Journal Homepage: -www.journalijar.com

INTERNATIONAL JOURNAL OF ADVANCED RESEARCH (IJAR)

Article DOI:10.21474/IJAR01/22748
DOI URL: http://dx.doi.org/10.21474/IJAR01/22748

ISSN (O): 2320-5407
ISSN (P): 3107-4928

RESEARCH ARTICLE

BIOTOPE FRAGMENTATION AND ECOLOGICAL UNDERPERFORMANCE IN THE QUEZON CITY MEDICAL CLUSTER: A BIOTOPE-BASED ASSESSMENT FOR DESIGNING AN ECOLOGICAL NETWORK FROM THE QUEZON INSTITUTE TO THE LUNG CENTER OF THE PHILIPPINES

Danielle Majella C. Milanes, Nappy L. Navarra and Jaclyn Alexandra Marie B. Bello

Manuscript Info

Manuscript History
Received: 8 December 2025
Final Accepted: 10 January 2026
Published: February 2026

Key words:
medical cluster, patch-corridor-matrix, fragmentation, ecological network, Quezon City

Abstract

Urban ecological fragmentation threatens biodiversity and ecosystem service delivery in dense metropolitan environments.This study conduc ts a comprehensive biotope-based ecological assessment of the Quezon City Medical Cluster—a critical institutional corridor spanning the Quezon Institute to the Lung Center of the Philippines.Through hierarc hical spatial mapping,biotope delineation,quantitative ecological evalua tion,and prescriptive landscape planning,the study confirms severe habi tat fragmentation,low structural complexity, and widespread ecological underperformance.Sixty two biotopes were identified,most characterize d by young vegetation, simplified structure, and functional isolation due to impervious institutional and commercial land uses. The findings inform the development of a district wide ecological network composed of green corridors and stepping-stone biotopes, supported by a detailed management plan encompassing Creative, Connective, Integrative,and Protective strategies.The study concludes that restoring ecological flow, increasing habitat complexity,and embedding nature-based systems within the medical landscape are essential for achieving climate resilien ce, enhanced biodiversity, and improved environmental health within this critical healthcare district.

Introduction:

Background of the Study:

Rapid urbanization and infrastructural densification have accelerated ecological fragmentation in cities worldwide, weakening habitat continuity and diminishing the capacity of urban areas to sustain biodiversity (Beninde et al., 2015; McKinney, 2008). Metro Manila, one of the most densely populated megacities exemplifies this condition. Within Quezon City, the historic medical cluster spanning the Quezon Institute (QI) precinct to the Lung Center of the Philippines (LCP) retains some of the city's remaining institutional green pockets. These spaces include remnant tree stands, lawn expanses, and scattered open lots that function as micro-habitats within a heavily built-up matrix. Despite their ecological potential, these habitats exist as fragmented units separated by major arterial roads, high-traffic corridors, parking expanses, and extensive building footprints. International research shows that fragmentation not only reduces biodiversity but also limits ecosystem services such as microclimate regulation, stormwater infiltration, and psychological restoration, services critically needed in health districts (Yu & Hien,

Corresponding Author:-Danielle Majella C. Milanes

2006). However, the Philippines lacks biotope-based planning frameworks, unlike European cities such as Berlin and Zurich, where biotope mapping is foundational to ecological planning (Senate Department for Urban Development Berlin, 2014). The absence of ecological network planning in the medical cluster of QC has resulted in missed opportunities to enhance environmental quality, mitigate heat stress, and support the wellbeing of patients and healthcare workers. This study addresses this gap through a biotope-centered ecological assessment aimed at understanding fragmentation patterns and designing a functional ecological network for the district.

Problem Statement:
Although the medical cluster of Quezon City contains multiple vegetated pockets and institutional landscapes, these biotopes are fragmented, poorly connected, ecologically underperforming, and insufficiently integrated into a district-wide green system.

Specifically:
1. Biotope fragmentation across the district leads to isolated patches with limited ecological value.
2. Lack of habitat connectivity between medical institutions prevents species movement and reduces ecosystem service provision.
3. Urban heat stress, high imperviousness, and limited canopy cover diminish the district's ability to support ecological health and climate resilience.
4. No existing biotope-based ecological network or planning framework guides the district's landscape development.
5. There is no empirical assessment linking ecological underperformance to spatial patterns of fragmentation within the QCMC.

Thus, the central research problem is: How can a biotope-based ecological assessment reveal patterns of fragmentation and underperformance within the Quezon City Medical Cluster, and how can these findings inform the design of an ecological network connecting QI and LCP?

Significance of the Study:
This study is necessary for four major reasons:

Ecological Risk and Climate Vulnerability:
Quezon City is a heat-vulnerable district with rising temperatures, high traffic emissions, and significant tree loss. A fragmented ecological system worsens heat accumulation and reduces air quality, which is critical for a district hosting national specialty hospitals.

The Absence of a Biotope-Based Framework in Philippine Urban Planning:
While European cities (e.g., Berlin, Zurich) systematically use biotope mapping to guide land-use and ecological planning, Philippine cities rely mainly on land-use and zoning categories that do not capture ecological processes. This results in overlooked habitat resources and uninformed landscape decisions.

The Need for an Ecological Network Within a Medical District:
Medical landscapes perform essential psychological and physiological functions for patients, healthcare workers, and communities (Ulrich, 1984; Marcus & Sachs, 2014). Integrating ecological corridors can enhance restorative environments and reduce health stressors in a district meant to promote wellness.

Contribution to Quezon City's Green Lung Vision:
Quezon City's environmental programs call for the establishment of green corridors and climate-adapted districts. Yet, the medical cluster's ecological role remains unassessed. This study provides the scientific basis for linking the district to the citywide Green Lung Network.

Scope and Delimitations:
This study focuses on the biotope classification, ecological performance assessment, and landscape metrics analysis of the medical cluster of Quezon City, with the primary goal of formulating an ecological network design that links the Quezon Institute to the Lung Center of the Philippines. Its scope is limited to evaluating the ecological, spatial, and environmental dimensions of the district, explicitly excluding clinical, institutional, or medical operational concerns. The assessment is based solely on visible and measurable green structures identified through GIS

analyses, remote sensing data, and on-ground visual surveys, emphasizing physical habitat qualities rather than socio-institutional factors. Furthermore, while the study examines habitat potential and ecological suitability of identified biotopes, it does not conduct full-scale biodiversity inventories; instead, wildlife considerations are restricted to inferred habitat capacity rather than detailed species-level documentation. This delimitation ensures that the study remains centered on spatial-ecological performance and the design implications of fragmentation patterns within the medical cluster.

