CURRENT CONCEPTS AND INNOVATIVE RESEARCH IN ARCHITECTURE, PLANNING AND DESIGN

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Editor

Assoc. Prof. Dr. Enver KENDAL

Current Concepts and Innovatıve in Architecture, Planning and Design
Editor: Assoc. Prof. Dr. Enver KENDAL

Design: All Sciences Academy Design
Published Date: December 2025
Publisher's Certification Number: 72273
ISBN: 978-625-8536-90-4

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CONTENT

Ley Lıne Aesthetıcs in The Energetıc and Symbolıc Fabrıc of Urban Landscapes

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ABSTRACT

This document contains a summary text format for their research that has been accepted into the Book Section under Duvar Publishing House. It can be used as a basic template for a Microsoft Word-based typesetting system. The summary, purpose, approach used, key results and important conclusions should be briefly stated. An abstract of 200-250 words is required.

Keywords – Include at least 5 keywords or phrases

INTRODUCTION

Although the formal development of cities is often explained through physical planning decisions, transportation networks, and topographical conditions, such an approach risks rendering the historical, cultural, and emotional layers of space invisible. The city, however, is not merely an organism composed of the built environment and functional systems; rather, it constitutes a multilayered field of memory shaped by rituals, social practices, modes of remembrance, and collective experiences (Rossi, 1982; Boyer, 1996). Understanding urban space therefore requires moving beyond its physical обол and tracing the imprints of historical orientations embedded within contemporary spatial configurations while deciphering networks of invisible relationships.

The continuity of routes, the positioning of squares, and the distribution of public focal points within cities often emerge not from deliberate planning alone, but from the accumulation of historical practices. Consequently, spatial form evolves into a layered structure in which time overlaps and coexists. Within this context, the concept of spatial memory provides a fundamental theoretical framework for interpreting urban landscapes. The determining role of spatial memory offers a critical basis for explaining why certain orientations and alignments observed in cities are not merely coincidental. Over time, topographical boundaries, ancient transportation routes, and the locations of religious and cultural centers generate what may be described as a "network of spatial continuity" (Halbwachs, 1992; Nora, 1989). While this network can often be traced through visible physical elements, in some cases it is discernible only through historical and cultural traces. At this juncture, the concept of ley lines—initially discussed within an esoteric context—is reconsidered as an interpretative approach for explaining spatial continuities in urban studies (Williamson & Bellamy, 1983).

Historical and Popular Origins of the Ley Lines Concept
Popular Perception and Collective Mythology

The archaeologist Alfred Watkins, who revitalized the popular discourse surrounding this concept, observed that Roman roads often coincided with the alignments of much older settlements and sacred sites established by earlier civilizations (Charlesworth, 2010). He noted that numerous ancient structures across different regions appeared to be aligned along straight lines and suggested that this linear order might be related to historical settlement logic. Using ancient maps, place names, and dowsing techniques, Watkins identified these alignments and argued that societies deliberately located their roads, temples, and significant structures along ley lines in order to harness the Earth's magnetic energy (Figure 1).

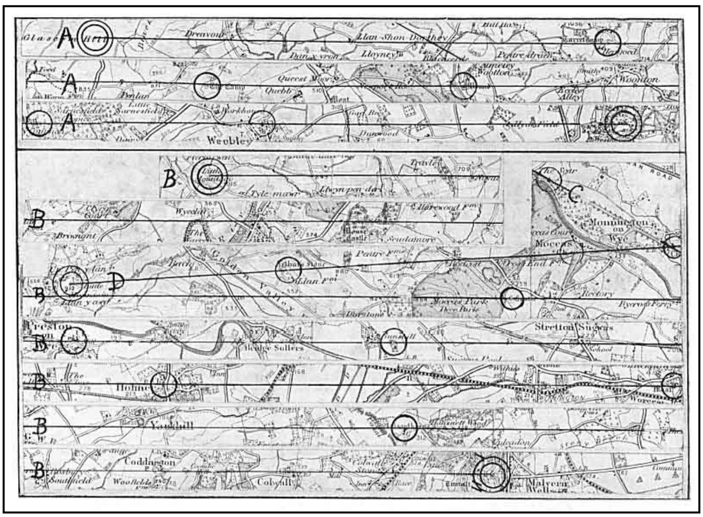


Figure 1. Alfred Watkins' Original Ley Line Map (URL-1)

First articulated in Europe in the early twentieth century, proponents of ley lines claimed that such alignments were known to ancient societies and that structures were intentionally constructed along these axes. From the 1960s onward, advocates of the Earth Mysteries movement and various esoteric traditions further asserted that ley lines governed terrestrial energies. According to this perspective, the presence of specific urban axes is not coincidental but rather the result of overlapping continuities among memory sites, natural thresholds, and historical traces. Cities are thus assumed to function as "living relational systems" structured through this invisible network (Figure 2).

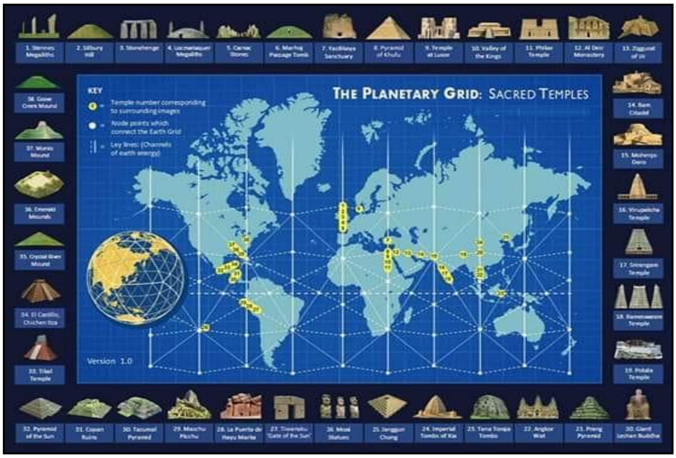


Figure 2. Planetary grid map with assumed ley-line alignments and sacred sites (URL-2).

Over time, ley lines ceased to represent a singular explanatory model and instead evolved into a pluralized discursive field represented differently across various geographies. Concepts such as global energy networks, planetary grid systems, and cosmic alignments have reinforced the circulation of the idea within popular culture (Figure 3). Although these representations do not claim scientific validation, they are significant in illustrating how the concept shapes collective imagination and perceptions of space..

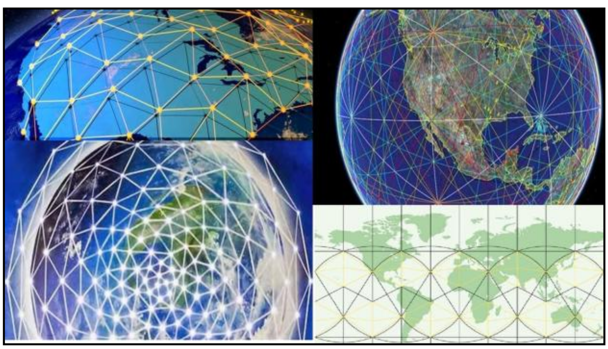


Figure 3. Global ley line models of the Earth's energy grid (URL-3).

Theoretical Reading: Spatial Memory, Identity, and Urban Landscape

Spatial memory is a dynamic phenomenon shaped by the relationship between space and individual as well as collective processes of remembrance. Halbwachs' (1992) theory of collective memory demonstrates that remembering is not solely a mental process but a social practice sustained through spatial contexts. Nora's (1989) concept of lieux de mémoire further suggests that certain spatial focal points function as nodes where collective memory becomes concentrated. In this sense, the city is not a passive surface upon which traces of the past are merely represented; rather, it constitutes a memory landscape continuously reproduced through everyday use, ritual movement, and spatial experience. Urban identity is constructed not only through symbols and images but also through embodied spatial experience and continuity (Massey, 2005). These continuities become legible through the linear axes and orientations observed in the urban landscape.

Memory Sites and Cultural Landscape

Memory sites are considered areas that contain the most concentrated layers of meaning within the cultural landscape. Historical routes, sacred spaces, monumental structures, and public focal points are not merely physical entities; they function as spatial references that carry the continuity of collective memory. One of Watkins' most well-known observations associated with the concept of ley lines is the Saint Michael Alignment, which demonstrates that numerous historical structures in Britain are aligned along specific linear trajectories (Figure 4). This example enables an abstract concept to be materialized at the local scale, making visible the relationship between linear alignments and cultural as well as symbolic continuities (Charlesworth, 2010).

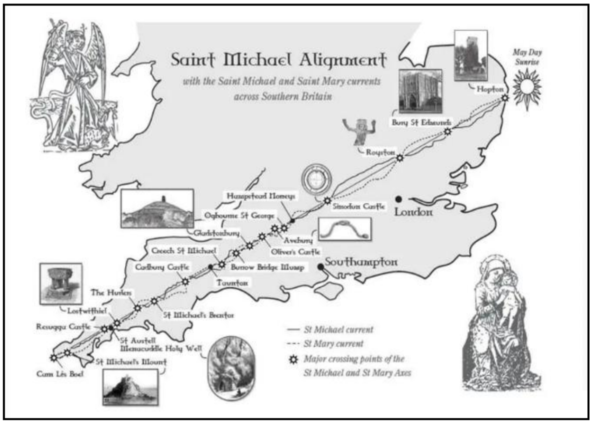


Figure 4. Map illustrating the Saint Michael ley alignment across southern Britain (URL-4).

Conceptual Lines, Sacred Geometry, and Symbolic Readings

Sacred geometry and conceptual lines encompass interpretative approaches that seek to ascribe symbolic meaning to space. Within such readings, ley lines are not treated as physical energy flows but rather as metaphorical instruments that explain the human–place relationship through concepts of cosmic unity, balance, and orientation. These symbolic approaches do not claim scientific proof; instead, they reveal how spatial imagination and cultural narratives shape perceptions of landscape. Within this interpretative framework, Stonehenge—one of the most frequently referenced Neolithic structures and approximately 2,000 years old—is often described as a focal point where multiple ley lines converge, linking sites of ancient cultural significance across the landscape. When considered alongside Avebury in Wiltshire and Glastonbury Tor, Stonehenge is commonly interpreted as forming a geometrically equilateral triangular configuration along the Saint Michael alignment (Figure 5).

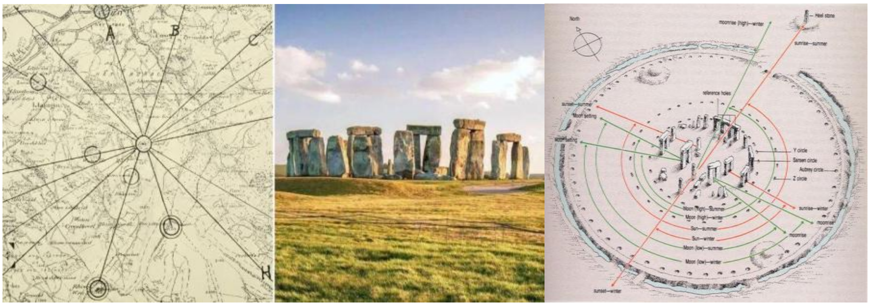


Figure 5. Stonehenge alignment along the Saint Michael ley line (URL-5-6).

Ley Line Discourse in the Anatolian Context: Cultural Landscape, Sacred Geography, and the Differentiation of Scientific Energy Concepts

Originally emerging from interpretations of spatial continuities observed in the rural landscapes of Britain, this approach suggests that a linear organization exists among structural elements from different historical periods and that this organization plays a key role in reading historical landscapes.

In Turkish culture, while the concept of "energy centers" lacks a systematic and explicit modern terminology, the attribution of sacredness to certain places demonstrates strong historical and cultural continuity. Spatial elements such as "sacred mountains," "shrine areas," "saints' tombs," and "pilgrimage sites" indicate a widespread belief that particular locations possess qualities distinct from others. These sites are regarded not only as locations for religious rituals but also as spaces where collective memory, spiritual intensity, and symbolic meaning converge (Eliade, 1959; Ak, 2018).

Especially within the Alevi–Bektashi tradition, the practice of pilgrimage (ziyaret) fosters the perception of specific geographic points as spiritual centers. The rituals performed in these spaces reinforce their sacredness through embodied experience, silence, orientation, and ritual repetition. Attributes such as "healing," "peace," or "spiritual power" associated with these places in folk belief are sometimes expressed through the concept of "energy" in modern discourse; however, such usage remains symbolic and cultural rather than scientific (Faroqhi, 2014; Ak, 2018).

At this point, rather than establishing a direct causal relationship between ley line discourse and the understanding of sacred space in Turkish culture, it is more prudent to acknowledge the existence of a similar spatial logic of meaning-making (Figure 6). Academic archaeology and geography approach the scientific validity of ley lines with caution, emphasizing that many observed alignments may be coincidental or the result of selective mapping techniques. Particularly across large geographic areas, establishing linear relationships among numerous historical and natural elements is statistically inevitable. Consequently, ley lines are addressed not as a scientific geophysical model but as a cultural, symbolic, and belief-based interpretative framework (Ak, 2018)..

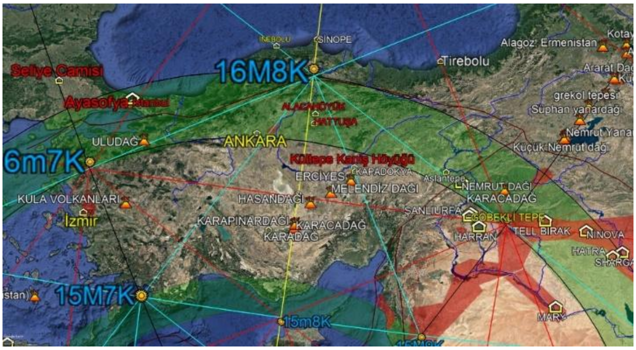


Figure 6. ………… (URL-7)

Recent popular and amateur publications focusing on Anatolia frequently propose that ley lines form north–south or radial networks connecting ancient settlements, volcanic regions, geothermal zones, and historical sacred structures. These narratives often claim that sites such as Çatalhöyük, Cappadocia, Hattusa/Alacahöyük, the Karaman Karadağ volcanic field, and Sinop İnceburun align along a single axis, with some lines even linked to the Giza pyramids (Figure 7) (Nevbahar Dergisi, 2021).

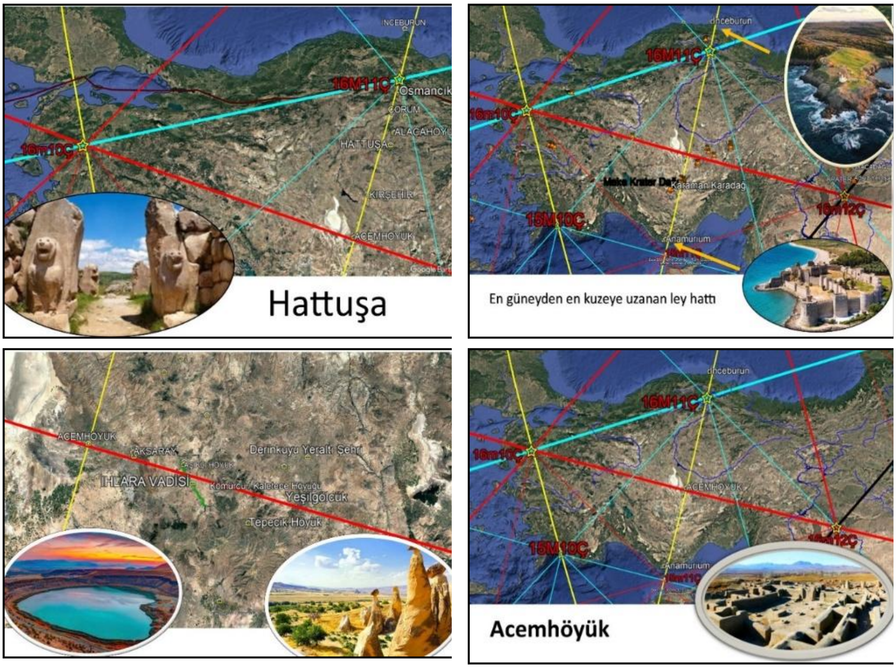
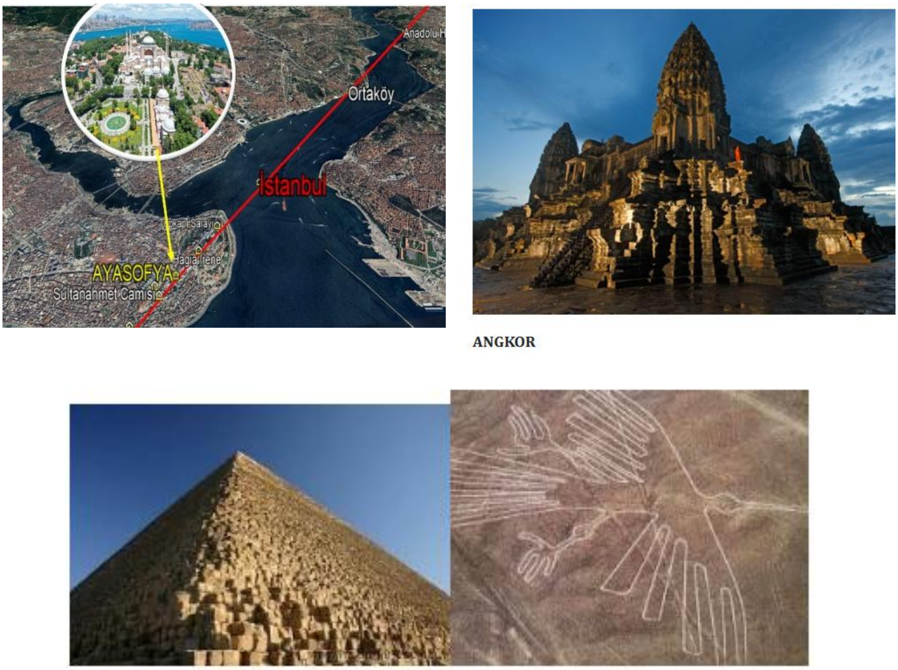


Figure 7. ………… (URL-8,9,10)

This approach, which interprets geomorphological formations (volcanism, fault zones, crater structures) and cultural heritage sites within a single “energy corridor” metaphor, is typically constructed through selected examples without transparent spatial analysis methods such as statistical alignment testing, alternative sampling controls, or comparative site selection. In academic literature, such intangible narratives may be evaluated as cultural phenomena within the frameworks of “visitor experience,” “atmosphere of place,” “ritual landscape,” or “sacred geography.” However, presenting them as if they imply direct geophysical evidence is considered problematic in terms of scientific rigor (Hardy, 2011).



GİZA NAZCA

Figure 8. ………… (URL-11)

Similarly, Istanbul-focused narratives interpret alignments such as the Hagia Sophia–Sultanahmet–Topkapı–Hippodrome axis as a “corridor of sacred centers,” while at the global scale, alignments or triangular configurations involving Nazca, Giza, and Angkor are associated with the golden ratio, sacred geometry, and the concept of “Earth chakras” (Figure 8). Encyclopedic critiques emphasize that drawing desired points into a straight line on a map is relatively easy and that excluding incompatible examples produces subjective and selective patterns (ArkeoTekno, 2013; Mukaddes Pekin Başdil, n.d.).

In summary, within the Anatolian context, ley line discourse is best understood not as a scientific geophysical theory but as a symbolic network reading that emerges during the interpretation of cultural landscapes and is reinforced through site selection, ritual practices, and historical memory. Accordingly, the most reliable academic approach is to discuss ley lines not through the language of “proven energy” but within the context of cultural narratives, spatial imagination, and the production of sacred geography, while situating physical energy strictly within its established scientific definition.

Urban Morphology and Invisible Ecologies

As Corner (1999) emphasizes, landscape is not composed solely of visible physical components but constitutes a relational system formed by the intersection of social practices, ecological processes, and cultural meanings. Ecological corridors, species migration routes, subsurface water flows, and public axes sustained by historical orientations represent key elements of this invisible ecological fabric (Hou, 2010; Forman, 2014).

The arrangement of building blocks, the continuity of main arteries, and the positioning of public focal points observed in urban morphology are not merely the outcomes of functional requirements. Rather, they reflect a layered structure produced by the superimposition of historical routes, ritual paths, and ecological transitions with contemporary planning decisions (Moudon, 1997; Batty, 2003).

Invisible Lines in Cultural and Sufi Landscape Perceptions

In Sufi and cultural narratives, space is regarded not merely as a physical entity but as a living system associated with meaning, balance, and wholeness. Invisible lines emerge as symbolic expressions of spatial continuity and sacredness within these narratives. Rather than proving the scientific reality of ley lines, such interpretations contribute to understanding the role of space in the production of cultural memory.

