# Climate change related urban transformation and the role of cultural heritage

Matthias Ripp & Christer Gustafsson
(Eds.)


Foreword by Claire Cave

IL Sileno Edizioni

Geographies of the Anthropocene

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Matthias Ripp & Christer Gustafsson
*Editors*

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*Climate change related urban transformation and the role of cultural heritage*

Matthias Ripp, Christer Gustafsson (Eds.)

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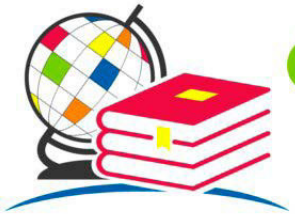

Geographies of the Anthropocene

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# Geographies of the Anthropocene

Open Access and Peer-Reviewed series

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The book series “Geographies of the Anthropocene” edited by the Scientific International Publisher “Il Sileno” (Il Sileno Edizioni) will discuss the new processes of the Anthropocene epoch through the various worldviews of geoscientists and humanists, intersecting disciplines of Geosciences, Geography, Geoethics, Philosophy, Socio-Anthropology, Sociology of Environment and Territory, Psychology, Economics, Environmental Humanities and cognate disciplines.

Geoethics focuses on how scientists (natural and social), arts and humanities scholars working in tandem can become more aware of their ethical responsibilities to guide society on matters related to public safety in the face of natural hazards, sustainable use of resources, climate change and protection of the environment. Furthermore, the integrated and multiple perspectives of the Environmental Humanities, can help to more fully understand the cultures of, and the cultures which frame the Anthropocene. Indeed, the focus of Geoethics and Environmental Humanities research, that is, the analysis of the way humans think and act for the purpose of advising and suggesting appropriate behaviors where human activities interact with the geosphere, is dialectically linked to the complex concept of Anthropocene.

The book series “Geographies of the Anthropocene” publishes online volumes, both collective volumes and monographs, which are set in the perspective of providing reflections, work materials and experimentation in the fields of research and education about the new geographies of the Anthropocene.

“Geographies of the Anthropocene” encourages proposals that address one or more themes, including case studies, but welcome all volumes related to the interdisciplinary context of the Anthropocene. Published volumes are subject to a review process (**double blind peer review**) to ensure their scientific rigor.

The volume proposals can be presented in English, Italian, French or Spanish.

The choice of digital Open Access format is coherent with the flexible structure of the series, in order to facilitate the direct accessibility and usability by both authors and readers.

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# 4. The Vulnerability of Historic Urban Landscape Triggered by Improving Visibility

## The Case of Visual Integrity of the "West Lake Cultural Landscape"

*Yijin Zhang*[1]

**Abstract**

As air governance has achieved positive results, improving atmospheric visibility has expanded the range of sight. As a result, some heritage property, particularly Historic Urban Landscapes, have begun to face new threats from urbanization. Within these heritage sites, construction projects are restricted by visual analysis in order to preserve the spatial pattern or texture with historical value. Thus, this study helps establish the "Visibility Changes—Urbanization—Value of HUL" linkage model, discussing how the positive effects of air governance affect or even break the original balance between the city and the heritage.

As a typical Historic Urban Landscape, Hangzhou and its world heritage "West Lake Cultural Landscape" will be incorporated into this model to complete an empirical study. The actual scenario of visibility changes and urban expansion is utilized to explain the cumulative effect, which alters the visual integrity of the historical spatial pattern and thereby worsens the vulnerability of heritage. This study essentially employs Outstanding Universal Value to analyze the solutions to the various practical challenges faced by the property. Moreover, it is necessary to include potential impacts within the wilder settings into the heritage management framework and to improve heritage management processes and technologies to be much more methodical, forward-thinking, precise, and intelligent.

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**Keywords**

Visibility, Visual Integrity, Urbanization, Potential Vulnerability, Historic Urban Landscape

## 1. Introduction

As stated plainly in "UNESCO's Recommendation on the Historic Urban Landscape", the impacts of climate change as well as rapid and uncontrolled urbanization may cause fragmentation and degradation of Historic Urban Landscape (HUL). Besides, because of the incorporation of the broader urban context and its geographical setting (UNESCO, 2012), HUL is more sensible to changes in the natural and urban environment than any other ordinary World Heritage properties. Therefore, it is crucial to consider how heritage protection should respond to urbanization and climate change.

Approximately one-third of the World Heritage Sites on the "List of World Heritage in Danger" are threatened by excessive urbanization, which has resulted in a weakening of authenticity and integrity (World Heritage Centre, UNESCO, 2023), specifically including the disappearance of traditional urban textures due to historical building damage, boundary erosion caused by construction in the buffer zone, the visual integrity of historical city monuments destroyed by high-rise structures, etc. As can be seen, striking a balance between urbanization and heritage protection is difficult. As a result, heritage managers pay more attention to urban expansion, particularly the supervision of tall buildings. In the UK, for example, in addition to management requirements such as "Tall Buildings: Historic England Advice Note 4" (Historic England, 2022), there are also some specific practical manuals such as "Guidelines for Landscape and Visual Impact Assessment" (Landscape Institute, 2013) and "Visualization of Development Guidance" (Landscape Institute, 2019) that were released. Furthermore, for a monographic study on height restriction and visual integrity, several experts provide technical optimization alternatives for city planning and urban design for historical cultural cities such as Beijing (Wang, 2010) and Quanzhou (Wang, et al., 2016).

Climate change is a fairly broad topic, and studies on it tend to concentrate more on its negative aspects, including air pollution, rising temperatures, the recurrence of extreme weather, etc. (WU, et al., 2022). Among air pollution

studies, scientists such as Qu Jing (Qu, 2022) and Tan Chen (TAN, et al., 2019) concentrate on the disintegration and destruction of surface materials caused by air pollutants. However, research on the long-term effects of positive climate change is scarce. Improving air quality, for instance, is only mentioned as an example of potential future changes in "Guidance and Toolkit for Impact Assessments in a World Heritage Context" (UNESCO, et al., 2022), but has not been further discussed or studied. In order to close the research gap, this study uses improving visibility as starting point.

Without a doubt, both climate change and unrestricted construction impose a strain on heritage protection, but the combined impacts of them are dismissed. Even though "Guidance and Toolkit for Impact Assessments in a World Heritage Context" mentions that "the cumulative effects of several elements or projects may make a World Heritage property vulnerable and that other factors, such as climate change, may amplify the effects of a proposed action" (UNESCO, et al., 2022), it only draws attention to the impact of potential changes, but has not developed specific cases. This paper, however, in order to fill these research gaps, examines the medium mechanism of visibility under the linkage frame of "Visibility Changes—Urbanization—Value of HUL", forming a model that can demonstrate cumulative effects. Moreover, improving visibility derived from air quality improvement is used as a meta-change to study how it catalyzes the contradiction between urbanization and HUL protection.

The World Heritage property "West Lake Cultural Landscape" with vast urban geography is a classic example of HUL. The West Lake is surrounded on three sides by "cloud-capped hills" and on the fourth by the old town of Hangzhou, which is a unique city-lake-hills spatial landscape. The visual integrity of this characteristic landscape pattern is used as an example to demonstrate how the "Visibility Changes—Urbanization—Value of HUL" model works. On the basis of simulation outcomes, the development tendencies are explored in relation to the wilder setting and cumulative impacts. Based on these findings, mitigations for sensitivity induced by visibility changes and urbanization, in conjunction with actual heritage management, were developed. Additionally, it considers strategies for balancing the interests of more stakeholders, as well as developing more advanced and refined specifications for the current heritage management paradigm.

