

Green Walls Benefits in Contemporary City

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1 ABSTRACT

There is nothing new about using vegetation in buildings and construction of cities. Greenery has always played an important role in the construction of cities. However, contemporary cities are currently dominated by building structures to the detriment of natural elements, causing problems of congestion and pollution. The urban rehabilitation policies should always consider both buildings and vegetation as being defining elements in the city. Green spaces should be present alongside one of the fundamental elements of cities. Not only because they improve the city image, from an aesthetic point of view, but also due to social, cultural or landscape factors.

The most recent and compulsory Portuguese urban rehabilitation principles emphasize the improvement of sustainability. It is, therefore, critical to draw attention to this area and find innovative solutions in this domain, especially with regards the integration of vegetation in historical areas.

Green walls can be a good choice towards achieving sustainable urban rehabilitation, due to the lack of free space which exists in the consolidated urban fabric.

This paper aims to reflect about green walls benefits in the contemporary city and in the urban rehabilitation, identifying the advantages of their utilization as an enhancement of the quality of city image, especially in dense urban areas.

2 EVOLUTION OF USING VEGETATION IN THE CITY

Vegetation has been used for many centuries in buildings and construction of cities.

One of the most famous examples of integration of vegetal elements in buildings is the Hanging Gardens of Babylon ordered by the ancient civilizations of the Tigris and Euphrates river valleys in Mesopotamia (Dunnett, et al., 2010). These gardens were characterized by terrace construction with trees, waterfalls and irrigation systems, creating the perception of being suspended. The vegetation was visible from a great distance (see Figure 1).

The cities of the Greek and Roman empires were characterized by olive trees and grape vines which were cultivated purposely so as to climb building walls (Newton, et al., 2007). These vegetation elements were used as ornamental elements of buildings envelope.

With the advent of industrial city a new concept of town planning practise emerged. Since then, green spaces such as, urban parks, neighbourhood gardens, set of trees aligned alongside of streets or a curtain of trees began to be used as part of the city planning and urban design.

The most notable examples are the Garden Cities proposed by Ebenezer Howard at the end of the 19th century, such as Letchworth (1904), Hampstead (1906) or Welwyn (1921) built on the outskirts of the city of London (see Figure 2).

During the first half of the 20th century, there were several cases of planned green spaces as part of new urbanizations, not as garden cities but as garden suburbs. New residential areas emerged with small public gardens serving the neighbourhoods and conforming buildings and street shapes.



Fig. 1: Hanging Gardens of Babylon (Gardens Pictures, accessed in 13.03.2012).



Fig. 2: Welwyn Garden City, United Kingdom (Google Earth, accessed in 17.01.2012).

Since the Industrial Revolution, urban areas have increased its density significantly. In this context have emerged new organizational models based on the expansion and dispersion of cities, which are causing severe functional and ecological problems.

The environmental conditions of urban areas are deteriorating due to increasing air temperature and pollution levels, to soil waterproofing and lack of permeable areas.

Coating materials absorb more solar radiation than vegetation, which cause the increment of urban areas temperature.

The traffic congestion in cities gives rise to increasing levels of pollution, causing the *greenhouse effect*, an overheat of urban areas, mostly during the night (Oberndorfer, et al., 2007).

Soil waterproofing makes it impossible to naturally drain rainwater, causing problems of surface runoff.

Large urban areas are also affected by increasing energy consumption, lack of amenities, high maintenance costs and absence of green spaces.

All these problems have called into question the meaning of green spaces in the city and its interaction with nature.

In this way there is urgency to redefine city public spaces, in order to turn them into being more dynamic, inhabitable and sustainable (AA.VV., 2008).

3 GREEN SPACES IMPORTANCE IN THE CITY

3.1 The call for greening in the urban context

Vegetation has an undeniable therapeutic benefit to citizens, while promoting urban biodiversity (flora and fauna), allowing the presence of several species of plants, birds, bees and other beneficial insects (Weiler, et al., 2009).

Green spaces elements (i.e. trees, small gardens, green parks) are all identifiable components in the city structure, making part of the composition of urban context and also organizing, defining and containing spaces (Lamas, 2003).

The provision and the localization of green spaces have particular importance in the configuration of the city. The presence of green areas in the urban context can contribute to the quality of life of citizens in many ways.

