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The Influence of Land Topography on Landscape Architecture through Several Views

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Abstract

This research focuses on the different relationship between land topography and landscape architecture, examining how natural terrain influences design decisions, spatial organization, and overall landscape quality. The study evaluates the effectiveness of topographic analysis techniques and their implications for the practice and education of landscape architecture. Findings indicate that land topography significantly shapes design processes and outcomes, highlighting the importance of integrating topographic considerations into landscape architecture practice. Practical recommendations are offered to enhance the integration of land topography into design practice, with a focus on contextually sensitive approaches and sustainable landscape practices. Furthermore, the research identifies challenges and opportunities in landscape architecture education related to the incorporation of topographic analysis. The research aims to contribute to the creation of resilient and harmonious landscapes that enrich human experience and support ecological integrity, thereby fostering a culture of innovation within the landscape architecture profession.

Keywords: Landscape architecture. Land topography. Design decisions. Sustainability

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تأثير تضاريس الأرض على الهندسة المعمارية للمناظر الطبيعية من خلال منظورات متعددة الأوجه

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ملخص:
تركز هذه الدراسة على العلاقة متعددة الأوجه بين تضاريس الأرض والهندسة المعمارية للمناظر الطبيعية، حيث تبين كيفية تأثير التضاريس الطبيعية على قرارات التصميم، وتنظيم المساحات، وجودة المناظر الطبيعية العامة. تقوم الدراسة بتقييم فعالية تقنيات تحليل التضاريس وتداعياتها على ممارسة وتعليم الهندسة المعمارية للمناظر الطبيعية. تشير النتائج إلى أن تضاريس الأرض تؤثر بشكل كبير على عمليات التصميم والنتائج، مما يسلط الضوء على أهمية دمج الاعتبارات التضاريسية في ممارسة الهندسة المعمارية للمناظر الطبيعية. يتم تقديم توصيات عملية لتعزيز دمج تضاريس الأرض في ممارسة التصميم، مع التركيز على النهج الحساسة للسياق والممارسات المستدامة للمناظر الطبيعية. بالإضافة إلى ذلك، تحدد الدراسة التحديات والفرص في تعليم الهندسة المعمارية للمناظر الطبيعية المتعلقة بدمج تحليل التضاريس. تهدف الدراسة إلى المساهمة في إنشاء مناظر طبيعية متينة ومتناغمة تثري تجربة الإنسان وتدعم النزاهة البيئية، وبالتالي تعزيز ثقافة الابتكار داخل مهنة الهندسة المعمارية للمناظر الطبيعية.

الكلمات المفتاحية: هندسة المناظر الطبيعية، تضاريس الأرض، قرارات التصميم، الاستدامة.

1. Introduction:

Landscape architecture involves much more than just planting a tree around the building after finishing construction. The main purpose of landscape architecture would be about the beauty and use the out-door space as the most beneficial way. It needs to concern with the man made construction and natural, the problems from these. So, the architect needs to know the idea of construction too, not only the design part. There are many parts and elements for architects to

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explore and consider more on. For the elements such as, the circulation, layout plan, surrounding, ventilation, etc. It also covers the part of the environment that would affect our site landscape such as, wind, light, water, smell, and other like animals that we cannot control.

As landscape is a big part of the architecture. Architects have a job to make landscape be the most aesthetic, functional, and meaningful to the building and surrounding. Whatever how the design be, the landscape needs to be in the scope of the surrounding environment. It needs to be a part of the area. Meaning in both the boundary and the design. It could be outstanding in the design but it does not mean it needs to be different from the existing surrounding. It needs to be considered to the flows between building and surrounding too.

That would make the building belong to the site, and the site is blending to the building and surrounding. [1]

A landscape is a repository of cultural values and documents past civilizations. Thus, a landscape can be viewed as a specific type of heritage.[2]

Landscape and its natural and cultural value have long been of interest to researchers and have played a significant role in shaping planning policies. Landscape itself is considered a specific type of heritage. Cultural landscapes provide an interface between nature and culture, the tangible and intangible, and biological and cultural diversity. They represent a closely woven network of relationships and are integral to cultural and personal identity. The World Heritage Committee (UNESCO) has established three categories of cultural landscapes, one of which includes landscapes intentionally designed and created by humans, such as gardens and parkland landscapes constructed for aesthetic purposes. These landscapes are often (but not always) associated with monumental buildings and ensembles. However, most studies on landscape value generally refer to an integrity criterion, which encompasses coherence, harmony, visual balance, undisturbed functional entities, continuity over time, and the alignment of land use with the landscape's natural characteristics.[3]

