn (A) and winter (W) comfort curves go up, toward to

| Fig. 3. Typical example of soft zone: Turia Park (Valencia) (courtesy of F. Gómez) |
| Fig. 4. Typical example of hard zone: outlying district of Valencia (courtesy of F. Gómez) |

Fig. 5. Behavior of the DI comfort index for the different seasons of the year (the highest comfort value is 20.28) (the values of the X axis correspond to the amount of green zone for Districts 19, 10, 4, 11, 2, 7, and 6)
In these formulas, the statistical determination continues to be superior to the work from Seoul and greater by more than 50% in all of the cases, allowing these formulas to be considered reliable tools to obtain a fairly precise idea of the relationship between green areas and comfort indexes. With these formulas, it would be possible to calculate the amount of green area required for a district in the city by substituting $B$ or $D$ for the percentage of soft or hard ground in the district and giving maximum values to the index to obtain the amount of green area per m²/1,000 m² land.

The results from the first part of the study provide information on species that provide the best shade on streets or in parks, those that retain the most pollution, and the role they play in city heat islands.

The formulation of these tables is in terms of the type of ground: soft ground, hard ground, and green zone for surface area in the district.

### Planning Criteria

Some scholars, including Lewis et al. (McHarg 1969), interested in the reconciliation of nature and human habitat, have proven that the processes that shaped the earth and the unlimited complexity of the life forms that have developed throughout history are an indispensable basis for the shaping of human settlements.

The disciplines responsible for the shape of the city have very little to do with natural science or ecological values. If urban design is conceived as the art and science dedicated to enhancing the quality of the physical environment of a city, to provide civilized and enriched places for the people who inhabit it, there is no doubt that the present bases for urban design must be reexamined (Deelstra 1992).

Because ecology has recently become the essential basis for planning regional space, it is vital for modified natural processes inside cities to become the central theme of urban design.

The sustainability concept, more recent than ecological science and with more extensive fields of study, is particularly concerned with cities because these are where the planet’s highest population concentrations are found.

The city of Valencia can benefit from what is stated in the Leipzig charter on Sustainable European Cities (European Union Member States’ Ministers responsible for Urban Development 2007), whose recommendations should be the basis of any reform of urban planning.

The most widely used gauge for measuring and valuing sustainability in cities are “sustainability indicators.”

Most international institutions and public and private bodies connected with development of cities have drawn up a list of “sustainability indicators,” omitted from this paper because they are so well known. In all cases, however, one of the indicators considered vital for sustainability in cities is the need for an amount (percentage) of green space in the total surface area of the city and the necessary accessibility to these green zones for a large part of the population.

These two questions form the basis of the research covered in this article and the objectives that will be seen for the green plan of Valencia.

The epigraphs before this work analyzed the role of green areas in the city. At present, the role of water (bodies of water, lakes, rivers, fountains) is being studied, and it too will likely play an extremely important role in the improvement of urban environments.

It is clear, therefore, that water and plants are important elements in the improvement of the climate and comfort of a city. But what is its sphere of influence? How much vegetation or superficial water is needed to achieve a significant effect on the comfort of a city? Where should they be located (Hough 1995)?

The answer to these questions depends on the region’s climate, the type and variations in climate from one place to another, the characteristics of the place, its topography, and the characteristics of the city’s built area.

One author (Meiss 1979) already suggested that, from a climatic point of view, a combination of small spaces distributed uniformly throughout the city is more effective than the concentration of very large areas in only a few places.

Later studies (Horbert et al. 1982; Nikolopoulou et al. 2006) confirmed that the planning of green areas should be considered from two fundamental perspectives: continuity and accessibility. Both favor an appropriate use by the citizens and conditions in accordance with the function they fulfill in the urban scheme.

