RESEARCH

Heritage impact assessment of Adi Ganga Kalighat, Kolkata, India, towards SDG 11.4 and 8.9 for urban heritage

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Abstract

This study addresses the complex issue of preserving the historic fabric and cultural assets while promoting sustainable development in urban areas, focusing on the Adi Ganga River in Kolkata, India. The problem arises due to the encroachment and poor maintenance of historical sites. The research questions aim to assess the protection of Adi Ganga River's historic fabric and enhance heritage preservation in line with UN SDGs 11.4 and 8.9, emphasizing cultural conservation and sustainable tourism supporting regional heritage and livelihoods. The study utilizes Heritage Impact Assessment (HIA) to evaluate the protection of Adi Ganga River's historic fabric and enhance heritage preservation in line with sustainable development goals. It provides an impact assessment matrix for mitigating the adverse impact of development projects on cultural heritage sites and reveals 25 critical development indicators. HIA is an effective tool for preserving cultural heritage assets and achieving sustainable development goals. Incorporating HIA into the Environmental Impact Assessment structure can create an organized and transparent process for assessing the ecological implications of development projects on cultural heritage sites. The findings emphasize the significance of sustainable HIA for preserving tangible/intangible heritage, promoting tourism and employment, and balancing sustainability and culture in sustainable development. This research holds significance as it emphasizes the importance of cultural heritage in fostering sustainable development and aligning with UN SDGs. Policymakers should consider incorporating sustainable HIA in decision-making to balance sustainability and culture.

Keywords: Cultural heritage, Urban development threats, Historical Restoration Framework, Mitigation strategies, Environmental Impact Assessment

Introduction

Cities are complex organisms that require multidisciplinary study. Urbanization is no longer a widespread phenomenon involving physical [57] and cultural change [6] but threatens water establishments [46] and the environment [67, 86, 88]. It has developed into a geographical consequence of the dispersed networks of economics, immigration, assets, and connectivity that define urban life. This global urban culture's rise has had significant and intricate interpersonal, design, financial, physiological, and

geopolitical impacts [54]. Rapid development is taking place for developing countries like China and India to establish themselves. As a result, urban growth would become more erratic [66]. The adverse effect of urbanization is visible in different spheres of life, one of the most beingthe degradation of cultural heritage, its essence and historical value. It is a typical example of cities having monuments and modern buildings next to each other. Thus, it develops a contradiction between the heritage of the past and modernization. This contradiction damages the historic fabric, which is a drawback to gaining opportunities as economic and social factors. Other factors that impact the heritage: are climate change [11, 31, 32], socio-economic transformations [3], and environmental threats [7]. All aspects mentioned above contradict culture to act as a sustainable development tool needed to preserve the heritage and Culture longevity.

Figure 1 helps to understand a crisis in management that plays a crucial role in issues faced by world heritage. Thus, urgently addressing the need for the Heritage Impact Assessment is to preserve and conserve heritage monuments, which are an integral part of cultures and history.

In the paper [61], the discussion seeks to analyze extant heritage impact assessment (HIA) frameworks, strategies, and instruments and establish an impact assessment technique to reference modern urbanization. The framework is the subject of Isfahan's Masjed-e Jame. The necessary gathered information is by fieldwork to identify and classify the effects of the Atiq project on the site. The development of obtained data is analyzed using an impact assessment model and relevant abatement solutions to mitigate adverse asset consequences. Similarly, the paper [4] examines the effects of urban uprising initiatives and risks from urban growth on sites considered cultural heritage sites. The suggestion of worldwide impartial monitoring is to ensure the implementation of mitigating measures. Independent monitoring is necessary for the project's environmental management to ensure the project's sustainability [8]. The suggested impact assessment approach in the Heritage Impact Assessment preserves and establishes a systematic basis for defining, evaluating, and counteracting prospective influences of new urbanization on ethnic historic buildings characteristics. It helps city planners, cultural decision-makers, heritage conservators, and specialists
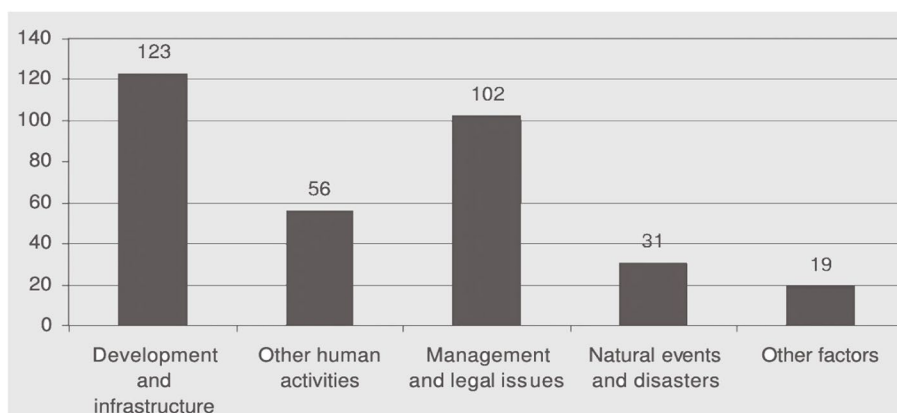

Fig. 1 Main categories of issues facing World Heritage site [58]

establish an innovative solution to culture and history that preserves sustainability. India is rich in culture and is considered a living Heritage in the World [9, 63, 64].

Nevertheless, unfortunately, urbanization and not having iron-clad heritage policies have caused damages to the monuments, the precincts, and the water bodies surrounding it, leading to the eventual loss of heritage entirely. The challenge is establishing a linkage by providing sustainability while keeping the essence of cultural heritage within policy and planning, achieved with the help of the HIA to link culture and sustainable development. a Heritage Impact Assessment is an assessment tool to help determine and analyze the possible effects of manufactured risks and initiatives on heritage sites.

Research aim

The study examines the dangers of urban expansion and the consequences of urban insurrection activities in a historically significant location. The necessity of Heritage Impact Assessment as a technique for resolving disputes to improve the survival of cultural heritage will then be covered while simultaneously achieving UN Sustainable Goals. The exploration of Adi Ganga, Kalighat, is to determine how urban threats have affected the river and whether HIA might aid in lessening the effect and accelerating the resolution of disputes. Employing the Adi Ganga Kalighat, Kolkata, as a research subject, the methodology's usefulness of the evaluation at the community scale. The regional strategy in this study anticipates the implementation of SDGs 8 and 11. The practical realization of these objectives should strike an equilibrium between preserving a historic district and uncontrolled urban expansion. Other issues include management constraints brought on by municipal financial reductions, a shortage of clearly stated policies, and poor management frameworks where transparency and decision reviews are uncommon.

