

<https://doi.org/10.1038/s40494-026-02381-2>

# Element mining, network associations and scene reconstruction of qiantang river poetry road literary allusion landscapes

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Literary allusions are a living gene pool for contemporary literary landscape inheritance. Focusing on the Qiantang River Poetry Road literary heritage corridor, this study innovatively constructing the Element Mining-Network Connection-Scenario Reconstruction analytical framework for poetic literary allusions. It develops a watershed literary gene map (228 standard allusion terms, 4229 allusion-related connection groups) to visualize implicit links between allusions and between allusions and their environments. Key findings: 1) Allusions and landscape elements show significant correlations; the upper, middle, and lower reaches have distinct allusion image clusters: boat hermitage, fishing hermitage, and tidal culture narrative systems. 2) Top-recognized scenarios: Autumn Waters Canoeing (44Wd), Misty Rain Solitary Angling (48Wd), Tidal Thunder Resonance (86Wd). 3) At the watershed-scale, patterns of Shared Allusion Motifs, Divergent Scene Typologies and Shared Scene Archetypes, Divergent Allusion Themes emerge. This study provides a context-specific reference model for the protection and activation of river-basin-based regional literary heritage corridors.

Literary landscapes serve as composite carriers of natural and humanistic elements: on the one hand, they rely on natural or humanistic landscapes; on the other hand, they endow these landscapes with new humanistic significance and aesthetic value through literary works. As a core component of literary works, literary allusions refer to ancient stories and terms with clear provenances, derived from classical texts of successive dynasties and quoted in literary creations<sup>1</sup>. As early as over 1500 years ago, *The Literary Mind and the Carving of Dragons*-a classic Chinese treatise on literary theory-stated that Shilei (allusions) are the essential elements of literary composition, emphasizing that allusions are pivotal to literary writing. In the 20th century, the academic work *The Art of Allusion in Victorian Fiction* further argued that the use of allusions is not merely a reproduction of existing culture, but more importantly, a creative reconstruction of regional culture. Today, allusions continue to exert significant value in fields such as the activation of cultural heritage and digital humanities, commercial innovation and brand semiotics, and educational reform and interdisciplinary narration.

As a bridge connecting nature and culture, allusions play a core role in the development of cultural tourism landscapes. For instance, Hangzhou's West Lake adopts various allusions-including scenic spots named after historical figures (the Ten Views of West Lake), relics related to historical

allusions, and poems by poets of successive dynasties-as cultural symbols. These allusions endow the natural lake landscape with profound cultural connotations, making West Lake a unique lake cultural landscape on the World Heritage List and embodying the ideal integration of human culture and the natural environment<sup>2</sup>. Beyond this, as a bridge connecting ancient and modern times, allusions vividly reflect changes in social moral orientations and have long served as a key vehicle for national education and moral cultivation. For example, The Parable of the Prodigal Son-a biblical fable from medieval Europe-conveys the themes of forgiveness and redemption. This parable shaped European society's perception of poverty and practices of relief, and continues to influence social governance concepts in Europe and even globally<sup>3</sup>. It is evident, therefore, that literary allusions constitute a living gene pool for the protection and inheritance of contemporary literary landscapes.

With the establishment of institutional protection frameworks by relevant international organizations, the innovation in digital protection technologies, and the exploration of public communication channels, the protection and inheritance of literary allusions have attracted widespread social attention. However, the living inheritance of literary allusion connotations currently faces severe challenges in regional practice. Phenomena

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such as the Shamanic creation myths of the Ewenki people in Northeast Asia being on the verge of functional extinction, a sharp decline in the number of inheritors of the African epic *Sundiata*, and the gradual disappearance of the recitation traditions of the mythological system in the Persian *Shahnameh* all indicate that: due to the obscurity and rarity of allusions themselves, coupled with the intense impact of contemporary multiculturalism, many traditional allusions—such as historical stories, myths and legends, and folk anecdotes—have lost their basic momentum for inheritance because they have lost their original cultural context<sup>4</sup>. Therefore, in response to this phenomenon, it is necessary for us to establish an open and shared regional literary allusion database. Fortunately, contemporary literary tourism research, represented by Kirwan and others, has excavated and refined typical regional literary allusion symbols such as Dickens' London<sup>5</sup>, Lu Xun's Shaoxing<sup>6</sup>, and Hemingway's Cuba<sup>7</sup>. This model has promoted the widespread dissemination of local literary branding; however, it still carries the risks of over-symbolization and fragmentation, which tend to overlook the complexity and diversity of literary connotations. Therefore, it is crucial to focus on the inherent relevance of allusions in the course of historical evolution (compared with isolated allusions, allusion image clusters composed of multiple overlapping allusions can better reflect the integrity of the cultural context of a specific region) and systematically promote the network-based and cluster-based mining of regional allusions<sup>8</sup>.

On the other hand, there has always been an inseparable inherent connection between allusions and environmental elements in Chinese and Western literature. Mrs. Dalloway, a pinnacle work of 20th-century modernist literature, continuously reinforces the series of allusions symbolizing the cycle and end of life from Shakespeare's *Cymbeline* by implanting natural images such as scorching sun and harsh winter into the urban streets of London<sup>9</sup>. Research on the former residences of Lu Xun and Lin Yutang—well-known Chinese literary tourism destinations—has found that historical buildings and landscape scenarios can largely arouse nostalgic experiences and emotional resonance among tourists. It can be seen that when literary landscapes are deeply integrated with the environment, they can trigger people's in-depth cultural interaction and scenario resonance, and their inheritance effect is often better<sup>10</sup>. For instance, Zhang et al.<sup>11</sup> confirmed through a study on Huangshan Scenic Area in China that even rainy and foggy weather—traditionally regarded as “bad weather”—can enhance tourists' positive aesthetic evaluation of the overall landscape due to the literary associations it evokes with legends, poems, and other literary works. Therefore, based on existing literary landscape relics, constructing allusion scenarios composed of interconnected natural and humanistic landscape elements can largely enrich the immersive aesthetic experience of literary landscapes<sup>12</sup>.

In summary, how can we explore the network of connections between literary allusions to achieve cluster-based rather than isolated excavation of these allusions? How can we construct literary scenarios that integrate allusions with natural and humanistic landscape elements, enabling scenario-based rather than exhibition-style presentation of literary allusions? Ultimately, it aims to protect and inherit the connotations of literary allusions in a more systematic and vivid manner, and realize the leap of literary landscapes from spatial carriers attached to texts to dynamic cultural and ecological arenas.

Fortunately, classical Chinese poetry, with its vast quantity and long history, is a brilliant pearl of world literature and serves as a dynamic material for the systematic excavation and scenario interpretation of literary allusions. During the period of imperial feudalism in China, poetry was regarded as the pinnacle of literary art and became an important basis for selecting officials through the imperial examination system. Thus, in a sense, all traditional Chinese scholars were poets, and poetry accounted for more than half of the collected works of Chinese scholars.

Furthermore, from *the Book of Songs* and *Songs of Chu* in the Pre-Qin period (Paleolithic Age—221 BCE), to Tang poetry and Song ci, and then to poetry of the Ming and Qing dynasties, the aesthetic paradigm of emotion-scene integration and the writing mode of conveying aspirations through objects were gradually finalized<sup>13</sup>. This writing structure determines the

extensive integration and connection of natural landscape elements, humanistic landscape elements, and allusion elements in classical poetry<sup>14</sup>. For example, through field surveys and tourism guide text analysis in the Three Gorges region and its surrounding areas, Yu & Xu found that poet-related allusions and landscape elements mentioned in poetry became the main objects of tourists' gaze. Poetry can enhance tourists' aesthetic appreciation of landscapes in both spatial and temporal dimensions; further, by developing the Literary Place Schema (LPS) framework, they verified the close connection between prior knowledge from literary texts and literary tourism behaviors and experiences<sup>15</sup>. It is evident that excavating allusion knowledge from classical poetry, extracting core landscape elements, and exploring the laws of combinations between elements are of great significance for enhancing the aesthetic experience of literary landscapes<sup>16</sup>.

Currently, traditional humanities research on the preservation and inheritance of literary allusions in classical Chinese poetry mostly adopts methods such as extensive textual research in philology and in-depth close reading of historical texts. Proceeding from a specific historical period<sup>17</sup>, a specific poet<sup>18</sup>, or a certain type of imagery<sup>19</sup>, such research explores the macro-level historical origins and micro-level rhetorical art of literary allusions. Meanwhile, relevant researchers possess diverse professional competencies and perspectives as linguists, historians, and philosophers, along with high-level literary expertise. This has laid a solid literary foundation, established interpretive paradigms, and developed aesthetic theories for subsequent studies on allusions; yet there remain issues worthy of attention regarding the structured acquisition and visualized expression of literary landscapes in the aforementioned research:

(1) Due to the broad elements, long history, and obscure semantics of literary allusions in classical Chinese poetry, manual identification is highly challenging. With the development of digital humanities technology, the construction of various classical poetry text corpora and literary allusion enhancement models<sup>20,21</sup> has provided a data and technical foundation for introducing natural language processing (NLP) methods into the research on literary allusions in classical poetry.

Common models for addressing this issue include the BERT-based retrieval model<sup>22</sup>, unsupervised Bayesian model<sup>23</sup>, and multi-task learning framework<sup>24</sup>. The BERT model improves semantic representation through pre-training on ancient books but relies on external dictionaries, resulting in relatively weak capability in detecting unregistered allusions<sup>22</sup>; the multi-task learning model enhances the identification of long-tail allusions through joint training, yet its annotation cost is extremely high, making it difficult to scale up<sup>24</sup>. However, the lightweight sequence model ALBERT+CRF can make up for these shortcomings. For instance, in the entity recognition of wine culture in *the Complete Tang Poems*, through parameter sharing and attention mechanism, this model not only maintains high accuracy but also significantly improves inference speed, making it particularly suitable for real-time parsing scenarios of classical poetry<sup>25</sup>. Therefore, this study selects ALBERT+CRF as the preprocessing model for literary allusions in classical poetry, aimed at balancing accuracy and efficiency to provide underlying support for the construction of a large-scale allusion knowledge base.

(2) The visual analysis of landscape scenarios has become an important approach to exploring the protection and inheritance of cultural landscape heritage. Corresponding text network visualization models have emerged, among which the Fast-Newman clustering algorithm and layouts such as ForceAtlas2 built into Gephi are widely applied in the semantic analysis of poetic texts<sup>26,27</sup>. These tools are suitable for the visual analysis of complex poetic texts characterized by overlapping semantic layers and intertwined temporal-spatial dimensions<sup>16</sup>. For example, Li et al. focused on the protection and inheritance of the Zhedong Tang Poetry Road literary heritage corridor; by virtue of Gephi's modular algorithm, they realized the extraction of natural and humanistic landscape imagery along the Poetry Road and the visualization of clustered themes. However, its expression remains limited to textual semantic relationships, with insufficient concreteness and intuitiveness in presentation, making it difficult to directly guide the practical work of the living inheritance of heritage scenarios<sup>28</sup>.

Fortunately, with the development of Artificial Intelligence Generated Content (AIGC) technology, Stable Diffusion—an iconic AIGC tool—has demonstrated excellent performance in fields such as linguistics and design<sup>29,30</sup>. The study by Zhang et al. realized image generation based on text + spatial conditions through ControlNet technology, confirming the feasibility of AIGC in scenario concretization<sup>31</sup>. In addition, Jamil et al. combined the PoeKey algorithm with the Diffusion model, verifying the feasibility and effectiveness of integrating the Diffusion model into image generation from poetic literary texts; the research by Yousaf et al. further demonstrated how the Diffusion model transforms abstract poetic themes into visually engaging images<sup>30</sup>.

In summary, Gephi boasts advantages in semantic network deconstruction and logical relationship visualization, while Stable Diffusion excels in scenario concretization and dynamic narrative generation. Therefore, the combined application of Gephi and Stable Diffusion can serve as a valuable attempt to realize the transformation from poetic maps to the living activation of heritage<sup>32</sup>. Specifically, with Gephi as the front-end to generate more logical instructions, and Stable Diffusion 3 as the derivative tool to provide more vivid and concrete visual presentations, it is possible to construct a more complementary literary map of classical poetry allusion scenarios<sup>30</sup>.

Therefore, this study takes the Qiantang River Poetry Road Literary Heritage Corridor as its research object and innovatively constructs an analytical framework for poetic allusions featuring Element Mining—Network Connection—Scenario Reconstruction. Based on the ALBERT+CRF preprocessing model for literary allusions in classical poetry, a database of literary allusions and landscape elements along the Poetry Road is established. On this basis, by virtue of the association interpretation function of Gephi's semantic network and the text-to-image visual presentation technology of Stable Diffusion 3, the cluster-based mining of allusions is accomplished, and the scenario-based generation of allusions and their associated landscape elements is realized. This facilitates the living protection and inheritance of the overall cultural ecology of the Qiantang River Poetry Road, and provides a reference path for technology integration and mechanism innovation in the protection and inheritance of similar regional literary heritage corridors.

## Methods

### Study area and data sources

The Qiantang River Poetry Road has a total length of ~400 km, with the Qiantang River—Fuchun River—Xin'an River—Lanjiang River—Wujiang River—Qujiang River as its main route. It is another cultural heritage corridor following the Silk Road. During the Northern and Southern Song Dynasties, this area became the center of China's politics, economy, and culture, gathering numerous literati and witnessing frequent poetic exchanges. It carries the essence of Song Dynasty charm culture and serves as a model of Song Dynasty literary landscapes in China and even the world. In modern times, it has further developed into a gathering place of central cities in China's Yangtze River Delta, encompassing national historical and cultural cities and demonstration zones for ecological civilization construction in China. Its experience will provide extensive reference significance for the development of world historical cities<sup>33</sup>.

However, the current protection and utilization of the Poetry Road still face issues such as the ineffective exploration of regional cultural value, insufficient social recognition of the Poetry Road culture, and difficulty in evoking emotional resonance among tourists. Therefore, this study takes the Qiantang River Basin (28°04'N—30°24'N, 117°39'E—121°14'E) where the Poetry Road is located as the research scope. This basin covers an area of 33,076 square kilometers across the cities and counties along the route, including three reaches: the upper, middle, and lower reaches. It is expected to take the Qiantang River Basin as a typical case to explore the paths for the regional living inheritance of literary landscape heritage (Fig. 1).

The Song Dynasty represents the apogee of Chinese culture (as stated by Chen Yinke, a preeminent Chinese historian). Its allusion and imagery system reached the height of integrating essence and function. As a core

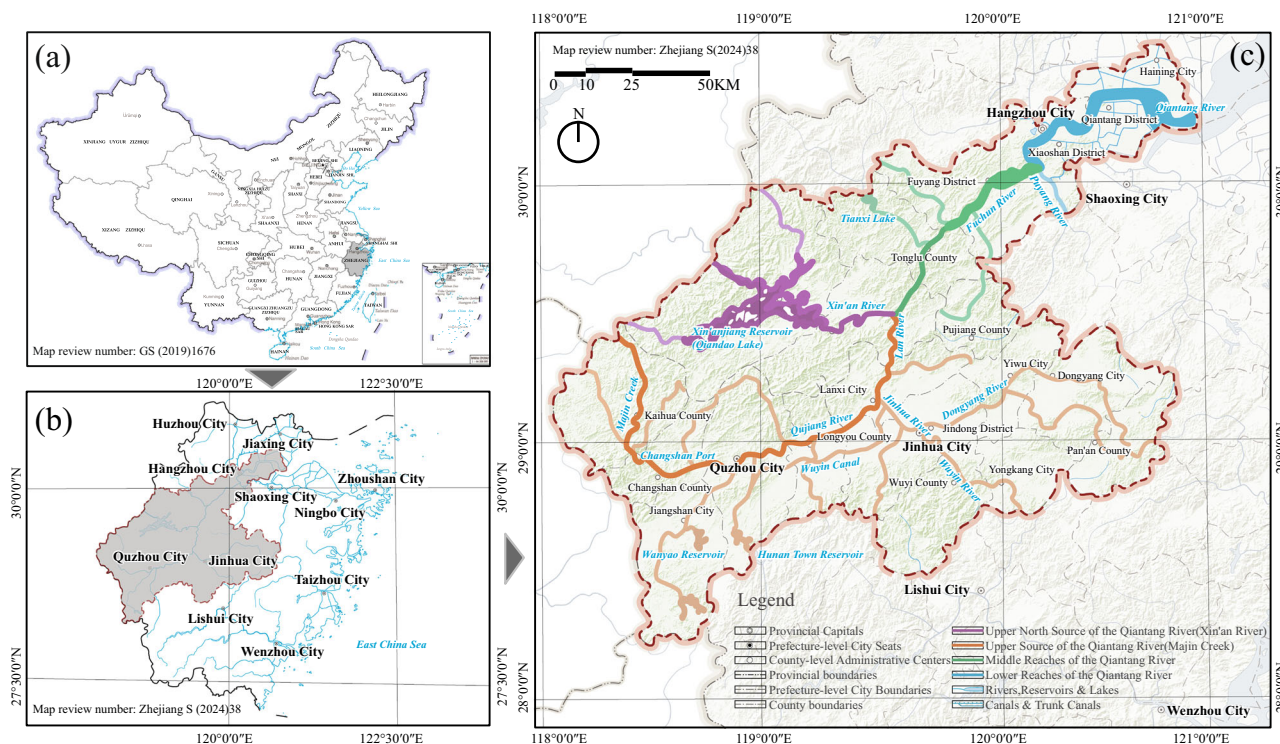
carrier of Song Dynasty charm culture, the poetry of the Song Dynasty associated with the Qiantang River inherits the traditions of Tang Dynasty poetry while integrating regional culture, thus possessing significant research value. The rationale for selecting this poetry as the object to study literary allusions is as follows: 1) Solid carrier foundation: The Qiantang River combines the attributes of a natural wonder (the massive tidal bore) and a humanistic hub adjacent to the capital of the Southern Song Dynasty, making it a frequently referenced imagery in Song Dynasty poetry. In *The Complete Song Poems*, there are over 500 poems mentioning the Qiantang River or Zhe River, covering works by great poets such as Su Shi and Lu You. This provides a stable carrier for allusions and meets the prerequisite for systematic research. 2) Comprehensive sample coverage: The poems contain three core categories of allusions: historical events (e.g., Qian Liu Shooting the Tide—a legendary story about Qian Liu, the founder of the Wuyue Kingdom, repelling floods by shooting at the tide), mythological legends (e.g., Tidal God Worship—folk beliefs in deities governing the Qiantang tidal bore), and pre-dynasty literary references (e.g., adapting imagery from Tang Dynasty poetry). These fully cover the main types of allusions and satisfy the needs of multi-dimensional research<sup>34</sup>. 3) Effective cultural interpretation: Allusions are deeply intertwined with the spiritual world of literati in the Song Dynasty. Poets like Xin Qiji and Lu You expressed scholar-officials' sense of responsibility, aesthetic appreciation of landscapes, and feelings of seclusion through allusions such as river tides and Yan Ziling's Fishing Platform. This enables the reflection of the Song Dynasty's cultural context and expands the cultural dimension of allusion research<sup>35</sup>. 4) Feasible historical material mutual verification: Allusions can form a closed loop with Song Dynasty documents. For example, Qian Liu Shooting the Tide is verified in *History of the Song Dynasty: Treatise on Rivers and Canals*, and Tidal God Worship is corroborated by *Memoirs of Wulin*. This forms an evidence chain of literary and historical materials and enhances the credibility of research conclusions.

