論 文 の 内 容 の 要 旨

論文題目　Interpretation Patterns on the Design Integration of Local Ecosystem Services in Architectural Projects
（現代建築における敷地周辺の生態系サービスと建築物の統合パターンに関する研究）

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1. Object & Research Question(s)

In architectural design, Ecosystem Integration can be defined as the promotion of, and the collaboration with local ecological services and functions, through architectural projects. The concept of Ecosystem Integration implies a mutual cooperation between architecture design solutions and the site's natural elements, presenting an opportunity to increase both the quality of the built system and the local environment. While in the fields of urban planning and landscape design, comprising regional and macro scale projects, diverse methodologies and guidelines have been advanced towards the promotion and collaboration with natural systems, at the smaller scale of architecture projects, questions about application and evaluation methods and criteria remain essentially unanswered, requiring further research development. In order to provide more sustained design assistance and project guidance for ecosystem integration, the research aims to contribute to the field with insights on the development of a design assistance support method and criteria, to *reinforce and improve local ecosystem services integration in architectural design projects*.

Considering the importance of local provision and restoration of ecosystem services through architecture projects, particularly in urban areas, to increase community resilience and health of socio-ecological systems, the underlying question to the present research is: *how can the integration of local ecosystem services be improved at the scale of architecture?*

The evaluation of the integration of local ecosystem services in architectural projects unravels in two different but complementary analysis perspectives: 1) *Environmental Assessment* (with predominance of Quantitative Analysis), focusing on the benefits of ecosystem services and functions promotion, measured through objective indicators – that can be expressed in absolute values, or relative to plot size, resource use or previous state; and 2) *Design Integration* (with predominance of Qualitative Analysis), and focusing on the mutual relational effects between ecosystem services and functions with architectural quality criteria - not strictly measurable through objective indicators but mostly by qualitative interpretations.

Focusing on the questions of Design Integration, the present research suggests an assessment methodology [or *observational lens*], that is aimed to be used as a tool for thinking, to identify opportunities and provide project guidance, and evaluate different possible solutions, within a specific project, within a site. This proposed structured approach, for evaluation of design integration with local ecology is developed, in correspondence with other accepted benchmark methodologies, as the Millennium Ecosystem Assessment, based on the concept of ecosystem services [the tangible and intangible benefits from nature human beings depend for their existence and wellbeing], and it is thus designated as Ti[l]es (Tool for Integration of Local Ecosystem Services).

The idea encapsulated in this framework is that design integration could be represented visually, and interpreted through the number, diversity and range of these collaborative interactions between local ecosystem services and functions and architectural quality parameters. Within the proposed concept of Ecosystem Design Integration, our working hypothesis associates these collaborative interactions to more resilient ecological built systems, and the improvement of the project, both in terms of architecture and local ecology.

As such, the initial question is disaggregated into two complementing research interrogations: 1) *How collaborative interactions between local ecosystem services and architecture quality parameters are contemporarily perceived, interpreted, and attempted?* and 2) *How the proposed framework may contribute to its understanding and strengthened implementation?*

The research aims therefore to identify how the Design Integration of local Ecosystem Services has been and is presently referred and represented in contemporary architecture projects, focusing on the time period between 1990 and 2014 – following the dissemination of environmental assessment methodologies and the ongoing paradigm shift from mitigation to neutralization and into regeneration. Simultaneously, it attempts to clarify in what ways the Integration of ecosystem services might be perceived and interpreted by design teams (including architects and environmental consultants), and explores the potentialities and limits of the application of the Ti[l]es framework [and the parameters within it] to specific project targets and by multiple users.

2. Methods

The followed research methodology entails qualitative and quantitative methods, with a structured approach and diverse interdisciplinary processes of inquiry, including case study and documental analysis, interviews and surveys, and direct observation onsite. In order to investigate the application of the proposed design integration framework, the employed methodology, based on data triangulation, is unfolded in three stages: 1) the constitution of a reference database – multiple project analysis, 2) the application of the framework to specific case study targets –single project analysis, and 3) the application of the framework by multiple users with different qualitative perception – multiple user analysis. The thesis examines 240 general reference study cases, including projects and systems within international background, from which 162 are contemporary building projects. With an insight to architectural building projects situated within Japanese context, these general referenced cases comprise 60 collaborative interactions samples in Japan, from which 3 specific case study targets are selected for experimental application of the Ti[l]es framework. The data obtained with these

observations is then complemented and confronted with qualitative data surveys to an inquired panel of 30 design professionals and stakeholders, from where interpretation patterns on the design integration of local ecosystem services in architectural projects are finally derived.