## 2. "Visibility Changes—Urbanization—Value of HUL"

### *2.1 Visibility and Urbanization*

Atmospheric visibility, which can represent the transparency of the atmosphere, is an essential measure of air quality. Human activities and pollutants produced alter air visibility under the combined action of meteorological elements (Baumer et al., 2008). Pollutant concentration, which is heavily influenced by urbanization, is a key and important influencing factor for visibility change (Chang et al., 2009).

The academic community generally believes that the urbanization process will be accompanied by a large number of infrastructure construction and real estate investment, which will increase demand for high-energy consumption and high-pollution products such as cement, coal, and steel, thereby exacerbating haze pollution (Hao, 2014). Existing research findings on the relationship between China's urbanization promotion and atmospheric governance show that there is a linear correlation between the level of urbanization and air pollution. Most cities' urbanization processes are still exacerbating air pollution, while in the eastern regions that are economically developed, there is a substantial "Inverted U" curve link between urbanization level and air quality. It has demonstrated that the increase in air pollution is not an unavoidable result of urbanization but a periodic manifestation of it (SHAO, et al., 2019). According to the "Ecological Modernization Theory", as the social economy progresses from the low to the middle stage, the ecological environment will worsen, while air pollution will be mitigated through technological innovation when urbanization progresses to a higher stage (Sadorsky, 2014).

It can be shown that widespread urbanization in the early stages will exacerbate air pollution; however, in the high-level development stage of urbanization, the government will regulate air pollution by a variety of means, including restrictions on urban construction behavior. As a result, while there is no direct causal relationship between urbanization and air quality, they do impact and constrain each other to some extent. In addition, the level of air quality correlates with visibility. Consequently, the link between visibility and urbanization is as follows: when urbanization increases air pollution, overall atmospheric visibility drops; when air pollution is appropriately controlled, visibility increases.

It is important to note that visibility in this study primarily refers to annual average visibility, indicating the overall shift trend of air quality when stated. In truth, instantaneous visibility is a figure that varies greatly affected by a variety of factors, such as aerosol concentration, air humidity, atmospheric stability, and so on. Taking Hangzhou as an example, the monthly average visibility is better in the summer and worse in the winter. Besides, the daily visibility is typically poor between 7:00 and 8:00 a.m., while the best visibility occurs around 15:00, and the gap between their values can be more than 5 kilometers (Liu, 2018).

### *2.2 Visual Analysis for HUL*

For HUL, it is essential to maintain a sustainable balance between the urban and natural environments, although there is frequently conflict between them. Therefore, it is especially vital to limit construction height and scale with landscape approaches in order to preserve historical spatial characteristics, as indicated by the "Recommendation on the Historic Urban Landscape". There are some examples that many countries or locations around the world have performed exploration on landscape approaches. The "Visual Management System" was developed in the United States as early as 1970 (BILLINGTON, 1987). Paris had identified 45 landscape control regions as of 1999. Germany manages the urban landscape by building grading (Lv & Chen, 2019). London has an advanced HUL management system with defined tiers and linked systems, owing to its rich historical heritage. Since 1938, the London government has controlled the height of structures surrounding St. Paul's Cathedral and the Monument to the Great Fire of London by "Strategic View". The "London View Management Framework" published in 2012, set up a comprehensive high-level control system, identifying 27 "Designated Views", 13 "Protested Vistas" and a number of "Protected Silhouettes" associated with world heritage in order to balance the conflict between historical visual protection and urban expansion (Mayor of London, 2012).

The core of the landscape approach is visual analysis. The book "Foundations for Visual Project Analysis" goes into detail about the physical ideas of visual analysis (air refraction, the effect of earth curvature on sight), visual physiology, and the basic paradigm (Smardon, et al., 1986). The visual analysis, which is a reasonable and scientific urban planning aid, is based on the human visual sense, in which people perceive urban space by "seeing", while urban landscape illustrates its visual worth by "being seen". Visual analysis

can quantitatively analyze the construction relevant to historical landscape viewing corridors and skylines, as well as in and between landscape nodes, and then convert people's spatial perceptions into quantifiable indicators in order to protect the historic skyline, texture, or space pattern.

### *2.3 Model with Visibility Changes as Meta-Change*

According to the study above, there is a natural conflict between HUL and urbanization, and visibility has a correlation with urbanization. When Visibility Changes and Urbanization collaborate on heritage site, the "Visibility Changes—Urbanization—Value of HUL" linkage model (Figure 1) is produced, which will directly disclose HUL's vulnerability owing to changes in visibility.

Some unanticipated vulnerability of HUL has evolved in recent years as a result of extraordinary success in air pollution management. As air governance enhances visibility, allowing people to see farther during more periods, some proposed or even existing buildings will be seen in critical sight directions. When visibility was poor, these buildings were not visible, while now that visibility is good, they are exposed. However, these structures are frequently legally compatible. They got construction approval because they met heritage preservation standards, despite the fact that the standards were enacted at a time when visibility was previously poor. Consequently, changes in visibility have a cumulative effect on urbanization, which causes new problems for heritage protection.

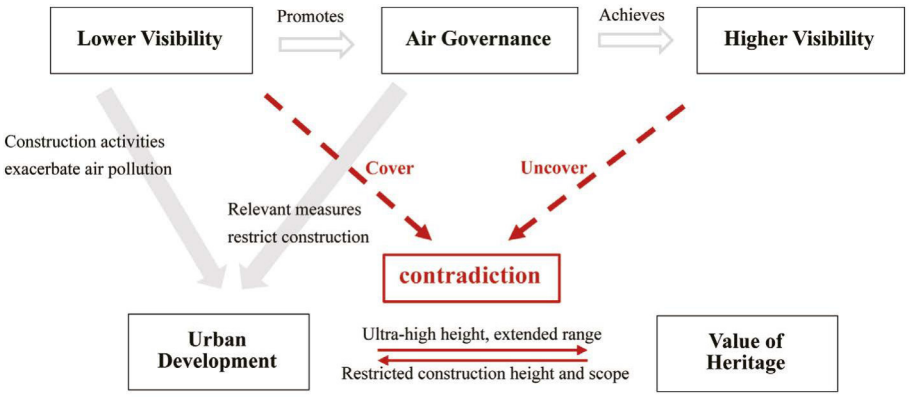


*Figure 1: The Interaction between Visibility Changes Urbanization Value of HUL Conservation - Imaged by author.*

*2.4 The Role of Visibility in the Model*

An obvious example can demonstrate how visibility variations affect different visual experiences. The two photos (Figure 2) were shot at different levels of visibility, and they were taken in the same location with the same


*Figure 2: Photos of the Same Scene with a Visibility Difference of more than Five Times Photograph taken by the author in 2023.*

camera settings to reduce the influence of insignificant elements. It is seen that the city behind the mountain ranges goes from being plainly visible to virtually invisible, and the view interaction between the lake and the city is quite different when the visibility varies by more than five times.

In fact, "air with specific visibility" acts as the medium or even a mask in the "Visibility Changes—Urbanization—Value of HUL" interaction paradigm. When visibility is low ("mask" with low transparency), the degree of invisibility of the city is higher, meaning that tolerance for construction within the context of heritage value is higher. However, even buildings that originally adhered to the heritage protection standards may have a detrimental influence on heritage value owing to being "re-seen" after the visibility is significantly improved ("mask" with high transparency). In other words, the level of visibility "determines" the extent to which the city impacts its heritage.