From the perspective of physical sciences, energy is a quantifiable concept measured in joules and subject to experimental testing, while power denotes the rate of energy transfer per unit time and is measured in watts. In this framework, the “spiritual,” “healing,” or “cosmic” attributes ascribed to ley lines do not correspond directly to the scientific definition of energy. Nevertheless, this discrepancy does not negate the cultural, symbolic, and belief-based significance of ley line discourse in spatial production processes (Hix, 2014; Bayard, 2020).

Mystical and Sufi traditions often emphasize parallels between energy centers within the human body and those of the Earth, explained through the microcosm–macrocosm analogy. Similar conceptual grounds can be found in Chinese cosmology's "dragon paths" and in Feng Shui's understanding of spatial energy flows. These narratives are significant in demonstrating that societies throughout history have considered intuitive, symbolic, and cosmological criteria in their spatial choices..

Implications for Urban Landscape and Design

Reconsidering the concept of ley lines within the urban context offers an explanatory and holistic interpretative framework for understanding the relationship between invisible ecologies and spatial memory. This approach enables urban landscapes to be evaluated not only through physical elements but also through the simultaneous interaction of historical continuities, cultural orientations, and ecological processes.

Urban space is thus addressed not as a static product of planning but as a dynamic system formed through the superimposition of multiple temporal layers. The continuity of ecological corridors, the orientation of water networks, and the determinative role of topographical thresholds often coincide with historical routes, indicating that the natural and cultural components of the landscape are organized according to a shared spatial logic. These overlaps suggest that focusing solely on existing land-use decisions in planning and design processes may be insufficient. Instead, acknowledging inherited traces and invisible relational networks becomes crucial for maintaining spatial continuity.

In this sense, ley line aesthetics does not offer a directly applicable design scheme but rather provides a critical perspective for reading urban landscapes. The overlap of historical routes with contemporary transportation axes, the persistent centrality of certain public spaces, and the intersection of ecological transitions with cultural landscapes represent practical manifestations of this perspective. Consequently, ley lines function not as formal guides for designers but as conceptual tools that facilitate awareness of the continuities underlying spatial decisions.

Conceptual Model and Analytical Contribution
The Role of Ley Line Aesthetics in Landscape Interpretation

This study repositions the concept of ley lines as an interpretative conceptual model for reading urban and cultural landscapes, disentangling it from metaphysical and energy-based discourses. Ley line aesthetics is not proposed as a formal design schema but as an analytical perspective that enables the reading of intersections among spatial memory, historical continuity, and invisible ecologies.

When examined through historical, theoretical, and spatial discussions, it becomes evident that ley lines do not claim physical reality; rather, they represent abstract structural backbones where spatial memory, historical continuity, and invisible ecologies intersect. The proposed conceptual model interprets linear alignments, axes, and focal points observed in urban space not as the outcomes of singular planning decisions but as structures emerging from the superimposition of relationships formed across different temporal layers. In this respect, ley line aesthetics diverges from deterministic approaches that seek to explain urban form solely through functional causality and instead enables spatial patterns to be read through historical and cultural continuities (Beck & Chrisomalis, 2008).

The analytical contribution of the model lies in its ability to address the landscape through both visible and invisible layers. Visible components such as the built environment, transportation networks, and open spaces are evaluated alongside invisible layers including collective memory, ritual movement, and ecological processes. Ley lines function as an interface between these two levels, revealing urban landscapes as spatial expressions of enduring relational networks rather than merely physical arrangements. This approach does not contradict existing landscape and urban theories; rather, it brings them together within a shared interpretative framework. The ley line assumption is thus regarded as an explanatory metaphor that enables fragmented elements of cultural landscapes to be read collectively. Accordingly, the study aims not to propose a new design method but to add conceptual depth to urban and cultural landscape analyses (Thurgill, 2015)..

RESULTS

The linear orientations, persistent routes, and temporally recurring use of specific focal points observed in urban space suggest a depth that cannot be explained solely through contemporary planning decisions. Such patterns point to long-term relational networks shaped by historical accumulations, cultural practices, and environmental conditions beyond physical arrangements. In this context, space emerges not as a static surface but as a relational structure continuously reproduced through everyday practices upon inherited traces. Continuity within this structure can be read not only through formal similarities but also through meanings, orientations, and mnemonic intensities embedded in space.

Studies on spatial memory and memory sites demonstrate that urban space is not a passive container of past traces but a dynamic structure constantly reproduced through social practices (Halbwachs, 1992; Nora, 1989; Assmann, 2011). Accordingly, linear axes, continuous routes, and the repeated use of specific spatial focal points in urban landscapes can be interpreted not merely as functional necessities but as embodied forms of memory. At this point, the ley line metaphor functions as a conceptual tool that helps render the historical and cultural dimensions of spatial continuity visible.

Landscape theory's treatment of landscape as a relational system further supports this perspective. As emphasized by Corner (1999) and Spirn (1998), landscape is not a neutral backdrop of physical elements but an assemblage where ecological processes, social practices, and cultural meanings intersect. The overlap of natural systems—such as ecological corridors, water networks, and topographical thresholds—with historical transportation routes and cultural pathways demonstrates the simultaneous operation of visible and invisible layers in urban space (Beck & Chrisomalis, 2008; Forman, 2014). These overlaps indicate, as proposed by ley line aesthetics, that urban landscapes can be interpreted through abstract structural backbones.

Conversely, the frequent association of ley lines with energy-based narratives in popular and esoteric contexts has led to academic skepticism toward the concept. However, metaphor-based interpretative approaches developed within cultural geography and spatial theory demonstrate that such concepts can generate analytical value without asserting direct empirical proof

(Cosgrove, 2008; Tuan, 1977). When approached from this perspective, ley lines transcend speculative discourse and become tools that contribute to the interpretation of spatial patterns within historical and cultural contexts.

This perspective necessitates evaluating ley line aesthetics not as a design prescription or universal model but as a critical and explanatory approach to reading urban landscapes. Neglecting historical depth and ecological continuity in urban design and planning processes can weaken the mnemonic and cultural layers embedded within landscapes. Particularly in cultural landscape interventions, acknowledging invisible relational networks plays a decisive role in preserving spatial identity and continuity.

In conclusion, the concept of ley lines is best understood not as a claim to scientific reality but as a conceptual interface that enables the joint consideration of spatial memory, cultural continuity, and invisible ecologies. This approach demonstrates that urban landscapes can be interpreted not only through visible formal arrangements but also through networks of remembered, experienced, and meaningful relationships. In doing so, ley line aesthetics provides a coherent intellectual foundation that adds analytical depth to the interpretation of urban and cultural landscapes..

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Evaluation of Sustainable Material Use in Interior Design in Terms if Environmental Benefits

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ABSTRACT

Technological advancements and their integration into agriculture, industry, and many other fields, especially the widespread mechanization, have brought significant environmental problems. The reliance on machine power to meet the needs of a growing population quickly and practically has led to the persistence of global environmental issues. The increasing rate of natural resource depletion necessitates the concept of sustainability.

The principle of sustainability has been adopted in many disciplines, including architecture and interior design, increasing the importance of materials that produce minimal or zero waste, are recyclable, and renewable. The use of eco-friendly building materials in interior design provides direct benefits to both the environment and the users, creating the healthiest possible living spaces for occupants.

The use of sustainable materials offers significant environmental benefits by slowing down the rate of raw material consumption. In cases of adaptive reuse of buildings, repurposing materials for different functions minimizes waste generation by saving raw materials and energy.

This study examines the environmental benefits of using sustainable materials in interior design across six main sections. The Introduction broadly discusses the concept of sustainability in interior analysis. Chapter 1 explains the definition, emergence, historical development, components, and benefits of sustainability. Chapter 2 addresses the definition, purposes, application areas, and architectural and interior applications of sustainable material. Chapter 3 explains the principles of sustainable design, the material-environment relationship, indoor conditions, and energy and resource use, all reduced to the interior context, and presents a regional evaluation of sustainable interior design factors. The Conclusion summarizes the findings.

Keywords – Sustainability, Environment, Recycling, Sustainable Material, Sustainable Design, Adaptive Reuse, Ecological Architecture.

INTRODUCTION

The main objective of this study is to emphasize the importance of sustainable and conscious material selection in interior design processes and to investigate the principles and environmental benefits of the concept of sustainability.

Increasing global population density, over-consumption of natural resources, and environmental pollution are severely negatively affecting the ecological balance of the Earth. Continuous technological progress since the industrial revolutions has accelerated the use of natural resources, increasing negative side effects caused by human activities such as pollution, toxic waste, global warming, ozone layer depletion, and deforestation. This situation endangers not only human life but also the future of other living organisms in nature.

The human need for shelter has been met through various solutions throughout history and has evolved into living spaces that meet housing, food/beverage, entertainment, and many other requirements today. In recent years, the need for sustainable housing has come to the forefront in parallel with the increase in energy and material consumption. The vision of creating a sustainable interior aims for a built environment that consumes minimum energy and materials, focuses on user comfort, and is in harmony with its surroundings (Güney and Kariptaş, 2019).

Considering that a significant portion of natural resources is consumed by the construction sector rather than motor vehicles, the critical importance of sustainable development and, consequently, sustainable architecture for future generations is evident (Altın and Orhon, 2014; Uz, 2020). Therefore, the concept of sustainable design has become an indispensable element in the design phase of many structures, such as residences, hospitals, and offices, in the 21st century.

2. SUSTAINABILITY AND SUSTAINABLE MATERIAL

This section discusses the theoretical framework and historical development of the concept of sustainability and its reflection in the construction sector, the concept of sustainable material.

2.1. Theoretical Framework of the Concept of Sustainability

Humanity is dependent on the Earth's resources to sustain its existence. Throughout history, societies have pursued prosperity and comfort, often disregarding the well-being and resources of future generations. The depletion of natural resources, initially assumed to be limitless, brought the concept of sustainability to the agenda as an essential solution (Öztürk, 2007).

2.1.1. Definition and Emergence of Sustainability

Accelerated economic growth after the Industrial Revolution, while raising living standards, disrupted the natural balance by causing global pollution due to increased use of raw materials, energy, and synthetic substances (Berber, 2012). The concept of sustainability emerged as a search for a solution to these environmental problems.

In its widely accepted definition, sustainability is the act of "meeting the needs of the present without compromising the ability of future generations to meet their own needs" (Tufan and Özel, 2018; World Commission on Environment and Development). In other words, it is about preserving the quality of life by considering the carrying capacity of the biosphere, ecosystems, and resources (Altın and Orhon, 2014). A sustainable system is also defined as the ability of a society or ecosystem to continue functioning without interruption, degradation, or over-exploitation of its primary resources.

Environmental problems became a popular research topic after the 1960s, coinciding with the increase in human-caused environmental destruction and the discovery of the ozone hole. Especially due to the construction sector's contribution to global problems, architectural media began to be associated with new concepts such as "green architecture," "smart construction," "energy efficiency," and "climate management" (Berber, 2012). Adopting the principle of sustainable development is a fundamental condition for preserving human well-being and leaving a sustainable world for future generations.

2.1.2. History and Development of Sustainability

Increased production and consumption needs, beginning with industrialization in the 18th century, led to the widespread limitless consumption of natural and human resources. With criticisms starting in the 1970s, the world recognized the need to strike a balance between development and the natural environment, paving the way for the concept of sustainable development (Ertem, 2020).

The term Sustainable Development was first clearly discussed and popularized in the Brundtland Report prepared for the World Commission on Environment and Development in 1987 (Tufan and Özel, 2018; Öç, 2013). The fundamental principles of the report include a political system that ensures citizen participation, an economic system based on independent technical information, and a production system that protects ecological foundations (Ertem, 2020).

The first major breakthrough in the concept's development was the 1972 report "The Limits to Growth," which drew attention to the interdependent relationship between the economy and the natural environment. Following this, the United Nations Conference on the Human

Environment in Stockholm in 1972 was the first universal event to include the concept of sustainable development within the framework of the environment and development relationship (Öç, 2013).

After the 1992 Rio Conference, sustainability began to be addressed more comprehensively, no longer limited only to the environment but also encompassing the economy and society (Tufan and Özel, 2018). Subsequent events, such as the UN Millennium Summit and the 2012 Rio Summit, which established the Millennium Development Goals (MDGs) and the Sustainable Development Goals (SDGs), ensured the concept's central position on the global agenda (Öç, 2013). Today, sustainable development goals play a key role in the agenda of all societal groups.

2.1.3. Three Core Components of Sustainability

Sustainable development is examined across three fundamental dimensions: environmental, economic, and social:

- Environmental Dimension: Aims for the preservation and renewal of natural resources and environmental heritage (Tufan and Özel, 2018). An ecologically sustainable system must keep the use of renewable resources below the rate at which nature can renew itself and must protect biodiversity (Sırkıntı, 2012). Criteria in this dimension include the reduction of waste and pollution (air, water, soil), conservation of biodiversity, reduction of CO_2 emissions, recyclability, and use of local resources (Tufan and Özel, 2018).

- Economic Dimension: The ability to generate income and job opportunities to maintain the population (Tufan and Özel, 2018). An economically sustainable system must be able to continuously produce goods and services and avoid sectoral imbalances. The sustainability of production and consumption patterns is essential (Sırkıntı, 2012). Criteria include minimum energy consumption and transportation costs, ease of maintenance/repair, durability, and less material use (Tufan and Özel, 2018).

- Social Dimension: The equal provision of welfare, security, health, and education without discrimination based on social class or gender (Tufan and Özel, 2018). A socially sustainable system must ensure equity, adequate social services, political accountability, and participation (Sırkıntı, 2012). Criteria include suitability to the regional social fabric, creating a healthy environment, ensuring human safety, and supporting local labor (Tufan and Özel, 2018).

2.1.4. Benefits of Sustainability

Sustainability offers comprehensive benefits across all three dimensions (Tufan and Özel, 2018):

• Environmental Benefits: Increasing biological diversity, improving air and water quality, reducing solid waste, and conserving natural resources.

• Economic Benefits: Lowering operating expenses, increasing product value and revenue, boosting employee productivity, and improving economic performance.

• Social Benefits: Improving indoor air, thermal, and psychological environments, enhancing user health and ergonomics, reducing societal infrastructure strains, and contributing to the general quality of life.

2.2. Concept and Use of Sustainable Material

All materials used in the construction and formation of a building are part of the ecological system. Therefore, as a requirement of sustainable architecture, the materials used both inside and outside the building must be harmless to the environment, natural, and ecological.

2.2.1. Definition of Sustainable Material

Sustainable building materials (or green building materials) are materials that cause the least harm to the environment and human health throughout their life cycle (raw material acquisition, processing, use, maintenance, and waste generation) and are sensitive to the limits of renewable resources (Tufan and Özel, 2018). Ecological designs should use materials that require less energy during production, transportation, use, and demolition, and should be reusable even after demolition (Aktuna, 2007).

Key characteristics of sustainable materials:

• They do not contain toxic components and are harmless to human health.

• They are recyclable or directly reusable.

• They do not harm the natural environment at the end of their service life.

• They are generally sourced from local resources (Tufan and Özel, 2018).

Material selection must meet sustainable development criteria in addition to good performance, quality, aesthetics, and cost. The life cycle of a building is examined in three phases: pre-construction (raw material, production, transportation), construction period (use, maintenance, repair), and post-construction (recycling, reuse) (Tufan and Özel, 2018). The reusability and recyclability of a material provide great environmental benefits by reducing natural resource consumption (Aktuna, 2007).

2.2.2. Use of Sustainable Material in Architecture

With the growing importance of sustainable development, the goal of protecting structures from the negative effects of nature has now shifted to the necessity of protecting nature and the environment from human activities. In this context, the concept of sustainable architecture (or green architecture) emerged. Green architecture is an approach that minimizes the negative impact of a project on the environment, considering the construction, management, and demolition processes as a whole (Sırkıntı, 2012).

The core criteria of sustainable architecture are (Altın and Orhon, 2014):

- Efficient use of the building area (Climate and environment-appropriate design)
- Energy conservation (Insulation, passive and active energy systems)
- Use of renewable energy sources
- Water conservation (Rainwater harvesting, purification)
- Use of local materials and labor
- Waste management and recycling (Use of recycled materials)

Traditional building materials like wood and stone have been used in structural systems, floors, and claddings from the past to the present and still hold great importance for sustainable architecture (Aydın and Alemdağ, 2014).

- Wood: A material derived from renewable natural resources; flexible, durable, and recyclable. It is one of the materials that causes the least environmental harm throughout its life cycle and has a high carbon sequestration capacity (Uz, 2020; Aydın and Alemdağ, 2014).

- Stone: Considered a sustainable building material due to its structural durability, non-harmfulness to the environment during production and use, and easy recyclability (Aydın and Alemdağ, 2024; Uz, 2020).

- Integration of Traditional Materials: The integration of traditional building materials with modern construction techniques stands out as one of the fundamental elements of the sustainable architecture approach. Materials like wood, stone, and adobe/rammed earth are increasingly preferred in modern building systems due to their advantages in terms of low carbon emissions and the conservation of natural resources (Lakot, 2024, cited in Kasap et al., 2025a). Adobe/rammed earth minimizes environmental impacts due to its low production energy requirement and is now being reinforced with modern construction technologies to create more durable and energy-efficient structures (Berber, 2012, cited in Kasap et al., 2025a).

The production of high-tech modern building materials, however, significantly contributes to environmental problems by affecting the environment at every stage of their life cycle. Therefore, material selection must consider criteria such as environmental impact prevention measures, recyclability, reusability, and energy efficiency (Aydın and Alemdağ, 2014; Güner et al., 2017).

The use of local materials reduces energy costs and air pollution from transportation, creating a positive impact across all dimensions of sustainable development. Furthermore, high-performance materials, such as nanotechnological products or those capable of generating/efficiently using energy for special projects, contribute to the economic and environmental dimensions of sustainability alongside traditional materials (Güner et al., 2017).

Sustainable architecture can be implemented not only in the design phase of new buildings but also through the adaptive reuse of existing structures. Demolishing time-expired structures and rebuilding them contradicts the concept of sustainability; instead, the repair and repurposing of existing buildings (Adaptive Reuse) saves material, energy, and resources (Yanılmaz and Tavşan, 2019). Adaptive reuse ensures sustainability by causing less pollution and resource consumption, replacing the significant environmental damage and natural resource depletion that would result from demolition (Bahar & Açıcı, 2021, cited in Kasap et al., 2025b).

2.2.3. Use of Sustainable Material in Interior Spaces

The interior space is a void that separates humans from the surrounding environment to a certain extent and is suitable for their activities (Güney and Kariptaş, 2019). Sustainable interior design requires spaces to be used efficiently and to meet user needs and optimal ergonomic conditions.

Core principles of a sustainable interior (Güney and Kariptaş, 2019):

- Correct Resolution of Spatial Organization: Proper configuration of volume-mass relationships and preventing the creation of unused areas during the planning phase.

- Functionality and Multi-Functionality: Designing multi-functional areas for long-term use of the space appropriate to its purpose. Solutions that can serve different functions should be preferred over unused areas.

- Flexibility: Interior elements should be expandable and modifiable to adapt to continuously changing demands and requirements. This also contributes to energy conservation and effective lighting/ventilation.

- Efficient Use: Using the area in the most accurate way to accommodate all required activities. This is achieved by reflecting the occupancy-to-void ratio, flexibility, and functionality in the design.

Another critical element in sustainable interior design is the awareness of furniture reuse and recycling (Güney and Kariptaş, 2019). In a world where resources are limited and demands are limitless, the reuse of furniture provides both economic and environmental benefits as waste management becomes a necessity. Furniture made from recycled materials or repurposed supports long-lasting use, reducing the environmental burden.

The inclusion of universal design principles (design for all) in interior design is also a sustainable approach. Universal design aims to create spaces that meet user needs regardless of age, disability, or a child-elderly distinction. This makes it possible for the space to be considered suitable for every user and allows for long-term use (Güney and Kariptaş, 2019).

3. PRINCIPLES OF SUSTAINABLE DESIGN AND ENVIRONMENTAL IMPACTS

This section examines the relationship between sustainable materials and the environment, and their environmental impacts in the context of interior spaces in detail.

3.1. Sustainable Material-Environment Relationship

One of the most crucial factors in creating the built environment is the climatic conditions of the region. While traditional architecture was created by considering climatic conditions based on years of experience, technological developments after the Industrial Revolution relegated traditional building knowledge to the background. However, consequences such as the energy crisis, depletion of natural resources, and environmental pollution have necessitated the re-evaluation of building design and production methods based on the concept of sustainability. One of the most appropriate solutions is the reinterpretation of elements taken from traditional architecture with today's user expectations (Aktuna, 2007).

3.1.1. Environmental Impacts of Sustainable Material Use

Reducing the environmental impact of buildings is possible through the development of sustainability in its economic, environmental, and social aspects. A significant portion of the negative impact of buildings on the natural environment stems from the construction materials used. Waste generated during the entire process, from material extraction to final processing, leading to air, water, and soil pollution, negatively affects the environment (Güner et al., 2017).

