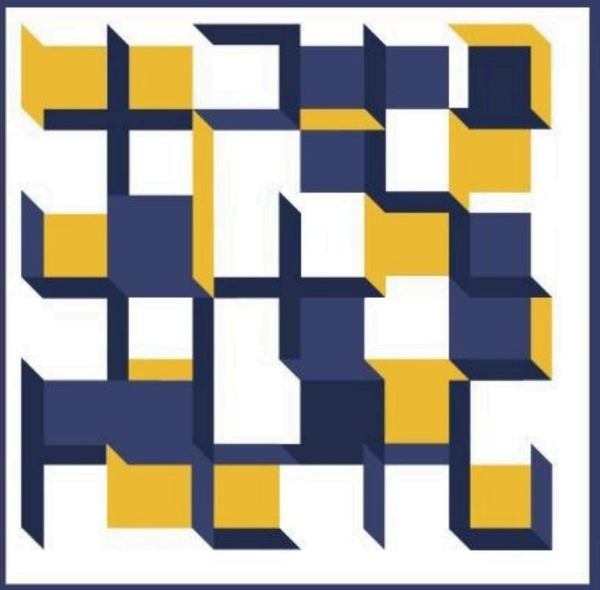
XXXII International Seminar on Urban Form

17 - 21 June 2025, Torino, Italy

URBAN MORPHOLOGY
IN THE AGE
OF ARTIFICIAL INTELLIGENCE



Mapping Governmental Land for Strategic Urban Development: A Data-Driven Approach

Presenter: Marina Pasia

Nadia Charalambous, Iason Giraud, Marina Pasia, Michalis Psaras

Society and Urban Form (SURF) Research Lab, Department of Architecture, University of Cyprus, Cyprus

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This project has received funding from the European Union's Horizon Europe Research and Innovation Programme under Grant Agreement No. 101078890

UK Research and Innovation

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TWIN2EXPAND

twinning towards
research excellence
in evidence-based planning
and urban design

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Key objectives & Research Question

Planning Question: How to identify the most suitable state-owned parcels for development, for government offices and/or multiple government services.

The primary objective of this study was to establish an evidence-based framework for identifying the most suitable government-owned land parcels for development, with a focus on accommodating government services and office spaces. Building upon the spatial analysis and mapping conducted and developing a Multi-Criteria Analysis (MCA) using the Weighted Sum Model (WSM) to assign a final suitability score to each parcel. The analysis covers a total of 61,661 government-owned parcels, incorporating both quantitative and qualitative weighting approaches:

- A data-driven weighting scheme derived from Principal Component Analysis (PCA), and
- A stakeholder-informed scheme based on direct rating questionnaires, where key decision-makers evaluated the importance of relevant planning and accessibility parameters.

Aim:

- Create an accurate database with a multicriteria evaluation for the most suitable parcels
- Provide a decision-making methodology to evaluate and assess development potential.

Challenges

1. Quality of Data:

The original dataset provided by the cadastral lacked percentage data, which would indicate the proportion of each zone relative to the total parcel area. To address this limitation, we conducted additional processing to ensure accurate and reliable calculations of zone distributions across all parcels.

1. Lack of Institutional Capacity in Public Sector:

a) **Limited GIS Expertise:** Lack of the technical background to follow spatial-analysis workflows

b) **Ambiguous Weighting Decisions:** stakeholders struggle to assign relative importance to different zones or criteria, leading to inconsistent or non-transparent weightings.

3. Time Constraints

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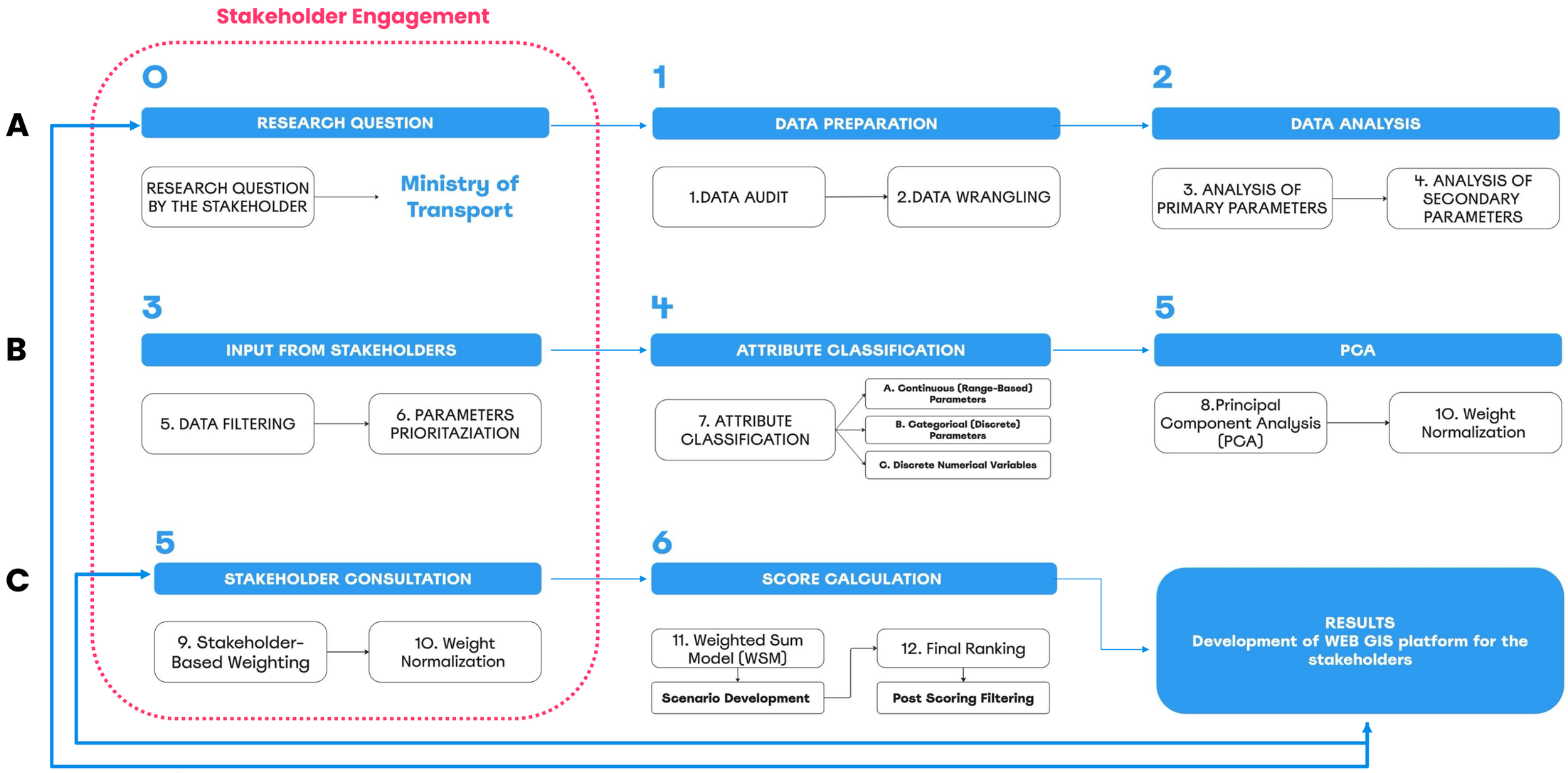
Methodology



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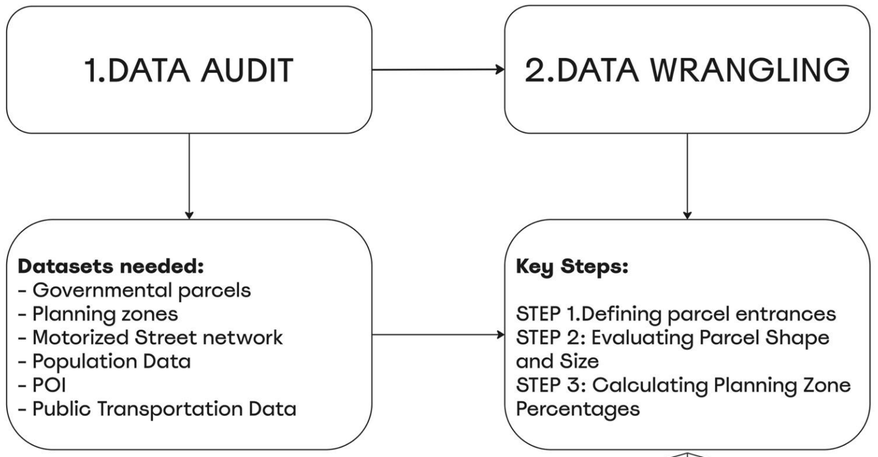
PHASE A

1

DATA PREPARATION



STEP 1.Defining parcel entrances

1.Motorized Network Preparation: Extracted simplified road network (car-accessible roads only).
2.Accessibility Analysis (2 km Radius): Analyzed angular betweenness for scoring street segments.
3.Excluding Motorways: Removed motorway segments, retaining primary, secondary, and tertiary streets.
4.Buffer Zone Creation: Created 20m buffer zones around parcels to identify street segments.
5.Selection of Optimal Street Segment: Chose the highest-ranking street segment for each parcel.
6.Data Cleaning: Removed duplicates to streamline computational processing.

STEP 2: Evaluating Parcel Shape and Size

Parameters Introduced:

-Minimum Bounding Rectangle: Smallest aligned rectangle enclosing the parcel.
Key Metrics:
-Area Ratio: Parcel area vs. bounding rectangle area (ratio close to 1 preferred).
-Bounding Geometry Diagonal Length: Longest diagonal of the rectangle.
-Diagonal-to-Height Ratio: Identifies irregularly shaped parcels (extreme ratios flagged).

STEP 3: Calculating Planning Zone Percentages

-Intersection with Planning Zones Map: Recalculated zone percentages for each parcel.
-Key Assumptions:
Z_ratio1: Percentage of first planning zone.
Z_ratio2: Percentage of second planning zone (0 if not applicable).
Z_ratio3: Aggregate percentage of other zones.
Zratio_SUM: Total sum of zone percentages for error validation.
-Handling Data Mismatches:
For parcels with zone codes >2999, 100% allocation to the first zone.