Methodology:

Hierarchical Spatial Mapping and Biotope Delineation:
This initial phase focuses on establishing a high-resolution, integrated spatial baseline by compiling and synthesizing fundamental environmental and land-use data. The goal is the systematic delineation of distinct ecological units for subsequent analysis.

A1. Topographical and Physical Baseline Mapping:
Before analyzing the living features, the core non-living (abiotic) elements of the landscape are mapped to understand physical constraints and opportunities.

These maps include:
Slope and Landform Map:
This critical layer, derived from digital elevation models (DEMs), delineates the topography of the study area, classifying zones by degree of slope (e.g., flat, gently sloping). Understanding slope is vital for assessing runoff velocity, soil erosion risk, and determining the appropriate placement and engineering requirements for green infrastructure such as rain gardens and bioswales. The Landform component identifies broad geomorphological units that influence drainage and development patterns.

Watershed Map:
This defines the hydrological context, showing surface runoff paths and drainage catchment areas. It dictates where water management and infiltration strategies are most ecologically effective.

Soil Map:
This layer specifies the underlying pedological structure, confirming the prevalence of Novaliches Clay Loam Adobe soil. This knowledge is essential for plant selection and for calculating the soil's capacity for water retention and nutrient cycling.

A2. Land Use and Biotope Inventory Mapping:
Before analyzing the living features, the core non-living (abiotic) elements of the landscape are mapped to understand physical constraints and opportunities.

These maps include:
Land Cover Map:
This detailed layer systematically categorizes the entire district into its primary surface uses (Residential, Commercial, Institutional) and precisely delineates the extent and location of existing Green Patch areas, which serve as the raw material for the ecological network.

Biotope Map (Baseline Output):
This map is the final output of the initial phase, created through spatial overlay analysis of all compiled data (Topography, Watershed, Soil, and Land Cover). It delineates every discrete, homogeneous ecological unit (biotope), providing the essential spatial inventory and boundaries for all subsequent quantitative analysis.

Quantitative Biotope Evaluation using the Assessment Matrix:
The methodology then shifts to a rigorous data-driven assessment, applying a structured Assessment Matrix to evaluate the ecological quality and performance of each unit delineated on the Biotope Map. The resulting scores justify the need for intervention.

B1. Assessment Matrix and Indicators:
Each biotope is scored across four weighted indicators to quantify its functional value:
Area (A):
Quantified by size classification (e.g., 1-3 ha., 3-10 ha.), acknowledging that larger biotope size correlates with greater ecological stability and reduced negative edge effects.

Period of Development (D):
Assesses the ecological age (e.g., 1-2 years, 5-10 years), highlighting the critical finding of widespread young or mid-aged biotopes, which exhibit low successional complexity and reduced maturity.

Rarity (R):
Measures the ecological uniqueness by assessing the density of similar biotope types within a predefined radial buffer (e.g., 2 km or 5 km). High rarity scores flag critically isolated or unique ecological features.

Habitat Complexity (H):
The most direct measure of biodiversity support. It scores the biotope based on the vertical layering of vegetation, ranging from the lowest score (e.g., almost exclusively grass or a single uniform layer) to the highest score (three or more distinct vertical layers: groundcover, shrub, and canopy). The low complexity scores across the cluster confirm structural simplification and ecological underperformance.

Prescriptive Synthesis and Ecological Network Design Outputs:
The final methodological stage translates the quantitative deficits into actionable, spatially defined blueprints for ecological restoration and network establishment.

C1. Ecological Network Map:
This prescriptive map utilizes the assessment findings to strategically design the spatial solution to fragmentation. It proposes the placement of Green Corridors (linear linkages) and Stepping-Stone Biotopes (non-linear patch links) to bridge the distance between existing high-value biotopes, thereby facilitating ecological flow: the movement of species, energy, and genetic material to improve the overall landscape resilience.

C2.ManagementMap and Interventions:
This final output is the implementation guide, spatially assigning specific management actions based on the ecological needs identified in the assessment (e.g., low-complexity areas require Creative Management).

The mapped strategies include:
- **Creative Management:** Targeted at barren or impervious sites, focusing on the introduction of green infrastructure (e.g., rain gardens, bioswales, soil remediation) to initiate new ecological processes.
- **Connective Management:** Actions mapped to physically and functionally link isolated patches, primarily through the strategic planting of green corridors and strengthening existing stepping-stone biotopes.
- **Integrative Management:** Strategies that embed ecological function into active human-use areas, such as designing healing landscapes and green roofs within institutional grounds.
- **Protective Management:** Actions mapped onto high-value conservation zones, focusing on resource protection through the enforcement of development limits and establishing root protection zones for mature vegetation.

Results and Discussions:
The research methodology culminated in a suite of interlinked spatial outputs and a comprehensive ecological assessment, collectively forming the data-driven basis for the proposed ecological network plan. The results are detailed by the maps and analyses produced.

Foundational Input Maps:
The initial results comprised the compilation of four essential thematic maps, which defined the physical and land-use context of the study area and served as the primary input layers for the Biotope Map. The findings of these maps were crucial for establishing constraints and opportunities:

A1. The Slope and Landform Map

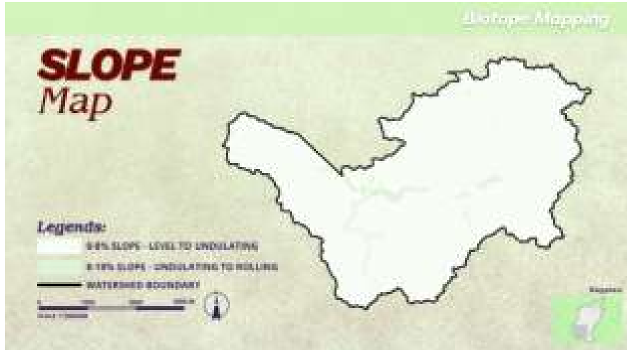

Figure 1. Slope Map

Figure 2. Landform Map

This map provided a topographical diagnosis, identifying areas with suitable gradients for development and, more critically, zones of high runoff potential. The resulting landform data influenced the placement of key infrastructure; for instance, areas identified as having a flatter slope were considered optimal for extensive planting, while steeper areas required erosion-control techniques, informing the parameters for the later Management Map.

