

Research Article

Residential Complexes and the Erosion of Natural Identity in Mountainous Cities: The Case of Sulaimani City

Saya H. Ahmad ^{1,*} , Wrya Sabir Abdullah ¹ 

¹ Department of Architecture, College of Engineering, University of Sulaimani, Sulaymaniyah, 46001, Iraq

*Corresponding Author: Saya H. Ahmad, E-mail: saya.hikmet@gmail.com

Article Info	Abstract
Article History	Rapid urbanisation in mountainous cities has accelerated the tension between the needs of development and conservation of natural identity. The research emphasises the importance of natural features (mountains) and their visibility in a city, which are usually cultural and natural landmarks that preserve the city's original natural identity. It examines how high-rise housing complexes impact the city's natural identity and visual scenery. The primary objective of this study is to evaluate the visual impact of residential building design on natural mountain landscapes (identity) using geographical information system (GIS) viewshed analysis. The results have shown that (88%), that's about (321.81 Ha), the natural context of the Goizha Mountain is interrupted and blocked by high-rise buildings. And only (12%), that is about (45.73 Ha), of the mountain scenery is visible. The study confirms that the disintegration of architectural design (form) from its natural context leads to significant visual distortion, ecological imbalance, a weakened sense of place, and the erosion of the city's natural identity. It highlights that context-sensitive design and height regulation are necessary to preserve the natural identity in mountainous areas.
Received Oct 26, 2025	
Revised Jan 12, 2026	
Accepted Feb 03, 2026	
Keywords	
Building height	
Mountainous cities	
Natural identity	
Residential complexes	
Urban expansion	
Visibility	
Visual pollution	



Copyright: © 2026 Saya H. Ahmad, and Wrya Sabir Abdullah. This article is an open-access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY 4.0) license.

1. Introduction

The rapid urbanisation of the 21st century has created profound challenges for balancing human settlement needs with the preservation of natural environments. Today, according to the United Nations (2018), more than 55% of the world's population lives in cities, and this figure is likely to reach 68% by 2050 [1]. Although urban growth is often portrayed as an economic and social need, its unplanned sprawl, especially high-rise developments, has significant consequences, distorting landscape visibility, ecological balance, and urban identity.

Mountainous cities, characterised by complex topographical terrains, vulnerable ecological environments, and important landscapes, are exposed to the negative impacts of these developments. In these contexts, mountains are not simply background scenery but significant natural and visual landmarks

that compose and integrate into the city's skyline and can play an important role in residents' sense of belonging and collective memory, as Lynch's theory of urban imageability suggests [2]. The high-rise buildings frequently intrude into these natural environments, altering their visual, environmental, and structural features, the identity of urban spaces, and reducing their ecological and cultural values.

This study highlights a significant problem: the rapid growth of housing developments in natural areas, particularly in mountainous regions, leading to major alterations and distortions in Visual Scenery, Natural Context, Green Spaces, and Tourism Amenities, all of which are fundamental to a city's natural identity. Similar trends have been observed worldwide, where the construction of high-rise buildings and skyscrapers, and rapid urbanisation, imperil the natural identity of cities like Vancouver, Kyoto, and Nanjing [2-4]. Unfortunately, Sulaimani city, a major urban centre in the Kurdistan Region of Iraq, exemplifies this problem clearly. The city has historically been known for and defined by its surrounding mountains, particularly Goizha Mountain, which has long served as a visual and symbolic anchor for the city, with significant natural and cultural value and as a reference point for its citizens. In recent years, several high-rise residential complexes have been constructed directly on the mountain slope, a significant part of the city's natural identity, altering its natural form and transforming green land into private residential areas, introducing urban forms that contrast sharply with the city's traditional low-rise fabric. As a consequence, these developments are about to replace the natural areas and lands, leading to the distortion and loss of the city's natural identity. These complexes tend to provide and fulfil housing needs, but also alter the city's silhouette, disturb natural features, and reduce the legibility of its mountains.

Although these developments are visually dominant in the city and continue to expand carelessly, their impact on mountain visibility and the city's natural identity has not been well studied. So, the study addresses this research gap by analysing the visual impact of high-rise residential buildings on the mountain visibility and natural identity of Sulaimani city through GIS-based viewshed analysis. It contributes to a better understanding of context-sensitive planning strategies that are necessary for sustainable urban growth in mountain areas. It presents an empirical-based framework for analysing the visual impacts of vertical expansion in ecologically sensitive areas, integrating the conservation of visual identity with spatial planning and other strategies for urban sustainability.

The study hypothesises that (Building Height) is an important and influential factor in the distortion or preservation of a city's natural identity. In particular, irrelevant building heights in residential complexes

in mountainous areas are expected to affect mountain skylines, create skyline conflicts, and distort the visual and cultural legibility of urban landscapes. The study aims to examine the relationship between residential complexes and a city's natural identity, focusing on the city of Sulaimani as a case study. Through a literature review, theoretical foundation, and a GIS-based viewshed analysis, the paper proposes a framework for comprehending and addressing the impacts of urban expansion on natural urban identity.

The findings and conclusions of this study provide rational support for the importance of integrating residential developments with natural features to preserve the mountain city's natural identity. It demonstrates that housing constructions that disregard the topography and visual characteristics of their surroundings result in a deterioration of natural identity, ecological balance, and consistency.

2. Literature Review

The study of mountainous cities indicates that rapid urban expansion toward natural areas significantly transforms landscape structure, especially by converting natural and green lands into urban perimeters. Research in the Hengduan Mountain Region in Southwest China has also shown that when a city grows in the environmentally sensitive areas, the dominance of the landscape decreases while its diversity and complexity increase [5]. Residential growth can produce homogenised forms that, if insensitive to context, tend to overwrite natural or cultural heritage and identity [6]. Tall buildings and mega projects can overshadow natural features, block visual connectivity, and create discontinuities in the ecosystem [7]. Especially, mountain cities exhibit a significant visual impact from the height and mass of their buildings, as their urban identity is strongly connected to their natural context.

Jaghli et al. (2024) emphasise that the impact of high-rise buildings on the urban fabric of Nicosia, Northern Cyprus, should be taken seriously, as this city has traditionally been developed as a low-rise city. Using ArcGIS Pro for analysis, 3D modelling, and seasonal shadow simulations, the study examines how the towers alter the urban silhouette, create shadow effects, and challenge the balance between cultural identity and modernisation. The authors argue that disregarding a context-sensitive approach may result in disharmonious visual treatment if high-rise buildings are not controlled in terms of their overall massing and urban heritage [2].

Al-Ansi, et al. [6] studied rapid growth driven by ambitious growth policies. The authors explain how disintegrated planning has led to uncontrolled urban expansion and the loss of cultural identity in the city

of Buraydah, located in Saudi Arabia, through a historical document study and archival research. Also, the study addresses a gap in research on mid-size Saudi cities, focusing on the impact of modernisation and population growth on urban forms, while highlighting the inadequacy of cultural preservation measures [6].

A 2D and 3D GIS-based visual analysis for vertical developments around Mufu Mountain in Nanjing, China, was also developed by Zhang, et al. [4]. The study simulates multiple building elevation scenarios and applies the Mountain View Index to quantify the relationships among developments, natural features, and landscape visibility. It exposes the limitations of standardised height regulations and how visual sustainability can be preserved with specific quantitative planning. The research addresses a methodological gap in urban planning by assisting planners in balancing population growth with the preservation of natural and cultural landscapes[4].

On the other hand, Legutko-Kobus, et al. [8] examine Romania's and Poland's approaches to managing urban natural assets under development pressures. The authors utilise ArcGIS to analyse national legislative systems, integrating this analysis with comprehensive case studies of forests and protected areas, thereby identifying systemic deficiencies in post-communist governance and in investor-led initiatives. The study shows that despite conservation laws in both countries, poor implementation and disjunct governance threaten natural habitats. The limited number of transnational and cross-disciplinary studies that address Central and Eastern European contexts is a research gap. Its results indicate stronger institutional integration, more multi-level governance, and greater public participation to achieve biodiversity preservation and urban sustainability [8].

In research [9], the authors examine architectural interventions in mountainous terrains in Qingdao, China. Based on their field surveys of 770+ buildings and their terrain-modelling methodology, they categorise slopes into three types and enumerate 20 design methods for various gradients. According to their results, slope is a significant determinant of building types and construction systems. The research addresses the absence of systematic architectural models and supports context-sensitive design aimed at reducing ecological disruption and costs, and improving sustainability in hilly and mountain settlements [9].

