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Eco-Reurbanization and Regenerative Design in Arid Climate Conditions: Transformation of the Architectural Environment of Uzbekistan

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Abstract: This article explores the concept of eco-reurbanization as a tool for adapting the urban environment of Uzbekistan to the challenges of climate change and rapid urbanization. Against the backdrop of increasing building density in megacities such as Tashkent, a decline in air quality and a reduction of green areas are being observed. The study substantiates a transition from harm-minimization strategies to regenerative design, in which architecture functions as a "living ecosystem" that replenishes natural resources.

Keywords: Eco-Reurbanization, Regenerative Design, Blue-Green Infrastructure, Arid Climate, Tashkent, Sustainable Architecture, Living Systems.

1. Introduction

Modern megacities of Uzbekistan are facing a complex set of challenges, including increasing building density, deteriorating air quality, and a shortage of recreational spaces. Under the conditions of global warming, the arid regions of Central Asia are exposed to extreme thermal stress, which makes traditional construction methods insufficiently effective. The relevance of this study is determined by the need to implement eco-reurbanization strategies — a comprehensive approach that integrates environmental principles into all aspects of urban renewal [1], [2], [3].

The problem addressed in this research lies in the absence of a unified methodological framework that combines the requirements of energy efficiency with the need to preserve biodiversity within the urban fabric. The aim of the study is to adapt the principles of regenerative design to the climatic characteristics of Uzbekistan in order to create a sustainable and healthy urban environment.

Literature Review and Theoretical Framework

The theoretical foundation of this study is based on the theory of living systems, which interprets life as a network of interconnected processes. According to F. Capra, the sustainability of any system is ensured through interdependence, partnership, and diversity [4], [5], [6], [7]. In architecture, this implies that a building should not function as a static object, but rather as a catalyst for positive transformations within its surrounding environment.

For Uzbekistan, the development of the concept of eco-reurbanization is of critical importance [8]. This concept has been developed, among other institutions, at the Tashkent University of Architecture and Civil Engineering. It views the city as an interconnected ecosystem in which the rational flow of energy and materials ensures the long-term resilience of urban systems. Particular significance is attached to the experience of applying biophilic design and the "smart" integration of natural elements into architecture.

2. Methodology

This research is based on a qualitative methodology that combines literature review, comparative analysis, and case study methods. Scientific publications on eco-reurbanization, regenerative design, ecological urbanism, and sustainable architecture were analyzed to establish the theoretical framework of the study.

A comparative assessment of international practices from Singapore, Copenhagen, and other successful regenerative urban projects was conducted to identify approaches applicable to Uzbekistan’s arid climate conditions. The study also applied the EURA (Ecological Urbanism Rapid Assessment) framework, which evaluates ecological functionality, anthropocentric functionality, and architectural form.

The obtained results were synthesized to determine effective strategies for integrating blue-green infrastructure, passive design solutions, biomimicry, and adaptive reuse into the architectural environment of Uzbekistan.

3. Results and Discussion

The research is based on the EURA (Ecological Urbanism Rapid Assessment) methodology, which includes assessment according to three vectors:

- Ecological Functionality (EFx): soil quality, conservation of water resources, and biodiversity preservation.
- Anthropocentric Functionality (AFx): stormwater management, public health, accessibility, and social equity.
- Anthropocentric Form (AFm): aesthetic and compositional qualities (line, color, texture) that contribute to the social adaptation of the architectural object.

The study also employs a comparative analysis of international experience (Singapore, Copenhagen) and its applicability within hot and arid climatic conditions [9], [10], [11].

The study revealed that, in the climatic conditions of Uzbekistan, the potential of architecture as a regenerative agent can be realized through the following models:

“Blue-Green Framework”: the integration of water elements (aryks, fountains) and vertical landscaping. This approach not only improves the microclimate by creating naturally cooled zones, but also supports biodiversity within urban areas.

Passive Design: the orientation of buildings to maximize the use of natural daylight and ensure cross ventilation, which is essential for reducing energy consumption during the summer season.

Biomimicry: the application of organizational principles found in natural systems. For example, the use of a ventilation system analogous to termite mounds (as demonstrated in the Eastgate Centre case study) makes it possible to significantly reduce air-conditioning costs without compromising comfort [12], [13].

Adaptive Reuse: the repurposing of existing buildings instead of demolition, which decreases construction waste and preserves the cultural identity of a place.

The distinction between the regenerative approach and the merely sustainable approach lies in the scale of intervention: architecture should not simply “cause less harm,” but should actively restore resources. In Uzbekistan, this may be expressed through the creation of buildings capable of capturing carbon or purifying water for reuse in irrigation systems.

However, the implementation of such projects faces legal and economic barriers. The industrial heritage of Tashkent is often perceived as a depressed urban zone, although it possesses significant potential for transformation into creative clusters and eco-parks. The experience of renovating industrial areas (as exemplified by the “1732” cluster project) demonstrates that the long-term ecological and economic benefits exceed the short-term costs associated with environmental remediation.

