

Safeguarding World Heritage Under Recurrent Flooding: A Sustainable-Development Policy Framework for the Historic City of Ayutthaya, Thailand

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Abstract

The Historic City of Ayutthaya, a UNESCO World Heritage property inscribed in 1991, was inundated by two of Thailand's most severe floods within a fifteen-year span: the catastrophic 2011 Chao Phraya basin floods and the widespread central-Thailand floods of 2025. Despite a flood-risk mitigation plan prepared after 2011 and a disaster-risk sub-plan within the site management plan, the 2025 recurrence shows that the property remains highly exposed, partly because basin-scale water management continues to route floodwater through the low-lying historic island. This paper is a policy analysis rather than an engineering study. Drawing on documented flood events, official conservation reports, and open satellite evidence, it frames heritage flood protection as a sustainable-development imperative, maps it explicitly to Sustainable Development Goal (SDG) 11.4 and related targets and to the Sendai Framework for Disaster Risk Reduction, and proposes an integrated six-pillar policy framework spanning governance mainstreaming, proactive water detention, institutionalized Earth-observation monitoring, financing and risk transfer, community and tourism resilience, and international partnership. The framework offers a transferable model for safeguarding riverine cultural heritage under intensifying, climate-driven flood risk.

Keywords: Cultural Heritage Protection; World Heritage; Flood-Risk Governance; Sustainable Development Goals; SDG 11.4; Disaster Risk Reduction; Sendai Framework; Climate Adaptation; Ayutthaya.

I. INTRODUCTION

Founded in the fourteenth century as the second capital of the Siamese kingdom, the Historic City of Ayutthaya was inscribed on the UNESCO World Heritage List in 1991 under criterion (iii) as exceptional testimony to a vanished civilization [1]. The inscribed property occupies the western part of an island encircled by the Chao Phraya, Lopburi, and Pa Sak rivers. That riverine setting, once a source of defense and trade, today concentrates flood exposure across a dense assemblage of temples, chedis, and archaeological remains that constitute the site's Outstanding Universal Value.

Within a single fifteen-year period the property has twice been submerged by major floods: the catastrophic events of 2011 and the widespread central-Thailand floods of 2025. Substantial national and international effort followed 2011, yet the 2025 recurrence indicates that exposure has not been meaningfully reduced. The persistence of the hazard is therefore not only a hydrological or engineering problem but a question of policy and governance: how a nation weights an irreplaceable cultural asset against competing demands in basin-scale water management, and how heritage protection is embedded within sustainable-development and disaster risk agendas.

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This paper makes four contributions. First, it synthesizes documented evidence of recurrent flood impacts on Ayutthaya from the 2011 and 2025 events. Second, it diagnoses the policy and governance gap that allows a protected World Heritage property to remain highly exposed. Third, it aligns heritage flood protection explicitly with the Sustainable Development Goals—particularly SDG 11.4—and with the Sendai Framework for Disaster Risk Reduction. Fourth, it proposes an integrated, actionable policy framework for flood-resilient heritage that is transferable to other riverine cultural sites.

Originality. The originality of this study lies in reframing a problem previously treated as technical as a matter of sustainable-development policy. Earlier work on Ayutthaya—the post-2011 flood-risk mitigation plan and GIS-based hazard assessments—is valuable but predates the 2025 recurrence and stops at hazard characterization; none situates the property’s flood protection explicitly within the Sustainable Development Goals and the Sendai Framework, nor offers an integrated governance response. To the authors’ knowledge, this is the first study to read the recurrent flooding of Ayutthaya through the lens of SDG Target 11.4 and the Sendai Framework and to translate that framing into a concrete, actor-specific policy framework transferable to other riverine World Heritage cities. The contribution is therefore conceptual and policy-oriented rather than methodological, and it is intended to be directly usable by heritage managers, water authorities, and disaster-risk institutions.

The analysis is deliberately non-technical. It draws only on documented flood events, official UNESCO and national reports, and openly available satellite evidence; it does not attempt original hydrodynamic modeling. Its purpose is to inform policy makers, heritage managers, and disaster-risk authorities rather than to advance a computational method.