Recent studies in mountainous cities suggest that urban terrain and mountain landscapes critically shape not only spatial developments but also residents' sense of urban quality. Changes in elevation, slope and access to mountain landscapes have significant impacts on residential land values [10]. Some cross-

cutting themes emerge throughout the former studies. First, urban identity, especially natural identity, is often disrupted by the rapid pace of urban growth and modern life. They serve as an example of the dangers of visual discord and cultural displacement arising from inappropriate design for vertical development [2]. Second, the studies support the need to incorporate environmental and ecological aspects in urban planning. Third, there is an obvious methodological contribution across the works, with innovative approaches ranging from GIS-based visibility simulations in Nanjing, Cyprus, and Poland to field-based slope classification and architectural design methods for mountain areas in Qingdao. Finally, these papers emphasise the significance of contextually embedded, interdisciplinary approaches. The preservation of forests, regulation of building heights, and construction in mountainous regions require the consideration of environmental systems, cultural heritage, and governance mechanisms.

2.1. Natural Identity of a City and Its Types and Features

Natural identity is the unique ecological, climate, and topographic features that define a city. It is a part of a larger city's identity that, in addition to the social and cultural dimensions, also includes the architectural dimensions [11]. Natural identity is demonstrated in elements such as rivers, coastlines, vegetation, wildlife, and mountains. Each of these elements provides a different support to urban life: ecological services, recreational uses, and cultural symbolism [12].

A city is a complex, dynamic spatial structure that encompasses both natural and constructed environments. According to Larsen [11], places are not static spaces; they are dynamic entities where human experiences, activities, and meanings merge and interact physically and temporally for various reasons. It argues that natural features, such as scenery, rivers, and topography, are integral parts of a place's identity.



Figure 1. Five main elements of a city [13]

The public image of a city seems to be the sum of many single perceptions. The secret to the right urban design and planning lies in understanding its basics. These are also evident in the well-known concept of urban form articulated by Kevin Lynch in 1960, which he describes as five fundamental elements to the

experience of being in a city: Paths, Edges, Districts, Nodes, and Landmarks, as shown in Figure 1. All these elements merge to create the urban fabric, which significantly influences the experiences of both citizens and outsiders within the city [13].

As natural landmarks, mountains have a significant impact on the natural identity of many cities. They dominate the skyline, forming a continuous visual perimeter around the city. Besides their aesthetic functions, mountains are crucial to Earth's ecology, supporting hydrology, hosting diverse floral species, and moderating microclimates [14]. They are also strongly associated with cultural heritage; for example, iconic natural formations such as Mount Fuji (in Japan) and Table Mountain (in Cape Town) act as spiritual and symbolic anchors [15]. Research on historic and mountainous cities shows that natural features such as mountains should not be seen solely as physical elements in the landscape, but rather as cultural and natural landmarks that shape urban identity and contribute to residents' collective memory [16]. The study in Chiang Mai has shown that visual continuity between mountains and the city is necessary to sustain the linkage between natural and cultural heritage, as inappropriate building heights or visually intrusive developments can break lines of sight and diminish one's sense of place in a city [17]. Excessive building heights and continuous high-rise development in natural areas can block the mountainous background, degrade visual quality, and weaken the city's natural identity [18].

The loss or obstruction of visibility of the mountains can heavily damage a city's natural identity. Several studies in countries such as China, Canada, and Japan have shown that preserving mountain views is a key planning strategy for maintaining cities' identity and sense of place amid vertical development [3, 4]. In Sulaimani, a city surrounded by mountains on many sides, maintaining this visual and ecological relationship is essential to preserving its identity and attractiveness.

A city's nature will shape its identity, economy, and quality of life in proportion. These are Parks, Rivers, Lakes, Mountains, and Green Areas that enhance the urban environment and significantly contribute to ecosystem health and city sustainability [11]. Parks and gardens are the lungs of a city, crucial to the health and well-being of humans and diverse plant and animal species. They are what allow residents to relax, exercise, or connect with the natural environment, which is essential for mental and physical health. Integrating trees and plants into urban settings can reduce the heat island effect, improve air quality, and reduce stormwater runoff, helping build the city's climate change resilience [11]. The main types and features of natural identity are illustrated in Figure 2.

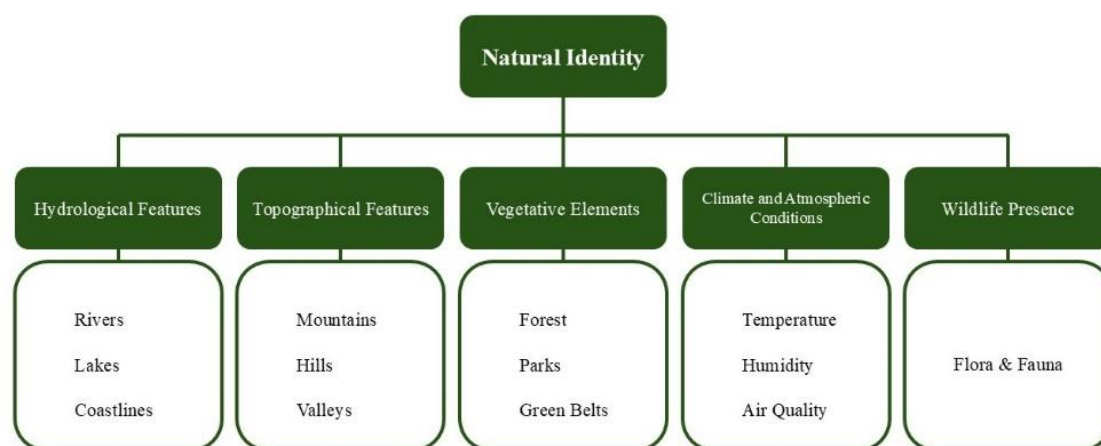


Figure 2. Natural identity and its main types and features in a city [11, 12]

2.2. Residential Complexes

Housing Projects are the new face of an urban populace in dire need of housing and facing a similarly urgent demographic increase. They often encompass large, planned communities in the form of high-rise towers and mid-rise housing clusters with embedded services, open spaces or parks, commercial areas, and recreational facilities [19]. They bring considerable advantages to housing delivery and land utilisation; however, they are most often detrimental to a city's natural identity when located in environmentally sensitive areas.

The development of residential complexes is one response to such shifts in socio-economic and technological progress, as can be seen from Roman insulae and medieval residential towers addressing early high-density living needs, to the mass workers' housing of the Industrial Revolution and post-World War II European grands ensembles, designed to meet housing shortages through modernist principles. In the modern era, residential developments are favouring environmentally friendly design concepts, including energy-saving technologies, green areas, and the reuse of green spaces by dwellings and community facilities [20]. These complexes are categorised into detached and semi-detached units, row and courtyard housing, high-rise systems with various circulation patterns such as gallery, double-loaded corridor, point and segment systems, with differing degrees of implications in terms of density, privacy, ventilation, as well as community interaction [19, 21, 22].

The architectural and urban elements integrated into these complexes illustrate their duality: architecture is grounded in spatial distribution, aesthetic considerations, and building usability, while planning emphasises land use efficiency, connectivity among structures, infrastructure, and integration within the broader urban system [23, 24]. Therefore, a good design must harmonise the two realms to

provide a livable quality of life, inclusivity, and resilience by addressing issues such as accessibility, noise control, privacy, and energy efficiency [25, 26]. In a formal sense, residential complexes have a shaping impact on urban character, resulting from height, skyline, silhouette, massing, façade articulation, and visual corridors, which together comprise legibility and identity for an urban environment, as well as environmental performance [27-29].

In residential buildings, sustainability is becoming a priority, encompassing all stages from overall planning to lifespan, including construction, operation, and deconstruction. Such strategies can be a passive design for natural ventilation and solar gain [30, 31], renewable or prefabricated materials [32], an orientation that corresponds to the local ecosystem with its green infrastructure development, and a social-environmental responsiveness aligning the built form with the community's norms and ways of life [33]. However, many developments still neglect green space conservation, climate-adaptive design, and ecological resilience to a great degree, resulting in surface sealing, identity loss, and social alienation [34].