A2. The Soil Map

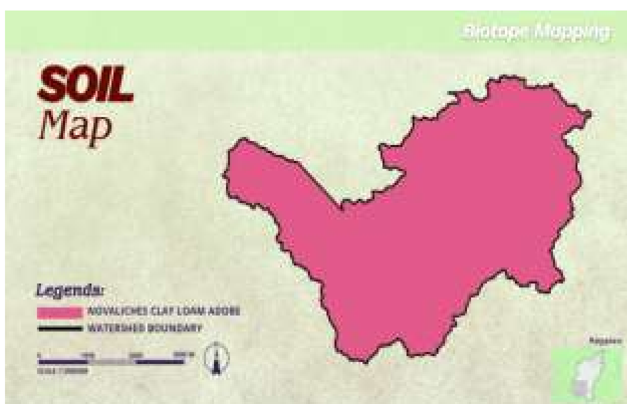

Figure 3. Soil Map

The primary finding of this map was the identification of Novaliches Clay Loam Adobe as the dominant soil type. This result has profound implications: while this soil is common in the region, its composition dictates lower permeability, which is a key contributing factor to urban runoff. Therefore, this map justified the need for permeable paving and bioswale interventions proposed in the management strategies.

A3. The Watershed Map

Figure 4. Watershed Map

The map's results delineated the specific hydrological catchment areas and flow paths within the cluster. This provided the spatial data necessary to design the "blue" component of the blue-green network, ensuring that water-management infrastructure (e.g., rain gardens) is strategically placed to intercept and filter runoff from key impervious areas.

A4. The Land Cover Map:

This map quantified the extent of the human-dominated landscape, clearly showing the overwhelming dominance of Institutional, Commercial, and Residential uses, which are synonymous with high impervious surface cover. Crucially, the map's result was the precise spatial location of all existing Green Patch areas, which, despite their fragmentation, were identified as the base ecological assets for the network design.

Figure 5. Landcover Map

B. Biotope Map:

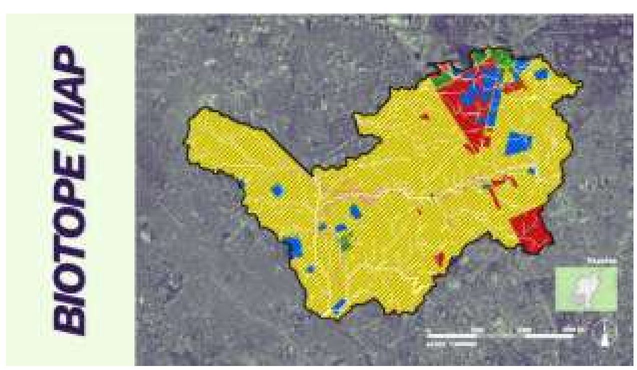

Figure 6. Biotope Map

The Biotope Map represents the central diagnostic result, produced by the spatial overlay and synthesis of the four input maps. The map's primary finding is the empirical and visual confirmation of severe habitat fragmentation. The map successfully delineated62 distinct, ecologically homogeneous biotope units. The spatial pattern of these units visually confirmed that the existing green spaces are not an integrated system but are scattered, isolated ecological islands separated by expansive, impervious road networks and institutional buildings. This result immediately established the need for the study's core objective: to design a network that mitigates this isolation.

Legend	Code	Soil type	Landform	Landcover	Biotope
	NC-F-R	Novaliches Clay Loam Adobe	Flat	Residential	Novaliches Clay Loam Adobe Flat Residential Area
	NC-F-C	Novaliches Clay Loam Adobe	Flat	Commercial	Novaliches Clay Loam Adobe Flat CommercialArea
	NC-F-I	Novaliches Clay Loam Adobe	Flat	Institutional	Novaliches Clay Loam Adobe Flat Institutional Area
	NC-F-G	Novaliches Clay Loam Adobe	Flat	Green Patch	Novaliches Clay Loam Adobe Flat Green Patch Area
	NC-U-R	Novaliches Clay Loam Adobe	Undulating	Residential	Novaliches Clay Loam Adobe Undulating Residential Area
	NC-U-C	Novaliches Clay Loam Adobe	Undulating	Commercial	Novaliches Clay Loam Adobe Undulating Commercial Area
	NC-U-I	Novaliches Clay Loam Adobe	Undulating	Institutional	Novaliches Clay Loam Adobe Undulating Institutional Area
	NC-U-G	Novaliches Clay Loam Adobe	Undulating	Green Patch	Novaliches Clay Loam Adobe Undulating Green Patch Area

Table 1. Biotope Matrix

Quantitative Assessment Results:

The systematic scoring of the Biotope Map units using the Assessment Matrix yielded quantitative results that detail the quality and functional deficit of the fragmented landscape.

C1. Area (A):

Figure 7. Area Map

The Area assessment was performed by systematically classifying each biotope unit delineated on the Biotope Map according to its size, using predefined categories. This metric is crucial because habitat size is a primary determinant of ecological function, influencing species richness, population stability, and the overall capacity to deliver ecosystem services.

This result of limited individual biotope area carries significant ecological implications, directly reinforcing the overall diagnosis of underperformance and fragmentation:

- **Vulnerability to Edge Effects:** The small size of most biotopes means they possess an extremely high perimeter-to-area ratio. This structural result exposes a disproportionately large percentage of the habitat interior to edge effects, negative influences originating from the surrounding urban matrix (e.g., pollution, noise, light, human disturbance). The small size renders these patches highly vulnerable and reduces their ability to sustain sensitive species or maintain stable microclimatic conditions.
- **Low Ecological Stability:** Habitats with limited area generally support lower population numbers and fewer species, making them less resilient to environmental stochasticity and external pressures. The small area confirms a low ecological stability across the cluster, necessitating the design interventions to physically link these patches into a larger, more stable Ecological Network Map.
- **Reinforcement of Fragmentation:** The finding of limited area reinforces the results of the Rarity assessment. The biotopes are not only isolated but also insufficient in size to act as robust stepping-stones or core areas on their own. Therefore, the Area assessment result provides the fundamental justification for the Connective Management strategy, which is designed to aggregate the limited area of individual patches into a single, functional network.