To achieve material sustainability, it is crucial that the material be obtained from natural resources, be recyclable, have low energy intensity, and be sourced from regions close to the construction site (Ertem, 2020).

Life Cycle Assessment (LCA) aims for a product to become part of nature from the extraction of its material to its use and demolition. For a sustainable system, the product life cycle must be a closed loop (Öç, 2013). The use of recyclable materials is an environmentally superior choice as it requires significantly less energy than obtaining new materials.

Examining the environmental impacts of building materials:

- Concrete and Cement: Their production involves extensive mining operations and causes significant carbon dioxide emissions (approximately one ton of CO_2 per ton of cement). The production of sand and gravel also has negative impacts such as water pollution and degradation of riverbeds. Reinforced concrete is a material unsuitable for recycling, and errors or low quality in its production are a major factor in loss of life and property during an earthquake (Uz, 2020). Noise and dust generated during demolition cause environmental problems.

- Wood: Has a very high recyclability rate. As a result of photosynthesis, it absorbs CO_2 from the air and releases oxygen, serving as an excellent carbon sink (Uz, 2020). Its renewability, lightness, earthquake resistance, and dampening properties make it advantageous in terms of sustainability. Repair and strengthening of wooden structures are easier compared to reinforced concrete.
- Stone: One of the oldest and most durable materials. Its natural abundance, durability, ease of maintenance, and reusability make it a suitable building material under ecological conditions (Uz, 2020). However, the physical appearance of quarries after operation can cause environmental pollution.
- Steel: Highly and indefinitely recyclable. It uses less energy in production and reduces the use of natural resources. Its flexibility, ability to absorb energy during an earthquake, and resistance to collapse even with deformation make it reliable in terms of earthquake risk. Its lightness also reduces the environmental harm caused during transportation (Uz, 2020). Disadvantages include its sensitivity to fire and corrosion.
- Sand and Gravel: Extraction of sand and gravel used for reinforced concrete structures from rivers, streams, or seas leads to changes in riverbeds, water pollution, disruption of the flow balance, and damage to biodiversity. Carbon dioxide emissions generated during transportation are also an environmental disadvantage (Uz, 2020).

3.2. Environmental Benefits of Sustainable Material Use in Interior Spaces

Sustainable interior architecture requires the designer to use their imagination and technical knowledge to create a structure in harmony with the environment (Ragheb and El-Shimy, 2016). Interior designers should adopt the "design for the environment" method, addressing not only the product's production but also its entire life cycle, including use and disposal.

The environmental benefits and impacts of using sustainable materials in interior spaces are as follows (Altın and Orhon, 2014; Güney and Kariptaş, 2019):

- Healthy Indoor Environment: Enhancement of user health and comfort through materials free of toxic components.
- Ecologically Appropriate Materials: Use of recycled, renewable, and local materials.
- Resource Consumption Reduction: Minimizing fossil fuel consumption for cooling and artificial lighting through properly designed shading and interior conditions.
- Reduction of Environmental Harm: Lowering the amount of pollution and solid waste generated during the production, use, and waste

phases. Restriction of harmful chemicals like adhesives, glue, and polish in furniture production.

- Minimum Material Use: Developing designs that reduce resource and energy use by utilizing multi-functional façades and elements.
- Durability and Long Life: Extending the service life of furniture and fixtures directly contributes to reducing the environmental burden.

For sustainable interior design, healthy indoor environments, use of ecologically beneficial materials, and design principles that are harmonious with the environment are required (Güney and Kariptaş, 2019). Designers must consider parameters such as LCA, energy efficiency, impact on indoor comfort conditions, compatibility with environmental conditions, and non-generation of environmental waste when selecting materials, developing solutions that align with the region's climate conditions (Altın and Orhon, 2014).

CONCLUSION AND EVALUATION

This study examined the environmental benefits of using sustainable materials in interior design, revealing the critical importance of this approach for ecological balance and the quality of life for future generations. In the face of global environmental problems caused by developing technology and increasing population, sustainability has become an inevitable necessity to slow the rate of natural resource depletion and minimize environmental impacts.

The findings show that the selection and use of sustainable materials provide energy and resource savings throughout a building's entire life cycle (raw material acquisition, production, use, and demolition), and reduce air, water, and soil pollution. The integration of traditional and local materials like wood, stone, and adobe with modern techniques forms the basis of sustainable architecture, owing to their low carbon footprint and high recyclability. Specifically, wood's carbon storage capacity and steel's high recyclability rate are notable features in terms of environmental benefits. Conversely, the high emissions and low recyclability potential of widely used materials like concrete and cement reinforce the necessity of finding alternatives for sustainable solutions.

In interior design, sustainable approaches, combined with principles of healthy indoor conditions, multi-functional and flexible spatial organization, and furniture reuse, enhance user ergonomics and well-being while ensuring the efficient and long-term use of resources. Preserving existing structures through adaptive reuse, rather than demolition and rebuilding, provides significant environmental benefits and cultural continuity.

In conclusion, architects and interior designers must consider not only traditional criteria such as aesthetics, cost, and performance when making material selection decisions but also Life Cycle Assessment (LCA), environmental impact, and the use of local resources. Promoting the use of sustainable building materials, raising public awareness, and collaboration among relevant professional groups are vital for creating energy-efficient and livable environments that support ecological balance.

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Toward a Hybridized Architectural Criticism: AI-Assisted Filmmaking as a New Critical Practice

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ABSTRACT

This paper explores how artificial intelligence (AI) can reconfigure architectural criticism (AC) through the medium of filmmaking. Recent developments suggest a shift in authority from the critic to artistic productions that embody diverse critical perspectives, particularly in short films. In this context, Psyche(O)geography, a short film produced with both conventional methods and AI tools, serves as an experimental case. Drawing on the Emotionalist manifesto, the film's production and outcome were examined through process reports, script analysis, and content analysis of the final work. Findings show that AI-assisted criticism can effectively articulate a critical stance, while the hybridized use of AI and conventional tools expands the scope of production. Yet, human judgment remains indispensable for contextual grounding and ethical responsibility. Interpreted through four interrelated dimensions—authorship (distributed voices), agency (AI as co-creator), relationality (affective and participatory critique), and mediation (multimodal representation)—the study proposes a transferable framework for future AC. This approach not only evidences the critical potential of AI-assisted filmmaking but also sets an agenda for developing critical literacy in a digital era where AI tends to mediate and co-produce cultural discourse.

Keywords – architectural criticism; artificial intelligence; filmmaking; the critic; the Emotinalists

INTRODUCTION

The introduction of AI and digital transformation has an impact on every discipline and practice. Primarily due to the introduction of computer-aided design (CAD) practices in the architectural field, conventional considerations of physical environments have undergone a rapid transformation. Building Information Management (BIM), which is viewed as a comprehensive process facilitator (Baracho et al., 2025), enables precise communication between stakeholders, making architecture a digitally driven profession that materializes and controls real-world environments. On the contrary, architectural criticism (AC) has generally transitioned into a more subjective field. Social media involvement encouraged public opinion to appear and even become viral on critical platforms, and the interactivity of the media provided AC with more collectivity. Clear authorities' volumes have been lowered, whereas voices from digital platforms, e.g., Dezeen, Archdaily, Archinect, and blogs have created a mosaic of critical niches, each sounding at a different frequency. Decentralization of authority once belonged to academia, journals, and well-known critics, and its fragmentation into diverse topics, such as sustainability, social justice, and ethics, consists of the general content of the AC's picture of the new era.

This dissolved, unstable AC ecosystem also embodies the drawbacks of digitalization, as algorithmic bias can lead to unfavorable outcomes rather than maintaining them within a more human-centered framework. For instance, research has demonstrated how machine learning (ML) models evaluating façade aesthetics diverge from human architectural judgments, systematically favoring glossy parametric forms over community-driven or adaptive reuse projects (Park et al., 2024). Another research emphasized that media reinforce architectural capital and centralize global visibility, creating feedback loops where featured firms gain more projects simply by being published (Zhao, 2020). The need to establish a critical environment that can transcend the adverse effects of AI has become increasingly significant.

AC's conventional ties with history and theory need reconsideration in these AI-dominated circumstances. The newly established ties can be monitored through insights into new cases. In this context, the current study presents an interior perspective of a recent AC creation that utilizes AI as a collaborator.

Emotionalism (The Emotionalists, 2025), a newly emerging movement that reclaims the emotional, the personal, and the deeply human in the AI and automation-driven world, established the basis for the critical act of producing the short film *Psyche(O)geography* (CritArch, 2025). This paper analyses the film and explores the role of AI in AC, explicitly conveyed through a short film format.

AC in this paper is understood as an interpretative and reflective practice that articulates meaning in the built environment through multimodal expression. In this frame, filmmaking was treated as an alternative form of criticism that transforms a discourse into an experiential and narrative act. In doing so, the present study employs Generative AI, which is used for the creative co-production of text, images, and videos, to explore how emotion, memory, and human agency can remain central in human-AI collaboration in the context of criticism. The Emotionalist manifesto provides the theoretical foundation for the experiential inquiry, positioning emotion and memory as counterarguments to the sterile logic of the algorithm. In this sense, AI-assisted filmmaking becomes both a method and a critique —a way to examine architecture/environments as lived, affective experiences rather than abstract systems. Accordingly, this study asks how Emotionalist principles can be conveyed through AI-assisted filmmaking as a form of AC and how human-AI collaboration reconfigures critique within a hybrid ecology of creative practice.

In this paper, generative AI refers to tools used to co-produce text, images, and video for the film; references to other AI/ML techniques in AC (e.g., evaluative or predictive models) are distinguished accordingly.

Background and Objective Emerging Contradictions and Dilemmas in AC

Since the early 2000s, discussions on AC have been addressing the tension between form-based and function-based approaches. Practices of AC were criticized for being overly focused on aesthetics rather than addressing the practical needs of society, as well as vital dimensions such as safety, efficiency, and user well-being. A more pragmatic framework was requested to integrate subjective experiences with objective measurements (Davis & Preiser, 2012). On the other hand, subjectivity, reflected in interpretation, language, and meaning, was reported to be an integral part of criticism. As a form of architectural discourse and practice, criticism and its associated language are reportedly learned through architectural education (Raman & Coyne, 2000). The critic was named the judge, and the criticism written by the judge was valued for its retrospective and operative role in placing architectural practice into history and canons (Macarthur & Stead, 2006).

These ideas on AC, in fact, date back to literature and cultural theories of the past. The multiplicity of text-reader relationships and, therefore, the possibility of diverse interpretations of a text, which provide a dynamic position for *meaning*, freeing it from the hegemony of the creator-author, was proposed in the 1960s (Barthes, 1977). In the same period, the individual subject author was depersonalized and was replaced with the *discourse* concept (Foucault, 1998). Emancipation from the authority of the single person as the author/critic raised the discursive production, in which anything that is related to the discourse can be added.

A dialogue-oriented and polyphonic form of criticism transcending the limits of doctrinal and aesthetics-based approaches was advocated for developing a healthy public-professional conversation (Pousin, 2013). Rather than limiting AC to architecture and philosophy, it has been recommended that AC be opened to broader disciplines, such as cognitive sciences, politics, gender studies, and environmental humanities (Liu, 2025). AC has also been viewed as a transformative force for developing multi-perspective historical narratives in architecture, and the shift towards environmental, feminist, and digital methodologies has been regarded as a critical response to past limitations in architectural history (Heynen, 2024). Therefore, building new tracks in AC is not only closely related to the discursiveness and interpretive culture theories, but also to the rise of new frameworks in all architecture-related fields.

Focusing on public architecture awards, the role of social media in democratizing the field of architecture was explored. Findings indicated that the data about voters was insufficient, expert commentaries were missing, and final decisions favored architects with strong digital networks, all suggesting a lack of media literacy (Tempestini, 2025). Therefore, media involvement in AC, or AC's involvement in media, also presented media-induced problems, degrading AC content and diverting it into different tracks. It can be argued that the media, increasingly shaped by AI, which also proposes its interpretations and discourses, requires a shift in a positive direction. Similar diversions have been reported in theoretical writing in architecture as well; loosely defined appropriations of scientific theories have been found to legitimize personal agendas rather than foster collective critical discourses (Sotés et al., 2025). This situation brings into the open the strong urge for an AC that nourishes the discipline of architecture and other related disciplines aimed at improving human-made physical environments. In response, the following section frames filmmaking as a critical interpretive extension of AC, transforming it from a primarily textual discourse into a spatial and affective mode of reflection.

New-generation AC; Film making

Computerization of design, as mentioned earlier, increases the use of performance-based approaches while diminishing the value of subjective or value-based approaches. Building Performance Simulation (BPS), for instance, utilizes physics-based models to deliver detailed and measurable predictions, as it can be easily integrated with Machine Learning (ML), enabling speed and accuracy in operations (de Wilde, 2023). Similarly, early systems utilizing critical modules, which were already designed to assist designers in testing various issues, such as window sizes or unsafe exits (Chun & Lai, 1997), remain relevant today in the form of their advanced iterations. These data-driven insights support better-informed critiques and decision-making, as empirical evidence replaces the subjective interpretation in design and management phases.

On the other hand, subjective, human-centered, philosophical, and ethical discourses still exist. In AC, filmmaking has emerged as a vital medium for reflecting spatial experience beyond the limitations of the conventional textual analysis. Cinema has been recognized as a significant medium in AC, as it reveals an explosion of spatial perception through movement and narrative (Vidler, 1993), serves as a tool for spatial critique by challenging the static nature of architectural environments (Keiller, 2007), enables critical historiography that fosters reflexive and temporally nuanced interpretations of space (Macarthur & Stead, 2006), and acts as a conceptual bridge linking theory, practice, and critique, thereby expanding the discursive scope of architectural analysis (Rendell, 2007).

Films also occupy a significant place in the new generation of criticism. Some films question the role of AI, examining how its pervasive use impacts existing/future environments, while others employ AI purely as a tool to convey critical discourse. Remarkable examples include Where the City Can't See (2016), In the Robot Skies (2016), and Renderlands (2017) by director-architect Liam Young, who once remarked, “an architect’s skills are completely wasted on making buildings” (Wikipedia, 2025a). Another is What’s Next? (2025), a film that employs AI-generated environments, directed by Cao Yiwen, who noted, “if a hundred people end up with a hundred of the same short videos by using AI, they can’t organize it into the same story” (Adlakha, 2025). Where the City Can't See (2016) is described as the first narrative fiction film captured entirely with laser scanners, presenting the journey of a group of young factory workers who hack the city in a near-future world under the control of smart systems (Young, 2016). Together with Renderlands (2017), which documents the outsourced production of digital worlds across transnational render farms in India (Young, 2017), the two films form a critical continuum in the director’s oeuvre that interrogates the spatial, ethical, and technological infrastructures shaping contemporary urbanity. What is Next? (2025) can be read as a critical visual-spatial experiment in which AI-generated hallucinatory images construct a counterfeit paradise where desire, consumption, and dystopia intertwine, ultimately confronting the viewer with a mirror reflecting the architecture of their own cultural imagination (Berlinare, 2025).

Architecton (2024), directed by Victor Kossakovsky, features AI-enhanced visuals, while The Brutalist (2024), directed by Brady Corbet, incorporates AI-generated architectural blueprints (Wikipedia, 2025b; Mulkerrins, 2024). In all these films, AI operates as both a creative and critical medium that reshapes the ways architectural ideas and environmental ethics are conceived, visualized, and debated-marking AI-assisted filmmaking as an emergent paradigm of AC. Therefore, AI-assisted filmmaking can be regarded as a new-generation approach for developing and expressing a critical stance.

Materials and Methods Research Design and Data Sources

The paper presents a qualitative inquiry on the produced film Psyche(O)geography (2025). Content analysis was employed in two steps to elucidate the film's features. The film was analyzed to assess its critical stance on Emotionalism, and a production analysis was conducted to identify the Generative AI tools used in its creation. Notes taken by the tutor during lessons, as well as student mid-term and final reports on the filmmaking process, the script, and the produced film, were used as data.

Data breakdown regarding the production of the film was found to be the following:

• Literature review on Emotionalism, the real context (a street), the symbols (a statue) taking place in the context, and the main imagery character (the mythical Psyche) in the film.

• Mind maps, for building the critical stance, and the script/scenes

• Emotion maps for structuring effective mood changes,

• ChatGPT inquiries, for developing the script, dialogues, and the voice-over,

• ChatGPT inquiries for developing text-to-image and image-to-video prompts,

• Video recordings in real environments.

The following subsection details the case study, Psyche(O)geography, which served as the experimental medium for applying and examining Emotionalist principles through AI-assisted filmmaking.

The case

The case is based on the short experimental film Psyche(O)geography (2025), which explores the application of Emotionalist principles through AI-assisted filmmaking. While the Emotionalist framework could, in principle, be extended to other media forms—such as immersive, interactive, or textual modes of architectural criticism—this study intentionally focuses on the short-film format. This focus enables a more in-depth and coherent examination of AI-assisted criticism through a single expressive medium. The film was conceived as both a creative output and a research instrument within this study. As the producer of the film is an Emotionalist, the study deliberately adopts the Emotionalist framework as both a conceptual and methodological standpoint, ensuring coherence between creative intent and critical interpretation rather than dispersing focus across multiple theoretical positions.

The newly emerged Emotionalists (The Emotionalists, 2025) formed the basis of the film's critical stance through their manifesto, practice, and discourse. The Emotionalists support emotional involvement in art, architecture, and design. They are against designs being dominated by sterile logic, as indicated by the algorithm, which suggests an overuse of Machine Learning. They accept technology but demand that it be used humanely to serve humanity. It is a movement of seeing, thinking, and making; it places importance on memory, remembrance, feeling, sensation, crafting, authenticity, artistic expression, emotional resonance, and the complexity of existence. All these constitute a suitable basis for criticism as well. Therefore, this newly emerging movement was chosen as the starting point for developing critical stances in the related course. Figure 1 displays the word cloud of Emotionalism, derived from their main statement and manifesto.

Figure 1. Key Emotionalist terms forming the conceptual basis of AI-assisted criticism (The Emotionalists, 2025)

In the 2024-25 Fall semester, two graduate students and a tutor collaborated to produce a short film that explored the Emotionalist thoughts, exemplifying them to initiate new critical discussions. Two graduates developed the film Psyche(o)geography (CritArch, 2024) by utilizing a diverse range of Generative AI and conventional tools. AI tools were utilized in selected phases—writing, visualization, and reflection—where they could enhance creativity and combine different modes of expression, helping to test how Emotionalism adapts across each stage of the creative process. The tutor acted as the producer, checked every step against the Emotionalist manifesto and its possible interpretations. In 14 weeks, the film was fully completed and published on social media.

A hybrid method was used to make the film. Four-hour weekly sessions facilitated discussions and a systematic step-by-step review of all operations. The process began with a literature search on Emotionalism, followed by the selection of real urban environments, the development of a character, the writing of a story, the organization of mood flow, and the scripting of scenes. As scenes were developed and finalized, corrections, additional materials, and possible responses were reviewed collaboratively. The critical act was characterized by the collaboration of three individuals: two were engaged in production, and one was in oversight.

Motivation and research questions

The study aims to examine the applicability of the Emotionalist manifesto within an AI-assisted filmmaking process that functions as a form of AC. It explores both the film's conveyance of Emotionalist principles and the conceptual implications of the human-AI collaboration. Specifically:

RQ1: To what extent and in what ways can Emotionalist principles be applied and conveyed through AI-assisted filmmaking as a form of AC??

RQ2: How can the collaborative AI-human interaction give rise to conceptual dimensions -such as authorship, agency, relationality, and mediation- that reframe AC as a hybridized practice?

While RQ1 focuses on the extent and modes of conveying Emotionalist principles in the film, ensuring that the film has a genuine critical stance, RQ2 addresses the emergent conceptual matters that occur during the human-AI creative process. Together, they allow the study to assess both the expressive and theoretical dimensions of AI-assisted AC.

Operational definitions and analytical approach

The conveyance quality (RQ1) refers to the extent to which the film effectively communicates Emotional principles, including emotion, memory, and spatial experience, through visual, narrative, and auditory layers. The researcher identified the Emotionalist attributes — memory, remembrance/memory recall, feeling, sensation/spatial empathy, crafting, authenticity, artistic expression, emotional resonance/affective tone, and complexity of existence— and various AI tools generated summaries of the film. These summaries, as reflexive mirror tools, were then compared with the original overview and the Emotionalist principles. Furthermore, the film script was analyzed using Voyant Tools, and the film's thematic intensities and co-occurrence patterns were detected qualitatively. No significance testing or interrater reliability analysis was applied, as the study aimed at interpretive rather than numerical evaluation of semantic patterns. Qualitative depth and reflexive analysis were aimed at, as reliability was supported through triangulation across the script, production reports, AI outputs, and researcher reflections, ensuring conceptual consistency between intention and result.