Therefore, this study takes 683 Song Dynasty poetic texts (with a total of 46,060 Chinese characters) from *Selected Poems of the Qiantang River* (Anthology of Qiantang River Poetry, co-edited by the Provincial Poetry Federation and Hangzhou Publishing House, represents China's first authoritative compilation of Qiantang River-themed poetry spanning the Eastern Jin, Southern Dynasties, Sui, Tang, Five Dynasties, Song, Yuan, Ming, Qing, Republican era, and mid-20th century. This seminal work collects 2374 poems by nearly 500 poets, systematically organized into downstream, midstream, and upstream (northern/southern sources) sections following the river's upstream journey conceptual framework.) as research materials. These include 150 poems about the upper reaches by 63 poets, 233 poems about the middle reaches by 136 poets, and 301 poems about the lower reaches by 149 poets. These texts have been converted into an electronic dataset titled Qiantang River Poetry Road Song Dynasty Poetry Corpus.

Based on this, we innovatively constructed an allusion analysis framework featuring Element Mining—Network Connection—Scenario Reconstruction. Specifically, we applied the ALBERT+CRF deep learning model to achieve the structured recognition of allusions in Song Dynasty poetry; through Gephi's semantic network, we realized the association interpretation and cluster segmentation between allusions, as well as between allusions and their environments; and with the help of Stable Diffusion 3 (a generative AI tool) and GIS kernel density analysis, we enabled the visual scenario generation of literary allusion image clusters (Fig. 2).

### Recognition and validation of literary allusions in classical poetry based on the ALBERT model

The ALBERT (A Lite BERT) model is a lightweight pre-trained language model developed by the Google Research team<sup>36</sup>. Its core innovations lie in drastically reducing the model parameter scale through factorized embedding parameterization and cross-layer parameter sharing techniques, while introducing a sentence-order prediction task to enhance semantic comprehension capabilities. Technical implementations of the model are



**Fig. 1 | Study extent and environment of the upper, middle and lower reaches of the Qiantang River Poetry Road.** **a** Covers the scope of China’s map: the five-pointed stars on the map indicate Beijing, the capital of China; the solid concentric circles represent provincial-level administrative centers; the gray solid lines denote the boundaries of provinces, autonomous regions, or municipalities directly under the Central Government; the gray dash-dot lines stand for the boundaries of special administrative regions; and the gray-colored area represents the scope of Zhejiang Province, China. **b** Covers the scope of Zhejiang Province’s map: the concentric circles on the map indicate provincial-level administrative centers; the solid concentric circles represent prefecture-level city administrative centers; the black solid lines denote provincial boundaries; the blue-colored areas and irregular lines represent rivers, reservoirs, lakes, and canals; the combination of river channels and

blue short solid lines evenly distributed perpendicular to the river channels represent canals; and the red dash-dot lines indicate the scope of the Qiantang River Basin in Zhejiang Province. **c** Covers the scope of the Qiantang River Basin in Zhejiang Province: the orange solid lines on the map represent the Upper South Source of the Qiantang River (Majin Creek); the purple solid lines denote the Upper North Source of the Qiantang River (Xin’an River); the green solid lines stand for the Middle Reaches of the Qiantang River; and the blue solid lines represent the Lower Reaches of the Qiantang River. The base map is sourced from the Standard Map of China (<http://bzdt.ch.mnr.gov.cn/index.html>), and the scope of the Poetry Road is determined according to Document Zhe Zheng Fa [2019] No. 22 of the Zhejiang Provincial Government of China.

accessible via its official repository<sup>37</sup>. Replacing the traditional next-sentence prediction task with a sentence-order prediction loss function, ALBERT performs exceptionally well in natural language processing tasks such as named entity recognition (NER). It is particularly suitable for scenarios requiring accurate extraction of entity relationships in texts<sup>38</sup>.

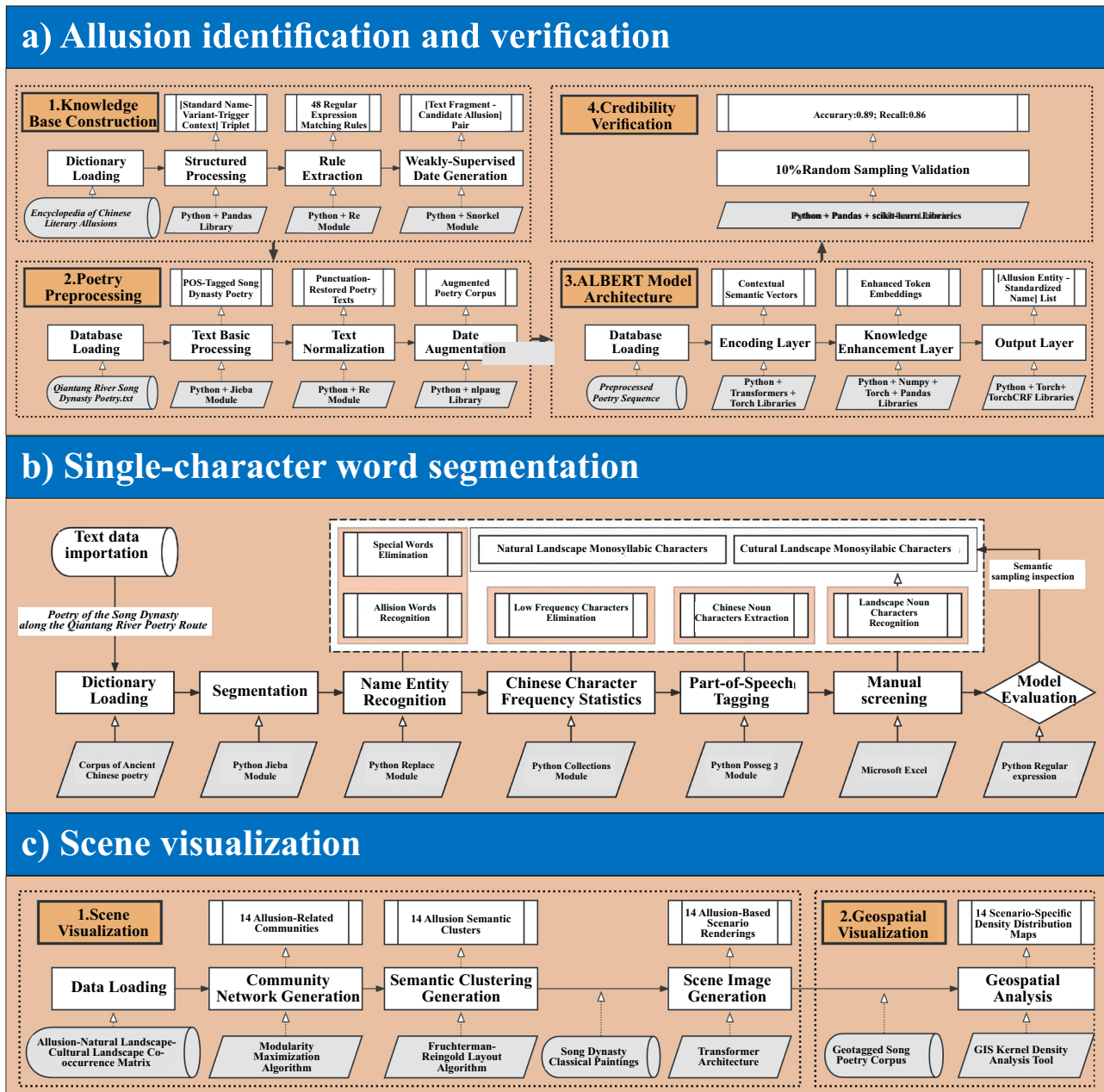
For this study, a structured knowledge base containing over 9,000 allusion entries was constructed based on *A Dictionary of Chinese Literary Allusions (Grand Dictionary of Chinese Allusions*, a National Tenth Five-Year Plan Major Publishing Project, constitutes the most comprehensive Chinese allusion reference to date. It catalogs 32,000 entries encompassing event-based allusions, phrase-based allusions, and their variants across four million characters, serving as an indispensable resource for literary and cultural studies. Contextual trigger rules for each allusion were extracted, and 48 regular expression matching rules were generated to form a weakly supervised data source. Further, the Jieba tokenizer was employed to conduct preprocessing tasks on the Song Dynasty Poems of the Qiantang River.txt corpus, including corpus construction, word segmentation, part-of-speech tagging, sentence segmentation, and punctuation normalization, followed by adversarial sample augmentation. Subsequently, a knowledge base-based attention enhancement module was integrated after the ALBERT encoding layer. For instance, when the model processes the term “Yan Fuzi”, it automatically increases the semantic association weight between “Yan Fuzi” and Yan Guang’s standard name. Ultimately, the “Structured Corpus of Allusions in Song Dynasty Poetry from the Qiantang

River Poetry Road” was generated, containing poem titles, alternative entity names, and standard allusion names.

Validation of the model’s reliability was conducted using core NER metrics such as Precision and Recall<sup>36</sup>. Given the uniqueness of Chinese allusion recognition, this study further adopted ALBERT’s evaluation method for Chinese NER and introduced a weighted F1-score by entity type. Metrics were calculated separately for subcategories such as “person-related allusions” and “geography-related allusions” before weighted integration, aiming to address the imbalance in entity type distribution in classical Chinese texts<sup>38</sup>.

(1) Precision focuses on the proportion of results predicted as allusions by the model that truly conform to the actual allusion entries; it essentially reflects the model’s ability to minimize misjudgments, specifically by preventing non-allusion content from being incorrectly included in the research samples. In this study, Precision is directly associated with the sample purity of subsequent allusion element mining and network correlation analysis. A high Precision value indicates that most of the allusions predicted by the model are authentic and valid, which can reduce invalid analyses on pseudo-allusions in subsequent work and ensure the reliability of the research data. The formula is as follows:

$$\text{Precision} = \frac{TP}{TP + FP} \times 100\% \quad (1)$$



**Fig. 2 | Technical framework of allusion identification and verification, single-character word segmentation, and scene visualization.** **a** Illustrates the processes of Knowledge Base Construction, Poetry Preprocessing, ALBERT Model Architecture, and Credibility Verification. Gray-colored blocks represent input modules or data; white rectangular blocks denote phased workflows; and white rectangular blocks with two vertical lines stand for phased output results. **b** Demonstrates the process of extracting single characters related to natural scenic elements and humanistic scenic elements through single-character word segmentation of Song Dynasty poems. **c** Presents the processes of Scene Visualization and Geospatial Visualization (Drawn by the author).

TP (True Positive) refers to the number of samples predicted as “positive” by the model with actual labels being “positive”. In this study, it specifically denotes the number of real allusion entries correctly identified by the model, where the content has been verified as authentic allusions through A Dictionary of Chinese Allusions and expert validation. FP (False Positive) refers to the number of samples predicted as “positive” by the model but with actual labels being “negative”. In this study, it refers to the number of entries predicted as “literary allusions” but verified as non-authentic allusions.

(2)Recall focuses on the proportion of all actual allusion entries that are successfully identified as allusions by the model; it essentially reflects the model’s ability to minimize omissions, specifically by ensuring that real allusions are extracted as completely as possible. In this study, Recall directly determines the coverage of allusions with respect to the literary allusions of

the Qiantang River Poetry Road. A high Recall value indicates that most of the real allusions are detected by the model, which can fully preserve the diversity of allusions (e.g., allusions related to historical events, myths and legends, and pre-Song Dynasty literature are all fully extracted). This provides comprehensive data support for subsequent research, including allusion network correlation analysis (such as the analysis of correlations between different types of allusions) and scenario reconstruction (such as the restoration of cultural scenarios of the Poetry Road based on a complete allusion database). The formula is as follows:

$$\text{Recall} = \frac{\text{TP}}{\text{TP} + \text{FN}} \times 100\% \tag{2}$$

TP is the same as in formula (1), i.e., the number of real allusions correctly identified by the model. FN (False Negative) refers to the number of samples with actual labels being “positive” but predicted as “negative” by the model. In this study, it refers to the number of real allusion entries existing in the annotation set that are not identified as “literary allusions” by the model.

(3) There is an inherent trade-off between Precision and Recall (for instance, increasing Precision may lead to a decrease in Recall, and vice versa). The F1-Score, which is the harmonic mean of these two metrics, serves to comprehensively evaluate the overall performance of the model, thereby avoiding the one-sidedness of relying on a single indicator. Its value ranges from 0 to 100%, with a value closer to 100% indicating better model performance. In this study, the F1-Score is the core comprehensive indicator for determining whether the ALBERT+CRF model is suitable for the research. Since the subsequent tasks of this study, including allusion element mining, network correlation analysis, and scenario reconstruction, all rely on allusion data that is both accurate and complete (requiring both the avoidance of noise and the minimization of omissions), the F1-Score can balance the requirements for both accuracy and completeness. A relatively high F1-Score indicates that the model performs excellently in terms of both accuracy and completeness, which can provide solid support for the scientific validity of subsequent research. The formula is as follows:

$$F1 - Score = 2 \times \frac{Precision \times Recall}{Precision + Recall} \times 100\% \quad (3)$$

Precision is the precision calculated by formula (1); Recall is the recall calculated by formula (2); The coefficient “2” ensures that precision and recall have equal weights in the harmonic process, avoiding the dominance of a single indicator. In this study, the F1-score is the core indicator for evaluating the comprehensive performance of the model.

### Monosyllabic word segmentation-based text mining of song poetry

In classical Chinese, especially in classical poetry composition, monosyllabic words account for over 80%. It can be said that single-character nouns are key to summarizing the core semantics of classical poetry<sup>39,40</sup>. Therefore, in this study, after excluding proper nouns such as allusions, place names, and personal names, functions such as Replace(), Collections(), and Posseg() in Python programming were used to perform single-character segmentation and part-of-speech tagging on Song Dynasty Poems of the Qiantang River.txt. Low-frequency single characters (appearing fewer than 2 times) and meaningless single characters were cleaned, resulting in the “Landscape Element Monolexemic Lexicon of Qiantang River Poetry Road in Song Dynasty” (containing a total of 703 monosyllabic landscape nouns).

Referring to the practices of literary landscape studies by Li et al., Qiao et al.<sup>26</sup>, and Xu et al.<sup>16</sup>, the landscape elements were classified into single characters for natural landscape elements (394 characters) and single characters for humanistic landscape elements (309 characters) according to landscape types. Finally, credibility sampling validation was conducted on the resulting dataset of landscape single characters using Python regular expressions<sup>16</sup>.

### Monosyllabic word segmentation-based text mining of song poetry

Semantic association, a key feature of human language, implies a wealth of valuable information<sup>41</sup>. Drawing on the preprocessing methods proposed by Li et al. and Xu et al.<sup>16</sup>, this study used the Python Replace function and took Catalogue of Literary Allusions in Song Dynasty Poems of the Qiantang River Poetry Road.csv and List of Single Characters for Landscape Elements in Song Dynasty Poems of the Qiantang River Poetry Road.txt as filter criteria. The 684 Song Dynasty poems were converted into sequences of allusion landscape elements, natural landscape elements, and humanistic landscape elements, and a co-occurrence matrix was constructed for co-occurrence semantic network analysis. Gephi is an open-source network

visualization and analysis platform developed under the leadership of an interdisciplinary team from the French National Center for Scientific Research and École Centrale Paris. Currently, it has become one of the widely used standardized tools in the field of network science. It supports the calculation of various network metrics such as centrality analysis, modular clustering, and path analysis, and possesses real-time visualization capabilities for large-scale networks. Gephi has been widely applied in fields including epidemiology, biomedicine, and bibliometrics. Therefore, this study utilized metrics such as modular computing, weighted degree, and edge weight, as well as the Fruchterman-Reingold layout algorithm in Gephi 0.10.1 software. An intuitive textual semantic graph layout was generated to reveal the implicit structure within the complex poetic semantic network. Co-occurrence semantic network scenarios for the upper, middle, and lower reaches of the Qiantang River Poetry Road were automatically generated around literary allusion imagery clusters, respectively. Finally, the study selected the top three clusters in terms of average weighted degree for further analysis in each of the upper, middle, and lower reaches (see Section 3.2).