C2. Period of Development (D)

Figure 8. Period of Development Map

The Period of Development assessment provided a crucial temporal diagnosis of the Quezon City Medical Cluster's green spaces, quantifying the ecological age and maturity of each unit identified on the Biotope Map. This assessment is vital for understanding the stability and functional capability of the habitat. The quantitative result of the Period of Development assessment revealed a critical structural deficit: a predominance of young or mid-aged biotopes across the cluster. The analysis confirmed that a significant number of ecological units were classified in the lower to middle age ranges (e.g., 2-5 or 5-10 years), with very few reaching the highest maturity categories (>20 years).

This result, the widespread dominance of young vegetation carries severe implications for the ecosystem's long-term health and functional performance, providing a clear justification for protective and integrative management:

- **Limited Ecological Maturity and Stability:** Young biotopes lack the structural complexity and stability of mature ecosystems. They possess shallow root systems, lower levels of accumulated biomass, and simpler nutrient cycling, making them highly susceptible to environmental stress, drought, and urban disturbance. The result confirms a systemic lack of ecological resilience across the cluster.
- **Reduced Ecosystem Service Delivery:** The finding of low maturity directly impacts the delivery of essential ecosystem services. Mature habitats (e.g., 20+ years) are superior at sequestering carbon, filtering air pollutants, and maximizing canopy interception of rainfall. The current youthful structure signifies a substantial underperformance in these critical climate-regulating functions.
- **Justification for Protective and Integrative Management:** The Period of Development assessment dictates the need for Protective Management for the few existing mature patches (to safeguard what little stability exists) and Integrative Management for the mid-aged institutional areas. The goal is to enforce Development limits and

prevent further loss, allowing the existing young and mid-aged biotopes the necessary time and protection to progress toward greater ecological maturity. The ultimate objective is to increase the mean Period of Development score across the entire cluster.

C3. Habitat Complexity (H):

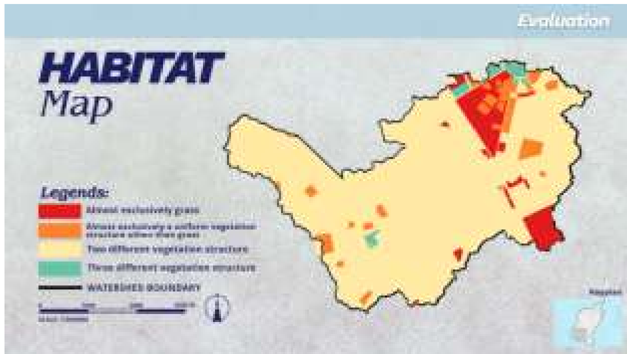

Figure 9. Habitat Map

The Habitat assessment provided the most critical structural diagnostic result of the entire study. This assessment directly quantified the internal quality and vertical stratification of the ecological units defined on the Biotope Map, serving as the most reliable proxy for the cluster's ability to support biodiversity and regulate microclimate.The quantitative result of the Habitat Complexity assessment confirmed a systemic structural deficit across the medical cluster of Quezon City. The analysis revealed that the majority of sites possessed simplified habitat structures. The dominant classification for most biotopes fell into the lowest scoring categories, often confirmed as almost exclusively grass or a single uniform vegetation structure. This result directly implicates prevailing urban institutional landscape management practices, which typically favor ease of maintenance over ecological performance.

The result of widespread habitat simplification is one of the most significant findings of the study, carrying severe implications for the cluster's functional capacity and justifying the necessity of Creative and Connective Management strategies:

- **Low Biodiversity Support:** Simplified habitats dramatically restrict the range of ecological niches and resources available. A biotope consisting predominantly of a single layer (e.g., only grass or a uniform tree canopy) cannot support the diverse life cycles and shelter needs of varied fauna, insects, and microbial communities. The low complexity score confirms that the existing green spaces are biologically poor, limiting support and contributing to the overall ecological underperformance.
- **Compromised Microclimate Regulation:** Multi-layered vegetation is essential for maximizing evapotranspiration, shading, and air filtration. The pervasive lack of a robust shrub and canopy layer means these biotopes are inefficient at mitigating the urban heat island effect and reducing heat stress. This structural deficit is particularly concerning within a healthcare corridor where stable microclimate regulation is a critical environmental service.
- **Justification for Creative Management:** This result directly informs the Creative Management strategy. Since the problem is structural simplification, the solution must be the active creation of complexity. Interventions such as the implementation of Rain gardens and Pollinator Gardens are explicitly required to introduce the necessary multi-layer vegetation structure, thereby elevating the Habitat Complexity score and restoring functional quality to the landscape.

C4. Rarity (R):

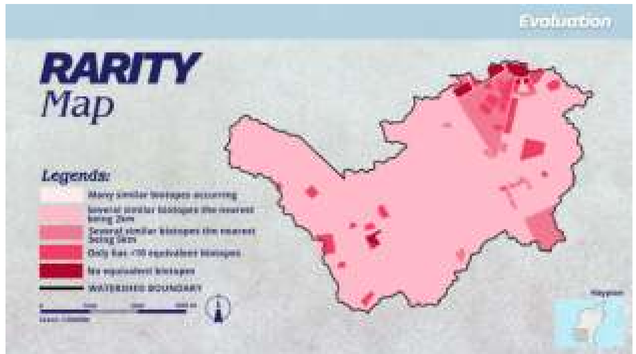

Figure 10. Rarity Map

The Rarity assessment provided the critical diagnostic result concerning the spatial distribution and connectivity of the ecological units, moving beyond the physical size and structure to address functional isolation within the urban context. The quantitative result of the Rarity assessment confirmed a high degree of functional isolation across the medical cluster of Quezon City. The analysis revealed that key existing green patches, even those with relatively higher scores in other categories, functionally existed as ecological islands. They were surrounded by expansive, impervious surfaces, leading to high Rarity scores. This result indicates that while green spaces are physically present, they are functionally disconnected from the broader regional ecosystem, operating independently and without mutual ecological support.