The greater challenge, however, stems from the volatility of this mask, because instantaneous visibility is not a constant value that might shift substantially over the seasons or even a single day. In other words, the same urban construction state will be perceived differently within varied degrees of visibility. The randomness and unpredictability caused by this have also posed significant obstacles to the harmony between heritage and city. Therefore, similar unexpected crises may arise near properties that are maintained based on visual analysis. In the context of China's rapid urbanization, the

balance between urban expansion and heritage protection is anticipated to be challenged more frequently as the "mask" becomes more transparent. Thus, heritage and city administrators should be on the lookout for such changes.

## 3. Visual Integrity of the "West Lake Cultural Landscape"

*3.1 Maintain the Authenticity and Integrity of the World Heritage "West Lake Cultural Landscape"*

The West Lake (Figure 3) is a "famous cultural lake" with water as its main scenery and culture as its key asset (Chen, et al., 2012). On the basis of criteria (ii), (iii), and (vi), the "West Lake Cultural Landscape" of Hangzhou was successfully inscribed on UNESCO's World Heritage List as a cultural landscape property in 2011.

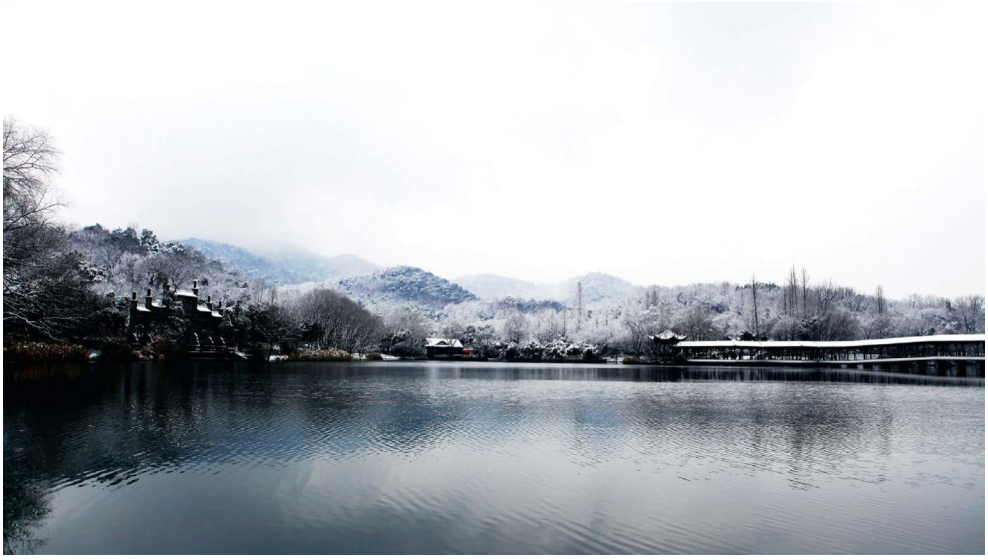

*Figure 3: Snow Scene of the West Lake - Photograph taken by the author in 2018.*

West Lake is surrounded on three sides by "cloud-capped hills" and on the fourth by the city of Hangzhou (Figure 4). It is a unique urban-lake spatial character that is essential to the authenticity and integrity of the heritage, as the World Heritage Committee emphasized in document "WHC-11/35. COM/8B" that "ICOMOS considers that it will be absolutely crucial that this skyline is maintained.

The State Party should give consideration to maintaining the skyline of hills to the north and south as viewed when looking east and ensure that there is no encroachment of the city behind those hills that are visible from the lake and that all relevant development is subject to a HIA that considers impact on the attributes of Outstanding Universal Value (OUV)" (World Heritage Committee, 2011).

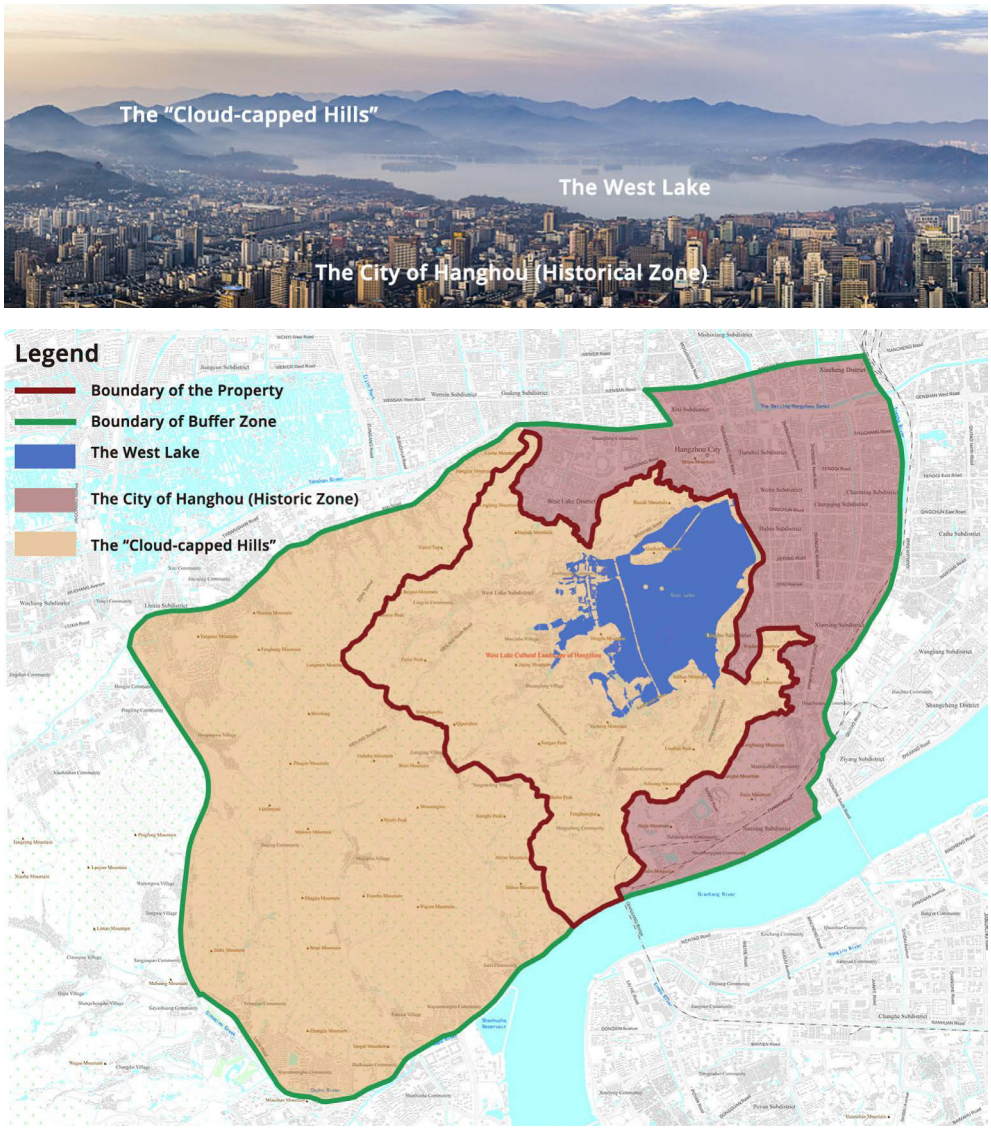


*Figure 4: The Unique City-Lake-Mountain Spatial Character*
*Imaged by author. Reference: Hangzhou Municipal Government, 2008. Planning for the Protection and Management of Hangzhou West Lake Cultural Landscape (2008-2020). Hangzhou: Hangzhou Municipal Government.*

*3.2 Measures to Limit Building Height in Hangzhou*

Similarly, "Planning for the Protection and Management of Hangzhou West Lake Cultural Landscape (2008-2020)" uses visual analysis to specify 20 viewpoints and 4 sight lines (Figure 5) to protect the distinctive spatial pattern, the integrity of the mountain skyline, as well as the urban landscape to the east of the lake. Look straight ahead from these crucial viewing zones when cruising around the West Lake, there should be no encroachment of the city behind those surrounding hills that are visible from the lake (Hangzhou Municipal Government, 2008).

