A Multiscale Methodology for the Circular Regeneration of Historic Villages, Cultural Landscapes and Rural Territories

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Abstract. Historic villages, rural territories and cultural landscapes are increasingly recognized as strategic contexts for testing regeneration models that integrate heritage conservation, ecological transition and local development. However, interventions in these areas are still often fragmented and building-centred, with limited integration between environmental performance, conservation needs, local economies and community governance. This paper proposes a multiscale and multicriteria methodology for the circular regeneration of historic villages and rural territories. This article proposes a multiscale and multicriteria methodology for the circular regeneration of historic villages and rural territories, conceived not as a tool limited to the technical rehabilitation of individual buildings, but as a framework oriented toward territorial regeneration. From this perspective, historic building stock, adaptive re-use, the selection of materials, and the use of appropriate technologies are interpreted as integrated components of a broader process, which also involves governance arrangements, local economies, community participation, eco-logical infrastructures, and service systems. Within this approach, evaluation plays a central role: it is not understood merely as an ex-post tool for verifying implemented interventions, but as a continuous decision-support process capable of guiding design choices, strengthening governance, and aligning local transformations with a shared community vision.

Keywords: Circular Regeneration · Historic Villages · Rural Territories · Cultural Heritage · Multicriteria Evaluation · Adaptive Reuse · Circular Region · Community-Based Regeneration

1 Introduction

Recent debate on the circular economy has progressively extended from industrial systems and waste reduction to the built environment, where circularity is increasingly interpreted as a strategy for extending building life cycles, reducing re-source consumption, and strengthening local resilience (Foster, 2020; Finamore et al., 2024). In particular, recent studies have shown that, in the heritage and existing-building sectors, restoration, continuous use, rehabilitation, and adaptive reuse are central to improving circularity and reducing environmental impacts (Foster, 2020; Dişli, 2023). While this transition

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has been widely explored in metropolitan and urban contexts, rural municipalities and historic village systems remain comparatively under-investigated, despite their strategic relevance for ecological transition and territorial cohesion.

This gap is particularly significant in historic villages and rural territories, where built heritage, landscape, local resources, and community practices are deeply interconnected. In such contexts, heritage should not be understood as an isolated stock of buildings, but as a territorial infrastructure capable of activating regeneration processes, local economies, and forms of ecological and social resilience. Recent contributions on heritage led rural regeneration and community-based planning suggest that these areas can operate as laboratories for sustainable development, especially when regeneration is linked to local participation, co-creation, and heritage-based innovation processes (De Luca et al., 2021; Egusquiza et al., 2021).

This challenge can be interpreted through the concepts of the circular city and circular region, with particular attention to the role of multidimensional and multicriteria evaluation, indicators, and participatory approaches in guiding circular transformations across villages, landscapes, and rural systems. Recent research has stressed both the need for urban and territorial scale circularity indicators and the value of participatory evaluation frameworks for adaptive reuse projects, particularly where heritage, community interests, and long-term sustainability goals must be balanced (Paoli et al., 2022; Gravagnuolo et al., 2024).

In this perspective, the paper proposes a methodology that links heritage conservation, circular regeneration, and territorial evaluation within a single decision-support frame-work. Unlike existing approaches, which tend to focus either on adaptive reuse at the building scale or on rural regeneration as a policy process, the proposed methodology integrates territorial profiling, transformability assessment, participatory scenario-building, and multidimensional evaluation within a single multiscale framework. This integration is consistent with recent work emphasizing the environmental benefits of circular adaptive reuse, the role of heritage communities in decision-making, and the relevance of participatory multicriteria assessment for selecting regeneration scenarios in complex contexts (Foster, 2020; Gravagnuolo et al., 2021; Gravagnuolo et al., 2024).

Accordingly, the term regeneration is used here to indicate an integrated territorial process that combines the recovery and adaptive reuse of historic buildings with broader strategies for landscape enhancement, ecological transition, service innovation, local economic activation and community-based governance. The framework therefore does not focus exclusively on building-stock rehabilitation; rather, it uses the building stock as one entry point within a wider village and rural-territorial system.