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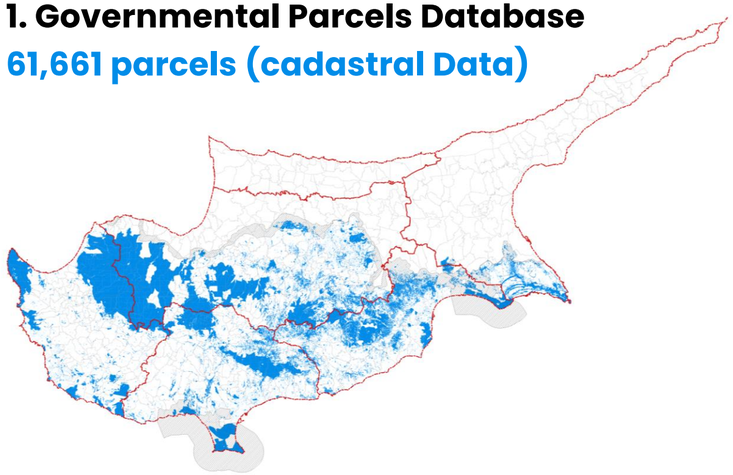
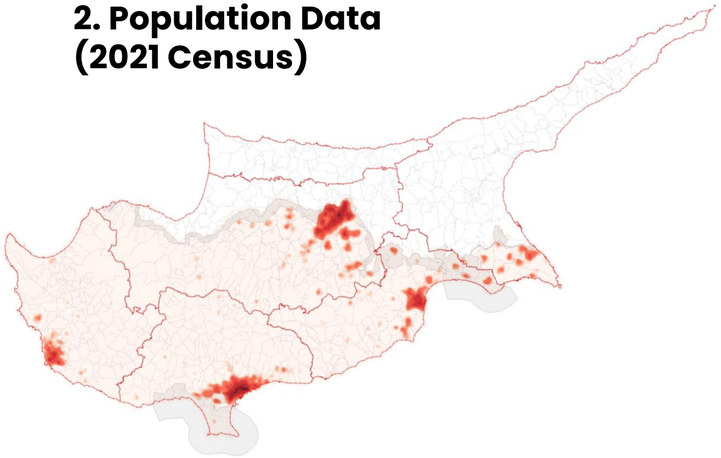
Data Audit

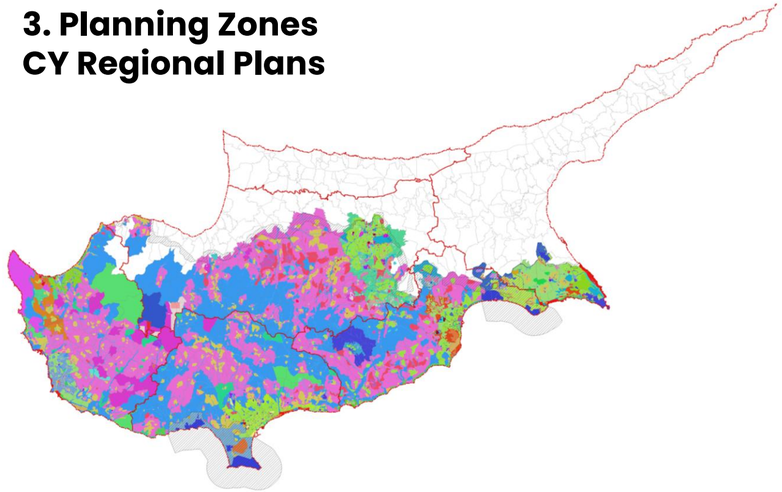
1. Governmental Parcels Database
61,661 parcels (cadastral Data)



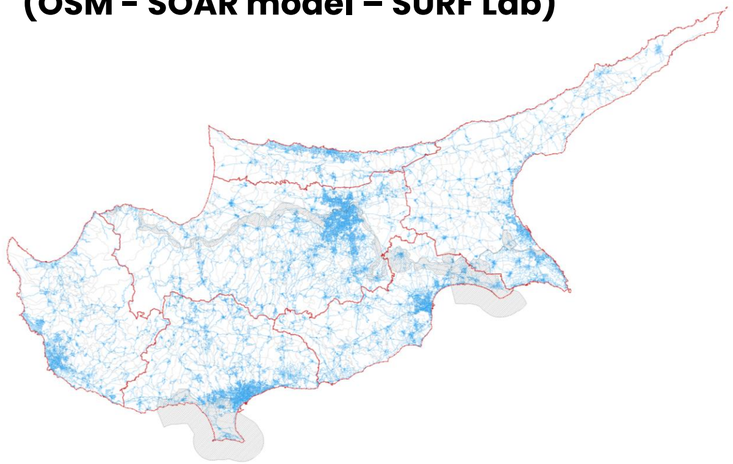
2. Population Data (2021 Census)



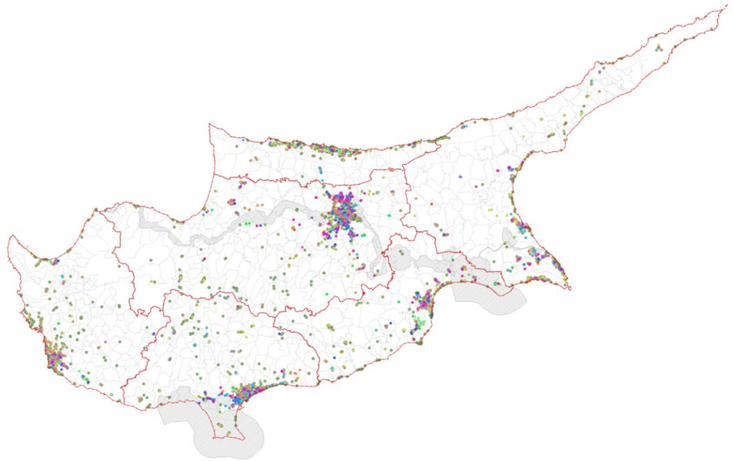
3. Planning Zones CY Regional Plans



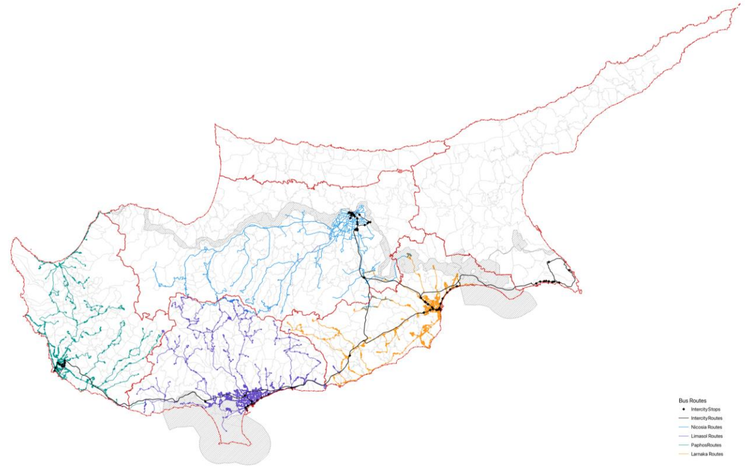
4. Motorize and Non-Motorize Network (OSM - SOAR model – SURF Lab)



5. Points of Interest – POIs (OSM)



6. Bus Routes & Bus Stop Data (OSM)



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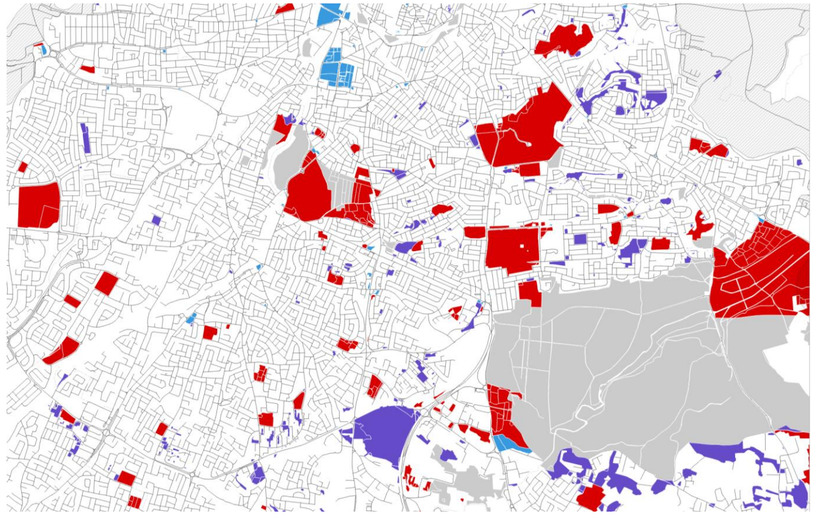
Data preparation and main methodological assumptions

1

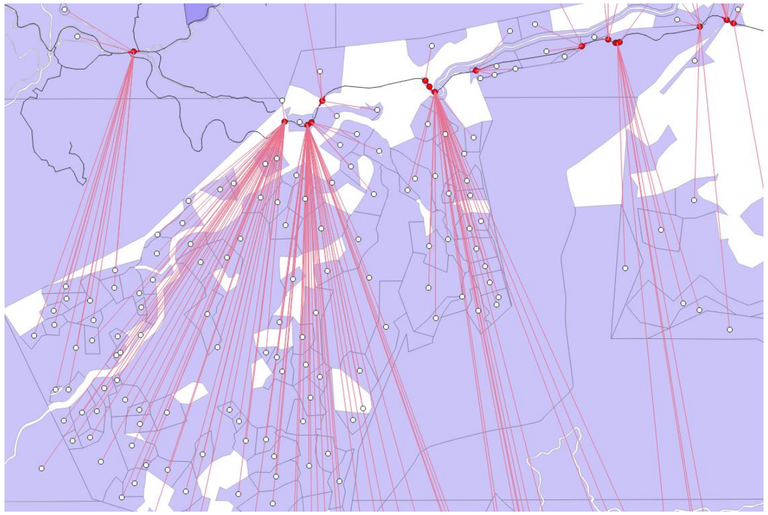
Data Filtering Based on Planning Characteristics



The first phase involved evaluating the governmental parcels database, comprising 61,661 geolocated parcels with attributes such as geometry, eligibility for developments and planning zone classification.
ZONE TYPE 1: Planning Zones that allow Office Building Development (for ex.: Public Uses, Special-use zone)
ZONE TYPE 2: Planning Zones that allow Commercial Developments (for ex.: Commercial Zones)
ZONE TYPE 3: Other Planning Zones that are Eligible for Development (for ex.: Residential Zones)
ZONE TYPE 0: all the other Parcels not Eligible for Development (for ex.: Protected areas)

2

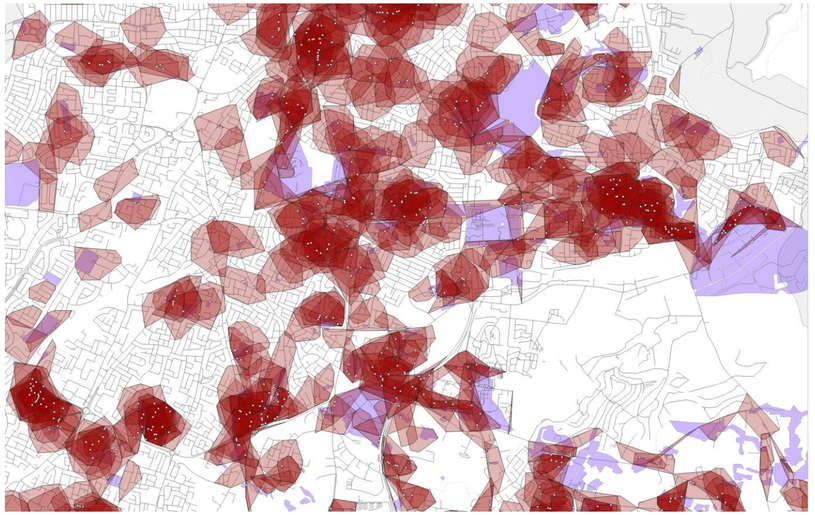
Aggregation of parcel to their appropriate "entrances" to the street network



An accessibility analysis performed within a 2 km radius to measure the importance of each street segment - based on how often they are likely to be used (angular betweenness). Motorways were excluded, making the assumption that parcel entrances should connect to primary, secondary, or tertiary roads. For each land parcel, a 20-meter buffer is created to identify nearby street segments. The most accessible street within this buffer was selected, and its center point was marked as the parcel's entrance. This ensure accurate and consistent placement of entrances across all parcels for further simulations.