The environmental impacts of housing developments are also notable. Construction on hillslopes and mountainous areas requires cut-and-fill operations, leading to a loss of vegetation cover and increased soil erosion [9]. These types of interventions also disrupt habitats, leading to biodiversity decline and increased landslide risk [35]. At the same time, the impervious surfaces of large complexes disrupt the water cycle, increasing surface runoff and flood hazards [36]. Recently, in Sulaimani city, GIS-based studies indicate that rapid growth in private-sector residential developments has occurred without sufficient integration with land-use plans, resulting in the transformation of environmentally sensitive areas and green spaces. This rapid development has led to the distortion of urban forms and the loss of natural landscapes, emphasising the need for more context-sensitive planning strategies in the development of residential complexes [37, 38]. Ultimately, the contributions of residential complexes to urban identity go beyond a mere housing function and stem from their role as instruments of social structuring, environmental preservation, and cultural maintenance.

3. Materials and Methods

The study uses a quantitative, spatially explicit approach in Geographic Information Systems (GIS). The most important technique is viewshed analysis, which allows visual spectral analysis from selected locations in the city. The viewshed analysis is a common tool in urban planning for estimating the unobstructed visibility of landscapes interrupted by buildings, wind turbines, or towers [3].

The research methodology was conducted on one of the most obvious examples of the problem of blocking views, scenery, and panoramas of natural mountains by buildings: the Qaiwan Heights residential complex in Slemani, located exactly on Goizha Mountain. The process began by collecting the project's architectural drawings from the main developer (Qaiwan Group) and the project designer (Masterplan drawings for the buildings' exact locations and footprints, and Section and Elevations for the buildings' heights). The 2D drawings were taken in AutoCAD as (DWG) files, then they were burnt with the DEM file from ESRI World Elevation data in ArcGIS Pro, version 3.5. Then, in the GIS, the buildings were assigned their actual heights and façade intrusions and extrusions, based on the architectural drawings, to build the 3D model of the project. After that, the tool of (Viewshed / Visibility) in the program has been used to identify the visible and invisible areas of the mountain in the area of interest (AOI). Finally, the program generated a result map showing the mountain's visible and invisible areas in different colours: we selected red for the invisible areas and green for the visible areas, and it processed the data to calculate the exact percentages of each. The process is illustrated in Figure 3.

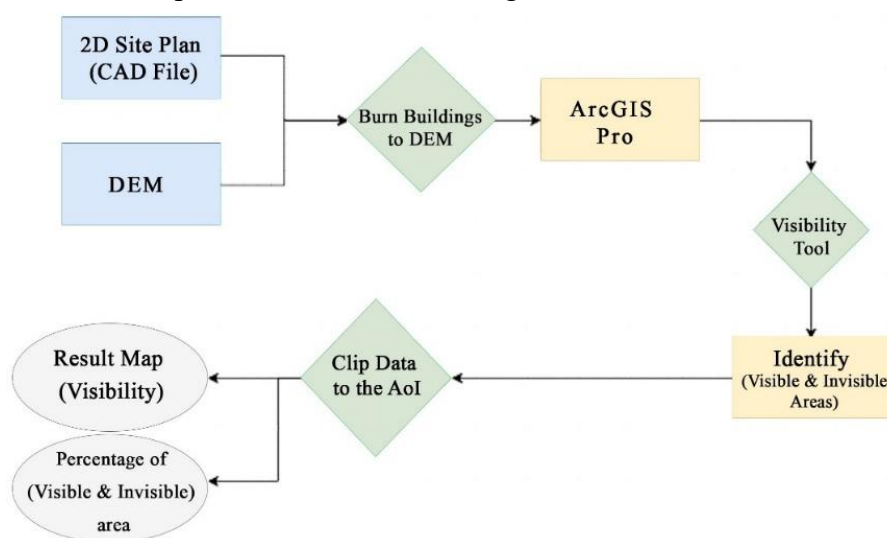


Figure 3. The methodology of the research to analyse the visibility of the mountain in Qaiwan Heights

The DEM source is high-resolution ESRI World Elevation data. We extracted the data at scale (9,027.98 level 16) for the area of interest; the output was (2.3m) resolution. Because the building's layer is vector, to get a smooth result when running the process, we resampled the DEM to a (1m) resolution, then burned it with the buildings, and then we plugged it into the tool. The data were collected on October 24, 2025. The elevation type is a Digital Elevation Model (DEM), which represents terrain including any man-made buildings and structures. During visibility, the mountain is assessed from a single observer's perspective at an average human eye height of 1.60 m. The observer point's location, coordinates, and

justifications for selecting its place will be explained in detail in the next section.

The resulting maps clearly illustrate the percentages of visibility and blockage. Under this approach, the natural identity transformation of a city can be reasonably, objectively, and scientifically evaluated in the context of mountain cities.

3.1. Case Study: Qaiwan Heights, in Sulaimani

Qaiwan Heights is a massive housing project situated on Goizha Mountain in the city of Sulaimani, in the Kurdistan region of Iraq, as illustrated in Figure 4. The project's location offers residents panoramic views, raising questions about its impact on the city's natural identity. Beyond its physical significance, the region's natural elements have been recognised as a cultural legacy and an essential part of the city's identity. Goizha also constitutes symbolic territory, serving as an anchor for people who perceive their presence here through various perspectives that strengthen a sense of belonging, memory, and history. These implications are relevant in the development of high-rise housing complexes in environmentally and culturally sensitive settings, not only for ecological sustainability but also for social cohesion and promotion of cultural continuity in Sulaimani.

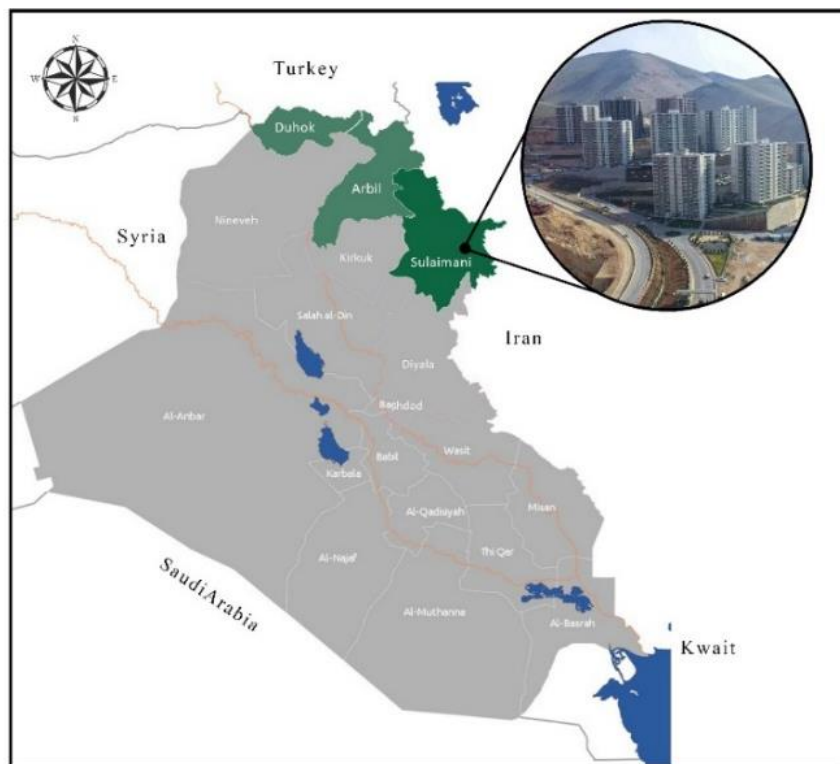


Figure 4. Residential complex of Qaiwan Heights in Sulaimani

The site is approximately 84 Ha in size and consists of three main zones: Zone A with 16 residential buildings; Zone B with 38 residential buildings; and Zone C with 24 residential buildings, as illustrated in

Figure 5. The development contains buildings at various stages of completion, including both completed structures and those under construction.