The result of acute isolation carries severe consequences for the long-term ecological viability of the cluster, providing the primary justification for the Ecological Network Map and the Connective Management strategy:

- **Impediment to Ecological Flow:** The high Rarity scores confirm that the dense urban matrix acts as an effective ecological barrier. This severely restricts ecological flow, the essential movement of species, energy, and genetic material,which is necessary for maintaining the long-term health, genetic diversity, and stability of flora and fauna populations. Isolation increases the risk of local extinctions within the fragmented patches.
- **Justification for Connective Management:** The Rarity assessment provides the most direct justification for the network design. Since the problem is quantified as isolation, the solution must be connection. The result dictates the urgent need for the strategic implementation of Greencorridors and Stepping-Stone Biotopes, as prescribed in the Management Map. These interventions are specifically designed to bridge the quantified isolation gaps and reduce the functional Rarity of existing patches.
- **Conservation Priority:** Biotopes identified with high Rarity scores demand high conservation priority. The result flags these unique and isolated units as irreplaceable assets that require immediate Protective Management to ensure their continued survival within the hostile urban environment, preventing the complete loss of their unique ecological function.

Code	Land Cover	Soil	Landform	Biotope Type	Area (Ha)	A	D	R	H	Total	Assessment
Nc-F-I	Novaliches Clay Loam Adobe	Flat	Institutional	Novaliches Clay Loam Adobe Flat Institutional Area	1.6613	1	4	3	2	10	**IMPROVE**

Nc-F-I	Novaliches Clay Loam Adobe	Flat	Institutional	Novaliches Clay Loam Adobe Flat Institutional Area	6.3053	3	4	3	2	12	**CONSERVE**
Nc-F-I	Novaliches Clay Loam Adobe	Flat	Institutional	Novaliches Clay Loam Adobe Flat Institutional Area	16.4005	4	4	3	2	13	**CONSERVE**
Nc-F-I	Novaliches Clay Loam Adobe	Flat	Institutional	Novaliches Clay Loam Adobe Flat Institutional Area	4.0990	2	4	3	2	11	**CONSERVE**
Nc-F-I	Novaliches Clay Loam Adobe	Flat	Institutional	Novaliches Clay Loam Adobe Flat Institutional Area	2.7475	1	4	3	2	10	**IMPROVE**
Nc-F-I	Novaliches Clay Loam Adobe	Flat	Institutional	Novaliches Clay Loam Adobe Flat Institutional Area	1.9259	1	4	3	2	10	**IMPROVE**
Nc-F-I	Novaliches Clay Loam Adobe	Flat	Institutional	Novaliches Clay Loam Adobe Flat Institutional Area	1.6827	1	4	3	2	10	**IMPROVE**
Nc-F-I	Novaliches Clay Loam Adobe	Flat	Institutional	Novaliches Clay Loam Adobe Flat Institutional Area	3.6392	2	4	3	2	11	**CONSERVE**
Nc-F-I	Novaliches Clay Loam Adobe	Flat	Institutional	Novaliches Clay Loam Adobe Flat Institutional	15.3446	4	4	3	2	13	**CONSERVE**

				Area							
Nc-F-I	Novaliches Clay Loam Adobe	Flat	Institutional	Novaliches Clay Loam Adobe Flat Institutional Area	4.2607	2	4	3	2	11	**CONSERVE**
Nc-F-I	Novaliches Clay Loam Adobe	Flat	Institutional	Novaliches Clay Loam Adobe Flat Institutional Area	4.4710	2	4	3	2	11	**CONSERVE**
Nc-F-I	Novaliches Clay Loam Adobe	Flat	Institutional	Novaliches Clay Loam Adobe Flat Institutional Area	2.6282	1	4	3	2	10	**IMPROVE**
Nc-F-I	Novaliches Clay Loam Adobe	Flat	Institutional	Novaliches Clay Loam Adobe Flat Institutional Area	1.9891	1	4	3	2	10	**IMPROVE**
Nc-F-I	Novaliches Clay Loam Adobe	Flat	Institutional	Novaliches Clay Loam Adobe Flat Institutional Area	2.5878	1	4	3	2	10	**IMPROVE**
Nc-F-I	Novaliches Clay Loam Adobe	Flat	Institutional	Novaliches Clay Loam Adobe Flat Institutional Area	4.7533	2	4	3	2	11	**CONSERVE**
Nc-F-I	Novaliches Clay Loam Adobe	Flat	Institutional	Novaliches Clay Loam Adobe Flat Institutional Area	2.9325	1	4	3	2	10	**IMPROVE**

Nc-F-I	Novaliches Clay Loam Adobe	Flat	Institutional	Novaliches Clay Loam Adobe Flat Institutional Area	4.9956	2	4	3	2	11	**CONSERVE**
Nc-F-I	Novaliches Clay Loam Adobe	Flat	Institutional	Novaliches Clay Loam Adobe Flat Institutional Area	4.2213	2	4	3	2	11	**CONSERVE**
Nc-F-I	Novaliches Clay Loam Adobe	Flat	Institutional	Novaliches Clay Loam Adobe Flat Institutional Area	3.9638	2	4	3	2	11	**CONSERVE**
Nc-F-I	Novaliches Clay Loam Adobe	Flat	Institutional	Novaliches Clay Loam Adobe Flat Institutional Area	1.2641	1	4	3	2	10	**IMPROVE**
Nc-F-I	Novaliches Clay Loam Adobe	Flat	Institutional	Novaliches Clay Loam Adobe Flat Institutional Area	1.2509	1	4	3	2	10	**IMPROVE**
Nc-F-I	Novaliches Clay Loam Adobe	Flat	Institutional	Novaliches Clay Loam Adobe Flat Institutional Area	1.8210	1	4	3	2	10	**IMPROVE**
Nc-F-I	Novaliches Clay Loam Adobe	Flat	Institutional	Novaliches Clay Loam Adobe Flat Institutional Area	4.3603	2	4	3	2	11	**CONSERVE**
Nc-F-I	Novaliches Clay Loam Adobe	Flat	Institutional	Novaliches Clay Loam Adobe Flat Institutional	1.7323	1	4	3	2	10	**IMPROVE**

				Area							
Nc-F-I	Novaliches Clay Loam Adobe	Flat	Institutional	Novaliches Clay Loam Adobe Flat Institutional Area	1.5349	1	4	3	2	10	**IMPROVE**
Nc-F-I	Novaliches Clay Loam Adobe	Flat	Institutional	Novaliches Clay Loam Adobe Flat Institutional Area	1.5473	1	4	3	2	10	**IMPROVE**
Nc-F-I	Novaliches Clay Loam Adobe	Flat	Institutional	Novaliches Clay Loam Adobe Flat Institutional Area	6.8555	3	4	3	2	12	**CONSERVE**
Nc-U-I	Novaliches Clay Loam Adobe	Undu lating	Institutional	Novaliches Clay Loam Adobe Undulating Institutional Area	1.5178	1	4	3	2	10	**IMPROVE**