In the landscape architecture field and its related disciplines, spatial design is a core activity oriented toward generating solutions for urban and rural areas and project sites such as parks, gardens, and squares, or exploiting potentials by creating conditions for spatial, ecological, and social developments. Spatial design is also essential when designing buildings, as they serve as fundamental elements,

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playing a vital role in linking urban spaces with architectural spaces.[4]

For understanding, what topographic maps represent is the construction of a topographic profile. A topographic profile is a cross-sectional view along a line drawn through a portion of a topographic map. In other words, if you could slice through a portion of the earth, pull away one half, and look at it from the side, the surface would be a topographic profile. Not only does constructing a topographic profile aid in understanding topographic maps, it is very useful for geologists when analyzing numerous problems. To construct a topographic profile, you must first decide on a line that is of interest to you. This could be an area where you want to go for a hike and want to know how steep to expect it to be, a line that shows the maximum relief (relief is the difference in elevation between the highest and lowest points(in the map area, or any other area in which you are interested. [5]

Therefore, based on the previous discussion, the call for landscape architecture, as a maturing academic discipline, to urgently develop its methodological repertoire to generate new knowledge has become increasingly persistent over the last few decades. Deming and Swaffield emphasize that the production and consumption of knowledge is now the 'new normal' in landscape architecture academia. They argue that as the discipline expands and engages with other fields, there is a need to broaden and deepen academic thinking.[6]

2. Research problem

The research problem revolves around understanding the intricate relationship between land topography and landscape architecture. It also focuses on realizing how natural terrain influences design decisions, spatial organization, and the overall aesthetic and functional qualities of landscapes, while considering the evaluation of the effectiveness of topographic analysis techniques in devising design interventions and solutions.

3. Vision

The research envisions a comprehensive exploration of the dynamic interaction between land topography and landscape architecture. By investigating multifaceted perspectives and integrating topographic analysis, the vision aims to contribute knowledge, enrich discourse, address environmental challenges, and guide future research directions in this field. Furthermore, the role of architects and urban

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designers is essential in shaping the relationship between topography and landscape. Architects and urban designers play a crucial role in interpreting and responding to the land's natural features, ensuring that their designs harmonize with the environment while enhancing urban and rural spaces. Their expertise in creating functional, aesthetic, and sustainable designs is central to achieving a balance between human activity and the natural landscape.

4. Hypothesis of the research

The hypothesis assumes that land topography significantly influences design decisions and spatial organization in landscape architecture. Through terrain analysis, it is expected that a deep understanding of natural topography will enhance design practices, guide decision-making processes, and promote sustainable landscapes that are responsive to the context.

5. The importance of the research

1- It contributes to the advancement of knowledge in the fields of landscape architecture and architecture by exploring the complex relationship between land topography and design. By delving into multiple perspectives and incorporating topographic analysis, the studies enhance the understanding of how landscape architects engage with natural formations and how these designs can integrate with architectural elements to create balanced environments that harmonize urban and natural spaces.

2- Provides insights to guide design practice by elucidating the impact of land topography on design decisions. With such knowledge available, practitioners are better positioned to enhance design processes and outcomes, ultimately contributing to the creation of more sustainable and visually appealing landscapes.

3- Addresses pressing environmental challenges by examining the impact of land-use changes on natural habitats and emphasizing the importance of conservation within cultural landscapes. By advocating for environmentally sensitive approaches, research endeavors contribute to the preservation and restoration of ecosystems, thus fostering healthier and more resilient landscapes.

4- Enhance the development of methodological repertoire by advocating for the integration of terrain analysis and embracing interdisciplinary perspectives, thus contributing to broadening and deepening the understanding in the field of landscape architecture.

5- Guiding future research directions through a comprehensive

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exploration of topography and its implications for landscape architecture, contributing to the identification of knowledge gaps and enhancing research initiatives that pave the way for future investigations in this field.

6. Objectives of the research

1- The research aims to explore the intricate relationship between land topography and the principles and practices of landscape architecture. It involves examining how natural terrain influences design decisions, spatial organization, and the overall aesthetic and functional qualities of landscapes.

2- Evaluate the use of topographic analysis in landscape architecture, focusing on assessing the effectiveness and relevance of topographic analysis techniques. It involves evaluating the utility of methods such as topographic modeling, geomorphic classification, and terrain analysis in understanding geographic forms and informing design interventions.