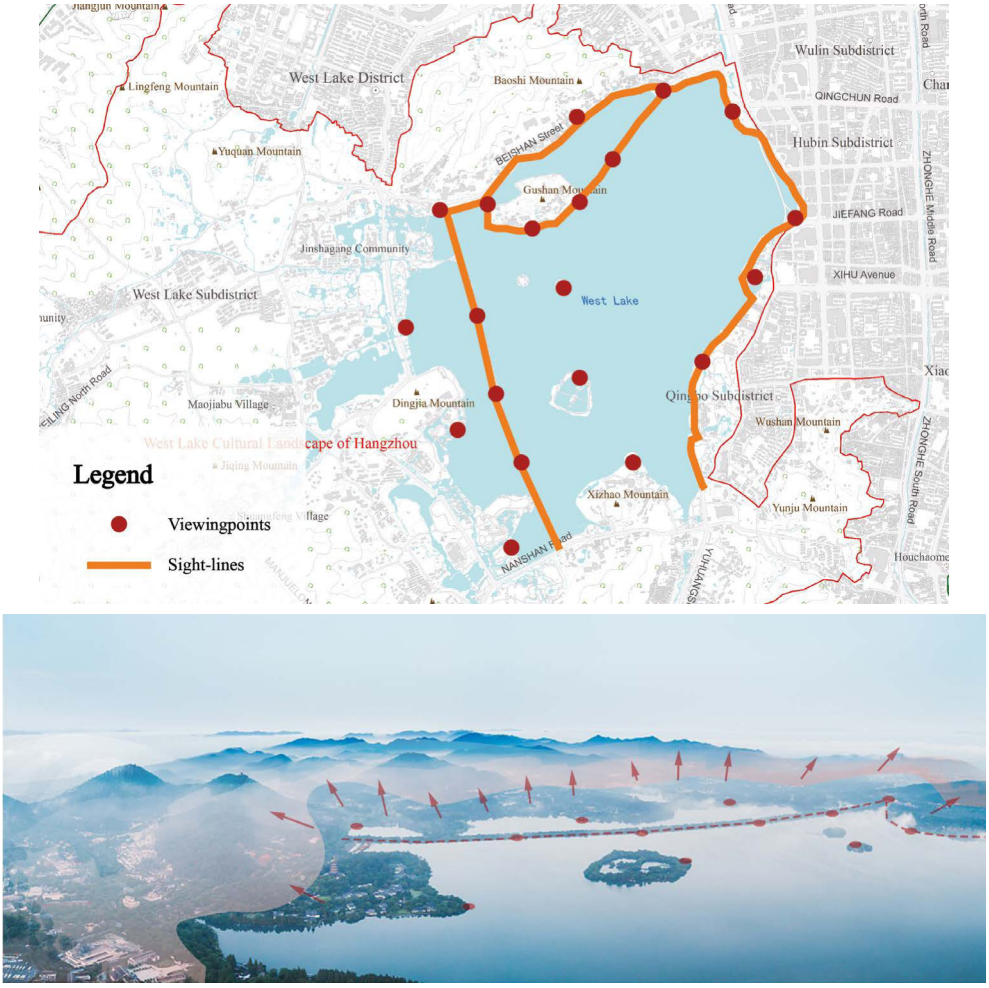


*Figure 5: The Viewpoints and Sight lines*
*Imaged by author. Reference: Hangzhou Municipal Government, 2008. Planning for the Protection and Management of Hangzhou West Lake Cultural Landscape (2008-2020). Hangzhou: Hangzhou Municipal Government.*

The "Planning for the Protection and Management of Hangzhou West Lake Cultural Landscape (2008-2020)" conducts visual analysis with 20 viewpoints and 4 sight lines, dividing the height control system of surrounding buildings into eight levels: 12 meters, 15 meters, 15-18 meters, 18-20 meters, 25-28 meters, 30-40 meters, 40-55 meters, and 55-70 meters (Hangzhou Municipal Government, 2008).

In addition to the aforementioned "Building Height Restriction Zones", a broader city region is designated as "Areas of Potential Impact" (Figure 6), whose boundary is approximately 12 kilometers away from the center of the West Lake. For the construction projects in this area, Hangzhou Municipal Government conducted a HIA at first, then further determined the features such as height, volume, and color.

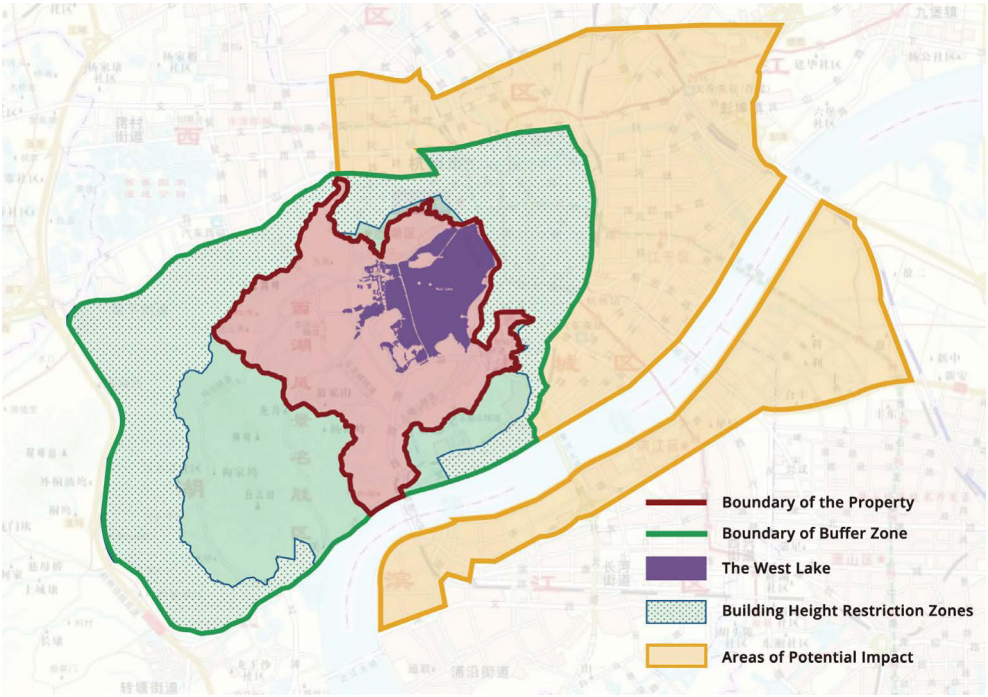


*Figure 6: Areas of Height Limitation*
*Imaged by author. Reference: Hangzhou Municipal Government, 2008. Planning for the Protection and Management of Hangzhou West Lake Cultural Landscape (2008-2020). Hangzhou: Hangzhou Municipal Government.*

