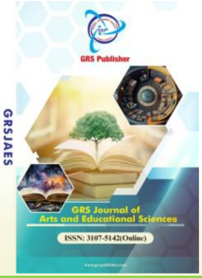
OPEN ACCESS

GRS Journal of Arts and Educational Sciences
Abbreviate Tittle- GRS J Arts Edu Scin
ISSN *(Online)* - *3107-5142*
https://grspublisher.com/journal-details/GRSJAES
Vol-1, Iss-3 (Sept- 2025)



Environmental Study: Green Facade and Its Impact on Human Life, and Its Role in Sustainable Architecture

Mohammad Masoud Moradi & Dr. Mohammad Ekram YAWAR

[1]PhD Candidate in Agriculture Faculty, Department of Agricultural Economics, Ankara University.

[2]Dean of the Faculty of Law, International Science and Technology University, Warsaw, Poland.

https://orcid.org/0000-0003-3198-5212 https://orcid.org/0009-000895521912

Article History
Received: 10.07.2025
Accepted: 08.08.2025
Published: 17.09.2025

Corresponding Author: Mohammad Masoud Moradi

Abstract: Global warming and climate change are among the most pressing challenges facing humanity today. Approximately 70% of cities are affected by these issues, with nearly all urban areas at risk. Large cities are responsible for more than 70% of global carbon dioxide emissions and consume 2.3 times the world's energy, making urban strategies critical to controlling climate change. Rising urban air temperatures have prompted architects to explore innovative solutions, such as green facades, in both new and existing buildings. Vertical green systems are increasingly used to improve air quality and enhance environmental conditions around structures. This article introduces the main types of green walls and highlights their benefits for human health and the surrounding environment. The research methodology includes case studies, comparisons with conventional buildings, and surveys of building residents. The acceleration of global warming and climate change has made it imperative to adopt adaptive strategies. Utilizing vertical green spaces on buildings not only mitigates the heat island effect but also contributes to sustainable architecture and enhances the quality of life for residents.

Keywords: *Green facade, green roof, sustainable architecture, global warming*.

Cite this Article

Mohammad. M. Moradi & Dr. Mohammad. E. YAWAR , Environmental Study: Green Facade and Its Impact on Human Life, and Its Role in Sustainable Architecture (2025) *GRS Journal of Arts and Educational Sciences, Vol-1(Iss-3).18-24*

Introduction

Today, one of humanity's most pressing challenges is global warming, and a key goal is to mitigate its effects through the construction of sustainable structures. In urban environments, where horizontal space is limited but vertical space is abundant, vertical greening provides an effective solution to integrate architecture and nature.

Vertical greening technology combines plants with building structures, offering innovative opportunities for sustainable architecture (Koma et al., 2014). Building facades are constantly exposed to environmental stressors such as sunlight, acid rain, and air pollution, which can damage materials over time. Living wall systems not only protect facades but also provide benefits similar to green roofs, including improved insulation, air purification, and aesthetic enhancement (Kohler, 2008).

Selecting the most suitable vertical garden system depends on factors such as the building's location, height, orientation, and available space (Ottmann, 2016). The concept of green facades is not new—it has been employed for thousands of years—but modern approaches combine sustainability with advanced design and technology. This article will examine some notable case studies, particularly in Germany, to highlight the effectiveness of green facades.

Types of Green Walls (Vertical Greening)

Green walls can be classified based on their growth systems and functional methods:

1. **Green Facades**
   - **Direct System:** Plants grow directly on the building wall.
   - **Indirect System:** Plants grow on support structures or trellises attached to the wall.
2. **Living Walls**
   - **Passive Living Walls:** Walls with plants used primarily for decorative purposes.
   - **Active Living Walls:** Walls integrated with irrigation, drainage, and structural support

systems to sustain plant growth and enhance environmental performance.