The integration of plants affects positively the urban environment. Vegetation is a climate moderator, helping to reduce the imperviousness of soil and contributing to storm water management, improving the air quality through the production of oxygen, absorption of pollution like CO₂ and heavy metals (Bruse, et al., 1999) and trapping dust particles.

Green areas can have a positive effect on urban environmental conditions and consequently in the health of citizens. When applied in a significant scale they can be beneficial to the thermal comfort of urban spaces, providing shade, promoting the evapotranspiration, inducing a cooling effect and contributing to the mitigation of urban heat island effect.

Green spaces have a social and emotional importance in the citizen's quality of life and well-being. In fact, the presence of nature in cities encourages the use of outdoor spaces, increasing the interaction and social integration among citizens (Chiesura, 2004).

Given that the main part of the world population is living in cities, it can be said that the green spaces have a strategic importance in the contemporary urban context.

There are several types of green spaces in the contemporary city and all of them have their own role in the urban context. These different types of green spaces are designed in different urban scales with different functions in the city.

Green spaces are drawn to different scales in the context of a city and they are always an important presence in the townscape, ranging from more detailed scale of a set of trees along the street network or a small green patch framing the building shape, to the large scale of an urban park serving the entire city.

3.2 Urban parks

The larger green spaces in the cities are the urban parks built in order to serve the whole city scale.

Urban parks have "a major role in the midst of an urban development of considerable density" (Cohen, 2001: 259). They provide an extensive space for recreational purposes and for citizens to relax, allowing them to be with nature inside the city.

The park of the City in Oporto, the second main city in Portugal, localized in the North of the country near the Atlantic sea shore, is an interesting example of an urban park.

This city park was defined as part of the planning process of Oporto city. For the first time in the 1960s, the architect Robert Auzelle, planned this green area in the contents of the city Urbanization Plan.

This urban park, designed by Prof. Sidónio Pardal (a landscape architect), opened in 1993 (the first phase) and was concluded in 2002. It is the largest urban park in the country with an area of 83 hectares of vegetation extending to the Atlantic Ocean, giving it a special environment worldwide (see Figure 3).

The retaining walls are built with stone coming from demolition of buildings and other structures, and this material assumes a prevailing characteristic of this park.

The park includes draining ponds for the retention of rainwater, surface spillways for ponds, tanks shelters, paths and paving borders. All these elements which constitute this urban park create an idea of rural countryside and nature in the city.

The urban park of Oporto has a symbolic meaning for the citizens as a place which is included in their daily life.



Fig. 3: Urban Park of Oporto City, Portugal (Google Maps, accessed in 13.03.2012).

3.3 Neighbourhood gardens

In the contemporary city, neighbourhood gardens create a relationship with the streets and buildings of the surroundings. This kind of neighbourhood gardens can “be included in the city pattern (...) serve as an intimate meeting place and offer some orientation” (Cohen, 2001: 260).

Much less attention is being paid to that type of nature, close to where people live and work, to small-scale green areas in cities and to their benefits to citizens.

The presence of a small garden conforming a building, a block or a neighbourhood is also important in completing the image of the city, improving the quality of life of its users.

They are leisure areas and informal areas for walking and picnicking and for keeping in touch with nature in the contemporary city.

Small gardens are an opportunity to be in contact with nature in a humanized and urbanized environment.

In urban areas of greater building density, the use of existing free space within the blocks is an opportunity to bring the presence of nature through green spaces to the city.

Small gardens can be built on these sites, ensuring citizens a sense of intimacy and privacy. These green sites are an excellent choice for urban sociability. They can be used such as play spaces for children, away from the noise and danger of cars, or as a place for relaxation (see Figure 4).



Fig. 4: A neighborhood garden. Foundation Calouste Gulbenkian, Lisbon (DocLisboa 2007, accessed in 13.03.2012)

3.4 Trees alignment alongside the streets

It can be said that the tree is the most detailed green element in the contemporary city.

Despite of this fact, the presence of a set of trees along a street network could change completely the image of that place.

In addition to the well known environmental benefits, the presence of trees in the streets has the function of improving the aesthetic domain of the place. One street is deeply different with or without the presence of trees. The trees help to disguise a street with poor building façades in architectonic or aesthetic terms and help to improve its image.