### *3.3 Procedure for HIA of West Lake Cultural Landscape*

ICOMOS requires that "Impact assessment processes should be embedded in the management system of the World Heritage property" (UNESCO World Heritage Centre, 2021), so the Hangzhou Municipal Government promulgated the "Regulations on the Administration of Hangzhou West Lake Scenic Area" (Hangzhou West Lake Scenic Area Management Committee, 2011), requiring construction projects that may affect the OUV of West Lake Cultural Landscape to conduct HIA to ensure that the site selection, layout, height, volume, shape, style, and color are in harmony with the landscape and its surroundings. It is worth emphasizing that the Hangzhou Municipal Government formed this HIA process spontaneously, which is extremely different from when the World Heritage Committee or the UNESCO World Heritage Center demands the submission of an impact assessment. In addition, "HIA should begin at the earliest consideration of a proposed action", so the procedure of HIA (Figure 7) includes an encompassing survey, evaluation report authoring, collaborative review by multi-professional experts, online and offline public notification, and so on. After that, the outcome of the HIA will be

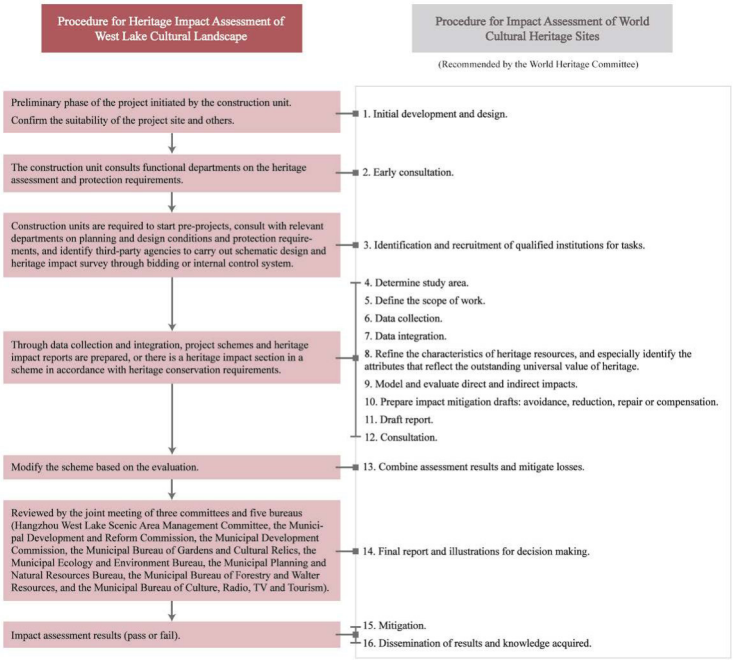


*Figure 7: Procedure for Heritage Impact Assessment of West Lake Cultural Landscape - Imaged by author.*

used for a joint meeting by three committees and five bureaus of the Hangzhou Municipal Government, affecting whether or not the project can be approved (UNESCO World Heritage Centre, 2021).

It has resulted in HIA being an essential venue for equal talks because it incorporates several parties in the decision-making process, including the government, management, stakeholders, and specialists from various sectors.

## 4. Empirical Case of "Visibility Changes Urbanization Value of HUL"

The "Planning for the Protection and Management of Hangzhou West Lake Cultural Landscape" issued in 2008 is still in effect today, mandating several heritage conservation and management criteria, including urban height limitations. Thus, 2008 is a significant time node in this study when analyzing and discussing the changes between now and then. The changes in the urban and natural environments of the West Lake cultural landscape since 2008 will now be incorporated into the "Visibility Changes—Urbanization—Value of HUL" model, and the potential impacts on the visual integrity or OUV of HUL will be disclosed.

### *4.1 Visibility Changes in Hangzhou*

Average yearly visibility in Hangzhou from 1994 to 2022 reveals a nearly "smiling" curve as the overall changing pattern (Figure 8). Annual average visibility declined from 1994 to 1999, fluctuated from 2000 to 2015, and has increased significantly after 2016, which reveals that air pollution governance in Hangzhou has been effective over the last ten years and visibility has improved. This is because Hangzhou has reduced air pollution over the years through a variety of measures, including reasonable planning of urban layout and transportation systems, more efficient use of land resources, and improvement of the actual efficiency of urban space, as well as strictly limiting construction activities to reduce site and road dust (Hangzhou Municipal Ecology and Environment Bureau, 2021).

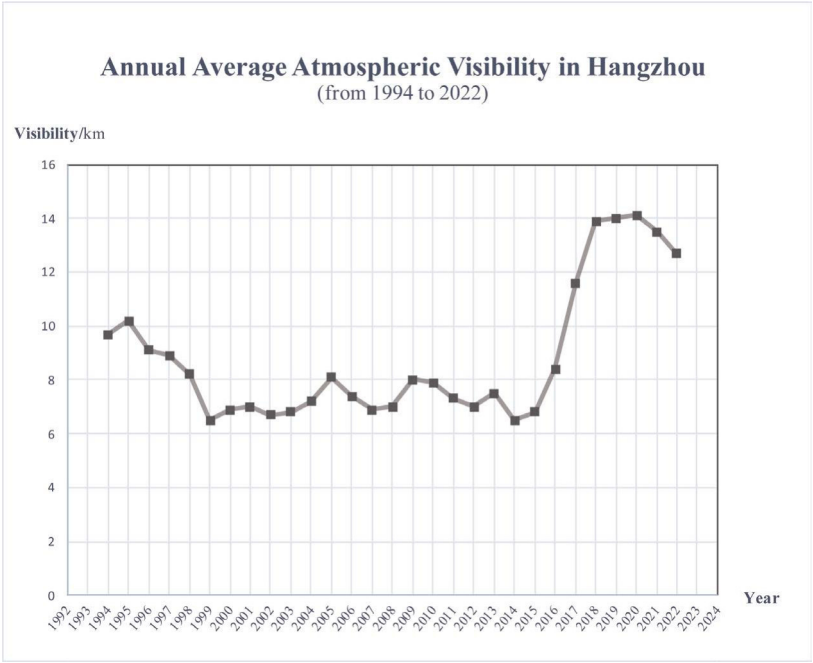


*Figure 8: Annual Average Atmospheric Visibility in Hangzhou (from 1994 to 2022). Imaged by author. Data Sources: Hangzhou National Reference Climate Station. Reference: Liu, R., 2018. Characteristics of Visibility and its Relationship with PM2.5 in Hangzhou from 1994 to 2017. Zhejiang Meteorology, 39(3), pp. 17-21*

### *4.2 Urbanization in Hangzhou*

China's economy has grown significantly in recent decades, and the urbanization rate has risen from 19.39% in 1980 to 64.7% in 2020 (National Bureau of Statistics, 2022). As one of the most economically developed areas in eastern China, Hangzhou has maintained a significant development rate, with an urbanization rate of 83.6% in 2022 (Zhejiang Provincial Bureau of Statistics, 2022), which is significantly higher than the national average.