2 Theoretical Background

2.1 Circular Regeneration and Heritage-led Territorial Development

In the heritage field, circularity has progressively moved beyond simple material recycling to encompass adaptive reuse, reversibility, value retention, life-cycle thinking and the re-generation of existing assets. Recent studies highlight that the conservation and reuse of existing buildings represent one of the most effective strategies for reducing environmental im-pacts in the construction sector, as they preserve embodied energy,

materials and cultural values while avoiding demolition and new resource consumption (Foster, 2020; Dişli, 2023). In this perspective, adaptive reuse is not only a technical intervention, but a systemic approach that integrates evironmental, cultural, social and economic dimensions within a circular framework (Gravagnuolo et al., 2018) argue that adaptive reuse of cultural heritage is a key strategy for implementing circular economy models in cities and territories, because it preserves embodied cultural and material value while enabling the activation of new social, cultural and economic functions (Angrisano et al., 2025). Similarly, recent contributions emphasize the role of participatory processes and heritage com-munities in enhancing circularity outcomes, particularly in con-texts where decision-making must balance conservation needs with innovation and local development goals (Gravagnuolo et al., 2021; Egusquiza et al., 2021).

When applied to rural systems, however, circularity must be interpreted at a broader territorial scale, extending beyond in-dividual buildings to include settlement structures, landscape systems and local resource networks. Rural territories are characterized by low-density patterns, strong interdependencies between natural and built environments, and the presence of underused heritage assets, which require integrated and place-based approaches to regeneration. Recent European poli-cy frameworks highlight that circular economy strategies still face significant challenges in achieving integration across local and regional scales, particularly in non-urban and peripheral areas (European Commission, 2020; European Commission, 2024). In addition, European territorial policies emphasize the need to strengthen cohesion, resilience and place-based development strategies in rural and inner areas, recognizing their strategic role in the green transition (European Commission, 2021).

This policy dimension is particularly relevant in the Italian context, where historic villages and rural territories often overlap with inner areas affected by demographic decline, reduced accessibility to essential services and fragile local economies. For this reason, the proposed framework should be read in relation to the Italian National Strategy for Inner Areas (SNAI), which promotes place-based development, service accessibility and territorial cohesion in marginal areas. At the European level, it is also consistent with the Long-Term Vision for the EU's Rural Areas, the Circular Economy Action Plan and the Circular Cities and Regions Initiative, all of which stress the need to connect ecological transition, local development and multilevel governance in rural and peripheral con-texts.

Recent studies on heritage-led rural regeneration further suggest that villages and rural landscapes can function as laboratories for circular transition, especially when regeneration processes are linked to local resources, community participation and multilevel governance frameworks (De Luca et al., 2021; Egusquiza et al., 2021; Suárez et al., 2025; Scioti et al., 2022).

This perspective calls for the development of place-based and multiscale methodologies capable of translating circular economy principles into low-density territorial systems, where village networks, ecological infrastructures and local communities play a decisive role (Verardi et al., 2023; Angrisano, M.; 2023). In such contexts, circularity should be understood not only as resource efficiency, but as a broader process of territorial regeneration aimed at strengthening resilience, reactivating local economies and

enhancing the long-term value of cultural landscapes (Foster, 2020; Paoli et al., 2022; Gravagnuolo et al., 2024).

The literature reviewed in this paper can therefore be organized into three complementary strands. The first concerns circularity and adaptive reuse in the built heritage field, with attention to embodied value, reversibility, durability and com-patible technologies. The second addresses rural and inner-area regeneration, emphasizing territorial cohesion, local re-sources, community participation and multilevel governance. The third focuses on evaluation frameworks, indicators, KPIs and multicriteria decision-support tools, which are needed to compare alternative scenarios and make trade-offs explicit. The originality of the present contribution lies in bringing these strands together within a single methodological sequence for heritage-sensitive rural territories.