II. RECURRENT FLOODING AT AYUTTHAYA: EVIDENCE FROM 2011 AND 2025

➤ *The 2011 Catastrophe*

From early October 2011, the historic island and its surroundings were submerged for more than a month, with floodwaters reaching roughly two metres in depth. More than one hundred monuments in and around the property were affected. Documented damage included cracking of the reclining Buddha at Wat Lokaya Sutha, structural harm to a chedi at Wat Phra Ram, and collapse of sections of the enclosure walls at Wat Chaiwatthanaram and Wat Mahathat [3]. Beyond the monuments, flooding forced the closure of major manufacturing plants in the province, and the nationwide disaster ultimately caused hundreds of deaths [2]. Figure 1 contrasts the flooded island in October 2011 with normal conditions three months earlier, illustrating how completely the surrounding floodplain and much of the island were inundated.



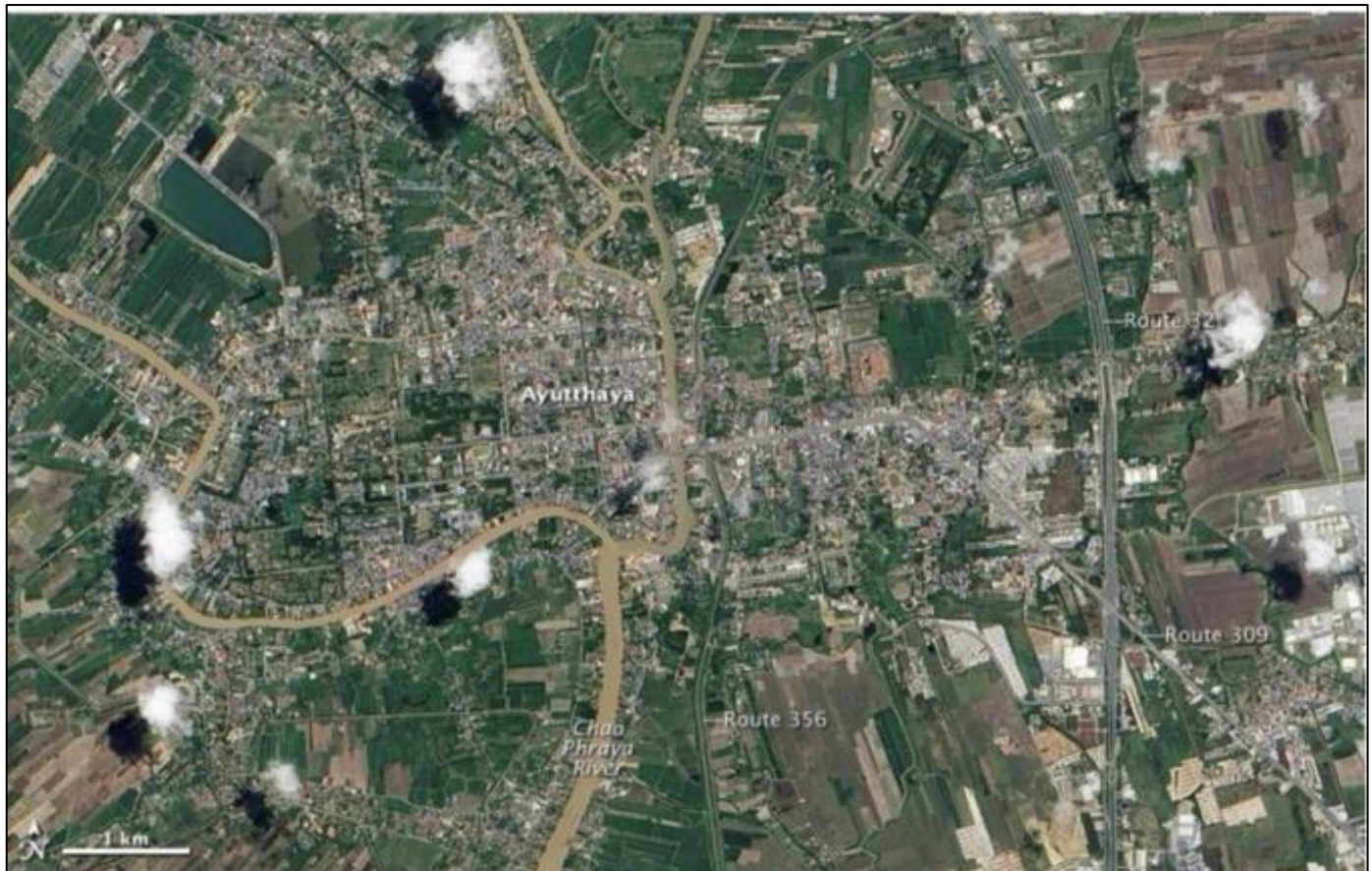


Fig 1 The Historic City of Ayutthaya during (top) the 23 October 2011 flood and (bottom) normal conditions on 11 July 2011, imaged by the Advanced Land Imager on NASA's EO-1 satellite. In October, the Chao Phraya River (lower left) has overflowed across the floodplain and much of the historic island. Imagery: NASA Earth Observatory / U.S. Geological Survey (public domain) [2].

