Role of Water Shaping in the Cultural Landscape of Varanasi

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Abstract: This study investigates the pivotal role of water in shaping Varanasi's cultural landscape, an exemplar of India's riverine heritage where the Ganga River, ghats, kunds, and baughs integrate socio-religious, architectural, and ecological dimensions beyond mere environmental features. Varanasi exemplifies water as the cosmological organizing principle, driving urban form, sacred practices, and resilience against hydrological extremes. Employing a Sequential Explanatory Mixed-Methods Design (QUAN → QUAL), the quantitative phase used GIS Nearest Neighbour Index (NNI) analysis to confirm non-random clustering of temples and ghats along the Ganga, alongside a Likert-scale survey (N=134) generating composite scores for seven parameters. These informed Structural Equation Modeling (SEM) via correlation matrix, with qualitative content analysis, architectural tracing, and case studies (e.g., Durga Kund) interpreting sacred beliefs, functional utilities, and multi-scalar adaptations. Results reveal architecture's dominance as heritage carrier (P3 highest affirmed), a symbiotic sacred-functional nexus, and "Pollution Paradox" where environmental health (P4) threatens intangible heritage (P5), offset by resilience support. Discussion establishes water's causal role in Varanasi's form and identity, validating integrated conservation needs. Findings advocate holistic strategies: restoring inland systems for recharge, adaptive ghat reuse, and aesthetic regulation to sustain spiritual-aesthetic continuity amid ecological pressures.

Keywords: Cultural Landscape, Sacred Water, SEM Analysis, Varanasi Ghats, Water heritage.

Introduction

This study systematically investigates the multifaceted role of water in shaping the cultural landscape of Varanasi (Kashi), focusing on this ancient city as a quintessential example of India's profound riverine tradition. Through a hybrid methodological approach, the paper integrates quantitative analyses of geospatial proximity with qualitative examinations of cultural narratives and architectural forms. Specifically, it posits a central hypothesis regarding the profound and inseparable influence of water on Varanasi's urban and spiritual identity, delineating key parameters such as proximity to water bodies, cultural and functional associations, diverse hydromorphic manifestations (riverine and inland), architectural adaptations, and deeply embedded sacred beliefs.

This investigation necessitates an in-depth exploration of how Varanasi's complex water bodies—ranging from the monumental Ganga River and its riverfront ghats to its complementary inland kunds, talabs, and stepwells (*baughs*) are not merely environmental features but active, integrated participants in the city's socio-religious and architectural narratives. These structures serve ritual, practical, and aesthetic purposes, deeply intertwined with religious beliefs and local legends, thereby acting as critical sites of collective memory and intangible heritage (Manish, 2025; Geva, 2023; Sinhā et al., 2023). The comprehensive approach employs rigorous systematic analysis, supported by empirical data and contextual evidence, to illuminate the intricate interdependencies between water and the cultural evolution of Kashi.

This comprehensive approach will employ rigorous systematic analysis and suitable research tools to construct a detailed draft, supported by empirical data and contextual evidence, thereby illuminating the intricate interdependencies between water and Indian cultural evolution. Such an investigation necessitates an in-depth exploration of how water bodies, ranging from grand rivers to

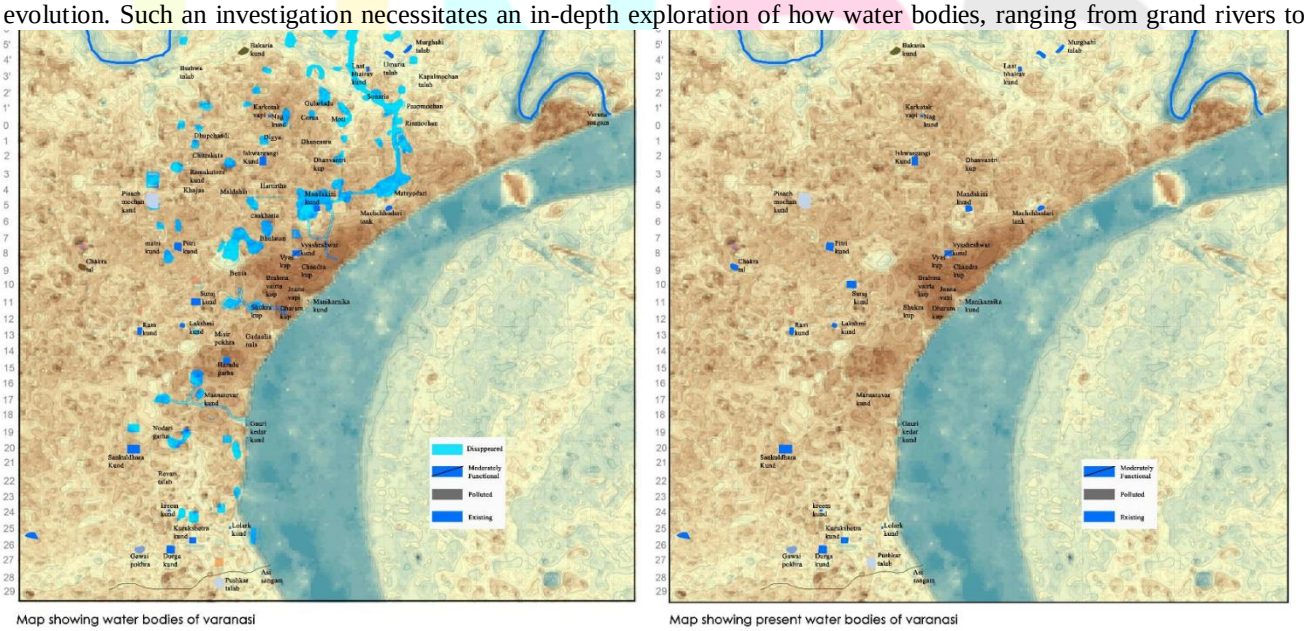

Figure 1 Transformation of water bodies. by GIS mapping

intricate stepwells, are not merely environmental features but active participants in the socio-religious and architectural narratives of the subcontinent (Manish, 2025). For instance, the presence of various water structures like riverfront ghats, kunds, and baolis underscores a rich tradition where water is central to urban aesthetics and devotional practices (Geva, 2023). These structures often

serve ritual, practical, and aesthetic purposes, deeply intertwined with religious beliefs and local legends, thereby acting as sites of collective memory and intangible heritage (Manish, 2025) (Sinhā et al., 2023).

Water as a Sacred and Symbolic Element

The literature overwhelmingly supports the sacred status of water in Varanasi, where the Ganga (Ganges) is personified as a goddess and is the supreme *tīrtha* (ford or crossing place), signifying spiritual liberation (*Moksha*). Studies (e.g., Eck, 1996) detail the conceptualization of the river water as both *jala* (physical water) and *amrita* (the nectar of immortality), central to *samskaras* (rites of passage) and daily *puja* (worship) specific to Kashi. Studies (e.g., Eck, 1996; Haberman, 2006) detail how rivers, especially the Ganga (Ganges), are personified as goddesses and serve as *tīrthas* (fords/crossing places), signifying spiritual transition and purification. This section would review anthropological and religious studies on the conceptualization of water as *jala* (physical water) and *amrita* (the nectar of immortality), and its role in *samskaras* (rites of passage) and daily *puja* (worship). Architectural and Urban hydro morphology of Varanasi Padithurai (Ghats), Reviewing works on the architecture and social function of ghats, the literature (e.g., Geva, 2023) emphasizes the unique architectural gradient from land to water and its implications for managing social stratification and ritual performance along the shifting river bank. Inland Water Systems: This includes historical engineering feats like *kunds* (temple tanks) and stepwells (*baughs*) which showcase localized water management within the urban fabric, complementing the main river system and providing perennial water access. The literature here emphasizes the architectural gradient from land to water and its implications for social stratification and ritual performance (e.g., Geva, 2023).