Studies conducted in Dallas and Fort Worth, Texas showed the advisability of continuous green areas as the best way to achieve filtration and oxygenation of the air as it moves toward the interior of the city, one example of this could be the study of St. Louis green belt (Fig. 6). The most recent study in Chicago considered that a

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**Table 6.** Formulation of the WBGT Comfort Index (Adapted from Gómez et al. 2008)

<table>
<thead>
<tr>
<th>Type of ground</th>
<th>Hard (m² green /1,000 m² surface area)</th>
<th>Soft (m² green /1,000 m² surface area)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spring</td>
<td>0.1644; $R^2 = 0.5557$</td>
<td>1.1369; $R^2 = 0.5348$</td>
</tr>
<tr>
<td>Summer</td>
<td>0.2987; $R^2 = 0.5444$</td>
<td>1.2503; $R^2 = 0.5423$</td>
</tr>
<tr>
<td>Autumn</td>
<td>0.9969; $R^2 = 0.5645$</td>
<td>0.9586; $R^2 = 0.5490$</td>
</tr>
<tr>
<td>Winter</td>
<td>0.9499; $R^2 = 0.5674$</td>
<td>0.9121; $R^2 = 0.5471$</td>
</tr>
</tbody>
</table>

**Table 7.** Formulation of the Vinje’s Comfort Index (Adapted from Gómez et al. 2008)

<table>
<thead>
<tr>
<th>Type of ground</th>
<th>Hard (m² green /1,000 m² surface area)</th>
<th>Soft (m² green /1,000 m² surface area)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spring</td>
<td>0.1334; $R^2 = 0.5650$</td>
<td>0.1181; $R^2 = 0.4453$</td>
</tr>
<tr>
<td>Summer</td>
<td>0.0758; $R^2 = 0.4879$</td>
<td>0.0721; $R^2 = 0.4452$</td>
</tr>
<tr>
<td>Autumn</td>
<td>0.1255; $R^2 = 0.5844$</td>
<td>0.1124; $R^2 = 0.5239$</td>
</tr>
<tr>
<td>Winter</td>
<td>0.1610; $R^2 = 0.4803$</td>
<td>0.1488; $R^2 = 0.4691$</td>
</tr>
</tbody>
</table>

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**Fig. 6.** Periurban green belt in St. Louis (courtesy of U.S. Army Corps of Engineers Digital Visual Library)
master plan with development corridors and open air spaces would have a positive effect on air quality (Hough 1995).

Application to the City of Valencia

The choice of a human settlement has always been a complicated matter, only accessible to experts and those who know the territory and its long-term dynamics.

Therefore, this paper includes a brief introduction of the historic and present-day vision of the city of Valencia. Fig. 7 shows that Valencia lies in the east of Spain, by the Mediterranean sea and with an average height of 16 m and a fairly regular relief, on a plain rising gently inland with contours parallel to the coast.

Valencia city lies at the lower end of the river Turia flood plain, and it was founded on an island between two arms of this river; as it grew the city overflowed the small island and gradually settled on the plain that surrounded this, until it became a metropolitan area of 1.8 million inhabitants (Fig. 7), counting the number of small surrounding municipalities.

The river Turia, Valencia’s Albufera lake, the Mediterranean sea and the alluvial plain, all form the exceptional landscape of the Valencia metropolitan area (Fig. 8); four scenarios of remarkable cultural and landscape value sharing water culture as their central argument.

The Huerta is an ancient cultural landscape in which the prominent aspect is the irrigation system, with Roman origins, although the Arab age was when a major hydraulic infrastructure was created with numerous canals (Fig. 9), drying out large swampy zones that covered a good deal of the plain around the city.

A productive fertile space was gradually created by incorporating the knowledge and agronomic and hydraulic techniques from the Near East, and it became the richest market garden in the world [Food and Agricultural Organization (FAO)-UNESCO 1974], along with the Coazi valley in Colombia, or one of the five most important in Europe, according to the Dobíš report (EEA 1995) (Fig. 10).

The river Turia itself, with its entrainment of so much sediment over the centuries that favors the market garden area and the source of the canals nurturing it, divides the present space into the northern Huerta and southern Huerta.