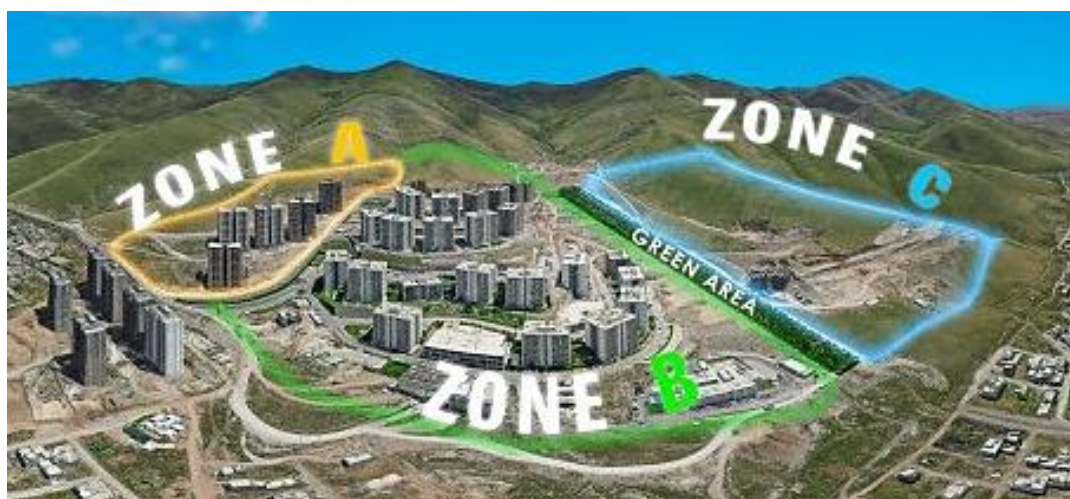


Figure 5. Three main zones of residential buildings in Qaiwan Heights

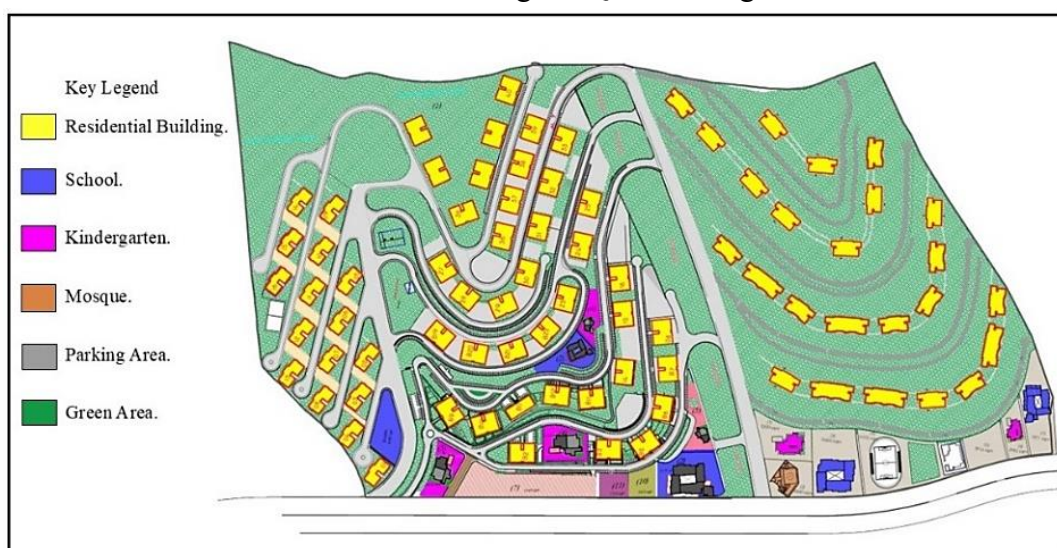


Figure 6a. The master plan of the Qaiwan Heights development



Figure 6b. The master plan of Qaiwan Heights features topographic terrains

In addition to residential buildings, it includes various modern infrastructure and community services, such as supermarkets, cafes, schools, kindergartens, and mosques, which is their vision for a self-sufficient urban consuming community, as illustrated in Figures 6 (a, b).



Figure 7. Cutting the mountainous area and building a residential complex



Figure 8. High building density in the project area

The Qaiwan Heights project has drastically changed the topography of the Goizha Mountains. As shown in Figure 7, significant construction and terrain modification were necessary to accommodate the foundations of so many high-rise residential buildings, resulting in a dramatic alteration of the original mountain topography. As shown in Figure 8, the project features high building density and short distances between high-rise residential blocks, resulting in visual and physical disruptions to the surrounding landscape. In addition, the significant erosion of the mountain necessitates the construction of large retaining walls to stabilise the terrain and support the built structures, some of which reach heights of up to 18 meters. As shown in Figure 9, the project highlights the environmental and urban planning implications

of building housing complexes in environmentally and culturally sensitive places, like Goizha Mountain, where previously designated as public and natural areas, have been converted to private housing land-use, resulting in significant changes in the land-use patterns and landscape character, along with the blocking of the natural scenery. Figure 10 shows the mountain's natural topography in 2014, before the Qaiwan Heights project was built on it, based on historical imagery from Google Earth.



Figure 9. Building a high-rise residential complex the project. Source: Google Earth Imagery 2014

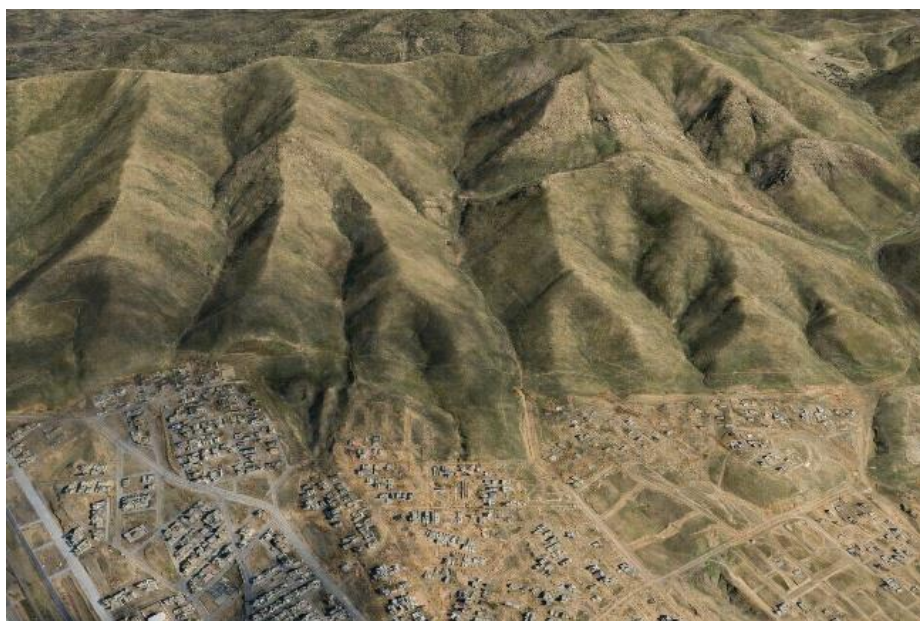


Figure 10. Goizha Mountain, before building on Goizha Mountain

To objectively evaluate the project's impact on Goizha Mountain's visibility, a comprehensive analysis was conducted across multiple platforms. The 2D drawings of the project (Masterplan, Section, and Elevations) were collected from the project owner in CAD format, then imported into ArcGIS to build the 3D model of the complex, as illustrated in Figure 11.

As the project is still under construction, some buildings have not been completed yet, while others are completed and contain residents, but the visibility analysis has considered the whole project, including existing, under-construction, and proposed buildings. Because those towers were included in the project's architectural design, they will be constructed in the near future. To obtain an accurate estimate of the mountain's blocked area, the entire project has been analysed in GIS. Figure 12 shows the existing buildings, those under construction and the proposed buildings.

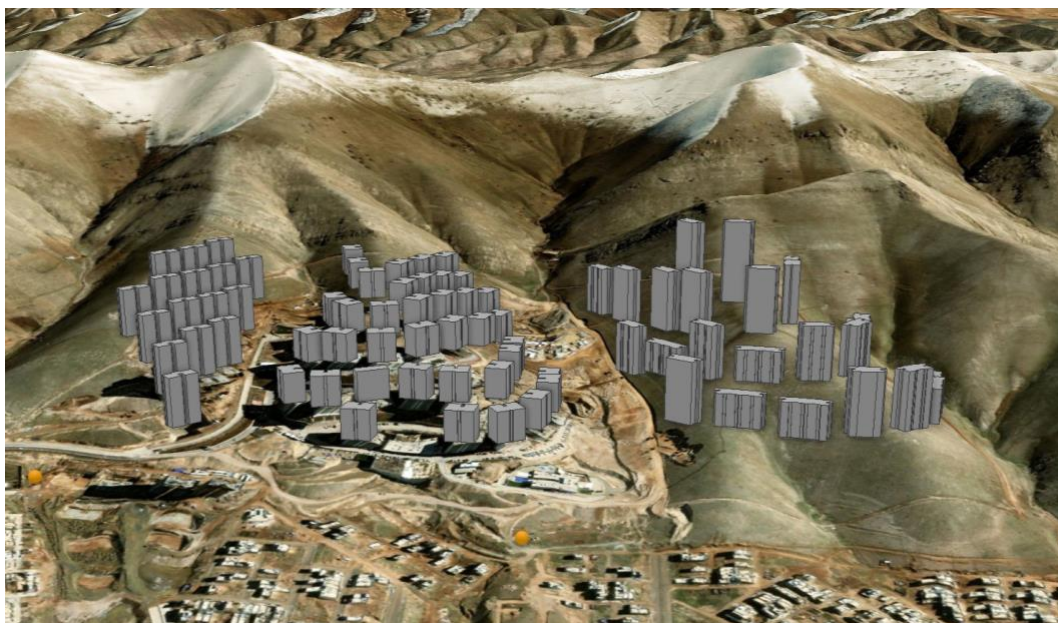


Figure 11. 3D modelling of Qaiwan Heights residential complex [Source: Google Earth imagery, annotated by the authors]