2.2 Evaluation as a Strategic Process

A second key issue concerns the role of evaluation. In heritage-led regeneration, evaluation is no longer understood only as an ex-post verification of impacts, but increasingly as a continuous and strategic process supporting the definition of scenarios, priorities and governance arrangements. This perspective is particularly strong in the literature on circular adaptive reuse, where evaluation criteria are used to balance cultural, environmental, social and economic dimensions (Gravagnuolo et al., 2018).

Similarly, the RURITAGE methodology shows that community-based regeneration in rural areas benefits from participatory and collaborative processes, organized through Rural Heritage Hubs and co-creation practices, in which evaluation supports decision-making and aligns actions with locally shared visions (Buglione et al., 2026; De Luca et al., 2021).

This perspective suggests that evaluation should be embedded within the regeneration process itself, not limited to the final measurement of impacts.

2.3 Research Gap and Aim of the Paper

Current scientific literature review tends to address circular economy, heritage conservation, adaptive reuse and rural re-generation through partially separated perspectives. Heritage studies frequently privilege conservation and building-scale adaptive reuse; circular economy studies often concentrate on material flows, resource efficiency and technical performance; while rural regeneration research tends to emphasize governance, local development and territorial cohesion. Although each of these strands is relevant, existing approaches rarely provide an operational methodology capable of connecting building stock, cultural landscape, local resource systems, community actors and evaluation criteria across multiple scales.

Historic built heritage represents the result of a long and complex evolutionary process, intrinsically linked to the functional role of buildings and to the territorial and environmental conditions in which they are embedded. The original con-figuration of these architectural structures, shaped by the geo-graphical and climatic features of the site, the availability of local materials, traditional construction techniques, and the socio-cultural practices of resident communities, has progressively changed over time under the

influence of evolving planning policies, management strategies, technological progress, and regulatory developments.

In numerous cases, the lack of comprehensive guidance frameworks and decision-support methodologies for interventions in complex historic environments—frequently subject to heritage protection constraints—has created substantial operational challenges both for technical professionals and for public administrations responsible for supervising transformation processes. As a consequence, many improvement initiatives have produced fragmented and often ineffective outcomes, contributing to widespread degradation across entire settlement systems, with only a few isolated building units benefiting from targeted interventions.

At the same time, where intervention processes have been undertaken, rehabilitation activities have commonly been implemented through a succession of isolated actions focused on individual buildings and developed according to a predominantly "case-by-case" design approach. Although these interventions have generally adopted technically reliable and technologically appropriate solutions, such a fragmented method-ology has significantly prolonged the overall recovery process while progressively weakening the perception of the settlement as a coherent and unified organism. This has ultimately generated functional and managerial fragmentation within the historic built environment.

From this perspective, addressing the issues related to sustainable and circular reuse requires the adoption of an integrated systemic approach. Such an approach should consider both the territorial context and the individual buildings as interconnected elements of a single complex system. Moreover, it enables the compensation or integration of operational limitations affecting specific buildings through opportunities and intervention potentials identifiable at broader territorial and settlement scales.

Within this interpretative framework, the comprehensive assessment and qualification of the environmental, contextual, architectural, constructional, and performance-related characteristics of the built heritage becomes a key objective. The aim is to define a balanced operational framework capable of ensuring the conservation of original material and formal values, the enhancement of both existing and potential relationships between the built environment and its surrounding context, and the technically compatible improvement of the actual performance of historical construction systems.

The specific gap addressed by this paper is therefore methodological: the lack of a clear multiscale framework for sup-porting circular regeneration in historic villages and rural territories, where technical choices on materials and technologies must be coordinated with wider territorial scenarios, governance processes and community priorities. Existing studies provide useful concepts and assessment tools, but they do not sufficiently clarify how these components can be combined into a decision-support sequence applicable to low-density and heritage-sensitive contexts.

The aim of the paper is to define a simplified but structured theoretical-methodological framework for the circular regeneration of historic villages, cultural landscapes and rural territories. The expected output is not an empirical validation, but the formalization of a transferable decision-support frame-work that identifies phases, actors, data categories, evaluation domains and possible outputs. The framework operates at multiple scales, from the building and open-space scale to the village, landscape

and territorial network scale, and is intended to support the co-definition and comparison of regeneration scenarios.

