



Research Paper

Reducing environmental impacts of urbanization through vertical living walls

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ABSTRACT

Increase in population density is usually manifested by an increase in buildings, and in many cases, greenery gets neglected resulting in a decrease in oxygen and an increase in population in urban areas. Urban developers, architects and landscapers can play a role in increasing oxygen by increasing greenery in urban developments. In cases where there is no room for horizontal traditional parks, buildings can house vertical gardens or living walls on their facades. However, the process is costly in terms of water consumption and can create filtration problems if not properly erected. They can cover the facades of residential buildings, power buildings and auxiliary buildings around nuclear power plants. This study discusses the practicality of the application and its advantages and disadvantages.

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Key words: Green walls, vertical living walls, oxygen, power buildings, auxiliary buildings, nuclear power plants.

INTRODUCTION

With the growing densities in cities, urban areas are attracting more people every day thus increasing the number of buildings. More green areas are needed to produce oxygen for people to breathe. The concept of vertical gardens or living walls or green walls are appreciated for extra oxygen. Lately in 2019 in Heliopolis and Nasr City, two suburbs of Cairo, many street island parks were demolished to make room for the erection of 14 bridges. Unfortunately, Oxygen was compromised in favour of traffic fluidity.

VERTICAL GARDENS / LIVING WALLS / GREEN WALLS

Invented by Patrick Blanc (<https://www.verticalgardenpatrickblanc.com/>), a living wall is a system that allows plants to grow on a vertical panel. It can be either soil-based or hydroponic (water-based). Defying gravity, a living wall requires specific engineering, yet some systems are easier than others to install and maintain. There are interior and exterior living walls. They differ from green façades (e.g. ivy walls) in that the plants root in a structural support which is fastened to the wall itself ([http://www.greenovergrey.com/living-](http://www.greenovergrey.com/living-walls/what-are-living-walls.php)

[walls/what-are-living-walls.php](http://www.greenovergrey.com/living-walls/what-are-living-walls.php)). A living wall is a wall partially or completely covered with greenery that includes a growing medium, such as soil or a substrate. Most green walls also feature an integrated water delivery system. A living wall is also known as a vertical garden. It provides insulation to keep the buildings inside temperature (Kate, 2018). A living wall is a system that allows plants to grow on a vertical panel. It can be either hydroponic (water-based) or soil-based. Defying gravity, a living wall requires specific engineering, yet some systems are easier than others to install and maintain. There are interior and exterior living walls.

Figure 1 is an example of a separate green wall while Figure 2 is an example of an interior living wall and Figure 3 is an example of a building with ivy walls. Figure 4 is a details of Figure 1

WATER SOURCE

In a recirculating system, the source of water is an irrigation tank which is either remote-controlled or directly underneath the living wall. The irrigation tank is filled manually on a regular basis to provide an adequate supply of irrigation water. Water is pumped from the tank to



Figure 1: Vertical garden or living wall or green wall (<http://www.greenovergrey.com/living-walls/what-are-living-walls.php>).



Figure 2: Interior living wall (<https://www.naava.io/editorial/what-are-green-walls>).



Figure 3: Interior living wall (<https://www.naava.io/editorial/what-are-green-walls>).

