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Integrating Geo-Archives, Textual Memory, and Institutional Praxis: The SE-HGA Protocol for Ottoman Water Management in the Konya Plain

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Abstract

Historical research on human–environment relations often separates material landscape change from the cultural and institutional systems through which change was perceived and managed. This article develops Socio-Ecological Historical Geoarchaeology (SE-HGA) as a conceptual integration and reporting protocol for combining geo-archives, documentary evidence, spatial reconstructions, and material practices while retaining differences in provenance, scale, chronology, and uncertainty. The design combines a purposive, DOI-verified methodological corpus with two bounded secondary-data demonstrations concerning the Konya Plain. The principal sixteenth- to nineteenth-century illustration recodes published legal, fiscal, spatial, and infrastructural claims; an independent 1907 irrigation-project study is then used as a transfer stress test. Neither exercise constitutes empirical validation. Claims are recorded by provenance, temporal and spatial support, genre, epistemic status, and ordinal confidence, and their relations are classified as convergence, complementarity, contradiction, silence, or scale mismatch. A worked encoding of 17 suğlas (seasonally inundated cultivation units) in an Ottoman kanunname (provincial law code) and 10 fiscally visible suğlas in a 1584 register shows why literal disagreement should not be averaged away. The application also demonstrates why the approximately 40.7% disappearance or abandonment of 499 recorded settlements cannot be attributed to hydroclimatic stress without testing security, route exposure, fiscal pressure, and institutional capacity. The demonstrations illustrate P1, P2, P3, P4, P5, and P8 to different degrees, while P6 and P7 remain untested; none of the eight propositions is fully tested. SE-HGA's present contribution is therefore procedural: it makes evidential dependence, incompatibility, and insufficiency auditable and identifies the primary data required for subsequent validation.

Keywords: historical geoarchaeology; Ottoman environmental history; landscape epistemology; historical GIS; archival geography; water management

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1. Introduction

Landscapes are neither passive stages on which history unfolds nor infinitely malleable texts whose material properties disappear behind interpretation. They are historically produced configurations in which topography, water, soils, sediments, climate variability, infrastructure, memory, law, labor, and political authority interact across unequal temporal and spatial scales. This apparently simple proposition remains methodologically difficult. Physical evidence and documentary evidence are created by different processes, preserved unevenly, dated at different resolutions, and interpreted through disciplinary traditions that do not always share definitions of causation, agency, or proof.

Geoarchaeology emerged from the productive encounter between earth science and archaeology, but its disciplinary identity has long been debated. Early definitions emphasized geological contributions to archaeological problems, whereas later work expanded the field toward reciprocal human–landscape relations and socially informed interpretation [1–3]. Recent syntheses increasingly treat human adaptation, landscape resilience, and the integration of archaeological and palaeoenvironmental records as central concerns rather than peripheral applications [4–6]. Even so, a recurrent asymmetry remains: the physical archive is often rendered analytically dense, while institutions, perception, and textual memory are treated as contextual annotations.

The inverse asymmetry appears in parts of environmental history and archive-centred historiography. Administrative records, judicial registers, endowment deeds, chronicles, and technical reports can reveal how societies categorized environmental problems, distributed rights, organized maintenance, and attributed responsibility. Yet the physical landscape may enter the narrative as a generalized background or as a climatic event inferred from documents alone. Historical climatology has demonstrated that documentary evidence can be calibrated and critically compared with instrumental and proxy series, but it has also stressed the need to understand source production, seasonality, representativeness, and spatial reach [7–11]. The methodological challenge is therefore not merely to place different sources beside one another. It is to make their evidential relations explicit without erasing their distinct ontologies.

Early modern Ottoman landscapes provide an especially productive setting for this problem. The empire encompassed highly varied geomorphological and hydroclimatic zones, while its institutions generated extensive but selective documentary traces concerning land, water, taxation, cultivation, endowments, infrastructure, disputes, and crisis. Foundational environmental histories show how irrigation, provisioning, climatic stress, local expertise, and imperial administration interacted across Ottoman regions [12,13]. Studies of rice cultivation, urban water protection, irrigation, marshlands, and hydraulic imaginaries further demonstrate the interpretive potential of Ottoman records when read alongside environmental evidence [14–19]. Together, these works show that Ottoman environmental history cannot be reduced to a single state logic. Imperial commands, local practices, expert knowledge, ecological constraints, and contested interests produced different outcomes across regions and periods.

This study develops and applies Socio-Ecological Historical Geoarchaeology, abbreviated SE-HGA, as an epistemic integration and reporting protocol for heterogeneous landscape evidence. The protocol connects three recursively related domains: physical and environmental processes, textual memory and cultural interpretation, and institutional and spatial praxis. Its research contribution lies in a set of auditable rules for documentary criticism, chronological independence, claim-level encoding, uncertainty representation, scale harmonization, and the evaluation of rival explanations.

The research design combines a purposive synthesis of DOI-verified theoretical and methodological literature with a structured secondary-data demonstration centred on Ottoman water management in the Konya Plain and a separate transfer stress test using an independent study of the 1907 Konya Plain Irrigation Project. These exercises demonstrate the protocol; they do not validate its empirical performance. Four research questions guide the analysis. First, what epistemological problems arise when material and textual archives are combined? Second, which elements of social–ecological, historical–ecological, phenomenological, and spatial–humanities scholarship can be integrated without collapsing their differences? Third, how can an Ottoman-oriented workflow transform broad interdisciplinarity into reproducible analytical decisions? Fourth, which observations would support or falsify the propositions generated by the protocol?

2. The Epistemological Problem of Landscape

2.1. Beyond Environmental Determinism and Textual Isolation

Environmental determinism was entangled with social theory, imperial classification, and geopolitical hierarchy, often presenting unequal political relations as predictable effects of climate or terrain [20–22]. In Middle Eastern contexts, timeless narratives of aridity, scarcity, and institutional failure may also reproduce Orientalist assumptions [23]. SE-HGA therefore rejects explanations in which drought, flood, slope, or soil directly produces a social outcome without identifiable institutional, technological, perceptual, and political mediation.

Rejecting determinism does not make physical processes discursive inventions. Critical physical geography instead brings biophysical mechanisms and social power into the same inquiry [24,25]. A river may change course, a spring may decline, or a surface may aggrade whether or not an archive records it. The historical consequences, however, depend on water rights, maintenance, labor, technology, and cultural valuation.

The opposite error is textual isolation. Administrative records preserve what became taxable, disputable, exceptional, or institutionally legible, not a complete account of past conditions. Silence may reflect routine practice, archival loss, exclusion, or genuine absence. SE-HGA therefore treats documents as historically produced evidence with specific genres, audiences, and incentives. It neither subordinates texts to environmental proxies nor mistakes documentary frequency for environmental magnitude.

2.2. Landscape as Temporality, Affordance, and Practice

Landscape archaeology has long treated space as an accumulation of dwelling, movement, and practice rather than a static container [26]. Phenomenological approaches foreground embodied experience, but their subjectivity and replicability remain contested [27,28]. GIS and three-dimensional visualization can discipline such interpretations without validating them automatically [29,30]. Affordance offers a useful bridge by linking material properties to situated possibilities for action [31].