3 The Methodology for the Circular Regeneration of Historic Villages, Cultural Landscapes and Rural Territories

The framework was constructed through a theoretical synthesis of three bodies of literature: circular adaptive reuse and heritage conservation; rural and inner-area regeneration; and evaluation, indicators and multicriteria decision-support approaches. These strands were compared in order to identify recurrent analytical dimensions, actor groups, decision points and expected outputs. The four methodological phases there-fore derive from a structured conceptual integration rather than from a single case-study application. This makes the pa-per primarily methodological and theoretical, while future empirical testing will be required to validate and refine the framework (Fig. 1).

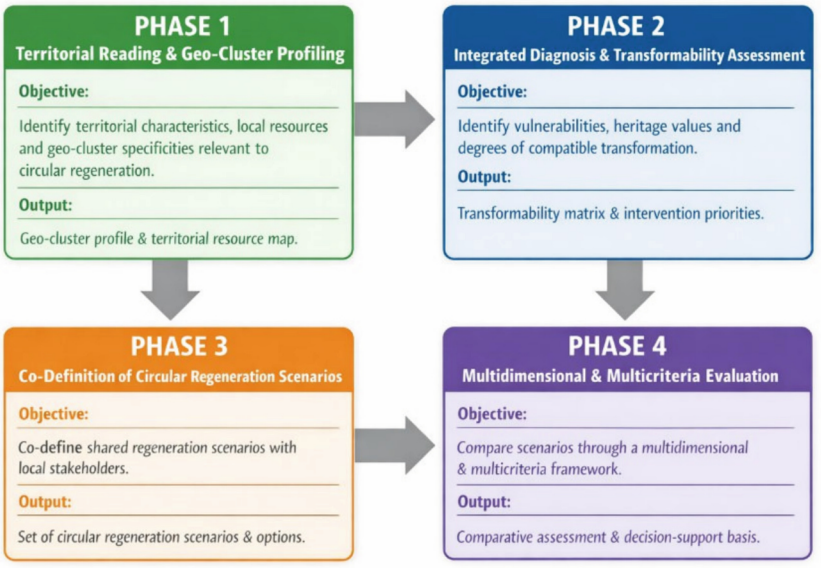

Fig. 1. Methodology for the Circular Regeneration of Historic Villages, Cultural Landscapes and Rural Territories

Phase 1 - Territorial reading and geo-cluster profiling focuses on the construction of a territorial profile of the village or network of villages.

The analysis includes environmental and climatic conditions, landscape structure, settlement morphology, recurrent building types, local materials, available energy resources, underused heritage assets, accessibility, services and socio-economic net-works. The concept of geo-cluster is used to identify relatively homogeneous areas sharing environmental, constructive and socio-cultural characteristics (Sesana M.M. et al., 2015; Lombardo G. et al., 2015; De Fino M., et al. 2017).

This phase is essential because circular regeneration depends on the recognition of territorial invariants and local potentials: reusable building stock, local supply chains, renewable energy sources, ecological assets, and community capacities. In line with the literature on rural circularity, the purpose is to move from a purely building-based reading toward a territorial under-standing of resource flows and development opportunities (Alonso et al., 2024). The output of this phase is to generate a geo-cluster profile and territorial resource map (Fig. 1).

The Phase 2 — Integrated diagnosis and transformability assessment focuses on the diagnosis of the historic building stock and the village system. It includes the assessment of conservation conditions, construction pathologies, energy weaknesses, environmental vulnerabilities, functional obsolescence and reuse potential. At the same time, it identifies the cultural and landscape values that must be preserved and the degrees of compatible transformability.

A key aspect of this phase is that performance is not limited to operational energy efficiency. Instead, it includes resilience, adaptability, maintenance capacity, landscape compatibility and contribution to territorial cohesion. This broader notion is consistent with circular adaptive reuse approaches, which stress that heritage interventions should be assessed through multiple dimensions rather than through energy criteria alone (Gravagnuolo et al., 2018). The Output is to develop a trans-formability matrix, critical issues and intervention priorities (Fig. 1).