The creative agency (RQ2) refers to the degree and type of authorship—and decision-making—that were distributed across human and AI tools. To develop the arguments regarding the creative agency, the tutor reviewed the content of all written material, differentiating between parts produced through AI and those produced with conventional tools. All material was manually and thematically coded to identify the emergent conceptual dimensions that redefined the nature of the hybridized criticism.

AI tools were employed not only as production instruments but also as analytical partners. Their use enabled testing whether human-machine collaboration produced meaningful results, rather than simply accelerating the generation of images and text. The filmmaking process integrated conventional cinematic methods with AI-generated scripts, images, and videos to explore hybrid authorship and the affective potential of narrative, thereby raising the conceptual framework for interpreting the findings and situating AI-assisted criticism within broader theoretical debates (RQ2).

All inquiries were conducted three months after the production, after a certain critical distance was deemed to have been established.

RESULTS

Film content and production content were analysed separately. The researcher synthesized the findings to elucidate the emerging framework of new-generation AC and the role and impact of AI on its development.

Conveyance of Emotionalist Principles

The film is about Psyche, who seeks to discover who she is by strolling through the city center (in response to her deceased father's mysterious message that appeared on her mobile phone), recalling her childhood memories, revisiting places, and forming bonds with the city, its people, and herself. It is a section from her story of becoming. Figure 2 displays scenes that represent the characteristic phases of Psyche's journey.

To ensure objectivity and analytical depth, the researcher reconstructed the film's narrative by employing diverse AI tools, i.e., Galaxy AI, Monica AI, Noise AI, and Revisely AI, and synthesized the film's story from multiple analytical texts through ChatGPT. The synopsis obtained in the 13-minute film is as follows: "In an urban odyssey, Psyche—symbol of the soul—descends into the underworld not only to retrieve beauty but to confront buried memories. Her journey echoes through the city's shadowed alleys and fading facades, where walking becomes a contemplative act and flânerie reveals hidden layers of meaning. On streets like Olgunlar, she encounters quiet acts of resistance—miners seeking dignity, booksellers fostering connections, and intellectuals woven into the fabric of everyday life. Transformed by these encounters, Psyche sees the city as a living archive of resilience, memory, and self-discovery."

The original overview of the film was verbalized as follows (CritArch, 2025): *"Psyche(O)Geography is a short film exploring the psychological and emotional transformations of the human soul—the Psyche—through the act of remembering and revisiting spaces. Memory and environment become the catalysts for this journey, as Psyche symbolizes the human search for identity, connection, and existence. Cities are more than physical landscapes; they are living archives where we discover who we are. Within their hidden niches, silent yet enduring, our collective memories reside. In Ankara, the modern capital of the Turkish Republic, places like Olgunlar Street continue to exist in quiet resilience, waiting for attentive and sincere flâneurs to uncover their stories and reflect on their significance. It is our emotions—our curiosity—that bind us to the city, to others, and to our authentic past. Psyche(O)Geography is an open invitation to revive flânerie, to reconnect with the city, and to reconstruct the human soul through emotion in an increasingly digital world."* (CritArch, 2025)

A comparison of the two short texts reveals consistency; the concepts and acts align firmly with each other and the Emotionalist concerns displayed in Figure 1.

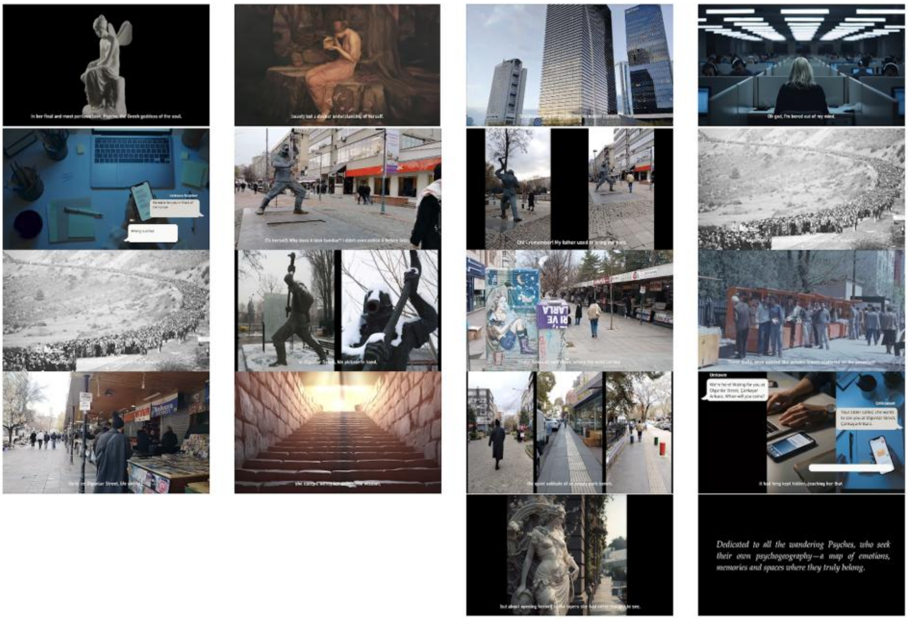


Figure 2. Selected frames from Psyche(O)geography showing the Emotionalist narrative of memory and space (CritArch, 2025)

For a deeper insight, the film script, which was developed through iterative processes with ChatGPT, was analyzed through Voyant Tools, an open-access qualitative analysis tool (Sinclair & Rockwell, 2016). The 1745-words script was studied by the re-searcher first; repeating words indicating narrative features such as scenes and story-telling elements were excluded, and second, the word cloud (thematic intensity), the bubblelines (how words are distributed across the text over time) and the trend (the relative frequency of selected words across different segments of the text) analysis were run (Fig 3). Psyche (the character), the street (in the forms of real and imagined), Olgunlar Street (the place of memory), and the statue (an object of remembrance dedicated to miners) established the central axis, as they reappeared several times in different sections of the film. Walking also appeared as the central secondary theme. The presence of the character searching for her past (memories, remembrances) and present (being bored in the algorithmic world, looking for piece), a memory place (a point in the city once had been experienced together with the father), the town represented through its old-new contrasts (the new rigid skyscrapers vs the old human-scale city centre), the artwork (the statue symbolizing miners), and walking (flânerie) all were found to be conveying the Emotionalist consideration (see Figure 1). Analysis revealed that the walking/strolling character left the leading role to the city, the street, and the statue as the film continued, making them appear as characters.

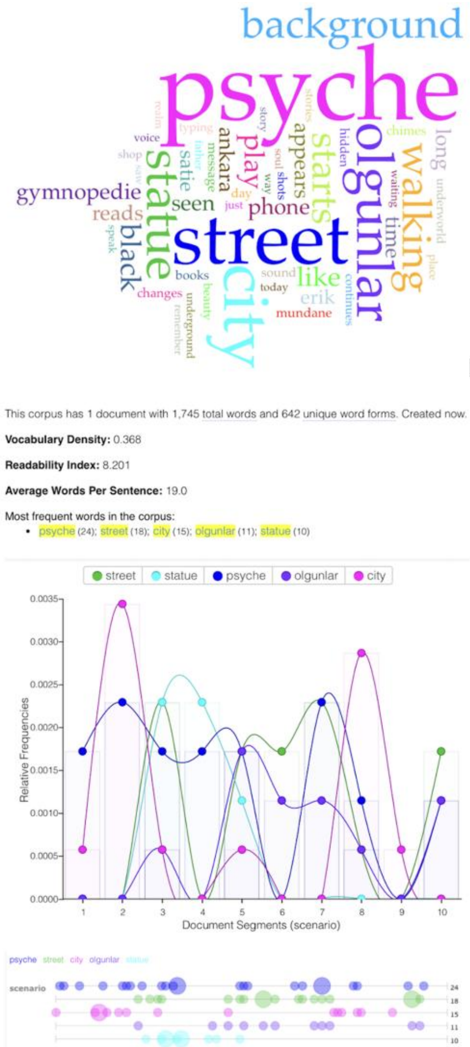
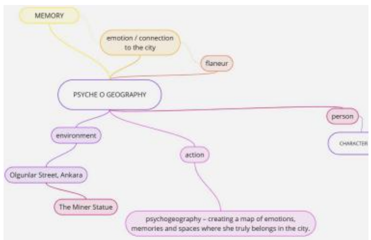


Figure 3. Textual analysis of the script, revealing emotional and spatial patterns, Voyant Tools AI

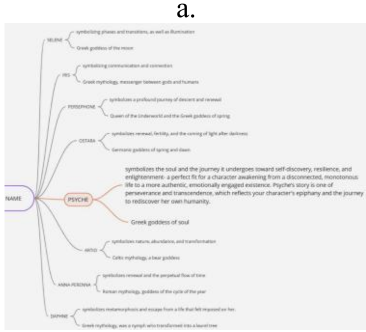
The analysis also revealed a consistent presence of affective tone and spatial empathy throughout the film, particularly in human-directed sequences, whereas memory recall appeared more fragmented and episodic, suggesting a meaningful conveyance of Emotionalist principles. Voyant Tools analysis supported this pattern, showing a dense co-occurrence of spatial vocabulary (e.g., street, city, statue) and a moderate presence of affective and memory-related terms throughout the voyage and transformation of the main character.

Distribution of Creative Agency

Canva In the production process, mind maps were prepared using the Canva tool (Canva, 2025). After the literature review and several discussions, the first mind map was created at the beginning of the production. It identified the components of the film and their potential relationships, providing a basis for the story from a critical stance. Figure 4a displays the related mind map, indicating the person (character), action (psycheogeography), walking (flaneurie), environment (street and symbols), emotion (connection to the city), and remembering (memory) as the main components, whereas Figure 4b displays the alternatives for the main character that were listed and tested by the team. A psychogeographical journey of the character was tied to the place (Olgunlar Street), as walking there evoked a range of emotions.



a.



b.

Figure 4a & b. Early mind maps outlining the film concept and alternative mythological characters

ChatGPT ChatGPT (OpenAI, 2025) was deployed to assist in developing a strong storytelling tone. After introducing the general framework and details of the story, the tool was asked to refine and enhance the narrative's tone. The narrative's tone and content were utilized again to produce the voice-over narration. Iterations educated GPT for the story and style, as GPT responses sharpened the story's details. GPT was the machine collaborator of the whole project.

Text-to-Image/Video AI Tools Imagine Art, Ideogram AI, Leonardo AI, Vivago AI, and several text-to-image AIs were prompted to produce representations of the mythological character Psyche, her work environment, and her symbolic exit (meaning awakening) from the underground cave. Psyche's main characteristics were sourced from various scholarly references; she was redefined within the film's framework, and new digital representations of Psyche were created (see Figure 5). ChatGPT was used to improve prompts. Iterations and fast production of AI provided several trials and selections for the best-fitting final image. Processes were similar for all the environments created through AI.

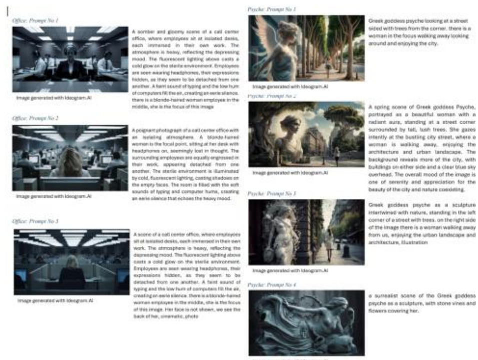


Figure 5. AI-assisted depictions of Psyche and her workspace

Wheel of Emotions Plutchik's Wheel of Emotions (Mondal & Gokhale, 2020; Whatley, 2025) was used for visualizing character's emotional journey during the film that started with anticipation (curiosity) and continued with -in order- amazement (memory), joy (remembering and continuing the journey), admiration (discovering the hidden layer of the city), optimism (self-discovery and resilience) and serenity (attachment to the city and collective memory). Discovering/revisiting a place from childhood was associated with emotional transformation, from positive to very positive, from being provoked to attachment. Negative emotions were neglected since the filmmaking team associated emotionalism with optimism and sincerity.

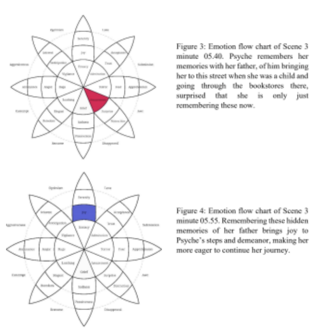


Figure 6. Visualization of the character's affective progression using Plutchik's emotion model

Literature Review Representing the real environment in Ankara, Olgunlar Street was chosen as a place of memory, serving as an antithesis to the newly growing high-rise Eskişehir Road, which lacks a sense of memory yet. Olgunlar is a street set up in the 1970s and has been hosting students, researchers, and book lovers since the 1990s. The street began as an ordinary thoroughfare connecting a main boulevard (Atatürk Boulevard) with the bustling streets behind. In the 80s, it was pedestrianized, and pools and seating were added. It stood as a passive, shadowed place for vagrants, the homeless, and displaced people for a while until book vendors arrived in the early 90s. It became a popular destination for students and researchers seeking old books. In time, new book sellers were added to the society as well. In 1992, the Miner Statue, created by sculptor Metin Yurdanur, was placed in the street. The statue represented the 48.000 miners who marched from Zonguldak to Ankara in 1991, seeking dignity for their labor. Booksellers' stalls and the statue of resistance established a symbiotic relationship, serving book lovers in Ankara (İlkay, 2024; Özcan, 2011; Özkan, 2010). This memory space was represented through photographs and voice-over narration in the film. Literature search findings were used to gather the facts, and ChatGPT was utilized to integrate all these facts into a poetic narrative.

Acting The real Psyches were played by the two students who made the film. To bring the character's journey to life, they walked through the memory place several times, wandered around, and discovered the adjacent streets to which it is connected. Therefore, they, as Psyches, delved into their memories through visiting the memory place and its renewed surroundings. Walking, flanerie, drifting, and strolling were the key actions for meeting the city and returning to it to rediscover personal identity. The mythological Psyche's journey was often represented as the real journey of individuals seeking their identity and sense of presence.

The findings indicate that creative agency was asymmetrically but collaboratively distributed between human and AI contributors: while generative AI generated visual and narrative variations, the human participants retained control over emotional tone, sequencing, and critical intent. This negotiated authorship confirmed the emergence of a hybrid mode of criticism in which creative agency operates relationally rather than hi-erarchically, forming the basis of a four-dimensional framework discussed through the Discussion section.

The Film: Overall

The film's psycheogeography was constructed through passages from the real (conventional) to the unreal (AI) and vice versa. These flows consisted of diversifying space for a critical stance, enriched with a story that continues in both real and unreal environments, featuring real and surreal characters. Diverse AI tools (the ChatGPT for writing the script and the voiceover, text-to-image, and text-to-video AI agents for creating characters and places) facilitated the unreal. In contrast, the realness was obtained through conventional methods and materials (Plutchik's wheel of emotions, literature search for the place, and recordings in the place), all integrated into the film through iterative chats with ChatGPT.

The study demonstrates that AI-assisted filmmaking not only displays the Emotionalist stance but also expands it, transforming memory, flânerie, and affective resonance into a multimodal critique that creates the potential to place Emotionalism within contemporary architectural discourse. Psyche(O)geography experience also exemplifies how AI-assisted filmmaking transforms AC into a cinematic act of remembering, where AI-generated imagery and human experience of a memory-laden street are amalgamated into an immersive, multimodal critique.

DISCUSSION

This study demonstrates how AI can be integrated into the new AC, forming a hybrid-critical practice. The discussion frames AI-assisted criticism around four key dimensions: authorship (distributed and collective voices), agency (AI as active co-creator), relationality (criticism as affective and participatory), and mediation (hybrid multimodal forms). Each dimension emerged as a recurring theme that reflected the evolving interaction between human and AI participants. Authorship became distributed across multiple intelligences; agency was shared and negotiated; relationality reflected affective connections among humans, machines, and spatial narratives; and mediation described the hybridized, multimodal nature of the resulting critical discourse. The framework offers a conceptual lens for understanding AI-assisted criticism as a distributed, affective, and multimodal form of criticism. The short film Psyche(O)geography serves as an experimental case that illustrates these dimensions and points toward a transferable model for rethinking the future of criticism.

Authorship

In the age of AI, authorship in AC is destabilized. As previous theories display, authorship is less an individual essence than a discursive function that organizes and legitimizes meaning (Barthes, 1977; Foucault, 1998). In AI-assisted filmmaking, authorship becomes divided between humans and machines, creating an integrated/amalgamated voice that challenges the long-standing one-person critic (Macarthur & Stead, 2006). This dispersion necessitates the development of new mediation tools/techniques to prevent algorithmic authority from supplanting human judgment.

The collaborative methodology adopted—the three individuals collectively shaping the film—and human-AI hybridity directly challenge the single-person authority that has long dominated the field (MacArthur & Stead, 2006). This echoes the democratizing potential of digital criticism (Tempestini, 2025), highlighting how social media architectures can facilitate the emergence of alternative critical voices. Yet, the risk of over-dependence on AI tools necessitates active human mediation to avoid biases, ethical lapses, and decontextualized outputs (Park et al., 2024). Furthermore, AI tools like Voyant for textual analysis and AI video summarizers exemplify how AI can also play a role in post-production critique, providing a feedback loop where AI is both co-author and co-critic—a dynamic that has been barely explored in the literature to date.

Agency

In AI-assisted criticism, agency extends beyond human actors to include the active role of machine collaborators. Rather than functioning solely as technical assistants, AI tools propose infinite scope for narratives, images, and meanings, positioning themselves as co-creators of the critical process. This redistribution of roles redefines AC as a hybridized act. The case of Psyche(O)geography illustrates this dynamic, showing how AI was not only employed in image and video editing but also acted as a narrative agent of the critique itself.

The findings align with recent assertions that AI can extend the domain of architectural production beyond data-driven design to include expressive and interpretive dimensions (de Wilde, 2023). The case showed that AI was instrumental not merely as a visual production assistant but as a narrative agent capable of co-constructing affective and symbolic content—an evolution from its conventional role in design automation (Chun & Lai, 1997; Baracho et al., 2025). This supports the argument that AC must extend beyond conventional epistemologies to engage with broader interdisciplinary and technological frameworks (Liu, 2025). The production's iterative use of ChatGPT for narrative and visual refinement also underscores AI's growing competency in processing subjective human content, too. With their native fluency in digital media and inclination toward collaborative production, Gen Z and younger cohorts (Hernandez-de-Menendez et al., 2020; Serbanescu, 2022) appear to be the ones spearheading this shift.

Relationality

According to the relational aesthetics theory, art and criticism are processes of encountering and dialogue (Bourriaud, 1998). In AI-assisted criticism, this perspective is reflected through the Emotionalist stance, where the affective resonance makes criticism experiential. In the context of AI-assisted criticism, relationality can be reconceptualized as the co-production of affective encounters not only among humans but also between humans and algorithms. Through this extended frame, criticism becomes a hybrid relational field, where memory, emotion, and machine mediation together generate shared critical experiences that transcend the limits and scope of subjectivity. The case of Psyche(O)geography demonstrates how human and machine collaboration can materialize such relational qualities through seamlessly integrating individuals, places, and algorithms into a shared critical practice.

The film's alignment with Emotionalism reintroduces subjectivity, emotion, and memory as vital epistemological factors in criticism, which have been neglected in performance-driven digital workflows. By focusing on affective urban memory and flânerie, the project exemplifies how AI tools can materialize theoretical concepts proposed by humans into dynamic audiovisual content, mostly developed through algorithms, extending earlier concerns (Keiller, 2007). This demonstrates the critical spatial practice where affect and context become integral parts of the new architectural meaning-making (Rendell, 2007). The Emotionalist lens critiquing the algorithmic flattening of spatial experience—an issue that had already been problematized in literature examining how AI and media favor visual over the experiential in architecture (Park et al., 2024; Zhao, 2020) was surpassed through the deliberate use of a memory-laden environment, rebelled against the flattening, and reinforced the role of narratively rich, emotionally attuned spatial critiques.

Mediation

As emphasized in the theory of remediation (Bolter & Grusin, 1996), mnemonic media practices (Annabel, 2024) continuously refashion older forms while producing hybrid representations. In the context of AC, filmmaking becomes a mediating practice, where old and new texts, images, personalities, and algorithmic outputs converge into a multimodal critique. The film Psyche(O)geography exemplifies this process by weaving together AI-generated visuals and conventional recordings/photographs of people and environments. This AI-assisted remediation transforms AC into a cinematic experience, demonstrating how AI extends AC towards immersive, multimodal representation. The memory-laden environment acts as a mnemonic device that triggers human memory, therefore serving to relationality and remediation at once.