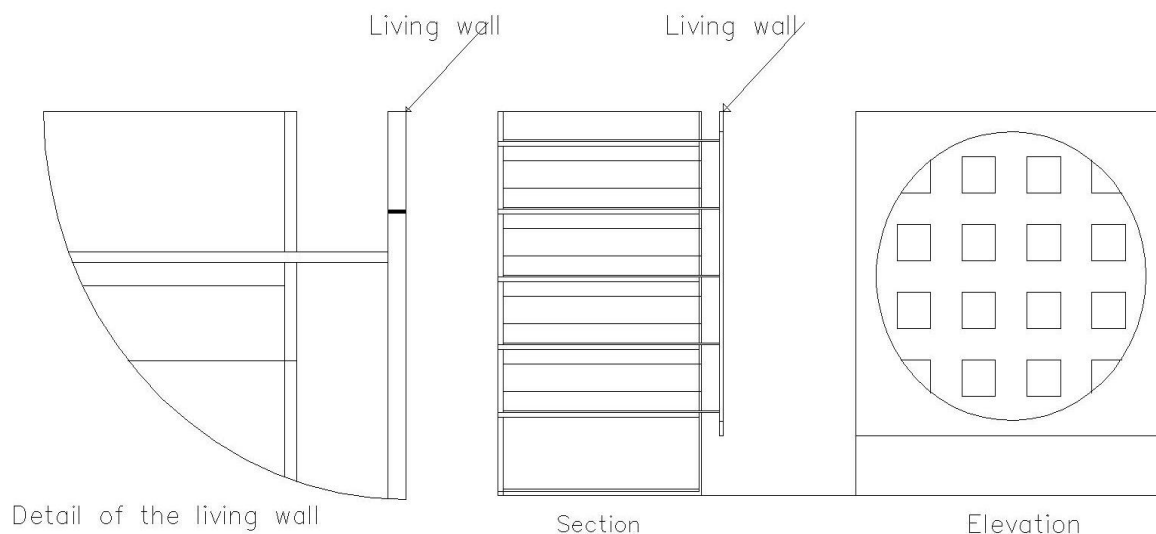


Figure 4: Detail of a living wall, section and elevation of the living wall.
Source: By author.

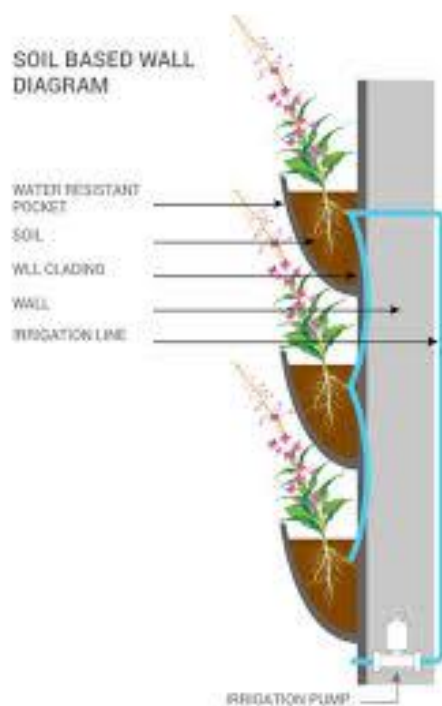


Figure 5: a section in a soil-based wall diagram (<http://verticaloxygen.com>).

the living wall.

SOIL-BASED AND HYDROPONIC SYSTEMS

After comparing the two systems in Table 1, and showing them in Figures 5 and 6, it can be concluded that soil-based

systems are easier, use less water and are less expensive than hydroponic ones.

Advantages of living or green walls in interiors and exteriors

Aesthetic appeal: Vertical living walls are interesting to look at. They can act as artwork on a bare wall whether as interior or on facades. They are very trendy.

Cleaner air: Fourth, plants can help “clean” the air indoors. Many people think that having a living wall in a living room or other area of the home provides a great health benefit. Indoor plants tend to collect and show dust, but when vertically grown, they collect and show less dust and they are also easier to clean.

Biodiversity: The variety of plant and animal life in the world or in a habitat, a high level of which is usually considered to be important and desirable.

Building envelope insulation: A vertical wall parallel to the original building wall (Figures 1 and 4)

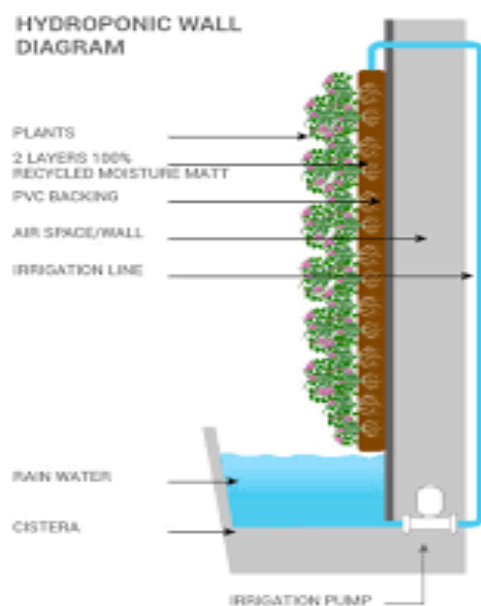
Space saving: Green walls take up very little footprint in the garden but provide maximum number of plants to the original building wall.

Improving air quality: Plants produce oxygen and absorb CO₂ from the air.

Green space: Increasing any green space in the urban environment it helps to reduce the Urban Heat Island Effect (UHIE) which is the effect that occurs when buildings and

Table 1: A comparison between soil based and hydroponic systems (Pauline, 2014).