For SE-HGA, affordance is relational. A spring, wetland margin, terraceable slope, or alluvial surface offers possibilities that become actionable through knowledge, technology, labor, rights, and coordination. Connectivity extends this principle from isolated features to networks of movement and access [32]. A canal may support irrigation, taxation, transport, or disease exposure for different actors. Its historical function cannot be inferred from its form alone.

Practice connects these possibilities to accumulated intervention. Learned routines, unequal capacities, and institutions shape how people modify a landscape. Jusseret's [3] socially informed geoarchaeology is important because it rejects a physical landscape first described by science and a social meaning added later. SE-HGA likewise treats material transformation, social classification, and institutional action as distinguishable but historically co-produced.

2.3. Historical Ecology and the Long Duration

Historical ecology connects event-based history with cumulative landscape change and rejects pristine baselines disturbed only in the recent past [33]. Its cross-disciplinary and biocultural orientation supports the combined use of archaeological, ecological, and historical evidence [34–37]. This perspective is valuable for Ottoman studies, where hydraulic, agricultural, and settlement systems often incorporated earlier structures and continued to change after imperial rule.

Long duration can nevertheless conceal rupture when continuity becomes the default explanation. Landscapes contain abandonment, reactivation, thresholds, and changes in institutional regime. A canal may persist physically while its management and meaning change, just as a stable administrative term may refer to different material arrangements. SE-HGA therefore treats continuity as a claim to be tested.

3. Research Design, Corpus, and Method

The theoretical and methodological synthesis uses a purposive corpus of 71 DOI-verified works in the submitted version and 72 in this revision after the addition of Lawrence [38]. Candidate discovery was iterative rather than systematic. It covered geoarchaeology, landscape phenomenology and affordance, historical ecology, social–ecological resilience, historical GIS and spatial humanities, historical climatology, Anatolian palaeoclimate, Ottoman environmental history, and Konya regional studies. Searches were conducted through Crossref metadata, publisher platforms, and broad scholarly discovery interfaces using combinations of the terms geoarchaeology, historical geoarchaeology, historical ecology, landscape affordance, resilience archaeology, historical GIS, spatial humanities, documentary climatology, Ottoman environmental history, Ottoman water management, Konya Plain, Çarşamba, irrigation, and suğla. The bibliographic audit for the revision was closed on 31 August 2026. Because the original search was purposive and its rejected-candidate log was not retained, the total number of records considered cannot be retrospectively verified; the corpus must not be interpreted as a systematic review or a complete map of the relevant scholarship.

The retained literature was examined through four analytical questions: what each field treats as admissible evidence; the spatial and temporal scales at which its claims are formulated; the way agency and causation are conceptualized; and the forms of uncertainty or source bias made visible. Inclusion required direct methodological relevance to at least one of these questions or direct relevance to a worked regional demonstration. The protocol-development corpus and the regional application literature were tagged separately. Duplicate records, items without sufficient relevance to an analytical rule or application claim, and modern secondary works whose DOI-to-title and DOI-to-author correspondence could not be verified were excluded. The analysis identifies transferable rules for an interdisciplinary reporting protocol and probes their coherence through published cases; it does not estimate effect sizes or claim exhaustive disciplinary coverage.

DOI verification was treated as a bibliographic integrity requirement rather than evidence of substantive quality. Each modern secondary reference was checked against authoritative DOI metadata and, where available, its publisher record for title, author sequence, year, and venue. The criterion does not apply to primary historical evidence such as court registers, kanunnames (provincial law codes), tax registers, endowment deeds, archival documents, historical maps, or material geo-archives. DOI-based inclusion inevitably underrepresents older monographs, archival editions, regional publications, Turkish-language scholarship, and other relevant works without registered identifiers. Such material may and should be used in a primary-data implementation after normal source criticism. The restriction is a reproducibility decision for this conceptual article, not a hierarchy of scholarly value.

4. Socio-Ecological Foundations of SE-HGA

SE-HGA is grounded in a heuristic account of landscape co-evolution drawn from coupled human and natural systems, social–ecological resilience, historical ecology, landscape archaeology, and critical geography. These studies are not collapsed into a totalizing theory. They identify three analytical domains whose relations must be specified in explanations of long-term human–environment change.

4.1. Physical and Environmental Substrate

The first domain comprises topography, hydrology, geology, soils, sediments, climatic variability, ecological dynamics, and hazards. These elements define neither destiny nor a fixed carrying capacity. They establish changing boundary conditions, energetic costs, resource distributions, and material pathways. Holling's [39] distinction between stability and resilience initiated a major shift from equilibrium assumptions toward persistence under disturbance. Subsequent work emphasized adaptive cycles, transformability, cross-scale feedbacks, and the complexity of coupled systems [40–45]. SE-HGA adopts the relational insight of this literature while resisting the temptation to treat all historical societies as instances of an abstract system model.

Physical processes operate across multiple temporalities. Tectonic change, soil formation, channel migration, seasonal drought, and sudden flood are not interchangeable "environmental variables." Geoarchaeological work demonstrates the importance of reconstructing process histories and human impacts at appropriate scales [4,46]. The substrate is therefore represented as a stratified set of processes with uncertainty, not as a single environmental score.

4.2. Textual Memory and Cultural Interpretation

The second domain concerns the ways societies perceive, name, remember, value, and narrate landscape. It includes belief, practical knowledge, legal classification, risk memory, and institutional language. Traditional ecological knowledge research shows that knowledge can function as adaptive management when it is embedded in practice, institutions, and intergenerational learning [47]. Phenomenological and affordance-based landscape studies add the insight that perception is embodied and action-oriented rather than a detached mental representation [26,31]. Historical texts provide access to portions of these interpretive worlds, but only through genres that must be critically read.

This domain prevents two reductions. First, it prevents researchers from assuming that modern scientific categories were shared by historical actors. A "drought," "marsh," "waste," "productive field," or "dangerous river" may carry specific fiscal, religious, legal, or political meanings. Second, it prevents physical change from being equated with social crisis. An event becomes a crisis through exposure, institutional response, competing claims, and cultural expectations.

4.3. Institutional and Spatial Praxis

The third domain is the realm of action: settlement selection, mobility, cultivation, water allocation, construction, maintenance, taxation, repair, abandonment, and conflict. It connects environmental affordances and cultural interpretation through practical capacity. Institutions matter because collective infrastructure requires rules, labor, finance, authority, and mechanisms for resolving disputes. Social–ecological frameworks are useful here, particularly when they identify nested governance, feedback, and the possibility of transformation rather than assuming automatic adaptation [48]. Historical analysis must nevertheless specify which institutions existed and who benefited from them.

Praxis changes the substrate. Terraces alter erosion and soil retention. Canals redirect water and sediment. Embankments modify flood regimes. Settlement concentration changes demand and waste. These transformations generate feedback that may enhance short-term production while producing long-term maintenance burdens or new vulnerabilities. The model therefore includes maladaptation as well as adaptation. Persistence is not automatically equitable, sustainable, or desirable. Their recursive relations and the protocol's cross-cutting controls are summarized in Figure 1.