Filmmaking operates as a medium of criticism, fulfilling the assertion that cinema offers an explosion of space and critical narration (Vidler, 1993) as well as the call for polyphonic criticism that transcends rigid disciplinary boundaries (Pousin, 2013). Therefore, the integration of mnemonic elements provides a polyphony by transforming AC into an act of remembering; space becomes a site of collective memory, and criticism evolves from dramatization to remembrance. Other experimental films, such as In the Robot Skies and Renderlands, take up the abstract and placeless digital domains to critique the spatial politics of technology and surveillance (Adlakha, 2025). On the contrary, the film Psyche(O)geography presents a specific remediation that resists the placelessness often associated with AI imagery by rooting the film in the memory-laden Olgunlar Street.

Taken together, these dimensions constitute a transferable framework for AI-assisted criticism, with the Psyche(O)geography case illustrating both its potential and its limits. In particular, the film demonstrates how memory-laden spaces necessitate the presence of a human author, whose irreplaceable agency activates spatial memory, sustains relationality, and reinforces remediation in ways that AI alone cannot achieve.

All occurred AI hallucinations, biases, and visual or contextual inaccuracies that dissatisfied the two directors and one producer were eliminated during the process. Therefore, the ethical balance between authenticity and artificial enhancements was provided by human control. Literature reviews, on-site filming, acting, and using the Wheel of Emotions also helped the team stay in realistic frames rather than letting AI manage or divert the production.

The present exploratory study prioritizes interpretive depth over empirical generalization. As a single case, its insights are transferable conceptually. Therefore, future studies could include external reviewers or audience evaluations to enrich interpretive robustness and test the framework across different cultural or media contexts. While geographically specific, the emotional and mnemonic dimensions explored here are universal, offering a foundation for comparative inquiries into AI-mediated AC.

CONCLUSIONS

This study shows that AI-assisted filmmaking can reorient AC by merging human judgment with machine creativity. Through the framework of authorship, agency, relationality, and mediation, criticism emerges as distributed, multimodal, and participatory rather than bound to a single authoritative voice. Future researchers can apply this 4D framework to analyze other cases of AI-assisted criticism or digital media critique. Yet this hybridity also demands new evaluative criteria and ethical vigilance to ensure that human responsibility remains central.

Future studies can expand the AI-assisted filmmaking experiment through cross-media comparisons, independent viewer evaluations, and systematic testing of AI interpretive accuracy. While this paper prioritizes transferability over generalization, it provides a methodological scaffold for subsequent empirical validation and ethical reflection.

Beyond documenting a single experiment, the study sets out an agenda: to develop critical literacy and new modes of practice for a generation that will think, create, and critique with AI as an active partner—reshaping not only the methods of criticism but also its very cultural authority.

Acknowledgments The author would like to express sincere gratitude to the young and talented graduate degree students, Architect Tuğçe Gül (Gazi University) and Architect Çağılsu Kardeş Yağmur (TOBB and Gazi

University), for their creative vision, dedication, and collaborative spirit throughout the production process of the film Psyhe(O)geography. Their efforts made the 2024-25 Winter Semester of ARCH5161 Criticism in Architecture (Gazi University) a truly artistic and experimental environment. They caused this paper to present a direct insight into the experiment.

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Plant Preferences in Residential Gardens: Culture–Environment Interactions Across The Border Between Artvin (Turkey) and Sarpi–Kvariati–Gonio–Avgia–City Center (Georgia)

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ABSTRACT

This study investigates the relationship between plant preferences in residential gardens and culture–environment interaction through a comparative analysis of the Kemalpaşa–Hopa–Arhavi corridor in Artvin (Türkiye) and the Sarpi–Kvariati–Gonio–Avgia–City Center settlements in Georgia. Within the scope of the research, a total of 335 plant species were identified across both regions. The species were evaluated based on family composition, leaf habit, housing age, housing type, garden location, and distance from the international border. The findings reveal that, despite similar climatic conditions, plant compositions differ in a non-random and statistically significant manner between the two regions.

Family-level analyses indicate that Rosaceae is the dominant family in both regions; however, evergreen-dominated families such as Cupressaceae, Ericaceae, and Taxaceae are more strongly represented in Sarpi–Kvariati–Gonio–Avgia–City Center, whereas deciduous and fruit-bearing families are more prominent in Kemalpaşa–Hopa–Arhavi. Chi-square (χ^2) tests demonstrate statistically significant differences in family distribution, leaf habit, and species richness depending on region ($p < 0.05$).

A significant relationship was found between housing age and plant species richness in both regions, with particularly high species richness observed in residential gardens older than 50 years in Sarpi–Kvariati–Gonio–Avgia–City Center. Analyses of housing type and garden location reveal that back gardens in Sarpi–Kvariati–Gonio–Avgia–City Center support higher species richness through semi-natural and productive uses, while front gardens in Kemalpaşa–Hopa–Arhavi are characterized by aesthetic and representational functions. As distance from the border increases, species similarity between the two regions decreases, indicating that border areas function as cultural transition zones reflected through plant composition.

In conclusion, this study demonstrates that residential gardens are not merely aesthetic landscape elements but dynamic systems where cultural practices, ecological continuity, and socio-economic preferences are manifested. The findings highlight that the landscape character of border regions is shaped by multi-layered interactions extending beyond climatic factors alone.

Keywords – Plant Preferences, Residential Gardens, Culture–Environment Interactions Artvin-Georgia

INTRODUCTION

Cultural transition areas—namely regions where two or more cultures intersect and interact—are areas characterized by high levels of cultural and linguistic diversity and complex social and physical structures. Although the people living in the cities of Artvin (Kemalpaşa–Hopa–Arhavi) and Sarpi–Kvariati–Gonio–Avgia–City Center (Georgia) lived closely intertwined with one another until the recent past, political, social, and economic changes throughout history, together with climatic, edaphic, and biotic factors resulting from geographical differences, have led to the formation of distinct cultural structures in both cities. These cultural differences are also reflected in the residential gardens where individuals live, manifesting themselves in landscape elements such as plant species, land use, and purposes of use (Bakan, 1987; Demir, 1998; Demir et al., 2010; Delahay et al., 2023).

Gardens can be regarded as spaces that reveal both individual and collective values as reflections of the cultural and social life of the family unit. A family garden reflects individuals' social life, national consciousness, and solidarity, while also revealing the character of those who live in that garden (Gültekin, 1991; Clayton, 2007). Throughout history, gardens have served as refuges where people can escape the stress of daily life and interact with nature. Although gardens differ in size, design, and function, the social and ecological environments they create reflect the economic and cultural level of the period in which they exist, as well as geographical and climatic conditions (Francis & Hester, 1990; Gross & Lane, 2007; Haluza et al., 2025).

In residential areas, the design of residential gardens and plant selection vary not only according to natural conditions but also depending on cultural structure, traditions, socio-economic status, and individual preferences. Culture shapes individuals' perceptions of the environment, their methods of organizing space, and their aesthetic choices; therefore, even in regions with similar natural conditions, cultural differences significantly influence garden use and plant preferences (Demir et al., 2010; Akdoğan, 1995; Gür, 2000; Korpelainen, 2023). Residential gardens constitute an important component of urban landscapes as areas that strengthen social relations, provide aesthetic values, and perform ecological functions (Beckett et al., 1998; Cameron et al., 2012; Urban Ecosystems, 2024).

Garden use is shaped by aesthetic and functional priorities; while visual and aesthetic concerns come to the forefront in front gardens, back gardens are more often used for relaxation, agriculture, or social interaction (Daniels & Kirkpatrick, 2006; Yılmaz & Irmak, 2004; Landscape and Urban Planning, 2023). Plant selection and garden design are directly related to both local biodiversity and cultural identity. While native plants provide aesthetic and ecological contributions, cultural and socio-economic factors influence the use of exotic species and the form of aesthetic arrangements in landscapes (Fraser & Kenney, 2000; Kurz & Baudains, 2012; Urban Forestry & Urban Greening, 2024).

This study examines the selection processes of plants in residential gardens located in two neighboring countries. Plant preferences are shaped by plant characteristics, user preferences, the culture of the place where people live, and the influence of cultural processes (Daniels & Kirkpatrick, 2006b; Freeman et al., 2012; Head & Muir, 2006; Kendal et al., 2012; Marco et al., 2010; Yabiku et al., 2008; Dimitriou & Karatasou, 2017; Keblinska, 2019; Delahay et al., 2023). Specific functions and qualities of plant species constitute the reasons for their selection by meeting users' needs (Marco et al., 2010). Factors influencing individuals' plant preferences include visual characteristics, maintenance requirements, shade provision, privacy, fruit or yield production, scent, and color (Kurz & Baudains, 2012; Dimitriou & Karatasou, 2017; Keblinska, 2019).

Because residential gardens reflect people's lifestyles and perceptions of the environment (Kendal et al., 2012; Delahay et al., 2023), plant diversity within gardens develops or declines over time depending on natural and cultural factors. In this context, the research involves a comparison of gardens in two neighboring countries in order to understand the relationship between culture and plants. In gardens where plant diversity develops depending on natural and cultural activities, garden use, plant selection patterns, and plant trade also change under the influence of cultural structure. Usage classes were addressed in line with previous studies, and the areas where plants were located were evaluated as front, side, and back gardens. The usage classes of plants were determined as aesthetic, visual, and functional.

It was observed that plants classified under the visual category were preferred by users; their functions such as creating scenery and providing shade were effective in their selection. The study determined that plants in the visual category contributed aesthetically to gardens and constituted the dominant usage type through features such as cover and shade provision. Plant selection is influenced by beliefs, tastes, lifestyles, and habits embedded in cultural structures (Ambrose, 2005; Berberoğlu et al., 2010; Clayton, 2007; Fraser & Kenney, 2000; Martin et al., 2004; Williams, 2012; Zmyslony & Gagnon, 1998; Özbilen, 1995). This study demonstrates that cultural structure has a pronounced effect on plant diversity and usage classes. Based on the findings obtained, differences in plant preferences were compared in relation to the effects of cultural structure.

Residential gardens—green spaces such as front, side, and back gardens belonging to individuals' homes—are among the unseen yet critical components of green infrastructure in cities. Under increasing urbanization and concretion, private gardens have become "micro-green spaces" of vital ecological and social importance (Delahay et al., 2023; Korpelainen, 2023). These areas not only meet recreational or aesthetic needs; they also contribute to biodiversity, provide ecosystem services, offer opportunities for direct contact with the environment, and constitute important spaces for food production and individual well-being (Korpelainen, 2023; Haluza et al., 2025).

Cultural transition areas—regions where different cultures intersect and interact—contain many social, historical, and geographical dynamics. In addition to natural conditions and climatic characteristics, historical accumulation, socio-economic structure, traditions, and social habits shape individuals' perceptions of space and spatial organization preferences (Bakan, 1987; Demir et al., 2010). Especially in settlements such as two neighboring cities that display both similarities and differences in cultural context, comparative examination of plant selection and usage patterns in residential gardens can reveal tangible traces of culture–environment interaction.

Plant diversity and landscape arrangements in gardens are reflections of both the relationship established between nature and individuals and society, and users' cultural identity, aesthetic understanding, and social values (Bhatti & Church, 2004; Clayton, 2007; Gross & Lane, 2007). Recent studies have re-emphasized this multidimensional role of residential gardens and shown that they are valuable not only individually but also socially and ecologically (Haluza et al., 2025; Delahay et al., 2023). However, the potential offered by home gardens is often overlooked; due to contextual and local dynamics, gardens may be excluded from the definition of "green space" or may not be adequately evaluated (Haluza et al., 2025; Delahay et al., 2023).

The foundation of this research lies in this gap: by comparatively examining plant selections in residential gardens, garden design preferences, and usage patterns in geographically close yet socially, historically, and economically different cities in two neighboring countries, the study reveals how culture–environment interaction is shaped through plant preferences. This approach offers a multi-layered analysis encompassing not only aesthetic and ecological dimensions but also social dimensions such as cultural identity, historical accumulation, and social values. While an increasing number of studies in the literature address the contributions of residential gardens to biodiversity, ecosystem services, and public health (Delahay et al., 2023; Korpelainen, 2023; Haluza et al., 2025), studies that examine the culture–garden relationship through comparative analysis across two different countries remain limited. Therefore, this study aims to make a significant contribution both theoretically and practically. In summary, this research, which addresses the ecological, social, and cultural dimensions of residential gardens in a holistic manner, takes current literature into account and aims to contribute to academic knowledge while shedding light on urban landscape planning, cultural heritage conservation, and green infrastructure policies.

In traditional gardens, 60–80% of species diversity originates from dominant families that constitute 15–20% of all plants (Marco et al., 2010;

Kendal et al., 2012). The high proportion of fruit-bearing species in gardens indicates the continuity of traditional subsistence-based garden use (Dimitriou & Karatasou, 2017; Keblinska, 2019). In cultural gardens, species selection tends to cluster based on ecological adaptation, economically productive species, and cultural affiliation (Fraser & Kenney, 2000; Kendal et al., 2012; Delahay et al., 2023).

MATERIALS AND METHODS

Residential gardens are regarded as the basic units of urban open green spaces and exhibit different approaches not only in terms of aesthetic and functional characteristics but also with respect to the plant materials used. This study examines the relationship between the plants preferred in residential gardens and their characteristics through objective measurements. This approach enables the results obtained to be objectively compared with studies conducted in other regions. The main objective of the research is to evaluate the influence of cultural structure on plant selection in residential gardens and on preferences for aesthetic plant characteristics. It is assumed in this study that garden plants will display different cultural characteristics and that people's preferences for these characteristics will be reflected in the plants cultivated in their gardens.

Within the scope of the study, plant species diversity and the plant materials used in the residential gardens of inhabitants living in Sarpi–Kvariati–Gonio–Avgia–City Center (Sarpi, Kvariati, Gonio, Avgia, and the city center), Hopa (Sarp, Kemalpaşa, and the district center), and the Arhavi district center were investigated. In the study, the effects of cultural characteristics such as historical accumulation, socio-economic status, traditions, and habits on plant diversity were evaluated in addition to edaphic, biotic, and climatic factors. Furthermore, the design and landscape characteristics of the plants used in these areas were analyzed, and possible relationships between cultural structure and plant preferences were examined.

Study Area

The research was conducted in randomly selected residential gardens located in Sarpi, Kvariati, Gonio, Avgia, and the city center of Sarpi–Kvariati–Gonio–Avgia–City Center, as well as in the settlements of Sarp, Kemalpaşa, Hopa, and Arhavi located along the Kemalpaşa–Hopa–Arhavi border (Figure 1).

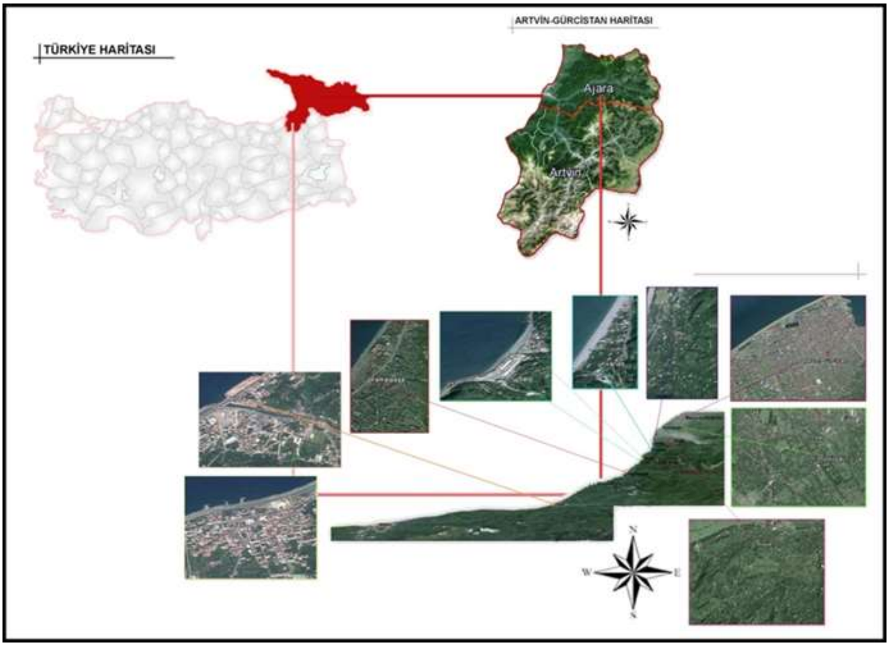

Figure 1. Study Areas (Sarpi, Kvariati, Gonio, Avgia, Batumi, Sarp, Kemalpaşa, Hopa, and Arhavi)

Sarpi–Kvariati–Gonio–Avgia–City Center is located on the opposite side of the national border and covers an area of approximately 19 km² with a population of about 180,000. Different garden arrangements have been observed in urban and rural areas depending on the age and type of residential buildings (Bakan, 1987; Demir, 1998; Demir et al., 2010; Gür, 2000). Hopa district covers an area of approximately 289 km² with a population of 33,129, while Arhavi district covers 314 km² with a population of 15,622 (Anonymous, 2012). The study areas are located within the Colchic subregion of the Euro-Siberian region and fall within grid square A8 according to Davis's grid system (Davis et al., 1988).

Sample Selection and Parameters

In the study, three main parameters were taken into consideration: distance from the border, housing type, and building age:

• *Distance from the border:* Defined as 0–10 km, 10–20 km, and >20 km. Sample gardens were randomly selected within these zones by considering the density of buildings in neighborhoods and streets.

• *Housing type:* Based on field observations, housing types were classified into four categories: traditional houses (Type 1), detached houses (Type 2), villas (Type 3), and apartment blocks/residential complexes (Type 4).

• *Building age:* Building age was evaluated in three groups: <10 years (Y1), 10–50 years (Y2), and >50 years (Y3).

Plant material was examined in randomly selected sample gardens within each housing type and age group. In total, 200 sample sites were visited, and all plant species were recorded during the most suitable seasons. Woody trees, shrubs, ground cover plants, and climbers were included in the sampling. Habitats were initially marked in spring and resampled in summer to record species exhibiting peak phenological stages.

Data Collection and Floristic Analysis

During field surveys, site survey forms and plant inventory forms were used to record woody plant species in residential gardens (Demir, 1998; Demir et al., 2010; Yılmaz & Irmak, 2004). For each plant material, its name, quantity within the garden, location of use, landscape characteristics, and intended use were determined (Akdoğan, 1995; Cameron et al., 2012). Measurements were supported by on-site observation, photography, and sample collection (Berberoğlu et al., 2010; Beckett et al., 1998). Collected specimens were stored in the herbarium of the Faculty of Forestry at Artvin Çoruh University. Taxonomic identifications were conducted by comparing specimens with reference materials in *Flora of Turkey and the East Aegean Islands* (Davis, 1965–1985) and other relevant literature and herbarium collections. Species occurrence rates were calculated based on values of 10% and above per sampling area (Marco et al., 2010; Kendal et al., 2012).

In the floristic analysis, the family and origin distributions of plant species identified in each residential garden were determined, and the landscape use characteristics of the most frequently encountered species were examined (Daniels & Kirkpatrick, 2006b; Fraser & Kenney, 2000; Keblinska, 2019). In addition, plant diversity was evaluated in relation to housing type, building age, and distance from the border using the χ^2 test (Yabiku et al., 2008; Martin et al., 2004; Dimitriou & Karatasou, 2017).

Data Analysis

In the study, species richness and diversity of residential gardens were analyzed under the influence of natural and cultural factors (Bakan, 1987; Demir, 1998; Demir et al., 2010; Delahay et al., 2023). Geographic differences, including climatic, edaphic, and biotic factors, as well as cultural characteristics such as historical accumulation, socio-economic status, traditions, and habits, were taken into account (Francis & Hester, 1990; Gür, 2000; Bhatti & Church, 2004; Korpelainen, 2023). Analyses were conducted under three main headings:

• Family distributions and landscape use characteristics of plant species in residential gardens on both sides of the border (Daniels & Kirkpatrick, 2006b; Marco et al., 2010; Keblinska, 2019).

• χ^2 tests and statistical relationships between plant species richness and housing type, building age, and distance from the border (Yabiku et al., 2008; Martin et al., 2004; Dimitriou & Karatasou, 2017).

• Evaluation of the effects of geographic and cultural factors on species diversity (Head & Muir, 2006; Kendal et al., 2012; Delahay et al., 2023).

The use of plants in the landscape was examined in terms of aesthetic and visual characteristics (flower, fruit, leaf, stem-shoot, habitus, texture, scent) and spatial-functional characteristics (hedging, fruit production, boundary definition, ground covering, guidance, screening, emphasis, shading, naturalness) (Akdoğan, 1995; Clayton, 2007; Kurz & Baudains, 2012; Cameron et al., 2012). Front, back, and side garden uses were analyzed by considering economic and aesthetic purposes (Zmyslony & Gagnon, 1998; Yılmaz & Irmak, 2004; Daniels & Kirkpatrick, 2006b).

