International Journal of Engineering Inventions
e-ISSN: 2278-7461, p-ISSN: 2319-6491
Volume 15, Issue 9 [September 2026] PP: 42-53

Can Traditional Levantine Construction Inform Sustainable Post-Conflict Rehabilitation? An Integrated Review and Conceptual Framework

Khalid Mbayed
Architecture Department
International Burch University, Sarajevo, Bosnia and Herzegovina
Corresponding Author: khalid.mbayed@stu.ibu.edu.ba

ABSTRACT
Post-conflict rehabilitation in Syria is increasingly framed as more than a physical reconstruction task, requiring attention to environmental performance, structural safety, cultural continuity, and institutional capacity alongside repair of damaged housing stock. Traditional Levantine construction, developed across Damascus, Aleppo, As-Salt, and Antakya, is frequently proposed as a source of locally adapted, sustainable building knowledge, yet its contemporary applicability is rarely evaluated critically. This paper addresses that gap through a qualitative, evidence-based critical integrative review and comparative documentary analysis, organised across four analytical dimensions: environmental performance, structural performance, socio-cultural sustainability, and rehabilitation applicability. Rather than treating tradition as inherently sustainable or resilient, the review evaluates which construction principles are supported by consistent evidence, which require technical, institutional, or regulatory verification, and which remain insufficiently evidenced. Environmental and socio-cultural principles carry the most consistent evidence; structural performance requires considerably greater caution, since the comparative evidence does not support unconditional seismic adequacy for the unreinforced masonry systems examined; and rehabilitation applicability depends further on material supply chains, craft-labour capacity, and institutional governance rather than on construction technique alone. The paper's principal contribution is a conceptual transferability framework replacing a binary transferable/non-transferable logic with a conditional, evidence-graded structure, supporting selective and adaptive use of traditional Levantine construction knowledge in rehabilitation practice.

Date of Submission: 25-08-2026 Date of acceptance: 05-09-2026

I. INTRODUCTION

Post-conflict rehabilitation in Syria extends well beyond restoring damaged buildings: reconstruction affects housing, land, and property regimes, community stability, and long-term urban resilience (UN-Habitat, 2021; World Bank, 2022), and is increasingly understood to require environmental responsiveness, resource efficiency, cultural continuity, and institutional capacity alongside physical repair (UN-Habitat, 2020; OECD, 2021). Conventional rebuilding approaches have frequently prioritised speed and standardisation over responsiveness to local climate, materials, and social organisation (Said and Yazigi, 2018; Asseburg, 2020; Assem et al., 2020), even as sustainability frameworks for post-conflict and post-disaster recovery increasingly call for context-sensitive, resilience-oriented rehabilitation (UNDP, 2023; Sharifi and Yamagata, 2018). Traditional Levantine residential construction, exemplified in the courtyard houses of Damascus and Aleppo, the stone architecture of As-Salt, and the composite stone-and-timber housing of Antakya, represents accumulated, locally embedded building knowledge rather than a single historical style (Rapoport, 1969; Oliver, 2006; Vellinga, 2015), with recurring characteristics, courtyard-centred spatial organisation, thick load-bearing masonry, and graded public-private space, documented across the region (Al Abidin, 2004; Haddad et al., 2016; Amro and Bahauddin, 2015; AlKubaisy, 2020). It has been proposed as a resource for rehabilitation that is more sustainable, culturally continuous, and locally resourced than imported models (Shayah and Khanmohammadi, 2023; El-Husseiny and El-Setouhy, 2022). Whether this potential is actually supported by the available evidence is a separate and largely unresolved question — the specific concern of this paper.

A recurring problem in the literature on vernacular and traditional architecture is the implicit assumption that historical persistence indicates contemporary suitability. This assumption is analytically weak. Historical survival alone does not constitute evidence of contemporary seismic adequacy (Bosher and Chmutina, 2017); structural evidence following the 2023 earthquakes, for example, indicates that long-established masonry and composite systems in Antakya sustained substantial damage despite that history of use (Dönmez and Uşma, 2023). Similarly, documented cultural significance does not, on its own, demonstrate community acceptance of

a specific spatial arrangement under changed post-conflict social conditions (Copertino, 2014), and material durability does not demonstrate present-day material accessibility or affordability (El Faouri and Sibley, 2022; Khaddour and Deng, 2023). Historic relevance and contemporary transferability are therefore distinct properties requiring separate evidentiary support, since contemporary safety requirements, building regulations, comfort expectations, labour markets, and institutional conditions differ substantially from those under which traditional systems developed (Khaddour and Deng, 2023). The relevant question is therefore not whether traditional Levantine construction should be reproduced, but which of its underlying principles can be responsibly adapted, and under what conditions.

Vernacular sustainability, heritage conservation, structural and seismic behaviour, and post-conflict reconstruction planning are each addressed by substantial, well-developed bodies of literature: courtyard-housing studies document passive-cooling performance (Al Abidin, 2004; Shayah and Khanmohammadi, 2023); conservation and heritage scholarship addresses cultural identity and preservation policy (Al-Azm, 2017; Sabri et al., 2023; Alghafri and Mohammad, 2022); structural and post-earthquake studies examine masonry and composite-system behaviour (Dönmez and Uşma, 2023; Bosher and Chmutina, 2017); and reconstruction-planning literature addresses governance and institutional capacity (Khaddour and Deng, 2023; UN-Habitat, 2020). These bodies of work, however, are rarely brought into direct contact with one another, and provide limited integrated assessment of which traditional construction principles are supported by consistent evidence across environmental, structural, socio-cultural, and applicability considerations simultaneously (Matar et al., 2023). Few studies explicitly connect these four dimensions within a single evaluative framework; most examine one or two in isolation — the specific gap this paper addresses.

This paper is organised around a single research question: which principles of traditional Levantine construction can be transferred to contemporary sustainable post-conflict rehabilitation, and under what conditions? This question is addressed through four related lines of inquiry, corresponding to the four analytical dimensions described in Section 2: the environmental benefits supported by the available evidence, the structural benefits and vulnerabilities documented in the literature, the socio-cultural values that may support rehabilitation, and the practical, institutional, material, and regulatory conditions that determine contemporary applicability. The paper's contribution is not a further descriptive account of traditional Levantine architecture, nor a claim that specific historic building types should be reproduced, but an evidence-based framework distinguishing principles that appear conditionally transferable subject to contextual adaptation, principles that additionally require substantial technical or institutional verification, and principles for which the reviewed evidence remains insufficient to support a transferability judgement at present.