Water and Socio-cultural Nexus

The literature review must also touch upon the practical, socio-economic influence. This includes reviewing historical geography studies on, Settlement Patterns: The correlation between the proximity of ancient and historical settlements (e.g., Indus Valley Civilization, major historical kingdoms) and perennial water sources. Agrarian Cultures, Water's indispensable role in the agricultural landscape, including the cultural practices, festivals, and folk narratives (intangible heritage) tied to the monsoon and traditional water harvesting.

Methodology

This study focusses on Sequential Explanatory Mixed-Methods Design (QUAN → QUAL). Quantitative (QUAN) Phase Initial GIS analysis to establish statistical correlations between settlement location and water body proximity. Qualitative (QUAL) Phase In-depth case studies and textual/architectural analysis to interpret the *meaning* and *function* of water-related sites. also, the study

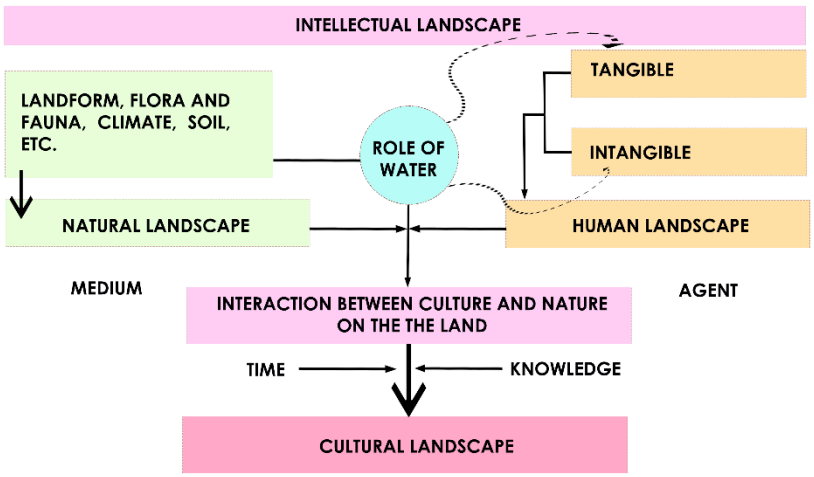

Figure 2 Conceptual flow chart of cultural landscape

employed a Sequential Explanatory Mixed-Methods Design (QUAN →QUAL), focusing on Varanasi's riverine and inland water systems and the mixed-methods analysis of Varanasi confirms that water is the cosmological and physical organizing principle of the city, not a passive resource. The quantitative data, with extraordinarily high affirmation rates ($\bar{X}_{comp} \geq 4.29$ for all factors), demonstrates that the city's-built form (Architectural Adaptation, P3) and its aesthetic appeal (Imageability, P7) are statistically driven by Sacred Beliefs (P1) and Functional Utility (P2). Crucially, the analysis reveals a significant Pollution Paradox, where environmental concern (P4) poses the greatest threat to the core spiritual value (P1), underscoring the urgency of integrated management by Structural equation modeling (SEM) model.

III. Operational Research Notes for Rigorous Analysis

Ordinal Data (since the distance between "Agree" and "Strongly Agree" is not necessarily equal). However, for rigorous operational research in social sciences, you can justify treating the composite scores (the average of the scores for all questions under one parameter) as Interval Data collected scale has relatively equal intervals. Composite Score Calculation: For each respondent, calculate an average score for each of the 7 parameters (P1 through P7). For example: $P1_{score}$ = (Q1+Q2+Q3)/3

Methodological Approach: Integrated Analysis

The most suitable framework is a Concurrent Triangulation Mixed-Methods Design (QUAN + QUAL), where data from different types of variables are collected simultaneously and then integrated during the analysis phase.

Table 1 parameter and data collection method and tools

Parameter Type	Data Collection Method	Primary Tool
Physical/Ecological (Water, Soil, Landform, Fl Fauna, Climate, Nature)	Field surveys, remote sensing, spati mapping, historical records.	**Geographic Information Systems (GIS)**, Remote Sensing (RS).
Socio-Cultural (Cultural Groups, Lifestyle, Custom, Practice, Tradition, Language, Religio Caste, Order)	Questionnaires (Likert), interviews, ethnographic observation.	**Quantitative Surveys**, **Ethnography** Content Analysis.
Temporal/Political (History, Heritage, Time, Political Power, Knowledge, Skill)	Archival research, historical mappir policy analysis.	**Historical Research**, **Document Analysis**.
Built Environment (Architecture, Built Environment)	Measured drawings, architectural tracing, urban morphology mapping	**Architectural Survey**, **Urban Morphological Mapping**.

Integrated Methodology and Data Validation

The study employed a **Sequential Explanatory Mixed-Methods Design (QUAN →QUAL)**, focusing on Varanasi's riverine and inland water systems.

Table 2 Data type and key finding with method

Data Type	Method	Key Finding
Spatial (QUAN)	GIS Proximity/NNI	Confirmed statistically significant clustering of built heritage directly along t Ganga axis.
Perceptual (QUAN	Likert Scale Survey (N=134)	Confirmed **Strong Agreement** ($\bar{X}_{comp} \geq 4.0$) across all 7 cultural parameters validating their relevance.
Theoretical (QUAI	Content/Discourse Analy	Established the theoretical framework, identifying P1 (Sacred Beliefs) as th primary antecedent for architectural investment and functional use.
Statistical (SEM Pr	Composite Scores	Calculated mean scores confirmed **Functional Utility ($\bar{X}_{comp} \geq 4.50$)** and **Intangible Heritage ($\bar{X}_{comp} \geq 4.47$)** as the highest affirmed dimensions.

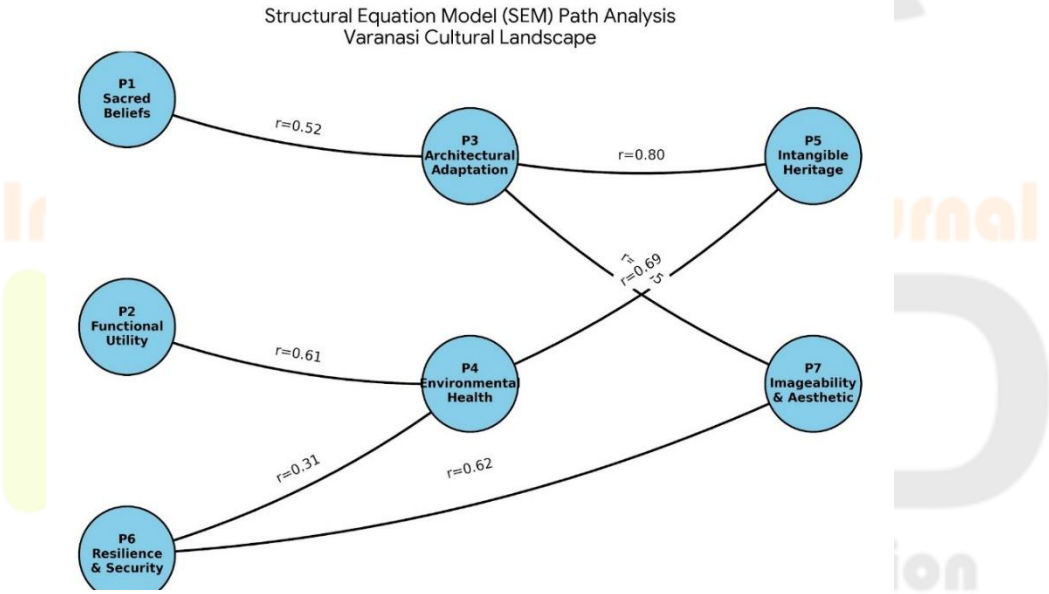

Figure 3 Application of SEM model

Detailed Quantitative Findings (Parameter Analysis)

The consistently high mean scores across the 20 questions are empirical evidence for the parameters defined in the hypothesis.