Table 2. Biotope Assessment for Institutional Land Use

NC-F-C	Novaliches Clay Loam Adobe	Flat	Commercial	Novaliches Clay Loam Adobe Flat Commercial Area	108.9788	5	2	1	1	**9**	**IMPROVE**
NC-F-C	Novaliches Clay Loam Adobe	Flat	Commercial	Novaliches Clay Loam Adobe Flat Commercial Area	47.9407	5	2	1	1	**9**	**IMPROVE**
NC-F-C	Novaliches Clay Loam Adobe	Flat	Commercial	Novaliches Clay Loam Adobe Flat Commercial Area	2.6377	1	2	1	1	**5**	**CREATE**

NC-F-C	Novaliches Clay Loam Adobe	Flat	Commercial	Novaliches Clay Loam Adobe Flat Commercial Area	5.6667	3	2	1	1	**7**	**IMPROVE**
NC-F-C	Novaliches Clay Loam Adobe	Flat	Commercial	Novaliches Clay Loam Adobe Flat Commercial Area	1.5222	1	2	1	1	**5**	**CREATE**
NC-F-C	Novaliches Clay Loam Adobe	Flat	Commercial	Novaliches Clay Loam Adobe Flat Commercial Area	1.4976	1	2	1	1	**5**	**CREATE**
NC-F-C	Novaliches Clay Loam Adobe	Flat	Commercial	Novaliches Clay Loam Adobe Flat Commercial Area	1.9322	1	2	1	1	**5**	**CREATE**
NC-F-C	Novaliches Clay Loam Adobe	Flat	Commercial	Novaliches Clay Loam Adobe Flat Commercial Area	11.9477	4	2	1	1	**8**	**IMPROVE**
NC-F-C	Novaliches Clay Loam Adobe	Flat	Commercial	Novaliches Clay Loam Adobe Flat Commercial Area	1.4249	1	2	1	1	**5**	**CREATE**
NC-F-C	Novaliches Clay Loam Adobe	Flat	Commercial	Novaliches Clay Loam Adobe Flat Commercial Area	1.1229	1	2	1	1	**5**	**CREATE**
NC-F-C	Novaliches Clay Loam Adobe	Flat	Commercial	Novaliches Clay Loam Adobe Flat Commercial Area	1.1250	1	2	1	1	**5**	**CREATE**
NC-F-C	Novaliches Clay Loam Adobe	Flat	Commercial	Novaliches Clay Loam Adobe Flat Commercial Area	2.9795	1	2	1	1	**5**	**CREATE**
NC-F-C	Novaliches Clay Loam Adobe	Flat	Commercial	Novaliches Clay Loam Adobe Flat Commercial Area	1.1132	1	2	1	1	**5**	**CREATE**

NC-F-C	Novaliches Clay Loam Adobe	Flat	Commercial	Novaliches Clay Loam Adobe Flat Commercial Area	1.5755	1	2	1	1	**5**	**CREATE**
NC-F-C	Novaliches Clay Loam Adobe	Flat	Commercial	Novaliches Clay Loam Adobe Flat Commercial Area	5.5443	3	2	1	1	**7**	**IMPROVE**
NC-F-C	Novaliches Clay Loam Adobe	Flat	Commercial	Novaliches Clay Loam Adobe Flat Commercial Area	2.4169	1	2	1	1	**5**	**CREATE**
NC-F-C	Novaliches Clay Loam Adobe	Flat	Commercial	Novaliches Clay Loam Adobe Flat Commercial Area	1.9728	1	2	1	1	**5**	**CREATE**
NC-F-C	Novaliches Clay Loam Adobe	Flat	Commercial	Novaliches Clay Loam Adobe Flat Commercial Area	1.5798	1	2	1	1	**5**	**CREATE**
NC-F-C	Novaliches Clay Loam Adobe	Flat	Commercial	Novaliches Clay Loam Adobe Flat Commercial Area	5.5178	3	2	1	1	**7**	**IMPROVE**
NC-F-C	Novaliches Clay Loam Adobe	Flat	Commercial	Novaliches Clay Loam Adobe Flat Commercial Area	1.3636	1	2	1	1	**5**	**CREATE**
NC-F-C	Novaliches Clay Loam Adobe	Flat	Commercial	Novaliches Clay Loam Adobe Flat Commercial Area	3.8683	2	2	1	1	**6**	**IMPROVE**
NC-F-C	Novaliches Clay Loam Adobe	Flat	Commercial	Novaliches Clay Loam Adobe Flat Commercial Area	1.3624	1	2	1	1	**5**	**CREATE**
NC-F-C	Novaliches Clay Loam Adobe	Flat	Commercial	Novaliches Clay Loam Adobe Flat Commercial Area	1.6525	1	2	1	1	**5**	**CREATE**

NC-F-C	Novaliches Clay Loam Adobe	Flat	Commercial	Novaliches Clay Loam Adobe Flat Commercial Area	3.4381	2	2	1	1	**6**	**IMPROVE**
NC-F-C	Novaliches Clay Loam Adobe	Flat	Commercial	Novaliches Clay Loam Adobe Flat Commercial Area	2.2938	1	2	1	1	**5**	**CREATE**
NC-U-C	Novaliches Clay Loam Adobe	Undu lating	Commercial	Novaliches Clay Loam Adobe Undulating Commercial Area	8.4472	3	2	1	1	**7**	**IMPROVE**