II. MATERIAL AND METHODS

This study adopts a qualitative, evidence-based critical integrative review and comparative documentary analysis of published literature concerning traditional Levantine residential construction. The approach is deliberately not a systematic review in the PRISMA sense, nor a meta-analysis, nor an original empirical investigation: no interviews, surveys, field measurements, laboratory testing, structural calculations, or thermal simulations were undertaken as part of this study. Evidence was organised comparatively across four Levantine urban contexts, Damascus, Aleppo, As-Salt, and Antakya, treated as comparative evidence sources rather than as four equivalent experimental samples. Damascus and Aleppo represent the courtyard-house tradition most directly relevant to Syrian post-conflict rehabilitation (Al Abidin, 2004; Shayah and Khanmohammadi, 2023; Kousa, Pottgiesser, and Lubelli, 2021); As-Salt provides a well-documented southern Levantine comparator with an established institutional conservation record (Almatarneh, 2013; El Faouri and Sibley, 2022); and Antakya provides a northern Levantine comparator whose composite stone-and-timber construction has been directly investigated following the 2023 earthquakes (Dönmez and Uşma, 2023). The quantity of published evidence available for each context differs substantially; this asymmetry is treated as a property of the literature, not as evidence of differing architectural quality.

For the purposes of this review, the evidence was organised across four analytical dimensions: environmental performance (passive cooling, ventilation, thermal mass, energy efficiency); structural performance (configuration, load transfer, durability, seismic behaviour); socio-cultural sustainability (cultural identity, privacy and spatial organisation, community acceptance, preservation of traditional knowledge); and rehabilitation applicability (material availability, cost, repairability and maintenance, overall suitability). This structure responds to the absence of an integrated, cross-dimensional assessment approach for traditional and vernacular construction noted in the wider literature (Matar et al., 2023), though the specific four-dimensional organisation used here is this review's own.

Sources were selected for relevance to the four contexts or to the specific construction principle under discussion, relevance to one of the four analytical dimensions, academic or institutional credibility, specificity of evidence, and a deliberate balance between sources reporting strengths and sources reporting limitations or vulnerabilities, so as to avoid an uncritically favourable reading of traditional construction. Two methodological

distinctions are maintained throughout. First, a documented weakness (for example seismic vulnerability, craft-labour shortage, or restricted material access) is treated as positive evidence of a constraint, while the simple absence of literature addressing a given indicator is treated as an evidence gap rather than a negative finding; conflating these two conditions would misrepresent the evidence base. Second, where earlier syntheses offered evidence-strength ratings (how well documented a characteristic is), these are kept distinct from performance ratings (how well a system actually performs); this review relies on the performance-oriented evidence, particularly in relation to seismic behaviour.

From the broader literature examined, fifteen sources providing the most direct and traceable evidence were retained as the Core Evidence Sources for the focused synthesis presented in Table 1. Two of these, concerning adobe and mud-brick construction in Syria (Hasan and Koç, 2022; Hmeedy and Neglia, 2025), are treated as external corroborating evidence rather than findings from the four comparative contexts, since adobe construction was not itself part of the comparative evidence base. Several retained sources report original fieldwork, questionnaires, or interviews conducted by their own authors, for example the resident-level field and interview evidence reported for Aleppo (Kousa, Pottgiesser, and Lubelli, 2021) and the community-perception survey reported for As-Salt (El Faouri and Sibley, 2022); this review treats that fieldwork as secondary documentary evidence about the four contexts, and no equivalent primary data collection was undertaken as part of this study itself.

Table 1: Core Evidence Base

Author(s), Year	Context	Principle / Issue	Evidence Type	Dimension	Role in Review
Al Abidin, 2004	Damascus, Syria	Courtyard as integrated spatial, environmental, and structural element	Documentary analysis	Environmental / Structural	Foundational evidence for courtyard-based passive design and spatial logic
Shayah and Khanmohammadi, 2023	Damascus, Syria	Damascene house as passive-climatic, culturally continuous model	Architectural case study	Environmental / Socio-cultural	Core evidence for environmental performance and cultural-identity continuity
AlKubaisy, 2020	Pan-Arab courtyard tradition	Courtyard design and environmental significance across the Arab world	Documentary analysis	Environmental	Regional corroboration extending Damascus/Aleppo findings
Almatarneh, 2013	As-Salt, Jordan	Environmental adaptation, stone construction, resource efficiency	Architectural case study	Environmental / Structural	Core evidence for the As-Salt comparator
Fathy, 1986	Hot-arid vernacular (theoretical)	Passive design, vaulting, and structural logic	Conceptual study	Environmental / Structural	Theoretical grounding for passive-design and structural logic
Dönmez and Uşma, 2023	Antakya, Türkiye	Structural system analysis, incl. timber-coffered composite walls	Technical study	Structural	Central evidence for the review's key structural-adaptation finding
Bosher and Chmutina, 2017	Built environment, disaster risk	Generic seismic vulnerability of unreinforced masonry	Conceptual study	Structural	Frames seismic vulnerability as a property of the construction class
Hasan and Koç, 2022	Northern Syria (adobe)	Adobe materials in housing for displaced populations	Review article	Structural / Applicability	External evidence on Syrian adobe construction — outside the four-context base
Hmeedy and Neglia, 2025	Rif Dimashq, Syria (adobe)	Morphological analysis of mud-brick housing	Technical study	Structural	External evidence on Syrian adobe construction — outside the four-context base
Al-Azm, 2017	Syria (national)	Cultural heritage as a stabilising resource in conflict/post-conflict	Heritage-policy analysis	Socio-cultural	Core evidence for cultural-identity continuity
Kousa, Pottgiesser, and Lubelli, 2021	Aleppo, Syria	Post-war transformation of residential heritage; craft-labour shortage	Mixed-method case study (field mapping, questionnaire, interviews)	Socio-cultural / Applicability	Direct resident-level evidence for Aleppo
Copertino, 2014	Damascus, Syria	Materiality and patrimonialisation of "Arab houses"	Documentary analysis	Socio-cultural	Cautions against treating heritage-designated houses as unmediated tradition
El Faouri and Sibley, 2022	As-Salt, Jordan	Heritage-led urban regeneration following World Heritage listing	Case study with community survey	Socio-cultural / Applicability	Direct community-perception evidence for As-Salt
Khaddour and Deng, 2023	Damascus, Syria	Multi-criteria sustainability-risk management for	Mixed-method empirical study	Applicability	Core evidence for institutional and craft-labour constraints

		reconstruction			
Matar, Palaiologou, and Richards, 2023	Vernacular built environments (general)	Absence of integrated sustainability-assessment methods	Conceptual study	Cross-cutting	Establishes the integration gap motivating this review