RESULTS AND EVALUATION

Within the scope of this study, a total of 170 plant species were identified in residential gardens in the Sarpi–Kvariati–Gonio–Avgia–City Center area, while 165 plant species were recorded in residential gardens in Kemalpaşa–Hopa–Arhavi. The plant species diversity, classified under 70 different families, revealed that the distribution of species was not homogeneous in either region and that certain families became distinctly dominant.

In the Sarpi–Kvariati–Gonio–Avgia–City Center sample, the families with the highest representation in terms of species number were Rosaceae, Fabaceae, Cupressaceae, and Oleaceae. These families were particularly prominent with evergreen and broad-leaved ornamental plants and showed high distribution rates in front and side gardens. In contrast, the Kemalpaşa–Hopa–Arhavi sample exhibited a more balanced and widespread distribution of the Rosaceae, Salicaceae, Fagaceae, and Pinaceae families.

Table 1:Distribution of the most dominant plant families in Sarpi, Kvariati, Gonio, Avgia, and the City Center

Family	Percentage (%)	Ecological / Functional Significance
Rosaceae	20%	Balance of ornamental and fruit-bearing species
Cupressaceae	12%	Evergreen silhouette
Oleaceae	8%	Hedge, boundary, shade
Ericaceae	6%	Adaptation to humid climate
Magnoliaceae	4%	Prestige & aesthetics
Arecaceae / Palmae	3%	Tropical landscape effect
Rutaceae	5%	Fruit + ornamental use

When the plant families were examined in terms of leaf characteristics, it was determined that the proportion of evergreen families (particularly Cupressaceae, Oleaceae, and Lauraceae) was significantly higher in the Sarpi–Kvariati–Gonio–Avgia–City Center. Evergreen-dominated families (Cupressaceae, Magnoliaceae, and Arecaceae) constitute approximately 40% of the total species. Based on this ratio, it can be stated that evergreen species are more dominant in the study area. At the same time, the high level of family diversity indicates that residential gardens are designed not only as functional spaces but also as representative landscape areas.

Table 2: Distribution of the most dominant plant families in Kemalpaşa–Hopa–Arhavi

Family	Percentage (%)	Ecological / Cultural Significance
Rosaceae	28%	Fruit production
Fabaceae	7%	Agriculture + nitrogen fixation
Salicaceae	5%	Proximity to water
Juglandaceae	4%	Food-based use
Vitaceae	5%	Vine (grape) culture
Oleaceae	6%	Hedge + shade
Cupressaceae	5%	Boundary landscape

Kemalpaşa–Hopa–Arhavi, on the other hand, is characterized by the dominance of deciduous families (Rosaceae, Salicaceae, Fagaceae). Rosaceae alone accounts for 28% of the total species. The proportion of deciduous families reaches approximately 70%. Evergreen families rank second and play a complementary role. The family distribution indicates a agricultural–production-oriented structure, with fruit-bearing families (Rosaceae, Juglandaceae, Vitaceae) being significantly dominant. This demonstrates that residential gardens in Kemalpaşa–Hopa–Arhavi are designed as life-supporting spaces.

Table 3: Fundamental differences at the family level of plant species on both sides of the border

Feature	Sarpi, Kvariati, Gonio, Avgia and City Center	Kemalpaşa–Hopa–Arhavi
Family diversity	High	Moderate
Evergreen ratio	High	Low
Rosaceae dominance	Moderate	Very high
Tropical–subtropical families	Pronounced	Very limited
Landscape orientation	Aesthetic–productive	Functional–productive

When examining the fundamental differences at the family level, it becomes evident that in two neighboring regions located within the same climatic zone, plant taxa are selectively concentrated, and that family preferences are not shaped solely by ecological or aesthetic factors; rather, they are also a direct reflection of social and cultural practices and are closely associated with traditional landscape habits.

Family-based distributions, leaf phenology, and spatial arrangement patterns reveal that residential gardens are not merely aesthetic spaces but dynamic systems that carry ecological, cultural, and socio-economic functions. At the family level, Rosaceae clearly emerges as the most dominant family in both regions. Rosaceae is followed by Cupressaceae, Oleaceae, Fabaceae, Pinaceae, and Caprifoliaceae. However, the proportional distributions of these families differ statistically between Sarpi–Kvariati–Gonio–Avgia–City Center and Kemalpaşa–Hopa–Arhavi.

The higher proportion of Rosaceae species in Kemalpaşa–Hopa–Arhavi indicates that fruit-bearing and deciduous species play a central role in traditional garden use. In contrast, evergreen-dominated families such as Cupressaceae, Taxaceae, and Ericaceae show higher representation rates in Sarpi–Kvariati–Gonio–Avgia–City Center. This pattern is directly related to the humid climatic conditions of Sarpi–Kvariati–Gonio–Avgia–City Center and landscape preferences oriented toward aesthetic values.

χ^2 difference analyses based on family × region cross-tabulations demonstrate that family composition varies in a non-random manner depending on the region ($p < 0.05$). The data indicate that deciduous species are more numerous in terms of species richness in both regions. However, the intensity of evergreen species use is higher in Sarpi–Kvariati–Gonio–Avgia–City Center compared to Kemalpaşa–Hopa–Arhavi. In Sarpi–Kvariati–Gonio–Avgia–City Center, evergreen species are particularly concentrated within the families Cupressaceae, Ericaceae, Taxaceae, and Araliaceae, whereas in Kemalpaşa–Hopa–Arhavi, deciduous species belonging to Rosaceae, Salicaceae, and Juglandaceae are dominant.

χ^2 tests reveal that the relationship between leaf habit (evergreen/deciduous) and region is statistically significant. This finding indicates that plant selection is shaped not only by climatic conditions but also by cultural and use-oriented preferences.

Plant Occurrence Rates According to Building Age

In this study, the occurrence rates of plant species identified in residential gardens in Sarpi–Kvariati–Gonio–Avgia–City Center and Kemalpaşa–Hopa–Arhavi were comparatively evaluated according to building age classes (0–10 years, 10–50 years, and >50 years). The tabulated data indicate that plant species are sensitive not only to regional differences but also to the temporal development processes of settlements.

In 0–10-year-old buildings, ornamental species characterized by rapid growth and low maintenance requirements are observed at higher rates in both regions. In particular, species with high aesthetic value such as Acer palmatum, Camellia japonica, Chamaecyparis lawsoniana, and Rosa spp. stand out in this age group in Sarpi–Kvariati–Gonio–Avgia–City Center. In Kemalpaşa–Hopa–Arhavi, species such as Rosa spp., Hydrangea arborescens, and Malus spp. are more dominant in young residential gardens. This pattern indicates that landscape design in newly developed residential areas is more planned and that visually aesthetic-oriented species selection plays a decisive role.

In 10–50-year-old buildings, a marked increase in species diversity is observed. In both Sarpi–Kvariati–Gonio–Avgia–City Center and Kemalpaşa–Hopa–Arhavi, fruit trees, deciduous species providing shade, and long-lived ornamental plants are represented at higher rates within this age group.

In the >50-year-old building group, more pronounced differences emerge between Sarpi–Kvariati–Gonio–Avgia–City Center and Kemalpaşa–Hopa–Arhavi. In Kemalpaşa–Hopa–Arhavi, local, traditional, and production-oriented species (e.g., Castanea sativa, Juglans regia, Morus alba, Salix alba) are found at higher rates. In contrast, Sarpi–Kvariati–Gonio–Avgia–City Center is characterized by the dominance of evergreen and strong landscape-identity species such as Taxus baccata, Rhododendron ponticum, and Tilia spp.

This difference indicates that plant composition in older settlements is shaped by cultural heritage, long-established habits, and long-term environmental adaptation. In particular, species such as Corylus avellana, Juglans regia, Prunus avium, Pyrus communis, and Laurus nobilis reach high occurrence rates in 10–50-year-old residential gardens in both regions. This increase can be associated with the transformation of gardens over time from purely aesthetic spaces into functional and productive areas.

On both sides of the border, an increase in building age is accompanied by an increase in plant species diversity and occurrence rates. In Sarpi–Kvariati–Gonio–Avgia–City Center, the continuity of evergreen and moisture-loving species is maintained in older residential gardens, whereas in Kemalpaşa–Hopa–Arhavi, deciduous, fruit-bearing, and shade-providing species become distinctly prominent in older residences. These trends demonstrate that residential gardens gradually transform from ornamentally oriented uses into spaces with higher functional and ecological value over time. The relationships between building age and plant species occurrence rates indicate that gardens are not static but dynamic, time-dependent landscape systems. While aesthetic priorities dominate in young residences, plant selection in middle-aged and older groups is shaped by usage habits, production needs, and cultural continuity.

These results demonstrate that residential gardens are living components of the cultural landscape and that plant composition is reconfigured in parallel with the aging process of settlements.

Table 4: Relationship between building age and plant species richness in Sarpi–Kvariati–Gonio–Avgia–City Center

Housing Age	Low (%)	Medium (%)	High (%)
0–10 years	62	28	10
10–50 years	24	49	27
>50 years	11	29	**60**
χ^2	significant, $p < 0.01$		

In Sarpi–Kvariati–Gonio–Avgia–City Center, plant species richness increases markedly as building age increases. In particular, the dominance of high species richness in residences older than 50 years clearly reveals the effect of long-term garden use and cumulative plant establishment. Humid subtropical climatic conditions allow species to persist for long periods and enable the composition to become increasingly complex.

Table 5: Relationship between building age and plant species richness in Kemalpaşa–Hopa–Arhavi

Housing Age	Low (%)	Medium (%)	High (%)
0–10 years	**55**	34	11
10–50 years	31	**45**	24
>50 years	19	37	**44**
χ^2	significant, $p < 0.01$		

In Kemalpaşa–Hopa–Arhavi, there is also a statistically significant relationship between housing age and plant species richness. However, compared to Sarpi–Kvariati–Gonio–Avgia–City Center, the rate of reaching high species richness is more limited. This situation can be associated with climatic variability, maintenance practices, and the predominance of functional concerns in species selection. In Sarpi–Kvariati–Gonio–Avgia–City Center, high species richness is much more pronounced in houses older than 50 years, whereas in Kemalpaşa–Hopa–Arhavi there is an increase, but a more balanced and controlled distribution is observed. In both regions, the results of the χ^2 test indicate a significant relationship between housing age and plant species richness. However, the strength and direction of this relationship are more pronounced in Sarpi–Kvariati–Gonio–Avgia–City Center.

Chi-square (χ^2) analyses revealed a statistically significant relationship between housing age and plant species richness both in Sarpi–Kvariati–Gonio–Avgia–City Center (χ^2 test, $p < 0.01$) and in Kemalpaşa–Hopa–Arhavi (χ^2 test, $p < 0.05$). In both regions, plant species richness increased as housing age increased; however, this trend was more pronounced in Sarpi–Kvariati–Gonio–Avgia–City Center, where residential gardens older than 50 years were predominantly characterized by high species richness. This stronger relationship observed in Sarpi–Kvariati–Gonio–Avgia–City Center highlights the role of long-term ecological continuity and favorable climatic conditions in shaping residential garden biodiversity, whereas in Kemalpaşa–Hopa–Arhavi, garden composition appears to be more influenced by functional and management-oriented factors.

Housing age emerges as one of the strongest factors determining plant composition. In the 0–10 year housing group, ornamental, fast-growing, and visually high-value species are dominant in both regions.

Evergreen landscape species are more common in Sarpi–Kvariati–Gonio–Avgia–City Center, while flowering ornamental plants are observed at higher rates in Kemalpaşa–Hopa–Arhavi. In the 10–50 year housing group, species diversity increases markedly, and fruit trees and multi-purpose species become more prominent. The representation rates of the Rosaceae and Oleaceae families increase in both regions. In the >50 year housing group, traditional fruit and shade trees dominate in Kemalpaşa–Hopa–Arhavi, whereas long-lived evergreen and cultural landscape species are dominant in Sarpi–Kvariati–Gonio–Avgia–City Center. This situation indicates that gardens become carriers of cultural heritage over time. χ^2 analyses reveal that the relationship between housing age and species distribution is statistically significant ($p < 0.05$).

Plant Distribution According to Housing Types

High occurrence rates are concentrated in Type 3 and Type 4 housing. Species accumulation is evident in long-used gardens. Due to climatic favorability, exotic and evergreen species are widespread. Fruit-bearing and local species are concentrated in Type 1–2 housing. In Sarpi–Kvariati–Gonio–Avgia–City Center, there is a statistically significant relationship between housing type and plant occurrence rates (χ^2, $p < 0.01$). Housing type is a strong factor determining the ecological evolution of garden structure. Long-term settlement and climatic continuity increase species richness.

Table 6: General Trends in the Concentration of Plant Species According to Housing Types in Sarpi–Kvariati–Gonio–Avgia–City Center

Housing Type	Dominant Plant Groups	Ecological / Spatial Interpretation
Type 1	Fruit trees (Citrus spp., Diospyros kaki), native species	Traditional, production-oriented gardens
Type 2	Broad-leaved trees (Tilia, Acer, Juglans)	Semi-private spaces, shade-oriented use
Type 3	Evergreen shrubs (Buxus, Lauracerasus, Hedera)	Spatial continuity and privacy
Type 4	Exotic & ornamental species (Phoenix, Magnolia, Cycas)	New housing areas, aesthetics-oriented

Table 7: General Trends in the Concentration of Plant Species According to Housing Types in Kemalpaşa–Hopa–Arhavi

Housing Type	Dominant Plant Groups	Ecological / Spatial Interpretation
Type 1	Fruit trees (Malus, Prunus, Pyrus)	Functional, food-based use
Type 2	Deciduous ornamental trees	Controlled landscape preferences
Type 3	Shrubs and climbing species	Adaptation to spatial limitations
Type 4	Limited exotic species	Maintenance and climatic constraints

Species are distributed more evenly among housing types. The proportion of exotic and evergreen species is lower compared to Sarpi–Kvariati–Gonio–Avgia–City Center. Garden composition is largely based on functionality and ease of maintenance. In Kemalpaşa–Hopa–Arhavi, there is a weak to moderate statistically significant relationship between housing type and plant occurrence rates (χ^2, $p < 0.05$). Garden plant selection is shaped mainly by user preferences and maintenance practices. The determining role of housing type is lower compared to Sarpi–Kvariati–Gonio–Avgia–City Center.

While housing type is a strong determinant in shaping garden plant composition in Sarpi–Kvariati–Gonio–Avgia–City Center, plant distribution in Kemalpaşa–Hopa–Arhavi is formed more in line with user preferences, ease of maintenance, and functional requirements. This situation indicates that long-term ecological accumulation and climatic advantages in Sarpi–Kvariati–Gonio–Avgia–City Center play a biodiversity-enhancing role even at the residential scale.

Analyses conducted according to housing type indicate that plant selection is directly related to spatial scale. Species diversity is significantly higher in detached houses with gardens. In multi-storey housing types, evergreen species with low maintenance requirements and adaptability to limited spaces become prominent. While housing type differences in Sarpi–Kvariati–Gonio–Avgia–City Center are particularly effective in the distribution of evergreen species, in Kemalpaşa–Hopa–Arhavi housing type differences have a more pronounced effect on the presence of fruit trees.

Plant Occurrence Rates According to Distance from the Border

On the Sarpi–Kvariati–Gonio–Avgia–City Center side, the occurrence rates of many species (e.g., Hydrangea, Rhododendron, Camellia, Hedera, Juniperus) are markedly higher in the >20 km group. In the 0–10 km band, species diversity and occurrence rates are relatively low. Distribution is not uniform. The χ^2 test is statistically significant for Sarpi–Kvariati–Gonio–Avgia–City Center ($p < 0.01$). As distance from the border increases, urban pressure decreases, microclimatic continuity increases, and garden use duration becomes longer. Therefore, in Sarpi–Kvariati–Gonio–

Avgia–City Center, plant species richness and occurrence rates increase markedly with increasing distance from the border.

For the Kemalpaşa–Hopa–Arhavi side, many species (e.g., Citrus, Rosa, Prunus, Vitis) show higher rates in the 0–10 km band. At distances greater than 20 km, species numbers and occurrence rates decrease, and distribution becomes functional and selective. Species cluster within specific distance classes. The χ^2 test is also significant for Kemalpaşa–Hopa–Arhavi ($p < 0.05$). In areas close to the border, decreasing settlement density and the stronger influence of agricultural–urban transition zones, and in inland areas the reduction in garden scale, affect species diversity.

In Sarpi–Kvariati–Gonio–Avgia–City Center, ecological continuity and climate are the determining factors, whereas in Kemalpaşa–Hopa–Arhavi, socio-economic and use-based factors dominate. Species diversity decreases. As the distance from the border increases, species similarity between the two regions decreases. In the 0–10 km band, similar species and families are more frequently observed in both regions. At distances greater than 20 km, species compositions diverge markedly depending on local climate, culture, and plant supply opportunities. This situation clearly demonstrates that border regions reflect their character as cultural transition zones through plant composition.

Table 8. General Trend of Plant Occurrence Rates According to Distance from the Border

Region	0–10 km	10–20 km	>20 km	χ^2 Sign.	Direction of Effect
Sarpi–Kvariati–Gonio–Avgia–City Center	Medium–High	High	Very High	$p < 0.01$	Species richness and occurrence increase with distance
Kemalpaşa–Hopa–Arhavi	High	Medium	Low–Medium	$p < 0.05$	Species density increases closer to the border

Table 9. Distribution of Species According to Garden Locations

Region	Garden Location	Observed Species Density	Ecological / Spatial Character
Sarpi–Kvariati–Gonio–Avgia–City Center	Front Garden	Medium	Aesthetic, semi-public
	Side Garden	Low–Medium	Transitional space
	Back Garden	High	Natural, productive, semi-natural
Kemalpaşa–Hopa–Arhavi	Front Garden	High	Representative, orderly

	Side Garden	Medium	Circulation
	Back Garden	Medium–Low	Limited use

In Sarpi–Kvariati–Gonio–Avgia–City Center, back gardens are characterized by food production, the conservation of local species, and high species richness supported by spontaneously developing vegetation, whereas in Kemalpaşa–Hopa–Arhavi, front gardens are characterized by representation and aesthetics, planned landscaping, and controlled but limited diversity, with species selection dependent on user preferences.

Table 10. Comparison of Spatial Garden Use

Criterion	**Sarpi–Kvariati–Gonio–Avgia–City Center**	**Kemalpaşa–Hopa–Arhavi**
Dominant Garden	Back garden	Front garden
Species Character	Fruit + local	Ornamental + exotic
Ecological Continuity	High	Medium
Management Intensity	Low	High
χ^2 Significance	$p < 0.01$	$p < 0.05$

The spatial distribution of plants within residential gardens differs statistically by country. In residential areas of Sarpi–Kvariati–Gonio–Avgia–City Center, front gardens function as representational spaces where aesthetic and exotic plant use is concentrated, whereas in Kemalpaşa–Hopa–Arhavi, back gardens have become prominent as zones of vegetative density dominated by food production. This differentiation stems from cultural landscape traditions, socio-economic behavior, and functional differences in garden organization. On both sides of the border, the evaluation of plant species according to their position within the garden reveals that:

• Front gardens are dominated by plants with high aesthetic value, mostly evergreen and ornamental species.

• Back gardens are characterized by fruit-bearing, deciduous, and production-oriented species.

• Side gardens function as transitional spaces between these two usage patterns.

This spatial differentiation clearly demonstrates that gardens are multifunctional cultural landscape units. The findings indicate that the plant composition of residential gardens in Sarpi–Kvariati–Gonio–Avgia–City Center and Kemalpaşa–Hopa–Arhavi is shaped jointly by climatic conditions, cultural practices, the age and type of housing, and spatial usage patterns.

RESULTS AND DISCUSSION

Within the scope of this study, a total of 165 plant species were identified in residential gardens located in Sarpi–Kvariati–Gonio–Avgia–City Center (Georgia) and Kemalpaşa–Hopa–Arhavi, classified under approximately 70 families. This high level of diversity at both species and family scales indicates that residential gardens are not merely aesthetic spaces but also important biological areas shaped at the intersection of cultural practices, ecological processes, and spatial use patterns. Similarly, previous studies have emphasized that residential gardens make significant contributions to urban-scale biodiversity and often harbor more heterogeneous species compositions than public green spaces (Daniels & Kirkpatrick, 2006b; Marco et al., 2010; Cameron et al., 2012; Delahay et al., 2023).

The findings demonstrate that plant species richness and family composition vary significantly depending on housing type, housing age, distance from the national border, and garden location variables. This indicates that species distributions are not random but are closely related to socio-spatial and cultural dynamics (Head & Muir, 2006; Kendal et al., 2012; Keblinska, 2019).