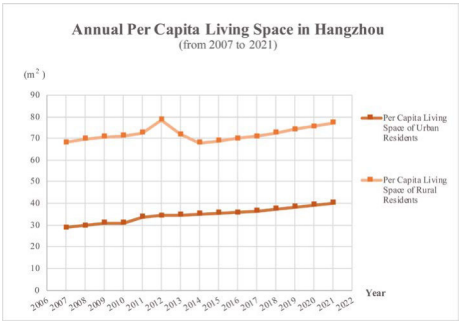



*Figure 9: Construction in Hangzhou (from 2008 to 2021)*
*Imaged by author. Data Sources: Hangzhou Municipal Bureau of Statistics, 2008-2022. Statistical Bulletin of Hangzhou National Economic and Social Development. [Online] Available at: http://tjj.hangzhou.gov.cn/col/col1229279682/index.html?uid=7298287&pageNum=2*

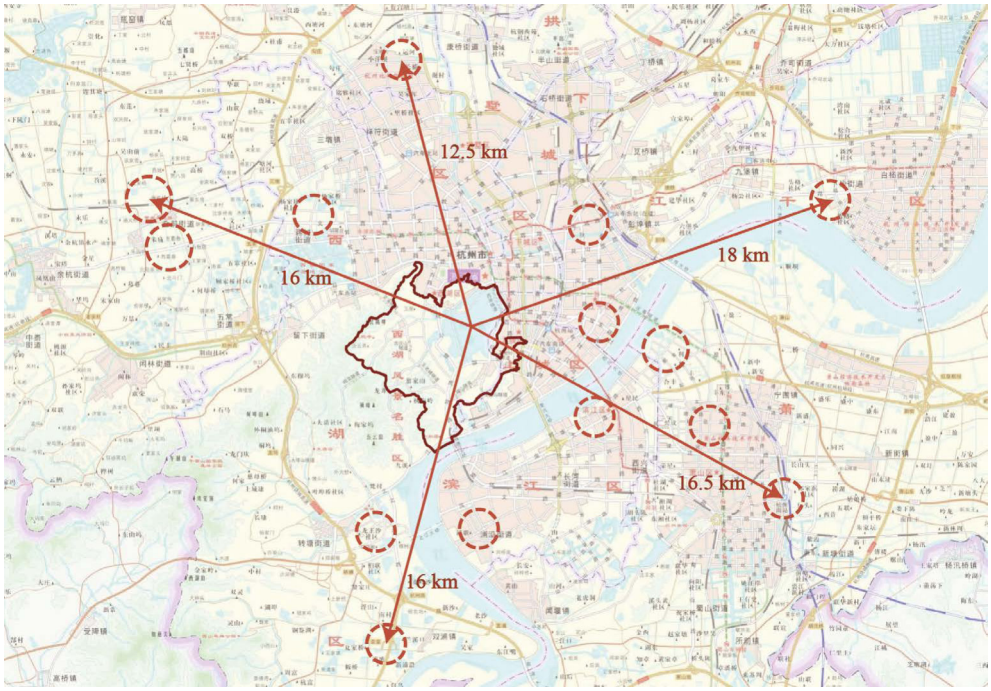


*Figure 10: The Proposed High-rise Complex in Hangzhou*
*Imaged by author. Reference: Hangzhou Bureau of Planning and Natural Resources, 2021. Explanation on the Acceptance of Public Participation Opinions in the Announcement of "Hangzhou Master Plan (2021-2035)" (Draft). [Online] Available at: http://ghzy.hangzhou.gov.cn/art/2021/9/7/art_1229369034_3930971.html*

From 2008 to the present, data on construction in Hangzhou (Figure 9) have generally increased, including infrastructure investment, construction value added, per capita living space of urban residents and rural residents, completed area of real estate commercial housing, and so on. In general, the total quantity of urban construction in Hangzhou has been increasing during the last fifteen years (Hangzhou Municipal Bureau of Statistics, 2008-2022). Furthermore, the "Hangzhou Master Plan (2021-2035)" projects that by 2035, Hangzhou will have diverse groups of super high-rise buildings (Figure 10), with a permanent population of around 15 million people (Hangzhou Bureau of Planning and Natural Resources, 2021).

### *4.3 Visual Analysis Simulation*

One of the 14 proposed high-rise complexes located roughly 17 kilometers from West Lake was chosen to run a visual analysis simulation. Assuming that people stand at one of the 20 viewpoints, stare at one skyscraper (assuming it is 300 meters high) of the high-rise complex. The visual simulation results reveal that, in theory, this tall building would be exposed behind the mountain (Figure 11). So, will this structure actually be exposed?

*Figure 11: Visual Analysis Simulation*
*Image Sources: Simulation Results from Hangzhou Planning and Design Institute.*

Because the average annual visibility has been above 12km since 2018, and the number of days with visibility above 20km has increased significantly, the likelihood of this building being seen is increasing even more, causing the building to appear and disappear. However, if the visibility is similar to

that of 2008, the average yearly visibility in Hangzhou was approximately 7km, and more than 80% of the days had visibility of less than 10 km (Hong, et al., 2019), making the building nearly impossible to expose practically. Therefore, even if the urban development situation remains constant, changes in visibility will significantly impact on visual integrity.

The simulation findings demonstrate that at the current visibility level, encroachment of the city is beginning to be visible behind the hill, which may threaten the heritage's integrity. Nevertheless, this structure is legal under the current heritage management system. In reality, it is completely unexpected that this tall building would damage the ridgeline's integrity, given that the existing management system places no constraints on construction beyond 12 kilometers from the lake (Figure 12). Outside theproperty area and the buffer zone, there is a larger area of potential impacts among the existing management system, but most of the high-rise clusters planned for the next 10 years are even outside this wilder area. If the same simulation is run for these planned tall buildings, the negative effects of exposure may reoccur and lead to even worse cumulative outcomes.

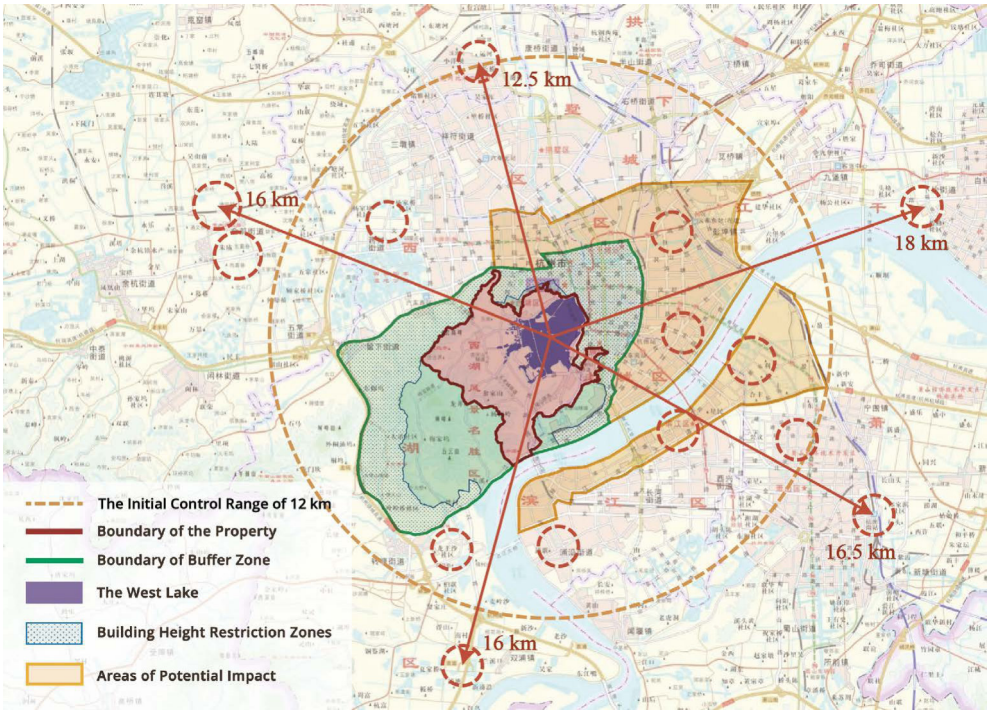


*Figure 12: The Initial Control Range within 12 km*
*Imaged by author.*

Therefore, it is revealed from the "Visibility Changes - Urbanization - Value of HUL" model that the relationship between heritage and the city, which was already difficult to achieve a balance, has become more precarious, and unexpected vacancies in urban management have quietly arisen.