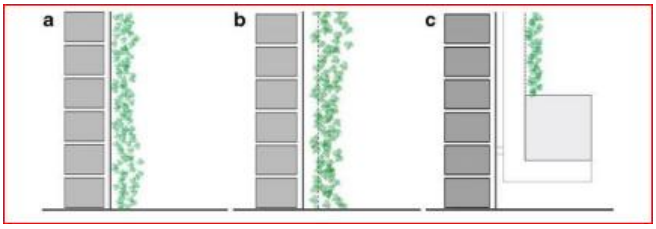
(Rokhshan Dehrou et al., 2015).

Green Façade

Green facades use climbing plants, which can be either deciduous or evergreen, to cover building walls. They can be implemented using:

- **Direct system** (traditional architecture)
- **Indirect system** using steel cables, nets, or scaffolding (grid)
- **Planting methods** include planting in the ground, in plant boxes at different heights, or on the roof (Kohler, 2008)

Figure 1 – From left: a) direct system, b) Indirect system, c) Indirect system planted in plant boxes (Green Roof Organization, 2008).



Green Facade – Direct System

In the direct system, climbing plants are planted at the base of the building and attach themselves directly to the walls, fully covering the facade. This system has been widely used in traditional architecture.

- **Advantages:**
  - Provides a cost-effective method for creating green space.
  - Self-adhering climbers with sucking roots can cover the entire height of walls efficiently.
- **Limitations:**
  - Not suitable for all building facades.
  - Invasive climbing plants may damage walls, especially during maintenance or removal, causing rot and structural issues (Perini & Rosasco, 2013).

Image 2 – Direct green facade (Rokhshan Dehrou, 2016)

Green Facade – Indirect System

In the indirect system, climbing plants are supported away from the wall using structures such as cables, nets, or scaffolds.

- **Materials used for support systems:** steel, aluminum, wood, or plastic (Perini & Rosasco, 2013).
- This system allows flexibility in plant growth and prevents damage to the building's surface.

Systems of Vertical Greening

A. Grid Panel System

- **Analogous panels:** Three-dimensional, lightweight, rigid, and strong panels made of steel (coated, galvanized, and welded) (Kohler, 2008).
- **Application:** Provides a durable and structured framework for climbing plants.

Figure 3 – Analogous grid panel system (Rokhshan Dehrou, 2016)

B. Cable or Wire Mesh Rope System

- Requires flexible and elastic cables that can be designed in various shapes and sizes.
- **Applications:**
  - Metal rope systems are suitable for slow-growing plants and provide better anchorage.
  - Cable systems are ideal for fast-growing plants with dense foliage (Otley et al., 2011).

Figure 4 – Stainless steel wires (Rokhshan Dehrou, 2016)

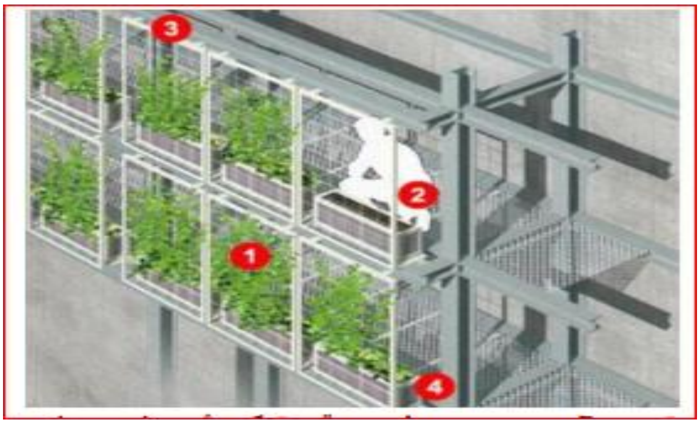
Figure 5 – Cable and wire mesh rope (Rokhshan Dehrou, 2016)

C. Direct Green System Combined with Plant Boxes

- Combines the indirect system with plant boxes to cover a larger area of the building at multiple heights.
- **Requirements:**
    - Equipment for nutrient delivery and irrigation, similar to living walls (Raitry et al., 2012).