Figure 12. The different status of the project buildings (Existing, Under-construction, and Proposed)

In the GIS, a visibility analysis was performed using an observer point set in front of the project, at an average height (Height) of 160 cm, to identify and classify the visible areas of the natural mountain scenery and the invisible regions interrupted and obstructed by the residential towers. The location and exact coordinates of the observer point or point of view (PoV 1), along with other details (Heading, Tilt, Horizontal Angle, Vertical Angle, Minimum Distance, and Maximum Distance) in the setting of the viewshed tool, are illustrated in Figure 13, in this case study the maximum distance is about 1.2km so the ground curvature effect is about (10cm) which doesn't have a significant effect on the analysis.

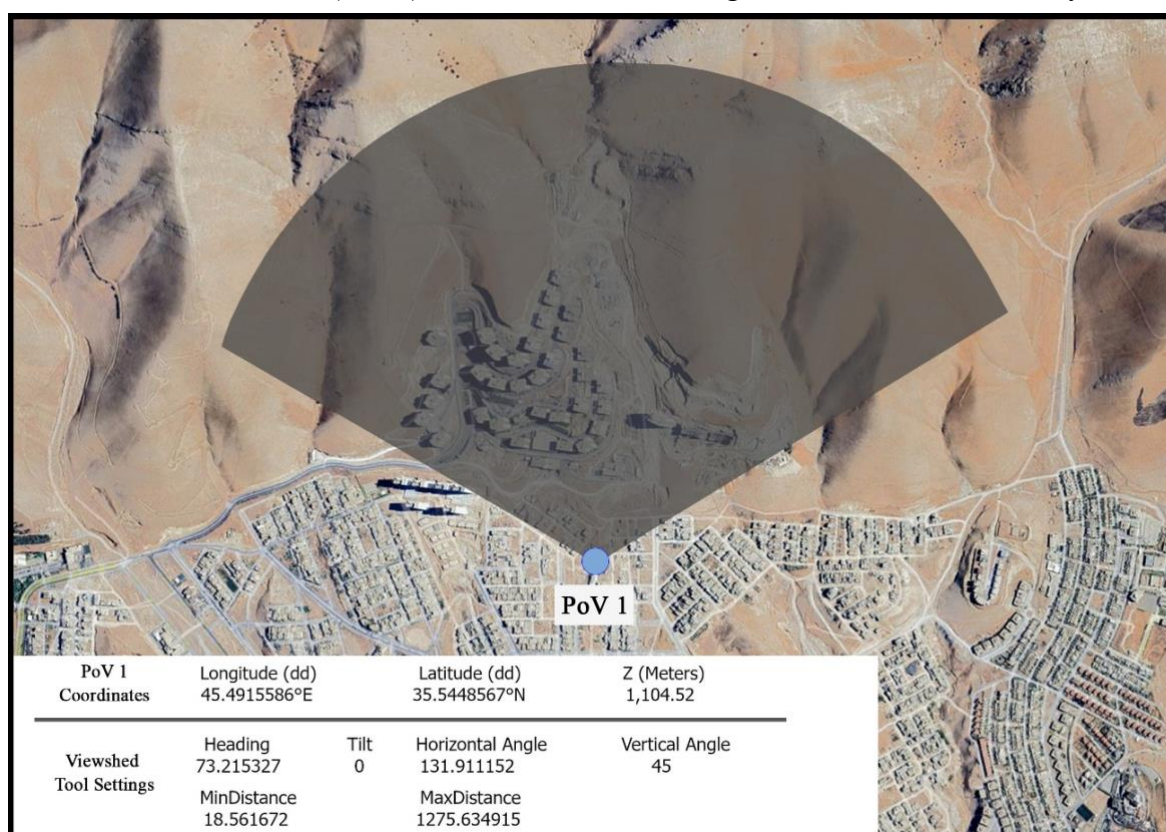


Figure 13. The coordinates of the observer point and the settings of the viewshed tool in GIS. [Source: Google Earth imagery, annotated by the authors]

The observer point was selected in that location for some specific reasons, which are these:

- The location is directly in front of the project, in the centre, and opposite the mountain, offering a panoramic view of the project and its natural surroundings.
- The location is within a residential area, where the high-rise buildings of Qaiwan Heights block a significant portion of the natural mountain scenery, which is a public right especially for residents living in those neighbourhoods.
- The location is in an open space within an area with future development capacity; the area is not fully

developed yet, and may be a public park.

d) The selection is within the field of view of any observer.

4. Results and Discussions

In the GIS-based visibility analysis of the Qaiwan Heights residential complex, the mountain view was analysed using the viewshed tool. The visible areas of the mountain were presented in (Green Colour), while the area where residential buildings block its view is presented in (Red Colour). Figure 14 shows the visibility analysis of the mountain from a top view, while Figure 15 illustrates the mountain visibility from an aerial view. The study shows significant changes in the visual and topographical integrity of Goizha Mountain and in the natural identity of Sulemani city.

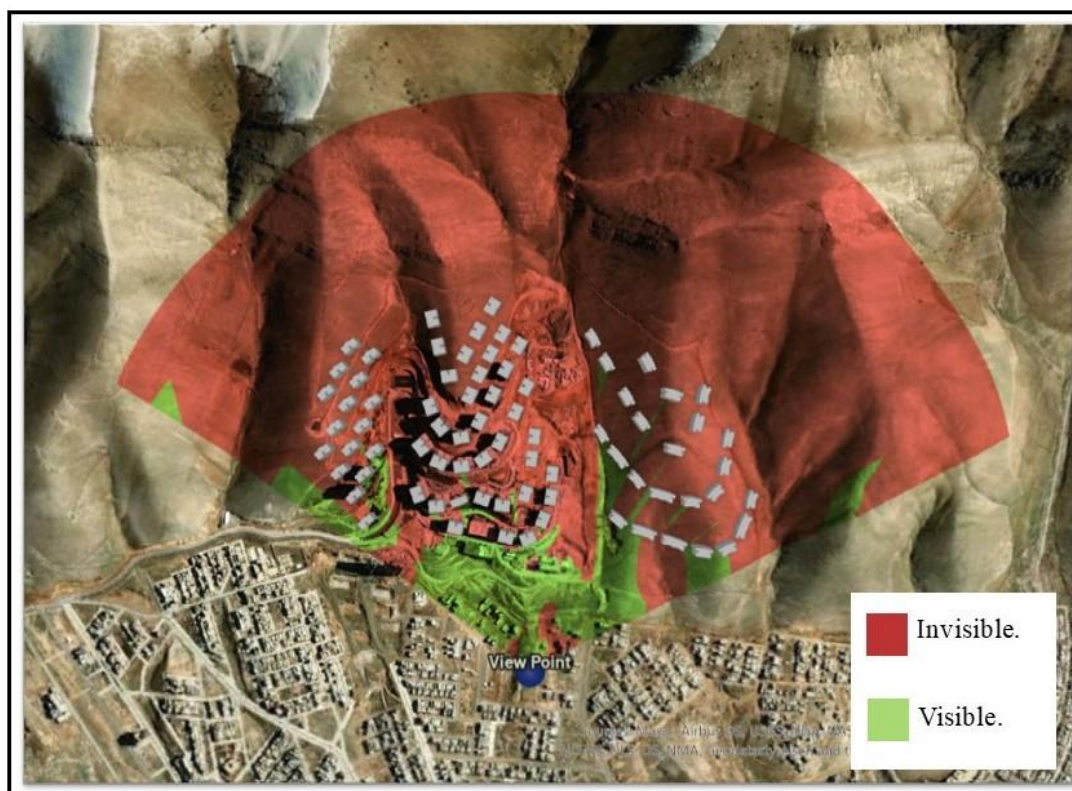


Figure 14. Visibility analysis of Qaiwan Heights, by GIS viewshed analysis, top view [Source: Google Earth imagery within GIS]

According to the project area's visibility analysis, only 12% of the mountain scenery is visible within and around the complex. In comparison, approximately 88% of the area is obscured by high-rise residential buildings, as illustrated in Figure 16. Also, Table 1 shows that, out of the (367.54 Ha) total area of the project, only (45.73 Ha) of the mountain is visible, while the blocked area is (321.81 Ha). The findings clearly show that the height and density of the buildings, combined with inadequate spacing between them,

have created a sufficient visual barrier, interfering with the continuation of the mountain silhouette and creating visual crowding on the horizon.