The northern side is used for typical market garden products and orange groves, and the southern part contains the market garden, which has been left between the city and the new Turia riverbed, and on the other side, the rice fields and marshland of the Albufera.

On this space just defined, the city of Valencia and a further 40 municipalities have grown, originally organically. Regrettably, during the 1960–1980s, with their inexorable developmentalism and no coordination of the urban development of these municipalities, a situation of total lack of understanding between the city and the outskirts was nevertheless reached, as has occurred in practically all the world’s cities (Hill 1986). Now 72% of the heritage elements of great value inventoried in Valencia’s Huerta are abandoned or in a serious state of degradation.

The urban and industrial development quoted has generated serious dysfunctions in the water system in the Huerta. But above all, the urban development expectations, the low profitability of farm work, and the social devaluation of farmer’s work are causing the gradual desertion of the Huerta.

The image preferred by Europeans is that of a city surrounded by its landscape, but this image is now less reflective of reality. At this crossroads, the International Seminar on the Huerta of Valencia was held in 1994, attended by experts from all over the world with the intention of providing ideas to save this territory.

The important contents of the Valencia seminar were used as a basis for drawing up a green plan for the city with the basic aims of increasing the city’s appeal; correcting the contamination and urban discomfort; protecting the market garden; improving the coastline, water masses, and natural spaces; and increasing the areas of active recreation-leisure.

Fig. 7. Situation of Valencia metropolitan area (Landscape Planning Department, Generalitat Valenciana, with permission)
The content of this green plan set out to improve and increase the free and green spaces in the city and, in parallel, conserve the Huerta. In spite of the diagnosis of this market garden, there are still quite a number of its interstices within urban space, although with a high level of degradation (Fig. 11).

The spaces in the south have also undergone enormous aggression, although help arrived in time to protect the Albufera lake (protected as a nature reserve since 1990 with a special protection plan) and the Saler Park, consisting of 713 ha of pine trees on the dunes separating the Albufera lake from the Mediterranean. The protection was accomplished through the qualification of nondevelopable land in the latest general plan for the city.

On the administrative side, these surveys have been carried out by the two most important political bodies in the city: the Valencia Council and the Valencian Environmental Ministry.

The scope of work now refers to the municipal area of Valencia, which, according to the latest general plan approved, has the surface areas provided in Table 8.

**Green Planning**

People have been demanding an in-depth review of urban planning systems for years now. Some earlier works are those of Olsted and De Stein, first with Central Park in New York (Manhattan 1866) and then with the Parkways complex in Boston, at the same time as the First International Congress on Hygiene and Urbanism Problems was held in Paris (1900). Only a few years later (1907), the Second Congress recommended ensuring 15% green space for all the cities and a forest reserve in the surroundings with an area not under 10 km².

In 1932, the Athens charter was drawn up, leading to a form of city planning by means of “zonification,” which in its speculative practical application resulted in a considerable reduction in the provision of green spaces.

In the 1970s, a new trend emerged in Europe and America through ecologism. In 1969, the National Environment Policy Act (NEPA) was passed in the United States—the first forceful law defending the environment. American Ian McHarg wrote *Design with Nature*, which invoked the new design concept (McHarg 1969).

Another great event was the First International Ecology Congress (held at The Hague, 1974) and the works of the Dutch precursors: Le Roy, Leeuwen, and Ruff (1987) and Englishmen such as Nicholson, with his theories on ecological planning and landscape ecology, based at the renowned Urban Planning School in Delft, Holland.

The appearance of the UNESCO Man and Biosphere (MAB) Programme (1971) with a new approach was also important because of its vision of man as central actor in relation to the physical and biological setting (the biosphere); in particular the MAB-11 line, which was concerned with the ecological studies integrating urban systems as a basis for planning.

More recently, one of the documents with perhaps the greatest impact was published by the European Union [Commission of the European Communities (COM) 1990]. The spirit and letter of the green paper on the urban environment stresses green planning as the revision of the principles and practice of urban planning,
bringing in positive components and environmental, ecological, and landscape restrictions. Of course, these suggestions are general, and each city must consider its solutions according to the requirements of its physical medium and the population affected.