(1) Edge weight is a core indicator for measuring the tightness of connections between nodes in a network, and provides a weighting basis for subsequent weighted degree and modular analysis. In this study, the total co-occurrence count of two nodes in Song Dynasty poems was taken as the quantitative basis for edge weight, which reflects the actual intensity of co-occurrences between allusions or landscape elements in the Song Dynasty poems related to the Qiantang River Poetry Road. The formula is as follows:

$$W_{ij} = \sum_{k=1}^n f_{ijk} \quad (4)$$

Where  $W_{ij}$  denotes the edge weight between node  $i$  and node  $j$ ;  $f_{ijk}$  represents the co-occurrence count of the two nodes in the  $k$ -th text (a co-occurrence count of 1 is recorded for one occurrence, counts are accumulated for multiple co-occurrences, and 0 is recorded for no co-occurrence); and  $n$  stands for the total number of texts included in the analysis.

(2) The average weighted degree of nodes is used to quantify the intensity characteristics of node connections in a network, and its core lies in incorporating the calculation of edge weight based on traditional degree centrality. In the literary allusion network of the Qiantang River Poetry Road, nodes represent landscape imagery or allusion themes, and edge weight is defined as the intertextuality frequency between two nodes (e.g., allusion citations, imagery co-occurrence counts). The selection of this parameter can effectively distinguish between high-frequency intertextual allusions and incidental connections and reveal the radiation intensity of core imagery. The formula is as follows:

$$k_w(i) = \sum_{j \in \tau(i)} w_{ij} \quad (5)$$

Where  $\tau(i)$  denotes the set of adjacent nodes of node  $i$ , and  $w_{ij}$  denotes the edge weight between node  $i$  and node  $j$ .

(3) Modularity is used to evaluate the strength of a network’s community structure and quantify the density difference between intra-community connections (connections among nodes within a community) and inter-community connections. In this study, a community corresponds to a semantic cluster of literary allusions along the Poetry Road. Based on the Louvain algorithm proposed by Vincent D. Blondel et al., the community structure is optimized iteratively in two stages by calculating the modularity gain ( $\Delta Q$ ) of node movement:

$$\Delta Q = \frac{k_{i,new}}{m} - \frac{k_i \sum \text{tot}}{m^2} \quad (6)$$

Where  $k_{i,new}$  denotes the sum of edge weights between node  $i$  and all nodes in the target community  $C_{new}$ ;  $\sum \text{tot}$  represents the total weighted degree of all nodes within the target community  $C_{new}$ ;  $k_i$  stands for the

weighted degree of node  $i$ ;  $m = \frac{1}{2} \left( \sum_{i,j} A_{i,j} \right)$ , where  $m$  denotes the total edge weight of the entire network.

$$Q = \frac{1}{2m} \sum_{i,j} \left[ A_{ij} - \frac{k_i k_j}{2m} \right] \delta(c_i, c_j). \tag{7}$$

Where denotes the edge weight between node  $i$  and node  $j$ ;  $k_i$  represents the total weighted degree of node  $i$ ;  $m$  stands for the total network weight;  $\delta(c_i, c_j)$  is an indicator function that determines whether node  $i$  and node  $j$  belong to the same community. It takes a value of 1 if the two nodes are in the same community, and 0 otherwise. The Q-value ranges from [-0.5, 1). When the Q-value falls between 0.3 and 0.7, it indicates that the clustering effect is favorable<sup>42</sup>.

### Monosyllabic word segmentation-based text mining of song poetry

Stable Diffusion 3 is a text-to-image generative model based on the Multimodal Diffusion Transformer (MMDiT) architecture. Compared with other open-source models of the same type, it features higher text adherence and image quality<sup>29</sup>. In this study, Stable Diffusion 3 was used to convert the semantic groups of literary allusion clusters in Song Dynasty poetry into concrete landscape images. The specific process is as follows: 1) Prompt engineering: Prompts were designed with a three-tier structure: “core allusion + poetic context + landscape attribute”; 2) Parameter configuration: The image resolution was set to 768 × 768, the Classifier-Free Guidance (CFG) value was set to 8.0 (to enhance text relevance), and Rectified Flow was selected as the sampling method; 3) Result validation: A two-layer verification mechanism was adopted to ensure effectiveness: Semantic consistency with the landscape descriptions in the original poems; Consistency with diverse historical materials such as ancient books, historical maps, and ancient paintings. Based on the verification results, prompts were revised to finally generate reasonable and artistic scenario images.

GIS kernel density analysis is a classic method for quantifying the spatial agglomeration characteristics of geographical elements. Its core principle is to calculate the spatial distribution density of elements through a kernel function and generate a continuous density surface to reveal agglomeration hotspots. In this study, kernel density analysis was used to visualize the geographical distribution characteristics of literary allusion cluster semantic groups. The calculation formula is as follows:

$$\hat{f}(x, y) = \frac{1}{nh^2} \sum_{i=1}^n K\left(\frac{d_i}{h}\right). \tag{8}$$

Where  $\hat{f}$  denotes the kernel density value at any point  $(x, y)$  in space;  $h$  represents the search radius (only elements within a distance  $\leq h$  from the target point  $(x, y)$  are included in the calculation);  $n$  refers to the total number of geographical element points to be analyzed within the circular area centered at  $(x, y)$  with radius  $h$ ; if an element point is beyond the radius  $h$ , it is excluded from the density calculation for point  $(x, y)$ ;  $d_i$  represents the straight-line distance from the  $i$ -th element point ( $i=1, 2, \dots, n$ ) to the target point  $(x, y)$ .

Ultimately, this study achieved dual visualization of images and space, with mutual validation between the two: Stable Diffusion 3 converted abstract cluster labels into perceptible landscape imagery, while kernel density analysis quantified their geographical distribution patterns.

## Results

### Statistical analysis and validation of representative allusions

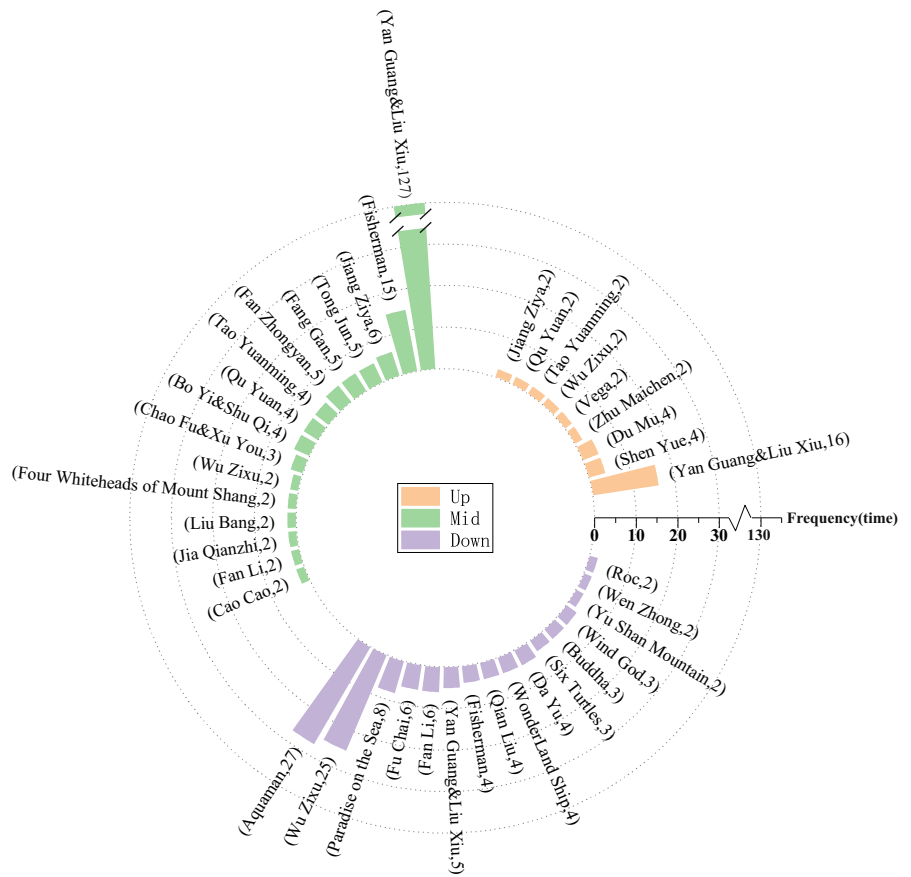
Based on the structured allusion data sequences (comprising poem titles, alternative entity names, and standard allusion names, Supplementary Tables 1–3) obtained through deep learning, this study identified a total of 533 allusion occurrences using standard allusion entries as the basis-

equivalent to an average of 0.78 literary allusions per Song Dynasty poem. The results indicated that “Yan Guang & Liu Xiu” (148 Fr) was the most frequently occurring allusion across the entire basin, followed by “Wu Zixu” (29 Fr), “Aquaman” (27 Fr), and “Fisherman” (19 Fr) (Fig. 3). Further validation using core metrics including Precision, Recall, and F1-Score showed that the model achieved an overall Precision of 0.89, Recall of 0.86, and F1-Score of 0.87. In the specialized evaluation for low-frequency allusions (entries with a frequency  $\leq 5$ ), all three metrics exceeded 0.75. Compared with models using BERT as the pre-trained backbone, the proposed model demonstrated significant improvements in both overall performance and recognition accuracy for low-frequency allusions<sup>43</sup>. This aligns with the conclusion put forward by Zhou et al. (2023) that “pre-trained language models (e.g., ALBERT) have advantages in fine-grained entity recognition in ancient texts”<sup>43</sup>, further verifying the reliability and applicability of ALBERT +CRF for literary entity recognition in poetry (Table 1).

Among the findings, “Yan Guang & Liu Xiu” ranked as the most frequent allusion in both the upper and middle reaches of the Qiantang River Basin. The Book of the Later Han: Biographies of Hermits clearly records that Yan Guang “lived in seclusion on Fuchun Mountain, making a living by farming and fishing.” The “Fuchun Mountain” mentioned herein refers to the location of Yan Ziling’s Fishing Platform in present-day Tonglu County, Zhejiang Province, which belongs to the Fuchun River Basin—a tributary of the Qiantang River’s middle reaches. Meanwhile, Meicheng is situated in the upper reaches of the Qiantang River. A Study of Plums in Meicheng (Meicheng Meihua Kao) notes that Yan Guang once assisted Liu Xiu in planting plum trees and constructing a city here to fend off enemies. Although this claim lacks support from official historical records, it spread through literary notes such as the Ming Dynasty’s Supplements to the Records of West Lake Tours, gradually integrating Yan Guang’s image into the origin narrative of Meicheng. Additionally, leveraging its superior geographical location at the “confluence of three rivers,” Meicheng became a hub for Huizhou merchants traveling eastward and the transportation of goods from western Zhejiang to other regions. Such strong geographical mobility facilitated the dissemination of allusions alongside commercial activities. Therefore, despite Yan Guang being a native of Yuyao in Kuaiji, he was transformed into a cross-regional shared cultural heritage through the association of landscapes like Yan Ziling’s Fishing Platform in the upper and middle reaches of the Qiantang River.

The most frequent allusion in the lower reaches of the Qiantang River Basin was “Aquaman.” Through the literary device of “multiple denominations for a single allusion,” this reference reinforced Wu Zixu’s symbolic image as a loyal, righteous, and vengeful figure in the history of the Wu-Yue rivalry, as well as his role as a meritorious figure in water conservancy development against the backdrop of Jiangnan’s hydrological projects. Records of the Grand Historian: Biography of Wu Zixu defined Wu Zixu as a “resolute man of honor” and praised his forbearing spirit of “abandoning petty righteousness to avenge great humiliation,” establishing him as a core reference for later literati in shaping tragic heroic characters. Local gazetteers such as Yuejue Shu, Gazetteer of Yanzhou Prefecture, and Gazetteer of Hangzhou Prefecture emphasized Wu Zixu’s foundational role in “dredging rivers for navigation,” which laid the groundwork for commerce in the lower reaches of the Qiantang River. Furthermore, Records of the Seasons in Jingchu records that “the dragon boat races during the Duanwu Festival in the Eastern Wu were associated with Wu Zixu—a tradition predating the legend of Qu Yuan. Over time, the “Tidal God Worship” ceremony and Tide-Watching Festival held on the 18th day of the eighth lunar month in the lower reaches gradually merged, forming a trinity of local folk activities: “Worshipping Wu Zixu, Dragon Boat Racing, and Composing Poems on the Tide.” This elevated Wu Zixu to a collective memory in the construction of Duanwu Festival customs. With the inheritance and superimposition of historical narratives, specialized records on water conservancy, and folk beliefs, Wu Zixu’s image evolved from a historical figure to the “Guardian Deity of Jiangnan’s Water Towns,” becoming a symbolic vehicle for poets to eulogize the prosperity of the regional economy.

**Fig. 3 | Comparison of allusion quantities across river segments.** This figure shows the core allusions and their frequency in the upper, middle, and lower reaches of the Qiantang River. Up indicates Upstream, Mid indicates Midstream, Down indicates Downstream. Orange-colored blocks represent the core allusions and their frequency in the upper reaches of the Qiantang River Basin; green-colored blocks denote those in the upper-middle reaches of the Qiantang River Basin; and purple-colored blocks stand for those in the lower reaches of the Qiantang River Basin (Drawn by the author).



**Table 1 | Results of the credibility test**

Evaluation dimensions	Allusion types	Sample size (items)	Precision	Recall	F1-Score
Classified by Allusion Types	Historical Events Category	185	0.91	0.89	0.9
	Myths and Legends Category	128	0.88	0.86	0.87
	Previous Generation Literature Category	109	0.85	0.79	0.82
Overall model performance	All types merged	422	0.89	0.86	0.87
Comparative experiment (baseline model)	BiLSTM+CRF	422	0.81	0.78	0.79
Special Evaluation of Low-Frequency Allusions	occurrences ≤ 5 times	63	0.80	0.75	0.77

<sup>\*</sup>(Drawn by the author).

**Allusion-centric cluster scene analysis**

Through automated clustering of single-character terms of literary allusions and landscape nouns in Song Dynasty poems from the upper, middle, and lower reaches, total clustered scenarios corresponding to each reach were obtained (Fig. 4). After excluding clusters unrelated to literary allusions, a total of 14 allusion-related clustered scenarios, 96 core allusions, 703 landscape elements, and 4229 allusion-related semantic associations were identified (Tables 2, 3, Supplementary Tables 4–6). Based on the analysis of average weighted degree (Wd), the ranking of the degree of recognition was determined as follows: lower reaches (133 Wd) > middle reaches (85 Wd) > upper reaches (62 Wd). Below is an analysis of the results, using the three clusters with the highest degree of recognition in each reach as examples.

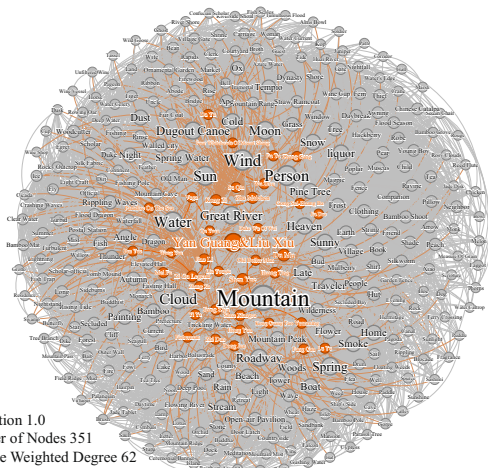
The three highest-cognition clusters in the upstream section are ranked as follows: Cluster 1 (44Wd) > Cluster 2 (25Wd) > Cluster 3 (21Wd)(Fig. 5).

Upstream Cluster 1-Autumn Waters Canoeing: The allusion elements with the most prominent characteristics in Cluster 1 were “Yan Guang & Liu Xiu” (296 Wd), “Zi Gu Legend” (46 Wd), and “Jiao Li” (46 Wd) in sequence. The main natural landscape elements associated with these allusion clusters

included “Wind” (360 Wd), “Great River” (270 Wd), and “Autumn” (126 Wd), while the key humanistic landscape elements were “Dugout Canoe” (252 Wd), “Painting” (172 Wd), and “Scholar-official” (46 Wd). Existing studies have shown that the weight distribution of natural and humanistic landscape elements in Poetry Road texts can directly reflect the emotional tone of specific cultural scenarios. The frequent occurrence of “Wind” and “Autumn” often forms a fixed semantic association with a “sense of bleakness”<sup>26</sup>. For instance, in the line “The resentment linked to the ‘Shu Lou’ sword has faded; the river merges into the Xin’an River, its waters crystal-clear”, the turbidity of officialdom is contrasted with the clarity of the Xin’an River. This technique of using water as a metaphor for virtue is a typical expression in the literary works of the Qiantang River Poetry Road, conveying the poet’s longing for pure and authentic beauty. Thus, this cluster can be summarized under the scenario theme of “Autumn Waters Canoeing”.