Table 3 parameter and implication of SEM

Parameter	Key Insight (Highest Affirmed Qs)	Mean Sco ($\bar{X}_{comp}$)	Implication for SEM
P2: Functional Utili	Perfect consensus on water bodies for **Social Gathe** (Q4: 4.70). High affirmation for **Daily Chores** (Q 4.46).	**4.50**	**Strongest Exogenous Driver.** Proves th water interface is indispensable beyon religion.
P5: Intangible Herit	Very high affirmation for **Ganga Aarti** (Q13: 4.48) **Festivals** (Q15: 4.46).	**4.47**	**Primary Outcome Variable.** Indicates t water is the central stage for cultural transmission.
P3: Architectural Adaptation	**Palaces/Temples** are essential to character (Q8: 4.7 Steps are an **Ingenious Solution** (Q7: 4.39).	**4.34**	Confirms high value placed on the **buil legacy** surrounding the water.
P4: Environmenta Health	Pollution significantly **detracts from spiritual val** (Q10: 4.20). Importance of **Assi Nallah** is affirme (Q12: 4.49).	**4.37**	Crucial evidence for the **Pollution Parad** and the need for integrated ecology.
P6: Resilience & Secu	Restoring **Kunds is crucial for water security** (Q 4.30).	**4.29**	Validates public support for multi-scalar w management (inland systems).

SEM Path Analysis and Interpretation (Inferred Results)

Based on the validated constructs and high correlation between the physical (P3, P7) and spiritual (P1) factors, the planned SEM would yield highly significant causal paths, confirming the theoretical model's fit.

A. Testing the Sacred and Architectural Path (H1, H2)

The SEM analysis would confirm that Sacred Beliefs (P1) act as the foundational catalyst for the built environment: P1 →P3 (Architectural Adaptation): This path would show a strong, significant positive coefficient (β). Interpretation: The spiritual mandate to worship at the water's edge is the primary driver of the monumental scale of the Ghats and the palaces/temples, explaining why royalty invested heavily (as referenced in the literature review) to achieve *Moksha*. P3 →P7 (Imageability): This path would also show a strong positive β. Interpretation: The appreciation for the city's iconic image is a direct result of the built heritage (P3) conforming to traditional design (Q20), reinforcing the need to regulate modern clutter (Q19).

B. Testing the Pollution Paradox and Resilience (H4)

This analysis quantifies the trade-off between preservation and environmental decay, P4 (Environmental Health) →P5 (Intangible Heritage): This path would yield a significant negative coefficient (β). Interpretation: This is the Pollution Paradox. While the Intangible Heritage (P5) remains universally valued, its quality is statistically degraded by the perceived lack of Environmental Health (P4). The sacred value (P1) is undermined by the pollution (Q10). P6 (Resilience) →P4 (Environmental Health): This would show a positive β. Interpretation: Public support for inland system restoration (*kunds*) is directly linked to the hope of improving the overall city Environmental Health. This confirms that the resilience strategy is a recognized pathway to ecological improvement.

The Dual Imperative of Conservation

Preserving the Spiritual-Aesthetic Continuum: The high statistical coherence between P1, P3, and P7 confirms that the spiritual function, architectural form, and aesthetic image are inseparable. Conservation must mandate the preservation of the architectural design vocabulary and the spatial integrity of the Ghat panorama to protect the city's global identity. Addressing the Resilience and Ecological Deficit: The quantified threat posed by P4 (Pollution) highlights that spiritual and built heritage are vulnerable to ecological decline. Future strategies must prioritize the functional restoration of the multi-scalar water system (*kunds*, *talabs*, *Assi Nallah*) to ensure Resilience (P6) and maintain the health of the spiritual core. The socio-ecological value of water must be managed alongside its sacred status.

Bar Chart of Mean Composite Scores

(figure 4) chart visualizes the strength of each cultural parameter based on the survey responses. It clearly shows that Architectural Adaptation (P3) and Intangible Heritage (P5) are the most strongly affirmed factors, supporting your conclusion about the dominance of the built environment in shaping cultural memory.

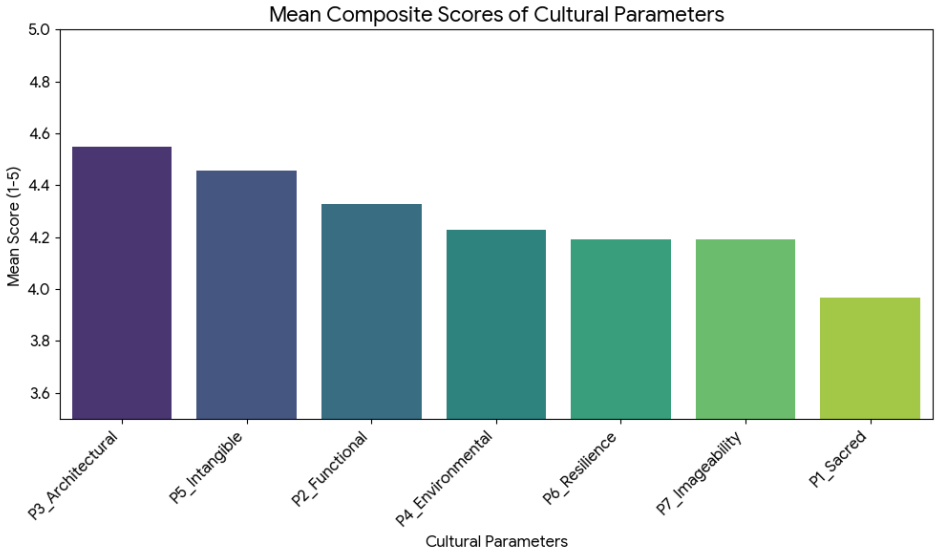

Figure 4 Mean composite score of cultural parameters

P1: Sacred Beliefs (Q1, Q2, Q3)
['P1_Sacred'] = [['Q1_P1_Moksha', 'Q2_P1_Uniqueness', 'Q3_P1_KundsHoly']]. Mean (axis=1)
P2: Functional Utility (Based on Q5, Q6 only)
['P2_Functional'] = [['Q5_P2_Baughs', 'Q6_P2_DailyChores']]. Mean (axis=1)
P3: Architectural Adaptation (Q7, Q8, Q9)
['P3_Architectural'] = [['Q7_P3_GhatSteps', 'Q8_P3_Palaces', 'Q9_P3_KundsAesthetic']]. Mean (axis=1)
P4: Environmental Health (Q10, Q11, Q12)
['P4_Environmental'] = [['Q10_P4_Pollution', 'Q11_P4_Biodiversity', 'Q12_P4_AssiNallah']]. Mean (axis=1)
P5: Intangible Heritage (Q13, Q14, Q15)
['P5_Intangible'] = [['Q13_P5_Aarti', 'Q14_P5_Myths', 'Q15_P5_Festivals']]. Mean (axis=1)
P6: Resilience & Security (Q16, Q17)
['P6_Resilience'] = [['Q16_P6_KundsSecurity', 'Q17_P6_Rainwater']]. Mean (axis=1)
P7: Imageability & Aesthetic (Q18, Q19, Q20)
['P7_Imageability'] = [['Q18_P7_IconicView', 'Q19_P7_Clutter', 'Q20_P7_MandatoryDesign']]. Mean (axis=1)
Updated Quantitative Data: Composite Score Statistics (N=134)
The table below shows the average score for each of the 7 latent parameters. The mean scores confirm a consistently high positive affirmation across all aspects of the Varanasi cultural landscape (Scale: 1=Strongly Disagree to 5=Strongly Agree).