This is a specialized planning instrument, run by multidisciplinary teams of experts and with a comprehensive vocation covering city and territory, and has more recently ratified the European Territorial Strategy (European Commission 1999).

There have already been many experiments in this type of study all over the world, but in Spain, Valencia was the ground-breaking city in drawing up a green plan for the whole municipal area. This has led to the support of the EU by means of its Life Program (the Financial Instrument for the Environment) and the UNESCO MAB Programme, with the aid of North American expert David R. Smith, based on his study of the city of Dayton.

**Content and Phases of the Valencia Green Plan**

The team drawing up the plan must be completely familiar with the city or the place, and its requirements will be conditioned by those of the area or territory to be organized.

The organization chart of the technical office of Valencia’s green plan is shown in Fig. 12.

This figure displays how the different fields of research and different work groups overlap to converge in the only technical support combining a synthesis of all the work done in this field.

**Analysis**

In this stage of the process, each group is working in the area with which it is entrusted. All this work is integrated in an in-depth analysis of the physical medium, whose definition has been explained in detail in the section on “Application to the City of Valencia.” Because the spaces to the south are already legally protected (the Albufera and the Saler), or their configuration makes them unfeasible for any other uses, such as the rice field marshland around the Albufera, these spaces lie outside the analysis made for the green plan, which thus focuses on the city and the Huerta surrounding it.

The environmental analysis of the city concentrates on the study of the present situation and any possible shortcomings.

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**Table 8. Surface Areas of the Municipal Area of Valencia City (Data from Plan Bureau, Valencia Council)**

<table>
<thead>
<tr>
<th>Land type</th>
<th>Surface (hectares)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urban land</td>
<td>3,632</td>
</tr>
<tr>
<td>Developable land</td>
<td>815</td>
</tr>
<tr>
<td>Nondevelopable land</td>
<td></td>
</tr>
<tr>
<td>Parque del Saler</td>
<td>713</td>
</tr>
<tr>
<td>Albufera lake and marshland</td>
<td>2,843</td>
</tr>
<tr>
<td>Rice fields</td>
<td>1,400</td>
</tr>
<tr>
<td>Coastline area</td>
<td>71</td>
</tr>
<tr>
<td>Turia riverbed</td>
<td>226</td>
</tr>
<tr>
<td>Huerta market garden</td>
<td>3,382</td>
</tr>
<tr>
<td>Unirrigated land</td>
<td>112</td>
</tr>
<tr>
<td>Amenities and infrastructures</td>
<td>269</td>
</tr>
<tr>
<td>Total</td>
<td>13,465</td>
</tr>
</tbody>
</table>

---

*Fig. 10. Huerta de Valencia, classified by the Dobříš report as one of the richest in the world (Landscape Planning Department, Generalitat Valenciana, with permission)*

*Fig. 11. Interstices of the Huerta in the city of Valencia (Landscape Planning Department, Generalitat Valenciana, with permission)*
This formula was chosen because this index was already found (Gómez et al. 2004) to perform best in the study made on all of these. The reason could be that one of the parameters implicitly involved is ambient temperature (globe), which is most sensitive to the situation of the microspaces on which the study was based, and for which soft zones (with low reflection) are also most sensitive.

This analysis is made for the whole city because in this case the surface area of the market garden inside the city is already known (Table 8).

The surface of the Huerta inside the municipal area is 33,820,000 m². Of this, 20% must be deducted from this figure through infrastructures and its own buildings, leaving 27,056,000 m² added to the present green zones, which totals 31,335,246 m² in all, for a provision for the population (800,666) of 39.13 m² per inhabitant.

There are proposals for the green zones to be valued in terms of provision m² per inhabitant; the English norms (Barker and Graf 1989) set 1 ha/1,000 inhabitant. In this case, it would work out that green zones should occupy 800 ha. For the whole municipal area, this works out to 3,133.5 ha, comfortably exceeding the provision recommended.