3- Seek to assess the impact of human-induced land-use changes on natural habitats within cultural landscapes. It involves studying trends in habitat loss and degradation, identifying key drivers of environmental change, and evaluating the effectiveness of efforts aimed at preserving intensively managed landscapes.

4- Propose practical recommendations for integrating topographic considerations into landscape architecture practice. It involves synthesizing findings from the exploration and evaluation phases to develop guidelines, methodologies, and design strategies that enhance the integration of land topography into the design process, fostering more sustainable and contextually responsive landscapes.

7. Conceptual framework of the research

The conceptual framework proposes that an in-depth exploration of land topography, informed by interdisciplinary perspectives, can enhance the theory and practice of landscape architecture. By understanding how natural terrain influences design decisions and spatial organization, landscape architects can create landscapes that are more contextually responsive and environmentally sustainable.

8. Topographic stories

Topographical Stories, Studies in Landscape and Architecture discusses several essential concepts of architecture and landscape but does not provide detailed evidence of a compositional scheme for any of the designs. The text is more of an art critique aimed at

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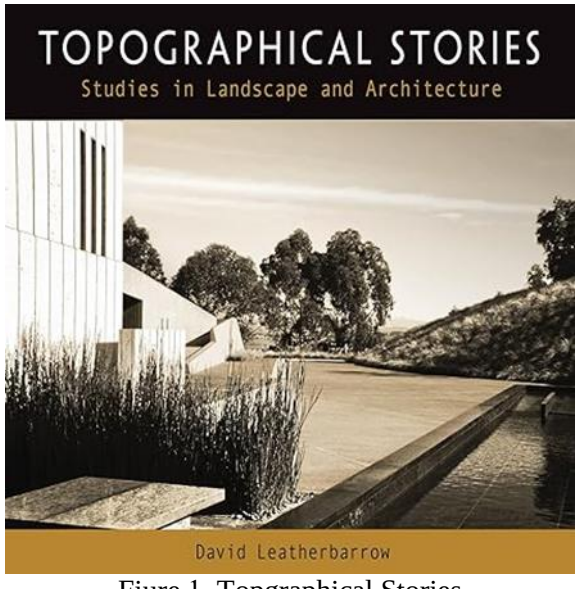
explaining architecture and landscape to contribute to everyday existence, rather than a comparative analysis of architectural or landscape design methodologies.[7]

Topographic concepts in architectural and landscape design play a pivotal role in shaping the relationship between the natural environment and architectural elements, creating spatial experiences that align with human needs and enhance the interaction between people and their surroundings [7], As shown in Figures 1 and 2.



Fiure 1. Topgraphical Stories
(Leatherbarrow 2004The source is cited from[7]

Figure 2. Leveling the Land (Leatherbarrow 2004)
The source is cited from [7]

9. Landforms

In addition, in the book of topographical stories, newly introduced use of the word ‘topography’, adding a bridging narrative between

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chapters. Leather barrow introduces ‘topography’ to draw a parallel between architecture and landscape.

The word is usually a technical term to describe a drawing of heights in grading, land measuring and cartography and is often used more generally as a description of the shape of a landscape.Leather barrow understands topography as a linkage between two disciplines but much beyond a common denominator. Briefly but clearly he analyses the debates which propose that landscape architecture and architecture are either just all the same, or in fact entirely different. [7]

Leather barrow develops his own critical position that opens possibilities of thought to design in the consecutive chapters. Finally, he establishes topography as a high means of artistic articulation. He develops similar criteria for the tasks of a design in the context of nature - either a landscape or a building -that each discipline is at its best in the vicinity of the other. Topography describes the condition of both landscape and architecture in its actual existence as “inescapably ambient”. [7]

10. Natural habitats and their preservation

The connection with land-use changes in the cultural landscape has led to a significant loss and degradation of natural habitats. For instance, in the Czech Republic, notable decreases in natural habitats began in the mid-19th century due to intensive farming practices. The fragmentation and loss of natural habitats remain key challenges for plant biodiversity conservation and are closely tied to the environmental degradation that occurred in Europe during the latter half of the 20th century, largely driven by intensified agricultural land management practices and increased urbanization. Thus, natural habitat conservation within intensively managed cultural landscapes is a constant concern.

The difference between the proportion of natural habitats in gardens and their surrounding areas in landscapes with a high level of human impact is significantly higher than the difference found in landscapes having a low level of human impact .[8]As shown in Figure 3.