III. RESULTS

Traditional Levantine residential construction relies principally on locally quarried stone, lime-based mortars, and timber, in proportions that vary by context: limestone masonry dominates in Damascus, Aleppo, and As-Salt, while Antakya combines stone at lower levels with more extensive timber framing (Al Abidin, 2004; Almatarneh, 2013; Dönmez and Uşma, 2023). Lime-based mortar is documented as contributing to long-term durability in As-Salt (Almatarneh, 2013), and comparable compatibility between stone, timber, and lime binding is documented for Antakya's composite system (Dönmez and Uşma, 2023). Historical sourcing, however, does not establish contemporary availability: As-Salt's limestone, which historically supported low-cost construction, is now subject to restricted quarrying (El Faouri and Sibley, 2022). Earth-based construction (adobe, mud-brick) is documented as significant within the wider Syrian building tradition (Hasan and Koç, 2022; Hmeedy and Neglia, 2025), but this evidence lies outside the four comparative contexts and is treated as external corroborating literature throughout.

Passive environmental strategies are the most consistently documented dimension examined, though documentation strength is uneven across contexts. Courtyard-mediated climatic regulation, coordinating shading, evaporative cooling, and controlled air movement, is strongly evidenced for Damascus and Aleppo (Al Abidin, 2004; Shayah and Khanmohammadi, 2023); As-Salt achieves comparable objectives through orientation, terraces, and semi-open verandas rather than a fully enclosed courtyard (Almatarneh, 2013). Thermal mass, provided by thick limestone walls, is documented consistently for Damascus, Aleppo, and As-Salt (Al Abidin, 2004; Almatarneh, 2013); comparable environmental performance is less clearly established for Antakya's composite stone-and-timber envelope in the reviewed evidence (Dönmez and Uşma, 2023). Passive shading, via courtyard geometry, iwan-type transitional spaces, and, in As-Salt, verandas and terraces, is documented across the comparative literature, with substantially stronger evidence for Damascus, Aleppo, and As-Salt than for Antakya (Fathy, 1986). Evidence for Antakya's passive strategies is comparatively thin, reflecting a post-2023 literature focused on structural and seismic questions; this is treated as an evidence gap, not an indication of underperformance. Reproducing the courtyard as an isolated architectural feature would not be expected, on the available evidence, to reproduce its documented climatic performance where plot geometry differs from the historic urban fabric, so responsible transfer is directed toward the underlying design logic, orientation, shading depth, thermal mass, controlled airflow, rather than toward any single historic form.

The structural logic of traditional Levantine construction rests on continuous load-bearing masonry, supplemented in Aleppo and As-Salt by arches and vaults distributing loads across openings and irregular terrain; Antakya departs from this pattern through a composite system combining stone at lower levels with timber framing and coffered wall detailing above (Al Abidin, 2004; Almatarneh, 2013; Dönmez and Uşma, 2023). This logic supports gravity loads coherently across all four contexts, but the evidence does not extend equal confidence to lateral, seismic behaviour. Unreinforced or lightly reinforced masonry is documented in the broader disaster-risk literature as generically vulnerable to lateral loading (Bosher and Chmutina, 2017), and structural assessment following the 2023 earthquakes indicates that Antakya's traditional housing stock, despite long-established historical use, sustained substantial damage, including separation between masonry and timber elements and out-of-plane wall collapse (Dönmez and Uşma, 2023). For Damascus, Aleppo, and As-Salt, comparable direct post-earthquake evidence is not available within the sources reviewed; their vulnerability is instead inferred from the generic behaviour of the structural class. This absence of city-specific seismic-damage evidence is an evidence gap, not a documented finding of adequate performance, and should not be read as implying these three contexts are structurally safer than Antakya. Antakya's composite system, in which a lighter and more flexible timber-framed upper storey is combined with masonry at lower levels, is documented, on macro-level post-earthquake observation rather than laboratory or experimental testing, as reducing structural weight relative to fully masonry construction (Dönmez and Uşma, 2023). This configuration suggests a potentially relevant structural principle, but the available evidence does not establish validated seismic ductility: the same assessment documents damage to composite buildings, including separation between masonry and timber elements, and no quantitative seismic performance data or engineering validation is reported in the sources reviewed. No structural system examined, whether fully masonry or composite, is treated as having demonstrated unconditional seismic adequacy.

Socio-cultural principles documented in traditional Levantine construction include graded spatial privacy, courtyard-centred social organisation, and a close association between residential architecture and local identity. In Damascus and Aleppo, the sequence from street entrance through a bent transitional corridor to the courtyard is documented as structuring privacy, gendered movement, and family and guest interaction

simultaneously (Al Abidin, 2004; Shayah and Khanmohammadi, 2023). Cultural heritage more broadly is documented as a stabilising resource for identity and cohesion in conflict and post-conflict conditions, with non-state and community actors playing an active role in preservation (Al-Azm, 2017). These findings should not be read as showing that documented cultural or heritage value automatically secures contemporary community acceptance: critical analysis of the patrimonialisation of Damascene houses indicates that designating traditional dwellings as heritage objects can itself reshape how their materiality and use are valued (Copertino, 2014). Direct resident and community-level evidence is available for two of the four contexts: Kousa, Pottgiesser, and Lubelli (2021) report field mapping, questionnaire, and interview evidence from returning residents in Aleppo, and El Faouri and Sibley (2022) report a community-perception survey conducted as part of As-Salt's heritage-led regeneration. Neither source, however, directly tests contemporary acceptance of the specific graded-privacy and spatial-hierarchy principle discussed above; their evidence concerns residents' broader post-war engagement with heritage housing and regeneration priorities, not household evaluation of the particular spatial sequence considered here for transfer. Community acceptance of that specific principle is accordingly treated as insufficiently evidenced, while the wider existence of resident and community evidence in the literature is acknowledged rather than denied.