The relationships between plant species richness and occurrence rates based on housing type differ in ways that cannot be evaluated independently of geographical context. In Sarpi–Kvariati–Gonio–Avgia–City Center, species richness shows a clear increasing trend associated with housing types, with particularly high species numbers in detached houses with large gardens and long-term use. This pattern allows residential gardens to mature ecologically over time, supporting plant continuity and natural dispersal processes. Similarly, Marco et al. (2010) and Daniels & Kirkpatrick (2006b) reported higher species diversity in long-term, unfragmented residential gardens, directly linked to ecological continuity.

In contrast, in Kemalpaşa–Hopa–Arhavi, plant species exhibit a more balanced and homogeneous distribution among housing types. This suggests that garden composition is largely shaped by planning, maintenance, and management decisions, with functional and aesthetic preferences prevailing over ecological continuity. Martin et al. (2004) and Zmyslony & Gagnon (1998) demonstrated that in planned settlements with dominant maintenance practices, species diversity tends to be more limited and controlled. Thus, while species richness in Sarpi–Kvariati–Gonio–Avgia–City Center is reinforced by the combined effects of spatial and ecological factors, Kemalpaşa–Hopa–Arhavi exhibits a more fragmented and management-oriented structure.

The relationship between distance from the national border and plant occurrence rates was found to be statistically significant in both regions; however, spatial patterns developed in opposite directions. In Sarpi–Kvariati–Gonio–Avgia–City Center, plant species were concentrated in areas located more than 20 km from the border (χ^2, $p < 0.01$). This indicates that reduced urban pressure strengthens ecological continuity and allows gardens to acquire a more semi-natural character. Similar findings have been reported in studies showing that residential gardens in areas with lower building density provide higher species diversity (Daniels & Kirkpatrick, 2006b; Luck et al., 2009).

In Kemalpaşa–Hopa–Arhavi, plant occurrence rates were predominantly concentrated within the 0–10 km distance band (χ^2, $p < 0.05$). This distribution indicates that intensive land use, regular maintenance practices, and function-oriented garden design play a decisive role in areas close to the border. Yabiku et al. (2008) and Dimitriou & Karatasou (2017) noted that in settlements under intensive use pressure, garden plants are more often selected for aesthetic and representational purposes. These contrasting spatial patterns clearly demonstrate that, despite similar biogeographical conditions, socio-spatial and managerial factors shape garden vegetation in fundamentally different ways.

Garden-scale spatial distributions also reveal a clear divergence between Sarpi–Kvariati–Gonio–Avgia–City Center and Kemalpaşa–Hopa–Arhavi. In Sarpi–Kvariati–Gonio–Avgia–City Center, plant species richness is predominantly concentrated in back gardens, and this distribution is statistically significant (χ^2, $p < 0.01$). The dominance of fruit trees, climbing species, and semi-natural plant communities in back gardens indicates that these areas function as spaces for production, storage, and ecological continuity. This finding aligns with observations by Head & Muir (2006) and Gross & Lane (2007), who emphasized that back gardens are generally less formal and more open to productive uses.

In Kemalpaşa–Hopa–Arhavi, most plant species are concentrated in front gardens, and this distribution is statistically significant (χ^2, $p < 0.05$). The prevalence of ornamental and formally controlled species in front gardens reflects a landscape approach dominated by visibility, representation, and aesthetic concerns. Similarly, Kurz & Baudains (2012) and Zmyslony & Gagnon (1998) identified front gardens as spaces where social representation and aesthetic order are most strongly expressed.

Evaluations at the family level show that Rosaceae, Fabaceae, Cupressaceae, Rutaceae, and Oleaceae are dominant in both regions. However, the usage rates and spatial distributions of these families differ markedly. In Sarpi–Kvariati–Gonio–Avgia–City Center, the high representation of fruit species from Rosaceae and Rutaceae supports the productive and semi-natural character of gardens. This finding is consistent with studies emphasizing the continuity of traditional garden use (Marco et al., 2010; Keblinska, 2019). In Kemalpaşa–Hopa–Arhavi, the concentration of Cupressaceae, Oleaceae, and ornamental shrub families in front gardens reflects more orderly and aesthetic-oriented landscape preferences. Kendal et al. (2012) and Clayton (2007) emphasized that the preference for ornamental and formal species is closely linked to cultural taste and management practices. These results show that family diversity is more evenly distributed across housing types in Sarpi–Kvariati–Gonio–Avgia–City Center, whereas in Kemalpaşa–Hopa–Arhavi, certain families are concentrated within specific housing types.

The relationship between housing age and plant species richness is significant in both regions, although it is stronger in Sarpi–Kvariati–Gonio–Avgia–City Center. In this region, gardens of houses aged 50 years and older exhibit high species richness (χ^2, $p < 0.01$), associated with long-term continuity and greater openness to natural plant dispersal. This finding supports the "garden continuity–species accumulation" relationship highlighted by Head & Muir (2006) and Freeman et al. (2012). In Kemalpaşa–Hopa–Arhavi, although species richness increases with housing age, the relationship is weaker (χ^2, $p < 0.05$). Renovation practices, landscape redesign, and maintenance interventions limit the influence of housing age on species richness. This aligns with previous studies indicating that planned landscape interventions can suppress biological accumulation (Zmyslony & Gagnon, 1998; Cameron et al., 2012).

In conclusion, differences in plant diversity between residential gardens in Sarpi–Kvariati–Gonio–Avgia–City Center and Kemalpaşa–Hopa–Arhavi cannot be explained solely by climatic or geographical conditions. Cultural practices, garden use habits, continuity of ownership, and landscape perceptions play decisive roles in shaping species richness and spatial distribution. While residential gardens in Sarpi–Kvariati–Gonio–Avgia–City Center function as ecologically continuous, productive, and multi-layered systems, gardens in Kemalpaşa–Hopa–Arhavi exhibit a more controlled, planned, and aesthetic-oriented usage pattern. These findings clearly demonstrate that, despite similar biogeographical conditions on both sides of the border, cultural and managerial factors are fundamental determinants in shaping residential garden biodiversity.

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The Role of Material Selection in Landscape Applications on The Ecological Footprint: The Use of Local and Natural Materials

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ABSTRACT

This study presents a conceptual and analytical framework that integrates the ecological footprint and life cycle assessment (LCA) approaches in order to support sustainable material selection in landscape architecture. The research was conducted using a literature review method, examining recent academic studies focusing on sustainability, material selection, locality, and environmental impact. Within the scope of the study, the environmental performance of structural materials used in landscape applications was evaluated under four main criteria: environmental impact, life cycle performance, locality and ecological compatibility, and applicability and socio-economic impact.

While the ecological footprint approach reveals the impact of material use on the planet's biological carrying capacity, the LCA method enables the analysis of the life cycle stages at which this impact is concentrated. Considering these two approaches together has made it possible to address material selection in landscape architecture as both a strategic evaluation process at the macro scale and a technical evaluation process at the micro scale. Although local and natural materials generally exhibit an advantageous profile in terms of low embodied energy, short transportation distances, and ecosystem compatibility, the study demonstrates that their life cycle performance may vary depending on maintenance requirements and conditions of use.

The main outcome of the study is the development of a multi-criteria decision matrix model for sustainable landscape material selection. This model allows material alternatives to be evaluated in a context-sensitive, comparable, and transparent manner, providing an applicable decision-support tool for landscape architects and local authorities. In conclusion, the study proposes a holistic and context-based evaluation approach by moving sustainable material selection in landscape architecture beyond single indicators and offers a conceptual contribution to the literature.

Keywords – Sustainable landscape, material selection, ecological footprint, life cycle assessment (LCA), local and natural materials, decision matrix

INTRODUCTION

Urbanization, which accelerated with the industrialization process, together with population growth and changing consumption patterns, has historically increased the pressure on natural resources to an unprecedented level (Steffen et al., 2015; UNEP, 2019). While humanity has intensively consumed the limited resources provided by nature in order to meet its needs, the regenerative capacity of ecosystems, their carrying limits, and long-term environmental impacts have often been overlooked. This situation has led to multidimensional environmental problems such as the loss of biodiversity, the destruction of natural habitats, and the global intensification of climate change (IPCC, 2022).

From the second half of the twentieth century onward, the increasing visibility of environmental problems has paved the way for the development of conceptual and measurable approaches that reassess the nature–human relationship. In this context, the ecological footprint approach has emerged as a holistic indicator that quantitatively reveals the pressure of human activities on nature through biologically productive land and water areas (Lin et al., 2018; Global Footprint Network, 2022).

The ecological footprint approach enables the evaluation not only of the amount of consumption but also of whether this consumption is compatible with the planet's carrying capacity (Fang et al., 2015). As a method applicable at individual, household, urban, and national scales, it allows the environmental implications of food, energy, housing, transportation, and waste generation to be analyzed in an integrated manner (Wiedmann & Lenzen, 2018).

The Living Planet Reports published by WWF reveal that, at a global scale, humanity's ecological footprint exceeds the planet's biological capacity. Current data indicate that if existing consumption trends continue, humanity will require the biocapacity of more than one planet (WWF, 2022).

The ecological footprint is an important assessment tool not only at global and national scales but also in the context of urban areas and the built environment. It is emphasized that the ecological footprints of cities extend far beyond their administrative boundaries, becoming dependent on areas many times larger than their own biological capacities (Goldfinger et al., 2017; Özdamar & Yiğit, 2024).

At this point, landscape architecture, owing to its interdisciplinary structure that holistically addresses the relationship between nature, humans, and space, has the potential to develop strategies aimed at reducing the ecological footprint (Musacchio, 2016; Thompson & Sorvig, 2018). Hardscape surfaces, structural elements, and site furnishings used in landscape applications play a decisive role in terms of natural resource consumption and long-term environmental impacts.

Material selection in landscape architecture should be evaluated through life cycle parameters such as raw material extraction, production processes, transportation distances, service life, maintenance requirements, and end-of-life scenarios (Cabeza et al., 2017; Buyle et al., 2019). In particular, the intensive use of building components with high embodied energy, such as concrete, steel, and synthetic materials, increases the carbon and ecological footprints of landscape applications (Ramesh et al., 2015).

This situation brings the importance of using local and natural materials in landscape architecture to the forefront. Preferring local materials not only reduces transportation-related energy consumption and carbon emissions but also contributes to strengthening regional identity and ecological compatibility (Pacheco-Torgal, 2017). However, the assumption that every local or natural material automatically has a low environmental impact is not scientifically valid; the environmental performance of materials should be analyzed using objective methods such as life cycle assessment (LCA) (Dodoo et al., 2018; Fang et al., 2015).

A review of the literature shows that studies addressing the relationship between material selection and sustainability in landscape architecture are predominantly based on carbon footprint and LCA approaches, while studies that place the ecological footprint concept directly at the center remain limited. This situation reveals the need for research that holistically addresses the ecological footprint perspective in the context of landscape materials.

MATERIAL SELECTION IN LANDSCAPE ARCHITECTURE IN THE CONTEXT OF SUSTAINABILITY

The concept of sustainability in landscape architecture is addressed not merely as an approach focused on environmental protection, but within the broader context of the continuity of ecological processes, the conservation of natural resources, and the balancing of human–nature interactions (Kibert, 2016; Thompson & Sorvig, 2018). Materials used in landscape design and implementation are directly related to sustainability goals due to their multi-layered impacts, ranging from production processes to modes of use and long-term environmental effects. Therefore, material selection is defined as one of the fundamental decision-making areas in which the sustainability approach in landscape architecture is concretized (Atabeyoğlu & Uzun, 2020).

Structural and semi-structural materials widely used in landscape applications create significant environmental burdens in terms of energy consumption, carbon emissions, and natural resource use. In the literature, sustainable material selection is defined as an approach that necessitates the preference for materials with low embodied energy, long service life, limited maintenance requirements, and the ability to be removed from the system at the end of their life cycle without causing environmental harm (Eş, 2008; Şen, Kaya & Alpaslan, 2018). In this context, sustainability is directly associated with material decisions made at the early stages of the design process, and it is emphasized that these decisions determine the overall environmental performance of landscape applications (Çetinkaya, 2025).

Within the context of sustainability, material selection is considered one of the most critical decision areas for reducing environmental impacts in landscape architecture. Numerous studies have demonstrated that structural and semi-structural materials used in open spaces have direct effects on energy consumption, carbon emissions, water management, and ecosystem integrity (Kibert, 2016; Thompson & Sorvig, 2018). Therefore, material selection in the landscape design process is addressed not merely as a technical choice based on aesthetic and cost criteria, but as a strategic design decision that determines long-term environmental performance (Yılmaz & Bulut, 2007).

The literature on landscape architecture emphasizes that environmental, economic, and social dimensions should be evaluated together in sustainable material selection (Yılmaz & Bulut, 2007; Atabeyoğlu & Uzun, 2020). Especially in urban areas, hardscape surfaces, site furnishings, and infrastructure components play a decisive role in urban heat island effects, stormwater runoff, and carbon emissions (Şen et al., 2018). In this regard, a sustainable material approach necessitates the integration of ecological performance into the design process at an early stage.

Today, global challenges such as climate change, environmental degradation, rapid depletion of natural resources, and intensive urbanization have made the adoption of sustainable design approaches in urban areas inevitable. This process places pressure on the carrying capacity of urban ecosystems and increases the need for design strategies that are compatible with natural systems and reduce environmental impacts (Kibert, 2016; Thompson & Sorvig, 2018).

In this context, landscape architecture stands out as a discipline with a holistic approach that integrates ecological balance while simultaneously addressing environmental, social, and economic dimensions. Landscape architecture is not limited to producing aesthetic and functional spaces; it aims to enhance the ecological resilience of cities through design decisions that take natural processes into account and promote harmony with ecosystems (Yılmaz & Bulut, 2007).

It is a commonly accepted approach in the sustainability literature that the production processes, service life, maintenance requirements, and disposal potential of structural materials used in landscape design should be evaluated together (Atabeyoğlu & Uzun, 2020). Within this framework, sustainable material selection is grounded in principles such as the conservation of natural resources, energy efficiency, low environmental impact, and circularity (Eş, 2008; Şen et al., 2018).

Life Cycle Assessment (LCA) is one of the fundamental tools that enables the objective and comparable evaluation of the environmental impacts of materials used in landscape applications (Bruno et al., 2025). Therefore, material selection in sustainable landscape design is considered a conscious and strategic decision-making process aimed at minimizing environmental impacts.

ECOLOGICAL FOOTPRINT AND LIFE CYCLE ASSESSMENT (LCA)

The ecological footprint (EF) and life cycle assessment (LCA) are addressed as two fundamental approaches that operate at different scales yet complement each other in sustainability discussions. While the ecological footprint enables the holistic and measurable assessment of the overall pressure exerted by human activities on nature through biologically productive land and water areas, LCA reveals in a detailed and quantitative manner the specific production, use, and end-of-life processes in which this pressure is concentrated (Rees & Wackernagel, 1996; Fang et al., 2015).

The ecological footprint approach stands out particularly as a consumption-based indicator due to its flexibility in being applied at different levels, ranging from individuals to cities, regions, and the global scale (Lin et al., 2018; Global Footprint Network, 2022). In this respect, the ecological footprint makes visible that design and material decisions taken in landscape architecture are not limited to the project site alone, but generate environmental impacts across a wide geography, from raw material extraction to production and transportation processes (Wiedmann & Lenzen, 2018). The literature emphasizes that urban areas, in particular, consume resources far beyond their own biological capacities, posing serious risks in terms of urban sustainability (Goldfinger et al., 2017; Özdamar & Yiğit, 2024).

Life cycle assessment (LCA), on the other hand, is primarily considered a product- and material-oriented technical evaluation tool in sustainability analyses. The LCA approach enables the quantitative assessment of environmental impacts occurring at each stage of a material's life cycle, including raw material extraction, production, transportation, use, maintenance, and end-of-life phases (ISO 14040; Cabeza et al., 2017). Through this approach, it becomes possible to demonstrate that some materials, which may appear to have low environmental impacts during the production stage, can increase the overall environmental burden during their use and maintenance phases (Buyle et al., 2019).

In the context of landscape architecture, basing sustainable material selection solely on LCA data or exclusively on ecological footprint indicators may lead to incomplete and misleading outcomes. Therefore, the literature emphasizes that the ecological footprint provides a more strategic and conceptual framework, whereas LCA should be used as a complementary tool within this framework to support technical, comparative, and implementation-oriented decisions (Fang et al., 2015; Laurent et al., 2019).

In landscape architecture, the ecological footprint makes the total environmental burden of urban open spaces and landscape applications visible at a conceptual level, while LCA enables the comparison of the environmental performance of alternative materials throughout their life cycles (Thompson & Sorvig, 2018; Bruno et al., 2025). For this reason, it is recommended that the ecological footprint approach be used during strategic planning and policy development stages, while LCA be employed during detailed design and implementation phases (Hammond, 2006; Atabeyoğlu & Uzun, 2020). The comparative tables presented in this study systematically demonstrate the complementary roles of these two approaches within the landscape design process.

Ecological Footprint (EF) and Life Cycle Assessment (LCA) are addressed as complementary tools in sustainability analyses (ISO 14040).

Table 1: Comparison of Environmental Characteristics of Structural Material Types

Material Type	**Embodied Energy**	**Transportation Impact**	**Recyclability**	**Ecological Compatibility**
Natural stone	Medium	Low (local sourcing)	Medium	High
Concrete	High	Medium	Low–Medium	Low
Wood	Low–Medium	Low	High	High
Recycled materials	Low	Variable	High	Medium–High

(*Source:*Ashby et al., 2009; Donnelly et al., 2006; *Ahmed et al., 2023*)

EVALUATION OF LOCAL AND NATURAL MATERIALS IN THE CONTEXT OF ECOLOGICAL FOOTPRINT

The use of local and natural materials is regarded as one of the fundamental components of sustainable landscape design. The literature emphasizes that materials used in landscape applications should be evaluated not only in terms of their aesthetic and functional properties, but also together with the environmental impacts they generate throughout their production, transportation, and use processes (Thompson & Sorvig, 2018; Atabeyoğlu & Uzun, 2020). In this context, it is particularly stated that the environmental impacts of material production and transportation processes are often overlooked during the design process; however, these processes play a decisive role in the total ecological footprint (Wiedmann & Lenzen, 2018).

The preference for local materials is defined as an important strategy that contributes to reducing energy consumption and carbon emissions by shortening transportation distances. It is frequently emphasized in the literature that transportation-related greenhouse gas emissions constitute a significant portion of the total carbon footprint in building and landscape projects; therefore, the use of local resources significantly improves environmental performance (Cabeza et al., 2017; Özdamar & Yiğit, 2024). This approach forms one of the main foundations of the “locality and ecological compatibility” main criterion in the decision matrix model.

Natural materials are generally considered advantageous in terms of sustainability due to their low level of processing and their ability to be more easily integrated into biological cycles. It is stated that natural stone, wood, and earth-based materials are widely preferred in landscape applications in terms of long service life, adaptation to local climatic conditions, and environmental integrity (Thompson & Sorvig, 2018). However, it is also emphasized that these materials do not always generate low environmental impacts under all conditions; in particular, production methods, extraction processes, and maintenance requirements significantly affect their overall environmental performance (Bribián et al., 2011; Buyle et al., 2019).

Current literature clearly demonstrates that being of local or natural origin alone is not sufficient for sustainability. For example, it is emphasized that local natural stone materials can cause habitat loss, soil degradation, and landscape disturbance during quarrying operations, while wood materials may generate high environmental burdens due to production processes that do not comply with sustainable forestry principles (Cabeza et al., 2017). This situation reveals that local and natural materials must necessarily be evaluated within the framework of the ecological footprint together with a life cycle assessment (LCA) perspective. This approach directly corresponds to the "life cycle performance" main criterion included in the decision matrix model.

It is also emphasized that the relationship established by local and natural materials with ecosystems involves not only physical but also cultural and spatial dimensions. The use of local materials contributes to establishing visual and cultural continuity between the landscape and its surrounding environment, while also supporting the preservation of local knowledge, traditional production practices, and regional identity (Thompson & Sorvig, 2018; Gültekin & Çelebi, 2022). In this respect, local and natural materials serve not only to reduce the ecological footprint but also to strengthen local identity in landscape design.

The comparative evaluation of local and natural materials in terms of embodied energy, transportation impacts, and ecological footprint potential necessitates the use of measurable and comparable criteria rather than intuitive preferences. Tables 2 and 3 presented in this study clearly demonstrate the importance of this multidimensional approach in material selection. The literature indicates that shortening transportation distances has a direct reducing effect on energy consumption and carbon emissions; therefore, the use of local resources is considered one of the most effective strategies in sustainable landscape design (Cabeza et al., 2017; Wiedmann & Lenzen, 2018).