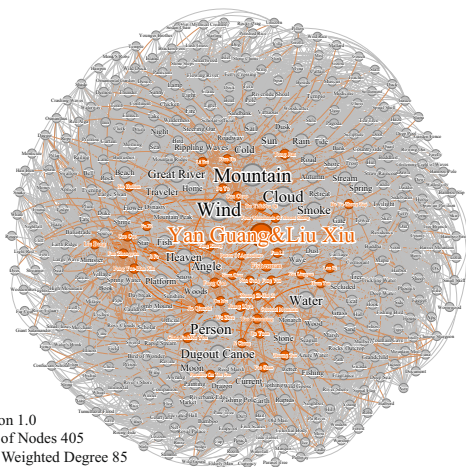
Taking Yan Guang & Liu Xiu—the allusion with the highest recognition in Cluster 1—as an example, its most closely associated allusion is “Jiang Ziya”. Both figures represent noble recluses; although Jiang Ziya’s

**Cluster of Upper Reach**



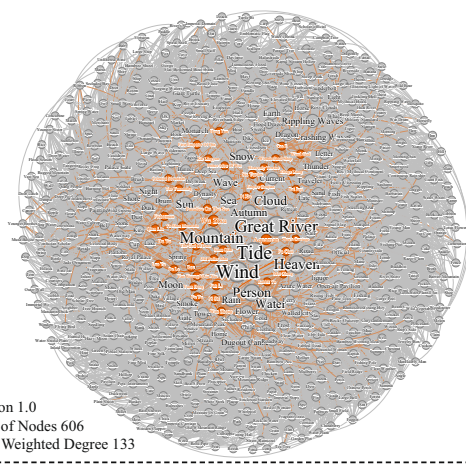
•Resolution 1.0  
•Number of Nodes 351  
•Average Weighted Degree 62

**Cluster of Mid-Reach**



•Resolution 1.0  
•Number of Nodes 405  
•Average Weighted Degree 85

**Cluster of Lower Reach**



•Resolution 1.0  
•Number of Nodes 606  
•Average Weighted Degree 133

Legend:  
 Average Weighted Degree  
 Edge Weight  
 Allusions  
 Natural and Cultural Landscape Monosyllabic Characters

(a)

(b)

(c)

**Fig. 4 | Comprehensive cluster distribution across river segments.** **a** Is the total cluster diagram of allusions and landscape elements in the upstream area; **b** is that in the midstream area; and **c** is that in the downstream area. The Resolution value is a core parameter that controls the granularity of community division; the magnitude of its value affects the algorithm’s preference for community size. In this study, the default Resolution value of 1.0 was adopted, at which the algorithm identifies a moderately sized community. Number of nodes is a core indicator for measuring network scale, reflected by the total number of gray and orange circles in the figure. The average weighted degree is used to quantify the strength characteristics of node connections in the network: a larger value indicates stronger connections, which is represented by the size of the gray and orange circles (larger circles correspond to higher average weighted degrees). Orange circles in the figure represent Allusion elements, while gray circles represent Natural and Cultural Landscape Monosyllabic Characters (Drawn by the author).

catching fish with a straight hook is hard” transforms the “difficulty of catching fish” into a metaphor for setbacks in official careers. By invoking Jiang Ziya’s allusion, the poet expresses helplessness toward reality and sentiments about his own situation, yearning to retreat to the rivers and lakes to find inner peace.

Furthermore, the natural landscape elements associated with “Yan Guang & Liu Xiu” include “Sun”, “Wind”, and “Great River”, which are specifically manifested as “Blazing Sun”, “High Wind”, and “Waves in the River”. The humanistic landscape elements most closely linked to “Yan Guang & Liu Xiu” are “Dugout Canoe”, “Wine Shop”, and “Fasting Hall”, embodied as “Leaf Boat”, “Old Tavern”, and “Famous Temple”. For instance, the line “Looking out, Yan Ling stretches over ten li; chaotic mountains hold the setting sun, wild geese call to each other” depicts the scene of Yan Ling Shoal at sunset—with overlapping mountains and calling geese—evoking a bleak and solitary autumn atmosphere. This further verifies the “intertextuality between allusion scenarios and on-site landscapes”<sup>16</sup>.

Upstream Cluster 2-Woodland Stream Hermitage: In Cluster 2, the allusion elements ranked by degree of recognition are “Du Mu” (81 Wd), “Shen Yue” (66 Wd), and “Huang Ting” (33 Wd) in sequence. The main natural landscape elements associated with these allusion clusters include “Cloud” (315 Wd), “Pine Tree” (183 Wd), and “Spring Water” (173 Wd), while the key humanistic landscape elements are “Liquor” (183 Wd), “Angle” (183 Wd), and “Tower” (183 Wd). Among these, elements such as “Cloud” and “Spring Water” often form a fixed association with “secluded spaces”<sup>44</sup>. Together, these natural and humanistic landscape elements depict a paradise far from the hustle and bustle of the world. For example, in the verse “Fishing boats moor by bamboo groves; monks offer celery in alms bowls at their retreats”, the tranquility of bamboo groves, the leisure of fishing, and the ascetic practice of monks complement each other, expressing the poet’s yearning for a simple reclusive life. Thus, this cluster can be summarized under the scenario theme of “Woodland Stream Hermitage”.

Taking Du Mu—the allusion with the highest recognition in Cluster 2—as an example, its most closely associated allusion is “Shen Yue”. Both figures served as local administrative officials in the upper reaches of the Qiantang River and were typical representatives of the ancient Chinese ideology of “seclusion while in office”. During their tenure, they wandered through the landscapes of Muzhou. This phenomenon of “yearning for seclusion while holding official positions” was typical among local officials in the Tang Dynasty, reflecting the dialectical unity of “pursuing an official career” and “seeking seclusion”<sup>26</sup>. For instance, the line “I chant loudly, giving thanks to Magistrate Shen; intoxicated, I always pity Du Ziwei” not only expresses admiration for the poetic talents of Shen Yue and Du Mu but also reflects that Muzhou was a highland for composing poetry about natural landscapes.

Furthermore, the natural landscape elements associated with Du Mu include “Cloud”, “Mountain Peak”, and “Haze”, which are specifically manifested as “White Cloud”, “Thousands of Mountains”, and “Morning Mist”. The humanistic landscape elements most closely linked to Du Mu are

hermitage was in a different location from Yan Guang’s, they both embodied the pursuit of a reclusive life and the adherence to noble virtues. This phenomenon of “cross-regional association of hermit allusions” is also evidenced in the Poetry Roads of the Yangtze River Basin, reflecting the collective cognition of ancient literati regarding the “recluse paradigm”. For example, the verse “I was once a fishing rod in the rivers and lakes; alas,

**Table 2 | Quantitative comparison of cluster scenarios across river segments**

River Segment	Upstream				Midstream						Downstream			
Modularity Q	0.36				0.31						0.31			
Cluster	1	2	3	4	1	2	3	4	5	6	1	2	3	4
AverageWeighted Degree	44	25	21	16	48	47	27	18	14	7	86	57	41	32
Numberof Nodes	57	101	88	49	110	134	41	58	31	31	167	226	119	41
Numberof Edges	1075	1168	760	345	1390	2013	501	432	176	105	3606	3747	1918	600

<sup>\*</sup>(Drawn by the author).

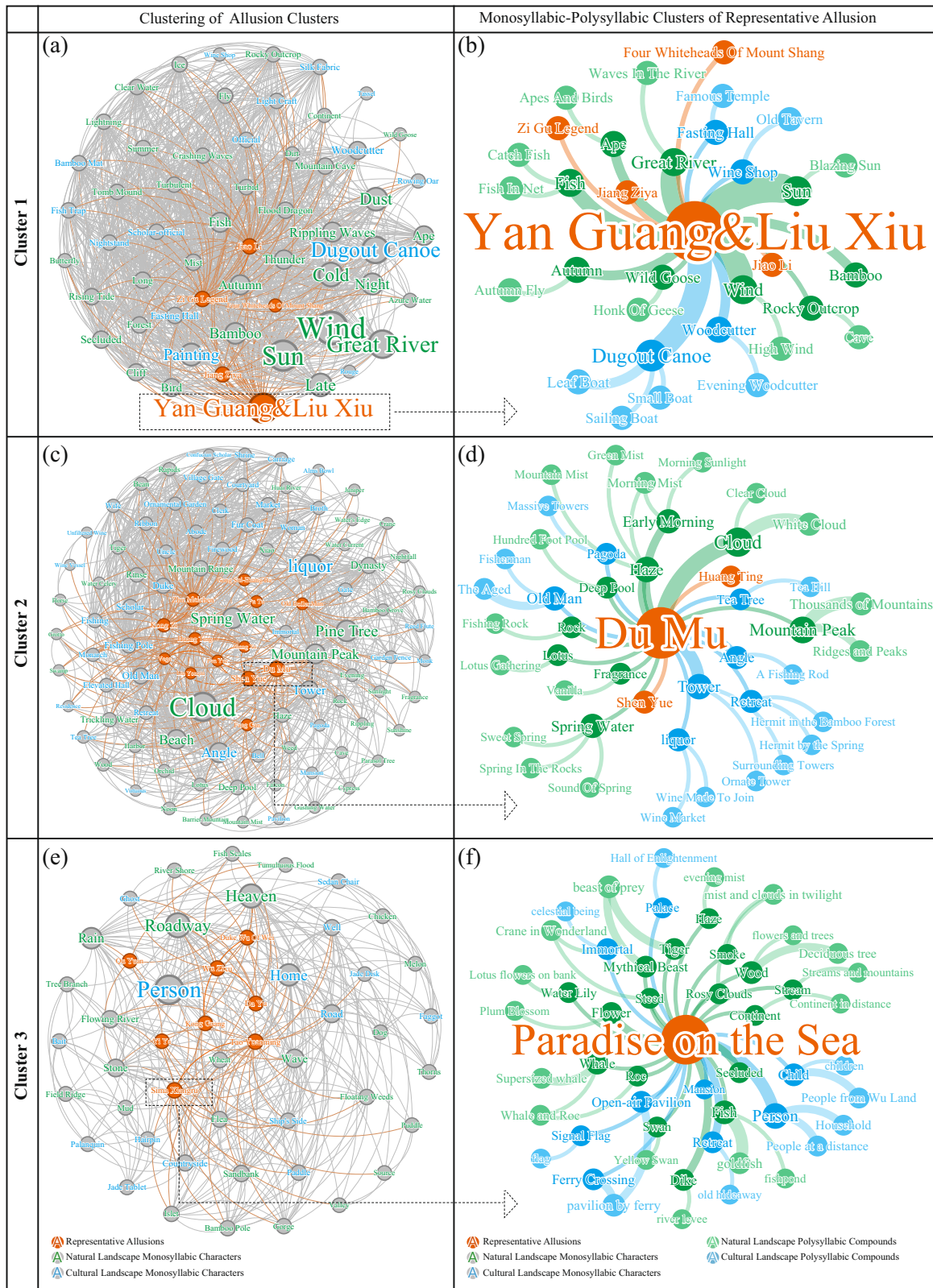
**Table 3 | List of allusion keywords**

Upstream				Midstream				Downstream			
Cluster	Allusions and landscape elements	Weight	Types	Cluster	Allusions and landscape elements	Weight	Types	Cluster	Allusions and landscape elements	Weight	Types
Cluster1	Yan Guang &Liu Xiu	296	a	Cluster1	Yan Guang &Liu Xiu	1145	a	Cluster1	Wu Zixu	552	a
	Jiao Li	46	a		Fisherman	210	a		Aquaman	419	a
	.....	.....	.....		.....	.....	.....		.....	.....	.....
	Wind	360	n		Wind	1045	n		Tide	2091	n
	Sun	315	n		Water	685	n		Great River	1938	n
	.....	.....	.....		.....	.....	.....		.....	.....	.....
	Dugout Canoe	252	c		Person	776	c		Traveler	586	c
Painting	172	c	Angle	583	c	Letter	556	c			
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	
Cluster2	Du Mu	81	a	Cluster2	Tong Jun	85	a	Cluster2	Fan Li	64	a
	Shen Yue	66	a		Cun Chuo	36	a		Yan Guang & Liu Xiu	56	a
	.....	.....	.....		.....	.....	.....		.....	.....	.....
	Cloud	315	n		Mountain	1054	n		Wind	726	n
	Pine Tree	183	n		Cloud	851	n		Heaven	564	n
	.....	.....	.....		.....	.....	.....		.....	.....	.....
	Liquor	214	c		Traveler	421	c		Tower	282	c
Angle	159	c	Home	295	c	Monarch	245	c			
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	
Cluster3	Sima Xiangru	30	a	Cluster3	Fang Gan	86	a	Cluster3	Paradise on the Sea	193	a
	Tao Yuanming	30	a		Li Bai	15	a		Fu Chai	77	a
	.....	.....	.....		.....	.....	.....		.....	.....	.....
	Roadway	243	n		Stream	358	n		Flower	707	n
	Heaven	225	n		Tide	216	n		Smoke	607	n
	.....	.....	.....		.....	.....	.....		.....	.....	.....
	Person	343	c		Dugout Canoe	618	c		Person	1512	c
Home	185	c	Retreat	230	c	Dugout Canoe	690	c			
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	

In the table, “a” stands for allusion; “n” stands for natural landscape monosyllabic; “c” stands for cultural landscape monosyllabic (Drawn by the author).

“Tower”, “Old Man”, and “Angle”, embodied as “The Aged”, “Ornate Tower”, and “Fisherman”. For example, in verses such as “Tranquil Tonglu Prefecture, half the spring mountains are tea plantations” and “Du Mu comes to mind; gurgling waters are everywhere”, elements like “Spring in the Rocks”, “Tea Hill”, and Du Mu appear together, evoking a quiet scene around the mountain hut with clear springs gurgling and tea forests spreading. During his tenure as the Provincial Governor of Muzhou, Du Mu composed poems eulogizing the local landscapes, creating stable landscape memory points for later literati. This “inheritance mechanism of ‘predecessors’ creation and successors’ remembrance” has become an important guarantee for the continuity of the Poetry Road’s cultural landscapes<sup>45</sup>.

Upstream Cluster 3-Riverside Village Dwelling: In Cluster 3, the allusion elements ranked by degree of recognition are “Sima Xiangru” (30 Wd), “Tao Yuanming” (32 Wd), and “Wu Zixu” (22 Wd) in sequence. The main natural landscape elements associated with these allusion clusters include “Roadway” (243 Wd), “Rain” (164 Wd), and “Flowing River” (73 Wd), while the key humanistic landscape elements are “Person” (343 Wd), “Home” (315 Wd), and “Countryside” (48 Wd). As the founder of pastoral poetry, Tao Yuanming used the imagery of “Home” and “Countryside” in his poems to construct an ideal rural paradigm in the minds of Chinese literati<sup>46</sup>. Together, these natural and humanistic landscape elements evoke a tranquil scene of rural pastoral life. For



example, the verse “Every step reveals green mountains embracing blue streams; every village sees wheat ridges interweaving with mulberry fields” depicts a pastoral landscape where green mountains surround clear streams and wheat fields blend with mulberry plots in villages. Thus, this cluster can be summarized under the scenario theme of “Riverside Village Dwelling”.

Taking Sima Xiangru—the allusion with the highest recognition in Cluster 3—as an example, its most closely associated allusion is “Tao Yuanming”. The allusion of Sima Xiangru and Zhuo Wenjun tending a wine shop first appears in Records of the Grand Historian: Biography of Sima Xiangru, which records their life choice: “They sold all their carriages and horses, bought a wine shop, and had Wenjun tend the wine counter while

**Fig. 5 | Comprehensive cluster distribution across river segments upstream allusion-centric semantic clustering network.** **a** Represents the semantic network diagram of Upstream Cluster 1; **b** represents the semantic network diagram of landscape monosyllables and words associated with the allusion “Yan Guang & Liu Xiu” (the allusion with the highest recognition degree, i.e., maximum average weighted degree of nodes) in Upstream Cluster 1; **c** represents the semantic network diagram of Upstream Cluster 2; **d** represents the semantic network diagram of landscape monosyllables and words associated with the allusion “Du Mu” (the allusion with the highest recognition degree, i.e., maximum average weighted degree of nodes) in Upstream Cluster 2; **e** represents the semantic network diagram of Upstream Cluster 3; **f** represents the semantic network diagram of landscape

monosyllables and words associated with the allusion “Sima Xiangru” (the allusion with the highest recognition degree, i.e., maximum average weighted degree of nodes) in Upstream Cluster 3. In Figures **a**, **c**, and **e**: orange text represents Representative Allusions; green text denotes Natural Landscape Monosyllabic Characters; and blue text stands for Cultural Landscape Monosyllabic Characters. In Figures **b**, **d**, and **f**: orange text represents Representative Allusions; dark green text denotes Natural Landscape Monosyllabic Characters; dark blue text stands for Cultural Landscape Monosyllabic Characters; light green text indicates Natural Landscape Polysyllabic Compounds; and light blue text represents Cultural Landscape Polysyllabic Compounds (Drawn by the author).

Xiangru served customers”. This became a classic narrative of literati pursuing a mundane yet contented life. Such yearning for an ordinary life resonates across epochs with Tao Yuanming’s pastoral imagery of “picking chrysanthemums by the eastern fence”. For instance, the line “Our old cottage in the hometown mountains remains; soon I shall compose poems of returning to farm life” conveys the poet’s desire for Tao Yuanming-style simple and unadorned rural life. Together, Tao Yuanming and Sima Xiangru shaped the cultural gene of “the dialectic between official service and seclusion” in Chinese literature<sup>47</sup>.

Furthermore, the natural landscape elements associated with Sima Xiangru include “Roadway”, “Heaven”, and “Flowing River”, which are specifically manifested as “Convenient Road Traffic”, “Milky Way”, and “River-Crossing”. The humanistic landscape elements most closely linked to Sima Xiangru are “Home”, “Countryside”, and “Person”, embodied as “Household”, “Home in the Mountains”, and “Scattered Village”. For example, in the verse “Every step reveals green mountains embracing blue streams; every village sees wheat ridges interweaving with mulberry fields”, the authentic landscapes (green streams, green mountains) and productive landscapes (wheat fields, mulberry gardens) appear together. This not only depicts the landscape pattern of the countryside but also reflects its vitality and dynamism. Such descriptive coupling of “natural-productive” landscapes confirms the typical pattern of landscape elements combinations in literary allusions: through the transportation network connected by “Roadway” and the life scenes carried by “Countryside”, a complete narrative of rural cultural space is constructed<sup>48</sup>.