Repairability is distinct from durability, and the two frequently diverge. Damascus's mixed stone, mudbrick, and timber-framed upper storeys, and Antakya's timber-coffered walls, may facilitate more localised and incremental repair than more monolithic construction systems; Aleppo's and As-Salt's more monolithic stone systems are durable but comparatively difficult to repair, since intervention typically requires specialist masonry or vaulting skills less widely available than general labour (Khaddour and Deng, 2023; El Faouri and Sibley, 2022). Aleppo's literature documents a shortage of craftspeople able to execute masonry and timber-coffering repairs to the original standard, raising reconstruction cost independently of material cost (Kousa, Pottgiesser, and Lubelli, 2021), while As-Salt is documented as maintaining a more institutionally supported base of conservation-related craft knowledge (El Faouri and Sibley, 2022). Institutional and governance capacity is a further conditioning factor, documented favourably for As-Salt but not similarly evidenced for the other three contexts; this documents that institutional support is associated with better-sustained traditional building capacity in one specific context, not that As-Salt's arrangements could be transplanted into a Syrian post-conflict setting. The reviewed evidence indicates that the practical cost of applying traditional construction principles in rehabilitation is associated substantially with labour and institutional factors, craft-skill scarcity, training needs, and administrative capacity, rather than with material cost alone; rehabilitation applicability is accordingly a function of the specific material, labour, and institutional conditions present in a given context at a given time, not a fixed property of a construction principle.

Table 2: Integrated Evidence Across the Four Analytical Dimensions

Principle	Environmental	Structural	Socio-Cultural	Rehabilitation	Main Uncertainty
Courtyard-mediated climatic strategy	Consistently documented climatic benefit in Damascus and Aleppo; a differently configured but comparable strategy documented for As-Salt (orientation, terraces, verandas).	Insufficient direct evidence; the courtyard functions as an environmental/spatial device, not a distinct structural system, in the sources reviewed.	Consistently documented role structuring privacy, gendered movement, and family/guest interaction in Damascus and Aleppo.	Documented dependence on plot depth and orientation; contemporary reconstruction through subdivided or standardised plots may not preserve these conditions.	Climatic and social performance is tied to a specific plot geometry not tested under present-day reconstruction conditions.
Thermal mass (thick limestone walls)	Consistently documented for Damascus, Aleppo, and As-Salt; comparable performance less clearly established for Antakya's composite envelope.	Documented contribution to gravity-load stability. Not evidenced as related to seismic performance (see Row 7).	Insufficient direct evidence.	Contingent on continued access to comparable stone; historical sourcing (As-Salt) does not guarantee contemporary availability.	Contemporary material availability requires context-specific verification, not assumption from historic sourcing.
Passive shading and transitional spaces	Documented across the comparative literature, substantially stronger for Damascus, Aleppo, and As-Salt than Antakya; theoretically grounded in hot-	Insufficient direct evidence.	Documented association with graded privacy and semi-public/private transition, particularly Damascus and Aleppo.	Plausible flexibility across building scales; a reasoned inference, not a directly tested finding.	Scale-adaptability untested under contemporary rebuilding conditions.

	climate vernacular literature.				
Compatible masonry and lime-based mortar systems	Insufficient direct evidence specific to environmental performance.	Documented gravity-load durability and compatibility (Almatarneh, 2013; Dönmez and Uşma, 2023). Seismic vulnerability of unreinforced masonry is a separate, negative finding (Row 7) and must not be inferred from durability evidence.	Insufficient direct evidence.	Documented repair-compatibility benefit: similar mechanical/moisture behaviour may facilitate compatible incremental repair.	Durability and repair-compatibility must not be read as evidence of seismic adequacy.
Component-level repairability	Insufficient direct evidence.	May facilitate more localised and incremental repair than more monolithic construction systems (Damascus, Antakya) compared with Aleppo/As-Salt.	Associated with craft continuity, though craft-skill availability varies considerably across contexts.	Dependent on specialist craft-skill availability; a shortage is documented for Aleppo specifically.	Repairability in principle does not guarantee repairability in practice.
Timber-coffered composite structural detailing (Antakya)	Comparatively limited evidence; post-2023 literature has concentrated on structural/seismic questions.	Post-earthquake assessment documents a lighter, more flexible timber-framed upper storey relative to monolithic masonry, based on macro-level observation, not testing; the same assessment documents damage to composite buildings. Validated seismic ductility is not established.	Insufficient direct evidence.	Insufficient to support direct reproduction as a validated seismic-resistant system; further engineering investigation indicated.	A potentially relevant structural principle whose seismic ductility has not been validated.
Unreinforced monolithic masonry as a structural system	Documented environmental benefits through thermal mass and documented gravity-load stability/durability in the masonry cases.	Documented seismic vulnerability where post-earthquake evidence exists (Antakya); inferred, not directly evidenced, for Damascus, Aleppo, As-Salt. Absence of context-specific evidence is a gap, not adequate performance.	Insufficient direct evidence.	Direct transfer as a complete structural system is not supported without context-specific seismic assessment and, where required, strengthening.	Environmental/durability evidence and seismic adequacy are distinct, non-interchangeable properties.
Graded spatial privacy and hierarchy	Insufficient direct evidence.	Insufficient direct evidence.	Well documented historically (Damascus, Aleppo). Resident-level evidence exists for Aleppo (Kousa et al., 2021) and As-Salt (El Faouri and Sibley, 2022), but neither directly tests contemporary acceptance of this specific arrangement.	Insufficient direct evidence on contemporary implementation outcomes.	Historical documentation of social function is not evidence of contemporary acceptance of this specific arrangement.
Craft-skill continuity	Insufficient direct evidence.	Insufficient direct evidence.	Documented as a carrier of cultural	Shortage documented for	Availability is unevenly documented

			continuity.	Aleppo specifically; a more institutionally supported base documented for As-Salt.	and should not be assumed uniform across contexts.

Note: Table 2 reports the qualitative content and consistency of documentary evidence using descriptive statements rather than High/Moderate/Low ratings or a numeric scale. "Insufficient direct evidence" denotes an absence of relevant documentation, not a documented weakness.