The tree has a fundamental role in giving shade as well as transforming dead areas or brownfields into social areas and giving colour to streets and public urban areas in general.

The Avenue called Avenida da Liberdade in Lisbon is an example of a main street which image is characterized by the presence of the alignments of trees in both sides of the road and alongside the sidewalks (see Figure 5). This avenue would have a completely different image without the presence of trees.

With the trees the Avenida da Liberdade became an open space where the citizens can stay, walk, meet and socialize. These green alignments are occasionally marked by cafes, kiosks or elements of land art.

With the presence of their trees this avenue assumes the role of a small central garden in one of the densest part of the city.

Finally, trees provide shade, function as acoustic curtains and contribute to a pleasant perception of comfort and amenity to pedestrians.



Fig. 5: Avenue "Avenida da Liberdade" in Lisbon, Portugal (Google Maps accessed in 13.03.2012).

In summary, despite the type or scale of green areas, all of them have many beneficial effects to human society in the city context, enriching "human life with meanings and emotions" (Chiesura, 2004:1). Some authors are showing that citizens are motivated for the presence of nature elements such as all kinds of green spaces in the city. Results confirm that the experience of nature in urban context is "source of positive feelings and beneficial services, which fulfil important immaterial and non-consumptive human needs" (Chiesura, 2004:1).

4 SUSTAINABLE URBAN REHABILITATION IN PORTUGAL

The concept of urban sustainability has been discussed since the 1990s. As decided in the Aalborg European Conference on Sustainable Cities & Towns in 1994, city policies must follow a sustainable development, making an effort to achieve social justice, sustainable economies and environmental sustainability (AA.VV., 1994).

In Portugal, during the last decade the population has grown 2%, while the number of dwellings has increased 16% (AA.VV., 2011), which means that there is a surplus number of dwellings.

In this country, the most recent town planning policies encourage urban continuity and preservation of historical parts of cities, focusing on two main goals, the rehabilitation of consolidated areas and the preservation of cultural heritage. Urban rehabilitation is now being included as part of the planning process. In this field were created the figures of detailed local plans, namely the Urban Rehabilitation Plan and the Heritage Safeguarding Plan.

The Urban Rehabilitation Plan includes sustainability in its three fundamental aspects (financial, social, cultural and environmental) as one of its ten principles.

Despite of the urban environment is still dominated by building structures; natural elements can be an important tool to achieve urban sustainability. Vegetation brings several benefits (social, economic, environmental, cultural and aesthetic) to the urban context.

Currently, in Portugal is compulsory in all new urban developments, to have areas for green spaces. The design parameters of these green spaces depend not only on the type of activity (residential, commercial, or industrial services) but also according to the type and size of dwellings.

As an example, it can be referred that the sizing parameters of green spaces are 28 m² per each single house dwelling. In the case of buildings for collective housing, the sizing parameters of green spaces are 28 m² per each 120 m² of construction area.

However, such rules are required only in new urbanizations. In urban rehabilitation actions, of consolidated city areas, there are not established rules requiring the presence of green spaces. Given that, in this kind of urban spaces the morphology of narrow streets or high building density, leaves no free spaces, the use of green walls could be the unique chance to bring nature to city.

5 STRATEGIES FOR USING GREEN WALLS

5.1 Opportunities

High dense urban areas have usually lack of public green spaces. So, in that case, green walls can be an interesting solution of greening cities vertically, without occupying any space at street level, contributing to the fruition of the urban environment.

The insertion of new coating solutions like green wall systems can be an interesting alternative to explore, either in new and existing buildings. In this way, degraded urban areas can acquire a new life, through the application of these systems, achieving a distinct image in the urban context.

Despite of using vegetation in buildings isn't new, the application of modern solutions of façade greening is still very recent (Dunnett, et al., 2010).

Green wall systems are becoming popular all over the world, but there are still few examples of their potential to enhance surroundings. In fact, these systems can be a new strategy for town planning and researchers are just becoming aware if its benefits to the urban context.

5.2 Benefits

Green walls contribute to the insertion of vegetation in the urban context, which is scarce in dense urban areas. They can contribute to cities sustainability based on environmental, social, aesthetical and economic benefits.