Heritage impact assessment and sustainable development

Cultural variety is a legacy of humanity and a necessary element of life. The principle of sustainable development, in their opinion, is culture. Local authorities advocate the establishment of a paradigm that strengthens culture and its elements [24, 73, 74, 80]. As the fourth component, culture is incorporated into numerous sustainable development approaches [13, 18, 75–77, 81]. However, Nurse [52] stated that culture should be the primary component of sustainable development rather than the fourth component. Cultural heritage includes all current manifestations of inventive human exercise, whether intangible or tangible, passed down from earlier centuries and deemed valuable by societies, organizations, or cultures. These manifestations are preserved and passed on to succeeding lineages for their advantage. Cultural heritage is crucial for the feeling of location and community stability, being a repository of memories and sources of motivation. It also adds to national and regional social image [18]. Intangible cultural heritage encompasses practices, portrayals, manifestations, understanding, abilities of societies and organizations, occasionally folks, and the tools, items, relics, and cultural sites connected to it [83].

Tangible cultural heritage includes landmarks, architectural ensembles, locations, and cultural vistas [82]. Cultural legacy is, in theory, as extensive and varied as the many human species groupings that have and still do occupy the planet. The historical

metropolises serve as an engine for sustainable economic growth. It is necessary to determine what is significant about the historic surroundings and preserve it effectively for the interest of current and subsequent populations because cultural heritage is a crucial element of sustainable development.

Figure 2 shows the importance of HIA in the SDGs, the metrics from the United Nations, and the threats to sustainable heritage safeguarding and preservation. This article will briefly cover the usage of HIA for heritage, emphasizing how it assists in achieving the SDGs on heritage. The paper [41] highlights the importance of culture as a fourth dimension in attaining sustainable development but notes a lack of comprehensive studies on this topic. It summarizes several general cultural indices and their advantages in building planning to outline culture for sustainable development and urbanism. The study recommends further research to create cultural markers appropriate to the context and policies to emphasize the need to consider culture in sustainable development. Environmental impact assessment (EIA) develops as a crucial tool for foreseeing effects before any environmental action by humans [84]. The Environmental Impact Assessment (EIA) process and its accompanying procedures are essential for determining significance when coping with the urbanization consequences on heritage assets.

The vision of sustainability defines inheriting a world for future generations as abundant as the one we live in one. However, the quest to achieve it lies with an argument of values, making it a cultural debate [33, 40, 59]. Hawkes explained how the impact of policies for development negatively affects the cultural society causing loss of historic fabric, with prevention by establishing artistic impact tools like Heritage Impact Assessment. Several organizations like UNESCO, World Heritage Centre, ICCROM, ICOMOS, the International Association of Impact Assessment (IAIA), and international development agencies accentuated the execution of HIA as a protection and methodology for and development of cultural heritage. HIA is a sustainable planning approach
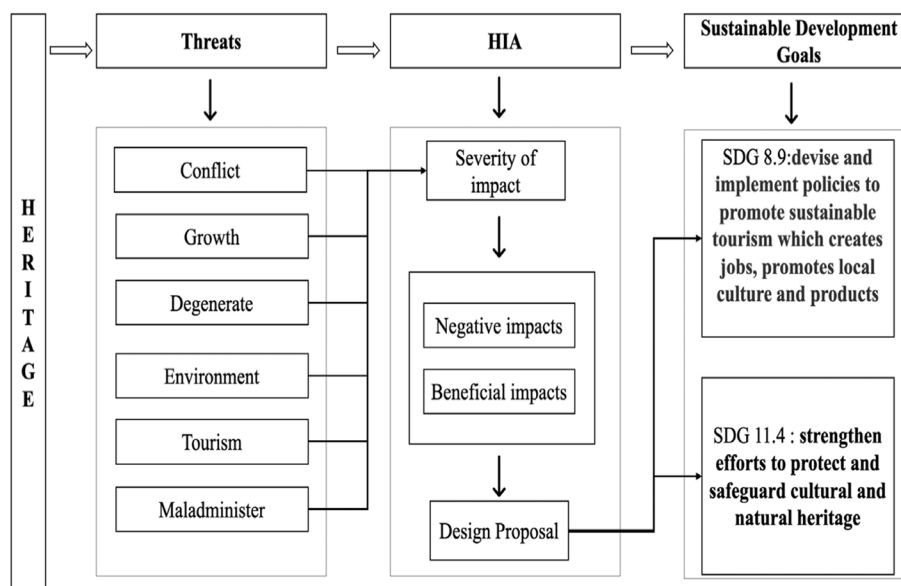

Fig. 2 Linkage between Heritage, HIA, and SDGs

that understands the adverse effect of several factors impacted by the built heritage environment. There have been very few investigations on heritage in Environmental Impact Assessments [38]. Lack of guidelines [12], definitions of cultural heritage that are narrowly centered and frequently quite restrictive [10], and recognizing potential heritage impacts earlier in the EIA methodology to determine the need for an EIA or scope of the report can help address rejection issues [70]. The HIA has been designed in line with the EIA framework to detect and assess significant effects on heritage assets, significantly enhancing heritage protection alongside sustainable development [5].

Unsustainable lifestyles and anthropogenic impacts have been discussed and studied for several decades [13, 22]. However, recent policy paradigms, such as the 2030 Agenda for Sustainable Development, have brought renewed attention to this issue. Regardless of the number of qualities, Tsaples and Papathanasiou [72] identify two competing perspectives on sustainability: comprehensive perspectives and a dichotomous view of how humans and the environment interact. Regarding the metrics, Tanguay et al. [69] distinguish between the policymaker method, an agreement among participants to arrive at a synthesized assessment technique, and the scientific method, which chases a vast array of data.

To curb the detrimental consequences of globalization, the Paris Declaration on Heritage as the motivity of development highlights the importance of heritage conservation. Additionally, it emphasizes how important cultural heritage is to promote sustainable development by promoting ecotourism, raising work opportunities and well-being, improving urban livability, creating a feeling of community, and other means. In its aim 11.4 for sustainable development, the UN 2030 Agenda for Sustainable Development emphasized the requirement to enhance measures to maintain and preserve cultural and natural assets [15]. The history conservation project leverages the regional area's architectural and cultural legacy resources to enhance dignity to meet the social and financial problems and possibilities of urban growth [77]. As a result, Goal 11 emphasizes using HIA as a policy declaration. A heritage impact assessment does not take place in a nihility. Instead, it solves problems causing damage to heritage and increases its life cycle. Hence mandating statutes or regulations is to provide authorization for the exercise. Nevertheless, particularly in developing nations, financial exigency often exceeds cultural requirements, and Tourism is an essential economic component by promoting using heritage. As a result, striking a balance between the utilization of HIA of the property for commercial advantage and its conservation becomes exceedingly challenging.