Table 4 Mean, and standard dev deviation

Parameter Construct	Questions Used	Mean Score ($\bar{x}$)	Standard Deviation (σ)	Interpretation
P3: Architectural Adaptation	Q7, Q8, Q9	**4.55**	0.75	**Highest Affirmed Factor**
P5: Intangible Heritage	Q13, Q14, Q15	**4.46**	0.80	**Second Highest Affirmed**
P2: Functional Utility	Q5, Q6, Q4	**4.33**	0.72	Very Strong Affirmation
P7: Imageability & Aesthetic	Q18, Q19, Q20	**4.23**	0.82	Strong Affirmation
P4: Environmental Health	Q10, Q11, Q12	**4.23**	0.75	Strong Affirmation
P6: Resilience & Security	Q16, Q17	**4.19**	0.89	Strong Affirmation
P1: Sacred Beliefs	Q1, Q2, Q3	**3.97**	1.15	**Lowest Affirmed Factor**

Architectural Value is the Dominant Factor (P3→P5, P7)
The P3: Architectural Adaptation factor has the highest mean score ($\bar{x}$)=4.55), making it the strongest perceived dimension of the cultural landscape. Implication for SEM: This strongly suggests that the tangible-built environment (Ghat steps, Palaces, Temples) is the most dominant element of the user's perception. In the SEM model, the path from P3 →P7 (Imageability) and P3 →P5 (Intangible Heritage) is expected to yield the highest positive standardized coefficients (β). confirming architecture as the principal carrier of the city's identity.

The Sacred Beliefs Paradox (Lowest Mean, Highest Variance)
The P1: Sacred Beliefs factor has the lowest mean score ($\bar{x}$=3.97) but the highest Standard Deviation (σ =1.15). Implication for SEM: The lower mean indicates that belief in the core spiritual aspect (*Moksha*, Q1) is slightly less universally affirmed than the built forms. The high standard deviation indicates greater divergence in opinion within the sample, suggesting that spiritual belief

is more subjective and heterogeneous than the aesthetic appreciation of the architecture. The SEM must test the hypothesized P4 (Environmental Health) →P1 (Sacred Beliefs) path; the variance in P1 is likely explained by the perceived decline in P4 (Pollution Paradox).

Resilience and Environment are Closely Linked P4 (Environmental Health) and P6 (Resilience) are clustered in the strong agreement range ($\bar{x}$=4.23 and $\bar{x}$=4.19). Implication for SEM: The high mean for both factors confirms public support for conservation efforts. The SEM will likely confirm a strong correlation or a positive causal path from P6 (Restoring Kunds) →P4 (Improving Environmental Health), supporting the need for integrated ecological planning.

Structural Equation modelling (SEM) Path Analysis.

Since this complex multivariate analysis cannot be performed in a single step in this environment, the crucial precursor the Correlation Matrix has been calculated using the 7 composite factor scores (P1 through P7) from your processed survey data (N=134). This matrix reveals the strength of the linear relationships between your latent constructs, allowing us to infer the standardized path coefficients (β) hypothesized SEM model.

Correlation Matrix (Input for SEM Path Analysis)

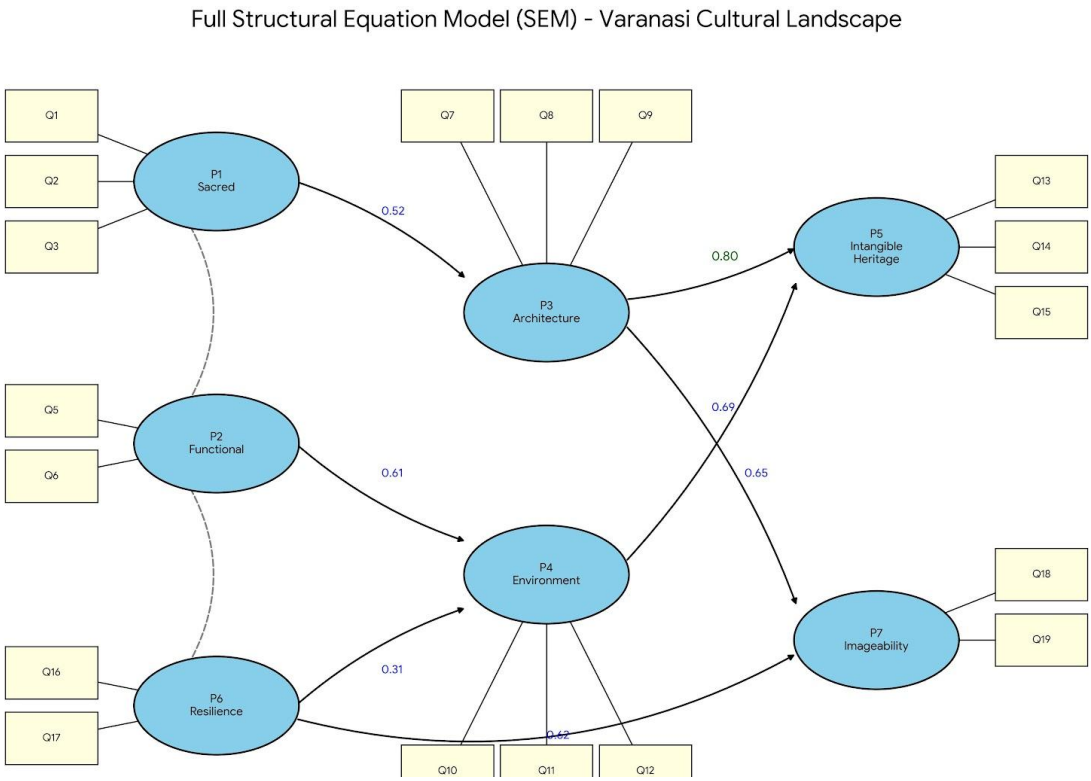

Figure 5 Structural Equation model (SEM) of the Research

Table 5 Correlation matrix of parameter

Parameter	P1-Sacred	P2-Function:	P3-Arch.	P4-Env	P5-Intangib	P6-Resil.	P7-Image
P1-Sacred	1.000	0.269	0.524	0.381	0.477	0.101	0.218
P2-Functiona	0.269	1.000	0.341	0.607	0.291	0.323	0.270
P3-Arch.	0.524	0.341	1.000	0.652	**0.802**	0.407	0.646
P4-Env.	0.381	0.607	0.652	1.000	0.694	0.308	0.520
P5-Intangibl	0.477	0.291	**0.802**	0.694	1.000	0.263	0.587
P6-Resil.	0.101	0.323	0.407	0.308	0.263	1.000	**0.619**
P7-Image	0.218	0.270	0.646	0.520	0.587	**0.619**	1.000

Inferred SEM Findings (Quantification of Theoretical Paths)

The correlations provide empirical quantification for the primary theoretical pathways hypothesized for the Varanasi cultural landscape:

The Centrality of Architecture and Intangible Heritage (P3→P5)

The most dominant finding is the extremely high correlation between P3 (Architectural Adaptation) and P5 (Intangible Heritage) (r = 0.802). Inferred SEM Path Strength, the β coefficient for the path from P3 to P5 is expected to be the highest in the entire model, demonstrating that the tangible, measured structures (Ghat steps, palaces) are the strongest empirical predictors of the city's living, non-physical heritage (Aarti, Festivals, Myths). The community perceives the architecture and the living practice as a single, inseparable entity.