Consequently, it must be evaluated as quickly as feasible that will the issue simulated above have to be resolved? How can this be resolved? And how can we avoid similar problems in the future?

## 5. Discussion

### *5.1 Is heritage Value Truly Threatened?*

The first point to address is whether the scenario depicted above genuinely affects heritage values. ICOMOS defines visual integrity as "maintaining the skyline of hills as viewed" with the specific constraint that "there is no encroachment of the city behind those hills that are visible from the lake" (World Heritage Committee, 2011). Thus, the heritage protection should base on the human sense of looking out, although computer-assisted analysis is essential when employing visual analysis. Similarly, Historic England issued the most recent "Tall Buildings: Historic England Advice" in 2022, and continues to emphasize how visualizations might best "reflect the human visual experience, particularly that from street level" (Historic England, 2022). Because the landscape approach is based on human viewing behavior, this form of analysis is fundamentally subjective and constantly changing in its randomness.

In truth, the simulation results of visual analysis are defined as "Zones of Theoretical Visibility" (Historic England, 2022), which are used to show the visual "line of sight" or catchment area from which a development can potentially be seen. As the human visual experience gains focus, what people can truly perceive requires greater thinking. The ability of human vision to perceive objects in the atmosphere is dependent on a variety of factors, including atmospheric qualities, distance between the object and the observer, physical characteristics of the item, and so on (Rao, 2010). First, based on current visibility levels, the simulation above predicts that the building behind the hills will be visible at times and invisible at others throughout the year, implying that this tall building is largely a looming shadow. Further-

more, human perception of spatial patterns differs from that of computers, as people observe the skyline of hills, they will reorganize the information they perceive and gain an overall picture. In other words, human perception will most likely interpret the distant, looming shadow as something on another layer that has nothing to do with the integrity of the hills' skyline. As a result, if the simulation result becomes reality, the influence on visual integrity or even heritage value will be limited. However, this does not mean that it can be disregarded, because the trend of urban expansion suggests that similar shadows will continue to appear. A looming shadow can be ignored by human vision, but a large-scale shadow cluster cannot, putting visual integrity at risk.

*5.2 How to Reduce Adverse Effects*

Although the possible implications of simulated buildings on visual integrity are limited, the greater risk is caused by the fact that city and heritage managers did not anticipate such potential impacts at present. It is possible that the structure might be discovered by chance after it reaches a certain height. In accordance with its emphasis on historical protection, the Hangzhou Municipal Government will promptly activate a reactive system. The next steps could be to immediately halt the construction project, organize a team of experts to conduct hazard analysis, and then take measures such as lowering the initial floor height, changing the facade style of the structure on the upper floors, and so on. It would result in large direct or indirect economic losses and significant coordinating strain on city administrators and heritage managers. Besides, due to the enormous amount of economic loss and compensation, reaching a consensus among the stakeholders will be difficult, increasing the risk of unfavorable outcomes such as project delays or even incompleteness.

Although the aforementioned reactive technique can fix the problem to some extent, the cost is prohibitively expensive. Obviously, identifying potential impacts and considering alternatives prior to project implementation is a superior strategy.

### *5.3 How to Deal with Potential Impacts in the Future*

#### *5.3.1 Visibility as Meta Change*

Although the tension between urbanization and heritage conservation has been exacerbated by successes in air governance, the favorable trend of visibility will continue because the government is still actively promoting environmental governance. In addition, the global climate governance system is being upgraded. The Transnational Municipal Network, for example, has been formed by the United States, the European Union, and other developed countries (Setzer, 2015). It is considerably more difficult to predict where the limit or threshold of visibility will be. Although the limit of visibility enhancement is not equal to the limit of human visual cognition, it is nevertheless required to "integrate urban heritage values and their vulnerability status into a wider framework of city development" (UNESCO, 2012).

#### *5.3.2 Wilder Settings*

The World Heritage Committee describes the city of Hangzhou's relationship with the lake as follows: "The lake is closed on its fourth side by a low-lying town that relates in scale to the overall landscape and is in itself beautiful (as Marco Polo described) (World Heritage Committee, 2011)". After thousands of years, despite the relative positions of the West Lake and the low-lying town keeps the same, the city of Hangzhou has expanded and encircled the West Lake, transforming it from being "on the west side" to "in the city". Consequently, the organizational relationship between the city and the lake has undergone tremendous shifts (Figure 13), so it is natural for the geographical relationship between the two to shift as well. Over the last few decades, Hangzhou has continuously absorbed other nearby cities and their residents, establishing a larger regional city, which provides the required managerial foundation for addressing potential impacts in wilder settings.

The "Centripetal City Theory" asserts that "balance in agglomeration" (Lu, 2022), which is the objective law of urban development, will continue to govern population concentration in major cities like Hangzhou. Indeed, by the end of 2022, Hangzhou's permanent population had grown from 8 million in 2008 to 12 million, with a projected increase to 15 million by 2035. There is an urgent need to widen the borders of heritage management in the face of blooming urbanization, but how can it be expanded in a sensible and feasible manner?

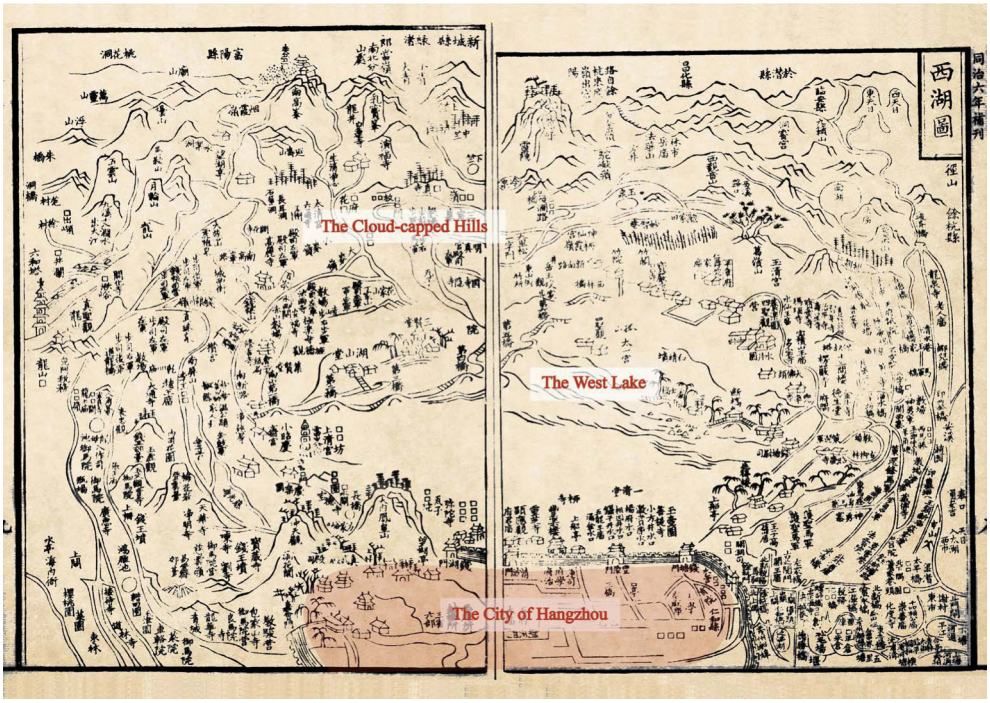


*Figure 13-1: Hangzhou and the West Lake in the Song Dynasty (10th-13th century A.D.)*