3

Catchment Calculations - NM Network For 400m and 800m



Catchment calculations were done using the non-motorized network. From each parcel entrance point, areas reachable within 400 meters and 800 meters were calculated. This represents how far a person can walk using actual pedestrian paths, rather than straight-line distances. These catchment areas help evaluate accessibility and walkability around each parcel, particularly in terms of access to nearby amenities.

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PHASE A

2

DATA ANALYSIS

3. ANALYSIS OF PRIMARY PARAMETERS

Analysing a set of Primary parameters defined by the stakeholders:

- Planning zone characteristics
- Land Area
- Land Value
- Building Density
- Connectivity and Centrality MN

4. ANALYSIS OF SECONDARY PARAMETERS

Analysing a set of additional parameters defined by researcher:

- Population Reach
- Transportation
- Geometry - dimentionality
- Local Integration (NMN)
- Amenities Reach

Land Zone statistics

Land Zone statistics, related to planning zone type, percentage over the parcel, total number of zones and classification based on zone eligibility for office, commercial and mixed under certain conditions.

Parcel building allowance statistics

Parcel building allowance statistics, building density, coverage percentage, land value, Existing development

Connectivity and centrality

Motorized network integration and betweenness analytics

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PHASE A

2

DATA ANALYSIS

3. ANALYSIS OF PRIMARY PARAMETERS

Analysing a set of Primary parameters defined by the stakeholders:

- Planning zone characteristics
- Land Area
- Land Value
- Building Density
- Connectivity and Centrality MN

4. ANALYSIS OF SECONDARY PARAMETERS

Analysing a set of additional parameters defined by researcher:

- Population Reach
- Transportation
- Geometry - dimentionality
- Local Integration (NMN)
- Amenities Reach

Amenities Reach	Amenities Reach	Transportation Reach	Connectivity and centrality
Population reach in various radii	Catchment parameters for amenities such as banks and ATM, Retail and services, Food and drinks and food markets	Bus stops catchment counts for city buses, intercity, pame express bus	Non-Motorized network integration and betweenness analytics

linking the dataset to the geospatial model, with motorized and non-motorized segment id as well as entrance ids

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Primary Parameters (set by the Stakeholders)

The evaluation process prioritized land parcels based on **a set of key parameters identified by stakeholders**. These core parameters were further complemented by **a set of secondary factors**, selected and structured into a comprehensive questionnaire designed by the research team.

		DESCRIPTION	QUESTION TO DEFINE IMPORTANCE	PRIORITY
Planning zone characteristics	1	**ZONE TYPOLOGY**	a simple classification about the zone typology that is broken down into 3 classes: most favorable Class 1: offices Class 2: commercial Class 3: allows to some extent the above	**1**
Building Allowance	2	**THE PARCEL AREA AS CALCULATED BY THE RESEARCHER'S TEAM**	the parcel area, as calculated by the research team	**2**
	3	**HOW MUCH SQM IT CAN BUILT**	Building density defines how much total floor space can be constructed on a parcel. How important is maximizing buildable space when selecting a site for development?	
	4	**THE ALLOWED AND CALCULATED COVERAGE**	Coverage percentage determines how much of the parcel's area can be built upon. Should parcels with higher coverage percentages be prioritized for more compact development, or should lower coverage percentages be preferred for open space and flexibility?	
Market Characteristics	5	**LAND VALUE BASED ON 2021 PRICES**	The economic feasibility of a site depends on land value. Should selection favor parcels with lower land costs to reduce investment, or should land value be weighed against other factors such as accessibility and zoning?	**3**
Connectivity and Centrality Motorized Network	6	**ANGULAR BETWEENNESS RADIUS 1200M, 5K, 10K, 20K FOR MOTORIZED NETWORK**	How important is the parcel's role as a network hub within 1200M, 5K, 10K, 20K radius, influencing larger-scale connectivity?	**4**
	7	**ANGULAR INTEGRATION RADIUS 1200M, 5K, 10K, 20K FOR MOTORIZED NETWORK**	How important is this parcel in terms of overall connectivity within 1200M, 5K, 10K, 20K radius, impacting regional accessibility?	

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Secondary Parameters (set by the Researchers)

The evaluation process prioritized land parcels based on **a set of key parameters identified by stakeholders**. These core parameters were further complemented by **a set of secondary factors**, selected and structured into a comprehensive questionnaire designed by the research team.

		DESCRIPTION	QUESTION TO DEFINE IMPORTANCE	PRIORITY
Population Reach	8	**SERVICEABLE POPULATION FOR 200M, 400M, 800M, 1200M, 5K, 10K, 20K RADIUS**	At 5km, the serviceable population includes a mix of city districts and suburban areas. Should site selection favor locations that cater to both central and peripheral populations?	**5**
Transportation	9	**COUNT OF REACHABLE BUS STOPS WITHIN 400M AND 800M**	Proximity to public transportation is a key factor in accessibility. How important is it for the selected parcel to have multiple bus stops within a 400m walking distance to enhance convenience for daily users?	**6**
Proximity to Amenities	10	**TOTAL COUNT OF RETAIL AND SERVICES SHOPS WITHIN 400M AND 800M**	The presence of retail and service amenities (e.g., supermarkets, pharmacies, bookstores, and beauty shops) can improve the accessibility and functionality of a location. How important is proximity to these amenities within an 400m radius in your decision-making process?	
	11	**TOTAL COUNT OF FOOD AND DRINKS SHOPS WITHIN A 400M AND 800M RADIUS**	The presence of food and drink establishments, such as cafés, restaurants, and bars, can enhance the attractiveness and functionality of a location. How important is proximity to these amenities within a 400m radius, in your decision-making process?	**7**
Geometry	12	**UCY AREA TO BOUNDING REC AREA**	a parameter that classifies higher more canonical parcels	**8**
Connectivity and Centrality	13	**ANGULAR BETWEENNESS RADIUS of 200M, 400M, 800M, 1200M FOR NON-MOTORIZED NETWORK**	How important is this location for pedestrian and bicycle flow across a 1.2 km radius, helping movement through the area?	
Non - Motorized Network	14	**ANGULAR INTEGRATION RADIUS 200M, 400M, 800M, 1200M FOR NON-MOTORIZED**	How accessible is this location for non-motorized movement within a 1.2 km radius, ensuring walkability and ease of travel?	**9**
Existing Development	15	**EXISTING BUILDING DEVELOPMENT**	If the parcel has an existing development	**10**

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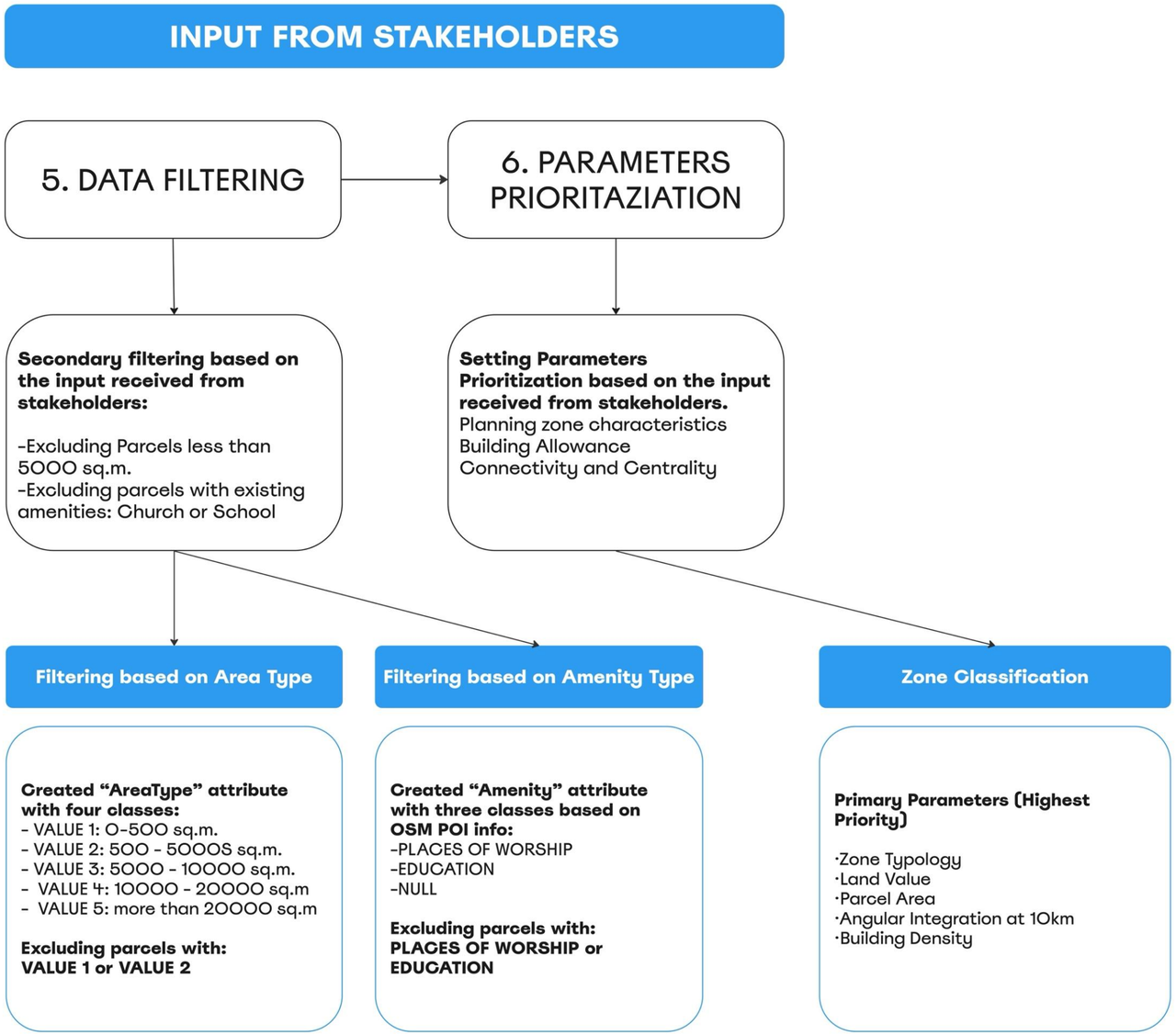
PHASE B