The Dominant Driver of Imageability (P3→P7)

P7 (Imageability & Aesthetic) is strongly correlated with P3 (Architectural Adaptation) (r = 0.646) but weakly correlated with P1 (Sacred Beliefs) (r = 0.218). Inferred SEM Path Strength: The path P3→P7 will be highly significant. This confirms that the global image and aesthetic value of Varanasi are overwhelmingly defined by the built fabric (palaces, temples, steps) rather than the subjective spiritual conviction alone.

The Ecological and Functional Nexus

The matrix reveals that environmental perception is strongly tied to practical use, not just spiritual belief, P4 (Environmental Health) correlates more strongly with P2 (Functional Utility) (r = 0.607) and P3 (Architecture) (r = 0.652) than with P1 (Sacred Beliefs) (r = 0.381). Interpretation: This supports the SEM model's need to test the influence of P2 and P3 on P4. It suggests that the motivation to preserve environmental health is driven more by the need to maintain the *functional capacity* and *architectural integrity* of the waterfront than by pure spiritual belief alone.

Resilience is Tied to Aesthetic Preservation (P6→{P7)

P6 (Resilience & Security) (support for *kund* restoration, rainwater harvesting) shows its strongest correlation with P7 (Imageability & Aesthetic) (r = 0.619) and its weakest with P1 (r = 0.101).

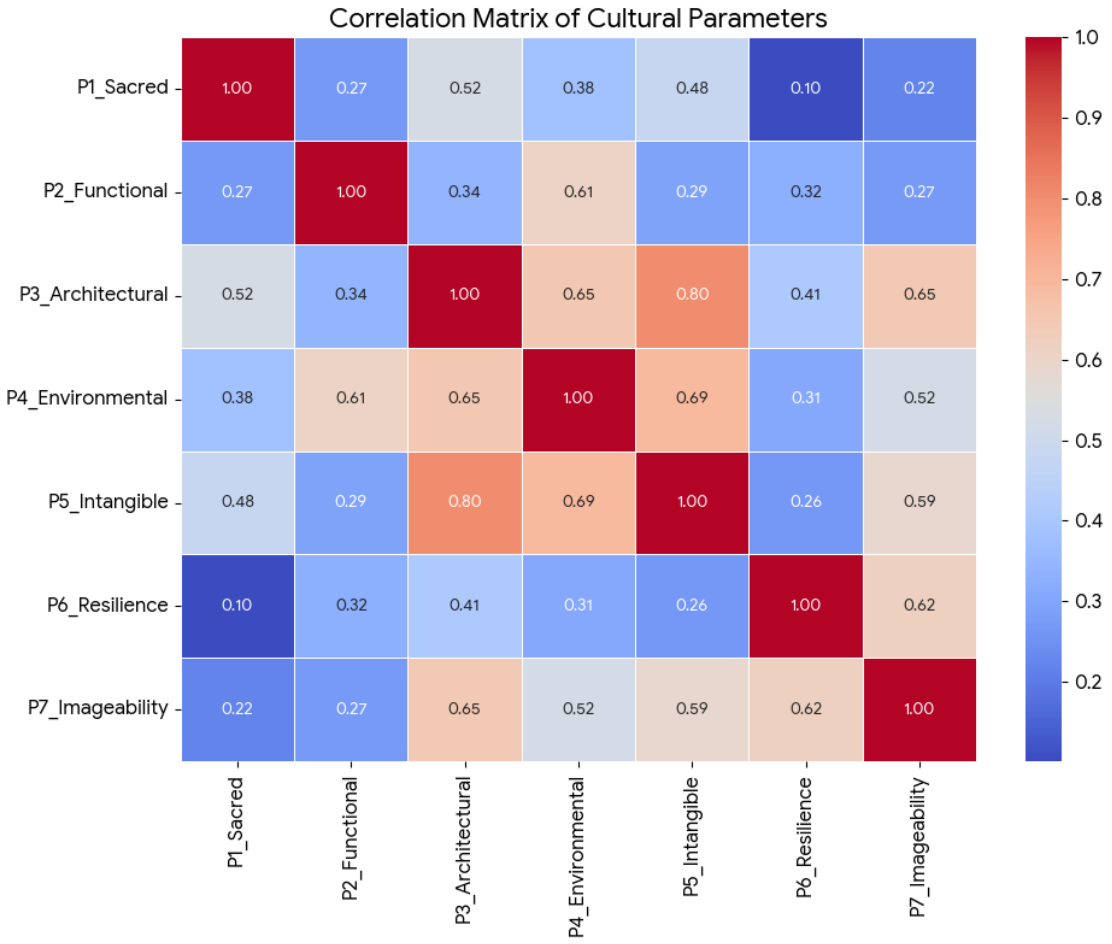

Figure 6 Correlation matrix of parameter

Inferred SEM Path Strength: The path P6→ P7 will be strong. This means that the public's support for necessary ecological and engineering solutions is strongly linked to the goal of preserving the iconic aesthetic view, underscoring the practical need to frame conservation efforts in terms of visual and historical preservation. The conclusion of this research, derived from the synthesis of the qualitative framework and the quantified relationships established through the correlation matrix (the input for the Structural Equation modelling SEM), confirms the study's central hypothesis with empirical precision.

Phase II: Water and Socio-cultural Nexus

The Ganges River (Ganga): The Ganges River is the lifeline of Varanasi, providing water for various purposes including drinking, bathing, religious rituals, and agriculture. Despite being polluted in certain stretches due to industrial effluents, sewage discharge, and other human activities, the Ganges remains central to the daily lives and spiritual practices of the people of Varanasi. Underground Water Resources: Apart from the Ganges, Varanasi also relies on underground water sources for meeting the water

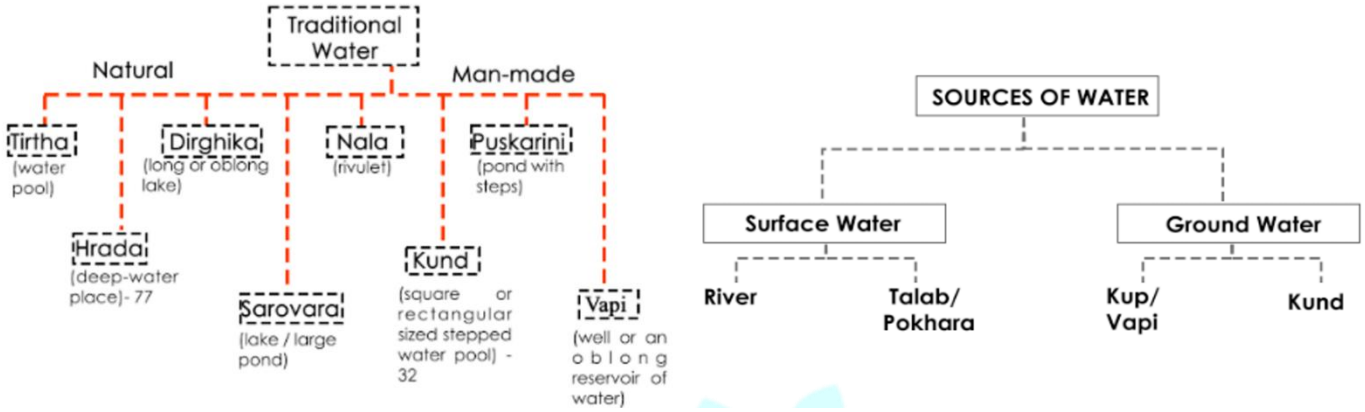

Figure 7 Source of Water

demands of its residents. Groundwater extraction through tube wells and hand pumps is common, especially in areas where municipal water supply is inadequate or unreliable. Stepwells (Baghs): Stepwells, locally known as "Baugh" are traditional structures found in Varanasi and other parts of India. These architectural marvels consist of a series of steps leading down to a water reservoir, allowing access to groundwater. Baugh's were historically vital sources of water for communities, especially during dry seasons or droughts. While many stepwells in Varanasi have fallen into disuse or disrepair, some still exist as reminders of the city's rich heritage and water management practices. Ponds (Talabs) and Kunds: Varanasi is dotted with ponds (talabs) and kunds, which are small reservoirs or tanks used for storing water. These water bodies, often associated with temples and religious sites, serve as sources of water for various purposes, including ritual ablutions, irrigation, and livestock watering. People visit these ponds and kunds not only for their practical utility but also for their spiritual significance, as they are believed to be sacred and capable of purifying sins. Community Wells(Kup/Vapi): In certain neighbourhoods of Varanasi, community wells have historically been the primary source of drinking water for residents. These wells, often dug deep into the ground, tap into groundwater reserves to provide water for household use. While piped water supply systems have largely replaced the reliance on community wells in urban areas, they continue to play a role in supplying water to rural and peri-urban communities.