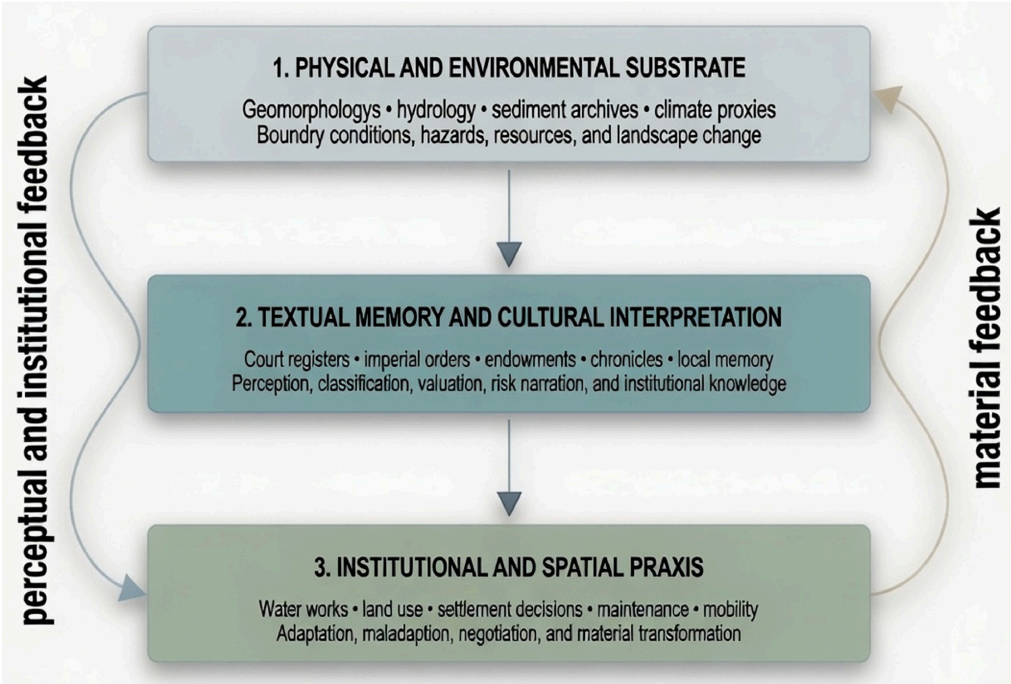

Figure 1. Socio-ecological foundations of the SE-HGA protocol. The three domains are analytically distinct, recursively connected, and governed by six cross-cutting controls: provenance, chronological independence, scale, uncertainty, source positionality, and rival explanation.

5. Evidence Architecture and Epistemic Controls

SE-HGA converts the three socio-ecological domains into an auditable research protocol by combining four evidence classes with six controls. Provenance records the origin, genre, context, and interpretive chain of each claim. Chronological independence prevents one evidence series from silently dating another. Scale identifies temporal and spatial support, while uncertainty retains ranges and plausible alternatives. Source positionality asks whom or what an archive makes visible, and rival-explanation control requires competing mechanisms for major causal claims. Table 1 summarizes the evidence classes; Section 6 shows how the controls are applied.

Digital integration can make heterogeneous sources appear more equivalent than they are. Deep mapping preserves layered and multivocal accounts, while historical GIS structures spatial comparison [49–51]. Because representation itself shapes historical understanding [52], SE-HGA treats maps and databases as analytical instruments rather than substitutes for source criticism.

5.1. Evidence Classes and Provenance

SE-HGA organizes evidence into four provenance classes. They are not disciplinary silos but records of the conditions under which claims were produced. Table 1 summarizes their contributions, characteristic risks, and minimum metadata.

5.2. Chronological Independence and Scale

Interdisciplinary comparison is strongest when evidence series are constructed independently. A flood chronology derived from court records cannot date sediment layers and then serve as independent confirmation of the same records. Likewise, regional palaeoclimate evidence cannot be assigned to a locality without an argument for spatial representativeness. Historical climatology provides methods for documentary calibration while warning that a textual mention is not an instrumental observation [53–55]. Researchers must therefore record how each chronology was produced, transferred, and compared.

An imperial order, a village dispute, a catchment-scale drought index, and a sediment core may concern the same region without supporting the same spatial claim. Historical GIS can organize these sources, but coherent maps may conceal uncertain dates, boundaries, and toponyms [56–59]. SE-HGA retains this uncertainty through ranges, confidence classes, alternative geometries, and explicit qualification.

Table 1. Evidence architecture of the SE-HGA framework.

Evidence Class	Typical Sources	Primary Analytical Contribution	Characteristic Risks	Minimum Metadata
Geo-archive	Sediments, soils, landforms, hydrological records, palaeoclimate proxies, archaeological stratigraphy	Physical processes, boundary conditions, rates, thresholds, and material transformation	Dating uncertainty, equifinality, spatial representativeness, proxy calibration	Location, stratigraphic context, dating method, error range, sampling resolution
Textual archive	Şer'iyye sicilleri, mühimme defterleri, waqf deeds, fiscal registers, chronicles, petitions, technical reports	Categories, perceptions, disputes, commands, rights, responsibilities, and remembered events	Institutional selectivity, genre conventions, copying, rhetorical strategy, archival survival	Date, author or office, genre, audience, archival reference, transcription or translation decisions
Spatial archive	Historical maps, cadastral information, routes, place names, settlement locations, remote sensing, GIS layers	Spatial relations, accessibility, network structure, land-use configuration, and change detection	Georeferencing error, toponym change, false precision, incompatible scales	Source scale, coordinate system, geometry type, positional error, confidence model, alternative geometries, transformation method, temporal validity
Praxis archive	Canals, terraces, wells, embankments, maintenance traces, settlement relocations, land-use decisions	Materialized agency, institutional capacity, labor organization, adaptation and maladaptation	Survival bias, uncertain function, reuse, mismatch between construction and use dates	Construction phase, use phase, maintenance evidence, actor attribution, confidence score

5.3. Source Positionality and Documentary Visibility

Every archive has a position. Court records privilege litigation, imperial registers administrative consequence, endowment deeds legally formalized resources, and environmental proxies processes preserved in particular settings. SE-HGA records the producer, institutional setting, and preservation pathway of each trace. Absence is classified as observed absence, documentary silence, preservation gap, sampling gap, or unresolved status rather than being coded automatically as no event.

Ottoman documentary frequency should be read as a visibility regime, not a census of environmental events. Background administration, maintenance, dispute, and crisis become visible through different institutional routes. Frequencies must therefore be assessed against archival survival, series coverage, jurisdiction, administrative change, and total document production. A cluster of petitions or repair orders may indicate disruption, access to institutions, or intensified state attention; a low count cannot establish environmental stability without independent evidence [14–16,19].

5.4. Ottoman Documentary and Material Archives

Early modern Ottoman landscapes can be studied through court and imperial council registers, endowment deeds, fiscal surveys, petitions, chronicles, travel accounts, and technical correspondence. These genres reveal different relations, including disputes, water rights, administrative priorities, infrastructure finance, and revenue categories, but none is a direct map of physical conditions. Material evidence such as canals, hydraulic structures, settlement mounds, field systems, alluvial sequences, and palaeoclimate proxies has different preservation and dating problems. A feature may survive without a corresponding text, and a documented repair may leave no identifiable structure. Such disagreement is evidence about preservation, scale, and institutional visibility rather than a defect to be smoothed away.