Table 3. Biotope Assessment for Commercial Land Use

NC-F-G	Novaliches Clay Loam Adobe	Flat	Green Patch	Novaliches Clay Loam Adobe Flat Green Patch Area	7.1985	3	5	4	4	**16**	**PRESERVE**
NC-F-G	Novaliches Clay Loam Adobe	Flat	Green Patch	Novaliches Clay Loam Adobe Flat Green Patch Area	1.1489	1	5	4	4	**14**	**CONSERVE**
NC-F-G	Novaliches Clay Loam Adobe	Flat	Green Patch	Novaliches Clay Loam Adobe Flat Green Patch Area	1.2895	1	5	4	4	**14**	**CONSERVE**
NC-F-G	Novaliches Clay Loam Adobe	Flat	Green Patch	Novaliches Clay Loam Adobe Flat Green Patch Area	7.2602	3	5	4	4	**16**	**PRESERVE**
NC-F-G	Novaliches Clay Loam Adobe	Flat	Green Patch	Novaliches Clay Loam Adobe Flat Green Patch Area	11.6841	4	5	4	4	**17**	**PRESERVE**
NC-U-G	Novaliches Clay Loam Adobe	Undu lating	Green Patch	Novaliches Clay Loam Adobe Undulating Green Patch Area	6.5905	3	5	4	4	**16**	**PRESERVE**
NC-F-R	Novaliches Clay Loam Adobe	Flat	Residential	Novaliches Clay Loam Adobe Flat	1795.02 3	5	3	1	3	**12**	**CONSERVE**

				Residential Area							

Table 4. Biotope Assessment for Residential Land Use and Green Patches

D. The Prescriptive Maps:

The quantitative findings directly determined the spatial configuration of the final prescriptive maps: the Ecological Network Map and the Management Plan

D1. The Management Map:

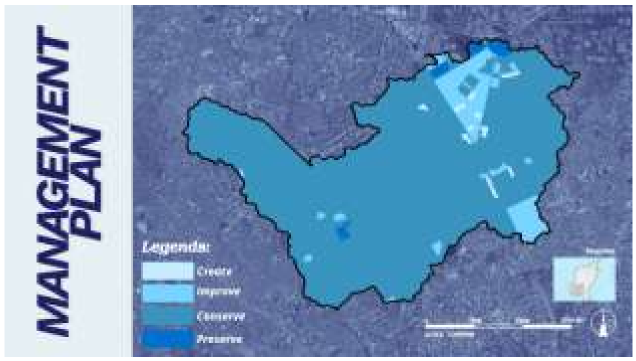

Figure 11. Management Plan

This is the implementation blueprint, spatially assigning management strategies tailored to the specific ecological deficits quantified in each biotope. The map's result is a site-specific action plan categorized into four functional groups, with the spatial deployment of resources dictated by the assessment scores:

Figure 12. Management Interventions: Ratings and Approach

Creative Management:

This strategy is assigned to areas identified by low Habitat Complexity scores and high impervious cover (as seen in the Land Cover Map). The results are interventions designed to establish new ecological value.

- **Water Management Outcomes:** The outputs include Rain gardens and Bioswales. These are crucial mapped results that utilize the information from the Watershed Map and Soil Map (Novaliches Clay Loam Adobe). They act as decentralized filtration and retention systems, transforming unproductive hardscape into functional bio-filtration landscapes that mitigate runoff and reduce flooding.
- **Structural Outcomes:** The map also prescribes Pollinator Gardens and Soil Remediation alongside Permeable Paving. The result is a targeted increase in pervious surface area and the introduction of diverse, multi-layer vegetation, directly reversing the trend of simplified habitat structure confirmed by the assessment. Shaded pedestrian zones further integrate green infrastructure with human use, mitigating the urban heat island effect.

Connective Management:
The outputs of this strategy are focused on solving the primary problem of Rarity/Isolation by establishing robust linkages proposed in the Ecological Network Map.

- **Linkage Outcomes:** The key spatial results include the creation of green corridors and interventions to strengthen stepping-stone biotopes. The discussion highlights that this is achieved through meticulous Planting on paths of potential connectivity. These mapped efforts ensure that the physical distance between isolated patches is overcome by continuous, ecologically supportive vegetation.
- **Structural Requirement Results:** The prescription of Multi-layer vegetation in these corridors is a critical design result; it directly addresses the low complexity findings by ensuring the connections are structurally robust enough to support shelter and feeding, not just transit. Furthermore, the inclusion of Wildlife-friendly elements and Wayfinding ecological markers ensures the success of ecological movement and educational outreach.

Integrative Management:
This strategy embeds ecological function within active land uses, particularly the Institutional areas, a direct response to the fragmentation within the boundaries of major healthcare facilities.

- **Therapeutic Outcomes:** The results include the mapped introduction of Healing landscapes, Courtyard gardens, and Sensory gardens. These are crucial prescriptive results that link environmental improvement to human health, providing therapeutic spaces that address the high-stress environment of the medical cluster.
- **Functional Outcomes:** The map also prescribes green roofs as a solution to limited ground-level area, transforming unused impervious surfaces into functional biotopes for stormwater management and insulation. Water features and Medicinal planting zones further integrate the natural environment with health research and well-being.

Protective Management:
This strategy focuses on safeguarding the existing, often young or mid-aged, ecological capital, directly addressing the findings regarding Area and Period of Development.

- **Conservation Outcomes:** The map clearly delineates Conservation zones and prescribes strict measures to enforce development limits and regulate institutional expansions. These are crucial policy results intended to prevent further loss or encroachment on the few existing assets.
- **Site-Specific Outcomes:** The most detailed results include establishing Root protection zones around mature trees, an essential intervention to protect the largest existing biomass against low-impact interventions. The final mapped result is the requirement for Informational and conservation signage to educate the public, ensuring that conservation efforts are transparent and maintained over the long term.

D2. The Ecological Network Map

Figure 13. Ecological Network Map

The Ecological Network Map serves as the definitive spatial result of the research, translating the quantitative diagnosis of habitat fragmentation and underperformance into a functional, prescriptive solution framework. This map is a direct and necessary response to the high Rarity (R) assessment scores, which confirmed the acute functional isolation of the green patches, and the low Habitat Complexity (H) scores, which underscored their poor structural quality. The map strategically moves beyond inventory by delineating a Functional Connectivity

Framework, which is composed of two critical elements. First, it identifies and prescribes the location of Green Corridors, which are essential linear ecological pathways designed to overcome the physical barriers of roads and buildings, thus facilitating ecological flow, the necessary movement of species and genetic material between isolated biotopes. Second, it strategically mandates the creation or enhancement of Stepping-Stone Biotopes, which are smaller, non-linear patches placed in critical interstitial locations to provide temporary refuge and foraging areas, particularly bridging long gaps between larger core areas. The implementation of this mapped framework is essential for enhancing the effective size and ecological stability of the cluster, compelling the execution of Connective Management and Creative Management strategies to ensure that the new links are designed with the required multi-layer vegetation and functional green infrastructure necessary to elevate the entire system's resilience and ecological performance.