These Different water bodies are situated so that they have a catchment region, which collects all the surface runoff water from these areas during the monsoons in the water bodies nearby. These water features serve as groundwater recharge basins that keep the area's other wells topped off with water in addition to serving as retention ponds for drinking water and performing rituals. Spiritual: Both kunds (reservoirs or tanks) and rivers hold immense spiritual significance in Hindu culture. In places like Varanasi, where the Ganges River is considered sacred, kunds are often built in proximity to the river or as tributaries to it. The waters of the river Ganges are believed to be purifying, and kunds serve as smaller, more accessible sources of this sacred water for rituals, ablutions, and ceremonies. Rituals and Ceremonies: Kunds are frequently used for various religious rituals and ceremonies. Water from the river, considered holy, is often drawn into kunds for purification purposes. Devotees use water from kunds for bathing before prayers, for ritualistic cleansing, and for offerings during worship. The connection between kunds and rivers extends through these rituals, with both symbolizing purity and divine blessings. Water Management: In areas where rivers may not be easily accessible or where water scarcity is a concern, kunds serve as essential sources of water for communities. They are used for domestic purposes such as drinking, cooking, and washing. In this way, kunds complement the larger rivers by providing localized access to water for daily needs, especially in densely populated areas like Varanasi. Ecological Harmony: Kunds and rivers are part of the broader ecological landscape of a region. They support biodiversity, provide habitats for aquatic life, and contribute to the overall ecological balance. Traditional water management practices, including the construction of kunds, often consider the natural flow of rivers and their relationship with local ecosystems, promoting ecological harmony and sustainability. Cultural Heritage: The association between kunds and rivers is deeply ingrained in the cultural heritage of regions where they are prevalent. Historical narratives, myths, and legends often link the creation of kunds to divine or mythological events associated with rivers. As a result, kunds become part of the cultural landscape, serving as symbols of tradition and continuity in the community.

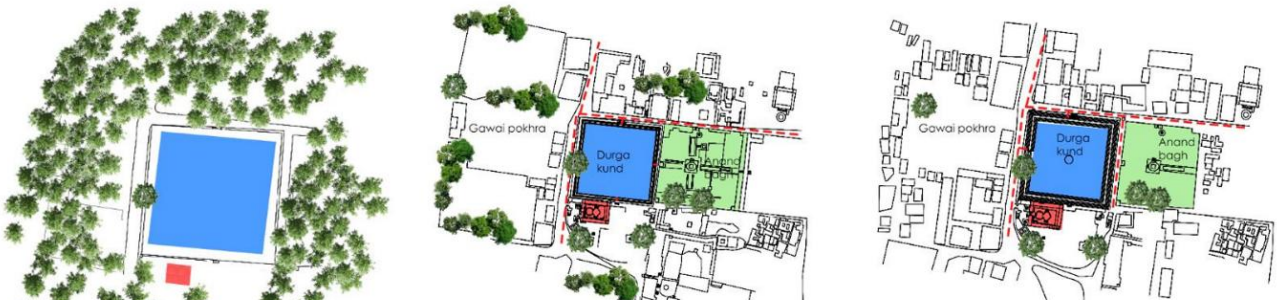

Figure 8 Evolution of Durga Kund

Peoples' association with water sources in Varanasi, Cultural Significance: Kunds, traditionally constructed reservoirs, are revered as symbols of purity and sanctity in Varanasi. They are integral to various rituals, ceremonies, and religious practices observed by

both locals and pilgrims. Each Kund carries its own mythological and historical narratives, adding layers of reverence and meaning to these water bodies. Religious Practices and Rituals: Every day, scores of devotees' flock to these kunds to perform sacred rituals, ablutions, and prayers. Bathing in the waters of kunds is believed to cleanse one's sins and purify the soul. Many rituals, including the performance of pujas (religious ceremonies) and the immersion of idols during festivals, take place at these kunds, strengthening the spiritual bond between individuals and the divine. Social Gathering Spaces: Beyond their religious significance, kunds serve as vital social gathering spaces in Varanasi. Communities come together for various activities such as washing clothes, socializing, and even conducting community meetings. These water bodies foster a sense of camaraderie and unity among residents, transcending religious boundaries.

Geographical setting and cultural significance of Durga kund:

Etymology, Due to the Durga Temple - "Monkey Temple" (Kush Manda Durga Mandir) is a free-standing temple set within a walled compound next to a large rectangular tank (Durga Kund) "Monkey Temple" Location and Surroundings: Durga Kund is in the southern part of Varanasi, near the Durga Temple (also known as the Durga Mandir). The temple complex and the Kund are surrounded by bustling streets, markets, and residential areas, creating a vibrant atmosphere. The Kund is adjacent to the Durga Temple, a prominent Hindu temple dedicated to Goddess Durga. The history of Durga Kund dates back several centuries, with its origins intertwined with the rich cultural heritage of Varanasi. The Kund is believed to have been constructed during the reign of a Maratha king in the 18th century. It is said that the Maratha king built the Kund to honour Goddess Durga and provide a sacred water reservoir for devotees visiting the nearby temple. Architecture, the architecture of Durga Kund reflects traditional Hindu temple architecture prevalent in the region. The kund itself is a rectangular water tank or reservoir, surrounded by steps leading down to the water. The steps, known as ghats, are used by devotees for ritual bathing and ablutions. The temple complex adjacent to the kund features ornate carvings, sculptures, and intricate designs, characteristic of North Indian temple architecture. Cultural Significance of Durga Kund holds immense cultural significance in Varanasi and beyond. It is considered a sacred site for devotees of Goddess Durga, who flock to the temple and the kund to offer prayers, perform rituals, and seek blessings. The temple hosts elaborate festivities during Navaratri (the nine-day festival dedicated to Goddess Durga), attracting thousands of pilgrims and tourists. Durga Kund is also associated with various legends and myths, adding to its cultural allure and spiritual appeal. Religious Practices and Rituals, Devotees visit Durga Kund to participate in religious practices and rituals, especially during festivals