Another provision put forward by some bodies is the total percentage of land: England considers a standard of 10% of the surface area to be necessary (Forestry Commission 1990). In this case, starting from the total green zones, the result is 23.27%, also greater than that criterion.

All this would provide the city of Valencia with a proportion of green areas far greater than what has been established by other bodies or international institutions, thanks to the green plan.

This plan proposes a multiple-point strategy of consolidating Huerta areas inside the city, creating peripheral parks in the north of the city to prevent its growth from destroying the most important and richest part of the Huerta, and consolidating in the south the natural spaces of rice fields, marsh land, Albufera lake, and Saler park, which, although 12 km from the city center, contains an extraordinary enclave between the Albufera lake and the Mediterranean.

In regard to ecology and city flows, in Gómez et al. (2004) the main connotations separating the city from its periphery were presented, examining the albedo of the different surfaces, the incidence of vegetation in urban space, species retaining the most solar radiation, and species retaining the most contamination (Fig. 13).

That study also made an in-depth analysis of the incidence of green zones in city climatology, specifically in heat islands (Gómez et al. 1998) and the incidence of the system of breezes reaching the city of Valencia, one of the factors of greatest comfort for the city, and the risk of the role of impairing those breezes by the dense construction to the southeast of the city, from which these breezes arrive.

The most important flows that have been studied in the environmental analysis of the city are those of energy and water, always from the angle meant by sustainability, according to all authors: marking the commitments between present needs and those of future generations.

Water flows were particularly problematic. The river Turia lies at the source of the Huerta’s irrigation, but, when it reaches the city, the river is divided into nine canals that spread over the whole market garden area. As it has grown, the city has unfortunately gradually invaded these areas and concealed and contaminated the part of those canals into which it poured its own wastewaters.

Energy flows are closely connected with public transport and private vehicle traffic. When the city decided to divert the river Turia, the cause of its catastrophic floods, the so-called “South...
Solution” (Fig. 15) envisaged using the original riverbed to improve city traffic by building an enormous motorway on it to act as a coordinating axis for all city traffic. That solution was fortunately dropped, and the 226 ha of the former riverbed were turned into a large linear park crossing the entire city.

Landscape analysis, the last of the three great themes of research, was the most complicated one because of the diversity and complexity of the city and its immediate surroundings, the Huerta, with the connotations already described. The landscape concept has evolved greatly over the last few years, and in the case of the green plan, because of Valencia Council’s delay in implementing this, it had to be the Valencian Authority Environment Ministry that assumed this study by means of a special plan for the protection of the Huerta (PAT).

This plan has always attempted to comply with the objectives defined in European Territorial Strategy and the European Landscape Convention. Apart from this, since 2004, the year in which it joined the European Landscape Convention (European Council), the Valencian region has had a landscape protection law, which to a large extent includes criteria from the two aforementioned documents.

Basically, as regards the Huerta, the phase of analysis was based on research into the serious deterioration of cultural and natural heritage, the loss and contamination of irrigation waters, the fragmentation and dissociation of the city, the abandoning of farming activity, and the deterioration of the visual landscape.

**Synthesis-Prognosis**

The etymological meaning of prognosis is “foreknowledge,” representing the threshold of planning.

In this stage of synthesis, it is vital to identify the system of green spaces, both urban and periurban, or also those with similar conduct. Orthogonal aerial photography with film sensitive to short infrared wavelengths was used to identify the soft tissues with low radiant reflection, such as green areas, tree areas, market garden crops, and fruit trees.

These images enabled location of the distribution of green in the urban and periurban areas.

One example of this procedure was implemented in the regional green plan of the Ille de France [Institut d’Aménagement et d’Urbanisme de la Région Ile-de-France (IAURIF) 1994], in which it distinguished what is known as the ecosystem of the urban region, consisting of the green section of agglomeration, the green belt, the rural crown, and the valleys and green connections.