Literature has thoroughly examined tourism and sustainable development themes from scientific and empirical perspectives [25, 26, 85, 89]. Furthermore, tourism has the potential to raise awareness about social and environmental issues. Consequently, Li et al. [42] have focused on how ecotourism and nature-based tourism can foster visitors' ecological consciousness. The aspects of sustainable development as highlighted by the [78], in addition to the works of Fosse and Le Tellier [28] and Fernández-Villarán et al. [27]. The current paper attempts to identify the understudied subject of investigating the impact of heritage assessment on encouraging practical tourism for sustainable development. Therefore, SDG 8.9, by 2030, establishes and executes strategies to boost sustainable tourism that produces job opportunities, promotes local culture and goods, and seeks to advance sustainable tourism.

Systematic literature review

The methodology for examining the existing literature strives to recognize, classify, and evaluate the most reliable, critical, and current research on urban design To promote urban renewal for financial, social interactions, and ecological sustainability through HIA.

The creation of a suggested scoping review procedure is for the investigation portion of the body of extant literature. Four significant stages make it up. The preferred reporting items for systematic reviews and meta-analyses inspired the description of these stages. (PRISMA).

The following stages are in the suggested planning review protocol:

1. Employing well-known study databases like Scopus and Web of Science to perform bibliographic queries to compile a meta-sample of proper research.
2. The selection of papers is through looking over their titles and abstracts.
3. Arrange the chosen works into groups based on viable factors.
4. The investigation is on different categories according to each case study's instruments and assessment techniques.

Step I

The Scopus search utility, available via the associated website, created the meta dataset. There were six terms (K) listed in the TITLEABS-KEY box: (K1) "Heritage impact assessment" (1,793 documents), (K2) "Heritage impact assessment" AND "Sustainability" (221 documents) and (K3) "Heritage impact assessment" AND "SDG" OR "Sustainable Development Goals" (24 Documents). To highlight the connection and immediateness among a few of the terms is the usage of Boolean operators (AND-OR).

Step II

The evaluation with step I is the quality of the 1357 documents listed. In addition, other quality variables are considered to study relevance, such as systematic/meta-review methods.

Step III

The fundamental research sample is into its constituent parts. The terms "historic," "urban," and "management" are used in the text body on an absolute and relative basis.

Step IV

Table 1 quickly lists the "Abstract summary," "study type," and "main findings" taken into account, which helps in finally classifying 21 papers for the research.

Table 1's data offers helpful pointers for building a theory review paradigm for (i) study, (ii) assessment, and (iii) the ensuing selection of viable project strategies. It is feasible to describe the endorsement of this approach for the analysis, assessment, and selection of sustainable urban initiatives in light of the findings from implementing the suggested survey procedure.

Table 1 Studies selection

Sl.No	Paper title	Study type	Main findings
1.	(Cho et al. 2022) [17]	Systematic review	For urban heritage sites, sustainability relies on social, economic, and environmental dimensions, with governance, technology, and culture playing a crucial role
2.	(Al-Sakkaf et al. 2022) [2]	Systematic review	Heritage buildings need a specific sustainability assessment tool to evaluate and improve sustainability while preserving them due to inadequate existing tools
3.	(Chahardowli et al. 2020) [16]	Review, meta-analysis	A proposed model for sustainable urban regeneration in historic cities, considering UNESCO's recognition of historic urban landscapes as world heritages
4.	(Ginzarly et al. 2018) [30]	Systematic review	The HUL approach lacks a value-based system in practice; case studies in non-western cities raise questions, and adapting local context is challenging
5.	(Ahmad et al. 2019) [1]	Systematic review	Customizing to the local context is necessary to achieve global targets, and regulatory involvement and assessment systems consider socioeconomics
6.	(Masini et al. 2022) [47]	Systematic review	Current sustainability-rating systems are inadequate for historic buildings; studies should balance all three dimensions of sustainability
7.	(Loli and Bertolin 2018) [43]	Systematic Review	A review of the sustainable refurbishment of historic buildings highlights research gaps and the paradox in Scandinavian countries
8.	(Karjalainen et al. 2021) [36]	Systematic review	Urban transportation sustainability assessments are fragmented and fail to accumulate knowledge. Over 2400 indicators are identified, with significant variation in their use, often leading to inconclusive results
9.	(Yoffe et al. 2022) [87]	Systematic review	Israeli experts prioritize assessing urban environment ecological and social performance indicators, using computerized or voluntary statistics for social
10.	(Kaya et al. 2021) [37]	Systematic Review	Regulatory facilitators for legacy responsive reprocessing are amenable to the circular economy paradigm, based on a study and poll
11.	(Foster and Saleh 2021) [29]	Systematic review	In circular city plans, European cities neglect heritage preservation, missing sustainability and identity preservation opportunities
12.	(Rey-Pérez and Pereira Roders 2020) [56]	Systematic review	HUL approach has few case studies and inconsistent implementation of the six-step process, yet it affects the heritage planning process
13.	(Dumitru et al. 2020) [23]	Systematic review	Nature-based solutions benefit individuals and communities. Robust monitoring frameworks are needed, with identified principles to guide assessment
14.	(Shirazi and Keivani 2017) [62]	Meta-analysis	Social sustainability is crucial, ten characteristics identified, and policy implications suggested for urban settings

Table 1 (continued)

Sl.No	Paper title	Study type	Main findings
15.	(Topal et al. 2021) [71]	Systematic review	The framework proposed for urban sustainability behavior consists of social and psychological factors, behavioral determinants, environmental, and contextual factors
16.	(Dastgerdi et al. 2019) [20]	Systematic review	Climate change impacts heritage sites; need for resilience policies. Meta-synthesis analyzed effects
17.	(Paschoalin and Isaacs 2021) [53]	Systematic review	Holistic renovation of historic buildings can reduce environmental impact. NZ lacks national guidelines to balance ecological and heritage values. Shared responsibility for conservation can lead to the sustainable development of cities and communities
18.	(Pera 2020) [55]	Systematic review	Urban analytics, sustainability evaluation, and performance assessment assess the environmental sustainability of urban systems. Urbanism and public governance aid sustainability objectives
19.	(Morano et al. 2021) [49]	Systematic review	Framework systematizes contributions to evaluate urban transformation projects. Diverse examples illustrate a theoretical and methodological framework for assessing projects from an urban sustainability standpoint
20.	(Superti et al. 2021) [68]	Meta-analysis	Circular economy is part of urban sustainability. Fifty-seven indicator sets are categorized into three frameworks to assess CE and urban sustainability, aiding urban transitions
21.	(Luo et al. 2022) [44]	Systematic review	Urban HIA research focuses on Enviro. Sciences and Public Environmental Occupational Health. China leads research, and Tehran Uni. is a top influencer

Application of HIA: case studies

The Surat Municipal Corporation thoroughly examined the old Fort of Surat (Fig. 3) structural integrity to ensure public safety utilizing HIA as the tool for analysis. The fort was built over several periods during repair, with the Firozshah Tughlaq era accounting for the fort's earliest construction. While conducting repairs, they found a Dutch-style courtyard and a ventilation system, potentially for a swimming facility, constructed using an open-structure construction method. During the restoration process, they gave the old fort a new name to preserve Surat's historical legacy [65].