Figure 6 – Indirect green system combined with plant boxes:

1. Container
2. Insulated containers
3. Motorized remote irrigation system
4. Wall decoration system



D. Green Walls (Vertical Greening)

Selection should consider **climate, light exposure, and architectural design**

- **Maintenance requirements:** watering, nutrient delivery, and pruning.
- **Plant selection:** based on environmental compatibility and natural support systems (Rokhshan Dehrou, 2016).

Investigating the Effects of Green Facades: Global Case Studies

Table 1 – Comparison of Benefits and Costs: Green Facades vs. Green Roofs
(Large effect: ++, Small effect: +, No effect or negative effect: -)

Benefits/Arguments	Green Facade	Value/Baseline	Green Roof	Value/Baseline
Visible from street level	++	Less than 2% of Berlin's total facades are green. High potential for creating urban green spaces. (Kohler et al., 1993)	-	Mostly not visible from the ground. 15-30% of new flat roofs in some areas of Germany are green roofs each year. (Hemmerle, 2002)

Edible Fruit Production	++	Espaliers have been used for hundreds of years.	+	Limited space for rooftop edible fruits, but projects like the rooftop rice paddy in China exist. (Valezquez and Quirres, 2007)
Biomass Production	++	Young creeping plants can produce up to 23 tons/ha/year. (Bartfelder and Kohler, 1987; Kohler et al., 1993)	+	Extensive green roofs are less productive to reduce maintenance costs. (Kohler et al., 1993)
Dust/Particulate Reduction	++	2% of annual dust can be trapped if an inner-city neighborhood is completely greened. (Kohler et al., 1993)	++	Better potential than green facades for dust trapping, depending on vegetation system and structure.
Heavy Metal Reduction	++	Dust trapped in/on leaves; Boston Poplar and Pichick adapt well to polluted urban environments. (Kohler et al., 1993)	++	High pH in the growing system contributes to significant heavy metal reduction. (Kohler et al., 1993)
Surface Shelter / Thermal Insulation	++	Winter up to 3°C (insulation on cold nights), Summer up to 3°C (shading effect); 25% temp reduction for north-facing walls (Bartfelder and Kohler, 1987; Minke and Witter, 1983)	++	Depending on vegetation layer and structure: Winter energy savings 3-8%; Summer air conditioning reduction up to 75%. (Kohler and Malvern, 2006)
Noise Reduction	++	Up to 5 dB reduction (Boston ivy), 2-3 dB (Rubus or Fallopia) (Baschen and Schreiber, 1999; Bukha, 1984)	++	5 dB reduction vs. conventional buildings; depends on soil layers and plant type. (Baschen and Schreiber, 1999)
Green Space for Walking	-	Only visual amenity; no recreational space (Ulrich, 1983)	++	Recreation possible on green roofs.
Nature Conservation / Biodiversity	++	Supports wood-adapted birds, spiders, beetles, thermophilic species. (Kohler, 1988; Klusznitzer, 1993)	++	Extensive green roofs provide habitats for various species; rare invertebrates may colonize if site/structure is suitable. (Seeman, 1998; Kodas, 2006)
Cost of Construction	++	Low: creeping plants like ivy or lily; requires scaffolding and soil. (AFL, 2000; Kohler et al., 1993)	+	Sometimes high if special structures or additional insulation are needed.
Results	**Easy to implement; high environmental impact; few requirements**		**More time and money required but very effective**	

Table 2: Positive and Negative Impacts of Green Facades

Method: Interviews with citizens
Node A: Residents in green houses (n=1556)
Group B: Residents in non-green houses (n=536)

Positive Arguments	Node A	Node B	Contra Arguments	Node A	Node B
More nature in cities	51	58	Often grafting	48	27
Improving visual appearance of the city	49	61	Eliminating leaf fall	43	36

Better feelings of citizens	29	38	Repair problems	40	41
Bird habitat structure	29	32	Clogging of gutters and vertical water tanks	28	29
Better air quality	29	21	Less sunlight entering the room	25	31
Thermal insulation in summer	22	20	Damage to the façade	21	22
Improving the urban environment	22	20	Regional green space for pets to rest	21	22
Better urban climate	18	17	More insects	18	36
Environmental learning	18	22	Roof damage	16	9
Thermal insulation in winter	18	11	Neighborhood problems	12	10
Biodiversity	18	21	Additional costs	12	15
Personality of the house	16	22	Problems of leaving together	8	17