Ottoman environmental histories demonstrate how material change and institutional action can be studied together. Research on Egypt, Baghdad, Istanbul, rice cultivation, and trans-imperial engineering links water, expertise, political authority, and hydroclimatic variability without reducing one archive to another [12–17]. For Konya, Uçar et al. [19] bring legal, fiscal, spatial, and topographic evidence into one published synthesis. Because Section 8 examines those claims directly, they are not repeated here.

5.5. Climate Evidence Without Climatic Reductionism

The Eastern Mediterranean experienced substantial hydroclimatic variability, and tree-ring and multi-proxy reconstructions provide indispensable regional context. Reconstructions for western and southwestern Anatolia demonstrate interannual and multidecadal variability in spring precipitation [60,61]. The Old World Drought Atlas enables wider spatial comparison, while modelling studies address interactions between climate and societal resilience in the Eastern Mediterranean [62,63]. Such evidence can constrain the plausibility of historical claims, but it cannot determine local social outcomes without mediating analysis.

Climatic inference therefore proceeds from proxy-supported variability to historically documented recognition and response, followed by comparison with rival explanations such as warfare, taxation, disease, market change, migration, and archival selectivity. Section 6 translates this sequence into operational decisions.

6. Operational Workflow

The operational workflow consists of six stages. It is designed to be reproducible without implying that historical interpretation can be automated. Each stage produces explicit research objects that collaborators and reviewers can audit. Figure 2 presents a schematic summary of the sequence, while Table 2 and Section 6.3 provide the complete decision rules and relation classification.

Table 2. Operational stages and decision rules.

Stage	Required Action	Primary Output	Failure Condition
1. Define the historical–environmental problem	Specify process, place, period, actors, and proposed causal relations before data integration.	Research question, spatial unit, temporal window, rival hypotheses.	A broad theme replaces a testable problem.
2. Build independent evidence series	Construct geo-archive, textual, spatial, and praxis datasets without using one to force the chronology of another.	Separate chronologies and provenance records.	Circular dating or confirmation is introduced.

Table 2. *Cont.*

Stage	Required Action	Primary Output	Failure Condition
3. Encode source claims	Record who or what produced each observation, its date, location, genre, uncertainty, and interpretive status.	Claim-level database or structured source register.	Documents and proxies are reduced to unqualified facts.
4. Harmonize scale and uncertainty	Choose defensible temporal bins and spatial units; encode points with error buffers, fuzzy membership surfaces, or source-specific alternative geometries; rerun analysis across plausible configurations.	Comparability matrix, confidence-coded spatial ensemble, and sensitivity report.	Fine-scale conclusions are drawn from coarse evidence, or uncertain boundaries are converted into one crisp polygon.
5. Triangulate and test alternatives	Classify convergence, complementarity, contradiction, silence, and scale mismatch; evaluate rival mechanisms and record evidential sufficiency separately.	Evidence matrix and causal comparison.	Agreement is assumed merely because sources concern the same place.
6. Construct a co-evolutionary account	Explain mechanisms, feedbacks, institutional differences, unequal outcomes, and limits.	Narrative model, maps, propositions, and residual uncertainty.	The conclusion collapses into deterministic or text-only explanation.

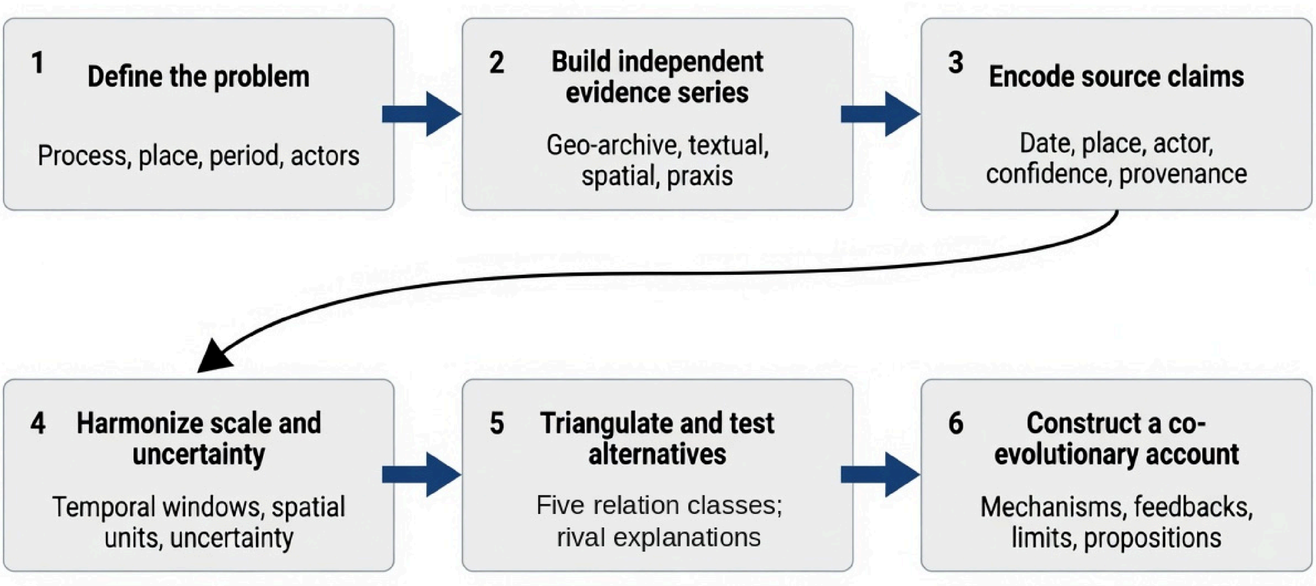

Figure 2. Six-stage operational workflow for SE-HGA research.

Workflow at a glance. (1) define a falsifiable problem; (2) build independent evidence series; (3) encode claims rather than documents; (4) harmonize scale and uncertainty; (5) classify evidential relations and test rival explanations; and (6) write mechanisms. Table 2 lists the decision rules, while Tables 3 and 4 show how stages 3–5 operate in the 17-versus-10 suğla example.

Table 3. Claim-level encoding schema for the SE-HGA protocol.

Element	Meaning	Minimum Encoding Requirement
s_i	Source and provenance	Archive or dataset, call number or sample context, creator, chain of transcription or processing
τ_i	Temporal support	Date, interval, dating method, uncertainty range, and temporal validity
x_i	Spatial support	Geometry, scale, positional error, alternative extent, and coordinate transformation
g_i	Genre or evidence class	Documentary genre, proxy type, spatial model, or material-practice record
π_i	Epistemic status	Observation, attribution, memory, prescription, rhetoric, or model-derived inference
u_i	Ordinal confidence class	Project-defined ordered category with stated criteria and sensitivity rule; no arithmetic aggregation

Table 4. Worked claim-level encoding of the Konya suğla discrepancy.