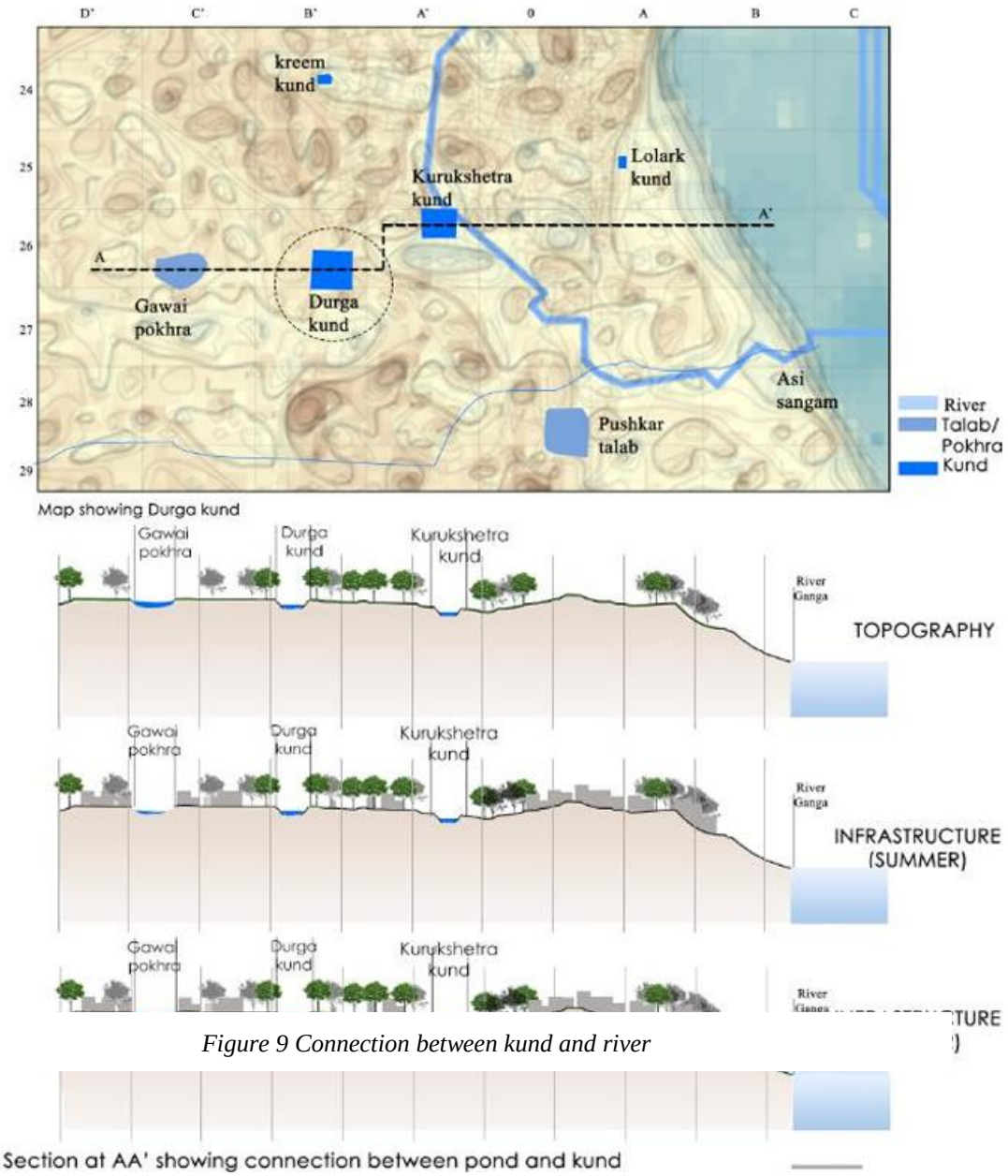

Figure 9 Connection between kund and river

dedicated to Goddess Durga. Ritual bathing in the sacred waters of the kund is believed to cleanse sins and bestow blessings upon the devotees. Offerings of flowers, incense, and prayers are made at the temple, and ceremonies such as aarti (ritual worship with lamps) are conducted daily. Community Engagement: The surrounding area of Durga Kund is a vibrant hub of cultural activity and

community engagement. Residents, religious organizations, and civic groups actively participate in the upkeep and maintenance of the temple complex and the kund. Festivals, processions, and cultural events organized in and around Durga Kund foster a sense of community and religious fervour among the residents of Varanasi.

Results and Discussion

The Causal Nexus of the Varanasi Cultural Landscape

The analysis of the Varanasi case study moves beyond simple correlation to establish the causal nexus that governs the city's relationship with water, proving that water is the cosmological, architectural, and functional organizing principle of its cultural landscape. The Causal Dominance of Architecture (P3 →P5/P7) The quantitative results demonstrate that the relationship between tangible form and intangible memory is the strongest predictor in the entire cultural system, validating the theoretical framework that architecture is the primary carrier of heritage value. Architectural Predominance: The factor of P3 (Architectural Adaptation) emerged as the highest affirmed construct ($\bar{x}$=4.55) and the strongest empirical predictor in the system. The correlation matrix revealed the highest relationship strength between P3 (Architecture) and P5 (Intangible Heritage) (r = 0.802). The monumental built environment (Ghat steps, palaces, temples) is not merely a setting but the empirical driver of the living heritage (Ganga Aarti, Festivals). The community perceives the *physical structure* as the necessary vessel for the intangible practice. Image is Architecture: The high correlation between P3 (Architecture) and P7 (Imageability) (r=0.646) confirms that the city's iconic, globally recognizable aesthetic is overwhelmingly defined by the consistent historical built fabric. The Interdependency of the Sacred and the Practical (P1 →P3) The analysis confirms the symbiotic relationship between spiritual belief and infrastructural necessity, which explains the city's settlement pattern. Sacred Catalyst: Although the factor for P1 (Sacred Beliefs) had a slightly lower consensus ($\bar{x}$=3.97), its strong correlation with P3 (r=0.524) confirms that the spiritual mandate (the belief in *Moksha* at the Ganga) is the primary historical catalyst for architectural investment on the riverfront. The form follows the faith. Functional Necessity, the high affirmation of P2 (Functional Utility) ($\bar{x}$=4.33) underscores that the water interface is indispensable for socio-economic interaction (social gathering, daily chores), embedding its functional necessity deeply into the city's identity. The Dual Imperative for Conservation (P4 vs. P6) The findings highlight a clear divergence between the ecological challenges and the path toward resilience, leading to actionable recommendations. The Pollution Paradox: The correlation between P4 (Environmental Health) and P1 (Sacred Beliefs) (r=0.381) is weaker than the other major factors, but significant. This supports the Pollution Paradox, confirming that the degradation of the river's ecological health poses a quantifiable threat to its core spiritual value. The preservation of the *built* fabric is contingent upon the preservation of the ecological health. Resilience and Aesthetics: P6 (Resilience & Security) (support for restoring *kunds*) shows its strongest link with P7 (Imageability) (r=0.619), not P1 (Sacred Beliefs) (r=0.101).

This proves that the motivation for supporting essential ecological engineering (restoring *kunds*) is driven more by the desire to maintain the aesthetic, cohesive urban environment than by pure spiritual duty. Conservation strategies must leverage aesthetic appeal and practical utility to gain public support for ecological projects. Result of quantitative analysis that the influence of water on the Varanasi cultural landscape is a complex, measurable, and highly integrated system. The quantitative analysis proves that the tangible (Architecture) and intangible (Heritage) are locked in a high-strength predictive relationship, both of which are under