The following step to the visible provision of green zone for the city of Valencia in the analysis involved defining the typology of these green zones, segregating natural areas, periurban areas, and setting standards in the two forms required by today’s ecological plan and as proposed by sustainability indicators: in square metres per inhabitant and percentage of surface area, in minimum surface area for each of the typologies recognizable and applicable to Valencia (Table 10).

One aspect linked to the actual provision already mentioned in this manuscript is the radius of influence, which characterizes accessibility to green spaces. The criteria for examining this have been used in other planning documents, specifically taken from Canada’s Green Plan, perhaps one of the most complete documents drawn up to date (Government du Canada 1990) (Fig. 14).
Going by these criteria and applying the radiuses of action, the whole map of the city was analyzed to insert the different types of green area that its people can access (Fig. 14).

The city of Valencia, because of its linear River Turia Park, has very good accessibility possibilities for a good deal of the population (Fig. 15).

As regards flows and ecology, in this phase, rather than flows, the periurban environmental quality, contamination (situation of drainage or subsoil and contaminated canals), noise contamination, and discomfort index are all applicable. For all the cases a conventional scale of 1–5 is applied, in which the lowest value represents the highest quality. The sum total allows ranges to be set, thus providing a final valuation result for each of the districts, as seen in Figs. 16 and 17.

In the same way as the quality factors of the urban landscape are integrated, marks for historical value, harmony in building, singularities, green provision in percentage, and trees per hectare are incorporated. Of the city’s 19 districts, the three outer districts are excluded from these graphs. This is the procedure that was used by the Green Plan Office.

In this phase, however, the methodology of the special plan for protection of the Huerta de Valencia was considered on the basis of first determining its most valuable landscapes (Fig. 18), analysis of its conflicts and tendencies, and the establishment of five strategies to guide specific protection action.

These strategies are of interest in this synthesis-prognosis stage: (1) protecting and connecting the landscapes of greatest value; (2) guaranteeing the continuity of farming activity; (3) integrating the infrastructures and urban outskirts in the landscape; (4) protecting and boosting cultural and visual heritage; and (5) fostering public leisure use of the Huerta.

The set of landscapes with greatest cultural, productive, landscape, natural, and leisure value and the ecological and functional connections among these form the landscape and identity of Valencia’s Huerta and should be preserved for future generations as an interconnected, accessible system.

These references are for the whole unit of the Huerta de Valencia, for which reason two spheres must be established.

- The Huerta as a whole, for which this protection concept attempts to place order on the chaos of the 40 municipalities growing on this, creating a continuous system of green corridors that ensure the effective separation of municipalities, an improvement in the visual landscape, and people’s public enjoyment of the metropolitan area.
- The Huerta space inside the municipal area of the city of Valencia, for which the protection would generate a continuous mesh of green spaces to structure and guide urban growth of the city.

According to landscape criteria for the Huerta space inside the Valencia municipal area, the study concentrates on the...
improvement in the perceptive surroundings of the urban zones with visual access to green zones and increased tourist appeal.

This may require the creation of itineraries and landscape routes, with viewpoints, information points, interpretation centers, and leisure areas, making use of the existing farming structure, particularly by using the historical network of paths and irrigation channels (paths, cattle tracks, canals, dams) (Fig. 19).

The synthesis phase goes deeper into the other strategies, above all in the territorial, landscape, and socioeconomic analysis of the Huerta, stressing that the protection of its heritage and cultural assets involves maintaining farming work.

To this end, management formulas are in development on the basis of the farmer; the increase in the competitiveness of farm