➤ *The 2025 Recurrence*

In November 2025, national satellite monitoring using Sentinel-1 radar identified inundation of approximately 2.44 million rai across seventeen central provinces, with Ayutthaya the most severely affected—about 405,067 rai across twelve districts [7], [8]. Authorities announced compensation for affected residents, and local communities publicly criticized basin water-management decisions, arguing that Ayutthaya was again being used to absorb floodwater in order to protect the downstream capital [8].

➤ *Interpretation*

Taken together, the two events show that severe flooding at Ayutthaya is recurrent rather than exceptional. The property sits on a low, flat river island near the downstream end of a large, increasingly variable monsoon basin, and its position makes it a natural—and, in practice, a sacrificial—detention area during major floods. Under climate change, which is intensifying monsoon extremes across the region, the exposure of the site can be expected to grow unless it is deliberately reduced through policy.

III. THE POLICY AND GOVERNANCE CONTEXT

➤ *Existing Responses*

Ayutthaya is not a neglected case. The World Heritage Committee's 2007 Strategy for Reducing Risks from Disasters at World Heritage Properties established

disaster-risk reduction as a core obligation of heritage stewardship [6]. After 2011, UNESCO Bangkok and IHE Delft, with support from the Asian Development Bank and national partners including the Hydro and Agro Informatics Institute, the Asian Institute of Technology, and the Fine Arts Department, developed a flood-risk mitigation plan for the site [4]. Disaster-risk management was subsequently embedded in the site's management plan through a dedicated sub-plan that emphasizes increasing temporary water-detention capacity within the island by dredging its historic moats, ponds, and canals before discharging and pumping [5]. Thailand has also strengthened its national Earth-observation capacity, deploying the high-resolution THEOS-2 satellite from 2023 and using it, alongside radar data, to monitor recent floods [9].

➤ *The Governance Gap*

That the property was again severely flooded in 2025 reveals gaps between planning and outcomes. Four are salient. First, heritage value appears to be inadequately weighted in basin-scale flood operations: when trade-offs are made across the Chao Phraya system, the historic island is treated as expendable storage rather than as a protected asset of global significance. Second, mandates are fragmented across cultural, water-resource, and disaster-management institutions, without a clear locus of accountability for heritage flood protection. Third, the financial response remains largely reactive—post-event compensation—rather than proactive investment in

prevention. Fourth, although national monitoring capability exists, it is not yet institutionalized as a standing service for heritage early warning and rapid damage assessment. These are governance and policy deficits, and they define the space that the framework below addresses.

IV. ALIGNING HERITAGE FLOOD PROTECTION WITH THE SDGS

Protecting Ayutthaya from flooding is not a cost external to development; it is a component of sustainable development itself. The 2030 Agenda makes this explicit. Target 11.4 commits states to strengthen efforts to protect and safeguard the world's cultural and natural heritage [10]. Flood protection for a World Heritage property is

therefore a direct means of implementing an agreed global target, and it connects to several others (Table I).

The linkage runs deeper than SDG 11.4. Recurrent floods impose deaths, displacement, and economic loss (Target 11.5) and demand the integrated, Sendai-aligned disaster-risk policies called for by Target 11.b [10], [11]. Because heritage tourism sustains local livelihoods, protecting the site also supports inclusive economic growth (Target 8.9). Adaptation to intensifying flood hazard is climate action (SDG 13), sound basin water management is integral to SDG 6, and the multi-actor cooperation the problem requires embodies the partnership principle of SDG 17. Heritage flood protection thus sits at the intersection of cultural, economic, environmental, and institutional dimensions of sustainability.