3



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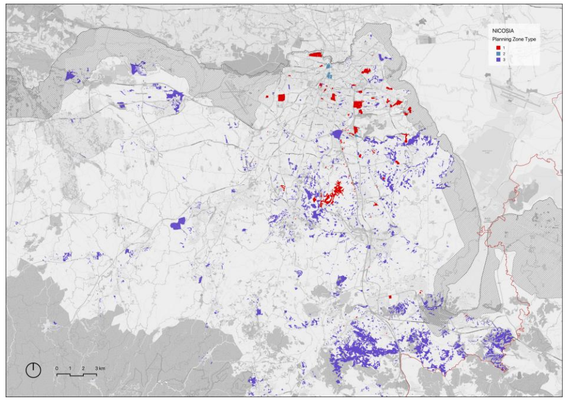
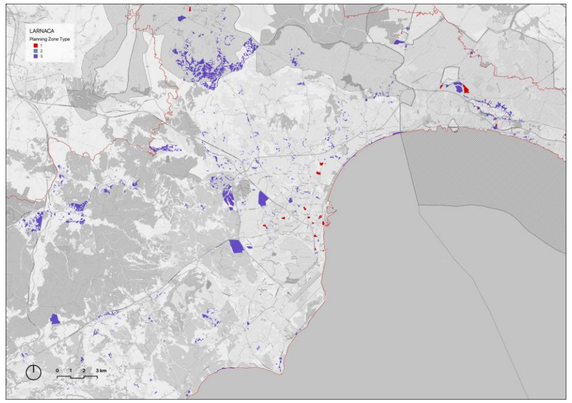
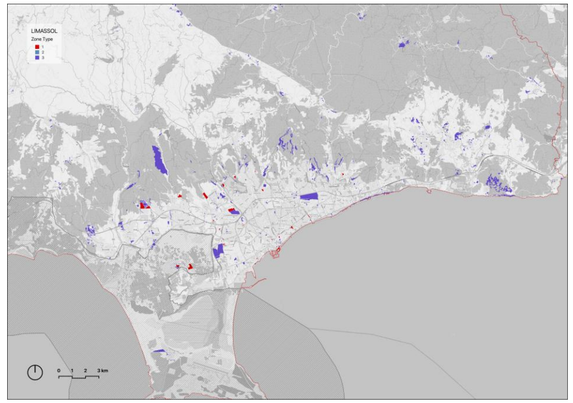
1. Planning zone characteristics

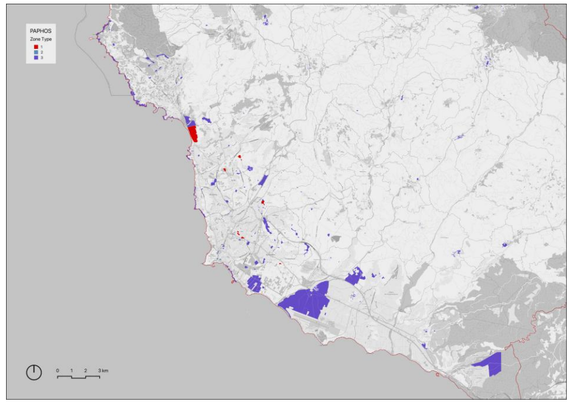
NAME	DESCRIPTION	QUESTION TO DEFINE IMPORTANCE	PRIORITY
P7_ZoneTy	zone typology	a simple classification about the zone typology that is broken down into 3 classes: most favorable Class 1: offices - governmental services Class 2: commercial use Class 3: all the parcels in planning zones that are eligible for planning Class 0: all the parcels in planning zones not eligible for planning	10

Planning Zones





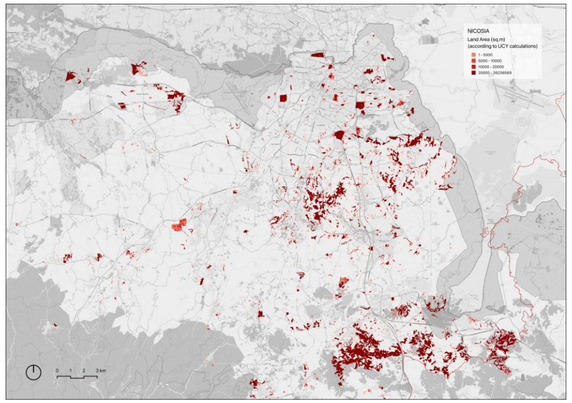


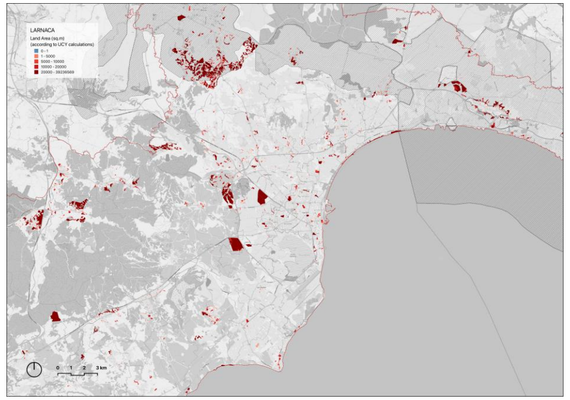


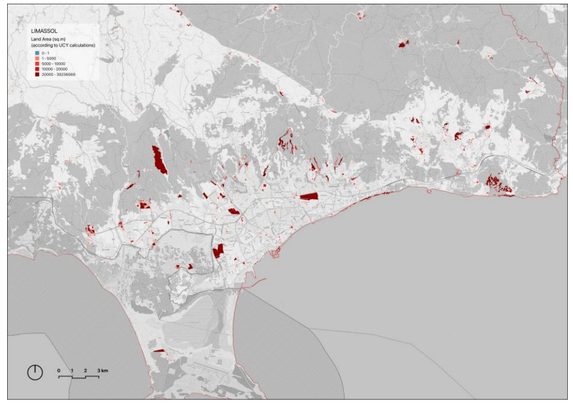
2. Building Affordance

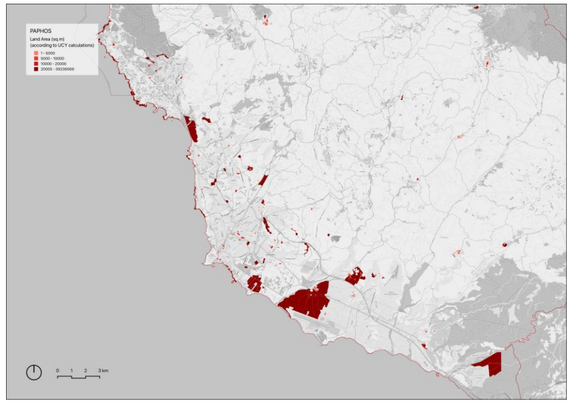
NAME	DESCRIPTION	QUESTION TO DEFINE IMPORTANCE	PRIORITY
P3_AreaCalc	**THE PARCEL AREA, AS CALCULATED BY THE RESEARCHER'S TEAM**	**the parcel area, as calculated by the research team**	**10**
P9_LandValu_21	**LAND VALUE BASED ON 2021 PRICES**	**The economic feasibility of a site depends on land value. Should selection favor parcels with lower land costs to reduce investment, or should land value be weighed against other factors such as accessibility and zoning?**	**10**
P9_BuildingDensity	**HOW MUCH SQM IT CAN BUILT**	**Building density defines how much total floor space can be constructed on a parcel. How important is maximizing buildable space when selecting a site for development?**	**10**
P9_CoveragePercentage	THE ALLOWED AND CALCULATED COVERAGE	Coverage percentage determines how much of the parcel's area can be built upon. Should parcels with higher coverage percentages be prioritized for more compact development, or should lower coverage percentages be preferred for open space and flexibility?	**7**
P9_LanDValBuilDensRatio	LAND VALUE TO BUIDLING DENSITY RATIO	This ratio compares land value to building potential, indicating cost-efficiency for development. Should priority be given to parcels where the cost per buildable square meter is lower to optimize financial investment?	**6**

Land Area (sq.m)





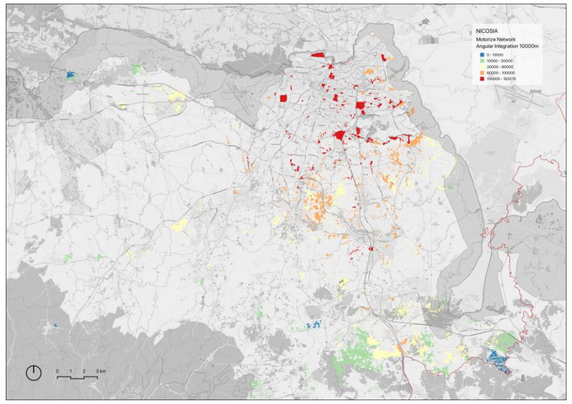


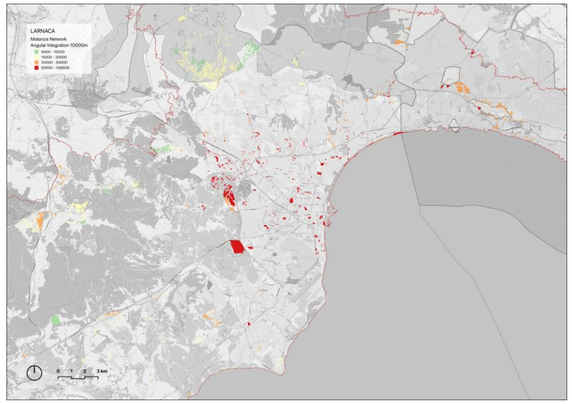


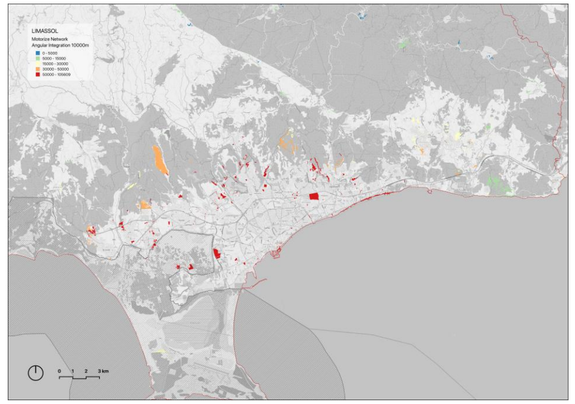
4. Centarlity - Motorized Network (PST tool)

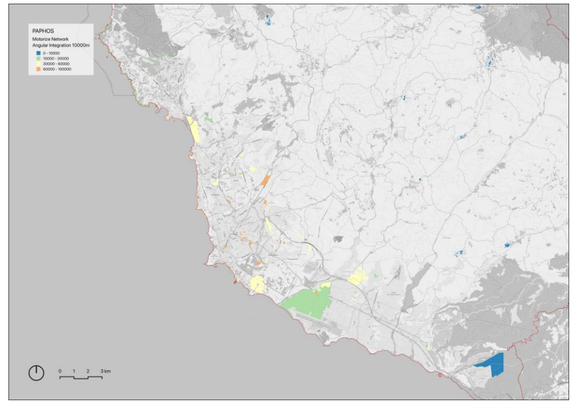
NAME	DESCRIPTION	QUESTION TO DEFINE IMPORTANCE	PRIORITY
P1_AIw1200wIH	ANGULAR INTEGRATION RADIUS 1200M FOR MOTORIZED NETWORK	How well is this parcel integrated into the road network within a 1.2 km (1200 meters) radius, meaning how easily can people reach this location from surrounding streets?	5
P1_AIw2kwIH	ANGULAR INTEGRATION RADIUS 2K FOR MOTORIZED NETWORK	How well is this parcel connected to other roads within a 2 km radius, affecting accessibility and ease of movement?	5
P1_AIw5kwIH	ANGULAR INTEGRATION RADIUS 5K FOR MOTORIZED NETWORK	How well does this parcel link to the broader road network within a 5 km radius, influencing medium-distance travel and accessibility?	6
P1_AIw10kwIH	**ANGULAR INTEGRATION RADIUS 10K FOR MOTORIZED NETWORK**	**How important is this parcel in terms of overall connectivity within a 10 km radius, impacting regional accessibility?**	**10**
P1_AIw20kwIH	ANGULAR INTEGRATION RADIUS 20K FOR MOTORIZED NETWORK	How well is this parcel integrated into a larger-scale network within a 20 km radius, affecting long-distance accessibility?	5