<table>
<thead>
<tr>
<th>Item</th>
<th>Min. average surface area</th>
<th>m²/inhabitant</th>
<th>Ratio of surface area (percentage)</th>
<th>Radius of influence</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Natural areas: natural spaces</td>
<td>2 ha</td>
<td>5</td>
<td>2.75</td>
<td>2 km for 20 ha; 5 km for 100 ha; 10 km for 500 ha</td>
</tr>
<tr>
<td>2. Periurban areas: periurban park (including woods)</td>
<td>25 ha</td>
<td>5</td>
<td>2.75</td>
<td>From 1–2 km</td>
</tr>
<tr>
<td>3. Urban areas</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-Urban park</td>
<td>10 ha</td>
<td>5</td>
<td>2.75</td>
<td>1,000 m</td>
</tr>
<tr>
<td>-District park</td>
<td>5–10 ha</td>
<td>2.5</td>
<td>1.38</td>
<td>500 m</td>
</tr>
<tr>
<td>-Local park gardens</td>
<td>1–5 ha</td>
<td>2</td>
<td>1.1</td>
<td>250 m</td>
</tr>
<tr>
<td>-Neighborhood gardens and squares</td>
<td>1,000 m² to 1 ha</td>
<td>1.5</td>
<td>0.8</td>
<td>100 m</td>
</tr>
<tr>
<td>-Recreation areas</td>
<td>&gt; 1,000 m²</td>
<td>1.5</td>
<td>0.8</td>
<td>100–1,000 m</td>
</tr>
<tr>
<td>Total</td>
<td>1,500 m²</td>
<td>12.5</td>
<td>6.83</td>
<td>400 m</td>
</tr>
<tr>
<td>-Pedestrian strolling and rest</td>
<td>2</td>
<td>1.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-Free areas</td>
<td>2</td>
<td>1.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Urban market gardens: leisure gardens</td>
<td>2 ha</td>
<td>1</td>
<td>0.55</td>
<td>1,000 m</td>
</tr>
<tr>
<td>5. Trees</td>
<td>1–3 trees per inhabitant</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Fig. 16. Urban environmental quality (Salvador Palomo 2003, with permission)

Fig. 17. Peripheral environmental quality (Salvador Palomo 2003, with permission)
Fig. 18. Huerta de Valencia, definition of spaces with greatest value stemming from the analysis (Landscape Planning Department, Generalitat Valenciana, with permission)

Fig. 19. Periurban spaces; the connection between the Huerta and the city (Landscape Planning Department, Generalitat Valenciana, with permission)

Fig. 20. Landscaping of Valencia’s northern ring road (Landscape Planning Department, Generalitat Valenciana, with permission)
work; the development of open and mixed financing formulas; 
the offer of new farming, cultural, and tourist services; and lastly, 
the creation of a body managing these strategies. Another of the 
tactics used was the landscape integration of transport infrastruc-
tures (Fig. 20).

The urban outskirts were studied, specifically the transition zones 
between urban space and the Huerta, through requiring an 
intervention strategy enabling consolidation of the limits of the 
Huerta and inviting the citizen to visit and enjoy this. This was one of the objectives of the green plan.

This penetrability and mutual accessibility between the city 
and Huerta is marked by the location and painstaking design 
of the rest areas, located on the extensive path network, which 
facilitate its public and recreational use. The idea behind this 
mutual rapprochement is that citizens should get to know traditional ways of life, farming culture, and the architectural heritage 
of the Huerta, transformed into a wide range of didactic, recrea-
tional, and service offers. Since the International Seminar on the 
Huerta (1993) was held there has been a very clear conviction that 
“getting to know the Huerta is the first step toward protecting it.” 
Protecting the Huerta necessarily involves city people’s persuasion 
of the environmental, social, and economic benefits stemming from 
conserving it.

Diagnosis

The diagnosis is a convincing document with a short description 
acting as a sound preliminary to the planning proposals. In parallel 
with the diagnosis, either before, after, or simultaneously, the 
solutions that assist in understand the processes and sustaining 
the conclusions of large groups and knowledge forums are of great 
interest.

The International Seminar on the Huerta de Valencia provided 
countless ideas on possible uses of the Huerta, taking into account
the example of such cities as London, proposed by the director of the London Ecology Unit (Goode 1993). The conclusions of this diagnosis are

- There is great interest in improving the environmental quality of the city and protecting the Huerta; the landscape, culture, and history of both are highly valued.
- The Huerta is open space, with water, pathway, and plot structures, with its own agrarian activity and with crops that can be varied. This space can and should enrich the environmental conditions of the city of Valencia.
- This whole process involves finding a protection concept for the most fragile space, and this requires a management system enabling the continuity of farming activity.
- The clearest way to ensure farm work involves improving the profitability of farm produce through agrarian and market mechanisms, although it will always require the economy of Fig. 24. Proposal of the green plan for the whole municipal area of the city of Valencia (the legend is explained in Spanish because it pertains to the green plan’s official document)
complementary activities to be comparable with other activities, in which the city must take a major role.