The three highest-cognition clusters in the midstream section are ranked as follows: Cluster 1 (48Wd) > Cluster 2 (47Wd) > Cluster 3 (27Wd) (Fig. 6).

**Midstream Cluster 1-Misty Rain Solitary Angling:** The cognitive prominence of allusion elements in Cluster 1 follows the order: “Yan Guang & Liu Xiu” (1145Wd), “Fisherman” (210Wd), and “Jiang Ziya” (95Wd). Key natural landscape features associated with these allusions include “Wind” (1045Wd), “Water” (685Wd), and “Smoke” (586Wd), while cultural elements comprise “Person” (776Wd), “Fishing Rod” (583Wd), and “Platform” (356Wd). These natural and cultural features collectively amplify the desolate solitude of mist-shrouded riverscapes. For instance, the verse “By the Qili Stream, near the Egrets’ Cove, a lone angler in misty rain” juxtaposes the vibrancy of waterfowl with the obscurity of foggy drizzle, metaphorizing the poet’s inner isolation and transcendence. This cluster is thus categorized under the “Misty Rain Solitary Angling” thematic scene.

Taking “Yan Guang & Liu Xiu”—the allusion with the highest recognition in Cluster 1—as an example, its most closely associated allusion is “Fisherman”. Both represent typical “fisherman” figures in history, and at the same time, they are detached onlookers and wise men. The allusion of Yan Guang fishing on the Fuchun River first appears in *The Book of the Later Han: Biographies of Hermits*, which records: “Yan Guang cultivated fields on Fuchun Mountain; later generations named the place where he fished ‘Yanling Shoal’”. This paradigm of practicing reclusive ideals in the identity of a fisherman resonates across epochs with the fisherman image in *The Songs of Chu: The Fisherman*, who chants, “The clear waters of the Canglang River can wash my hat tassels”. Together, they constructed the archetypal symbol of the “recluse-wise fisherman” in Chinese literature. For instance, the line “The far-flying wild goose is unattainable; the vast heaven

and earth accommodate the fishing rock” uses the high-flying wild goose as a metaphor for Yan Guang’s nobility and transcendence, expressing infinite admiration for his reclusive spirit.

Furthermore, the natural landscape elements associated with “Yan Guang & Liu Xiu” include “Wind”, “Water”, and “Smoke”, which are specifically manifested as “Misty Rain”, “Cool Breeze”, and “Clear Water”. The humanistic landscape elements most closely linked to “Yan Guang & Liu Xiu” are “Person”, “Angle”, and “Platform”, embodied as “Fishing Platform”, “Old Friend”, and “Pavilion Soaring into the Sky”. For example, verses such as “The true hermit vanished into the white waters; he concealed his traces amid weeds and brambles. The Han Dynasty’s rituals lacked eternal temples, yet the Yan family’s fishing platform endures” depict a virtuous man who retreated from the world, living in seclusion alone amid mountains and rivers. Meanwhile, by contrasting the eternity of the reclusive spirit with the rise and fall of dynasties, the poems vividly convey the impermanence of worldly affairs and the eternity of nature and history. In *Memorial to Mr. Yan’s Shrine*, used the natural imagery of “The clouds and mountains are verdant; the river flows boundlessly” to highlight the spiritual realm of “Mr. Yan’s virtue is as lofty as the mountains and as enduring as the rivers”. This further strengthened the symbolic connection between natural landscape elements such as “Wind” and “Water” and Yan Guang’s allusion, making the fishing platform a cultural landmark spanning millennia.

**Midstream Cluster 2-Tongjiang Homebound Sails:** The cognitive prominence of allusion elements in Cluster 2 follows the order: “Tong Jun” (85Wd), “Fang Gan” (36Wd), and “Tao Yuanming” (30Wd). Key natural landscape features associated with these allusions include “Great River” (575Wd), “Sun” (463Wd), and “Cold” (462Wd), while cultural elements comprise “Traveler” (312Wd), “Sail” (265Wd), and “Village” (137Wd). These natural and cultural features collectively evoke the solitude of voyagers navigating frigid waterways. For example, the verses “Before Tonglu County, rivers converge; beneath Hejiang Pavilion, myriad traveler-boats anchor” and “White clouds depart, phoenixes vanish; dusk rains whisper, stirring wanderer’s sorrow” depict bustling docksides while expressing poetic nostalgia for homeland, categorizing this cluster under the “Tongjiang Homebound Sails” thematic scene.

Taking “Tong Jun”—the allusion with the highest degree of recognition in Cluster 2—as an example, he was a renowned physician in ancient China who built a thatched hut on Tongjun Mountain to gather medicinal herbs and heal the sick, and has long been revered as the “Founding Father of Traditional Chinese Medicine”. According to records in *Shiben*: “Tong Jun served as an official during the reign of Emperor Yao of the Tang Dynasty (legendary Xia Dynasty era) and formulated medicinal prescriptions together with Wu Xian (another legendary physician)”. His deeds were further specified in *Compendium of Materia Medica* by Li Shizhen of the Ming Dynasty: “He was an official under Emperor Huangdi (the Yellow Emperor) and collected medicinal herbs on Tongjun Mountain”. More detailed records about his allusion of “practicing medicine in seclusion” are found in *Gazetteer of Yanzhou Prefecture*: “He built a thatched hut under a tung tree; when asked his surname, he pointed to the tung tree to indicate it”. These historical materials collectively establish a profound geographical connection between Tong Jun and Tongjun Mountain. For example, the verse “The green tung tree planted by Tong Jun’s own hand remains; every spring, its branches and leaves stay tender in the breeze” uses the vigorous growth of



**Fig. 6 | Comprehensive cluster distribution across river segments midstream allusion-centric semantic clustering network.** **a** Represents the semantic network diagram of Midstream Cluster 1; **b** represents the semantic network diagram of landscape monosyllables and words associated with the allusion “Yan Guang & Liu Xiu” (the allusion with the highest recognition degree, i.e., maximum average weighted degree of nodes) in Midstream Cluster 1; **c** represents the semantic network diagram of Midstream Cluster 2; **d** represents the semantic network diagram of landscape monosyllables and words associated with the allusion “Tong Jun” (the allusion with the highest recognition degree, i.e., maximum average weighted degree of nodes) in Midstream Cluster 2; **e** represents the semantic network diagram of Midstream Cluster 3; **f** represents the semantic network diagram of landscape

monosyllables and words associated with the allusion “Fang Gan” (the allusion with the highest recognition degree, i.e., maximum average weighted degree of nodes) in Midstream Cluster 3. In Figures **a**, **c**, and **e**: orange text represents Representative Allusions; green text denotes Natural Landscape Monosyllabic Characters; and blue text stands for Cultural Landscape Monosyllabic Characters. In Figures **b**, **d**, and **f**: orange text represents Representative Allusions; dark green text denotes Natural Landscape Monosyllabic Characters; dark blue text stands for Cultural Landscape Monosyllabic Characters; light green text indicates Natural Landscape Polysyllabic Compounds; and light blue text represents Cultural Landscape Polysyllabic Compounds (Drawn by the author).

verify the historical continuity of woodcutting and fishing as traditional livelihoods in the region: “Generally, people in the five counties make a living by cutting firewood in the mountains and fishing in the seas, ensuring self-sufficiency in food and clothing”. For instance, verses such as “On a frost-cleared day, the sound of bells and chimes echoes; at sunset, woodcutters and fishermen return home” depict elements like “frost-cleared sky”, “bells and chimes”, “sunset”, and “returning woodcutters and fishermen” in delicate detail, creating a serene and tranquil artistic conception.

Midstream Cluster 3-Egrets’ Cove Orchid Retreat: The cognitive prominence of allusion elements in Cluster 3 follows the order: “Fang Gan” (86Wd), “Li Bai” (15Wd), and “Fan Li” (12Wd). Key natural landscape features associated with these allusions include “Stream” (358Wd), “Tide” (216Wd), and “Cattail” (34Wd), while cultural elements comprise “Dugout Canoe” (618Wd), “Retreat” (230Wd), and “Oar” (47Wd). These natural and cultural features collectively embody the leisurely ethos of waterside seclusion. For instance, the verse “Emergent streams stretch wide under green hills; distant peaks dim in twilight haze” captures the tranquil interplay of hydrological and topographic elements, categorizing this cluster under the “Egrets’ Cove Orchid Retreat” thematic scene.

Taking “Fang Gan”—the allusion with the highest degree of recognition in Cluster 3—as an example, he was a native of the Qiantang region in the middle reaches of the Qiantang River. He exchanged poems with fellow poets such as Jia Dao and Luo Ye, and was revered as a “grand master” by younger generations of literati including Li Pin. His poetic works were widely acclaimed even during his lifetime. The *New Book of Tang: Bibliographic Treatise* specifically recorded his ten-volume poetry collection *Collected Poems of Mr. Xuanying*, confirming the authority of his literary status. Later generations described him with the phrase: “Though he held no official salary, his fame spread for ten thousand li”—a precise summary of his legendary life as a commoner who remained unappointed to any official post yet achieved far-reaching poetic renown. For example, the verse “Only the fragrance of his writings lingers, faintly emanating from the roots of grasses and trees” depicts the cultural charm of Tonglu as a subtle fragrance wafting from the roots of plants, praising the region’s serene artistic conception and profound cultural heritage.

Furthermore, the natural landscape elements associated with Fang Gan include “Cormorant”, “Stream”, and “Secluded”, which are specifically manifested as “Cormorants”, “Stream Wind”, and “Orchid”. The humanistic landscape elements most closely linked to Fang Gan are “Dugout Canoe”, “Retreat”, and “Grandchild”, embodied as “Grandchildren”, “Hermit”, and “Small Boat”. Fang Gan’s reclusive life scenes are clearly recorded in historical materials: *Biographies of Tang Dynasty Talents* states, “He lived in seclusion by Mirror Lake: to the north of the lake stood his thatched hut, and to the west lay Pine Island”. Verses such as “Most neighbors fish; half his children and grandchildren pursue literature. Orchids grow in the depths, exuding pure fragrance all day long” vividly depict the harmonious and tranquil life of his neighborhood, expressing admiration for Fang Gan’s noble virtues—even in seclusion deep in the mountains, he maintained his lofty and unsullied character.

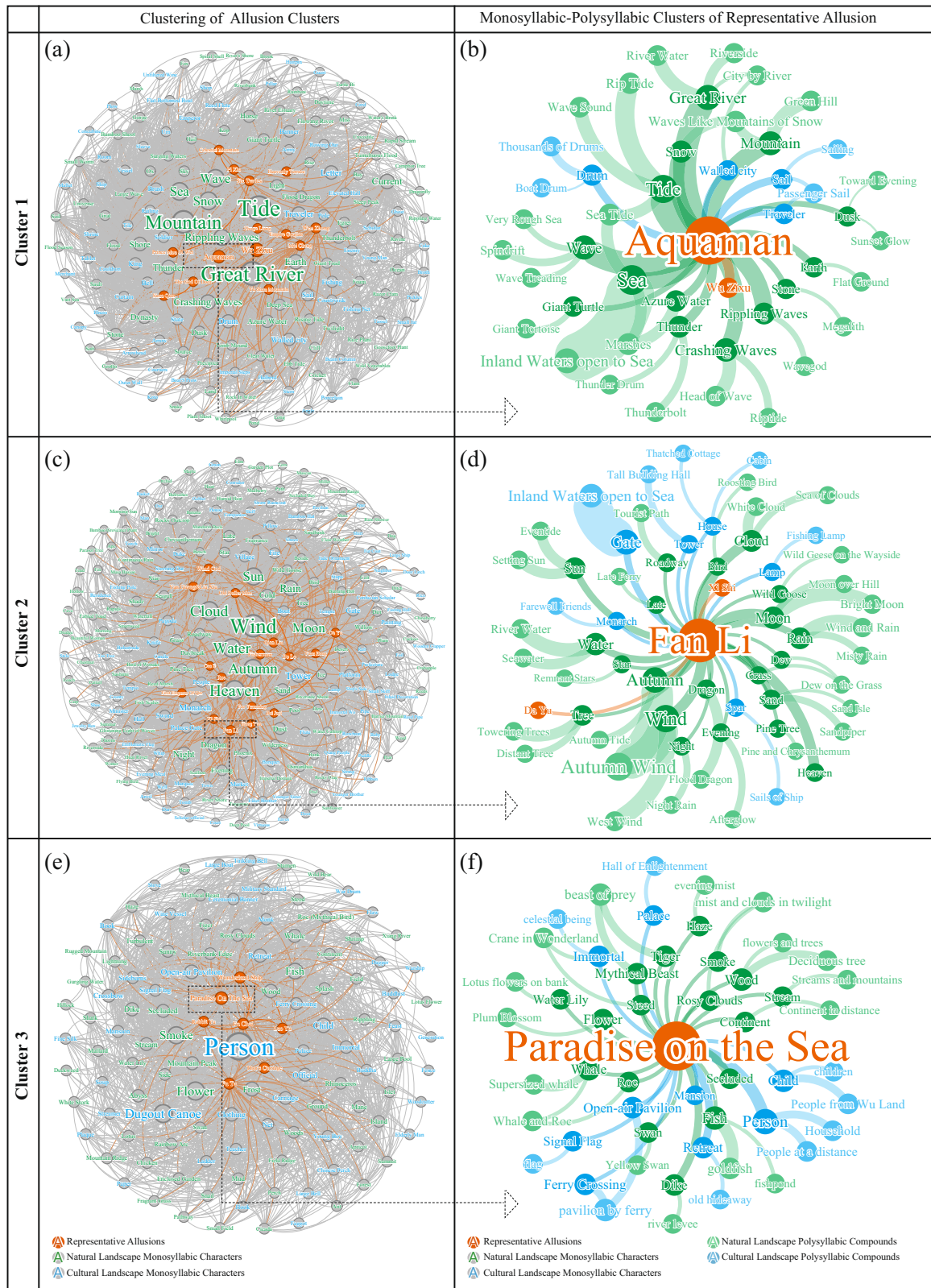
The three highest-cognition clusters in the downstream section are ranked as follows: Cluster 1 (86Wd) > Cluster 2 (57Wd) > Cluster 3 (41Wd) (Fig. 7).

Downstream Cluster 1-Tidal Thunder Resonance: The cognitive prominence of allusion elements in Cluster 1 follows the order: “Aquaman” (419Wd), “Wu Zixu” (552Wd), and “Wen Zhong” (85Wd). Key natural landscape features associated with these allusions include “Tide” (2091Wd), “Great River” (1938Wd), and “Mountain” (1790Wd), while cultural elements comprise “Traveler” (586Wd), “Letter” (556Wd), and “Drum” (516Wd). These natural and cultural features collectively depict the spectacle of tidal surges overturning vessels amid billowing clouds. For example, the verse “From Zhang Pavilion, I gaze upon Zhejiang’s tidal bore-earth-shaking, sky-piercing, its majesty unrivaled” captures the overwhelming grandeur of the Qiantang tidal bore, categorizing this cluster under the “Tidal Thunder Resonance” thematic scene.

Taking “Aquaman”—the allusion with the highest degree of recognition in Cluster 1—as an example, its most closely associated allusion is “Wu Zixu”. The *Lost Records of the Yue State* clearly record that after Wu Zixu’s death, “he returned to the divine realm of the sea, and his voice and omens lingered endlessly”. This marked the first establishment of his status as a “water deity” and became the origin of tidal god worship. *Extensive Records of the Taiping Era* further elaborated this into a concrete legend: “Wu Zixu rides a chariot drawn by white horses amid the tide crests”. This fused the abstract power of surging waves with the loyal indignation of the historical figure into a unified symbolic image. Here, “Aquaman” is often mentioned in association with the “Wu Zixu” allusion, as both symbolize water deities linked to billowing waves. For instance, the verse “To the rhythm, the wave deity comes against the current; who else bears resentment as unextinguished as Ling Xu?” references both the water deity and Wu Zixu. This indicates that the image of the water deity had gradually merged into the legend of Wu Zixu, becoming another symbol of the magnificent Qiantang River Tidal Bore.

Furthermore, the natural landscape elements associated with “Aquaman” include “Sea”, “Tide”, and “Great River”, which are specifically manifested as “Inland Waters Open to the Sea”, “Rip Tide”, and “River Water”. The humanistic landscape elements most closely linked to “Aquaman” are “Drum”, “Sail”, and “Traveler”, embodied as “Passenger Sail” and “Thousands of Drums”. For example, the verse “Passenger sails depart with the wind at dawn and dusk; fishing nets drift east and west with the waves” depicts the scene of passenger boats sailing away with the wind morning and evening, showcasing the bustle of ships on the river and the vibrancy of the river surface, thereby creating an open and broad artistic conception. The Tang Dynasty text *The Geographical Records of Prefectures and Counties in the Yuanhe Reign* once recorded that at the mouth of the Qiantang River, “All boats and ships must offer prayers at Wu Yuan’s (Wu Zixu’s) Temple before traveling”. This shows that passenger sails were not merely means of transportation, but also carried people’s reverence for the water deity.

Downstream Cluster 2-Seaside Tower Farewell: Dominant allusion elements in Cluster 2 include “Fan Li” (64Wd), “Yan Guang & Liu Xiu” (56Wd), and “Wind God” (51Wd). Key natural landscape features are “Wind” (726Wd), “Heaven” (564Wd), and “Cloud” (526Wd), while cultural elements comprise “Tower” (282Wd), “Monarch” (245Wd), and “Gate” (176Wd). These features collectively evoke the solitary ambiance of autumn moonlit towers along the Qiantang. The verse “The meddlesome Qiantang waters witness partings and returns” personifies the river as a



sentient observer of human transience, categorizing this cluster under the “Seaside Tower Farewell” thematic scene.