Phase 3 - Co-definition of circular regeneration scenarios is based on an explicitly participatory approach. It involves local administrations, residents, associations, technical experts, economic actors and third-sector organizations in the co-definition of regeneration scenarios. In this sense, the method-ology aligns with the emphasis on co-design, co-programming and co-evaluation, as well as with the RURITAGE experience of com-munity-based heritage management (De Luca et al., 2021).

The scenarios may include adaptive reuse of historic buildings, regeneration of public spaces, strengthening of local circular production chains, renewable energy communities, eco-logical restoration, soil regeneration, mobility improvements and service innovation. Within each scenario, the choice of materials and technologies is framed not only by technical performance, but also by compatibility with historic fabric, reversibility, durability, maintainability, use of local or recycled resources and contribution to territorial circularity. The Output of this phase is to develop a set of shared circular regeneration scenarios and related material and technological options (Fig. 1).

Phase 4 - Multidimensional and multicriteria evaluation represents the core of the methodology. Evaluation is conceived as a continuous process supporting decision-making

before, during and after implementation. The assessment framework is built around five domains:

- heritage and landscape quality;
- environmental and energy performance;
- circularity of resources and processes;
- socio-economic and community impacts;
- territorial and governance effects.

This structure is consistent with the literature on circular adaptive reuse and with cur-rent research on indicator systems for cities and regions. In the proposed framework, indicators and KPIs are not intended as purely technical metrics, but as tools for comparing scenarios, clarifying trade-offs and supporting shared decisions (Gravagnuolo et al., 2018). The output of this phase is to develop a comparative evaluation of scenarios and decision-support basis for the selection of priority interventions (Fig. 1).

Taken together, the four phases define an operational sequence in which territorial knowledge, diagnosis, participatory scenario-building and evaluation interact progressively to support regeneration choices across scales.

In operational terms, each phase is associated with a specific decision-support function: Phase 1 builds the knowledge base through territorial data and geo-cluster profiles; Phase 2 identifies constraints, values and degrees of transformability; Phase 3 translates diagnosis into shared regeneration scenarios; and Phase 4 compares these scenarios through multidimensional indicators and KPIs. This sequence is intended to make the framework usable both for research-oriented assessment and for preliminary planning processes involving public ad-ministrations, technical experts and local communities.

For these reasons, the framework should not be interpreted as a fixed protocol, but as a flexible decision-support structure that can be adapted to different territorial conditions. Future applications should test the methodology in diverse heritage-sensitive rural contexts, compare alternative indicator systems and integrate formal multicriteria and life-cycle-based tools. Such empirical testing will be necessary to verify the robustness of the framework and to assess its capacity to support implementation-oriented regeneration strategies.

At the same time, the framework has some limitations. First, it remains a theoretical and methodological proposal and has not yet been validated through a real case study. Second, the indicators and KPIs are defined at the level of evaluation do-mains and categories, but they require further specification according to local data availability, policy priorities and stakeholder needs. Third, the transferability of the framework depends on institutional capacity, quality of territorial data, and the effective involvement of local actors in participatory processes.

The proposed framework has potential applicability in historic villages, rural municipalities, cultural landscapes and networks of small settlements where regeneration requires the coordination of conservation, circular resource management, service provision and local governance. Its main added value lies in treating evaluation as a strategic and iterative process, capable of supporting the formulation, comparison and adjustment of regeneration scenarios rather than merely measuring final impacts.

4 Discussion

In this sense, the outcome of the research is not a single de-sign solution, but a structured methodological device that clarifies how circular regeneration can be framed, discussed and evaluated across scales. The framework makes explicit the connection between building-level actions and wider territorial regeneration processes, thereby addressing the ambiguity be-tween adaptive reuse and territorial development by treating them as complementary components of the same circular re-generation process.