Claim	$C_i = <s_i, \tau_i, x_i, g_i, \pi_i, u_i>$	Decision
K1: The fourth kanunname lists 17 suğlas.	s_i: fourth Karaman kanunname as reported through Erdoğru and Uçar et al. [19]; τ_i: late sixteenth century, exact year unresolved here; x_i: Çarşamba fan, Alemdar-Ismil span, individual equivalence unresolved; g_i: normative legal code; π_i: prescription/administrative description; u_i: low because the claim is accessed derivatively and unit equivalence remains unresolved.	Retain as a genre-positioned count, not a census of simultaneously operating units.
K2: The 1584 taxation registers list 10 suğlas with 30,000 akçe revenue.	s_i: 1584 fiscal registers as reported by Uçar et al. [19]; τ_i: 1584; x_i: Sahra area/Çarşamba fan, exact matching to K1 unresolved; g_i: fiscal register; π_i: recorded taxable visibility; u_i: low because the claim is accessed derivatively and its spatial equivalence to K1 remains unresolved.	Retain as a fiscal count, not a complete inventory of all legally recognized suğlas.
R(K1,K2)	Temporal support is close but not demonstrably identical; spatial identity is only partial; genres and institutional purposes differ; both claims are accessed through the same secondary synthesis and are therefore not independent at the reporting level.	Literal-count relation: contradiction. Institutional-visibility relation: complementarity. Evidential sufficiency: conditional. Convergence is prohibited until source coverage and unit identity are demonstrated.

6.1. Define the Problem

A valid SE-HGA project begins with a relation that could be wrong. "Water and society in the Ottoman Empire" is too broad. "Did canal maintenance capacity mediate the effects of multiyear spring drought on settlement continuity in a defined sector of the Konya Plain between specified dates?" is analytically useful. The question identifies a physical process, an institutional mechanism, an observable outcome, a place, and a period.

6.2. Build Independent Evidence Series

Researchers first construct separate inventories. Geomorphological and palaeoclimate data are dated using their own methods. Documentary events are dated and classified by archival genre. Infrastructure and settlement features are phased independently where possible. Only after these series are documented are correspondences sought.

6.3. Encode Claims Rather than Documents

A single document can contain multiple claims with different confidence. A petition may state that a canal failed, attribute blame to an official, estimate damage, and request tax relief. These are not one data point. Each claim is encoded as a structured tuple, given in Equation (1), rather than inheriting one undifferentiated document-level status:

$$C_i = \langle s_i,\ \tau_i,\ x_i,\ g_i,\ \pi_i,\ u_i \rangle \tag{1}$$

Here s_i records source and provenance, τ_i temporal support as an interval or probability distribution, x_i spatial support, g_i source genre, π_i epistemic status (observation, attribution, memory, prescription, rhetoric, or model-derived inference), and u_i an ordinal confidence class. Confidence is assigned to the encoded claim, not to a document or author as a whole. High requires identifiable provenance, direct support for the encoded statement, defensible temporal and spatial support, and no unresolved dependency that changes the claim. Moderate indicates direct or near-direct support but one material limitation in provenance, temporal or spatial equivalence, genre, or processing. Low indicates derivative reporting or multiple unresolved limitations. Unverified is used when provenance or support cannot be checked. The lowest materially relevant dimension controls the class; scores are never averaged. Sensitivity analysis repeats the relation classification after all moderate claims are treated first as admissible and then as insufficient. Table 3 defines the schema, and Table 4 demonstrates it with the Konya suğla counts.

In Table 4, Low describes the evidential position of the encoded claims in this article, not the reliability of the underlying primary records. Both counts are accessed through secondary reporting, and the named units have not been spatially matched. Direct examination of the registers and resolution of unit identity could therefore justify reassignment in a future primary-data application.

For a pair of claims C_i and C_j, the relation $R(C_i,C_j)$ is classified as convergence, complementarity, contradiction, silence, or scale mismatch. Source independence means that the claims share no calibration sequence, no transferred chronology, and no derivational dependency in which one claim was constructed from the other. Convergence may be reported only when the temporal and spatial supports overlap at defensible scales and the sources meet this independence rule, as formalized in Equation (2). Otherwise, the relation must remain complementary, contradictory, silent, or scale-mismatched rather than being presented as confirmation. SE-HGA distinguishes relation class from evidential sufficiency: the latter is recorded separately as supported, conditional, insufficient, or untested.

$$\tau_i \cap \tau_j \neq \varnothing \wedge x_i \cap x_j \neq \varnothing \wedge s_i \perp s_j \tag{2}$$

6.4. Harmonize Scale Without Erasing Uncertainty

Historical spatial data rarely support uniform precision. A village may be located confidently while its cultivated territory remains uncertain, and a drought reconstruction may have annual resolution but only regional spatial support. Stage 4 therefore represents each location as geometry plus confidence rather than as a coordinate alone. Secure toponyms may be encoded as points with explicit positional-error buffers; cultivated territories, wetlands, or customary-use areas may be represented as fuzzy membership surfaces with core, probable, and possible zones; and disputed boundaries or water rights may be stored as source-specific alternative geometries. The analysis should then be repeated across plausible spatial configurations and temporal windows to determine whether the substantive conclusion is stable. Raster probabilities, confidence surfaces, and alternative polygons should not be collapsed into a single precise boundary merely for cartographic convenience. Every spatial object should retain its source date, temporal validity, transformation method, confidence class, and competing interpretation. The result is an ensemble spatial model and sensitivity report rather than a falsely exact historical map [57–59].

6.5. Triangulate and Test Rival Explanations

Triangulation is not a search for superficial agreement. Sources may converge, complement one another, contradict one another, remain silent, or refer to different scales. Contradiction triggers renewed examination of dating, genre, preservation, and process. Rival explanations are ranked according to the observations they explain and the assumptions they require.

Coding consistency is maintained through a claim-level codebook and an explicit disagreement procedure. Before full coding, two coders should independently encode at least 20% of claims or 25 claims, whichever is larger. Agreement is evaluated separately for g_i, π_i, u_i, relation class, and evidential sufficiency; a single composite percentage is not used to conceal category-specific disagreement. Disagreements are identified by claim identifier, discussed against the source passage and codebook, and resolved by documented consensus. If consensus fails, a third qualified reader adjudicates. The codebook is then frozen, affected claims are recoded, and both the pre-resolution and final decisions are retained in an audit log. The present secondary-data demonstration did not conduct an independent double-coding exercise and therefore makes no inter-rater reliability claim. Its reproducibility claim is limited to transparent rules and inspectable worked decisions; empirical validation requires the independent exercise just specified.

6.6. Write Mechanisms, Not Correlations

The final narrative should specify a chain of mechanisms. For example: reduced spring precipitation lowered available surface water; allocation rules prioritized one use; maintenance labor declined under fiscal pressure; canal conveyance deteriorated; disputes increased; some communities shifted cultivation while others relocated. Each link requires distinct evidence and uncertainty. The result is a conditional historical explanation rather than a climate-to-collapse story.

7. Testable Propositions

The protocol generates eight propositions for future regional research. Table 5 specifies their observation units, operational variables, expected patterns, and falsification criteria. Table 6 distinguishes propositions generated by the framework from those illustrated by the Konya material and those actually tested. No proposition receives a complete empirical test in this article. P1, P2, P3, P4, P5, and P8 are illustrated to unequal degrees, while P6 and P7 remain untested. Each proposition remains conditional and may be rejected when the required primary data are assembled.

Table 5. Operational definitions and falsification criteria for SE-HGA propositions.