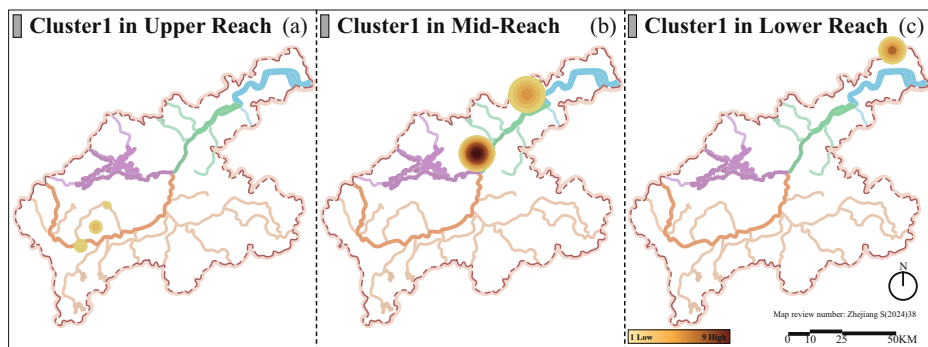
Taking “Fan Li”—the allusion with the highest degree of recognition in Cluster 2—as an example, its most closely associated allusion is “Xi Shi”. The love story of Fan Li and Xi Shi constitutes a pivotal plot in the narrative of the Wu-Yue rivalry during the Spring and Autumn Period (770–476 BCE). The

interweaving of its historical accounts and literary interpretations dates back to Han Dynasty (202 BCE–220 CE) documents. Records of the Grand Historian: The Hereditary House of King Goujian of Yue clearly records: “Fan Li packed up his light valuables, pearls, and jade, then set sail across the sea with his private followers, never to return.” This marked the first establishment of the legendary prototype of Fan Li retiring into seclusion

**Fig. 7 | Comprehensive cluster distribution across river segments downstream allusion-centric semantic clustering network.** **a** Represents the semantic network diagram of Downstream Cluster 1; **b** represents the semantic network diagram of landscape monosyllables and words associated with the allusion “Yan Guang & Liu Xiu” (the allusion with the highest recognition degree, i.e., maximum average weighted degree of nodes) in Downstream Cluster 1; **c** represents the semantic network diagram of Downstream Cluster 2; **d** represents the semantic network diagram of landscape monosyllables and words associated with the allusion “Tong Jun” (the allusion with the highest recognition degree, i.e., maximum average weighted degree of nodes) in Downstream Cluster 2; **e** represents the semantic network diagram of Downstream Cluster 3; **f** represents the semantic network

diagram of landscape monosyllables and words associated with the allusion “Fang Gan” (the allusion with the highest recognition degree, i.e., maximum average weighted degree of nodes) in Downstream Cluster 3. In Figures **a**, **c**, and **e**: orange text represents Representative Allusions; green text denotes Natural Landscape Monosyllabic Characters; and blue text stands for Cultural Landscape Monosyllabic Characters. In Figures **b**, **d**, and **f**: orange text represents Representative Allusions; dark green text denotes Natural Landscape Monosyllabic Characters; dark blue text stands for Cultural Landscape Monosyllabic Characters; light green text indicates Natural Landscape Polysyllabic Compounds; and light blue text represents Cultural Landscape Polysyllabic Compounds (Drawn by the author).

**Fig. 8 | Kernel density distribution map of each reach.** **a** Shows the kernel density distribution of Upstream Cluster 1 in the Qiantang River Basin; **b** shows the kernel density distribution of Mid-stream Cluster 1 in the Qiantang River Basin; **c** shows the kernel density distribution of Downstream Cluster 1 in the Qiantang River Basin. In this figure, the orange solid lines represent the Upper South Source of the Qiantang River (Majin Creek); the purple solid lines denote the Upper North Source of the Qiantang River (Xin’an River); the green solid lines stand for the Middle Reaches of the Qiantang River; and the blue solid lines represent the Lower Reaches of the Qiantang River. The yellow concentric circles in the figure indicate the gathering points of kernel density for Song Dynasty poems, with the gathering intensity increasing as the color gradually transitions from yellow to brown (Drawn by the author).



with Xi Shi. Spring and Autumn Annals of Wu and Yue further elaborated this into: “Fan Li then departed, sailing a small boat through the Three Rivers and into the Five Lakes; no one knew where he ultimately went.” This text achieved the symbolic fusion of a historical figure’s “retreat after achieving meritorious deeds” and the boundless vastness of natural landscapes. For instance, in the verse “Xi Shi leans graceful, favored by the king; Fan Li prepares to board the boat that will take him from the kingdom”, the poet employs contrast and transition to depict the divergent fates of Xi Shi and Fan Li, expressing sentiments about the destinies of historical figures.

Furthermore, the natural landscape elements associated with Fan Li include “Wind”, “Autumn”, “Moon”, and “Water”, which are specifically manifested as “Autumn Wind”, “Bright Moon”, and “River Water”. The humanistic landscape elements most closely linked to Fan Li are “Gate”, “Tower”, and “Monarch”, embodied as “Inland Waters Open to Sea”, “Tall Building Hall”, and “Farewell Friends”. Among these, the imagery of “Autumn Wind” has the highest frequency in this cluster. This symbolic tradition dates back to the Book of Songs, where the metaphorical and evocative device is used in the line “The autumn wind sighs; white dew turns to frost”. The legend of Fan Li further strengthened the emotional association between “Autumn Wind” and “missing loved ones” in the Qiantang River Basin. For example, the verse “In the fifth lunar month, the Qiantang River sees windy, rainy autumn; longing for someone, I often lean against the mountain-facing tower” depicts the windy and rainy autumn scenery of the Qiantang River in the fifth lunar month, revealing the poet’s inner loneliness and yearning for distant loved ones.

Downstream Cluster 3-Haze and Glow Celestial Quest: The cognitive prominence of allusion elements in Cluster 3 follows the order: “Paradise on the Sea” (193Wd), “Fu Chai” (77Wd), and “Fu Tu” (66Wd). Key natural landscape features include “Flower” (707Wd), “Smoke” (607Wd), and “Fish” (485Wd), while cultural elements comprise “Dugout Canoe” (690Wd), “Child” (368Wd), and “Open-air Pavilion” (306Wd). These features collectively depict a maritime utopia. The verse “Seafaring rafters, celestial maidens like E Lühua-dwelling where tides begin, at heaven’s edge”

conjures a mythic realm, categorizing this cluster under the “Haze and Glow Celestial Quest” thematic scene.

Taking “Paradise On The Sea”—the allusion with the highest degree of recognition in Cluster 3—as an example, the lower reaches of the Qiantang River are close to the East China Sea, sharing geographical proximity with the legendary three sacred mountains of Penglai, Fangzhang, and Yingzhou (said to be located in the East China Sea). Records of the Grand Historian: Book of Fengshan clearly states: “Penglai, Fangzhang, and Yingzhou—these three sacred mountains are said to lie in the Bohai Sea.” Liezi: Tang Wen further depicts their celestial characteristics: “The flat summits span nine thousand li; the terraces and pavilions are all made of gold and jade, and the birds and beasts are pure white”. This geographical proximity facilitates the association and citation of the “Penglai-Yingzhou” allusion in this region. For instance, the verse “We who come together are all companions from Penglai Mountain; our names are inscribed in the jade scriptures of celestial registers” refers to the fellow travelers who climbed the pavilion to watch the tide as “companions from the immortal realm.” This not only expresses the deep friendship between the travelers but also conveys the poet’s yearning for an otherworldly and transcendental life.

Furthermore, the natural landscape elements associated with “Paradise On The Sea” include “Fish”, “Whale”, and “Smoke”, which are specifically manifested as “goldfish”, “mist and clouds in twilight”, and “Supersized whale”. The humanistic landscape elements linked to this allusion are “Retreat”, “Open-air Pavilion”, and “Immortal”, embodied as “pavilion by ferry”, “Crane in Wonderland”, and “old hideaway”. For example, the verse “To travel east, no need for a sea-going vessel; a celestial steed chases the wind, with clouds as its canopy” depicts a scene of riding a celestial steed and sailing on clouds toward the immortal realm. It transforms the Qiantang River’s geographical feature of “convergence of river and sea” into the “accessibility to the immortal realm without a sea vessel”—inheriting the spatial imagination from Records of the Ten Continents, which states: “Yingzhou lies 700,000 li beyond the sea off Kuaiji”. This reflects the poet’s inner romance and transcendence.

### Visualized interpretation of locality-based strategies

Three representative allusion clusters from distinct river segments were selected for visualizing locality-specific strategies: the upstream Autumn Waters Canoeing cluster centered on Yan Guang & Liu Xiu, the midstream Misty Rain Solitary Angling cluster also anchored by Yan Guang & Liu Xiu, and the downstream Tidal Thunder Resonance cluster revolving around the Water Deity motif (other visualized scenarios involved in the study are presented in Supplementary Figs. 1–3).

Upstream: “Withdrawal-Engagement-Transcendence” Boat Hermit Culture Narrative System: In-depth analysis of poetic texts reveals that in Cluster 1 of the upper reaches, poems containing place names such as “Yingzhou” and “Lanke Rock” (now a scenic spot at Lanke Mountain in Quzhou) account for over 70% of the total poems in this cluster, and this region coincides precisely with a high kernel density zone (2 Kd) of the reach (Fig. 8); this spatial distribution characteristic provides crucial clues for the systematic reconstruction of historical landscape scenes of riverside human settlements in the upper reaches of the Qiantang River.

Therefore, this study first took keywords such as “Blazing Sun”, “Waves in the River”, and “Leaf Boat” derived from Cluster 1 (Section 3.2.1) as core elements to formulate the underlying logical instructions for this scene. On this basis, further research was conducted on historical materials to examine the local characteristics of the upper Qiantang River in the Song Dynasty: in terms of the style of human settlement spaces, Atlas of Yanzhou Prefecture records that riverside pavilions in Yanzhou (such as Xiaosa Tower) were single-story wooden structures built along the mountains and adjacent to the river, while Yan Ziling’s Shrine featured “bamboo walls and thatched roofs”, which defined the architectural form and material selection; Dream Pool Essays confirmed the small-scale characteristics of farmhouses along the Xin’an River, which were “roofed with thatch and enclosed by bamboo walls”; poems by Du Mu and Fan Zhongyan further clarified the spatial coupling relationship of “distant mountains—nearby cottages—flowing water”; in terms of production activities, Gazetteer of Yanzhou Prefecture stated that “annual tax revenue from fishing reached 10,000 strings of cash, with more than 300 fishing households in Qili Gorge”, recording the flourishing fishing industry in Qili Gorge; Painting of Sailing on the River After Snow depicted the fishing scene in the upper Qiantang River as “small boats casting nets + fish weirs along the riverbank”; the description in Commentary on the Water Classic: Jian River that “the Xin’an River is shallow and clear, with sandbars gathering fish” revealed that mountain-stream-type river channels provided an ecological foundation for fish migration, and all these together indicated the prosperity of the fishing industry in the upper Qiantang River; in terms of the ecosystem, Universal Geography of the Taiping Era recorded that “wild goose flocks stay for more than a month in autumn and winter” at Guanshan Mountain on the Fuchun River, while Gazetteer of Hangzhou Prefecture clearly stated that Lucizi Bay in Tonglu had “a thousand mu of reeds, where wild geese and ducks gather”; both documents jointly confirmed that this region was an important stopover for migrating geese and that there was a direct ecological correlation between reed wetlands and goose habitats. Finally, based on the “Autumn Waters Canoeing” scene, more refined scene maps of the upper Qiantang River were revised by adding elements such as bamboo-thatched buildings, fishing boats, and reed wetlands (Fig. 9).

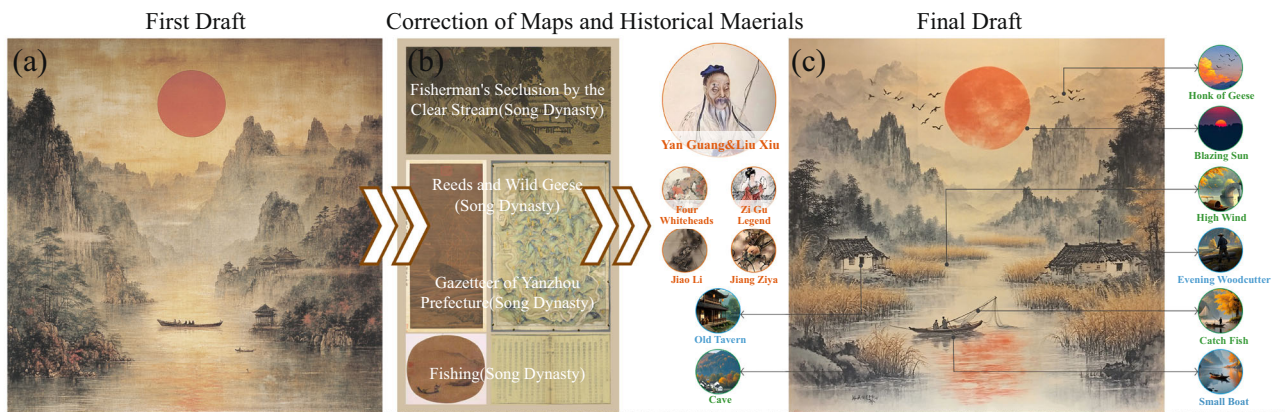
To further explore the contemporary transformation path of historical landscapes, this study sorted out benchmark cases of domestic riverside cultural experience projects to provide practical references for the construction of the literary narrative system in the upper Qiantang River. For example, during the 2024 “Landscape City · Autumn Tour Festival”, Shanghu Scenic Area in Changshu, Suzhou, China, launched dual-line role-playing activities themed on “knights-errant and recluses”, which achieved great success through scenario-based task chains and virtual-real integrated interactions (Chen X. Poetic autumn to learn from the ancient rhyme and modern style: Suzhou Changshu Cultural Tourism Scenic Area launched the theme activity of “Landscape City · Autumn Tour”. China Central Radio and Television International Online. <https://js.cri.cn/2024-09-18/925067d4-aeda-4c6e-d87e-9e2cf6d8b097.html>); the West Wuhuali

section of the Qinhuai River in Nanjing upgraded its night tour project centered on the theme of “Qinhuai Memories”, creating a film-level narrative experience; the glass curtain walls on both sides of custom-made cruise ships served as projection carriers, enabling real-time interaction among “people, ships, and landscapes” (Zhang D. Celebrate the National Day · Colorful Jiangnan | Wuhuali, Qinhuai Hexi\_ Taste the ancient charm and modern style, enjoy the light and shadow of the night tour. Jiangnan Times. [https://www.jntimes.cn/zdx/202210/t20221004\\_7716352.shtml](https://www.jntimes.cn/zdx/202210/t20221004_7716352.shtml)).

Based on the above research findings on the historical landscape scenes of riverside human settlements in the upper Qiantang River, combined with practical experience from waterborne literary tours and hermit-themed projects, this study constructed a triple cultural narrative system of “Seclusion—Engagement—Transcendence” (Fig. 9) by taking the core allusion of Yan Ziling’s “fishing seclusion in Fuchun” in the upper reaches, integrating the political metaphor of Jiang Ziya’s “fishing in the Wei River” and the folk legend of “Jiaochi (a mythical creature) hiding in deep waters and transforming into a dragon”. This system takes the Lanke Mountain-Wuxi River Scenic Area as the carrier, relies on its ecological foundation of Danxia landform and high-gorge flat lake, focuses on the natural temporal-spatial characteristic of “mountains and forests dyed in autumn colors”—the most prominent feature in the cluster—and creates a thematic scene of hermitage allusions in the “rivers and lakes” centered on “boating on autumn waters; the specific implementation paths are divided into three levels: 1) Taking the main peak of Lanke Mountain as the core area of cultural narrative, relying on the existing “Go Immortal Land” hermit culture IP, and leveraging the existing natural stone beam chessboard and the vast mountain forest space as the background, regularly organize professional and amateur Go competitions to attract tourists from different countries and backgrounds to participate and comprehend the great seclusion embodied in Go. 2) Taking the Wuxi River water area as the ecological experience extension zone, relying on the natural scenery of intertwined blue (water) and green (vegetation) of the Wuxi River, and using modern “boats” such as water bikes and kayaks as media, design a “boating to explore allusions” water experience route. This route connects the allusion plots of Yan Ziling, Jiang Ziya, and the Jiaochi (mythical dragon-like creature), allowing participants to enhance their understanding of the connotations of “Seclusion—Engagement—Transcendence” in this group of allusions while exercising through boating. For the creation of night activities, innovatively integrate drone swarms and water surface projection technology, and stage a large-scale historical drama titled “Yan Ziling and Jiang Ziya Discussing Hermitage by Fishing on an Autumn Night by the River” along the riverbank. This will comprehensively deepen tourists’ sensory experience and realize the modern interpretation of the spiritual core of “hermitage through fishing”. 3) Meanwhile, approximately 20 kilometers away from Lanke Mountain Scenic Area lies Yancun Ancient Village—a settlement of the southern-migrating branch of Yan Ziling’s descendants. This ancient village can be developed as an interactive participation expansion zone. Relying on precious settlement cultural spaces such as the Yan Clan Ancestral Hall within the village, design a “hermit role-playing” system. Tourists can choose to play roles such as Yan Guang, Jiang Ziya, or Jiaochi, and earn “Seclusion Points” by completing tasks like collecting medicinal herbs, boating, and playing Go. These points can eventually be exchanged for a customized cultural and creative gift box of Lan’ke Immortal Go Manual, enabling tourists to experience the “rivers and lakes hermit culture” through immersive hermit life and gain a profound understanding of it.