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Figure 3. The natural habitats of the Earth can be calculated by a simple mathematical process, which is the vertical distance divided by the horizontal distance, and it can be expressed as a percentage. Source (https://www.thelanddevelopmentsite.com).

11. Topographic modeling

One of the primary tasks of landscape architects is to design earthworks.28,29 Landscape architects work with topographic models derived from data collected by field surveys, airborne lidar, or photogrammetric with unmanned aerial systems. They design new landforms using analog methods – such as drawing contours maps by hand and hand sculpting physical topographic models in clay – and digital methods – such as drawing digital contour maps in CAD and digitally sculpting surfaces in 3D modeling software. Analog methods for topographic modeling are typically used in the early, conceptual phases of the design process because they are considered more intuitive, but less precise than digital methods. Digital methods for topographic modeling, on the other hand, can afford precise transformations, quantitative calculations, and dynamic modes of visualization such as zooming, 3D orbiting, and ray traced shading. Theoretically, tangible topographic modeling should combine the affordances of both – enabling natural sensing and manipulation with enriched visualization and quantitative analysis. [9]

Landscape architects utilize topographic models derived from data collected via field surveys, airborne lidar, or photogrammetry. Tools such as AutoCAD Civil 3D and ArcGIS are employed for analyzing and visualizing data, while SketchUp and Rhino assist in creating 3D models for conceptual and detailed designs.As shown in Fig 4.

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Figure 4. Tangible Landscape: a real-time cycle of 3D scanning, geospatial computation and 3D modeling, and projection and 3D rendering [9]

12. Typical methods for terrain analysis

Typical methods for teaching terrain analysis include in-situ surveying, drawing contour maps, and building physical models.
While surveying teaches students how topographic data is collected, drawing exercises involve interpolating contours from spot elevations and designing contour plans for new topographic features. Physical modeling exercises include building clay models and contour models of existing or designed topography. [10]
For drawing contour maps and analyzing terrain, digital tools like ArcGIS and AutoCAD Civil 3D offer advanced capabilities. Meanwhile, SketchUp and Rhino are used to integrate physical modeling with technical design phase, as shown in Figure 5.

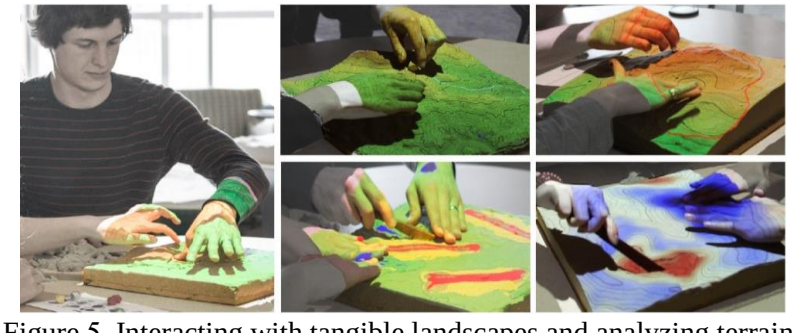

Figure 5. Interacting with tangible landscapes and analyzing terrains during experimental studies to identify topographic features. [10]

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13. The concept of digital terrain data classification

The concept of classifying digitised terrain data (such as the raster surface in according to spatial patterns goes at least as far back as 1967. Actual attempts to identify landforms such as pits, peaks, ridges and ravines were performed as early as 1975. Such orthographical representations of the terrain reveals more detailed characteristics of its appearance and shape than a standard elevation model. A significant portion of landform extraction research is focused towards hydrological applications—in fact, many classification approaches make use of hydrological analysis techniques in the process of identifying landforms. Schillaci et al. identify numerous examples of such applications, including drainage pattern extraction and river morphology. and watershed delineation. Other examples identified by Schillaci et al. that are not specifically related to hydrological applications include surface roughness assessment. The monitoring of slope movements. And predicting the spatial distribution of gully erosion and soil texture. Various classification approaches were recently investigated and compared by Romero and Clarke. for open-source and commercial software, and Schillaci et al. provide additional comparisons of classification methods and software. The methods that they investigated require separate workflows in order to identify different landform types, and generally require workflows comprising multiple steps for each. One example of such multiple workflows, and specifically related to our purposes, is the process that Eugenio et al. followed to identify ridges for watchtower placement. Their interesting approach is based on hydrological analyses that are not specifically intended for the purpose of identifying peaks or ridges. Essentially, the digital terrain model is inverted, after which a watershed. analysis is performed. A watershed analysis determines where water on terrain will flow and accumulate—when inverted, the original ridges and peaks become river courses and pits, where the water will flow and accumulate.