Proposition and Mechanism	Observation Unit and Operational Variables	Expected Pattern	Falsification Criterion
P1. Documentary visibility is institutionally mediated.	Event-period or decade; physical magnitude, total surviving documents, water-related entries, dispute/repair/fiscal-relief category, jurisdiction.	After controlling for total archive volume, dispute and intervention records vary with institutional salience rather than physical magnitude alone.	A stable monotonic relation between independently measured physical magnitude and normalized documentary frequency explains the data without institutional variables.
P2. Institutions differentiate outcomes under comparable exposure.	Matched settlements or irrigation sectors; hydroclimatic exposure, maintenance capacity, storage, rights, labor access, continuity or abandonment.	Comparable exposure produces different outcomes where institutional capacities differ.	Matched units with materially different institutional capacity show no systematic difference in outcomes across repeated cases.
P3. Recurrent maintenance predicts infrastructure persistence.	Individual hydraulic structures or channel segments; construction scale, repair frequency, funding continuity, responsible office, duration of function.	Maintenance continuity has a stronger association with functional lifespan than initial construction scale.	Construction scale predicts persistence after maintenance variables are included, while maintenance contributes no additional explanatory power.
P4. Apparent proxy-text contradictions concentrate in incompatible supports.	Paired claims; temporal overlap, spatial overlap, season, genre, petitionary incentive, relation class.	Contradictions decline after scale and genre incompatibilities are resolved.	Contradictions remain equally frequent among independently dated, spatially overlapping, genre-compatible claims.
P5. Short-term gains create delayed vulnerability under identifiable feedbacks.	Intervention episodes; immediate output gain, sedimentation, ecological change, maintenance burden, allocation inequality, later failure.	Delayed vulnerability occurs when specified feedback variables exceed defined thresholds or maintenance capacity declines.	Interventions with the specified feedback conditions show no higher later failure or burden than matched interventions without them.
P6. Explicit spatial uncertainty improves inferential robustness.	Alternative historical-GIS models; geometry confidence, buffer or fuzzy extent, model sensitivity, conclusion stability.	Conclusions retained across plausible geometries are more stable under sensitivity analysis than conclusions from one crisp geometry.	Uncertainty-aware and single-geometry models show equivalent stability, or the uncertainty model introduces no detectable change in inference.
P7. Routine management is underrepresented relative to crisis and dispute.	Register-year or decade; routine, dispute, repair, intervention categories; total entries, survival, jurisdiction, access.	Normalized crisis/dispute visibility exceeds routine-management visibility in administrative series.	After archival controls, routine management is represented at equal or higher rates, or crisis peaks disappear entirely.
P8. Aggregate resilience can conceal unequal local burdens.	Households, villages, user groups, or ecological zones; system persistence, access, labor, tax burden, displacement, ecological cost.	System-level persistence coexists with statistically or qualitatively documented unequal costs among actors or places.	Persistence is accompanied by no detectable distributional differences across adequately observed actor groups and scales.

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Table 6. Evidential status of the eight propositions in the present article.

Proposition	Framework Status	Konya Status	What Would Be Required for a Test
P1	Generated	Illustrated, not tested	Register denominators, source survival, event magnitude, and institutional category.
P2	Generated	Partly illustrated, not tested	Matched settlements or sectors with comparable exposure and differentiated institutional capacity.
P3	Generated	Mechanism illustrated; evidence insufficient	Structure-level repair histories, funding continuity, and functional duration.
P4	Generated	Worked relation illustrated, not tested	A sample of independently derived claim pairs with coded temporal, spatial, and genre compatibility.
P5	Generated	Illustrated in Section 8.5, not tested	Intervention episodes with short-term benefits, delayed costs, and matched counterfactuals.
P6	Generated	Untested	Alternative historical-GIS geometries and a preregistered stability metric.
P7	Generated	Untested	Complete entry counts normalized by register survival, jurisdiction, and total production.
P8	Generated	Distributional issue illustrated, not tested	Actor-level access, labor, taxation, displacement, and ecological cost.

8. Worked Demonstrations: Konya Water Management

The first demonstration concerns the sixteenth- to nineteenth-century Konya Plain because published research places geo-archives, legal and fiscal sources, remote sensing, settlement evidence, and hydraulic practices in the same regional discussion. The documentary and institutional claims rely substantially on Uçar et al. [19]; independent studies supply the geomorphological, palaeohydrological, climatic, and spatial components. No unpublished primary source or new field observation was analyzed. Sections 8.1–8.4 are therefore a worked illustration of how published claims are encoded and limited, not an empirical validation. Section 8.5 adds a temporally distinct and independently authored study of the 1907 Konya Plain Irrigation Project as a transfer stress test.

8.1. Physical and Environmental Substrate in the Konya Plain

The geo-archive is established independently of Ottoman documentary interpretation. KOPAL research reconstructs the Late Quaternary history of the endorheic Konya Basin through alluvial sequences and residual-lake sediments dated by radiocarbon, optically stimulated luminescence, and U-Th methods; it also warns that discontinuous shallow-basin sequences require basin-wide comparison and independent chronological control [64]. On the approximately 500 km^2 Çarşamba alluvial fan, Boyer et al. [65] integrate geomorphology and archaeological survey, distinguish two principal Holocene alluvial units, and show that alluviation, pedogenesis, erosion, flood regimes, and soil-water availability affected the archaeological visibility and suitability of different areas. Wainwright and Ayala [66] reconstruct and model the Neolithic Çarşamba riverscape, while Ayala et al. [67] show how agricultural practice adapted to multiple hydrological niches rather than one uniform floodplain setting. These studies provide process histories rather than a single environmental score.

The published geo-archive does not justify mapping every Ottoman canal command area or customary water-right zone as a precise polygon. Boon et al. [68] provide a quantitative spatial method by using planform sinuosity to classify natural and human-modified waterways within the Konya irrigation network. Securely identified settlements and surviving structures can therefore be represented with positional-error buffers, while seasonal wetland margins, suğla extents, cultivated territories, and customary-use areas require graded or alternative geometries. Hydrological accessibility and institutional exposure should be recalculated across plausible extents so that conclusions do not depend on one speculative boundary. The Neolithic studies are not treated as direct evidence for Ottoman institutions; they establish long-term palaeohydrological and spatial baselines against which later interventions can be evaluated.

The analytical implication is that a regional drought index cannot be translated directly into local water shortage. Storage, groundwater, channel condition, seasonal demand, upstream use, and maintenance mediate that relation. The KOPAL and Çarşamba-fan studies therefore supply physical boundary conditions and chronological cautions, while Ottoman records supply historically situated rules and interventions. Their relation is complementary unless temporal and spatial supports can be shown to overlap.

8.2. Textual Memory and Institutional Knowledge

The textual corpus summarized by Uçar et al. [19] includes five sixteenth-century kanunnames (provincial law codes), eleven Konya şer'iyye sicilleri (Islamic court registers) dated from 1595 to 1922, and three taxation registers, together with historical satellite imagery and topographic analysis. A suğla was a seasonally inundated or deliberately flooded cultivation area managed through small dams and diversions. A mirab was a water-distribution official; vakıf denotes a pious endowment; and akçe was an Ottoman silver monetary and accounting unit. The corpus identifies water as a regulated right, taxable resource, infrastructural obligation, and object of dispute. A late sixteenth-century kanunname and a later court case referring to a 1663 legal instrument reconstruct the proportional distribution of Meram Creek water. Two 1670 records describe irrigation turns and long-standing channel use, while another 1670 case records a mirab emini appointed when no local person was available to undertake water-management duties [19]. These are institutional claims, not direct measurements of discharge or drought severity.