Midstream: “Withdrawal-Engagement-Transcendence” Fishing Hermit Culture Narrative System: The allusion clusters in the middle reaches, like those in the upper reaches, fall under the hermit culture framework of “Seclusion—Engagement—Transcendence”. Their core symbols all revolve around Yan Guang, Jiang Ziya, and the image of recluses. However, influenced by differences in natural environmental characteristics, the middle reaches need to highlight the ecological symbol system of “misty rain—maple forests—cormorants” and emphasize the type of human activities represented by “fisherman—coir raincoat—angling”, forming a thematic

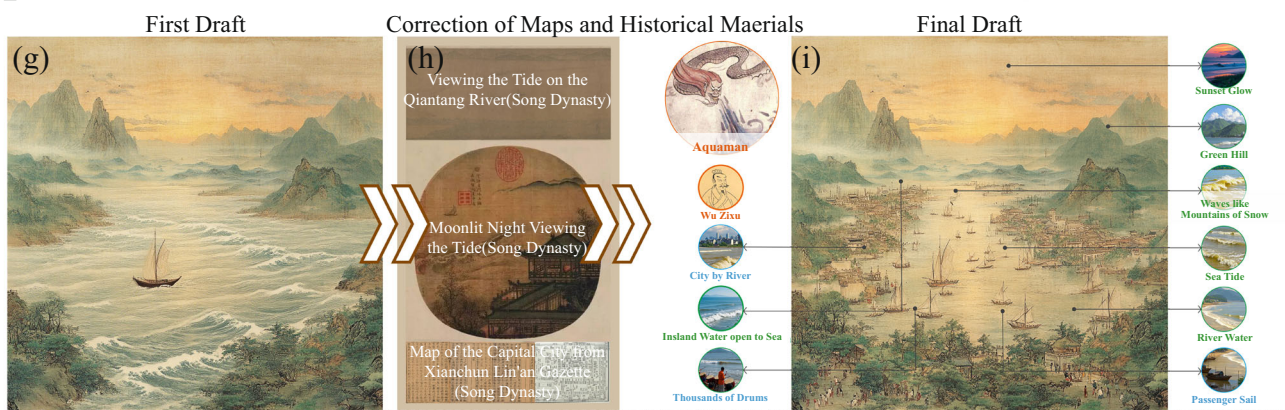
### Scenarios for Cluster1 in Upper Reach



### Scenarios for Cluster1 in Mid-Reach



### Scenarios for Cluster1 in Lower Reach



**Fig. 9 | Visualization scenario strategy of each reach.** **a** Refers to scenario images generated by using Gephi nodes of the cluster1 in upper reach as prompts for Stable Diffusion. **b** Illustrates the process of verifying and revising the first draft of cluster1 in upper reach using relevant historical materials, including ancient books and paintings. **c** Represents the text-to-image results of cluster1 in upper reach after correction based on historical materials. **d** Refers to scenario images generated by using Gephi nodes of the cluster1 in mid-reach as prompts for Stable Diffusion. **e** Illustrates the process of verifying and revising the first draft of cluster1 in mid-reach using relevant historical materials, including ancient books and paintings.

**f** Represents the text-to-image results of cluster1 in mid-reach after correction based on historical materials. **g** Refers to scenario images generated by using Gephi nodes of the cluster1 in lower reach as prompts for Stable Diffusion. **h** Illustrates the process of verifying and revising the first draft of cluster1 in lower reach using relevant historical materials, including ancient books and paintings. **i** Represents the text-to-image results of cluster1 in lower reach after correction based on historical materials. In this figure, content with orange circular borders represents Allusions; content with green circular borders denotes Natural Landscape Elements; and content with blue circular borders stands for Cultural Landscape Elements (Drawn by the author).

expression centered on “hermitage through fishing”—a differentiated narrative that complements the “hermitage by boat” theme in the upper reaches. The spatial agglomeration characteristics of this “hermitage through fishing” theme can be further verified through poetic text analysis. In Cluster 1 of the middle reaches, poems containing place names such as “Yan Ziling’s Fishing Platform” and “Yan Ziling’s Shrine” account for over 80% of the total poems in this cluster, and this region is a high kernel density

zone (9 Kd) in the reach (Fig. 8). This spatial distribution characteristic provides an important reference for the systematic reconstruction of historical landscape scenes of human settlements in the middle reaches of the Qiantang River.

Therefore, this study first took keywords such as “Misty Rain”, “Fishing Platform”, and “Clear Water” derived from Cluster 1 (Section 3.2.2) as core elements to formulate the underlying logical instructions for this scene. On

this basis, further research was conducted on historical materials: The middle reaches of the Qiantang River in the Song Dynasty were characterized by a typical landform of “two mountains flanking a narrow river channel” in the Qili Gorge; History of the Song Dynasty: Treatise on Rivers and Canals records that during the Southern Song Dynasty, tidal forces surged inland and caused seawall breaches; Shen Kuo’s Brush Talks from Dream Brook notes that Qian Liu (King of Wuyue) planted “huangzhu” (submerged wooden piles) to weaken tidal forces; combined with Xia Gui’s painting Distant Mountains and Clear Streams, which depicts scenes of turbulent currents interspersed with shoals, all these jointly confirm the hydrological characteristic of the middle reaches—dense shoals and shallows along the waterfront. Meanwhile, Su Shi’s lyric poem Xingxiangzi · Passing Qili Gorge implicitly conveys the imagery of “maple leaves dyeing the stream”; Lu You’s ci poems eulogize the scenery of “river maples and fishing lights”; Xiao Zhao’s painting Autumn Mountains with Red Trees depicts red maples covering the mountains and fallen leaves drifting on the river; the Gazetteer of Yanzhou Prefecture further traces that during the Song Dynasty, a “autumn forests with red leaves” landscape belt had formed along Wulong Mountain and the Xin’an River, highlighting the ecological and scenic value of maple trees in autumn. In terms of the adaptation of human activities, there were both productive activities such as cormorant fishing—Lu You’s Account of a Journey to Shu records that fishermen in Yanzhou “caught dozens of jin of fish daily using cormorants”, and the Gazetteer of Zhejiang Province notes that local residents “raised many cormorants to make a living from fishing”, with place names like “Cormorant Pond” also serving as evidence—and recreational angling activities. Centered on Yan Ziling’s Fishing Platform, ci poems by Su Shi and Wu Qian depict angling scenes; Ma Yuan’s painting Singing While Treading portrays the image of anglers by the river; and the Atlas of Yanzhou Prefecture clearly defines it as a “place for scholar-officials to go angling”. Finally, based on the “Misty Rain Solitary Angling” scene, more refined scene maps of the middle reaches of the Qiantang River were revised by adding elements such as cormorant fishing, autumn maples, and shoals (Figure 9).

To extract effective paths for the contemporary transformation of “hermitage through fishing” culture, this study sorted out two types of typical domestic benchmark cases. For example, Chengdu Wuhou Shrine (Memorial Temple of Marquis Wu) took “cooking wine with green plums and discussing heroes” as its core concept, pioneering a new paradigm of “museum dramatization” (Zhang D. Celebrate the National Day · Colorful Jiangnan | Wuhuali, Qinhuai Hexi\_ Taste the ancient charm and modern style, enjoy the light and shadow of the night tour. Jiangnan Times. [https://www.jntimes.cn/zdxx/202210/t20221004\\_7716352.shtml](https://www.jntimes.cn/zdxx/202210/t20221004_7716352.shtml)); West Sea of Lushan Mountain in Jiangxi launched the International Angling Sports Season in May 2025, designed hierarchical activities based on the hermit IP, and established a community co-construction model, forming a “hermitage through fishing” culture promotion group. These cases provide practical references for “hermitage fishing event design” and “ancient village linkage” (Zhang Y. “Green plum cooking wine and talking about heroes”! Chengdu Wuhou Temple “May Day” welcomes a cultural feast. Kandu Shizheng. [https://difang.gmw.cn/sc/2025-05/01/content\\_38004110.htm](https://difang.gmw.cn/sc/2025-05/01/content_38004110.htm)).

Based on the previous research conclusions on the interactive relationship between the natural foundation and human practices of the waterfront historical landscape in the middle reaches, combined with practical experience in planning literary drama festivals and “hermitage through fishing” cultural activities, this study constructed a “hermitage through fishing” cultural narrative system through a three-level spatial development model, relying on the natural canyon landscape of “mountains embracing water” at Yan Ziling’s Fishing Platform Scenic Area and focusing on the temporal-spatial characteristic of “misty and hazy rain”: 1) Taking the historical scene of “Yan Guang wearing a fur coat and angling” at the Fishing Platform relics as the core, and relying on the cultural heritage of the cliff carving group, organize immersive drama festivals themed on “Liu Xiu’s three visits to recruit talents”, “Yan Guang refusing the imperial edict”, and “angling in a fur coat” in spring, autumn, and winter respectively, in chronological order of historical events. This aims to activate the historical

site of “rivers and lakes hermitage”. 2) Relying on the natural landscape of “dense shoals and misty rain” in the Qili Gorge section, and integrating relevant historical narratives such as “Yan Guang angling in a fur coat”, “Jiang Taigong angling with a straight hook”, and “the fisherman singing by the Canglang River”, hold irregular fishing competitions including the “Yan Guang Cup”, “Ziya Cup”, and “Fisherman Competition”. These events connect the “leisurely fishing” of modern people with the spiritual connotation of ancient “hermitage through fishing”. 3) Link the relics of “Liu Xiu’s Valley” in Meicheng Ancient Town and the wood carvings themed “Yan Guang encouraging farming” in Shen’ao Ancient Village, and design a “hermit role development system”. The main storyline tasks revolve around Yan Ziling’s experiences: “angling in a sheepskin coat—gaming between monarch and minister—encouraging farming to benefit the people”, while the side tasks focus on the hermitage journeys of figures like Jiang Ziya and the Canglang fisherman. Tourists can earn “Seclusion Points” for the middle reaches by completing activities such as angling, coir raincoat weaving, and poetry competitions on stage, forming a cultural experience closed loop of “experience—accumulation—feedback” and promoting the in-depth dissemination of “hermitage through fishing” culture.

Downstream: “Nature Worship-Historical Memory-Spiritual Symbolism” Tidal Culture Narrative System: The allusion clusters in the lower reaches take “tide” as their core cultural symbol. The characteristics of their spatial agglomeration have been verified through poetic text analysis: in Cluster 1 of the lower reaches, poems containing place names such as “Xixing” and “Xiling” (now Xixing Ancient Town in Binjiang District, Hangzhou) account for over 60% of the total poems in this cluster, and this region is a high kernel density zone (5 Kd) in the reach (Fig. 8). This provides quantitative support for analyzing the characteristics of waterfront historical landscapes dominated by “tidal culture” in the lower reaches.

Therefore, this study first took keywords such as “Rip Tide”, “Passenger Sail”, and “Waters Open to Sea” derived from Cluster 1 (Section 3.2.3) as core elements to formulate the underlying logical instructions for this scene. On this basis, further research was conducted on historical materials: The waterfront space in the lower reaches centered on the core function of “tide-watching”. Xiancheng Lin’an Gazetteer: Map of Zhejiang River clearly states that the core tide-watching area in the lower reaches was located at the waterfront of Zhakou on the north bank of the Qiantang River. Li Song’s painting Watching the Tide by Moonlight vividly depicts the architectural style of buildings with overhanging eaves and interlocking brackets clinging to the riverbank; the scene in the painting—aristocrats in pavilions and commoners holding torches on the riverbank watching the tide side by side—echoes the scale recorded in Tales of Wulin that when Emperor Xiaozong of the Southern Song Dynasty watched the tide, “there were more than 20 li of colored curtains from Longshan downwards, with carriages and horses crowded so densely that there was barely room to walk”. Together, they constructed a tide-watching space system of “shared by officials and commoners”. The natural characteristics of the surging tide combined scientific causes and artistic expressions. Xiancheng Lin’an Gazetteer revealed the scientific cause of the tide: the trumpet-shaped terrain of Hangzhou Bay and the underwater sandbars “constrained and intensified the tide force”. Xia Gui’s painting Autumn Tide on the Qiantang River used a “half-composition” technique to highlight the visual impact of waves tens of feet high and small boats tossing in the middle of the river. Human activities were driven by “tides” as the core, forming an integrated landscape of multiple types. Tales of Wulin detailed the “tide-playing stunts” of “Wu people with disheveled hair and tattooed bodies, holding ten flags and moving in and out of the whale-like waves”, which were mutually confirmed by the tide-surfing scenes in paintings. Meanwhile, the Southern Song Dynasty integrated naval reviews with various folk performances such as water puppetry and acrobatics into tide-watching activities, forming a composite humanistic landscape of “military drills—competitive performances—folk exhibitions”. Finally, based on the “Tidal Thunder Resonance” scene, more refined scene maps of the lower reaches of the Qiantang River were revised by adding elements such as surging tide landscapes, tide-playing crowds, and tide-related activities (Figure 9).

To explore the contemporary transformation path of tidal culture, this study sorted out cases adapted to the characteristics of the lower reaches. For example, relying on its history as the starting point of the Southern Silk Road, Chengdu Jinmen built an immersive commercial and cultural experience venue, set up themed market spaces, and launched supporting regional products; Shenzhen Dapeng Peninsula created a land-sea integrated natural education platform, developing a series of cross-medium exploration courses such as coastal geomorphology classes, marine biology classes, and climate science classes, providing a basis for the construction of marine ranches. Therefore, based on the previous research conclusions on the waterfront historical landscapes in the lower reaches, combined with practical experience in planning literary-themed markets and natural study activities, this study constructed a tidal culture narrative system of “Nature Worship—Historical Memory—Spiritual Symbol” (Fig. 9), drawing on water deity allusions and legends such as “Yang Hou (a water deity) stirring waves” in the lower reaches and integrating the folk belief that “Wu Zixu’s soul drives the tide”. With Xixing Ancient Town as the core carrier, this system focuses on the temporal-spatial characteristic of “tides surging at the river mouth” and is implemented through a three-level spatial structure. The specific paths are as follows: 1) Taking the dual historical attributes of “canal transportation + tide-watching” in the ancient town as the core, extract tide-related elements from merchant culture, tide-watching customs, and poetic culture to establish a “Tidal Market”. The market is divided into “Ancient Tide Area” and “New Tide Area”, selling intangible cultural heritage products such as traditional sea salt and tidal calendars, as well as tidal energy cultural and creative products and digital hydrological artworks. 2) Taking the scattered “tide” relic areas along the riverside as the natural experience extension zone. Connect Xixing Ancient Town, Wugong Temple, Sanlang Temple, and other sites forming the “Xu Tide (tide related to Wu Zixu) cultural gene chain” via water buses; integrate the successive “tide sounds” and “tide-related stories” about water deities into contemporary cultural and artistic creations. Combined with traditional seasonal events such as the Dragon Boat Festival and Mid-Autumn Festival, design a three-part cultural music festival themed “Tide Worship—Tide-Playing—Tide Calming” on the 18th day of the eighth lunar month, realizing the integration of natural tide sounds and artistic expressions. Meanwhile, compile the beliefs in multiple deities (including Wu Zixu, Wen Zhong, and Cao E) along the “tidal cultural gene chain” into The Illustrated Genealogy of Qiantang Tide Deities, and develop a “scan-to-recognize-deities” function on smart devices to help tourists form a comprehensive understanding of the mythological genealogy. 3) In response to ecological issues facing the Qiantang River such as saltwater intrusion and wetland degradation, designate the riverside tidal culture belt as an ecological research and study base. Launch “Tide Force Decoding” and “Tidal Culture Protection” ecological study camps: organize young people to compare and observe hydrological data of the Qiantang River in ancient and modern times to understand the scientific causes of surging tides; arrange for them to work with cultural scholars to sort out the connection between tide deity legends and regional history. By integrating scientific knowledge of the Qiantang River tides with mythological narratives across disciplines, realize the intertextuality and symbiosis of cultural heritage and ecological protection.

## Discussion

Let us return to the dilemmas of dynamic inheritance of regional literary landscapes proposed in the introduction, and discuss how to explore the network of connections between allusions to achieve cluster-based rather than isolated excavation of literary allusions; how to construct literary scenarios that integrate allusions with natural landscape elements and humanistic landscape elements to realize scenario-based rather than exhibition-style presentation of literary allusions; and ultimately, how to protect and inherit the connotations of literary allusions in a more systematic and vivid manner, so as to provide a referable and innovative path for the dynamic inheritance of similar literary heritage corridors.

1) When describing landscapes, poets often cite allusions used by predecessors to depict natural landscapes to enhance the cultural connotation of their poems; when expressing emotions, they resort to allusions such as historical stories and myths to implicitly convey their feelings; when stating their aspirations, they even take ancient figures as role models and use relevant allusions to clarify their ambitions and pursuits<sup>49</sup>. The research results show that among the 683 Song Dynasty poems from the Qiantang River Poetry Road, there are 96 allusions with a total occurrence frequency of 533, meaning an average of 0.78 literary allusions per poem. This confirms that ancient poetry is a reliable source for allusion excavation<sup>16</sup>. However, the reliability of ancient poetry as an allusion source may vary across historical periods or thematic categories, which requires further verification. Meanwhile, through semantic spot-check verification, the Precision, Recall, and F1-Score of the ALBERT+CRF preprocessing model for literary allusions in Song Dynasty poems adopted in this study all exceed 86%. The study by Zhou et al. also applied an ALBERT+CRF preprocessing model for ancient poetry entities, and its Precision, Recall, and F1-Score all exceeded 96%, which is significantly higher than those of the BiLSTM-CRF or Bert-BiLSTM-CRF models. This further confirms the adaptability of the ALBERT+CRF model for the recognition of allusion entities in Song Dynasty poems<sup>43</sup>.