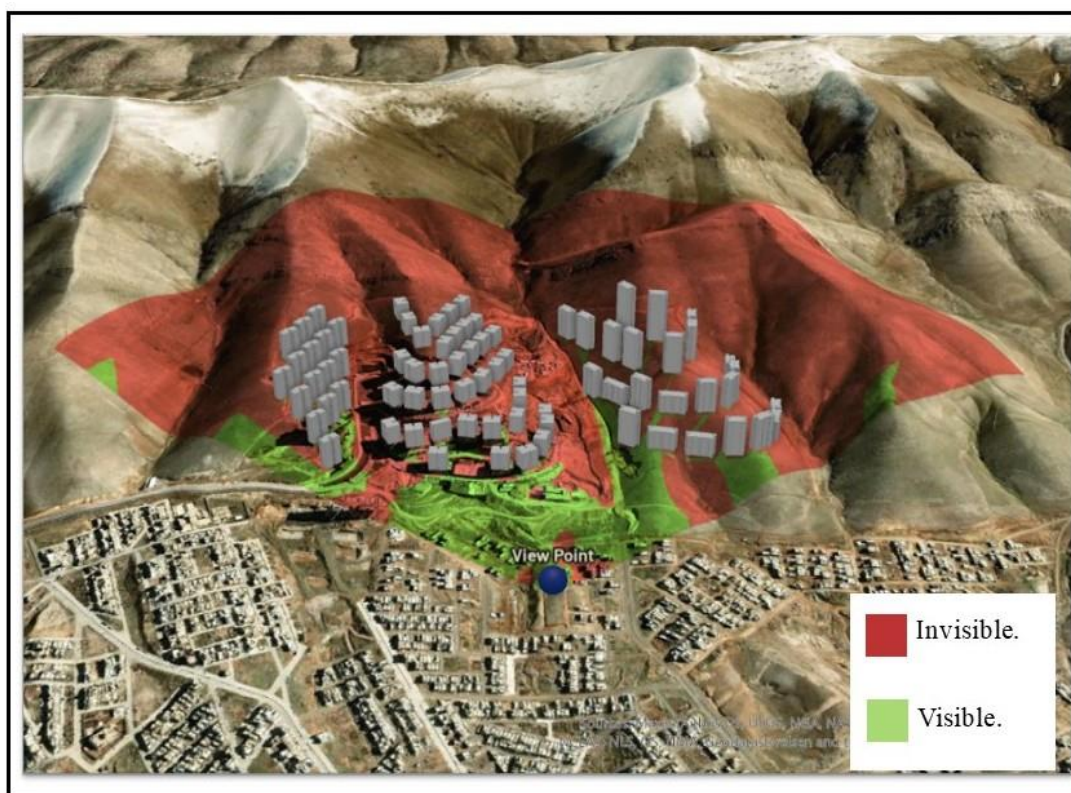


Figure 15. Visibility analysis of Qaiwan Heights, by GIS viewshed analysis, aerial view [Source: Google Earth imagery within GIS]

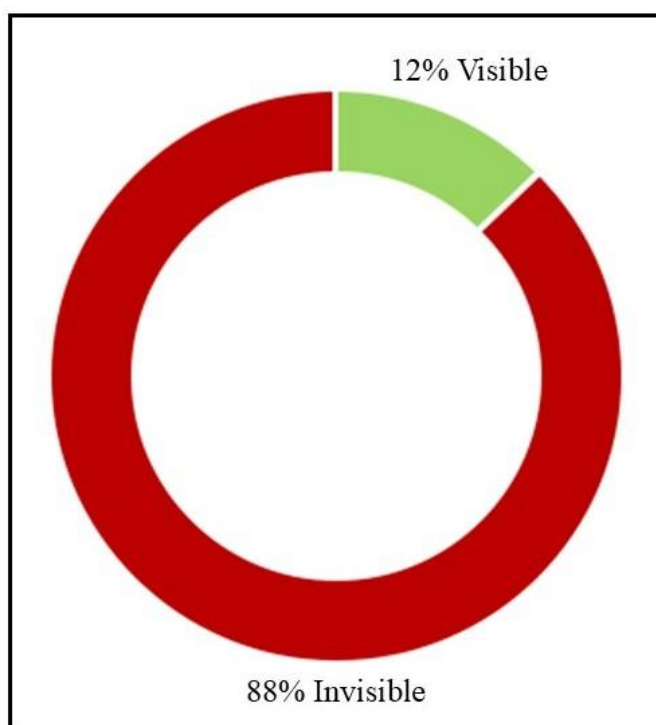


Figure 16. Mountain visibility percentage in Qaiwan Heights, analysed in GIS

Table 1. Mountain visibility area and percentage in Qaiwan Heights, analysed with GIS

Row Labels	Sum of Area	Percentage
Visible	45.73 Ha	12%
Invisible	321.81 Ha	88%
Grand Total	367.54 Ha	—

Figure 17 shows another visibility analysis conducted by GIS, which represents a visual perspective from a person standing at an average height of 1.60 meters in front of the Qaiwan Heights project. The 3D visualisation mimics a realistic viewing angle, showing how the increased height of residential buildings in the complex significantly reduces visibility of the natural Goizha Mountain behind the development. The study indicates a significant visual effect on the city's natural skyline and vertical buildings on its natural identity.

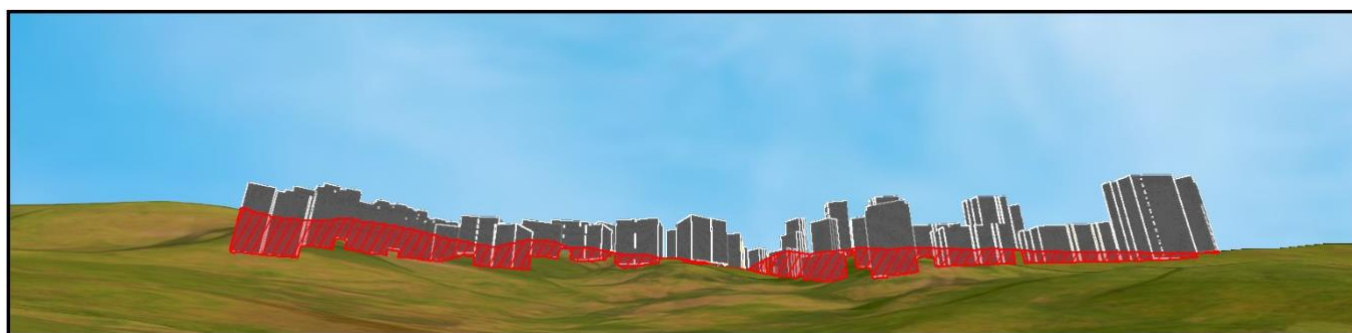


Figure 17. The obstructed area of Goizha Mountain by Qaiwan Heights residential towers, from the real point of view of a person of average height of 160 cm

The conclusion aligns with the study conducted in Nanjing (G. Zhang et al., 2023), which examines visibility and building height control in mountainous landscapes using a GIS model. The research employed a quantitative approach to examine vertical urban development in mountainous cities, revealing that excessively tall buildings distorted visual balance and diminished perceptions of the natural environment. The study classifies height-control strategies into three levels using a percentage-based parameter, where the percentage of the protected mountain landscape is represented as X:

- **Lenient:** [$X \leq 33.53\%$] (Low Mountain Visibility / High Development) [4].
- **Modest:** [$X \in 33.53\%, 66.87\%$] (Perceivable Mountain View / Medium Development) [4].
- **Strict:** [$X \in 66.87\%, 100\%$] (Relatively Integrated Mountain View / Low Development) [4].