The records cannot yet test documentary peaks as a scarcity index because the published study does not provide annual totals for all preserved entries or a denominator for overall register production. P7 therefore remains untested in this application. What can be demonstrated is the visibility mechanism: litigation, formal allocation, taxation, and exceptional appointment generate records, whereas uneventful maintenance is less likely to appear. A future test must classify all water-related entries by visibility regime and normalize them against register survival, jurisdiction, and total document production.

Sert's [15] comparison of Ottoman rice-related records with palaeoclimate evidence provides a complementary methodological precedent. In the Konya application, however, the natural and documentary series remain analytically independent until their temporal and spatial supports are established. This prevents the documentary record from dating the geo-archive and then being "confirmed" by the same chronology.

8.3. Institutional and Spatial Praxis in the Konya Plain

The praxis domain is visible in published evidence for construction, allocation, maintenance, taxation, and conflict. The late sixteenth-century fourth kanunname describes 17 suğlas across the Çarşamba fan, whereas the 1584 taxation registers identify 10 fiscally visible suğlas with a combined revenue of 30,000 akçe, approximately 5% of the reported income of the Sahra sub-district, which comprised 124 villages and about 5300 households [19]. Water distribution was organized through turns, proportional allocations, local officials, canal workers, and rights such as hakk-ı saki (the right to use water for irrigation and animal consumption) and hakk-ı mecra (the right to convey water across another property). These observations make institutional mediation measurable, but they do not prove long-term hydraulic performance.

Table 4 applies the complete tuple to the difference between 17 suğlas in the kanunname and 10 in the taxation registers. The kanunname is normative and prescriptive, whereas the fiscal register records taxable visibility at a particular administrative moment. The two claims are contradictory at the literal-count level but potentially complementary at the level of institutional visibility. They cannot count as independent convergence because both are accessed here through the same secondary synthesis, their named units have not been spatially matched, and their source coverage differs. Averaging them, treating the difference automatically as scribal error, or selecting the larger figure would each conceal the evidential problem. The example illustrates P1 and P4 but does not test either proposition.

The published settlement evidence also illustrates how P2 and rival causal explanations could be operationalized. Of 499 rural settlements recorded in the Hatunsaray, Sahra, and Sudiremi districts in 1584, 63 villages and 103 hamlets were abandoned during the first half of the seventeenth century, followed by another 26 villages and 11 hamlets in the second half. The combined 203 disappearances represent approximately 40.7% of the 499 recorded settlements [19]. White [13] situates the period within prolonged drought, provisioning failure, political error, and Celali-era violence. Yet the concentration of many abandoned locations along major routes supports a security-related mechanism rather than a purely environmental explanation [19]. Hydroclimatic stress is therefore one exposure variable within a causal comparison that must also include route proximity, violence, taxation, state response, and local institutional capacity. Without settlement-level dates, locations, exposures, and matched institutional variables, this is a design demonstration rather than a test of P2.

The regional application partially operationalizes P3 by identifying recurrent offices, financing rules, maintenance duties, and legal mechanisms that could be related to infrastructure persistence. It does not confirm P3 because no structure-level survival dataset or event-history analysis is available. The analysis therefore demonstrates the protocol's reporting discipline: evidence for a plausible mechanism is distinguished from evidence sufficient to test a proposition. Actor-specific outcomes are also preserved, since regional hydraulic persistence may coexist with unequal access, litigation, or transferred maintenance burdens.

8.4. Evidence Matrix and Evidential Limits

Table 7 applies the protocol to published evidence and distinguishes supported inferences from unresolved empirical requirements.

Table 7. Evidence matrix for the Konya Plain based on published research. The table recodes published findings and does not claim new primary data.

Protocol Question	Published Evidence	Relation and Evidential Status	Supported Inference	Unresolved Requirement
What constitutes the geo-archive?	KOPAL basin chronology and Çarşamba-fan alluvial history using independent dating, geomorphology, and archaeological survey [64,65].	Relation: complementarity	Physical processes, depositional discontinuities, flood regimes, and soil-water availability can be specified independently of Ottoman records.	Ottoman-period local chronologies for individual channels, wetlands, and hydraulic structures.

Table 7. *Cont.*

Protocol Question	Published Evidence	Relation and Evidential Status	Supported Inference	Unresolved Requirement
How was water made institutionally visible?	Five kanunnames, eleven şer'iyye registers, taxation records, remote sensing, and topographic analysis; cases concerning Meram Creek, irrigation turns, mirab authority, and water rights [19].	Relation: complementarity	Rules, actors, rights, and recorded conflicts can be coded without treating documents as direct hydrological measurements.	Complete register denominators and archival-survival measures are needed to test documentary-frequency hypotheses.
Can institutional mediation be quantified?	Seventeen suğlas in the fourth kanunname; ten suğlas and 30,000 akçe revenue in 1584, about 5% of Sahra income; 124 villages and approximately 5300 households [19].	Relation: contradiction at the literal-count level; complementarity after genre control. Evidential sufficiency: conditional.	Fiscal significance and institutional organization are measurable at the published scale.	Spatially explicit matching of suğlas, hydrology, settlement exposure, and maintenance histories.
Does the evidence test persistence or resilience?	Recurring offices, proportional allocation, turns, rights, and maintenance duties are documented [19].	Status: insufficient for confirmation	A maintenance mechanism is plausible and can be encoded for P3.	Structure-level dates, failure and repair events, beneficiaries, and event-history or survival analysis.
How should conflicting administrative counts be encoded?	The fourth late sixteenth-century kanunname describes 17 suğlas; the 1584 taxation registers identify 10 in the same broader area [19].	Relation: contradiction at the literal count level; possible complementarity after genre control	Normative and fiscal records produce different visibility regimes. The counts must remain separate until temporal, spatial, and administrative equivalence is demonstrated.	Source coverage, exact spatial identity of named suğlas, temporal offset, and register-production context.
Can rival explanations distinguish hydroclimatic from security-driven abandonment?	Among 499 rural settlements recorded in 1584, 63 villages and 103 hamlets were abandoned in the first half of the seventeenth century, with 26 villages and 11 hamlets disappearing later; many abandoned places were on major routes [13,19].	Status: causal competition with conditional complementarity	Drought and Celali-era disorder define exposure, but route-related vulnerability supports a security mechanism and prevents a direct climate-to-abandonment inference.	Settlement-level dates and coordinates, road proximity, local conflict exposure, taxation, water access, and matched institutional-capacity variables.

8.5. Independent Transfer Stress Test: The 1907 Konya Plain Irrigation Project

Lawrence [38] provides an independently authored environmental history of the 1907 Konya Plain Irrigation Project. For the transfer exercise, its central claim is encoded as follows: s_i is Lawrence's article and its cited project record; τ_i begins with the 1907 agreement and the subsequent implementation period; x_i is the project area of the Konya Plain; g_i is a political–economic environmental history; π_i is an attribution linking project design and governance to state consolidation, foreign finance, agricultural reorganization, and uneven local consequences; and u_i is moderate because the attribution is directly supported within the study but is not independently reproduced here from actor-level or ecological outcome data. The source is independent of Uçar et al. [19] at publication level and cannot verify the sixteenth-century suğla counts. Its value lies in testing whether the protocol remains discriminating when applied to a different period, source base, and institutional configuration.