Colonel James Achilles Kirkpatrick once lived in Hyderabad, India's Telangana Mahila Viswavidyalayam building (Fig. 4), renovated after a 20-year restoration effort. The World Monuments Fund started the repair effort, and the Queen Elizabeth II Platinum Jubilee Commonwealth Heritage Skills Training Programme helped with the finishing touches. The renovated structure will give the institution more amenities, such as improved spaces with greenery. The restoration included using conventional building methods, restoring a university entrance, and repairing the grand durbar hall's papier-mache roof. Of the bond between Kirkpatrick and his Indian wife,
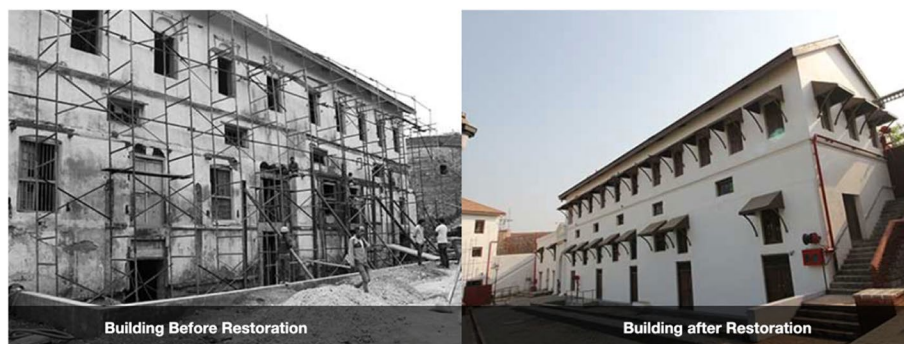
Fig. 3 Restoration of Surat Fort [65]

Fig. 4 Restoration of the Telangana Mahila Viswavidyalayam [48]

Khair-un-Nissa, the structure, designed in the Palladian villa style, inspired William Dalrymple's novel, White Mughals [48].

The current paper's novelty is the research gaps identified during the literature review analysis.

- Comprehensive studies on the role of culture as a fourth dimension in achieving sustainable development are lacking.
- There is a need for context-specific cultural indicators and policies to be developed and considered in sustainable development.
- The lack of guidelines and definitions of cultural heritage (HIA) in the Environmental Impact Assessment (EIA) process leads to the rejection of recognizing prospective heritage impacts earlier in the Process—the need for more research on the relationship between sustainability and culture.
- Employing consistent approaches for assessing success and creating a shared grasp of the markers and evaluation methods used to gauge sustainability is necessary to ensure that all parties engaged strive toward identical objectives.

Adi Ganga, Kalighat, Kolkata

Kalighat precinct is essential to the culture and architecture of its Kali temple, one of the 51 Shaktipeeth in India, and Adi Ganga beside the temple. The recognition of Kalighat temple and Adi Ganga are Heritage buildings grade-I [39]. Kalighat precinct is essential

to the culture and architecture of its Kali temple, one of the 51 Shaktipeeth in India, and Adi Ganga beside the temple. The city got its terminology from Kalighat, using the term Kalikata for its name. Adi Ganga, a tributary of the Bhagirathi-Hugli River, acted as a navigation channel. In 1775–1777, Major William Tolly, posted in Fort William, excavated Adi Ganga (Fig. 5) as a British East India Company to export and import goods. However, with urbanization, It now serves as a wastewater route for Calcutta's south side of town. The tuple, which initially hosted numerous bathing ghats, Hindu temples, and funeral sites on its shores before becoming an unruly drainage, is now home to many of these structures.

Figure 6 helps in understanding:

- Commercial spaces built mainly along the bank of the river,
- The area has three primary religious structures, making it a zone with many tourists.
- Lack of proper zoning.

Mandal concluded that Adi Ganga is the leading cause of waterlogging in Kolkata's southern part. The phylogenetic deterioration factors are garbage dumping, sewage disposal, various pollutions, and illegal encroachment that have notably or in association deteriorated the riverside ambiance. The present condition of the river is despicable, making its preservation critical [45].

Methods

Adi Ganga, Kalighat, is evaluated with a comprehensive knowledge of the function of HIA in anticipating and analyzing possible risks and minimizing conflicts to protect historical treasures. We employed both primary and supplementary surveys to compile evidence for this investigation. Strengthening the caliber of the research is

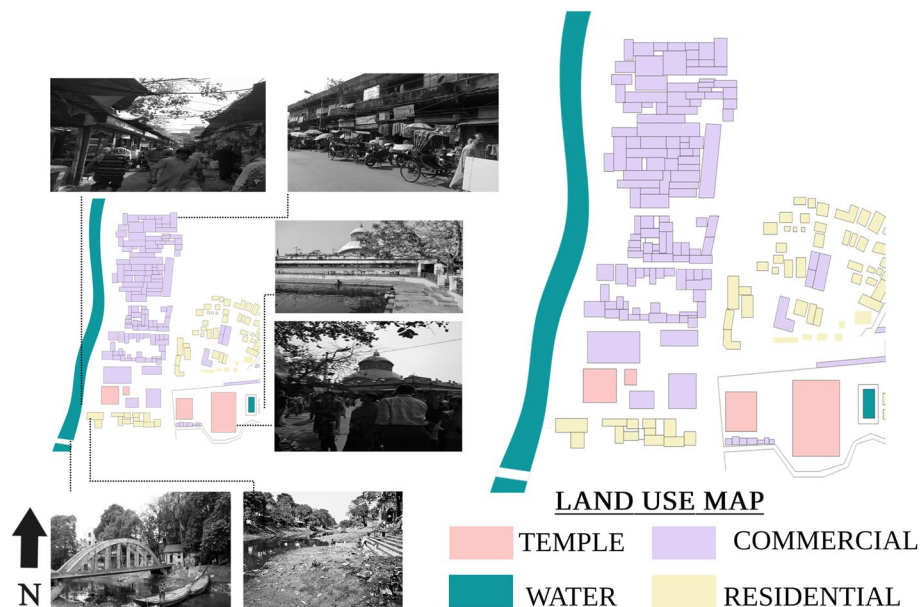**Fig. 5** (Left) AdiGanga in sixteenth and seventeenth century [51]. (Right) Kalighat in 1887 [34]

Fig. 6 Land use map (Source: Author)

by reviewing the HIA studies, application case files, and the decisions made by the UNESCO World Heritage Committee and the ICOMOS Advisory Body. Additionally, the authors cross-checked the information collected from the official records with the primary information acquired by on-site inspection and documentation of the cultural asset. Figure 7 describes the methodology for the research.