The current study in Sulemani demonstrates a similar visual distortion, in which the vertical developments on Goizha Mountain affect the city's horizon line, thereby diminishing its natural appeal.

According to the classification of this research, the building height-control strategy in Qaiwan Heights complex is in the class of Lenient, where the mountain visibility is low, and the development is high, as the percentage of mountain visibility is found to be only 12%, which is lower than 33% from the study. The significance of integrating visibility-based analysis into planning processes to ensure visual stability within the mountain's urban environment is emphasised in both cases.

The research on Northern Cyprus [2], however, is more concerned with the visual influence of high-rise buildings on low-rise urban fabrics. Even though the study area, both geographically and morphologically, differs from that of Sulaimani, it uses a technique similar to the one used here, utilising viewshed analysis and modelling in ArcGIS. It is suggested that vertical multi-storey structures built in low-rise cities in Northern Cyprus cause skyline deformation, which, in turn, creates visual disparities along urban approaches. Likewise, the urban morphology of the high-rise residential buildings in Qaiwan Heights, Sulaimani, is compact, leading to visual disturbance and affecting the mountain background, deforming the city's natural form.

The GIS viewshed analysis revealed that 88% of Goizha Mountain is obscured by high-rise buildings in Qaiwan Heights, leaving only 12% visible from the viewpoint. This amount of obstruction is quite different than having a moderate blockage, where the mountain may still be recognised as a continuous background feature, but 88% of a continuous blockage in the mountain view and lack of visual corridors in-between the buildings, makes the mountain no longer function as a clear landmark or visual reference which weakens people's everyday visual connection with the natural landscape. To assess the reliability of the viewshed results, the analysis was repeated using slight variations in observer height and position. The overall visibility pattern and the proportion of obstructed areas remained consistent, indicating that the results are not highly sensitive to minor parameter changes.

For many years, Goizha Mountain has been an integral part of Sulaimani city's fabric, a defining feature that shapes its natural identity and collective memory among residents, as well as their sense of place. The city is visually and symbolically separated from its natural context when this landmark becomes lost and disappears. This is more than just the loss of a physical barrier; it affects how people perceive the city, how strongly they feel a sense of belonging to it, and how deeply they feel attached to it. Clearly, distorting this natural landmark reduces residents' feelings and sense of belonging. On a broader perspective, urban development with excessively tall buildings and high density prioritises man-made

features over natural ones, reducing landscape legibility and weakening the city's natural identity.

The results clearly demonstrate a dramatic reduction in visual accessibility to a culturally significant site and a natural landmark. Consistent with previous studies, the findings emphasise that visibility-oriented planning strategies in mountainous cities are strongly required to protect the visibility of landmarks and promote a sense of place in the city, while preserving the natural environment and its visual cultural connection with the city.

5. Conclusions and Recommendations

This study examines results that highlight the importance of integrating residential developments with natural features to ensure that mountainous cities like Sulaimani harmonise with their environments. The analysis demonstrated that residential development, when disintegrated with the topography and visual characteristics of a context, results in the loss of natural identity, ecological balance, and visual continuity. The contradiction between architectural form and its relationship to context in Qaiwan Heights illustrates how urban expansion driven by economic or functional needs can fragment the natural landscape and erode significant sites, such as Goizha Mountain.

In environmental terms, altering natural slopes in mountainous regions through cutting, building high retaining walls, and constructing buildings results in a significant reduction in vegetation, which, in turn, promotes erosion and undermines the soil's organic cohesion. The limited visibility of natural environments results in an alienation between residents and their environment, thereby distinguishing society from the environmental characteristics that historically define Sulemani's identity. On the other hand, the distortion of the natural context may compromise the city's attractiveness to visitors and tourists.

This study emphasises the necessity for context-sensitive urban design and planning frameworks to address visibility analysis, topographic adjustments, and essential design parameters of regions. The GIS-based units in the planning process, such as display analysis, assist decision-makers in identifying and mitigating visual conflicts between artificial and natural environments. According to the visibility analysis and the loss of mountain legibility observed in this research, there are some practical, implementable recommendations we believe urge Sulaimani or other similar mountainous cities to consider:

1. Viewshed-based Height Regulation:

Maximum building heights should be tied to a GIS viewshed analysis based on major public

viewpoints. In areas with major natural landmarks, new developments should be permitted only if they do not exceed the defined threshold for visual obstruction of the natural features, particularly mountain skylines.

2. Mountain Ridge and Skyline Protection Zones:

Designating mountain ridges and upper slopes as visual protection zones, with a forbidden or restricted policy toward building heights. In these zones, building heights should step down towards the mountain to maintain the overall continuity of the natural skyline.

3. Categorised Zoning Controls:

A categorised zoning framework is recommended depending on the degrees of visibility identified through viewshed modelling, from strict control zones (high visibility sensitivity) to moderate, then to low control zones. Higher-density development should be positioned in the areas of low visual sensitivity.

4. Mandatory Visual Impact Assessment:

In mountainous areas, high-rise residential developments should require a visual impact assessment, in combination with human-eye-level 3D visual simulations, before design approval. This would enable planners and designers to assess distortions or obstructions during early design phases.

5. Integration into Planning Regulations:

Visibility criteria should be formally integrated into local planning codes, alongside density and land-use regulations, so that natural landmarks remain visible to residents and support the city's identity and people's sense of place.

Study Limitations and Possible Future Extensions

It is necessary to acknowledge the limitations of the viewshed methodology. The viewshed analysis does not account for trees or small natural obstacles and only assesses whether a natural feature is visible. However, it does not analyse the quality of the view, in terms of colours, textures, depth, or seasonal variations, which are also relevant for how places are experienced and form identities.

With a multi-view visibility approach, future research may expand current methodologies. Carrying out viewshed analyses from several observer points within an area representing different public spaces, streets, and residential areas could impart a comprehensive landscape visibility assessment across the urban landscape. On the other hand, the GIS visibility analysis could be combined with perceptual questionnaires and participatory tools to improve the correlation between quantified visual obstruction and residents'

experience, aiding in more comprehensive, context-sensitive planning strategies for mountain cities.

Data Availability Statement: The datasets generated and analysed during the current study are included within the article. Additional GIS and visibility analysis data are available from the corresponding author upon reasonable request.

Declaration of Competing Interest: The authors declare that they have no known competing interests.

Research Involving Human/Animal Participants: This article does not involve any studies conducted by the authors on animals or human participants.

References

- [1] U. N. D. o. Economic and S. Affairs, *World urbanization prospects: The 2018 revision*. UN, 2018. <https://doi.org/10.18356/b9e995fe-en>
- [2] M. Jaghlit, A. Özsaş-Akçay, and M. Eyyamoğlu, "Visual Impact of High-Rise Buildings on the Surrounding Environment: A Case Study in Northern Cyprus," in *Proceedings of the international conference of contemporary affairs in architecture and urbanism-ICCAUA*, 2024, vol. 7, no. 1, pp. 551-561, doi: <https://doi.org/10.38027/ICCAUA2024EN0155>.
- [3] Y. Xie, Y. Zhao, W. Liu, X. Bai, and H. Xu, "Exploring the impact of urban development on mountain view visualization using a GIS-based landscape assessment model: a case study in Lishui, China," *Geocarto International*, vol. 39, no. 1, p. 2322697, 2024, doi: <https://doi.org/10.1080/10106049.2024.2322697>.
- [4] G. Zhang, S. Cheng, and Y. Gao, "A visibility-based approach to manage the vertical urban development and maintain visual sustainability of urban mountain landscapes: A case of Mufu Mountain in Nanjing, China," *Environment and Planning B: Urban Analytics and City Science*, vol. 51, no. 2, pp. 384-400, 2023, doi: <https://doi.org/10.1177/23998083231177058>.
- [5] E. Dai, Y. Wang, L. Ma, L. Yin, and Z. Wu, "'Urban-Rural' gradient analysis of landscape changes around cities in mountainous regions: a case study of the Hengduan Mountain region in southwest China," *Sustainability*, vol. 10, no. 4, p. 1019, 2018, doi: <https://doi.org/10.3390/su10041019>.
- [6] N. A. Al-Ansi, B. Uddin, A. Alhrabi, and J. Wahid, "Impacts of Urban Growth Policy on Loss of Identity in Expanding Saudi Cities: A Case Study of Buraydah," *International Journal of Sustainable Development & Planning*, vol. 18, no. 10, pp. 2975-2987, 2023, doi: <https://doi.org/10.18280/ijstdp.181001>.
- [7] A. Yaran, "Investigating the aesthetic impact of tall buildings on urban landscape," *Journal of Building Performance*, vol. 7, no. 1, pp. 1-8, 2016.
- [8] P. Legutko-Kobus, M. Nowak, A.-I. Petrisor, D. Bărbulescu, C. Craciun, and A.-I. Gârjoabă, "Protection of environmental and natural values of urban areas against investment pressure: A case study of Romania and Poland," *Land*, vol. 12, no. 1, p. 245, 2023, doi: <https://doi.org/10.3390/land12010245>.
- [9] G. Zeng, D. Zhao, X. Chen, and X. Wang, "Architectural design methods for mountainous environments," *Journal of Asian Architecture and Building Engineering*, vol. 22, no. 5, pp. 2596-2612, 2023, doi: <https://doi.org/10.1080/13467581.2022.2160212>.
- [10] X. Wang, H. Wen, B. Gui, Z. Liu, and L. Yang, "Urban terrain, mountain landscape, and housing price: A heterogeneous investigation of the amenity effects in a mountainous city (Guiyang) from the vertical dimension," *Applied Geography*, vol. 174, p. 103479, 2025, doi: <https://doi.org/10.1016/j.apgeog.2024.103479>.
- [11] T. B. Larsen, "Life Takes Place: Phenomenology, Lifeworlds, and Place Making," *The AAG Review of Books*, vol. 8, no. 1,