An alternative landform classification technique is the implementation of predefined terrain patterns that may be matched to continuous land surfaces according to similarities in their geometry. The ten most significant landform classes—termed geomorphons—were identified by Stepinski and Jasiewicz as flats, peaks, ridges, shoulders, spurs, slopes, pits, valleys, foot slopes and hollows, as illustrated in Fig. Their classes were based upon fifteen such pre-defined landform classes first presented and investigated

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by Schmidt and Hewitt, Which were based upon the pioneering work of Dikau. and Wood, in developing geomorphon-based classification processes. The geomorphon classification approach has been successfully used in a variety of recent problems, ranging from the characterization of submarine bedforms. topographic modelling for landscape architecture. Geographical suitability calculations for agent-based simulation, and landslide susceptibility mapping.

To identify geomorphons, the entire terrain surface (all raster points) is traversed by a moving search region which matches the geometry of the raster points. [11]

14. Results

1- The research reveals a significant impact of land topography on design decisions in landscape architecture. Analyses indicate that variations in elevation, slope, and land patterns directly affect spatial organization, circulation routes, and the placement of vegetation within landscapes.

2- The results demonstrate the effectiveness of topographic analysis techniques, such as terrain modeling and geomorphon classification, in understanding and representing landforms. These methods offer valuable insights into the morphological characteristics of terrains and assist in decision-making processes during landscape design.

3- The research highlights the impact of human-induced changes in land use on natural habitats within cultural landscapes. Analysis suggests a correlation between intensive land management practices and habitat loss, emphasizing the importance of conservation efforts in preserving biodiversity and environmental integrity.

4- The findings propose practical strategies for integrating topographic considerations into landscape architecture practice. Recommendations include adopting site-specific design approaches, utilizing digital modeling tools, and collaborating with multidisciplinary teams to enhance the integration of land topography into design processes.

5- The research identifies challenges and opportunities in landscape architecture education related to the incorporation of topographic analysis. Findings emphasize the need for curriculum improvements, interdisciplinary collaborations, and providing experiential learning opportunities to better prepare future landscape architects to address the complex relationships between terrains and landscape architecture.

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6-Through the analyses obtained from the study, governmental decisions can be directed towards preserving sustainable landscape planning and management, supporting initiatives to utilize land, and providing conservation strategies aimed at enhancing sustainable landscapes that align with natural terrain features and support environmental health and human well-being.

15. Recommendations

1-The landscape of the building needs to be planned when the building is being planned.

2- Integrate topographic analysis methods and tools into landscape architecture curricula to enhance students' understanding of land topography and its implications for design. Provide hands-on training in digital modeling, geomorphon classification, and field surveys to equip future landscape architects with essential skills for site analysis and design.

3- Encourage collaboration between landscape architects, geographers, environmental scientists, and urban planners to leverage diverse expertise and perspectives in addressing the complex relationships between land topography and landscape architecture. Foster interdisciplinary research partnerships and joint projects to explore innovative approaches in landscape design, preservation, and management.

4- Promote contextually sensitive design approaches that respond to the unique characteristics of natural and cultural terrains. Emphasize site-specific design solutions that celebrate land topography, enhance environmental connectivity, and integrate cultural heritage preservation measures into landscape architecture projects.

5- Advance sustainable landscape practices prioritizing environmental integrity, biodiversity conservation, and resilience to environmental changes. Emphasize the importance of integrating green infrastructure, native plant species, and natural terrain features into landscape designs to mitigate the negative effects of land-use changes and promote ecosystem health and human well-being.

6-It is recommended to incorporate tools like AutoCAD Civil 3D, ArcGIS, and Rhino into architecture curricula to provide students with practical experience in terrain analysis and topographic modeling.

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16. Conclusion

In conclusion, this research sheds light on the vital role of land topography in shaping the theory and practice of landscape architecture. Through exploring multiple perspectives and integrating topographic analysis, the research paper has revealed the intricate interplay between natural terrain and design decisions. The findings highlight the effectiveness of topographic analysis techniques and emphasize the importance of integrating topographic considerations into design education and practice. Moving forward, adopting contextually sensitive design approaches and promoting sustainable landscape practices are essential for creating resilient and harmonious landscapes that enrich human experience and support environmental integrity.

The integration of advanced digital tools such as AutoCAD Civil 3D and ArcGIS enhances the precision and effectiveness of terrain analysis, contributing to the realization of contextually sensitive and sustainable designs.

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