- The protection and maintenance of work in the Huerta must be paid by the beneficiaries, those who value it and want its protection: the city and its inhabitants.

In view of and as a conclusion to this diagnosis, only two possible alternatives come to mind, illustrated in Figs. 21 and 22.

**Planning**

After diagnosing the situation and establishing the planning objectives, alternatives for action must be recognized and valued, choosing whichever is considered most appropriate and executing this. At the point at which planning leads almost imperceptibly into management, new problems are identified as a result of the option, and the process then repeatedly restarting.

Planning must get right down to the most specific aspects. It would not be enough to reach a precise definition of the type of vegetation, amount and place where this must be installed for the city to be comfortable; the installation of this vegetation must be planned, examined for compatibility with insertion in thoroughfares, defining the type of roads and streets properly, with definitions of vehicle traffic lanes, bicycle lanes, and others. (Fig. 23).

**Management**

The green plan works out in a management plan, which includes a number of projects, an action plan, and finally, control of the results and changes arising.

In this process, great importance is given to communication among planners and the public as a whole, whose lives and interests are affected by the organization imposed by the plan. The exchange of ideas and information is not only a democratic requisite, but also clarifies and legitimates the proposals of the team drawing up the project.

The plan for recovery of the Huerta itself, as a planning measure, has had to include a long period of informing and allowing participation of public opinion.

The chapter on the new management of the Huerta was of particular importance, logically involving the decisive significance of continuing to be what it is. To this end, any urban development speculation had to be ruled out and management measures introduced, with legal support, to guarantee maintenance of farm work, the basis of the live cultural landscape underlying the Huerta.

These measures must be based on the maintenance of private property and activity, fostering entrepreneurial initiatives to boost the competitiveness of farming work, and incorporating complementary activities and services to help raise farm income.

Compensatory measures must be considered for the environmental and landscape conservation functions and services provided by farming work, in the benefit of the urban medium, for which it constitutes a periurban park.

It is undeniable that if the Huerta is going to represent the development of an environmental space for the city, providing all sustainability criteria, this is a cost that the city must assume.

These aspects have quite unquestionably been the most costly and difficult to solve through requiring the acceptance of citizens in both areas—the Huerta and the city.

**Conclusions**

This work is part of an extensive investigation in the city of Valencia on the influence of green zones on the comfort of the city. The work structure was defined in the introductory section.

An attempt has been made to make this study a piece of applied research by analyzing the previous research and concluding that an improvement in the amount and arrangement of green areas in the city is very important, but not sufficient, for a city sustainability approach (Baycan-Levent and Nijkamp 2009).

The recent plan for protecting the Huerta was analyzed because, without departing from the green plan philosophy, this represents an updating of the proposals of European Territorial Strategy and the European Landscape Convention.

The final result of the application of this research was not altered by the simultaneous implementation of these two studies because the second of these, although with methods more appropriate for European proposals, reaches the very same conclusions—the need for the protection of the Huerta.

All of this led to a proposal for planning in the sphere of sustainability, with a management plan very close to the actual situation (Fig. 24).

This paper has complied with the objectives of moving from a basic or experimental piece of research (the first part) to applied research (the second part), in which the contents of the experimental part are practically applied.

As a final conclusion, the city of Valencia must consider the need to take growth in a new direction so that it does not continue to grow over the fabric of the Huerta, which is the best alternative that the city has to maintain sustainable growth.

These considerations have been made from a scientific research and should be made known to the persons responsible for the urban planning of the city, who ultimately must make the decisions.

**References**