- pp. 3-5, 2020, doi: <https://doi.org/10.1080/2325548X.2020.1689039>.
- [12] M. Akkar Ercan, "'Evolving' or 'lost' identity of a historic public space? The tale of Gençlik Park in Ankara," *Journal of Urban Design*, vol. 22, no. 4, pp. 520-543, 2016, doi: <https://doi.org/10.1080/13574809.2016.1256192>.
- [13] K. Lynch, *The image of the city*. MIT press, 1964.
- [14] D. Viviroli, H. H. Dürr, B. Messerli, M. Meybeck, and R. Weingartner, "Mountains of the world, water towers for humanity: Typology, mapping, and global significance," *Water resources research*, vol. 43, no. 7, 2007, doi: <https://doi.org/10.1029/2006WR005653>.
- [15] E. Bernbaum, *Sacred mountains of the world*. Cambridge University Press, 2022. <https://doi.org/10.1017/9781108873307>
- [16] B. ZHANG, Z. Yuxiang, C. ZHENG, and X. Guangtong, "Building Height Control Strategy for Qingyuan Mountain Area in Quanzhou, Fujian in the Relationship of "Mountain– City" Overlooking," *Landscape Architecture*, vol. 31, no. 7, pp. 122-130, 2024, doi: <https://doi.org/10.3724/j.fjyl.202309150422>.
- [17] J. Sukwai, N. Mishima, and N. Srinurak, "Balancing cultural heritage conservation: visual integrity assessment to support change management in the buffer zone of Chiang Mai historic city using GIS and computer-generated 3D modeling," *Land*, vol. 11, no. 5, p. 666, 2022, doi: <https://doi.org/10.3390/land11050666>.
- [18] B.-C. Kim, S.-N. Kim, and Y. Joo, "Visual impact control of urban waterfront development on the background mountain view: Examining its justifiability through two types of immersive virtual reality experiments," *Environmental Impact Assessment Review*, vol. 106, p. 107500, 2024, doi: <https://doi.org/10.1016/j.eiar.2024.107500>.
- [19] C. C. Marcus and W. Sarkissian, *Housing as if people mattered: Site design guidelines for the planning of medium-density family housing*. Univ of California Press, 1986. <https://doi.org/10.1525/978052090879>
- [20] D. H. Morad Aldoski and H. Sevinc, "A Sustainable Residential Building Model in North Iraq by Considering Occupant Behaviour, Sociocultural Needs, and the Impact on Energy Use," *Sustainability*, vol. 16, no. 9, p. 3651, 2024, doi: <https://doi.org/10.3390/su16093651>.
- [21] B. A. J. Leupen and H. A. F. Mooij, *Housing design-a manual*. NAI Publishers, 2011.
- [22] L. P. Nguyen, P. E. van den Berg, A. D. Kemperman, and M. Mohammadi, "Social impacts of living in high-rise apartment buildings: The effects of buildings and neighborhoods," *Journal of urban affairs*, vol. 47, no. 8, pp. 2894-2915, 2025, doi: <https://doi.org/10.1080/07352166.2024.2311165>.
- [23] S. Lehmann, "Sustainable urbanism: towards a framework for quality and optimal density?," *Future cities and environment*, vol. 2, no. 1, p. 8, 2016, doi: <https://doi.org/10.1186/s40984-016-0021-3>.
- [24] A. Tonkin, *Sustainable medium density housing: A resource book*. Development Action Group Cape Town, 2008.
- [25] H. Pineo, "Towards healthy urbanism: inclusive, equitable and sustainable (THRIVES)—an urban design and planning framework from theory to praxis," *Cities & health*, vol. 6, no. 5, pp. 974-992, 2020, doi: <https://doi.org/10.1080/23748834.2020.1769527>.
- [26] K. Rana, "Sustainable Housing as a Social Determinant of Health and Wellbeing," *Sustainability*, vol. 17, no. 16, p. 7519, 2025, doi: <https://doi.org/10.3390/su17167519>.
- [27] S. Bafna, "Space syntax: A brief introduction to its logic and analytical techniques," *Environment and behavior*, vol. 35, no. 1, pp. 17-29, 2003, doi: <https://doi.org/10.1177/0013916502238863>.
- [28] I. Bentley, S. McGlynn, G. Smith, A. Alcock, and P. Murrain, *Responsive environments*. Routledge, 1985. <https://doi.org/10.4324/9780080516172>
- [29] M. Carmona, "Place value: Place quality and its impact on health, social, economic and environmental outcomes," *Journal of urban design*, vol. 24, no. 1, pp. 1-48, 2018, doi: <https://doi.org/10.1080/13574809.2018.1472523>.
- [30] Y. Jabareen, "Teaching sustainability: A multidisciplinary approach," *Creative Education*, vol. 2, no. 4, pp. 388-392, 2011, doi: <https://doi.org/10.4236/ce.2011.24055>.
- [31] S. Yannas, "Solar energy and housing design," vol. 2, 1994. London, U.K: Architectural Association Publications.

- [32] E. P. Mora, "Life cycle, sustainability and the transcendent quality of building materials," *Building and environment*, vol. 42, no. 3, pp. 1329-1334, 2007, doi: <https://doi.org/10.1016/j.buildenv.2005.11.004>.
- [33] T. Beatley, *Green urbanism: Learning from European cities*. Island press, 2000.
- [34] Y. R. Jabareen, "Sustainable urban forms: Their typologies, models, and concepts," *Journal of planning education and research*, vol. 26, no. 1, pp. 38-52, 2006, doi: <https://doi.org/10.1177/0739456X05285119>.
- [35] F. Dai, C. F. Lee, and Y. Y. Ngai, "Landslide risk assessment and management: an overview," *Engineering geology*, vol. 64, no. 1, pp. 65-87, 2002, doi: [https://doi.org/10.1016/S0013-7952\(01\)00093-X](https://doi.org/10.1016/S0013-7952(01)00093-X).
- [36] D. R. Montgomery, "Soil erosion and agricultural sustainability," *Proceedings of the National Academy of Sciences*, vol. 104, no. 33, pp. 13268-13272, 2007, doi: <https://doi.org/10.1073/pnas.0611508104>.
- [37] J. Gu, X. Wang, and G. Liu, "Rediscovering the amenity value of urban landscapes in the mountainous areas with high-rise buildings from the perspective of 3D vertical urban systems," *Urban Forestry & Urban Greening*, vol. 60, p. 127018, 2021, doi: <https://doi.org/10.1016/j.ufug.2021.127018>.
- [38] S. S. Mohammed, H. Q. Rasul, and H. D. Mohammed, "GIS-based Spatial Analysis of the Evolution of Residential Developments; A Case-study of Sulaimani city, Iraq," *Kurdistan Journal of Applied Research*, vol. 8, no. 2, pp. 9-33, 2023, doi: <https://doi.org/10.24017/science.2023.2.2>.