Analysis method

ICOMOS [35] has provided guidelines on HIA for Cultural Heritage sites worldwide. One of the first guidelines that offer the Cultural Impact Assessment (CIA) framework by the International Network for Cultural Diversity [60] focuses singularly on Cultural HIA. Considering tangible and intangible factors while providing is an approach to sustainable development. This guideline's value assessment is an important step. First, the worth of heritage sites is determined using a six-point scale ranging from extremely high, which refers to world heritage characteristics, to unknown cultural values. Following that, impacts are classified into positive and negative effects using a five-point range of Major, Moderate, Minor, Negligible, and Neutral. Finally, they are analyzed using a five-point severity scale of Major, Moderate, Minor, Negligible Impacts, and No Change. Thus, the HIA matrix comprises two variables: the property value and the severity of the impacts. The eminent unpropitious effects are evaded or mitigated by designing long-term diminution methods.

Application of HIA relating to SDG 11.4

Following UNESCO treaties [80–83], cultural heritage identification, preservation, conservation, display, and restoration must be scientifically and technically sound. A crucial initial step for effective safeguarding and protection is the recognition of heritage which entails determining the significance of heritage using a variety of standards, including
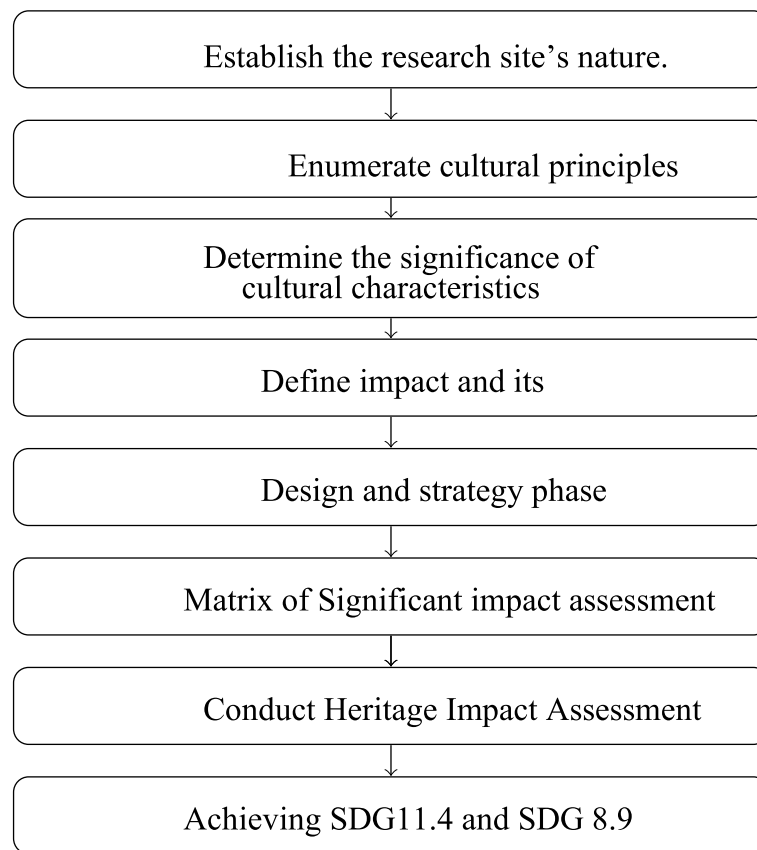
Fig. 7 Methodology adapted from [35, 60] and modified by the author

physiological, cultural, architectural, and historical significance. A heritage site location is typically the initial thing to be determined. Even if most of the heritage is known to locals or the government, much is still unexplored. The little story of the Adi Ganga's transformation, a now mostly forgotten existence, is only a tiny part of the larger picture of fluctuating development demands and goals within shifting historical settings [50]. The paper tries to achieve this in the amalgamation identification of threats, the severity of Impacts, and impact analysis constituting HIA which thus helps in achieving SDG 11.4

Threats

Table 2 represents the present and possible unfavorable impacts of Adi Ganga's threats to the particular attributes of Kalighat. The positive effect can also apply to judgemental factors as new possibilities to revitalize the heritage.

- Threat 1(I1): the soft edge no longer exists due to encroachment along the banks, leading to the heritage river drying up.
- Threat 2(I2): infrastructure problems occurred along the edge due to the illegal digging of sewage channels by the encroached dwellings which open into the river.
- Threat 3(I3): this left untreated water in the river course, and its drying has led to significant ecological issues.

Table 2 Threats of Adi Ganga

Impact identification	Threats of Adi Ganga in the current scenario (potential sources of impacts)			
	Encroachment	**Abandoned Ghats**	**Untreated Water**	**Sewage Channels**
Material and Structural Elements		Increase pressure in other ghats		Damage to the brick masonry structure
				Causing cracks
				Mortars composed of mud and lime disintegrate
				Influence on the physical integrity
Decorative elements			Creating fissures	Enabling masonry, gypsum, and tiled installations to break
			Damage to ghats	Limestone and ceramic craft that has decayed and fallen
				Gypsum layer disintegration
Form and design	Loss of aesthetic value of the original design	Loss of historic fabric	Loss of historic fabric	
Function and use	Influence on the originality of the shape and layout	Possible decrease of religious traditions in the Kalighat due to regional migration flows	Possible decrease of religious traditions in the Kalighat due to regional migration flows	Damage of Archaeological proof
	Drying up River			
Setting	The alteration of commodity's environmental and land use type as is the location	A decline in living heritage		The alteration of commodity's environmental and land use type as is the location
	Influence on the originality of the shape and layout	Effect on the essence of the form and layout		

The beneficial impact of the rejuvenation of Adi Ganga includes:

- Beneficial impact (B1): redefining the heritage river edge through the reclamation of the soft edge.
- Beneficial impact (B2): retrieval of the abandoned and demolished Ghats is to ease the pressure from the main ghat. Beneficial impact (B3): design interventions are for edge treatment.
- Beneficial impact (B4): making the edge is a community activity space.
- Beneficial impact (B5): design intervention is for water treatment.
- Beneficial impact (B6): design intervention is for sewage treatment.