Table 3 – Overview of Climbing Plants Tested at the Adlershof Project, Berlin (2003–2006)

Plant Species	**Development Quality**	**Growth Length (2003–2006)**	**Comments**
Wisteria sinensis	Fast growing, faster flowering	10 meters	Successful on ground level and all heights; requires strong support and training system for trunks
Actinidia komomikta	Slow growing	3 meters	Drought sensitive
Campsis tagliabuana	Medium growth in sheltered conditions	4–5 meters	Attractive flowering plant
C. orientalis, Clematis paniculata, C. tangutica	Slow growing, insect sensitive	3 meters	Requires professional care, e.g., nutrients, insecticides
Hydrangea petiolaris	Attractive but slow growing	3 meters	Requires professional care, e.g., pesticides
Vitis coignetiae	Attractive fruit on the oldest plants	3 meters	Requires high temperatures and guidance for upward stem orientation

Table 4 – Public Benefits of Green Facades (Shoka & Magdi Mohammad, 2012)

Place of Work	**Description**	**Benefits**
Impact of reducing urban tropical temperatures	Increasing temperatures in urban areas occur due to replacement of natural vegetation with sidewalks, buildings, and other structures. Sunlight is converted into heat in these built environments.	Provides natural cooling, reduces ambient temperature in urban spaces, slows vertical airflow, and cools shaded surfaces and people
Improves outdoor air quality	High urban temperatures, increased vehicles, air conditioning, and industrial emissions lead to higher nitrogen oxides, sulfur oxides, volatile organic compounds, carbon monoxide, and particulate matter.	Filters harmful gases and particulate matter
Aesthetic improvement	Green walls bring aesthetic diversity to environments people frequent daily	Creates visual interest, conceals unattractive features, increases property value, and enhances the attractiveness of structures

Table 5 – Private Benefits of Green Facades (Shoka & Magdi Mohammad, 2012)

Place of Effect	**Description**	**Advantages**
Improves energy efficiency	Regulates external temperatures, enhancing thermal insulation. Factors include climate, building distance, cladding type, and plant density.	- Traps air in plant mass - Limits heat movement - Reduces ambient temperature via shading and evapotranspiration - Provides wind buffer in winter

		- Reduces energy for indoor heating/cooling
Building structure protection	Buildings deteriorate over time due to freeze-thaw cycles, UV exposure, and weathering	- Protects exterior from UV, weather, and temperature fluctuations - Seals doors, windows, and cladding against wind pressure
Improve indoor air quality	Green walls filter pollutants from indoor environments through plants and biofiltration by microorganisms	- Captures airborne pollutants like dust and pollen - Filters harmful gases and VOCs from carpets, furniture, and other building elements
Noise reduction	Growing media in living wall systems help reduce transmitted or reflected sound. Influenced by media depth, materials, and coverage	- Reduces noise levels inside and outside the building
Leadership in energy and energy design	Green walls contribute directly or indirectly to achieving sustainability credits	- Supports green building certification and energy-efficient design
Marketing	Enhances aesthetic appeal and project value	- Creates attractive amenity space for marketing and promotion

Table 6 – Mental Priorities of Green Facade vs. White Stone Façade

(Y. Dadkhah & M. Dadkhah, 2017)

Mental Variables	Stone View (Mean ± SD)	Green View (Mean ± SD)	Difference (Mann-Whitney Test)
Capacity (Happiness & Unhappiness)	4.50 ± 1.85	7.50 ± 2.14	P < 0.000
Arousal (Calmness & Excitement)	5.02 ± 1.92	4.24 ± 2.14	P < 0.000
Attractiveness	3.94 ± 2.08	8.24 ± 1.16	P = 0.000
Enthusiasm for Visitors	3.59 ± 2.40	8.05 ± 1.52	P = 0.065

Conclusion

Global warming and climate change remain some of the most pressing challenges for humanity. Air pollution, particularly in large cities, and the loss of green spaces due to deforestation exacerbate urban environmental problems. As building facades expand vertically as well as horizontally, green facades offer a sustainable alternative to conventional facades.