Table 1 Alignment with Sustainable Development Goals

SDG target	Focus	Relevance to Ayutthaya
11.4	Protect cultural and natural heritage	Core aim: preventing irreversible loss of Outstanding Universal Value
11.5	Reduce disaster deaths and economic losses	Recurrent flood losses to monuments, communities, and the local economy
11.b	Integrated, Sendai-aligned DRR policies	Need to mainstream heritage flood risk into national and local DRR
13.1	Climate resilience and adaptive capacity	Adapting to intensifying monsoon flood extremes
6.5	Integrated water resources management	Basin-scale governance trade-offs affecting the island
17.16	Multi-stakeholder partnership	UNESCO, ADB, national agencies, universities, communities

V. A POLICY FRAMEWORK FOR FLOOD-RESILIENT HERITAGE

The framework organizes response into six mutually reinforcing pillars (Table II). It is designed to shift the site from a reactive, post-event posture toward proactive, institutionalized protection.

Governance and mainstreaming. Heritage flood risk should be given formal standing in national disaster-risk and Chao Phraya basin water-management decision-making, with a clearly accountable lead so that the property is no longer treated as expendable storage during flood operations.

➤ Proactive Detention and Heritage-Sensitive Water Management

The management plan's existing detention strategy should be fully operationalized—maintaining dredged moats, ponds, and canals, and using pre-flood detention and controlled pumping rather than relying on the island as an uncontrolled sink.

➤ Institutionalized Earth-Observation Monitoring

Routine satellite monitoring using THEOS-2 and Sentinel data should become a standing early-warning and rapid heritage-damage assessment service, with results delivered directly to site managers.

➤ Financing and Risk Transfer.

A dedicated heritage disaster-risk fund, parametric insurance for cultural assets, and the earmarking of a share of tourism revenue can move financing from reactive compensation toward proactive prevention.

➤ Community and Tourism Resilience.

Local preparedness, retention of the traditional craft skills needed for post-flood conservation, and visitor-safety and business-continuity planning protect both people and livelihoods.

➤ Knowledge and Partnership.

Sustained cooperation with UNESCO, ICOMOS, and development partners, supported by transparent monitoring indicators, enables continuous improvement and South–South transfer of the model to other riverine World Heritage cities.

Table 2 Six-Pillar Policy Framework

Pillar	Priority action	Lead actors / link
Governance	Give heritage formal standing in basin flood operations and DRR planning	Fine Arts Dept.; Office of National Water Resources — SDG 11.b
Water detention	Operationalize dredged detention, pre-flood storage, controlled pumping	Fine Arts Dept.; Royal Irrigation Dept. — SDG 6, 11.5
EO monitoring	Standing THEOS-2 / Sentinel early warning and damage assessment	GISTDA; site managers — SDG 11.4, 13
Financing	Heritage DRR fund; parametric insurance; tourism-revenue earmark	Ministries of Culture and Finance; ADB — SDG 11.4, 17
Community & tourism	Local preparedness; craftskill retention; visitor safety and continuity	Province; communities; tourism sector — SDG 8.9, 11.5
Partnership	Sustained UNESCO/ICOMOS/ADB cooperation; indicators; model transfer	UNESCO; universities — SDG 17

VI. RECOMMENDATIONS FOR FUTURE STUDY

This policy analysis opens several directions for further research. First, the qualitative exposure evidence presented here should be complemented by calibrated hydrodynamic modeling of the historic island to quantify the effectiveness of specific detention and barrier options before they are funded. Second, the very-high-resolution imagery now available from THEOS-2, combined with LiDAR-derived terrain, should support asset-level vulnerability assessments for individual monuments rather than the site as a whole. Third, the economic dimension warrants dedicated study—valuing heritage and tourism losses and empirically testing financing instruments such as parametric insurance and a heritage disaster-risk fund. Fourth, institutional and stakeholder research should examine how heritage priorities can be embedded within Chao Phraya basin water-management decisions, where the trade-offs that currently disadvantage the site are made. Finally, the transferability of the proposed sixpillar framework should be tested by applying it comparatively to other riverine World Heritage cities exposed to intensifying, climate-driven flood risk.

VII. CONCLUSION

The repeated flooding of Ayutthaya in 2011 and 2025 is a sustainable-development and heritage-governance challenge as much as a hydrological one. Existing plans are sound but under-implemented, and the property remains exposed largely because heritage value is not adequately protected within basin-scale water governance. Framing the problem through the Sustainable Development Goals—above all Target 11.4—and the Sendai Framework clarifies that safeguarding the site is an obligation of sustainable development, not a discretionary cultural expense. The sixpillar framework proposed here offers a proactive, accountable, and financeable path forward, and a transferable model for the many riverine World Heritage cities facing intensifying, climate-driven flood risk.

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