Evaluation of effects (severity of impacts)

Identifying the influence, character, and intensity of the impacts is necessary. The magnitude of effects is graded along a five-point scale, spanning significant through no change, per the ICOMOS HIA standard [35, 61]. When a threat influences a traditional characteristic, a zero impact alongside a no-change scale is insignificant. As a result, shifting

the favorable and unfavorable effects by ten data values from extremely detrimental consequences to inconsequential from most advantageous has modest ramifications. Furthermore, the intensity of the impact can be assessed on a scale of 1 to 5 in color (Fig. 8). Figures 8 and 10 show that the above measures are in five intensities of insignificant, low, medium, high, and very high: similarly, the explication of the amplitude of the severe and beneficial effects is a procedure for threat assessment procedure (Fig. 9).

   Based on Figs. 8 and 10, the strain of impact's severity through illustration to explain the proposal's attribute disentangles the technological effect study to simplify its effective communication with judgment-makers and shareholders.

Impact analysis: evaluating the importance of the impacts

Figure 11 illustrates the importance of the adverse effects and the property's value intensity. This matrix's output will help to establish alleviation measures particular to the impacts adequately, its corresponding risks, and the heritage characteristics affected.

Results and discussion

According to impact assessment research, there is a propensity to prioritize formalities over desired consequences since choices, and the court system eventually regulates decision-making procedures in an extensive legal and political context [19]. The overemphasis is placed on executive actions and the methodological phases of impact assessment when examining transformational leaders or safeguarded urban

Magnitude of Negative Impacts				
Sever (5)	**Major (4)**	**Moderate (3)**	**Minor (2)**	**Negligible (1)**
Extreme impact on the key characteristics of the cultural heritage property that convey OUV, and its setting	Highly significant impact on key characteristics of the cultural heritage property and its setting	Significant impact on the key characteristics of the cultural heritage property and its setting	Slightly significant impact on the key characteristics of the cultural heritage property and its setting	Insignificant impact on the key characteristics of the cultural heritage property and its setting
Level of Beneficial Impacts				
Most (5)	**Major (4)**	**Moderate (3)**	**Minor (2)**	**Negligible (1)**
Extreme socio-cultural, and economic benefits for cultural heritage property and its setting	Highly significant socio-cultural, and economic benefits for cultural heritage property and its setting	Significant socio-cultural, and economic benefits for cultural heritage property and its setting	Slightly significant socio-cultural, and economic benefits for cultural heritage property and its setting	Insignificant socio-cultural, and economic benefits for cultural heritage property and its setting

Fig. 8 Table for evaluating adversity of negative and beneficial impacts adapted from [35]

Impact Statement	Positive im act on attributes	Positive im act on settin	Level of Impact
B1: Redefining the heritage river edge through the reclamation of the soft edge	High	Very High	Most
B2: Retrival of Abandoned and demolished ghats to ease the pressure from main ghat	High	High	Major
B3: Design Intervention for edge Treatment	Medium	High	Moderate
B4: Making the edge a community space for activities	Medium	Medium	Moderate
B5: Design Intervention for water treatment	High	Very High	Most
B6: Design Intervention for sewage treatment	High	Very High	Most

Fig. 9 Level of Beneficial Impacts on Kalighat (Source: Author)

Impact Statement	Magnitude of Threat	Sensitivity of attribute	Severity of Impact
I1:Loss of aesthetic value of the original design to form and design due to encroachment	High	Medium	Moderate
I2:Impact on Authenticity of form and design due to encroachment	Very High	Very High	Severe
I3:Loss of aesthetic value of the original form and design due to encroachment	Very High	Very High	Severe
I4:Drying up of River in form and design due to encroachment	Very High	Very High	Severe
I5:Change of setting and land use structure of the asset due to encroachment	High	High	Major
I6:Impact on Authenticity of setting due to encroachment	High	Medium	Moderate
I7:Increase pressure in other ghats in materials & structural elements due to abandoned ghats	Medium	High	Moderate
I8:Loss of historic fabric in form and design due to abandoned ghats	Very High	Very High	Severe
I9:Potential loss of religious ritual in the Kalighat through migration of local population as a Impact on townscape due to abandoned ghats	Medium	Medium	Moderate
I10: Potential loss of religious ritual in the Kalighat through migration of local population as a Impact on visual integrity due to abandoned ghats	Medium	Medium	Moderate
I11: Loss of living heritage in settings due to abandoned ghats	Very High	Very High	Severe
I12: Impact on Authenticity of form and design in settingsdue to abandoned ghats	Medium	High	Moderate
I13: Causing cracks in decorative elements due to untreated water	Medium	High	Moderate
I14: Damage to the ghats in decorative elements due to untreated water	Medium	Medium	Moderate
I15:Loss of historic fabric in form & design due to untreated water	Medium	High	Moderate
I16: Potential loss of religious ritual in the Kalighat in function and usabilty due to untreated water	Very High	Very High	Severe
I17: Causing cracks in materials and structural elements due to sewage channels	High	High	Major
I18: Damage to the brick masonry structure in materials and structural elements due to sewage channels	Medium	Medium	Moderate
I19: Deterioration of mud and lime mortars in materials and structural elements due to sewage channels	Medium	Medium	Moderate
I20:Impact on structural integrity in materials and structural elements due to sewage channels	High	Medium	Moderate
I21: Causing cracks to tile works, plaster coating and stones in decorative elements due to sewage channels	High	High	Major
I22: Deterioration and collapsing tile works and stones in decorative elements due to sewage channels	High	High	Major
I23: Deterioration of plaster coating in decorative elements due to sewage channels	High	High	Major
I24: Damage to Archaeol-ogical evidence in function and usabilty due to sewage channels	Very High	Very High	Severe
I25: Change of setting and land use structure of the asset in setting due to sewage channels	Medium	Medium	Moderate

Fig. 10 Table for evaluating adversity of negative and beneficial impacts adapted from [35]

regions. Nevertheless, the main goal of HIA should be to protect the Outstanding Universal Value properties. To emphasize concrete results more significantly, Table 3 lists vital implementation-related strengths, weaknesses, opportunities, and threats. This SWOT analysis is on current research and knowledge of Environmental Impact Assessment for developments created in historic locations. This part details the implementation of HIA and its contributions to two key features corresponding to SDGs.

"Recommendations on mitigation measures" section discusses protecting and preserving Heritage (SDG 11.4) through mitigation strategies, and "Facilitating Sustainable Tourism (SDG 8.9)" section discusses promoting sustainable tourism (SDG 8.9).