Angular Integration Radius 10K For Motorized Network





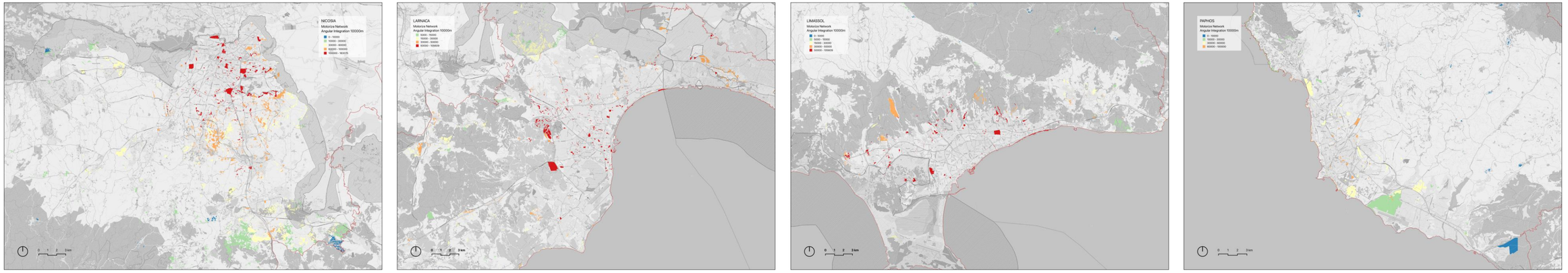




4. Connectivity - Motorized Network (PST tool)

NAME	DESCRIPTION	QUESTION TO DEFINE IMPORTANCE	PRIORITY
P1_ABw1200wl	ANGULAR BETWEENESS RADIUS 1200K FOR MOTORIZED NETWORK	How important is the parcel's role as a key connection point within a1.2 km radius, influencing local traffic flow and accessibility?	5
P1_ABw2kwl	ANGULAR BETWEENNESS RADIUS 2K FOR MOTORIZED NETWORK	How important is the parcel's role as a key connection point within a 2 km radius, influencing local traffic flow and accessibility?	5
P1_ABw5kwl	ANGULAR BETWEENNESS RADIUS 5K FOR MOTORIZED NETWORK	How important is the parcel's role in connecting roads within a 5 km radius, influencing regional accessibility and movement?	6
P1_ABw10kwl	**ANGULAR BETWEENNESS RADIUS 10K FOR MOTORIZED NETWORK**	**How important is the parcel's role as a network hub within a 10 km radius, influencing larger-scale connectivity**	**10**
P1_ABw20kwl	ANGULAR BETWEENESS RADIUS 20K FOR MOTORIZED NETWORK	How important is the parcel's connectivity role in road networks within a 20 km radius, supporting inter-district travel and movement?	7

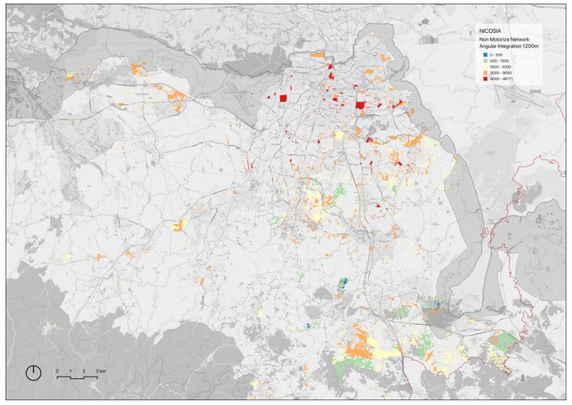
Angular Betweenness Radius 10K For Motorized Network

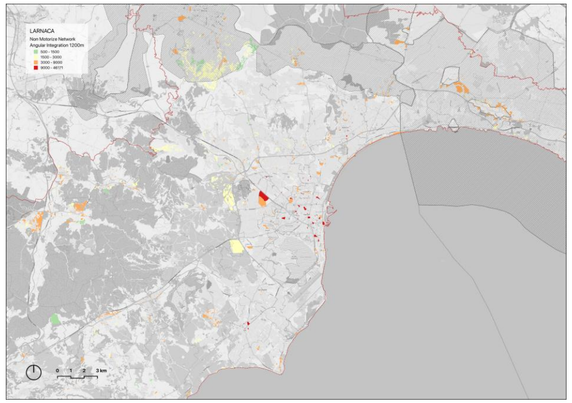


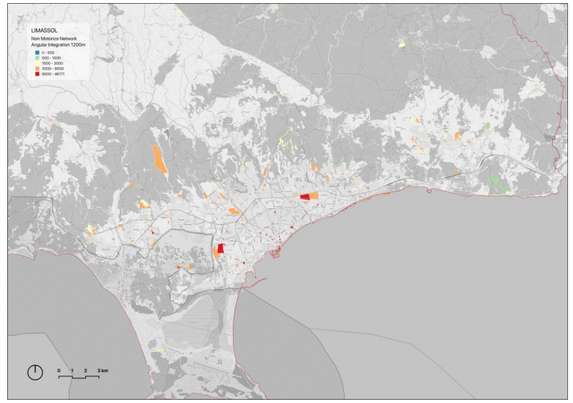
4. Centarlity – Non-Motorized Network

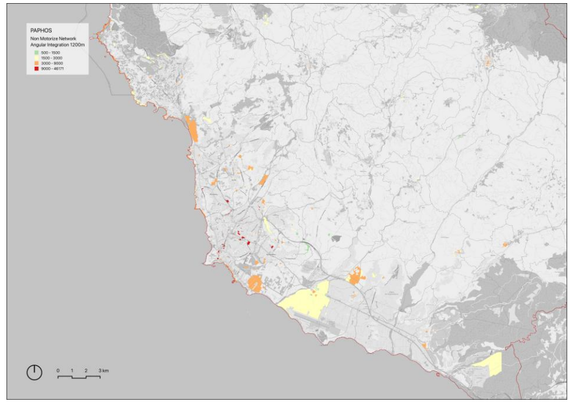
NAME	DESCRIPTION	QUESTION TO DEFINE IMPORTANCE	PRIORITY
P2_NM_AIw200	ANGULAR INTEGRATION RADIUS 200M FOR NON-MOTORIZED	How easy is it to reach this location by walking or cycling within a 200-meter distance?	2
P2_NM_AIw400	ANGULAR INTEGRATION RADIUS 400M FOR NON-MOTORIZED	How well is this location connected for non-motorized movement within a 400-meter radius, ensuring easy access?	2
P2_NM_AIw800	ANGULAR INTEGRATION RADIUS 800M FOR NON-MOTORIZED	How well is this location integrated into pedestrian and cycling routes within an 800-meter distance?	3
P2_NM_AIw1200	**ANGULAR INTEGRATION RADIUS 1200M FOR NON-MOTORIZED**	**How accessible is this location for non-motorized movement within a 1.2 km radius, ensuring walkability and ease of travel?**	**4**

Angular Integration Radius 1200m For Non-Motorized Network





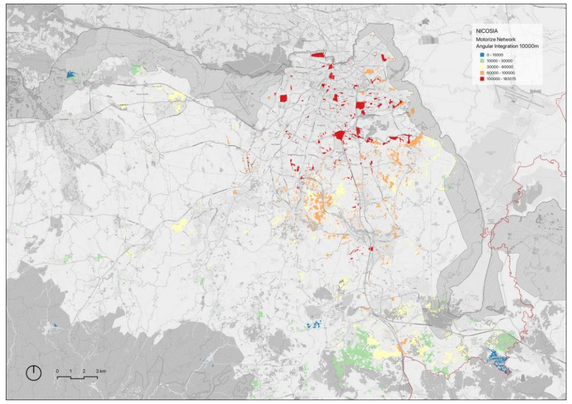


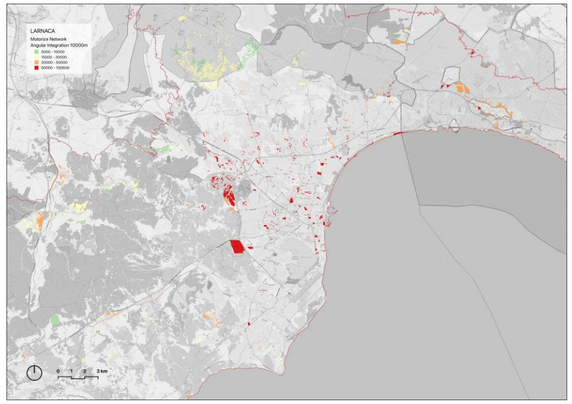


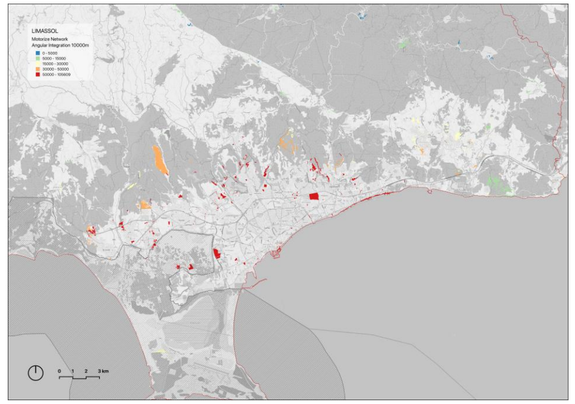
4. Connectivity – Non-Motorized Network

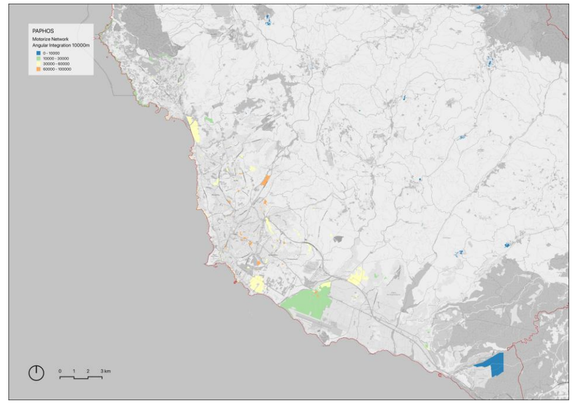
NAME	DESCRIPTION	QUESTION TO DEFINE IMPORTANCE	PRIORITY
P2_NM_ABw200	ANGULAR BETWEENESS RADIUS 200M FOR NON-MOTORIZED NETWORK	How important is this location as a key crossing point for pedestrians and cyclists within a 200-meter walking distance?	2
P2_NM_ABw400	ANGULAR BETWEENNESS RADIUS 400M FOR NON-MOTORIZED	How important is this location as a connection hub for people walking or cycling within a 400-meter distance?	2
P2_NM_ABw800	ANGULAR BETWEENNESS RADIUS 800M FOR NON-MOTORIZED	How important is this location as a key route for non-motorized travel within an 800-meter distance?	3
P2_NM_ABw1200	**ANGULAR BETWEENNESS RADIUS 1200M FOR NON-MOTORIZED**	**How important is this location for pedestrian and bicycle flow across a 1.2 km radius, helping movement through the area?**	**4**