The transfer exercise produces a specific restraint and a specific insight. Lawrence's institutional and distributive claims can illustrate P5 and P8, but the article-level evidence available here does not supply actor-level outcome data, a counterfactual project, or independently dated ecological response series; both propositions therefore remain untested. Boon et al. [68] independently classify natural and modified waterways through planform sinuosity, but their network-scale spatial evidence and Lawrence's 1907 political-economic account have different temporal and inferential supports. Their relation is complementarity at the broad level of landscape transformation and scale mismatch for project-specific causal effects, not convergence. This is precisely the kind of distinction that an undifferentiated appeal to interdisciplinary triangulation can leave implicit. Table 8 summarizes the transfer stress test and its evidential limits.

Table 8. Transfer stress test using an independent Konya study.

Encoded Claim	Relation Decision	Proposition Status	Unresolved Evidence
Lawrence attributes the project's design and implementation to the interaction of state consolidation, foreign finance, engineering, agricultural reorganization, and uneven local consequences [38].	Independent of Uçar et al. [19] at publication level; temporally distinct from the sixteenth-century counts.	P5 and P8 illustrated, not tested.	Project phases, ecological response series, actor-level benefits and burdens, and a counterfactual comparison.
Modified waterways can be classified spatially by sinuosity [68].	Complementarity for broad landscape transformation; scale mismatch for direct causal confirmation of Lawrence's claims.	P6 remains untested.	Time-specific geometries, positional uncertainty models, and conclusion-stability comparison.

9. Discussion

9.1. What SE-HGA Adds

The novelty of SE-HGA does not lie in asserting that environment and society interact, a premise already shared by historical ecology, environmental history, geoarchaeology, and coupled-systems research. Nor does it replace historical GIS, which reconstructs and analyzes spatial relations, or conventional interdisciplinary triangulation, which compares evidence from multiple sources. Its narrower methodological contribution is to impose a claim-level reporting contract before synthesis: provenance and derivational dependence remain visible; temporal and spatial supports must be compatible; genre and epistemic status are coded; confidence is ordinal and non-additive; relation class is separated from evidential sufficiency; and rival explanations receive explicit failure criteria.

Compared with historical GIS and spatial humanities, SE-HGA does not primarily contribute a new representational technology; it requires uncertainty, temporal validity, and alternative geometries to constrain what a representation may support. Compared with historical ecology and environmental history, it formalizes when environmental and documentary claims may be described as convergent. Compared with socially informed geoarchaeology, it gives documentary genre and institutional visibility an explicit place in the evidence model. Compared with conventional triangulation, it prohibits the number of source types from standing in for independence or support compatibility. Burke et al. [6] integrate environmental structure, demography, social networks, and cultural evolution through predictive complex-systems modelling; SE-HGA instead governs how historically contingent claims are prepared, compared, and reported before or alongside such modelling.

The worked decisions show what this protocol changes. Conventional synthesis might report the suğla evidence as a range of 10–17 or choose one count; SE-HGA retains a literal contradiction and reclassifies only the institutional meanings as complementary. A conventional narrative might align drought and abandonment; SE-HGA withholds causal attribution because 40.7% aggregate disappearance, regional hydroclimate, route exposure, and institutional capacity do not share adequate supports. A broad cross-period narrative might treat modified waterways and the 1907 project as convergent evidence of continuity; SE-HGA records complementarity at landscape scale and scale mismatch for project-specific effects. These are not necessarily new historical facts. They are more discriminating conclusions about what the available facts can and cannot establish.

9.2. Causation, Equifinality, and Feedback

Historical landscapes are equifinal: similar material outcomes can arise from different processes. Settlement contraction may follow hydrological change, taxation, insecurity, disease, market reorientation, or combinations of these. Canal abandonment may reflect reduced flow, sedimentation, labor shortage, political conflict, or a shift to another water source. Geoarchaeological interpretation must therefore distinguish process signatures where possible and retain multiple explanations where evidence is insufficient.

Feedback is equally important. Human interventions alter subsequent environmental conditions and institutional possibilities. A successful diversion may expand cultivation, increase maintenance requirements, modify sediment transport, create new rights, and intensify conflict during low-flow years. Coupled-systems literature is valuable because it directs attention to nonlinear change and cross-scale interactions [43,44]. Historical interpretation adds actor specificity, contingency, and changing meanings to those dynamics.

9.3. Resilience Without Romanticization

Resilience is useful when it denotes a specified capacity in relation to a specified disturbance and outcome. It becomes problematic when it functions as a retrospective synonym for survival. Reviews in archaeology show both the promise and translation problems of resilience theory [69–72]. SE-HGA therefore asks: resilience of what, to what, for whom, over which period, and at whose cost?

The framework distinguishes persistence, adaptation, transformation, and maladaptation. Persistence is continuity of a structure or practice. Adaptation is an adjustment that maintains a valued function under changed conditions. Transformation changes the system's organization or objectives. Maladaptation reduces future options or shifts vulnerability to other actors or scales. These categories should be supported by observed mechanisms rather than assigned impressionistically.

9.4. Limits of the Framework

SE-HGA has seven principal limits. First, it requires competence in archival criticism, geomorphology, chronology, and spatial analysis and will often require collaboration. Second, explicit uncertainty cannot recover missing or destroyed evidence. Third, maximum-detail encoding can become cumbersome, so granularity must follow the research question. Fourth, structured databases can impose presentist categories on historical terms. Fifth, the purposive DOI-verified corpus is neither systematic nor exhaustive; the original rejected-candidate denominator could not be retrospectively verified, and DOI availability underrepresents older, regional, Turkish-language, archival, and non-journal scholarship. Sixth, the present Konya exercises use published secondary evidence and do not provide independent empirical validation, inter-rater reliability, or tests of the eight propositions. Seventh, source architectures vary across regions and periods, so transferability concerns the logic of integration rather than a universal archive list. These limitations define the next research stage: a preregistered primary-data application with complete provenance, independent double coding, alternative spatial models, and proposition-specific tests.

10. Conclusions

This research developed SE-HGA as a conceptual integration and reporting protocol for material, textual, spatial, and practical evidence in Ottoman landscape research. It demonstrated the protocol through a bounded recoding of published sixteenth- to nineteenth-century Konya evidence and an independent transfer stress test using the 1907 Konya Plain Irrigation Project. Neither demonstration constitutes empirical validation, and none of the eight propositions was fully tested.

The protocol connects three socio-ecological domains with explicit controls for provenance, chronological independence, scale, uncertainty, source positionality, and rival explanation. A six-stage workflow, claim-level encoding schema, ordinal confidence rubric, worked tuple, five-valued relation classification, proposition-status table, and coding-disagreement procedure make the integration auditable. The main result is diagnostic: the current evidence can illustrate several mechanisms, but it cannot establish documentary-frequency effects, matched institutional outcomes, infrastructure survival, delayed vulnerability, spatial robustness, routine-management underrepresentation, or distributional inequality without additional primary data.

SE-HGA should be judged not by the novelty of its component concepts in isolation, but by whether future applications improve the transparency, falsifiability, and reproducibility of interdisciplinary landscape histories. In the present demonstrations, its added value is the disciplined refusal to treat shared topic, multiple genres, or broad spatial overlap as evidential independence. Empirical validation now requires a well-defined primary dataset and comparison against a conventional triangulation workflow using preregistered criteria.

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