The insertion of green walls contributes to increase urban biodiversity (Weiler, et al., 2009) without any ground level occupation. They can be an important strategy to improve the quality of urban areas with lack of free space, adding "nature to places where man once removed it" (Blanc, 2011).

Green walls along with other greening strategies can help to mitigate the problems mentioned above if applied in an urban scale and therefore contribute to the well-being and health of citizens.

These systems have the ability to improve air quality (Köhler, 2008), absorbing CO₂ and heavy metals (Bruse, et al., 1999) (Rahman, et al., 2011) and retaining dust particles, while the vegetation releases oxygen to maintain its vital functions. Green walls can help to mitigate the *greenhouse effect*, contributing to increase the levels of air humidity and to decrease air temperature.

These systems can contribute to the use of rainwater for irrigation, minimizing the consumption of tap water.

These systems enhance, aesthetically and visually, the spaces in which are inserted (Dunnett, et al., 2010).

On one side covering an extensive vertical surface with a garden can help highlighting the importance of a certain place (Jacobs, 1961).

On the other side green walls valorise not only the buildings in which are integrated, but also the surrounding area, having a therapeutic effect, due to the presence of vegetation, introducing nature into the daily life of citizens (Blanc, 2011).

Green walls can also contribute to the valorisation of historical areas, improving their property value (Ichihara, et al., 2011). This advantage can be applied since the building scale until the neighbourhood in which the green wall is integrated.

5.3 Applications

There are several solutions of green wall systems. However, it is important to identify and classify them according to their main characteristics.

Several designations are used to mention green walls. In fact, green wall concept is associated to all vertical surfaces covered with vegetation. In the context of green wall systems we can characterize two main typologies, green façades and living walls (Köhler, 2008) (Kontoleon, et al., 2010) (Pérez, et al., 2011).

Traditional green façades consist in the application of climbing plants (permanent or deciduous), with their roots embedded in the ground or inserted in vessels, developing upwardly along the vertical surface. Green façades also include descendent solutions with hanging plants. In this case there are pots with substrate

placed at different levels along the façade. These systems require a good anchorage for the vegetation to resist external aggressions and avoid its fall.

Recent solutions of green façades include cables or vertical structures fixed to the wall to support the development of vegetation. These systems enable to reach new heights and to introduce a wider range of climbing plants (see Figure 6).

Green façades are economic solutions, simple to perform, yet have a dispersed growth, taking several years to cover the entire surface.

Living walls include modular systems and vertical gardens. Living wall systems have emerged recently to enable rapid coverage of vertical surfaces and allow a uniform growth of plants. These systems can be an advantage when there is the intention to cover surfaces with large proportions, adapting to different types of buildings and various walls. They can be pre-planted or pre-seeded to increase the possibility of vegetation to succeed.

Modular systems consist in the application of interlocking units, containing the growing medium and the vegetation. These solutions can have several dimensions and compositions depending on the system (see Figure 7A). They are easy to assemble and disassemble, allowing the removal of a module for maintenance purposes.