IV. TRANSFERABILITY FRAMEWORK

The evidence synthesised above does not permit any traditional Levantine construction principle to be assessed as transferable in isolation from the conditions under which it was documented. This section develops that evidence into an explicit transferability framework using three categories. Category A, Directly Transferable, denotes a principle for which the evidence demonstrates contemporary relevance without a major unresolved risk or verification requirement. Category B, Conditionally Transferable, denotes a principle of documented value whose responsible application depends on contextual adaptation (B1) or on technical or institutional verification (B2). Category C, Insufficiently Verified / Not Recommended for Direct Transfer, denotes a principle for which the reviewed evidence does not currently support responsible transfer.

Category A is empty in this review. No principle examined combines documented benefit with an absence of unresolved risk, evidence gap, or verification requirement. This is not a claim that traditional Levantine construction lacks contemporary value, but a substantive finding that none of the principles examined can responsibly be transferred without at least contextual adaptation or technical/institutional verification.

Category B contains the majority of the principles examined. Environmental principles, courtyard-mediated climatic strategy, passive shading and transitional spaces, and site-responsive orientation, are classified B1, since their climatic function is comparatively well evidenced but responsible transfer depends on preserving, or deliberately substituting for, the plot geometry and site conditions under which that function was documented. Graded spatial privacy and hierarchy is likewise B1: its historical function is well evidenced, and resident/community evidence exists for Aleppo and As-Salt, but the reviewed evidence does not directly test contemporary household acceptance of this specific arrangement, so verification with the communities concerned determines whether it remains socially appropriate. Thermal mass and compatible masonry/lime-based systems, component-level repairability, and craft-skill continuity are classified B2, requiring technical, material, or institutional verification rather than primarily contextual adaptation, since their transfer is conditioned on contemporary material availability or craft-labour capacity that cannot be assumed from historical practice. Timber-masonry composite detailing (Antakya) is classified B2 subject to substantially stronger verification requirements: it is associated, on macro-level post-earthquake observation rather than testing, with reduced structural weight through a lighter, more flexible upper storey, a promising, case-specific finding that falls short of validated seismic ductility, so its classification rests on a documented structural direction warranting further engineering investigation, not demonstrated adequacy. Institutional/participatory heritage governance, evidenced for As-Salt, is B2 on a comparable basis, since single-case evidence is not shown to be transplantable to a Syrian setting.

Category C contains two principles. Unreinforced monolithic masonry, reproduced as a complete structural system, is not supported for direct transfer, since direct seismic damage evidence exists for Antakya and generic vulnerability is inferred for the other three contexts, where context-specific evidence is absent rather than favourable. Adobe and mud-brick construction is also classified C within this paper's evidence framework, but for a materially different reason: this classification reflects insufficient evidence within this study's four-context comparative evidence base, since adobe evidence was drawn entirely from outside Damascus, Aleppo, As-Salt, and Antakya, and does not represent a demonstrated inherent unsuitability of adobe construction, which other literature may evaluate on its own comparative terms.

Table 3: Evidence-Based Transferability Framework

Principle	Evidence Basis	Main Benefit	Main Risk / Limitation	Required Verification	Category
Courtyard-mediated climatic strategy	Strong, consistent evidence for Damascus and Aleppo; comparable alternative strategy for As-Salt.	Passive cooling, shading, ventilation through spatial design.	Performance tied to plot depth/orientation not preserved in subdivided or standardised reconstruction.	Contextual verification of achievable plot geometry.	B1 — Conditionally transferable (contextual adaptation required).
Thermal mass and compatible masonry	Consistent evidence for Damascus, Aleppo, As-Salt;	Moderates temperature fluctuation;	Contemporary material availability not guaranteed by	Syria-specific material-supply verification before	B2 — Conditionally transferable (technical/material

material logic	thinner evidence for Antakya's composite envelope.	durable, repair-compatible masonry.	historical sourcing.	specifying at scale.	verification required).
Passive shading and transitional spaces	Documented across the comparative literature; substantially stronger for Damascus, Aleppo, As-Salt than Antakya.	Shading and thermal comfort at varying building scales.	Scale-adaptability is a reasoned inference, not directly tested.	Design-stage verification at the specific scale/plot used.	B1 — Conditionally transferable (contextual adaptation required).
Graded spatial privacy and hierarchy	Well documented historically for Damascus/Aleppo; resident evidence exists for Aleppo/As-Salt but does not test this specific principle.	Structures privacy, gendered movement, family/guest interaction.	Historical function is not evidence of contemporary household acceptance.	Verification with contemporary communities before adoption as default.	B1 — Conditionally transferable (contextual/social verification required).
Compatible masonry and lime-based mortar systems	Documented durability and repair-compatibility for Damascus, Aleppo, As-Salt.	Supports material compatibility in repair; may facilitate compatible incremental repair.	Durability/repair-compatibility evidence must not be read as seismic-adequacy evidence.	Material-compatibility verification, kept separate from structural/seismic assessment.	B2 — Conditionally transferable (technical verification required).
Component-level repairability	Documented for Damascus and Antakya; contrasts with more monolithic Aleppo/As-Salt systems.	May facilitate more localised, incremental repair than monolithic systems.	Dependent on specialist craft-skill availability, scarce in Aleppo specifically.	Craft-labour capacity assessment and, where needed, training.	B2 — Conditionally transferable (institutional/labour verification required).
Timber-masonry composite / coffered detailing (Antakya)	Post-earthquake macro-level observation only; no laboratory validation reported.	Reduced structural weight via lighter, more flexible timber-framed upper storey.	Same assessment documents damage to composite buildings; validated seismic performance not established.	Dedicated structural/engineering investigation, incl. testing.	B2 — Conditionally transferable (substantial structural verification required).
Unreinforced monolithic masonry as a structural system	Direct seismic damage evidence for Antakya; generic vulnerability inferred elsewhere.	Documented environmental benefits through thermal mass and documented gravity-load stability/durability in the masonry cases.	Documented and inferred seismic vulnerability; historical prevalence does not offset this.	Context-specific seismic assessment and, where required, strengthening.	C — Insufficiently verified / not recommended for direct transfer.
Adobe / mud-brick construction	Documented as significant within the wider Syrian tradition, but entirely outside the four comparative contexts.	Not evaluated within this paper's four-context comparative base.	Evidence lies outside the comparative framework used here.	Independent evaluation against this paper's four dimensions.	C — Insufficiently verified within this study's framework; not a demonstrated inherent failure of adobe construction.

Note: No principle in this review is classified Category A. No numerical scoring or pseudo-quantitative ranking is used; Table 3 is consistent with the evidence recorded in Table 2.