Item	Soil-based	Hydroponic
Water consumption	215L per square meter per year (same as any landscape project)	860 - 1000L of water per square meter per year
Watering frequency	once a week	3-5 times per day
Cost	LE860-LE1000 per sq. meter	LE1000-LE2000 per sq. meter
Weight	32 kg per square meter	55 kg per square meter
Installation	Easy	High
Maintenance	Low	Medium
Risk	Low	High

**Figure 6:** A section in a hydroponic wall diagram (Pauline, 2014a).

hard surfaces absorb the sun's heat and then send it back into their surroundings.

Thermal insulation: The small cavity between the green wall and wall surface remains at a relatively constant temperature. This has a knock-on effect when it comes to cooling or heating your green wall-clad building as it adds a thermal barrier.

Acoustic insulation: Green walls help to absorb sound waves, so they are perfect for use as sound screens between properties.

Temperature regulation: Plants regulate temperature indoors and outdoors (<https://gardentabs.com/pros-cons/>).

Disadvantages

The consumption of water: Similar to agriculture, it

consumes water.

Limited growing space: Vertical planters generally don't provide a whole lot of space for roots to grow. Unless the planter is a heavy-duty structure, larger plants will not be able to be supported. This means the choices are more limited to smaller varieties or that grow more slowly.

Drying out: Some planters that receive a lot of sun can dry out easily, weakening or killing plants. For this reason, it is important to look at the materials used when building your planter. For instance, if you want to make a gutter garden to grow herbs and lettuces in a sunny space, use a white plastic gutter that will help reflect light and heat – instead of a dark grey metal gutter that will heat up faster.

Expense: Many premade vertical planting systems cost more than traditional pots. They are specially designed for easy set-up, easy maintenance and easy watering, which are all great benefits.



Figure 7: living wall in London's Athenaeum Hotel near Hyde Park designed by the inventor Patrick Blanc (<https://www.athenaeumhotel.com/the-living-wall/>).

Potential messiness: Containers where the plants grow out to the side rather than up present the problem of dirt falling out. A few ways to get around this issue are to:

- A chicken wire or other wire mesh material through which the plants are inserted.
- Make plants close together to almost form a “seal” where the dirt cannot escape. Succulents are good for this.
- Keeping the planter in a horizontal position for several months before standing vertical. This gives roots time to grow and take hold, which also helps keep the soil in place.

Watering and drainage: A simple solution that many growers use is choosing succulents or other drought-tolerant varieties. Smaller containers can also be more easily moved for occasional watering. Some larger structures include a catch basin at the bottom.

Maintenance: Maintenance of the vertical green wall is essential to maintaining it (<http://easyverticalgardening.com/types-of-vertical-gardens/pros-and-cons-of-vertical-gardens/>).

CASE STUDIES

Engulfing buildings with living walls

To increase oxygen and reduce pollution environmental effects on a city, engulfing buildings with living walls can present a useful project for entire cities that are suffering from these problems and have high rainfall, so no water is needed for watering. **Figure 7** is the case of the Athenaeum Hotel near Hyde Park in London.

Engulfing nuclear power plants and power buildings with vertical living walls

Auxiliary buildings of nuclear power plants and power buildings all over cities can be engulfed with living walls. Figure 8 is an example of auxiliary buildings covered by living walls in a gated community in Cairo..

Heliopolis neighbourhood “renovation”

In winter 2019, a major change has taken place in



Figure 8: Living walls covering generator rooms with green walls in Taj City between Suez road and the ring road in Cairo (<https://schaduf.com/schaduf-projects/tag-sultan/>).

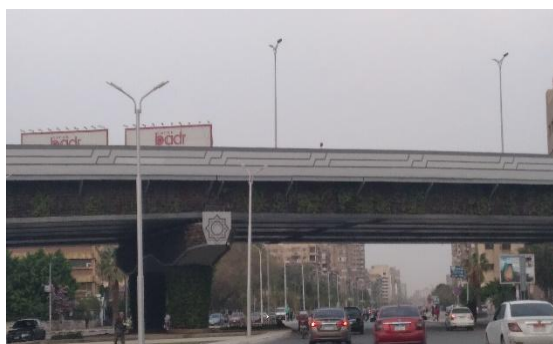


Figure 9: Living walls fill the spaces under the new bridge.

Heliopolis where many street islands parks were demolished for the sake of erecting bridges to help in connecting the neighbourhood to the New Capital and to ease the traffic to and from the neighbourhood. The side of the bridge was covered with living walls which eased some of the anger of the residents of the neighborhood. (Figure 9).

Conclusions

Living/ green walls increase oxygen, resist pollution and beautify a building or an interior. It can also environmentally compensate for lost horizontal parks. They can cover the facades of residential buildings, power buildings and auxiliary buildings around nuclear power plants. It might be water consuming but it can use recycled water.

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