3. Structure and Findings

The structure of the dissertation is organized into 4 parts: Part 1 – Ecosystem Integration in Architecture {CONTEXT}, Part 2 – Research Design Methodology {METHODS}, Part 3 – Collaborative Interactions {RESULTS}, and Part 4 – Interpretation Patterns {DISCUSSION and CONCLUSIONS}.

The present research builds up on critical background review, of theoretical, historical and methodological sources, from where it derives the *Context* of this dissertation. On Chapter 1, the constellation of terms and knowledge fields that concur to form the concept of ecosystem integration operated within the thesis are clarified, entailing the interpretation of several associated notions in the fields of Ecology and Architecture, including: Ecosystem Services and Functions, Design Integration, and Environmental and Architecture Quality Indicators.

In Chapter 2, it is analyzed how diverse forms of ecological collaborative approaches have been addressed in the course of art, architecture and broader social contexts. Focusing on the convergence to the integration of local ecosystem services within architectural practice, it is observed through a thematic organization of authors, how it might follow a rise, consolidation and finally the transition signs of a shift of environmental architecture towards regenerative design during the 20th century. An insight to the context of Japan is also provided, though a brief discussion of local key environmental issues, approaches to architecture, culture and ecology, and procedures towards ecosystem services and biodiversity conservation. The period from 1990 to 2014, covered by the present research, is characterized by the launch and generalization of building environmental assessment methodologies, and an ongoing theoretical transition from environmental mitigation benchmarks to neutralization, and lastly, into regeneration, particularly noticeable within the U.S. and U.K.

An overview of existing design assistance methods and potential resources for the application of ecosystem integration in architectural design is provided on Chapter 3. The significance of the integration of local ecosystem services is emphasized within urban systems, where ecological disturbance factors may be interpreted as regeneration priority areas to orient the focus of collaborative design. Existing methodological processes employed by relevant ecological approaches towards site restoration and local ecology integration, both used in landscape and architecture design, are also examined. Finally, a discussion and comparative analysis on commonly and prospective tools and indicators for assistance and assessment of environmental architecture and design, unveils its non-uniform character in addressing factors related to local ecology, and the difficulty of embracing qualitative appreciation within them, although it is noted an increasing tendency among many of them to provide visualization outputs that highlight its role as interpretation and thinking support.

The development of the research design methodology employed within the present thesis is explained in *Methods*. Addressing the underlying objective to *potentiate a collaborative integration of local ecosystems in architectural design*, Chapter 4 explains the general adopted methodological approach of the dissertation and explains the development of the analysis framework designated by Ti[l]es (Tool for Integration of Local Ecosystem Services). The objective of the proposed methodological framework is to clarify, identify, and interpret the reciprocal relations between architectural design and local ecology aspects. The method is projected as a potential design assistance tool, providing project guidance, identifying opportunities and evaluating different possible solutions, being based on a multi-criteria matrix diagram, or correlation framework, that references ecosystem services and architecture design quality parameters. In order to investigate the application of the Ti[l]es framework, the research design methodology comprises three methodological steps, described in Chapter 5: 1) the constitution of a reference database [multiple project analysis], 2) the application of the framework to specific case study targets [single project analysis], and 3) a qualitative data validation through the application of the framework [by multiple user analysis].

On the third part of the thesis, are presented the obtained *Results* within these analysis. In Chapter 6, the identification of collaborative interactions in multiple project reference database provides criteria and background for subsequent analysis of single specific projects and application of the tool. Chapter 7 observes the design integration within landscape and envelope surfaces of local ecosystem services and functions in specific individual projects, comparing the results obtained *inter se*, with the cumulative results of reference database, and with local ecology assessment parameters. Chapter 8 complements the precedent analysis, observing multiple user qualitative variations, and consistency verification in the use of the Ti[l]es framework, through interviews and surveys targeted to design teams and architecture field related professionals.

The possible causes and implications of the results are object of *Discussion* at the light of previously introduced topics. In Chapter 9, the inferences obtained from the 3 complimentary analysis stages, and the overall combined assumptions resultant from them, as well as the attempts to encapsulate suggestions for integration criteria and guidelines result in the subsequent *Conclusions*. The unveiled Interpretation Patterns on the Design Integration of Local Ecosystem Services indicate that to reinforce and improve local ecology integration in architectural design projects, broadly and transversally, a true necessity lies on the provision of ecological literacy instruments and on the adjustment of the mental framework of its agents.

While the design integration of local ecosystem services in architectural projects, - for its focus and reinforcement on local resources - is a promising mean to reinforce local community resilience and hazard protection in urban areas, contributing to establish positive economic synergies, the change that it proposes into architectural design is also exciting, as the attempts observed within contemporary architectural projects seem to indicate. As such, the scientific development of design assistance resources, as the proposed Ti[l]es framework, combining decision making and information functions, may contribute in the future to a full ecosystem integration, which for now is still an open possibility.