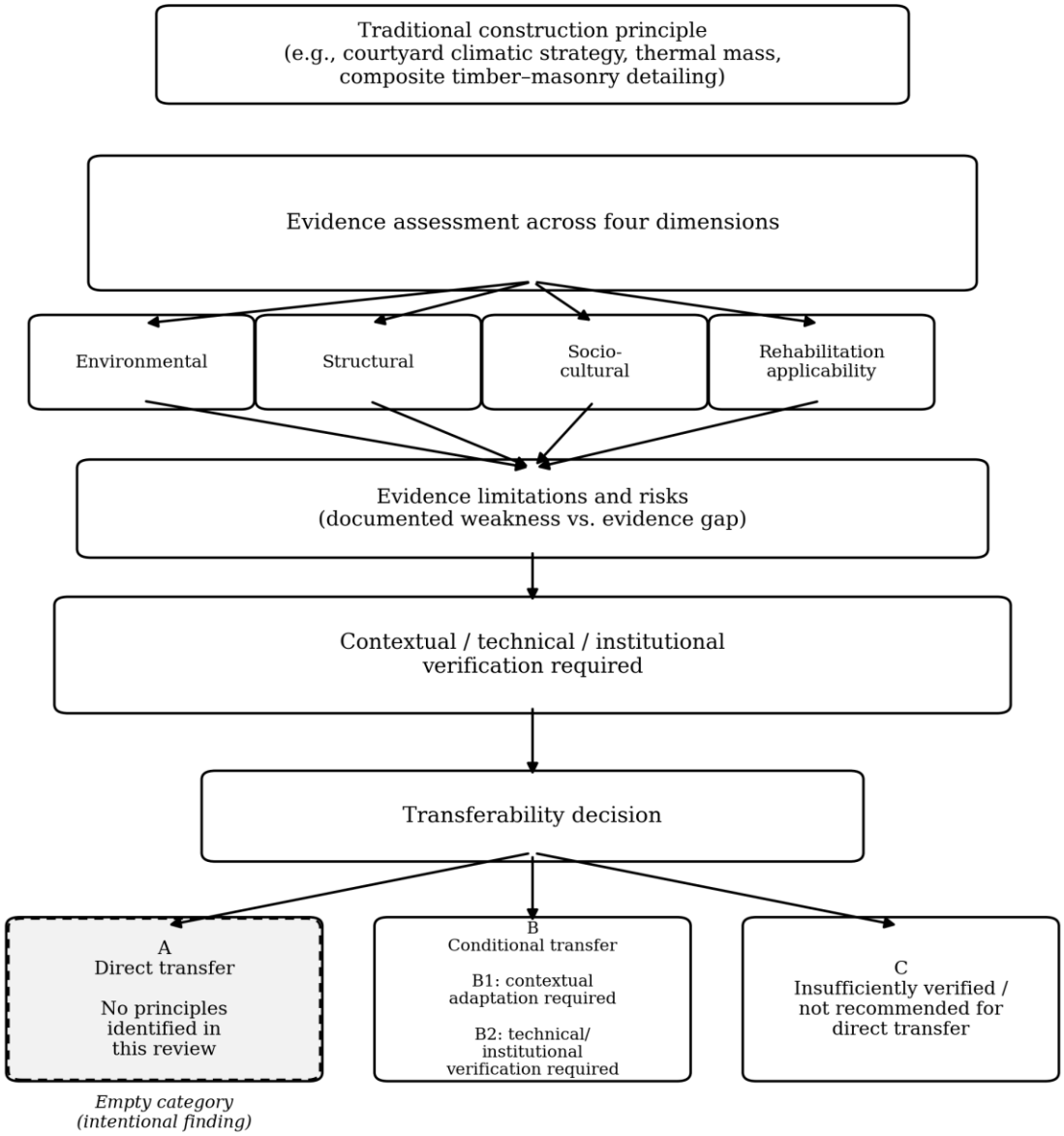

Figure 1: Evidence-Based Decision Pathway for Transferring Traditional Levantine Construction Principles

V. DISCUSSION AND CONCLUSION

The empty Category A finding is this paper's clearest evidence against literal reproduction of historic Levantine building forms in contemporary rehabilitation. Even the most consistently evidenced principles, courtyard-mediated climatic regulation, thermal mass, and passive shading, carry conditions attached to plot geometry, material supply, or site specificity that historic building forms cannot guarantee will be met in contemporary, often informally rebuilt, post-conflict settings. This supports the paper's central conceptual position: traditional Levantine construction's contemporary value lies in the selective, evidence-based transfer of underlying principles, not the reproduction of historic buildings as complete systems. What is transferable is the underlying logic, shading depth, thermal mass, spatial privacy gradient, repair compatibility, reinterpreted for present material, structural, and social conditions.

The most consequential tension identified concerns the relationship between environmental performance and structural, specifically seismic, adequacy. Thermal mass, masonry durability, and long-

established historical use are well documented for Damascus, Aleppo, and As-Salt, and these properties are frequently invoked in the wider literature as evidence of general resilience. The evidence reviewed here does not support that inference. Historical survival reflects, at most, adequate performance under the specific hazard conditions a building happened to experience; where direct post-earthquake evidence exists, for Antakya, it documents substantial damage to a long-established masonry-and-timber tradition, not resilience. For Damascus, Aleppo, and As-Salt, the absence of comparable direct evidence remains an evidence gap, not a favourable finding. Antakya's composite timber-masonry detailing deserves particular care in this context: the post-earthquake evidence documents its reduced structural weight and lighter, more flexible upper storey, based on macro-level observation rather than laboratory testing, while the same assessment documents damage to composite buildings alongside this feature. This suggests a potentially relevant structural principle, but the available evidence does not establish validated seismic ductility, and this paper treats the finding as warranting dedicated engineering investigation, not as a validated structural solution ready for adoption. Environmental and structural transferability must accordingly be assessed as separate questions, using separate evidence, even for the same building or wall.