Natural materials generally offer significant sustainability potential due to their low levels of processing, biodegradability, and lower environmental damage at the end of their life cycle. Nevertheless, the literature reveals that not every natural material automatically has a low ecological footprint; rather, production methods, service life, maintenance requirements, and reuse or recycling potential determine the total environmental impact (Bribián et al., 2011; Buyle et al., 2019). This situation further increases the importance of the comparative evaluations presented in Tables 2 and 3 and of the developed decision matrix model.

In conclusion, local and natural materials offer significant advantages in landscape design in terms of reduced transportation distances, ecosystem compatibility, and contextual sustainability. However, the transformation of these advantages into actual sustainability performance depends on the holistic and comparative evaluation of the environmental impacts exhibited by materials throughout their life cycle. This approach constitutes the theoretical and methodological foundation of the sustainable landscape material selection decision matrix developed in this study.

Table 2: Comparison of Ecological Footprint and Life Cycle Assessment (LCA) Approaches

Criterion	Ecological Footprint (EF)	Life Cycle Assessment (LCA)
Scale	Global – local	Product / material
Primary output	Biologically productive area (gha)	CO_2 emissions, energy use, water consumption, etc.
Focus	Consumption patterns and carrying capacity	Production processes and process efficiency
Comparability	High (country-, city-level comparisons)	High (product-based comparisons)
Contribution to landscape applications	Strategic planning and policy decisions	Technical material selection and design decisions

Source: Chambers et al., 2000; ISO 14040; Hammond, 2006

Table 3: Ecological Footprint–Related Characteristics of Local and Natural Landscape Materials

Material Type	Source	Embodied Energy	Transportation Impact	Ecological Footprint Potential
Local natural stone	Regional	Medium	Low	Low–Medium
Local timber	Renewable	Low	Low	Low
Soil / adobe	Local	Very low	Very low	Very low
Conventional concrete	Industrial	High	Medium	High

Source: Ashby et al., 2009; Ahmed et al., 2023; Bruno et al., 2025

COMPARATIVE EVALUATION OF STRUCTURAL MATERIALS IN LANDSCAPE ARCHITECTURE WITHIN THE CONTEXT OF ENVIRONMENTAL IMPACT

The view that the environmental impacts of structural materials used in landscape architecture cannot be evaluated through a single indicator is widely accepted in contemporary sustainability literature. It is emphasized that there is often no direct correspondence between traditional technical criteria such as structural durability, maintenance requirements, and mechanical performance, and environmental indicators such as carbon footprint, energy consumption, and ecological compatibility (Cabeza et al., 2017; Buyle et al., 2019). Therefore, conducting multidimensional and comparative evaluations in material selection is considered a mandatory approach for sustainability in landscape architecture (Atabeyoğlu & Uzun, 2020).

"Material – LCA – Ecological Footprint" comparisons reveal that the environmental performance of materials varies across different life cycle stages. The literature indicates that industrial and cement-intensive materials such as concrete and asphalt exhibit unfavorable environmental profiles, particularly during the production phase, due to high energy consumption and carbon emissions (Miller et al., 2016; Hammond & Jones, 2018). However, these materials may offer certain long-term environmental advantages during the use phase due to their high durability and low maintenance requirements.

Although wood- and earth-based materials demonstrate relatively low energy consumption and carbon emissions during the production phase, their total life cycle impacts may increase depending on usage and maintenance conditions. In particular, factors such as humidity, climatic conditions, and intensive use are emphasized as increasing maintenance requirements and, consequently, the environmental burden of these materials (Bribián et al., 2011). This situation highlights the critical importance of a life cycle perspective in the evaluation of landscape materials.

The comparative table of structural material properties clearly emphasizes the importance of criteria such as water permeability and urban heat island effect in sustainability assessments. It is frequently stated in the literature that impermeable surfaces increase stormwater runoff in urban areas and raise surface temperatures, thereby causing negative impacts on the urban microclimate (Santamouris, 2015; EPA, 2021). In this context, permeable pavement systems, natural surfaces, and semi-permeable materials offer significant advantages not only in terms of ecological footprint but also with respect to urban ecosystem services and climate adaptation strategies (Berardi et al., 2014; Gültekin & Çelebi, 2022).

The carbon footprint comparison graph serves as a visual summary of the theoretical framework presented in this study. The graph clearly shows that fossil fuel–based, cement-intensive, and high embodied-energy materials exhibit significantly higher carbon emissions, whereas biologically based, local, and minimally processed materials have lower carbon footprints. This finding supports recent LCA studies that highlight the decisive role of material origin and production methods in determining environmental performance (Cabeza et al., 2017; Wiedmann & Lenzen, 2018).

The impact diagram according to LCA stages makes visible the life cycle phases in which environmental burdens are concentrated. In particular, it is stated that the transportation phase significantly differentiates the environmental impacts of local and imported materials, while biodegradable or recyclable materials offer substantial advantages at the end-of-life stage (Buyle et al., 2019; Bruno et al., 2025). These analyses clearly demonstrate that material selection in sustainable landscape design cannot be reduced solely to the production phase; rather, all stages of the life cycle must be evaluated together.

Comparative analyses aim to evaluate the environmental performance of structural materials commonly used in landscape architecture in a multidimensional manner. The joint consideration of criteria such as structural durability, maintenance requirements, water permeability, and heat island effect indicates that single performance indicators are insufficient for sustainability assessments (Berardi et al., 2014; Santamouris, 2015). This approach constitutes the theoretical foundation of the "environmental impact" and "life cycle performance" main criteria included in the developed decision matrix model.

The literature emphasizes that industrial materials with high durability often exhibit high carbon footprints and low ecological compatibility, whereas natural and local materials can provide adequate functionality with lower environmental impacts (Atabeyoğlu & Uzun, 2020; Gültekin & Çelebi, 2022). In this context, the presented carbon footprint comparison graph and the impact diagram according to LCA stages clearly reveal the life cycle stages at which landscape materials generate environmental burdens, thereby supporting the necessity of a multi-criteria evaluation approach for sustainable material selection.

Comparison of Structural Material Properties – Carbon Footprint Comparison Graph – Impact Diagram According to LCA Stages

It is frequently emphasized in the literature that uniform and universal material solutions in landscape applications generate various ecological and spatial problems, whereas material choices sensitive to local conditions and environmental limits significantly enhance sustainability performance (Thompson & Sorvig, 2018; Kibert, 2016). In this context, the approach presented in Table 4 goes beyond being a simple inventory that classifies materials solely according to technical properties, and highlights the necessity of structuring it as a multidimensional evaluation tool that guides designers in the decision-making process.

In Table 4, different material types—such as local natural stone, local wood, earth-based materials, and biologically based innovative materials—are addressed together with their ecological advantages, limitations, and appropriate areas of use. This thematic approach demonstrates that material performance in sustainable landscape design cannot be explained solely by technical criteria such as durability or maintenance requirements; rather, context-appropriate use is the key determinant of total ecological footprint (Ashby et al., 2009; Atabeyoğlu & Uzun, 2020). For example, local natural stone can provide long-term environmental advantages due to its high mechanical strength and long service life; however, it is emphasized that environmental impacts arising from extraction processes, quarry operations, and labor requirements must be evaluated from a life cycle perspective (Gültekin & Çelebi, 2022).

Wood- and earth-based materials are highlighted in terms of sustainability due to their low embodied energy and relatively easy integration into biological cycles (Bribián et al., 2011; Van der Ryn & Cowan, 1996). Nevertheless, it is emphasized in the text that inappropriate use in relation to water exposure and climatic conditions may increase maintenance requirements. Particularly in humid climates or areas subjected to intensive use, frequent maintenance of wood- and earth-based materials can increase the total life cycle environmental burden (Bruno et al., 2025). This situation reveals that the "limitations" heading in Table 4 constitutes a critical component of sustainability assessments.

Biological waste–based innovative materials, especially mycelium-based products, are addressed in the literature as experimental and innovative solutions due to their low carbon footprint and circular economy potential (Jones et al., 2020; Attias et al., 2021). Although these materials exhibit very low environmental impacts, the text indicates that they have limitations in terms of structural strength, resistance to external factors, and long-term durability. Therefore, in the thematic evaluation, these materials are considered more suitable for temporary structures, installations, and low-load landscape applications rather than permanent and high-load-bearing elements. This approach demonstrates that sustainability should be considered not only in terms of reducing environmental impact, but also in relation to functional suitability.

Sustainable landscape material selection is not a universal search for a single "best" material, but rather a set of conscious choices that vary according to context, intended use, and life cycle performance (Thompson & Sorvig, 2018). Table 4 systematizes and renders this multidimensional decision-making process comparable, enabling designers to make measurable and justifiable choices instead of relying on intuitive preferences.

This thematic evaluation focusing on local and natural materials reveals that material selection in landscape applications should be addressed not only through technical performance, but also through ecological compatibility, contextual integrity, and local identity. The literature emphasizes that local stone, wood, earth, and biologically based innovative materials offer ecosystem-supportive, low-carbon, and context-sensitive solutions (Gültekin & Çelebi, 2022; Yılmaz & Bulut, 2007).

In this context, the thematic evaluation presented in Table 4 enables designers to make context-specific and sustainable decisions by jointly addressing the ecological advantages and limitations of each material type. This approach clearly demonstrates that sustainability is not a universal and singular prescription, but rather a multi-criteria, context-sensitive, and locally responsive decision-making process.

Table 4: Comparative Material – LCA – Ecological Footprint Table

Material Type	**Raw Material Source**	**LCA (Life Cycle Assessment)**	**Ecological Footprint Level**	**Evaluation for Landscape Use**
Natural Stone (local)	Local quarries	Low energy requirement in production; long service life; low maintenance needs	Low	Durable, aesthetic, and long-lasting; carbon emissions are reduced when locally sourced
Natural Stone (imported)	Distant sources	High energy consumption and CO_2 emissions during transportation	Medium–High	Provides visual diversity, but increases carbon footprint
Wood (local, certified)	Renewable natural resource	Low production energy; biodegradable; requires maintenance	Low	High ecological compatibility; regular maintenance is essential
Wood (imported / uncertified)	Forest resources	Risk of deforestation; high transport-related emissions	Medium	Should be used in a controlled manner due to ecological risks
Concrete (conventional)	Cement, aggregates	High energy consumption	High	Durable but environmentally

		and high CO_2 emissions during production		unfavorable in terms of sustainability
Permeable Concrete	Cement + porous structure	High production impact; contributes to the water cycle during use	Medium	Advantageous for sponge city approaches
Asphalt	Petroleum derivatives	Non-renewable resource; high emissions during production and use	High	Increases urban heat island effect; not recommended
Recycled Plastic	Plastic waste	Reduces raw material consumption; moderate production energy	Medium	Durable and low-maintenance; microplastic risks should be considered
Brick / Clay-Based Materials	Natural clay	High energy demand during firing; long service life	Medium	Compatible with traditional textures and contexts
Stabilized Earth Paths	Local soil	Minimal processing; very low energy consumption	Very Low	Ideal for natural areas and rural landscapes
Mycelium (fungal-based)	Biological waste + fungi	Very low energy demand; biodegradable	Very Low	Innovative and experimental; limited structural strength
Grass Pavers / Grass Grid Systems	Concrete + vegetation	Moderate production impact; provides ecological benefits during use	Medium	Enhances water permeability and continuity of green spaces

Source: Chambers et al., 2000; Rapport, 2000; ISO 14040; Hammond, 2006; Ashby et al., 2009; Kibert, 2016; Ahmed et al., 2023; Bruno et al., 2025

SUSTAINABLE LANDSCAPE MATERIAL SELECTION DECISION MATRIX

The complexity of sustainable material selection, which cannot be reduced to single-dimensional environmental indicators, is widely acknowledged in the literature. Particularly in landscape applications, it is emphasized that the environmental impacts of materials are not limited to the production phase alone; rather, impacts occurring throughout the entire life cycle—from raw material extraction and transportation processes to use, maintenance, and end-of-life scenarios—must be evaluated together with local context and application conditions (ISO 14040; Bribián et al., 2011). This perspective clearly reveals the need for a holistic, comparable, and systematic evaluation tool for sustainable landscape material selection.

In this context, the sustainable landscape material selection decision matrix model has been developed based on four main criteria: environmental impact, life cycle performance, locality and ecological compatibility, and applicability and socio-economic impact. The structure of the model is grounded in approaches emphasizing that sustainability discussions in landscape architecture should not rely solely on environmental indicators, but should also integrate technical, contextual, and social dimensions (Kibert, 2016; Thompson & Sorvig, 2018).

The "environmental impact" main criterion in the model is based on ecological footprint and carbon footprint approaches. Greenhouse gas emissions, energy and water consumption caused by materials during production, transportation, and application processes, as well as the impacts of surfaces on microclimate, are considered among the primary environmental indicators of sustainable landscape design decisions (Rees & Wackernagel, 1996; Hammond, 2006). Accordingly, carbon footprint, energy consumption, water use, and urban heat island effect have been structured as sub-criteria under the environmental impact category. The literature particularly emphasizes the decisive role of hard surfaces and structural elements on urban microclimate and stormwater management (Şen et al., 2018).

The "life cycle performance" main criterion is based on the life cycle assessment (LCA) approach. It is stated that the environmental performance of a material cannot be evaluated solely based on the initial production stage; rather, durability, maintenance requirements, and impacts occurring throughout the service life determine the total environmental burden (ISO 14040; Bribián et al., 2011). Accordingly, durability, maintenance requirements, recycling or disposal potential, and service life impact have been defined as sub-criteria representing life cycle performance. Turkey-focused studies also demonstrate that maintenance frequency and service life significantly affect the environmental impact of landscape materials (Atabeyoğlu & Uzun, 2020).

The "locality and ecological compatibility" main criterion is based on theoretical and applied evaluations related to the use of local and natural materials. The literature emphasizes that local availability reduces transportation-related energy consumption and carbon emissions, while natural and renewable resources provide solutions that are more compatible with ecosystems (Van der Ryn & Cowan, 1996; Gültekin & Çelebi, 2022). Furthermore, the interaction of materials with soil, water, and vegetation systems is considered critical for the ecological integrity of landscapes (Yılmaz & Bulut, 2007). Therefore, local sourcing level, natural resource characteristics, and ecosystem compatibility have been structured as sub-criteria under this main category.

The "applicability and socio-economic impact" main criterion is based on the understanding that sustainability must be addressed not only environmentally but also economically and socially. It is stated that many materials considered environmentally appropriate in landscape projects cannot be implemented in practice due to cost, technical feasibility, or local production conditions (Kibert, 2016; Thompson & Sorvig, 2018). This situation highlights the necessity for sustainable design decisions to be realistic, applicable, and compatible with local conditions. In this context, cost level, ease of application, and contribution to the local economy have been included in the model as sub-criteria representing the socio-economic dimension. Thesis studies conducted in Türkiye also indicate that local production and employment are important decision criteria in sustainable landscape applications (Ahmed et al., 2023).

In conclusion, the developed decision matrix model has been designed as a holistic synthesis of the ecological footprint approach, life cycle assessment, the use of local and natural materials, and contextual sustainability discussions presented in the Word document. The model aims to transform material selection in landscape architecture from intuitive preferences into a multi-criteria and comparable evaluation process. In this respect, the decision matrix provides a systematic and transferable sustainable material selection tool for both academic studies and practice-oriented landscape projects.

The developed sustainable landscape material selection decision matrix represents a synthesis of the theoretical framework and comparative analyses presented in previous sections. Multi-criteria evaluation approaches proposed in the literature for sustainable material selection constitute the main methodological foundation of this model (Kibert, 2016; Bribián et al., 2011). Through environmental impact, life cycle performance, locality, and applicability criteria, the decision matrix enables a holistic evaluation of materials and aims to make visible the common dilemma in landscape architecture between "environmentally sound but impractical" and "practical but environmentally impactful" materials.

Decision Matrix – Table of Main Criteria and Sub-Criteria

Table 5: Sustainable Landscape Material Selection – Decision Matrix Criteria

Main Criterion	Code	Sub-Criterion	Scope / Description
A. Environmental Impact	A1	Carbon Footprint	CO_2 emissions generated during production, transportation, and implementation processes
	A2	Energy Consumption	Total energy consumed during material production
	A3	Water Consumption	Amount of water consumed during production and use phases
	A4	Urban Heat Island Effect	Degree to which the surface contributes to the urban heat island effect
B. Life Cycle Performance (LCA)	B1	Durability	Physical and structural service life
	B2	Maintenance Requirement	Frequency and intensity of maintenance during use
	B3	Recycling / Disposal	Reuse, recyclability, or biodegradability potential
	B4	Service Life Impact	Long-term environmental impact and performance continuity
C. Locality and Ecological Compatibility	C1	Level of Local Sourcing	Availability of the material from local or regional sources
	C2	Natural Resource Character	Renewable or natural origin of the material
	C3	Ecosystem Compatibility	Level of interaction with soil, water, and vegetation systems
D. Applicability and Socio-Economic Impact	D1	Cost Level	Initial investment and life-cycle cost
	D2	Ease of Implementation	Technical feasibility, labor requirements, and construction process
	D3	Contribution to Local Economy	Potential to support local production, employment, and economy

RESULTS AND DISCUSSION

This study addresses sustainable material selection in landscape architecture by integrating ecological footprint and life cycle assessment (LCA) perspectives, with a particular focus on the environmental performance of local and natural materials within a conceptual and comparative framework. Conducted through a literature-based review approach, the study demonstrates that sustainability should not be evaluated solely through singular indicators such as low carbon emissions or energy efficiency, but rather as a multi-criteria decision problem in which environmental, ecological, and socio-economic dimensions are jointly considered.

The findings indicate that the ecological impacts of structural materials commonly used in landscape applications cannot be explained solely through traditional criteria such as technical durability and cost. While the ecological footprint approach makes visible the pressure of material consumption on the planet's biological carrying capacity, the LCA method reveals the specific life cycle stages in which this pressure is concentrated. Considering these two approaches together enables material selection in landscape architecture to be evaluated at both strategic (macro-scale) and technical (micro-scale) levels.

Comparative tables and thematic analyses show that local and natural materials generally exhibit lower embodied energy, shorter transportation distances, and higher levels of ecological compatibility. Local natural stone, local wood, and earth-based materials present an advantageous profile in terms of ecological footprint due to their longevity, relatively low maintenance requirements, and ecosystem compatibility. However, as emphasized in the study, this does not imply that every material of local or natural origin is automatically sustainable. In particular, maintenance requirements and usage conditions of some natural materials, such as wood, may increase total environmental impact over the life cycle. This finding clearly demonstrates that sustainability assessments must be sensitive to context and usage scenarios.

Industrial and cement-based materials (such as conventional concrete and asphalt) stand out with negative environmental indicators including high embodied energy, intensive carbon emissions, and urban heat island effects. Nevertheless, hybrid solutions such as permeable concrete and grass grid systems can provide more balanced environmental performance by offering benefits in water management and surface permeability during the use phase, despite their relatively high impacts during production. This highlights that the LCA approach should not be limited to the production phase alone, and that use and maintenance stages are also decisive in decision-making processes.

One of the key outputs of the study is the multi-criteria decision matrix model developed for sustainable landscape material selection. The model consists of four main criteria: environmental impact, life cycle performance, locality and ecological compatibility, and applicability and socio-economic impact. Its structure aligns with fundamental principles emphasized in the literature on sustainable building and landscape design, enabling systematic, comparable, and transparent evaluation of different material alternatives. In this respect, the decision matrix serves not only as a theoretical framework but also as a practical decision-support tool for landscape architects and local authorities.

From a discussion perspective, the primary contribution of the study lies in framing sustainable material selection in landscape architecture not as a search for the "best material," but as a problem of identifying the "most appropriate contextual solution." Variables such as climatic conditions, usage intensity, maintenance capacity, local production potential, and socio-economic conditions can cause the same material to exhibit different environmental performances in different contexts. Therefore, instead of uniform or universal material prescriptions, context-sensitive and multi-criteria evaluation approaches should be adopted.

In the context of Türkiye, the study indicates that local and natural materials have significant potential in sustainable landscape applications; however, this potential is often underutilized due to concerns related to cost, ease of application, and standardization. The decision matrix model developed in this study is expected to contribute to the stronger integration of environmental performance into decision-making processes, particularly in public projects and municipal applications.

In conclusion, this study provides a conceptual and methodological framework for sustainable material selection in landscape architecture by holistically integrating ecological footprint and LCA approaches. Future research that weights the proposed model with quantitative data, tests it across different climatic regions and usage scenarios, and supports it with applied case studies would offer significant contributions to both the academic literature and professional practice. In this respect, the study serves as a reference that supports both theoretical discussions and application-oriented decision-making processes in sustainable landscape design.

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