The framework also identifies the main data categories re-quired for implementation: spatial and environmental data, building and conservation data, socio-economic data, governance and stakeholder data, and performance indicators. These data categories support a decision logic based on progressive refinement: from territorial profiling, to diagnosis, to scenario construction, and finally to the evaluation and prioritization of interventions.

The result can be summarized through five core dimensions. The first is the territorial dimension, which includes settlement morphology, cultural landscape structure, ecological infra-structures, accessibility, services and socio-economic net-works. The second is the heritage and building-stock dimension, which includes conservation conditions, construction systems, material compatibility, adaptive reuse potential and degrees of transformability. The third is the circularity dimension, which concerns local resources, material flows, energy opportunities, reversibility, durability, maintenance and the use of local or recycled materials. The fourth is the social and governance dimension, which includes residents, local administrations, associations, economic actors, technical experts and third-sector organizations. The fifth is the evaluation dimension, which translates these elements into indicators, KPIs and multicriteria comparison criteria.

As a theoretical and methodological paper, the main research result is the formalization of a multiscale decision-support framework for the circular regeneration of historic villages, cultural landscapes and rural territories. The framework is organized as a sequence of four interconnected phases that trans-form territorial knowledge into shared regeneration scenarios and comparative evaluation outputs.

5 Conclusion

This paper has proposed a multiscale methodology for the circular regeneration of historic villages, cultural landscapes and rural territories. The framework clarifies regeneration as an integrated territorial process in which adaptive reuse of historic buildings, conservation of cultural landscapes, local circular economies, ecological transition and community governance are considered interdependent components.

The contribution of the paper is mainly theoretical and methodological. Its main result is the formalization of a decision-support framework that connects territorial reading, integrated diagnosis, participatory scenario-building and multidimensional evaluation. In doing so, the paper addresses the gap between building-centred adaptive reuse approaches and broader territorial regeneration strategies.

The proposed framework may support researchers, planners and local administrations in structuring early-stage regeneration processes, identifying relevant data categories, involving actor groups and comparing alternative scenarios. However, its generalization requires caution. The framework must be adapted to local contexts, data availability and governance conditions, and should be tested through empirical applications in different rural and heritage-sensitive settings.

Future developments should therefore include the application of the methodology to case studies, the construction of con-text-sensitive indicator systems and the integration of formal multicriteria methods and life-cycle-based tools. These steps will be necessary to verify the operational effectiveness, transferability and limitations of the framework.

This paper has proposed a multiscale methodology for the circular regeneration of historic villages, cultural landscapes and rural territories. The framework treats evaluation as an on-going decision-support process for regeneration strategies rather than as a final analytical exercise.

The proposed methodology contributes to current research in three main ways. First, it translates circular city and circular region principles into heritage-sensitive rural contexts. Second, it connects building rehabilitation with territorial development, community participation and local circular economies. Third, it structures evaluation as a multidimensional and multicriteria process capable of supporting decision-making across scales.

Its relevance is therefore threefold: for research, because it addresses the gap between heritage conservation and circular territorial development; for design, because it supports the se-lection of compatible materials, technologies and scenarios; and for policy, because it offers a framework that can strengthen governance and align local regeneration with shared eco-logical and community goals.

Future developments should include the application of the methodology to case studies, the construction of context-sensitive indicator systems and the integration with formal multicriteria methods and life-cycle-based tools. At the same time, further testing will be necessary to verify the transferability of the framework across different heritage and rural con-texts.

In this perspective, the regeneration of historic villages can be understood not as sum of isolated building interventions, but as a coordinated territorial process in which heritage, land-scape, community and circular resource management are mutually reinforcing.

At the same time, future developments of the research will include the application of the proposed framework to a real case study within an ongoing national research project. In particular, the methodology will be tested in the context of the project "Italian historic regeneration through circular ecological heritage communities", funded by the Italian Ministry of University and Research (MUR) under the Projects of Relevant National Interest—National Recovery and Resilience Plan (PRIN PNRR). This application will allow for the verification of the operational effectiveness of the framework and its adaptability to different heritage-sensitive rural contexts.

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