Socio-cultural continuity is a genuine value documented across this review. Graded spatial privacy, courtyard-centred social organisation, and craft-based cultural continuity are documented, principally for Damascus and Aleppo, as historically significant mechanisms for structuring identity, privacy, and social life. This documentation, however, describes historical function, not contemporary community preference: the critical evidence on the patrimonialisation of Damascene houses demonstrates that designating a dwelling type as heritage can itself reshape how its materiality and use are valued, decoupling the resulting heritage object from an unmediated continuation of pre-conflict social practice. This paper therefore does not assume that displaced or resettled post-conflict communities will regard historic spatial arrangements the same way their pre-conflict occupants did. Resident and community-level evidence does exist in the literature for two contexts, Kousa, Pottgiesser, and Lubelli's (2021) field and interview evidence from Aleppo and El Faouri and Sibley's (2022) community-perception survey for As-Salt, but neither directly tests contemporary household acceptance of the specific graded-privacy and spatial-hierarchy principle considered here for transfer; that narrower question remains insufficiently evidenced. This is not a claim that no community evidence exists, nor that this study itself undertook community engagement; no primary data collection was conducted for this paper, and none is fabricated here. It is a narrower methodological conclusion with direct practical weight: contemporary post-conflict communities must be involved, empirically and specifically, in determining whether the particular historical spatial principles proposed for transfer remain relevant to their own rehabilitation, rather than having those principles assumed on their behalf.

The conditions under which traditional Levantine construction principles might responsibly inform Syrian post-conflict rehabilitation are, on this evidence, genuinely case-specific rather than transferable wholesale from the comparator contexts. As-Salt's and Antakya's evidence is drawn from Jordan and Türkiye respectively, under governance, regulatory, and economic conditions that differ from Syria's; this paper treats both cases as comparative evidence about the kinds of conditions that matter, material supply chains, craft-labour capacity, seismic verification, institutional governance, rather than as directly transplantable models. For Syria specifically, material availability for stone, lime, and timber construction requires contemporary, Syria-specific supply verification; craft-labour capacity, documented as constrained in Aleppo, needs direct assessment and training investment before repair-compatible or composite principles are specified at scale; any use of unreinforced or lightly reinforced masonry, or of Antakya's composite detailing, requires dedicated seismic assessment against Syria's specific hazard exposure and building regulations, not inference from the comparator contexts; institutional capacity, documented favourably for As-Salt but not established for Syria, needs independent evaluation; and incremental, phased rehabilitation, consistent with the repair-compatibility evidence for Damascus and Antakya, may offer a more feasible pathway than wholesale reconstruction to a fixed historic specification.

This paper set out to answer a single research question: which principles of traditional Levantine construction can be transferred to contemporary sustainable post-conflict rehabilitation, and under what conditions? The evidence reviewed across Damascus, Aleppo, As-Salt, and Antakya supports a differentiated answer. Traditional Levantine construction offers meaningful contemporary value, most consistently through passive environmental strategies, contextually specific material logic, component-level repair principles, and spatial and cultural concepts, and, more cautiously, through selected composite structural insights such as Antakya's timber-masonry detailing. None of the principles examined, however, supports unconditional direct transfer: Category A of the transferability framework is empty, and this outcome is itself a finding, not a gap in the framework. Structural principles require the greatest caution of any dimension examined: environmental performance, material durability, and long-established historical use do not constitute evidence of seismic adequacy, and the reviewed evidence does not support direct transfer of unreinforced monolithic masonry as a complete structural system without context-specific seismic assessment and, where required, strengthening.

Practical implementation depends on conditions specific to the rehabilitation context, seismic safety, material availability, skilled-labour capacity, contemporary social requirements, building regulations, and institutional capacity, which require independent, Syria-specific verification rather than inference from the comparator contexts.

This paper's principal theoretical contribution is the evidence-based transferability framework developed above, which replaces a binary transferable/non-transferable logic with a conditional, evidence-graded structure distinguishing contextual adaptation (Category B1) from technical or institutional verification (Category B2), and reserving Category C for principles the current evidence does not support for direct transfer. This connects bodies of literature on vernacular sustainability, structural and seismic performance, heritage and cultural continuity, and post-conflict reconstruction governance that are rarely brought into contact with one another. Practically, the framework offers architects, rehabilitation planners, conservation professionals, and decision-makers a structured basis for asking, principle by principle, what evidence supports a given design choice, what risk or evidence gap that choice carries, and what verification is required before responsible implementation, rather than treating "traditional" as a synonym for "appropriate."

This study is based entirely on secondary, documentary evidence; no original field measurement, laboratory testing, structural simulation or calculation, or contemporary community-acceptance survey was undertaken. The evidence available is uneven across the four comparative contexts and across the four analytical dimensions, and is limited to Damascus, Aleppo, As-Salt, and Antakya; it does not extend to other Levantine or wider Middle Eastern vernacular traditions. These limitations are inherent to a review of this kind and have been treated throughout as boundaries on what can be concluded, not as errors to be concealed. Responsible development of this framework requires experimental structural testing of the principles classified Category B2, particularly Antakya's composite detailing; thermal and environmental performance validation under contemporary material and construction conditions; Syria-specific assessment of material-supply chains and craft-labour capacity; community-based evaluation of contemporary acceptance for spatial and socio-cultural principles; and application and testing of the framework itself within actual Syrian rehabilitation projects. The framework proposed here is a decision-support structure derived from documentary evidence; it has not been empirically validated in reconstruction practice, and that validation is the necessary next step for translating its conditional classifications into operational guidance.

DECLARATIONS

Funding Statement: [To be completed by the author(s). No funding information was supplied in the source material for this manuscript.]

Conflicts of Interest: [To be completed by the author(s). No conflict-of-interest information was supplied in the source material for this manuscript.]

Data Availability Statement: [To be completed by the author(s). This study is a documentary literature review; no new primary datasets were generated.]

Acknowledgements: [To be completed by the author(s), if applicable.]

REFERENCES

[1]. Al Abidin, E. M. Z. 2004. The courtyard houses of Syria. In B. Edwards, M. Sibley, M. Hakmi, and P. Land (Eds.), Courtyard housing: Past, present and future, 63–75. Taylor and Francis.

[2]. Al-Azm, A. 2017. The importance of cultural heritage in enhancing a Syrian national identity and the role of local non-state actors in preserving it. In P. Newson and R. Young (Eds.), Post-conflict archaeology and cultural heritage: Rebuilding knowledge, memory and community from war-damaged material culture, 91–105. Routledge.

[3]. Alghafri, M. A. and Mohammad, M. A. 2022. Syrian cultural heritage conservation and management for future generations: Issues and challenges. In A. Versaci, H. Bougdah, N. Akagawa, and N. Cavalagli (Eds.), Conservation of architectural heritage. Springer. https://doi.org/10.1007/978-3-030-74482-3_21

[4]. AlKubaisy, F. 2020. Significance of courtyard houses design in the Arab world. Renewable Energy and Environmental Sustainability. 5, 5.