In addition, the research results on the visualization of Song Dynasty poetry scenario strategies indicate that the collaborative framework composed of Gephi semantic network analysis and the Stable Diffusion generation model has effectively realized the quantitative modeling and concrete visualization of “allusion-landscape elements” integrated scenarios, fully verifying the application effectiveness of this framework in scenario-based presentation<sup>32</sup>. On one hand, Gephi semantic network analysis provides “quantitative instructions” for scenario construction, establishing a correlation matrix network of 145 pairs of allusions (between allusions) and a correlation matrix network of 4084 pairs related to allusions, which enables the accurate deconstruction of allusion connections. The results show that its modularity  $Q$  falls in the range of 0.3–0.7, indicating that the network has a significant clustering structure<sup>42</sup>. On the other hand, based on the quantitative instructions from Gephi, the Stable Diffusion model corrects the historical authenticity of scenarios by integrating multiple historical materials, and draws on the design logic of typical cultural tourism planning cases. A total of 14 literary allusion scenarios, including Autumn Waters Canoeing and Woodland Stream Hermitage, have been created and optimized, realizing the transformation from “abstract connections” to “concrete scenarios”. This provides a directly referable methodology for cultural tourism practices related to similar literary landscapes<sup>28</sup>.

2) Through textual semantic network analysis, this study verifies the canonical collection tradition of “cultural memory”<sup>50</sup> and the dual dialectical theory of “landscape form and literary spirit”<sup>51</sup>. We found that allusions that seem unrelated actually have significant correlations ( $0.3 < \text{modularity } Q < 0.7$ ). A typical example is Du Mu and Shen Yue: though Du Mu was a renowned poet of the Tang Dynasty and Shen Yue a litterateur and historian of the Southern Dynasties, both appear in Cluster 2 (“Woodland Stream Hermitage”) of the upper reaches. Further investigation reveals that both once served as local administrative officials in the upper reaches of the Qiantang River, making them typical representatives of the ancient Chinese ideology of “seclusion while in office”. Therefore, the construction of a poetic textual semantic network can serve as an effective approach to exploring implicit connections between allusions, promoting cultural identity, political legitimacy, or value inheritance. For instance, the “joint worship of Guan Yu and Yue Fei” is a cross-epoch phenomenon of worshipping martial sages centered on Guan Yu and Yue Fei in Chinese history. It reflects the selective reconstruction of the “loyalty and righteousness” value by both the official and folk sectors, becoming a typical practice of the cultural memory theory in the military and moral fields<sup>52</sup>.

In addition, there are also significant correlations between allusions and landscape elements ( $0.3 < \text{modularity } Q < 0.7$ ). A typical case is Cluster 3 (“Seeking Immortals Amid Mist and Clouds”) of the lower reaches: the allusion “Paradise On The Sea” is significantly associated with natural

landscape elements such as “goldfish”, “mist and clouds in twilight”, and “Supersized whale”, as well as humanistic landscape elements including “Retreat”, “Open-air Pavilion”, and “Immortal”. These landscape elements enhance the celestial atmosphere of the “Paradise On The Sea” allusion, while the allusion itself endows the landscape elements with unique and profound mythic richness. Therefore, exploring the correlation network between allusions and landscape elements can promote the interactive integration of material landscapes and cultural spirit. For example, Academician Meng Zhaozhen named the scenery beside Puzhao Temple at the foot of Mount Tai Pines Sifting Moonlight. This naming linked an originally isolated Chinese pine to the bright moon; furthermore, he built the “Moon-Sifting Pavilion” beside the pine, with the main couplet inscribed: “Raising two rafters to capture the moon; leaving four walls open lest they block the mountains”. Through this design, he integrated social beauty into natural beauty, creating the beauty of landscape art<sup>53</sup>.

3) Taking the Qiantang River Poetry Road as a case study, this research confirms that even similar natural landscape element scenarios can convey the connotations of different allusion connotation groups due to variations in humanistic landscape elements. Furthermore, through an internal comparison of clustered scenarios across different reaches of the Qiantang River Poetry Road, we found that the similarity of natural landscape elements among clustered scenarios within the upper, middle, and lower reaches all exceeded 70%, while the similarity of humanistic landscape elements was less than 10%. For instance, the allusion themes of Clusters 1, 2, and 3 in the lower reaches are “tidal culture theme represented by water deities and Wu Zixu”, “love theme represented by Fan Li and Xi Shi”, and “immortal hermitage theme represented by Penglai and Yingzhou” respectively. However, they all share natural landscape elements such as “river”, “sea”, and “tide” (similarity index,  $Si > 80\%$ ), while their humanistic landscape elements differ significantly ( $Si < 15\%$ ): Cluster 1 features “drum, sail, traveler”; Cluster 2 includes “gate, tower, monarch”; and Cluster 3 comprises “pavilion, hermit, immortal” ( $Si < 1\%$ ). This indicates that humanistic landscape elements play a prominent role in the construction of allusion scenarios.

The reason lies in the fact that in the creation of literary landscapes, “less explainable information” (represented by cultural landscape elements) is more likely to strengthen memory traces, whereas natural landscape elements often serve as the background for humanistic landscape elements rather than the focus of people’s vision<sup>49,54</sup>. Thus, when conveying the connotations of different allusions, even if natural landscape characteristics are similar, it is still possible to construct themes for different allusion connotation groups by highlighting the characteristics of humanistic landscape elements, thereby enhancing visitors’ long-term memory of and emotional resonance with literary landscapes<sup>54</sup>. Just as the natural lake landscape of Hangzhou’s West Lake mostly exists as a backdrop, humanistic landscape elements such as Su Causeway (which carries the historical story of Su Dongpo’s management of West Lake), Broken Bridge (a symbolic site of the Legend of the White Snake love story), and Crane-Release Pavilion (embodying Lin Bu’s hermitic sentiments) endow West Lake with unique cultural depth. These elements are also the iconic features that evoke deep emotional resonance among tourists from around the world<sup>55</sup>.

4) The spatial heterogeneity of literary landscape geographical phenomena determines that they exhibit significant differences at different scales<sup>56</sup>. Existing literary landscape studies have expanded from “point-based analysis” of single or multiple scenic spots to “systematic integration” research at the urban agglomeration scale, which helps reflect the functional complementarity and synergistic effects between cities. However, China’s administrative divisions have only gradually taken shape since modern times, disrupting the continuity of historical inheritance; in contrast, river basin units have existed since ancient times, featuring the continuity of natural geography and historical culture. Meanwhile, poetry road literary landscapes also have a long history dating back to ancient times. Therefore, from the perspective of the river basin scale, this study verified the regional diffusion phenomenon of allusion themes by comparing the differential impacts of different geographical environments in the upper, middle, and

lower reaches of the Qiantang River Basin on the characteristics of literary landscape scenarios.

A typical manifestation is that the allusions in Cluster 1 of the upper reaches and Cluster 1 of the middle reaches both focus on the hermitage theme centered on Yan Guang and Liu Xiu, but their landscape scenarios exhibit significant heterogeneity due to regional differences. Specifically, although the core hermitage theme (centered on Yan Guang-Liu Xiu) is consistent between the two clusters, the similarity of associated natural and humanistic landscape elements is less than 10%: Cluster 1 of the upper reaches corresponds to the scenario theme of Autumn Waters Canoeing, characterized by natural and humanistic landscape elements such as “sun,” “wind,” “bird,” “boat,” “woodcutter,” and “cottage”; while Cluster 1 of the middle reaches corresponds to the scenario theme of “Misty Rain Solitary Angling,” represented by elements like “road,” “heaven,” “river,” “angling,” “village,” and “person.” This phenomenon confirms the “geographical ontology” of literary geography from the river basin perspective—meaning that literary development takes “literary regions” as units with relatively stable regional attributes, but cross-regional integration can be achieved through the migration of writers and the dissemination of works<sup>57</sup>.

In addition, during the Tang and Song dynasties, the water transport network of the Qiantang River Basin was well-developed; the Quzhou area in the middle reaches even became the “Key Passage of the Southeast” (Dongnan Kongdao), where water and land transportation were closely integrated. The convenience of transportation further promoted cultural exchanges between different reaches<sup>58</sup>. This inspires us that even if the same literary allusion motif exists in different regional environments, we can deeply shape different aspects of the same allusion theme through the differences in local natural and humanistic landscape elements, thereby realizing win-win cooperation in cross-regional literary tourism.

The diverse interpretations of the “hermitage” theme in Suzhou classical gardens serve as a successful practice. For example, the Master-of-Nets Garden (Wangshi Yuan) constructs the hermitage theme related to the “fisherman” allusion through landscape elements such as the “Zhuoying Water Pavilion,” “swimming fish,” and “Duck-Shooting Corridor”; while the Couple’s Garden Retreat (Ou Yuan) expresses the farming-and-reading life of “joint farming and hermitage” (from the allusion of “Chang Ju and Jie Ni plowing side by side”) through elements like the “Lianlian Old House,” “Book Collection Tower,” and “Yellow Stone Rockery.” Such diverse scenario interpretations enhance the different aesthetic aspects of literary scenic spots sharing the same hermitage theme, enabling Suzhou classical gardens to not only showcase the humanistic artistic conception of individual gardens but also become an important heritage of world garden art through the collective value of classical garden clusters<sup>59</sup>.

This study still has the following limitations:

1) The Song Dynasty was a peak period in the evolution of Chinese culture, and also a period when the Qiantang River Basin emerged as a cultural center of China, which justified our focus on Song Dynasty poetry. However, this focus also limits our ability to capture diachronic changes in allusion characteristics: For instance, Tang Dynasty poetry (which witnessed the initial formation of the Qiantang River’s poetic status) may reflect earlier allusion motifs related to frontier defense (e.g., military-related allusions in poems by Wang Wei), while Ming-Qing poetry could reveal the impact of late imperial urbanization on allusion themes (e.g., merchant culture-related allusions). These diachronic dynamics are not addressed in our current study. Future studies could incorporate poems from Tang, Ming, and Qing dynasties, and compare allusion frequency, theme shifts, and landscape associations across periods to construct a more complete historical narrative.

2) Guided by the continuity of natural geography and the inheritance of historical culture, this study explored the differences in regional literary allusion scenarios across different reaches from the perspective of the river basin scale. However, restricted by the certainty of the research object scope, this study only focused on the Qiantang River Basin. Subsequent research should select 2-3 representative river basins (e.g., Yangtze, Pearl) for comparative analysis, and explore how geographical factors (e.g., terrain,

hydrology) and cultural backgrounds (e.g., ethnic composition, historical events) shape allusion cluster characteristics.

3) Considering the thematic focus of poetry road heritage corridors and the structural advantages of research materials, this study mainly used relevant ancient poems as materials to conduct research on the connotation of literary landscapes, while supplementing with literary historical materials such as ancient paintings, historical maps, and ancient books. And non-textual art forms such as folk music or traditional operas could provide auditory-visual dimensions of allusion dissemination, which our current text-based analysis cannot capture. In the future, relevant studies could target the particularities of literary landscape heritage corridors of different thematic types, and explore universal laws contained in other art forms such as music and folk songs.

4) This study carried out cross-method integration research using the ALBERT+CRF literary allusion preprocessing model, Gephi semantic network analysis, and Diffusion scenario visualization tools, providing a valuable attempt to solve the dilemmas faced by regional literary landscapes in dynamic inheritance. Nevertheless, although the ALBERT+CRF model can realize the accurate extraction of allusion entities, it has limited ability in semantic disambiguation of “polysemous allusions” (e.g., the “bright moon” refers both to a natural image and symbolizes the emotion of “homesickness”), and thus relies on manual annotation assistance. While the Gephi semantic network can present the static connections between allusions and landscape elements, it fails to incorporate dynamic variables such as “seasonal changes” and “literati’s itineraries”. In the future, through the continuous refinement of parameters in the model link, the application depth of the research framework in terms of the historical evolution logic of literary connotations and the accuracy of semantic recognition can be enhanced.

Understanding the clustering patterns of literary allusions will facilitate the future management and planning of literary landscape heritage. The key to protecting and planning cross-regional literary heritage corridors lies in preserving the ancient-contemporary continuity of literary connotations and the nature-culture synergy. For the Qiantang River Poetry Road specifically, this study reveals the associative characteristics and geographical spatial distribution patterns of literary allusions in a typical literary heritage corridor, including the laws of Shared Allusion Motifs, Divergent Scene Typologies and Shared Scene Archetypes, Divergent Allusion Themes both within and across the geographical units of the upper, middle, and lower reaches.

1) This study constructed an integrated framework for activating literary allusion scenarios, namely “Allusion Excavation—Landscape elements Deconstruction—Artistic Conception Reconstruction”, and conducted an analysis of the regional correlations of literary allusion connotation groups in the Qiantang River Poetry Road from a river basin perspective. A total of 533 allusion entities, 394 natural landscape element entries, 309 humanistic landscape element entries, and 14 literary allusion clustering connotation groups were identified in the Qiantang River Basin. This realizes the excavation of hidden patterns among poetry road literary allusions, providing direct guidance for the construction of cross-regional cultural tourism scenarios and the practical protection of literary heritage corridors.

2) The most recognizable associative allusion imagery groups in the upper, middle, and lower reaches are as follows: · Upper reaches: A “hermitage by boat” cultural narrative system composed of Yan Guang & Liu Xiu, Jiang Ziya, and Jiaochi (a mythical dragon-like creature); · Middle reaches: A “hermitage through fishing” cultural narrative system composed of Yan Guang & Liu Xiu, Jiang Ziya, and fishermen; · Lower reaches: A “tidal culture” narrative system composed of water deities and Wu Zixu. Centered around the above core allusion imagery groups, the most recognizable literary scenarios in the three reaches were formed respectively: · Upper reaches: Autumn Waters Canoeing (44 Wd), concentrated in the present-day Lanke Mountain-Wuxi River Scenic Area (2 Kd); · Middle reaches: Misty Rain Solitary Angling (48 Wd), concentrated in the Qili Gorge section

of the Fuchun River (9 Kd); · Lower reaches: Tidal Thunder Resonance (86 Wd), concentrated in the Qiantang River estuary area of Binjiang District, Hangzhou (5 Kd). Therefore, for areas with the highest recognition of these allusion landscape characteristics, priority should be given to strengthening the protection and utilization of the connotations of their literary landscape heritage, based on the narrative systems of associative allusion imagery groups.

3) Through quantitative semantic network correlation analysis, this study confirms that there are significant content correlations between allusions, and between allusions and landscape elements ( $0.3 < \text{modularity } Q < 0.7$ ). This inspires us to focus on and explore the clustering phenomenon of landscape scenarios in the protection, inheritance, and cultural tourism practice of literary landscapes, promoting the systematic and holistic protection of allusion culture.

4) A cross-regional comparison of allusion scenario characteristics reveals that the scenario narratives of literary allusion landscapes exhibit stratification and penetration at the river basin scale, and uncovers the regular characteristics of Shared Allusion Motifs, Divergent Scene Typologies and Shared Scene Archetypes, Divergent Allusion Themes. For the same allusion theme, the heterogeneity of landscape elements in different regions can be used to shape different aspects of the same type of allusion theme; In similar natural environments, highlighting the heterogeneity of cultural landscape elements can greatly emphasize the uniqueness of the thematic connotations of each allusion landscape scenario. This not only provides local cultural tourism authorities with a development path to avoid homogenization and highlight regional characteristics, but also, through the in-depth integration of allusions—landscape elements—scenarios, transforms the literary connotations in ancient classics from static displays into cultural experiences that are perceivable and empathetic to the public.

In summary, the core values of this study are as follows: Methodologically, it provides an analytical template for research on similar literary heritage corridors centered on poetic texts, advancing the protection of literary heritage from experience-based planning to data-driven precision research; Practically, it facilitates the contemporary construction of regional cultural identity and the dynamic dissemination of fine traditional culture, offering generalizable experiences for the protection and inheritance of similar linguistic intangible cultural heritage worldwide.

## Data availability

All data supporting the findings of this study are available within the paper and its Supplementary Information. Custom code used in this study is available from the corresponding author upon reasonable request, with a detailed description of the research purpose required for access. The following software versions and key parameters were employed for data generation and analysis: 1 ) Gephi 0.10.1: Used for network modularity analysis with the Resolution parameter set to 1.0. 2 ) Stable Diffusion 3: Applied for text-to-image generation, with the following configurations: Image resolution: 768 × 768 pixels; Classifier-Free Guidance scale: 8.0 (to enhance text relevance); Sampling method: Rectified Flow. 3) ArcGIS 10.6: Utilized for kernel density analysis, with parameters specified as: Search radius: 5 km; Weight field: Default (1 for all features); Cell size: 500 m.

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Received: 23 May 2025; Accepted: 11 February 2026;

Published online: 28 February 2026

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### Acknowledgements

The authors gratefully acknowledge the financial support from the Key Specialty Project of Ordinary Colleges and Universities in Shaoxing City, Zhejiang Province (SXSZY202412) and The “Four New” Research and Practice Project of Zhejiang Shuren University: “Landscape Planning and Design” (JXJ0224302).

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D.H.: Writing—original draft, Data curation, Investigation, Validation. T.X.: Conceptualization, Formal analysis, Project administration, Writing—original draft. Jue Li: Software, Visualization, Investigation, Formal analysis. Q.Y.: Software, Visualization, Investigation. W.N.: Writing—review and editing, Supervision, Project administration, Methodology. Jiayan Li: Writing—review and editing, Supervision, Project administration, Methodology.

### Competing interests

The authors declare no competing interests.

### Additional information

**Supplementary information** The online version contains supplementary material available at <https://doi.org/10.1038/s40494-026-02381-2>.

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