Rethinking the role of architecture in Uzbekistan requires a transition toward the model of the "city as an ecosystem." The main conclusions of the study are as follows:

The integration of water and greenery is an essential condition for the climatic adaptation of cities in the region.

Eco-reurbanization should become a priority strategy in the reconstruction of densely built-up districts of Tashkent and other major cities.

It is necessary to introduce rapid ecological assessment tools (EURA) into architectural and urban design practice in order to monitor the regenerative contribution of architectural objects [14], [15].

Further research should focus on the creation of a local database of industrial heritage sites suitable for eco-renovation, as well as on the development of digital models for assessing the microclimatic impact of new architectural projects.

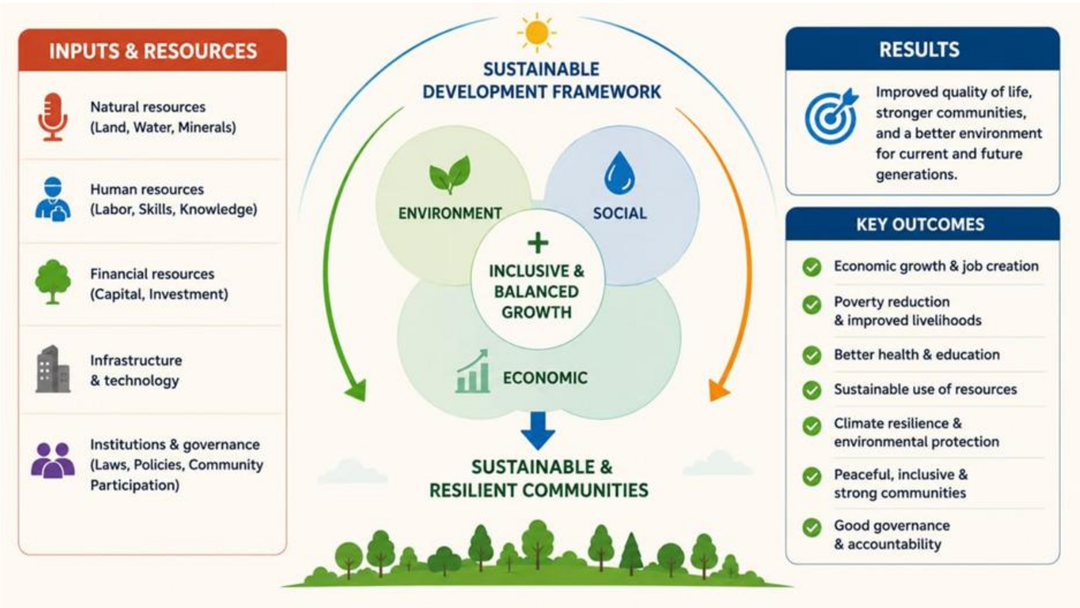

Figure 1. Sustainable Development Framework and Key Outcomes.

Figure 2. Main Directions.

This diagram presents four key directions of sustainable urban development: environmental system improvement, water resource management, social and spatial integration, and architectural transformation. Each direction focuses on enhancing ecological balance, efficient resource use, social well-being, and energy-efficient urban design.

Figure 3. Regeneration of Industrial Areas.

Key Features:

- Environmental cleanup of polluted sites
- Adaptive reuse of industrial buildings
- Creation of technology and community hubs
- Development of innovation clusters

Benefits:

Promotes economic growth, creates jobs, and provides new opportunities for local communities.

Figure 4. Climate-Adaptive Historic Reconstruction.

Key Features:

- Use of traditional passive design methods
- Seismic strengthening of buildings
- Integration of modern technologies with heritage structures
- Preservation of cultural identity

Benefits:

Enhances climate resilience, protects cultural heritage, supports sustainable tourism, and improves the long-term sustainability of historic cities.

4. Conclusion

The study demonstrates that eco-reurbanization and regenerative design provide effective approaches for addressing the environmental and urban challenges of Uzbekistan's arid climate regions. The integration of blue-green infrastructure, passive design strategies, biomimicry, and adaptive reuse can significantly improve urban resilience, environmental quality, and resource efficiency. Unlike conventional sustainable architecture, regenerative design actively contributes to the restoration of ecosystems and the enhancement of biodiversity within urban environments.

The findings indicate that the successful transformation of Uzbekistan's architectural environment requires a shift toward ecosystem-based urban development, where buildings function as active components of ecological systems. Furthermore, the implementation of ecological assessment frameworks such as EURA can support evidence-based planning and monitoring of regenerative outcomes. Despite existing economic and regulatory challenges, eco-reurbanization offers substantial long-term environmental, social, and economic benefits. Therefore, the adoption of regenerative design principles should become a strategic priority for future urban development and architectural practice in Uzbekistan.

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