Angular Betweenness Radius 1200m For Non-Motorized Network



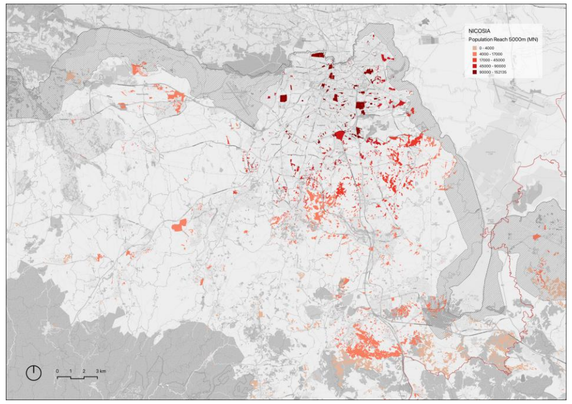


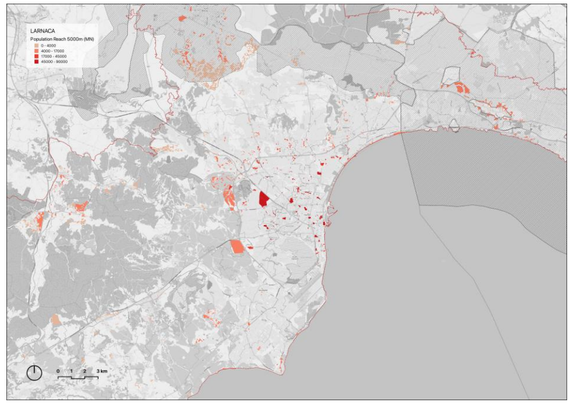


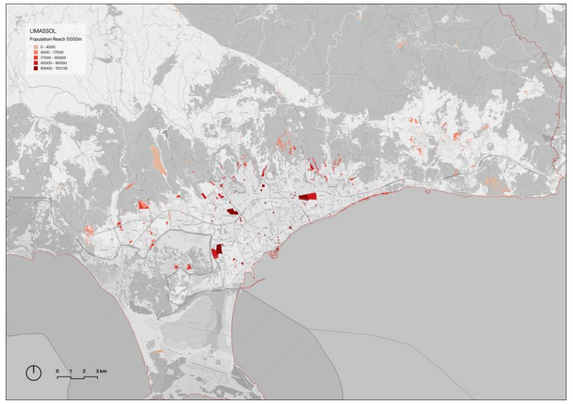


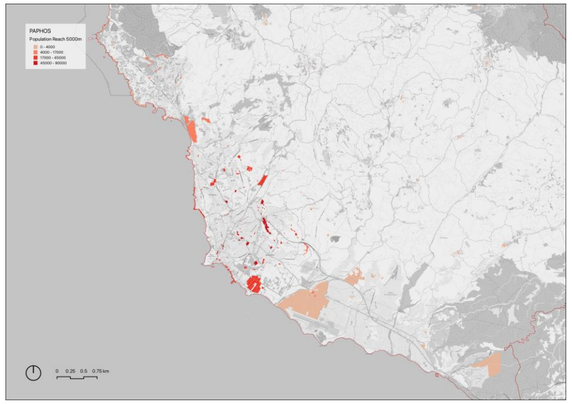
5. Population Reach

NAME	DESCRIPTION	QUESTION TO DEFINE IMPORTANCE	PRIORITY
P5_PO_ARw400pr	SERVICABLE POPULATION FOR 400M RADIUS	The number of people within walking distance of a site influences its accessibility and potential impact. How important is the size of the local population when selecting a parcel for development?	5
P5_PO_ARw800pr	SERVICABLE POPULATION FOR 800M RADIUS	At an 800m radius, the parcel's serviceability extends beyond immediate walking distance, covering a broader local area. Should the selected site prioritize accessibility to a larger but still localized population?	4
P5_PO_ARw1200pr	SERVICEABLE POPULATION FOR 1200M RADIUS	A 1200m radius expands the serviceable population to include adjacent neighborhoods. How important is it for the parcel to serve a wider community while maintaining pedestrian accessibility?	6
P5_PO_ARw2kpr	SERVICEABLE POPULATION FOR 2000M RADIUS	At a 2km radius, the parcel can reach a significant portion of the urban area, influencing accessibility for a mix of pedestrians, cyclists, and short-distance commuters. Should this be a key factor in site selection?	5
P5_PO_ARw5kpr	**SERVICEABLE POPULATION FOR 5K RADIUS**	**At 5km, the serviceable population includes a mix of city districts and suburban areas. Should site selection favor locations that cater to both central and peripheral populations?**	**7**
P5_PO_ARw10kpr	SERVICEABLE POPULATION FOR 10K RADIUS	With a 10km serviceable radius, the parcel could attract users from a wide metropolitan area. How critical is regional accessibility in your prioritization of parcels?	6
P5_PO_ARw20kpr	SERVICEABLE POPULATION FOR 20K RADIUS	A 20km radius extends the service reach to the entire urban region and its surroundings. Should long-distance accessibility and regional significance be a key determinant in the site selection process?	3





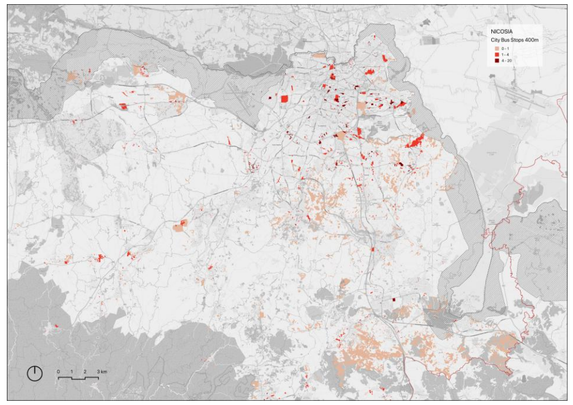


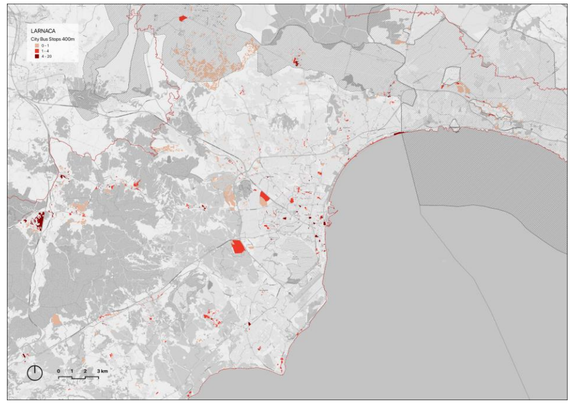


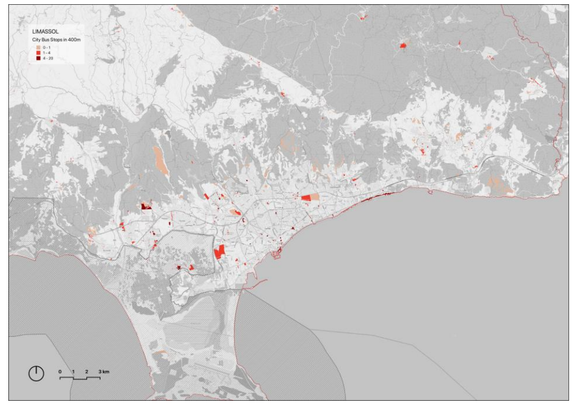
6. Transportation

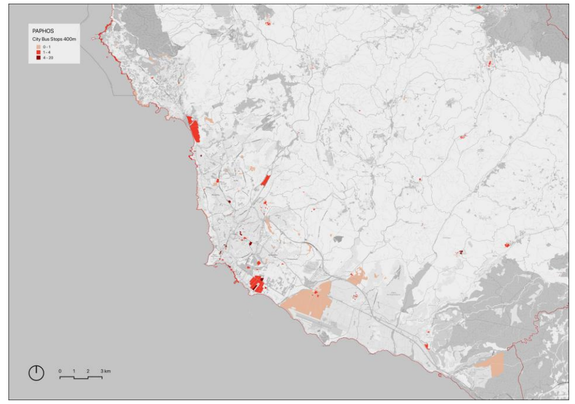
NAME	DESCRIPTION	QUESTION TO DEFINE IMPORTANCE	PRIORITY
P6_BS400_CountOfstops400	**COUNT OF REACHABLE BUS STOPS WITHIN 400M**	**Proximity to public transportation is a key factor in accessibility. How important is it for the selected parcel to have multiple bus stops within a 400m walking distance to enhance convenience for daily users?**	**6**
P6_BS800_CountOfstops800	COUNT OF REACHABLE STOPS WITHIN 800M	At an 800m radius, the site benefits from extended public transport accessibility, reaching a broader commuting population. Should priority be given to parcels with a higher number of reachable bus stops within this range?	4
P6_PE400_CountOfStops400	COUNT OF REACHABLE PAME EXPRESS STOPS WITHIN 400M	The Pame Express service provides a direct link between peripheral parking areas and the city core. How important is it for the selected parcel to be within 400m of a Pame Express stop to enhance accessibility for commuters?	4
P6_PE800_CountOfStops800	COUNT OF REACHABLE STOPS WITHIN 800M	At an 800m radius, access to the Pame Express service extends to a wider commuting population. Should priority be given to parcels that ensure seamless connectivity between the outskirts and the city center via this rapid transit option?	3
P6_IC400_CountOfStops400	COUNT OF REACHABLE INTERCITY STOPS WITHIN 400M	Intercity bus stops provide crucial connectivity between cities, facilitating regional mobility. How important is it for the selected parcel to be within 400m of an intercity bus stop to enhance accessibility for commuters traveling from other cities?	4
P6_IC800_CountOfStops800	COUNT OF REACHABLE STOPS WITHIN 800M	At an 800m radius, intercity bus access extends to a wider commuting population, improving regional connectivity. Should priority be given to parcels that allow easier access to intercity transportation options?	3

Transportation - City Bus Stops 400m (P6)