Conclusion:-

The comprehensive biotope-based ecological assessment of the medical cluster of Quezon City definitively diagnoses the district’s state of ecological underperformance driven by severe habitat fragmentation and structural deficit. The diagnostic results, derived from the Biotope Map and the Assessment Matrix, revealed a landscape critically defined by small, isolated ecological islands characterized by a predominance of young or mid-aged biotopes and profoundly simplified habitat structures (e.g., almost exclusively grass). This condition restricts biodiversity support, compromises microclimate regulation, and prevents effective ecological flow, diminishing the environmental quality of this vital urban healthcare corridor. The core conclusion is that the current status is ecologically unsustainable. Therefore, the strategic adoption and implementation of the Ecological Network Framework is mandatory, as demonstrated by the Ecological Network Map and the detailed Management Map, which provide the essential spatial and prescriptive guidance to restore connectivity, establish functional habitat complexity, and integrate ecological health with the district’s core healthcare mission.

Recommendations: Implementation of Management and Landscape Strategies:

The recommendations are strictly confined to the execution of the management strategies and specific landscape interventions detailed in the Management Map, ensuring that the solutions directly target the ecological deficits identified in the assessment.

Creative Management: Establishing New Ecological Value:

This strategy is recommended for areas identified with low Habitat Complexity and high imperviousness. The goal is to establish a new ecological function:

- **Water Management Integration:** It is highly recommended to prioritize the installation of Rain gardens and Bioswales. These systems should utilize native, multi-layer vegetation to manage stormwater runoff, increase infiltration (counteracting the low permeability of the existing soil), and create new, functional habitats where previously only impervious surfaces existed.
- **Surface Remediation and Structure:** The widespread use of Permeable paving is recommended to maximize pervious surface area. This should be combined with Soil remediation and the creation of Pollinator Gardens to establish stable, productive substrates and micro-habitats, supporting insect diversity and initiating complex ecological processes.

Connective Management: Restoring Functional Flow:

This strategy is the central recommendation for overcoming the severe biotope isolation confirmed by the Rarity assessment, thereby completing the Ecological Network Map.

- **Corridor Implementation:** The primary action recommended is the systematic creation of Green Corridors and the strengthening of Stepping-Stone Biotopes. This must be achieved through targeted planting on paths of potential connectivity to establish physical and functional linkages between isolated patches.
- **Structural Requirements:** To ensure functional success, all new corridors must adhere to Multi-layer vegetation standards, providing the necessary vertical structure (canopy, shrub, groundcover) for shelter, feeding, and effective microclimate regulation, directly addressing the deficit in habitat complexity.
- **Supporting Elements:** The integration of Wildlife-friendly elements and Wayfinding ecological markers is recommended to ensure the continuity of ecological flow and to provide educational value to the public regarding the network’s purpose.

Integrative Management: Fusing Ecology with Healthcare:
This strategy is recommended for embedding ecological functions within the large Institutional land uses, maximizing co-benefits for human health and the environment.

- **Therapeutic Landscape Development:** It is recommended that institutional grounds be redesigned to incorporate Healing landscapes, Courtyard gardens, and Sensory gardens. These must utilize diverse planting, often including Medicinal planting zones, to provide restorative, multi-sensory experiences that support the therapeutic mission of the cluster.
- **Building-Integrated Ecology:** The installation of green roofs is a key recommendation for institutional buildings. This strategy transforms large, unused impervious areas into functional biotopes, enhancing the overall habitat complexity and contributing significantly to stormwater management and urban heat island mitigation.

Protective Management: Conserving Existing Assets:
This final strategy is vital for securing the existing ecological capital, particularly those few areas with relatively higher Area or Period of Development scores, to prevent further degradation.

- **Policy and Zoning:** The highest priority is the immediate establishment of Conservation zones and the strict enforcement of Development limits to regulate institutional expansions. These policy results are essential to prevent further fragmentation and safeguard mature ecological structures.
- **Conservation Practice:** It is mandatory to establish legal Root protection zones around all mature trees to protect existing biomass against construction or maintenance damage. Furthermore, all activities within these protected zones must be restricted to Low-impact interventions, with clear Informational and conservation signage installed to promote awareness and stewardship.

References:-

1. Benedict, M. A., & McMahon, E. T. (2006). Green Infrastructure: Linking Landscapes and Communities. Island Press. Beninde, J., Veith, M., &Hochkirch, A. (2015).
2. Biodiversity in cities needs space: A meta-analysis of factors determining intra-urban biodiversity variation. Ecology Letters, 18(6), 581–592.https://doi.org/10.1111/ele.12427
3. Forman, R. T. T. (1995). Land Mosaics: The Ecology of Landscapes and Regions. Cambridge University Press.
4. Hilty, J. A., Worboys, G. L., Keeley, A. T. H., et al. (2020). Guidelines for conserving connectivity through ecological networks and corridors. IUCN.https://doi.org/10.2305/IUCN.CH.2020.PAG.30.en
5. Marcus, C. C., & Sachs, N. A. (2014). Therapeutic Landscapes: An Evidence-Based Approach to Designing Healing Gardens and Restorative Outdoor Spaces. Wiley.
6. McKinney, M. L. (2008). Effects of urbanization on species richness: A review of plants and animals. Urban Ecosystems, 11(2), 161–176.https://doi.org/10.1007/s11252-007-0045-4
7. Senate Department for Urban Development Berlin. (2014). BioMap: Biotope Area Factor – Methods and Implementation for Urban Ecological Planning. Berlin Senate Department for Urban Development and the Environment.
8. Sukopp, H., & Werner, P. (1983). Urban environments and vegetation. In A. J. P. Gore (Ed.), Ecosystems of the World 14A: Mires: Swamp, Bog, Fen and Moor (pp. 247–260). Elsevier.
9. Ulrich, R. S. (1984). View through a window may influence recovery from surgery. Science, 224(4647), 420–421.https://doi.org/10.1126/science.6143402
10. Yu, C., & Hien, W. N. (2006). Thermal benefits of city parks. Energy and Buildings, 38(2), 105–120.https://doi.org/10.1016/j.enbuild.2005.04.003