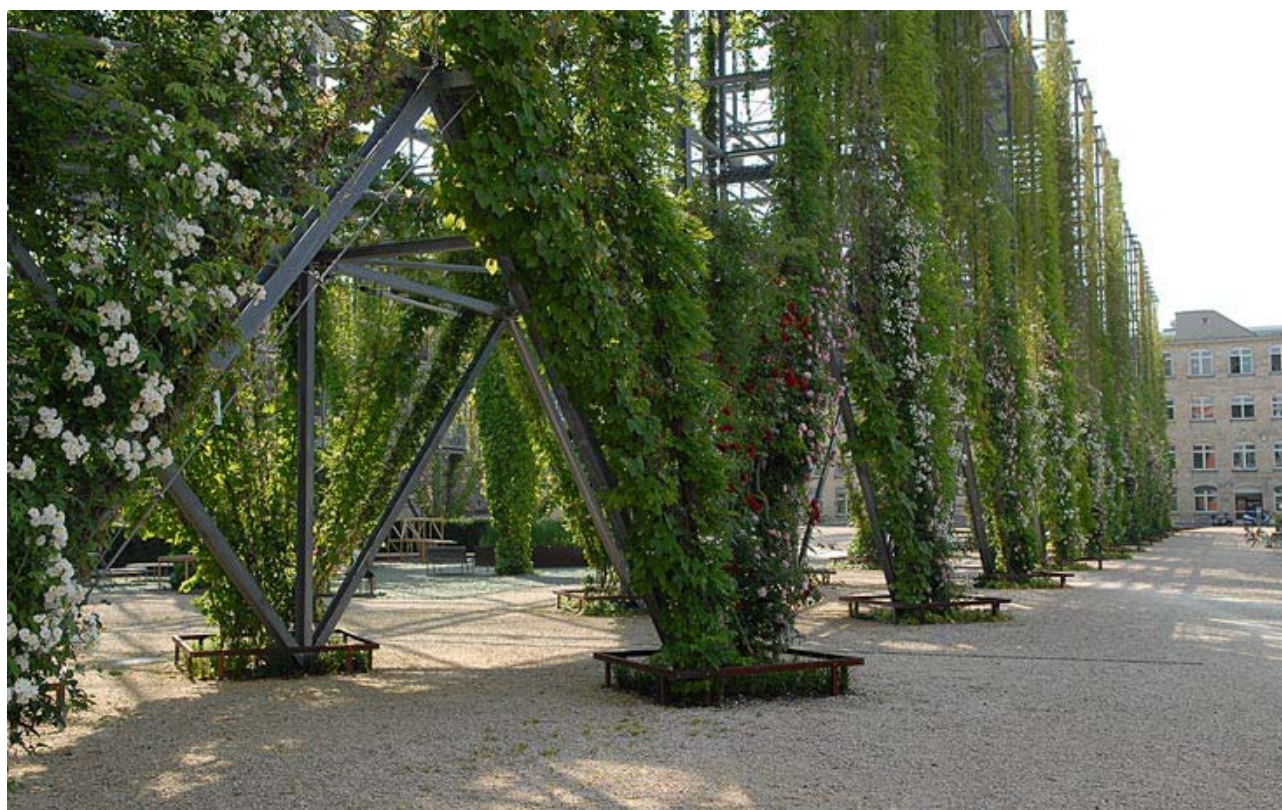


Fig. 6: Green façade of MFO Park in Zurich, Switzerland (Burckhardt + Partner Website, accessed 12.07.2011).

Vertical gardens are based on the application of lightweight screens like geotextiles where are introduced the plants individually (Ottel , et al., 2011).

The solutions of living walls allow the use of a wider range of plant species than green façades. They enable the development of artistic solutions, exploring the diversity of colours, density and pattern of leaves.

Some of the most notorious examples in this field are the hydroponic vertical gardens of Patrick Blanc. His work is widespread all over the world. It includes examples in the renovation of existing buildings and urban areas or in new constructions (see Figure 7B).

Nowadays, there are several solutions of each green wall systems, which offer different advantages. In the future it will be important to focus on aspects, such as the installation efficiency, the system maintenance and the costs during its lifecycle. The question will be to make green walls a viable alternative to green the cities.



A



B

Fig. 7: A. Modular living wall system of Natura Towers, Portugal (GJP Arquitectos Website, accessed in 23.11.2011);
 B. Vertical garden system of CaixaForum, Spain (Vertical Garden Patrick Blanc, accessed in 21.11.2011).

6 CONCLUSION

If in new urbanizations, the presence of green spaces is already a reality, in historic and dense urban areas the green spaces rarely exist. Consequently, there is a need to reformulate planning recommendations regarding the compulsory existence of green spaces not only in new urbanizations, but also in the urban rehabilitation actions of dense urban areas. As shown previously for the Portuguese case.

The role of green spaces in the cities could be understood in a diversify way, so as to achieve the needs, expectations and well-being of all citizens.

Town planners and urban designers should therefore take into account in the strategies for the contemporary cities more parameters about green spaces, traditional gardens or vertical green surfaces.

This article reflects about the advantages of the utilization of green walls, and their associated benefits, enabling the achievement of sustainable urban rehabilitation, due to the lack of free space in the consolidated urban areas (Virtudes et al., 2011).

In summary, the main goal of this article is to show, by the presented solutions, the importance of green walls for the urban rehabilitation in the contemporary city. They are elements of well-being for citizens, enhancing urban spaces and promoting the sustainability of the places they inhabit.

It is a challenge in the contemporary city for these professionals to advocate the use of green walls as a key strategy in order to provide to the citizens the contact with nature in the urban context.