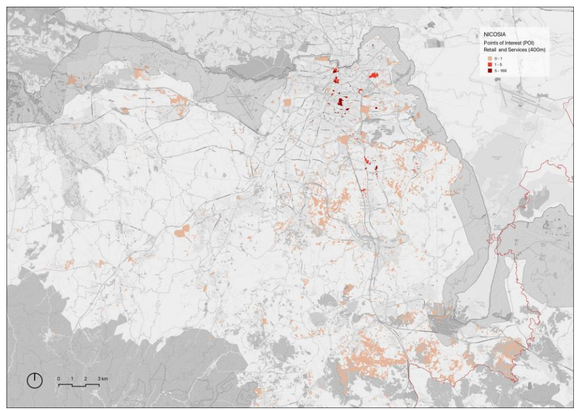


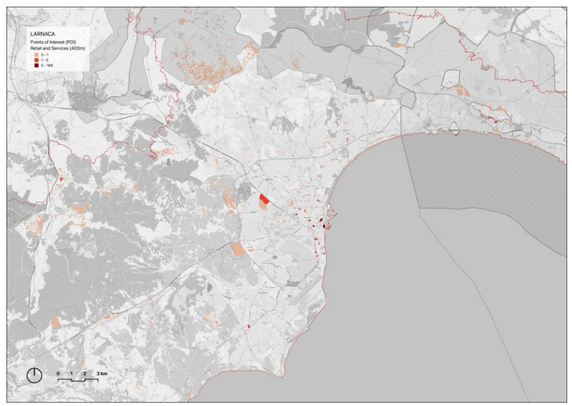


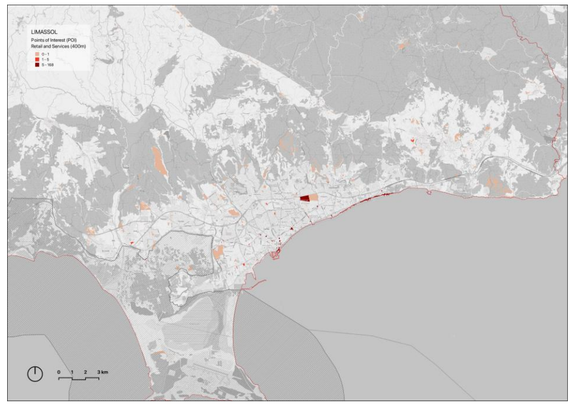
7. Point of Interest (POIs) – Retail and Services

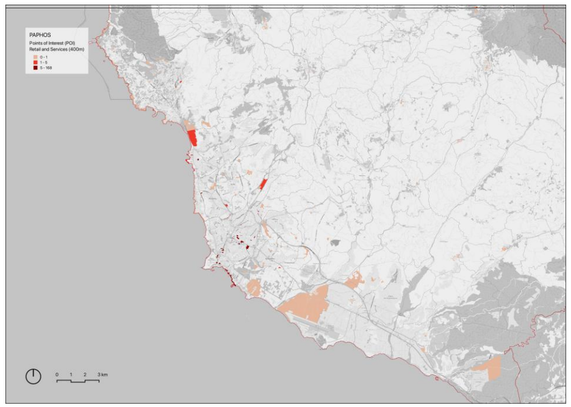
NAME	DESCRIPTION	QUESTION TO DEFINE IMPORTANCE	PRIORITY
P4_RS400_TotalCount400	**TOTAL COUNT OF RETAIL AND SERVICES SHOPS WITHIN 400M**	**The presence of retail and service amenities (e.g., supermarkets, pharmacies, bookstores, and beauty shops) can improve the accessibility and functionality of a location. How important is proximity to these amenities within an 400m radius in your decision-making process?**	**5**
P4_RS400_CountOfTypes400	COUNT OF DIFFERENT TYPE OF RETAIL AND SERVICES SHOPS WITHIN 400M	The diversity of retail and service amenities (e.g., supermarkets, pharmacies, bookstores, and beauty shops) can enhance the convenience and attractiveness of a location. How important is access to a variety of retail services within an 800m radius in your decision-making process?	3
P4_RS800_TotalCount800	TOTAL COUNT OF RETAIL AND SERVICES SHOPS WITHIN 800M	The presence of retail and service amenities (e.g., supermarkets, pharmacies, bookstores, and beauty shops) can improve the accessibility and functionality of a location. How important is proximity to these amenities within an 800m radius in your decision-making process?	4
P4_RS800_CountOfTypes800	COUNT OF DIFFERENT TYPE OF RETAIL AND SERVICE SHOPS WITHIN AN 800M RADIUS	The diversity of retail and service amenities (e.g., supermarkets, pharmacies, bookstores, and beauty shops) can enhance the convenience and attractiveness of a location. How important is access to a variety of retail services within an 400m radius in your decision-making process?	2

Point of Interest (POI) – Retail & Services (P4)









7. Point of Interest (POIs) – Banks and ATMs

NAME	DESCRIPTION	QUESTION TO DEFINE IMPORTANCE	PRIORITY
P4_BM400_TotalCount400	COUNT OF HOW MANY AMENITIES OF BANKS AND ATM WITHIN 400M	To evaluate accessibility to financial services, we analyze the count of banks and ATMs within a 400m radius of each parcel. This metric helps assess the suitability of parcels for governmental development by considering proximity to essential financial infrastructure	4
P4_BM400_CountOfTypes400	COUNT OF DIFFERENT TYPES OF AMENITIES OF BANKS AND ATM WITHIN 400M	The presence of various banking services, such as full-service bank branches and ATMs within a 400m radius, can enhance accessibility and convenience for governmental offices. How important is proximity to financial institutions in your site selection criteria?	2
P4_BM800_TotalCount800	COUNT OF HOW MANY AMENITIES OF BANKS AND ATM WITHIN 800M	To evaluate accessibility to financial services, we analyze the count of banks and ATMs within a 800m radius of each parcel. This metric helps assess the suitability of parcels for governmental development by considering proximity to essential financial infrastructure	4
P4_BM800_CountOfTypes800	COUNT OF DIFFERENT TYPES OF AMENITIES OF BANKS AND ATM WITHIN 800M	The presence of various banking services, such as full-service bank branches and ATMs within a 800m radius, can enhance accessibility and convenience for governmental offices. How important is multiple proximity to financial institutions in your site selection criteria?	2

7. Point of Interest (POIs) - Food and Drink

NAME	DESCRIPTION	QUESTION TO DEFINE IMPORTANCE	PRIORITY
P4_FD400_TotalCount400	**TOTAL COUNT OF FOOD AND DRINKS SHOPS WITHIN A 400M RADIUS**	**The presence of food and drink establishments, such as cafés, restaurants, and bars, can enhance the attractiveness and functionality of a location. How important is proximity to these amenities within a 400m radius, in your decision-making process?**	**5**
P4_FD400_CountOfTypes400	COUNT OF DIFFERENT TYPE OF FOOD AND DRINK SHOPS WITHIN A 400M RADIUS	The diversity of food and drink establishments, such as restaurants, cafés, and pubs, can influence the attractiveness and convenience of a location. How important is access to a variety of dining and social options within a 400m radius in your decision-making process?	3

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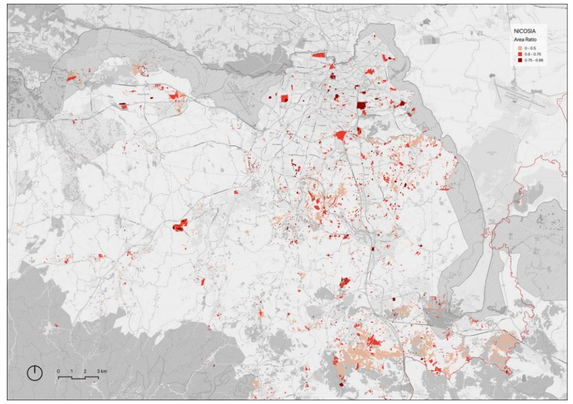
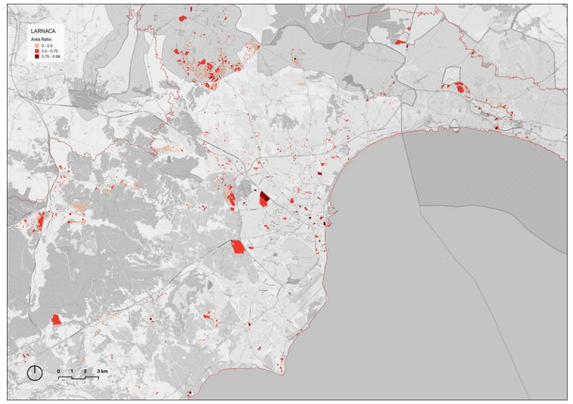
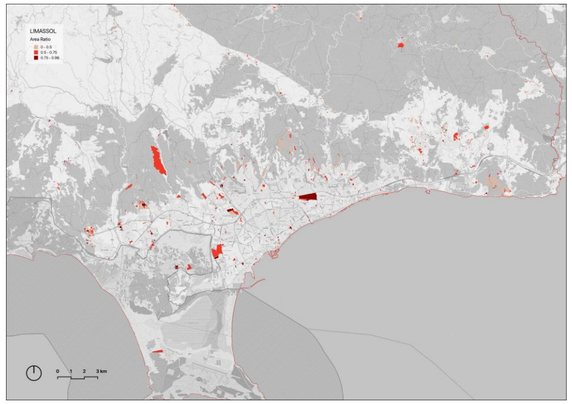
8. Geometry/Proportionality

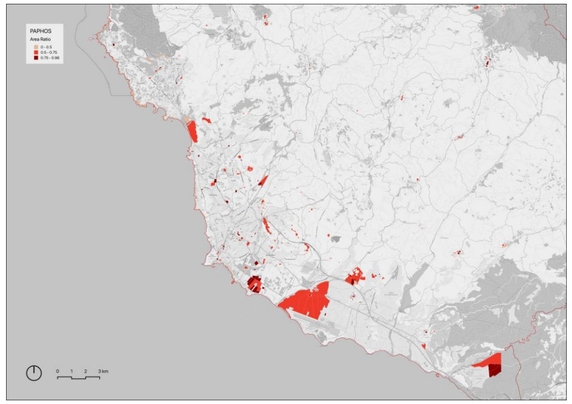
NAME	DESCRIPTION	QUESTION TO DEFINE IMPORTANCE	PRIORITY
P3_DimRatio	DIAGONAL TO HEIGHT RATIO OF BOUNDING REC	a parameter that classifies higher more canonical parcels	**5**
P3_AreaRatio	UCY AREA TO BOUNDING REC AREA	a parameter that classifies higher more canonical parcels	**5**

Area Ratio (P3)









PHASE B

4

ATTRIBUTE CLASSIFICATION

7. ATTRIBUTE CLASSIFICATION

- **A. Continuous (Range-Based) Parameters**
- **B. Categorical (Discrete) Parameters**
- **C. Discrete Numerical Variables**

Attribute Classification Datasets: Systematically categorize all collected variables to ensure compatibility with Multi-Criteria Analysis (MCA) and to allow appropriate normalization and weighting in subsequent steps.

A. Continuous (Range-Based) Parameters

Numerical variables exist on a continuous scale and typically influence suitability in a gradual manner:
Their values can be either beneficial (e.g., higher connectivity) or cost-related (e.g., higher land prices), depending on the planning context. Continuous variables require normalization to ensure comparability across different units and scales.

B. Categorical (Discrete) Parameters

Categorical parameters represent non-numeric or class-based values, such as land use categories or binary yes/no answers.
While these attributes are meaningful in planning, they require conversion into numerical form to be used within Multi-Criteria Analysis (MCA) frameworks like the Weighted Sum Model (WSM).

-Categorical Parameters Included in MCA

-Categorical Parameters Excluded from MCA (Used as Exclusion Filters)

C. Discrete Numerical Variables

Discrete numerical variables—often referred to as count variables—represent non-continuous, whole number values that quantify the presence or frequency of specific features within a defined spatial or contextual boundary.
In the context of this project, these variables primarily capture population-related indicators and counts of amenities, including both the total number and the diversity of types of amenities within specified distance thresholds (e.g., 400m, 800m).