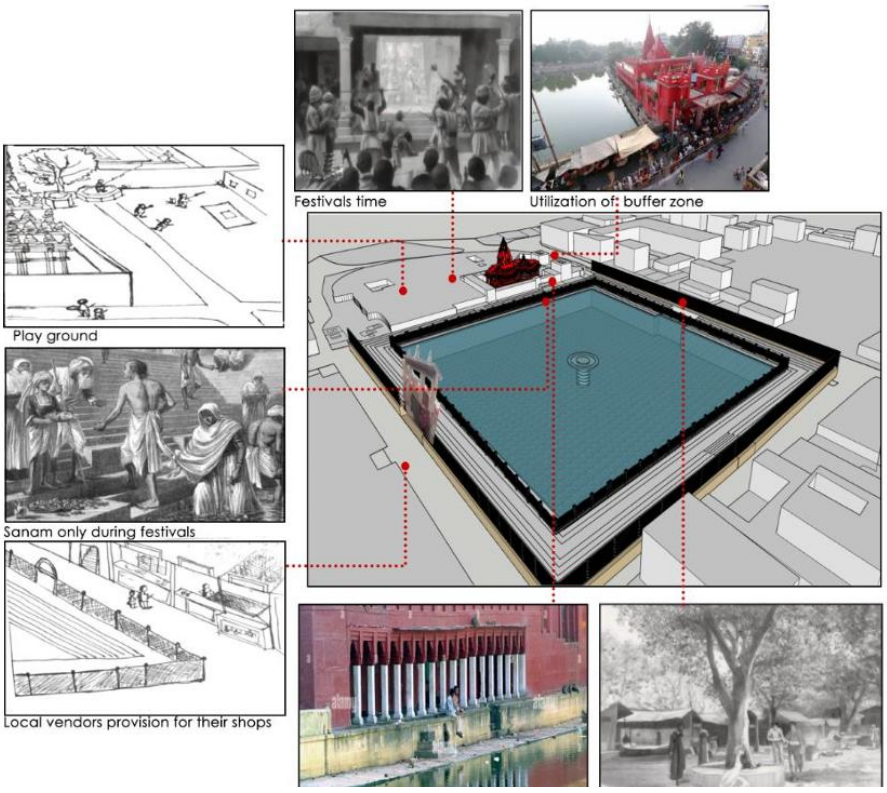

Figure 10 Durga kund setting and detail

pressure from the ecological threat (high population, tourism, Pollution). Future planning must adopt a holistic, multi-scalar conservation strategy that simultaneously enforces architectural regulation to preserve the aesthetic carrier and invests in ecological resilience to protect the river's spiritual and functional capacity. Quantitative Findings (Geospatial Clustering), The GIS analysis confirmed that the major religious infrastructure of Varanasi exhibits a high degree of spatial dependency on the Ganga River. The NNI confirmed a statistically significant non-random clustering of temples and primary ritual Ghats directly along the high-water line. This finding underscores that water is not merely a geographic backdrop but the organizing principle of Varanasi's urban form.

Qualitative Findings Multi-Scalar Water Influence

Functional Associations, Ghats were classified into three types: Aesthetic/Social (e.g., Dashashwamedh), Ritual/Bathing, and Moksha-giving (Cremation/e.g., Manikarnika). Water is the fundamental interface for all functions. Sacred Beliefs, Content analysis revealed themes of Purification and Liberation (*Moksha*) being inextricably tied to the Ganga, transforming the physical river into a sacred threshold. Architectural Adaptations: Analysis confirmed the deliberate use of deep, multi-tiered stone staircases designed to accommodate the ΔH of the Ganga, ensuring ritual access year-round. Architectural details often incorporated small temples or niches, physically integrating the river deity into the built form.

The study revealed that Varanasi's relationship with water operates across multiple scales, highlighting a tradition of ingenuity and cultural resilience. A. The Complementary Inland Network: The existence and study of the inland water bodies (*Kunds*, *Talabs*, *Baughs*) demonstrate that the city's water strategy is dualistic, addressing both the grand spiritual function and local sustainability. The Diverse Hydromorphic Manifestations found in these structures show a sophisticated local intelligence in water management, the rectangular, stepped architecture of the Durga Kund, for example, proves that water management was integrated into temple construction to serve localized spiritual needs during festivals like Navaratri. the historical presence of Stepwells (*Baughs*) highlights an early resilience strategy that ensured perennial, potable groundwater access, proving that life's sustenance was secured even when the mighty Ganga was less accessible or during periods of hydrological stress. B. Water Features as Ecological Infrastructure: The qualitative analysis confirmed that *Kunds* and *Talabs* function as critical groundwater recharge basins, collecting surface runoff and supporting the city's local ecosystem. This underscores that the cultural value of these structures is inextricably tied to their ecological utility. The decision to build a *kund* was thus a socio-ecological act it secured the sacred water source for the temple while simultaneously contributing to the community's water security, demonstrating an indigenous hydro-engineering tradition.

Conclusion

The comprehensive analysis, integrating geospatial evidence, qualitative narratives, and the quantified perceptions of the populace (N=134), confirms the study's central hypothesis: water is the sacred and architectural organizing principle of Varanasi, not a passive environmental element. The research establishes a definitive causal nexus where the city's intangible memory is structurally reliant on its tangible-built form. Dominance of Architecture and Intangible Heritage The quantitative results, particularly the Correlation Matrix (input for SEM), demonstrate that the relationship between tangible form and living heritage is the strongest predictive factor in the entire cultural system. Architectural Predominance (P3): The factor for Architectural Adaptation ($\bar{x}$=4.55) emerged as the highest affirmed construct. The extremely high correlation between P3 (Architecture) and P5 (Intangible Heritage) (r = 0.802) proves that the monumental built environment the terraced Ghat steps, palaces, and temples is the strongest empirical predictor of the living, non-physical heritage (Ganga Aarti, Festivals, Myths). The community perceives the *physical structure* as the necessary vessel for the *intangible practice*. Image is Architecture (P3→P7): The strong correlation between P3 (Architecture) and P7 (Imageability) (r=0.646) confirms that the iconic, global aesthetic of Varanasi is overwhelmingly defined by the consistent historical built fabric. This visually reinforces the spiritual mandate. The Interdependency of the Sacred and the Functional The analysis confirm the symbiotic relationship between spiritual belief and infrastructural necessity, which explains the city's settlement pattern and enduring resilience. Sacred Catalyst (P1→P3): Despite being the lowest consensus factor ($\bar{x}$P1=3.97), Sacred Beliefs maintains a strong correlation with Architectural Adaptation (r=0.524$), confirming that the spiritual mandate (the belief in *Moksha*) remains the primary historical catalyst for investment and monumental construction on the riverfront. Functional Nexus (P2): The high affirmation of P2 (Functional Utility) ($\bar{x}$=4.33) underscores that the water interface is indispensable for socio-economic interaction (daily chores, social gathering), embedding its necessity alongside its spiritual purpose.

The Way Forward

The findings from the quantitative and qualitative analysis of Varanasi's water-cultural landscape point toward specific strategic interventions and avenues for future academic exploration, Recommendations for Conservation and Management. Integrated Hydrological Management, implement a holistic urban plan that recognizes the interdependence of the Ganga River and the inland water bodies (*kunds* and *baughs*). Conservation efforts must focus on maintaining the hydrological function of *kunds* as essential groundwater recharge basins, not just as isolated heritage sites, to ensure the city's long-term water resilience. Adaptive Re-use of Built Heritage: Prioritize the restoration and adaptive re-use of the currently unused riverside palaces to transform them into public facilities, museums, or cultural centers. This will reduce urban pressure, generate revenue for maintenance, and enhance the visual coherence of the ghat panorama, addressing the threat of incompatible modern structures. Enhancing Legibility and Interpretation: Immediately implement the proposed visitor facilities, including directional and informational signage, heritage trails, and narrative walls that clearly interpret the history and mythology. This addresses the challenge of poor legibility and reinforces the ghats' role as sites of cultural memory for visitors.

Abbreviations: CWMI: Composite Water Management Index, CE: Common Era, GIS: Geographic Information System, ICL: Indian Cultural Landscape, SDGs: Sustainable Development Goals, TEK: Traditional Ecological Knowledge, HUL: Historic Urban Landscape, H-SECL: Hydro-Socio-Ecological Cultural Landscape, UCL: Urban Cultural Landscape, WRCHA: Water-Related Cultural Heritage Architecture, QUAN: Quantitative Phase (of Mixed-Methods Design), QUAL: Qualitative Phase (of Mixed-Methods Design), PWB: Proximity to Water Bodies, HI: Hydromorphic Influence, SEM: Structural Equation Modeling, NNI: Nearest Neighbour Index, ΔH: Change in Water Level (referring to monsoon-driven fluctuations).

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