Value of the Cultural	Severity Of Impacts				
Property	Negligible adverse-1	Minor adverse-2	Moderate adverse-3	Major adverse-4	Severe adverse-5
Very High Values	Slight/ Minor	Minor/ Moderate	Moderate/ Large	Large/Very Large	Very Large (I2, I3, I4, I8, I11, I16, I24)
High Values	Slight	Slight/Minor (I5, I7, I12, & I13)	Minor/Moderate (I1, I6 & I20)	Moderate/ Large (I5, I17, I21, I22, I23)	Large/Very Large
Medium Values	Slight	Slight	Slight/Minor (I9, I10, I14, I18, I19, I25)	Minor/Moderate	Moderate/ Large
Low Values	Slight	Slight	Slight	Slight/ Minor	Minor/Moderate
Negligible	Slight	Slight	Slight	Slight	Slight/ Minor

Fig. 11 Matrix of establishing the importance of the Impacts, the primary matrix adapted from [35] and modified by the Author

Table 3 SWOT evaluation of the paradigm for HIA

Strengths	Weakness
Long-term advancements in evaluations	Adds a new dimension to the assessment and expense;
Enhanced OUV characteristic mitigation	No immediate enhancements in OUV characteristic mitigation
Improved comprehension of significant risks to and determinants of OUV characteristics	Inadequate investigative avenues
Recognizes and takes into account both technical and thematic efficacy	Inability to conduct performance assessments
Improved understanding of the structural components and contradictions	A brief amount of duration
Enhanced clarity regarding the authenticity degree of OUV features;	It might not be suited to scenarios when there is no modification
Enhances the legitimacy of subjective judgments	Effectiveness assessments obtain the inability to capitalize on information and expertise
Opportunities	**Threat**
Enhanced communication among various entities in cultural heritage	Absence of electoral backing from interested parties
Improved comprehension of significant challenges to OUV qualities	Additional economic needs are now impacting expenditures for historical maintenance and safeguarding
Creation of instruction that is more precise and lucid	Absence of agreement on crucial efficacy factors
HIA efficacy is the subject of new study topics	A shortage of funds
The possibility of creating a standardized effect presents for specific modification drivers	Misused visibility to undermine OUV characteristics
Continuous monitoring of universal objectives and operational procedures based on efficiency evaluation expertise	Implementation of a reactionary instead of proactive preservation strategy in the occurrence of paradigm misunderstanding

Recommendations on mitigation measures

For the severe impacts on Adi Ganga in Kalighat, adequate mitigation strategies are in need. Such mitigation measures stimulate the management scheme's effectiveness and egalitarian urban evolution proposal and heritage conservation. Simultaneously, the positive impact acts as the possibility of encouraging compensation measures resources and reinforcing urban strategies to impart modern public demand while preserving cultural heritage sites. Regarding EIA, alleviation measures, as an inclusive term, comprise escape mechanism strategies for prohibition or removal of impacts, Alleviation strategies for diminishing consequences, and reimbursing procedures for reimbursing effects that could not prevent or compress [21].

- The excavating instrument with lesser vibration decreases vibration and impacts the property's structural and decorative elements.
- Provision of a separate ghat in need of performing rituals.
- Clearance of encroachers along the bank
- Provision of water filtration tank for water treatment
- To cover up illegal sewage dug by encroachers.
- Provision of separate activity areas for the community
- Demarcated area for immersion of Kali idol after Kali Puja to avoid water pollution.

Compensatory measures

- Provision of unique attributes for the local clique to buy new stores in the mini-market alongside the bank to evade the regional urbanization and disappearance of living heritage.
- To raise awareness of indigenous and contemporary dwellings and marketing via informative activities to conserve their cultural legacy and change the specific geographical context.
- Formatting durable adequate reconstruction and guidelines is to preserve the prevailing historic structure for adaptive reuse of heritage fabrication and protecting Adi Ganga's surroundings.
- Indelible planning for ameliorating the intangible heritage of the surrounding is by encouraging function and customs and conventional occasions of central and intermediary areas of the Kalighat.

Facilitating sustainable tourism (SDG 8.9)

Compiling diverse, sustainable tourism concepts is at various times [14]. The World Tourism Organization defines it as tourism that meets the needs of visitors, the enterprise, the ecosystem, and regions while adequately reflecting its current and foreseeable commercial, sociological, and ecological effects [79]. While promoting ongoing revenue and jobs for the local community, sustainable tourism minimizes the influence on local cultural heritage. With effective tourist management, UNESCO's World Heritage and Sustainable Tourism program supports the idea that tourism activities should assume

accountability for heritage protection and sustainable development. This section provides examples of design concepts and mitigation measures to increase tourism, improve the traveler experience, and lessen hazards to safety and property damage.

Design proposal for sustainable tourism

We are implementing the design proposal (Fig. 12) to rejuvenate, Adi Ganga in Kalighat recommends mitigation strategies following the above [35] guidelines to promote sustainable tourism.