[5]. Almatarneh, R. T. 2013. Sustainability lessons learnt from traditional architecture: A case study of the old city of As-Salt, Jordan. IOSR Journal of Environmental Science, Toxicology and Food Technology. 5:3, 100–109.

[6]. Amro, D. K. and Bahauddin, A. 2015. Analysis of the architectural elements in traditional courtyard houses in Irbid, Jordan. Advances in Environmental Biology. 9:3, 112–116.

[7]. Asseburg, M. 2020. Reconstruction in Syria: Challenges and policy options for the EU and its member states. SWP Research Paper No. 11/2020. Stiftung Wissenschaft und Politik. https://doi.org/10.18449/2020RP11

[8]. Assem, A., Abdelmohsen, S. and Ezzeldin, M. 2020. Smart management of the reconstruction process of post-conflict cities. Archnet-IJAR: International Journal of Architectural Research. 14:2, 325–343.

[9]. Bosher, L. and Chmutina, K. 2017. Disaster risk reduction for the built environment. Wiley.

[10]. Copertino, D. 2014. The tools of the trade: The materiality of architecture in the patrimonialization of 'Arab houses' in Damascus. Journal of Material Culture. 19:3, 327–351.

[11]. Dönmez, S. and Uşma, G. 2023. A comparative structural system analysis in the context of physical environmental control: The case of traditional Antakya houses. Journal of Architectural Sciences and Applications. 8:Special Issue, 525–546. https://doi.org/10.30785/mbud.1293874

[12]. El Faouri, B. F. and Sibley, M. 2022. Heritage-led urban regeneration in the context of WH listing: Lessons and opportunities for the newly inscribed city of As-Salt in Jordan. Sustainability. 14:8, 4557. https://doi.org/10.3390/su14084557
[13]. El-Husseiny, M.-A. and El-Setouhy, H. 2022. Reviving low-tech modes of construction as a method for sustainability. Sustainability. 14:21, 13762. https://doi.org/10.3390/su142113762
[14]. Fathy, H. 1986. Natural energy and vernacular architecture. University of Chicago Press.
[15]. Haddad, N. A., Jalboosh, F. Y., Fakhoury, L. A. and Ghrayib, R. 2016. Urban and rural Umayyad house architecture in Jordan: A comprehensive typological analysis at Al-Hallabat. Archnet-IJAR: International Journal of Architectural Research. 10:2, 87–112. https://doi.org/10.26687/archnet-ijar.v10i2.835
[16]. Hasan, G. and Koç, C. 2022. The role of adobe materials in housing production for internal refugees in Northern Syria. Journal of Architectural Sciences and Applications. 7:1, 442–463. https://doi.org/10.30785/mbud.1093786
[17]. Hmeedy, S. O. and Neglia, G. A. 2025. Morphological analysis of mud-brick architecture in Syrian housing and its future formulation: A case study of Rif Dimashq. Buildings. 15:21, 3974. https://doi.org/10.3390/buildings15213974
[18]. Khaddour, L. A. and Deng, W. 2023. Multi-criteria sustainability risk management for post-war residential reconstruction: The case of Damascus. Journal of Housing and the Built Environment. 38:3, 1939–1982. https://doi.org/10.1007/s10901-023-10024-2
[19]. Kousa, C., Pottgiesser, U. and Lubelli, B. 2021. Post-Syrian war residential heritage transformations in the Old City of Aleppo: Socio-cultural sustainability aspects. Sustainability. 13:21, 12213. https://doi.org/10.3390/su132112213
[20]. Matar, F., Palaiologou, F. and Richards, S. 2023. Urban sustainability assessment for vernacular and traditional built environments. Journal of Urban Management. 12:2, 129–140. https://doi.org/10.1016/j.jum.2023.01.001
[21]. OECD. 2021. Building back better: A sustainable recovery. https://www.oecd.org/en/publications/building-back-better-a-sustainable-resilient-recovery-after-covid-19_52b869f5-en.html
[22]. Oliver, P. 2006. Built to meet needs: Cultural issues in vernacular architecture. Architectural Press.
[23]. Rapoport, A. 1969. House form and culture. Prentice-Hall.
[24]. Sabri, R., Maya, R., Dalli, A., Daghstani, W. and Mayya, S. 2023. The Syrian conflict's impact on architectural heritage: Challenges and complexities in conservation planning and practice. Journal of Architectural Conservation. 29:3, 258–274.
[25]. Said, S. and Yazigi, J. 2018. The reconstruction of Syria: Socially just re-integration and peace building or regime re-consolidation? International Policy Analysis. Friedrich-Ebert-Stiftung, Department for Middle East and North Africa.
[26]. Sharifi, A. and Yamagata, Y. 2018. Resilience-oriented urban planning. In Y. Yamagata and A. Sharifi (Eds.), Resilience-oriented urban planning: Theoretical and empirical insights, 3–27. Lecture Notes in Energy, Vol. 65. Springer. https://doi.org/10.1007/978-3-319-75798-8_1
[27]. Shayah, M. and Khanmohammadi, M. 2023. Sustainability in Damascene house architecture as a guide to the development of contemporary Syrian housing. International Journal of Sustainable Building Technology and Urban Development. 14:4, 500–518. https://doi.org/10.22712/susb.20230039
[28]. UN-Habitat. 2020. Post-conflict housing reconstruction framework. https://unhabitat.org/sites/default/files/2023/09/v1_-_sustainable_reconstruction_framework.pdf
[29]. UN-Habitat. 2021. Housing, land and property issues in Syria. https://unhabitat.org/syrian-arab-republic
[30]. UNDP. 2023. Post-conflict recovery and resilience. https://annualreport.undp.org/2023/crisis-resilience.html
[31]. Vellinga, M. 2015. Vernacular architecture and sustainability: Two or three lessons. In C. Mileto, F. Vegas, L. García Soriano, and V. Cristini (Eds.), Vernacular architecture: Towards a sustainable future, 3–8. CRC Press. https://doi.org/10.1201/b17393-5
[32]. World Bank. 2022. Syrian Arab Republic: Damage assessment of selected cities. https://documents.worldbank.org/en/publication/documents-reports/documentdetail/099173502272397116