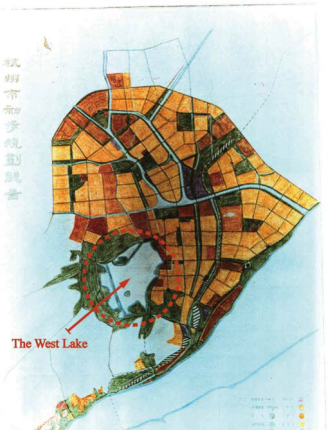


*Figure 13-2: Hangzhou and the West Lake in 1957*


*Figure 13-3: The Core Blocks of Hangzhou and the West Lake in 2023*

*Figure 13: Changes in Relationship between West Lake and Hangzhou*
*Image Sources: Que, W., 2000. Historical Illustrations of Hangzhou City and West Lake. Hangzhou: Zhejiang Public Press.*

In reality, current height regulations are effective in the relevant locations, nevertheless, the potential impacts of high-rise buildings in wilder settings have not been anticipated. Consequently, it merely needs to broaden regions of heritage sensitivity on the basis of the existing heritage management system, as well as be vigilant for tall building construction actions.

*5.3.3 Heritage Management should Have Boundaries*

Being aware of the potential impacts of tall buildings does not imply that they should be fully prohibited. Instead, an HIA of projected actions should be performed, with the impact on the OUV being assessed before deciding whether or not to implement them.

However, it is evident that heritage management should have boundaries, as suggested by various international documents that it is not completely unacceptable that the city has an impact on HUL. "Tall Buildings: Historic England Advice Note 4", for example, recommended that, when compared to dispersed tall buildings, a "well-defined, well-designed, integrated, and managed" tall building cluster can minimize cumulative impacts that may be harmful to the historic environment by delivering high densities (Historic England, 2022). This is essentially founded on the acceptance that high-rise structures must be created, with the goal of minimizing the impact on heritage rather than eliminating it entirely. Another important example is that ten years ago, the World Heritage Committee still praised that "the property's visual integrity toward the city side is well managed, considering the drastic urban changes of Hangzhou city over the past 10 years, from a regional town to a metropolis of eight million people", despite the fact that "Hangzhou with its tall buildings dominates the view to the east and tends to dwarf the lake buildings" (World Heritage Committee, 2011).

As a result, the perspective on heritage protection must shift in response to current urbanization situations. Given that Hangzhou's permanent population is expected to double by 2035, the connection between this "mega-new city" (Hangzhou Bureau of Planning and Natural Resources, 2021) and its heritage will definitely change. The city's relationship with HUL has always been fluid, so in the "Visibility Changes—Urbanization—Value of HUL" paradigm, heritage management is not absolutely prioritized above urbanization, and it is unreasonable to prioritize heritage while ignoring the regular necessities

of urban development. Therefore, the balance should be based on the best answer available in the current conditions, through multi-stakeholder debate and collaboration.

## 6. Conclusion

### *6.1 Keeping a Dynamic Balance*

Air pollution must be regulated, cities must continue to flourish, and cultural heritage must be preserved, the three exert impact and restraint on one another in the "Visibility Changes—Urbanization—Value of HUL" linkage model. Consequently, a balance of the three should be sought to ensure that the model does not collapse, rather than infinitely growing one component while suppressing the other two.

As the long saying "prevention is better than cure" has long reminded us, compared to emergency or rescue protection, prevention intervenes before issues even exist can maintain heritage value while sparing people and material resources. In today's increasingly complicated environment, heritage protection must be watchful for all types of changes, whether positive or negative, and respond quickly.

This study gives an example of cumulative impacts on heritage vulnerability, only focusing on the increased visibility and urbanization. Every World Heritage property is surrounded by a wider setting, which relates to the "property's topography, natural and built environment, land use patterns, spatial organization and visual relationships, and intangible dimensions such as perceptions and associations, social and cultural practices, etc. (UNESCO, et al., 2022)". In order to prevent these factors related to heritage sensitivity from adding up to create heritage vulnerability, even in unexpected ways, more forward-thinking and systematic preventive linkage systems must be established to combine multiple potential impacts in order to maintain the dynamic balance. When new projects are added to the system, these models will offer early warnings, allowing managers to execute HIA in a timely manner to limit risks in the early stages.

*6.2 Optimizing Management Tools*

The use of more intelligent tools will make it easier to improve management tools like HIA and visual analysis. Due to the numerous influencing factors involved in the property itself and its wilder setting, the use of computer-aided tools can establish a digital analysis platform that accumulates more factors, and can also have the ability to continually accept and conduct thorough analysis of later-appearing relevant elements in order to assist with overall urban governance. The benefits of intelligent tool-assisted analysis for visual analysis are even more obvious because it can provide a lot of accurate calculations from different angles. It is especially useful in a location with complex mountain formations like the West Lake Heritage Area, where viewers will see 360 degrees as they wander around the crucial viewpoints and sight lines. Consequently, to assist with the HIA, it is necessary to develop an objective digital analysis platform that can quantify the visual space of the urban landscape by researching the city's landscape pattern with digital tools such as GIS, computer science, 3D laser scanning technology, graphics, Python, and so on. Combined with factors that may cause heritage sensitivity such as visibility, natural and urban environments, the comprehensive and accurate analysis results obtained can aid in multi-dimensional evaluation for projected actions, maintaining the balance of heritage protection, as well as maximizing the balance of interests of all stakeholders.

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Starting with a systemic understanding of cultural heritage, climate-change related urban transformation processes are analyzed through a multi-disciplinary lens and methods that blend the arts, humanities, and sciences. Governance-specific topics range from relevant cultural markers and local policies to stimulate resilience, to a typology of heritage-related governance and the vulnerability of historic urban landscapes. A variety of contributions from the Americas, Asia, and Europe describe and analyze challenges and potential solutions for climate-change related urban transformation and the role of cultural heritage. Contributions focusing on innovation, adaptation, and reuse introduce the concept of urban acupuncture, adaptive reuse of industrial heritage, and how a historical spatial-functional network system can be related to a smart city approach. The potential role of cultural traditions for resilience is analyzed, as is the integration of sustainable energy production tools in a historic urban landscape. Examples of heritage-based urban resilience from around the world are introduced, as well as the path of medium-technology to address climate adaptation and prevention in historic buildings. The contributions emphasize the need for an updated narrative that cultural heritage can also contribute to climate adaptation and mitigation.

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