Regardless the green wall benefits, they are still a challenge in the contemporary city policies. This challenge must mobilize land and property owners, developers, special interest groups, national government and its agencies, and planning authorities themselves.

7 ACKNOWLEDGEMENTS

This work was developed in the context of a interdisciplinary research project, PTDC/ECM/113922/2009, studying the benefits of green surfaces in buildings, in C-Made / Centre of Materials and Building Technologies in a partnership the School of Agriculture of the Polytechnic Institute of Castelo Branco.

8 REFERENCES

- AA.VV.: Carta das cidades europeias para a sustentabilidade. Conferência europeia sobre cidades sustentáveis. Aalborg, Dinamarca, 27 Maio 1994.
- AA.VV.: Urban landscapes sostenibilidad. Barcelona, 2008.
- AA.VV.: Censos 2011. Resultados Preliminares. Lisboa, 2011.
- BLANC, Patrick: The Vertical Garden, from nature to cities. 2011.
- BRUSE, M., THÖNNESSEN, M. and RADKE, U.: Practical and theoretical investigation of the influence of facade greening on the distribution of heavy metals in urban streets. 1999.
- CHIESURA, Anna: The role of urban parks for the sustainable city. In: Landscape and Urban Planning, Vol. 68, Issue 1, pp. 129-138, 2004.
- COHEN, Nahoum: Urban planning conservation and preservation. New York, 2001.
- DUNNETT, Nigel and KINGSBURY, Noel: Planting Green roofs and Living Walls. Portland/London, 2010.
- ICHIHARA, K. and COHEN, J. P.: The New York City property values: what is the impact of green roofs on rental pricing? In: Springer Vol. 4, pp. 21-30, 2011.
- JACOBS, Jane: The dead and life of Great American Cities. New York, 1961.
- KÖHLER, Manfred: Green façades - a view back and some visions. In: Urban Ecosystems, Vol. 11, pp. 423-436, 2008.
- KONTOLEON, K.J. and EUMORFOPOULOU, E.A.: The effect of the orientation and proportion of plant-covered wall layer on the thermal performance of a building zone. In: Building and Environment, Vol. 45, pp. 1287-1303, 2010.
- LAMAS, José: Morfologia urbana e desenho da cidade. Lisboa, 2003.
- NEWTON, J., GEDGE, D., EARLY, P., WILSON, S.: Building Greener: Guidance on the use of green roofs, green walls and complementary features on buildings. London, 2007.
- OBERNDORFER, Erica, LUNDHOLM, Jeremy, BASS, Brad, COFFMAN, Reid R., DOSHI, Hitesh, DUNNETT, Nigel, GAFFIN, Stuart, MANFRED, Köhler, LIU, Karen K., ROWE, Bradley: Green Roofs as Urban Ecosystems: Ecological Structures, Functions, and Services. In: Bioscience, Vol. 57, pp. 823-833. Nr. 10, 2007.
- OTTELÉ, Marc, PERINI, Katia, FRAAIJ, A.L.A., HAAS, E.M., RAITERI, R.: Comparative life cycle analysis for green façades and living wall systems. In: Energy and Buildings, Vol. 43, pp. 3419-3429, 2011.
- PÉREZ, Gabriel, RINCÓN, Lúcia, VILA, Anna, GONZÁLEZ, Josep M., CABEZA, Luisa F.: Green vertical systems for buildings as passive systems for energy savings. In: Applied Energy, Vol. 88, pp. 4854-4859, 2011.
- RAHMAN, Abdul M. A., YEOK, Foong S., AMIR, Atikah F.: The building thermal performance and carbon sequestration evaluation for Psophocarpus tetragonobulus on biofaçade wall in the tropical environment. In: World Academy of Science, Engineering and Technology, Vol. 76, pp. 86-94, 2011.
- VIRTUDES, Ana, MANSO, Maria: Green façades: as a feature in urban design. In: ICEUBI 2011, International Conference on Engineering, University of Beira Interior, Covilhã, Portugal, 28-30 November, 2011.
- WEILER, Susan K., SCHOLZ-BARTH, Katrin: Green Roof Systems - A Guide to the planning, design, and construction of landscapes over structure. New Jersey, 2009.