Green facades provide multiple benefits:

- **Facade protection:** Shield buildings from snow, wind, sunlight, and acid rain.
- **Air purification:** Neighborhood-wide adoption can reduce air pollution and improve air quality.
- **Quality of life improvements:** Enhance thermal and sound insulation, serve as windbreaks, and improve occupant comfort.
- **Sustainability and energy efficiency:** Contribute to energy savings and sustainable architecture.
- **Mental health benefits:** Increase happiness, attractiveness, and enthusiasm of building users, enhancing overall well-being and performance.

In summary, green facades not only support environmental sustainability but also positively impact human health, comfort, and mental well-being, making them a valuable component of modern urban architecture.

References

1. Y. Dadkhah, M. Dadkhah, 2019, the effect of green facade and stone facade on individuals using the electroencephalogram method, International Congress of Mental Health Management and Psychological Sciences.
2. Bartfelder F, Köhler M (1987) Experimentelle Untersuchungen zur Funktion von Fassadenbegrünungen. Ph.D. Thesis Technical Univ. of Berlin (Berlin) pp 625.
3. Bastian O, Schreiber KF (1999) Analyse und Bewertung der Landschaft. Spektrum, Heidelberg.
4. Coma, J., Pérez, G., Solé, C., Castell, A. and Cabeza, L.F. 2014. Energy Procedia 57 1851-1859.
5. FLL (Forschungsgesellschaft Landschaftsentwicklung Landschaftsbau (ed.) (2000) Richtlinie für die Planung, Ausführung und Pflege von Fassadenbegrünungen mit Kletterpflanzen. Bonn, pp 54 (see: www.FLL.de).
6. Hämmerle F (2002) Der Gründachmarkt. In: Jb. Dachbegrünung, BGL (ed) Thalacker Medien, Braunschweig, pp 11–13.