- The Filtration Tank (Fig. 13) provision is to maintain Adi Ganga cost-effectively while simultaneously using it as a ritual platform. The provision of craft shops and food stalls in the shape of a Bunga enhances the community experience along the river.
- Providing a separate ghat for Kalipuja avoids pollution and makes easy maintenance of the ghat and river.
- Bathing Chambers (Fig. 14) to have a dip in the Ganga River (one of the core rituals for Hindus to perform in the river Ganga)
- Exhibition walls are for Kalighat Painting to enhance the culture and art of Kalighat.
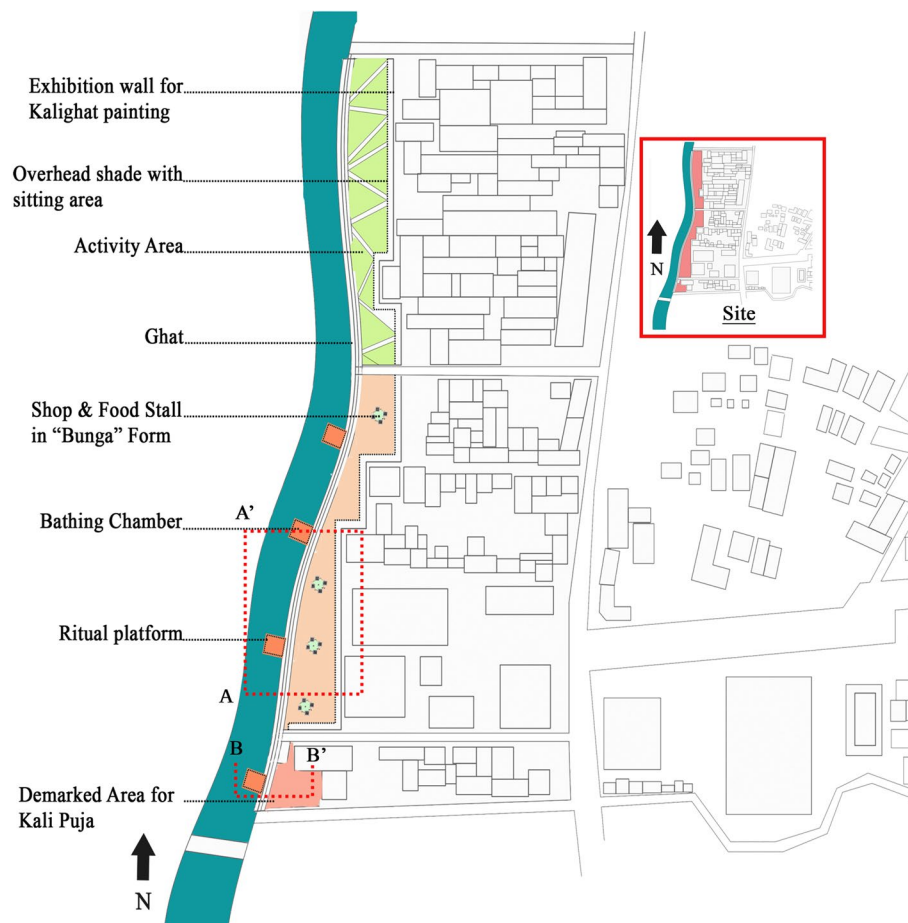
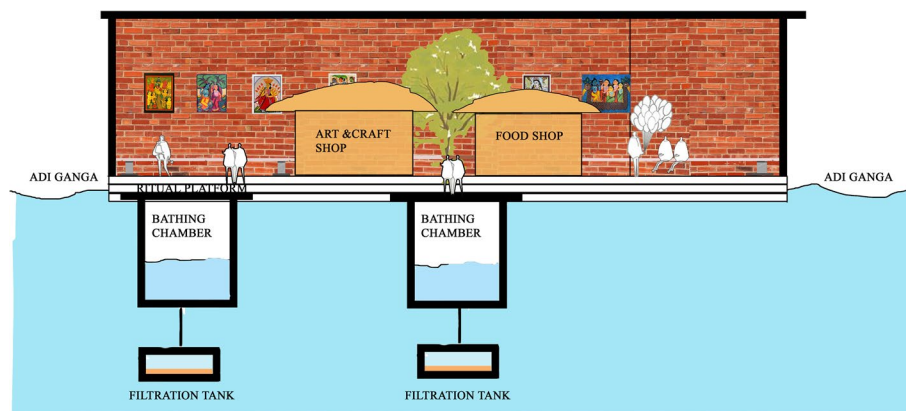**Fig. 12** Proposal for the Adi Ganga in Kalighat (Source: Author)
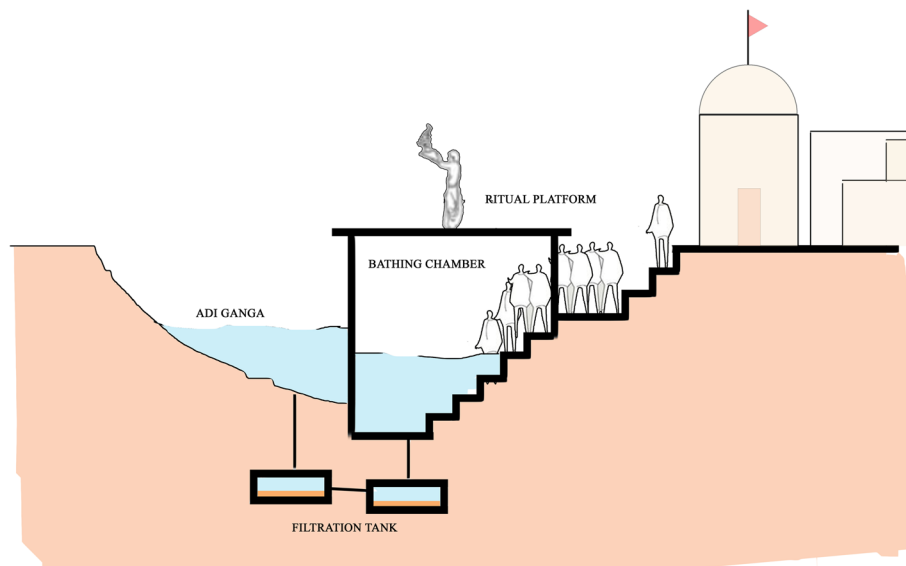
Fig. 13 Section of A-A' (Source: Author)

Fig. 14 Section of B-B' (Source: Author)

Conclusions

The Heritage Impact Assessment (HIA) has emerged as an essential tool for preserving and protecting cultural heritage assets in connection with sustainable development goals. Including HIA in the Environment Impact Assessment structure has helped create a more organized and transparent process that can evaluate the profound ecological implications of development or growth projects on cultural heritage sites. The study emphasizes culture's significance in sustainable development, and the SDGs recognize heritage's value by including it in specific goals like 8.9 and 11.4. The study has also introduced the concept of sustainable HIA to protect, preserve, and disseminate tangible and intangible heritage in a way that does not endanger the social and financial conditions necessary to maintain the workforce, distinctness, and well-being. Sustainable HIA is an essential element of sustainable development, which also includes the

preservation and conservation of tangible and intangible heritage and the encouragement of tourism that creates employment and raises awareness of regional goods. The case study of Adi Ganga of Kalighat has demonstrated the importance of implementing effective mitigation solutions to protect cultural heritage assets from the adverse effects of urbanization. Adopting proper countermeasures revitalizes Adi Ganga by identifying each unique hazard and its related impact on the cultural legacy of Kalighat's characteristics and location.

Furthermore, future studies should explore the applicability of this analytical approach to other urban situations. Researchers can expand the logical frameworks of present conceptualizations by considering insights from various urban settings and developing a holistic and transversal perspective. This strategy aids in striking a balance between adopting more general and less defined ideas about sustainability and using practical and informed views about sustainability that suit the local situation.

This research has highlighted the significance of protecting cultural heritage resources concerning sustainable development goals. A sustainable HIA may be useful for assessing the environmental consequences of development or expansion initiatives on cultural heritage sites and implementing practical preventative measures to safeguard them. This strategy can help promote a more comprehensive and crosscutting view of sustainable development and help strike an equilibrium between sustainability and culture.

Abbreviations

HIA	A heritage impact assessment's goal is to evaluate the possible effects of growth on the exceptional global significance of cultural assets
SDG	The Sustainable Development Goals (SDGs), also known as the Global Goals, are a group of 17 interconnected objectives that serve as a shared paradigm for peace and development for people and the ecosystem today and in the future
EIA	An instrument used to evaluate the essential environmental effects of a development or growth initiative is the environmental impact assessment
UNESCO	United Nations Educational, Scientific and Cultural Organization
ICCROM	International Centre for the Study of the Preservation and Restoration of Cultural Property
ICOMOS	International Council on Monuments and Sites
IAIA	International Association for Impact Assessment
CIA	Cultural Impact assessment

Declarations

Competing interests
The authors declare that they have no competing interests.

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