7. K. Perini and P. Rosasco, "Cost–benefit analysis for green façades and living wall systems," Build. Environ., vol. 70, pp. 110–121, Dec. 2013.
8. hler M (1988) Die Besiedlung von Kletterpflanzen durch Insekten und Spinnen in Berlin (West). Z f Angew. Zoologie 75:195–202.
9. Köhler M (2004) energetic effects of green roofs on the urban climate72-79. Nürtingen. In: International Green roof Congress. IGRA (Berlin), see: www.igra-world.com)
10. Green roof Congress. IGRA (Berlin), see: www.igra-world.com)
11. Köhler M (2005) Der einsatz von infrarot-thermographie bei der beurteilung von Gebäudebegrünungen. Dach+Gruen 14(1):8–12.
12. Köhler M (2006a) Extensive gründächer—rechenbare vorteile in der Eingriffsregelung. Stadt +Grün 55(9): 40–44.
13. Köhler M (2006b) Long term vegetation research on two extensive green roofs in Berlin. Urbanhabitats, Brooklyn Bot. Garden (USA): Vol 4 (1), Dec. 3–26.ISSN 1541-7115 www.urbanhabitats.org.
14. Köhler M, Bartfelder F (1987) Stadtklimatische und lufthygienische Entlastungseffekte durch Kletterpflanzen in hochbelasteten Innenstadtbezirken. Verh Ges f. Ökologie XVI: 157–165.
15. Köhler M, Schmidt M (1997) Verbundene Hof-, Fassaden- und Dachbegrünung. Landschaftsentwicklung- und Umweltforschung 105:1–156.
16. Köhler M, Malorny W (2006) Wärme-Dämmeigenschaften von Dachsubstraten mit Vegetationsschicht extensiver Dachbegrünung. Dach+Grün 15(3):8–13.
17. Köhler M, Barth G, Brandwein T, Gast D, Joger H, Vowinkel K, Seitz U (1993) Dach- und Fassadenbegrünung. Ulmer, Stuttgart, p 329.
18. Köhler M, Schmidt M, Junqueira M (2000) Dach- und Fassadenbegrünungen in Brasilien. DACH+GRÜN 9 (2):14–19.
19. Köhler M, Schmidt M, Grimme FW, Laar M, De Assuncao Paiva VL, Tavares S (2002) Green roofs in temperate Climates and in the hot-humid Tropics. Environ Manag Health 13(4):382–391 (UK) ISSN 0956-6163.
20. Liu K (2002) Energy efficiency and environmental benefits of rooftop gardens. National council of Canada. Ottawa (http://irc.nrc-cnrc.gc.ca/fulltext/prac/nrcc45345/nrcc45345.pdf).
21. Mann G (1998) Vorkommen und bedeutung von bodentieren (Makrofauna) auf begrünten Dächern in Abhängigkeit von der Vegetationsform. PhD, Dep. Biologie, Univ. Tübingen, Germany.
22. M. Köhler, "Green facades—a view back and some visions," Urban Ecosyst., vol. 11, no. 4, pp. 423–436, May 2008.
23. M. Ottelé, K. Perini, a. L. a. L. A. Fraaij, E. M. M. Haas, and R. Raiteri, "Comparative life cycle analysis for green façades and living wall systems," Energy Build., vol. 43, no. 12, pp. 3419–3429, Dec. 2011.
24. Minke G, Witter G (1983) Häuser mit grünem Pelz. 3. ed Frankfurt/Main.
25. mehdi rakhshandehroo. An Introduction to Green Walls: Green Facades,Putra Malaysia UPM,13.
26. mehdi rakhshandehroo, Meysam Deqati Najd, Mohd Johari Mohd Yusuf, (2015), Green Facades (Vertical Greening): Benefits And Threats, Mechanics And Materials, 5.
27. Sheweka, S. M. and Mohamed, N. M. (2012). Green Facades as a New Sustainable Approach Towards Climate Change. Energy Procedia, 18, 507-520.
28. Schlößer, S. A. (2003). *Zur Akzeptanz von Fassadenbegrünung: Meinungsbilder Kölner Bürger; eine Bevölkerungsbefragung* (Doctoral dissertation, Verlag nicht ermittelbar).
29. Ulrich RS (1983) View through a window may influence recovery from surgery. Science 224:420–421.
30. Velazquez L, Kiers H (2007) Hot trends in design: Chic sustainability, unique driving factors & boutique Greenroofs. Proc. 5th annual greening rooftops for sustainable communities Conference, Minneapolis.
31. Prof, Dr. Mohammad Ekram YAWAR, Dr. Ramazan Ahmadi, Muaiyid Rasooli PhD, & Lec. Abdul Jamil Sharify. (2025). Examining Diplomacy for Environmental Sustainability in Interaction with Artificial Intelligence. Içinde GRS Journal of Multidisciplinary Research and Studies (C. 2, Sayı 8, ss. 88-92). GRS Publisher. https://doi.org/10.5281/zenodo.16902942.
32. Yawar, M. E., & Sadat, S. A. (2025). Problems of Using Artificial Intelligence as a Judge in Legal Proceedings. Akademik Tarih ve Düşünce Dergisi, 12(1), 403-420. https://doi.org/10.5281/zenodo.15627539.
33. Prof, Dr. Mohammad Ekram YAWAR, Dr. Ramazan Ahmadi, Muaiyid Rasooli PhD, & Lec. Abdul Jamil Sharify. (2025). In the National and International Policy-Making System: The Place of Environmental Protection. Içinde GRS Journal of Multidisciplinary Research and Studies (C. 2, Sayı 8, ss. 93-100). GRS Publisher. https://doi.org/10.5281/zenodo.16902966.
34. Dr. Mehmet Uçkaç, PhD, & Dr. Mohammad Ekram YAWAR. (2025). Examining the Position and Role of Biotechnology in the Development of International Environmental Law. Içinde GRS Journal of Multidisciplinary Research and Studies (C. 2, Sayı 1, ss. 26-36). GRS Publisher. https://doi.org/10.5281/zenodo.16886409.