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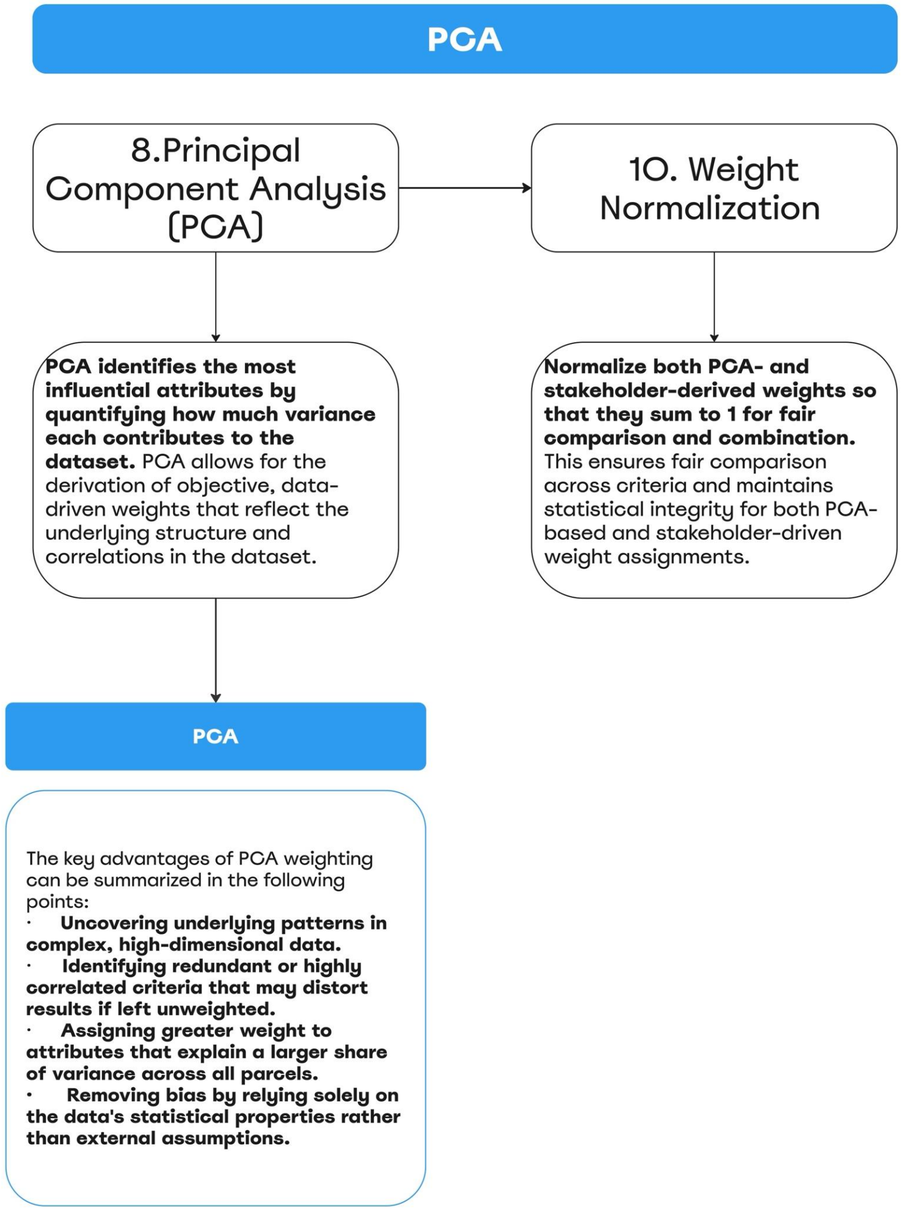
PHASE B

5



Data-Driven Weighting (Quantitative):
A Principal Component Analysis (PCA) was applied to the standardized dataset to identify which criteria contribute most to the total variance. Criteria with higher contributions were assigned higher weights. PCA offers a statistically robust way to detect patterns and reduce dimensionality, making it especially useful for objective prioritization.

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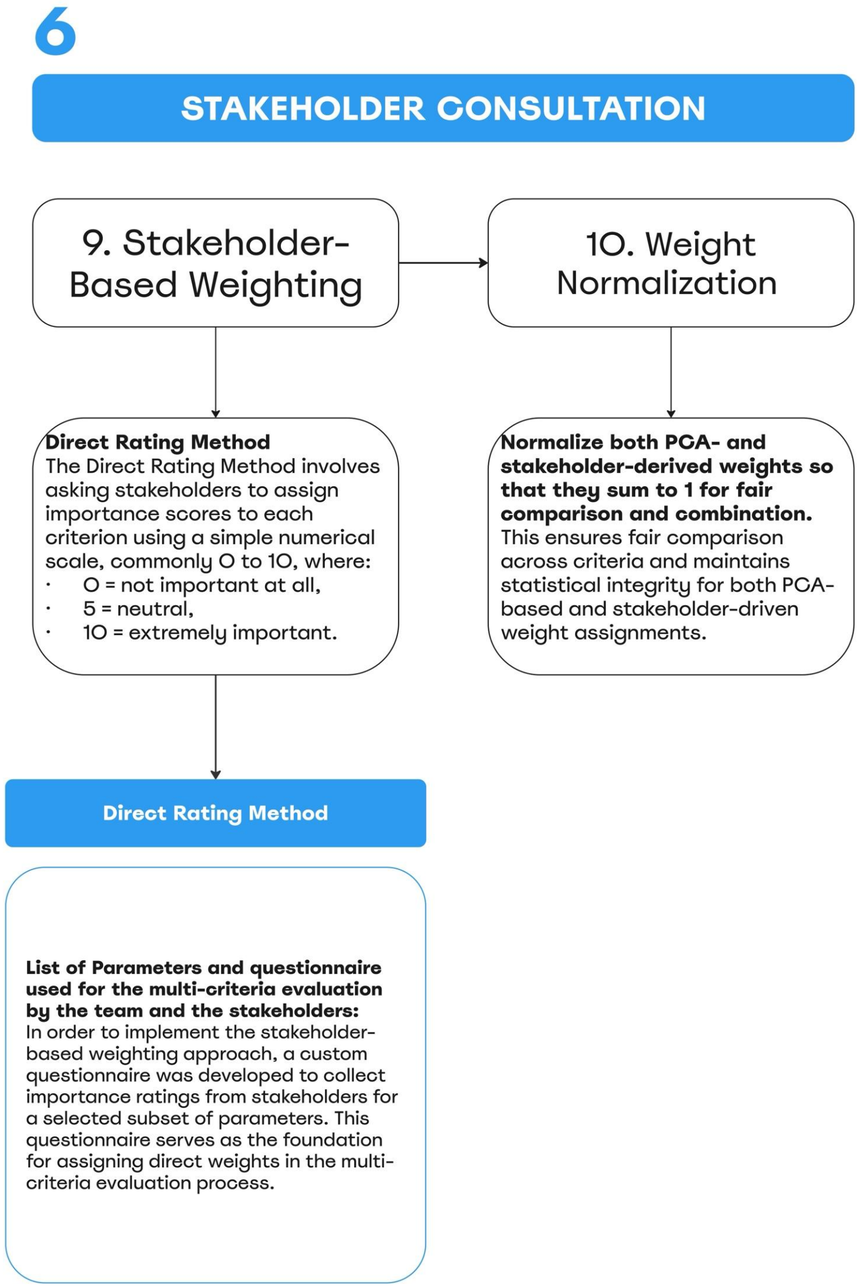
PHASE C

Expert-Driven Weighting (Qualitative)

A direct rating method was employed, allowing stakeholders to assign importance scores to each criterion on a scale (e.g., 0–10), where 5 represents neutrality. These ratings were then normalized to produce stakeholder-based weights. This method captures domain expertise, policy priorities, and contextual knowledge.



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Questionnaire - Direct Rating Method

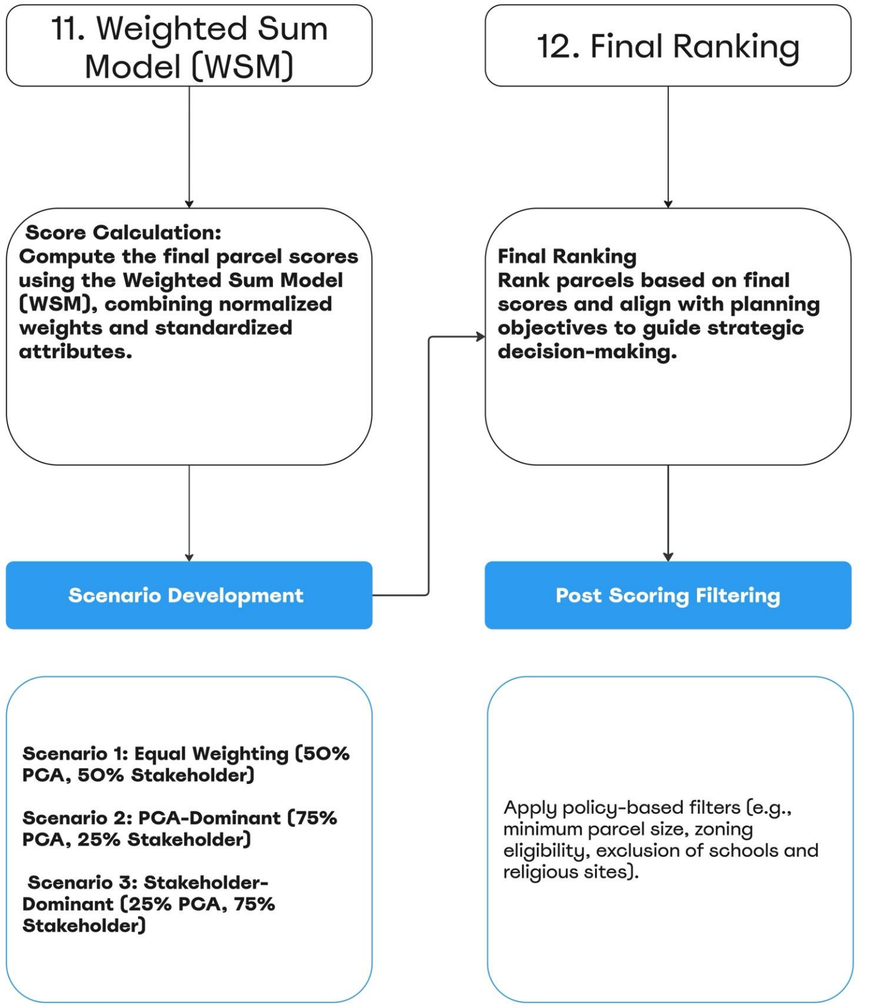
The questionnaire employed **a direct rating system, using a 0–10 scale**, enabling the team to quantify stakeholders will and priorities in a format that is accessible, transparent, and easily integrated into the multi-criteria evaluation model.

		DESCRIPTION	QUESTION TO DEFINE IMPORTANCE	PRIORITY
Stakeholders	Planning zone characteristics	1	ZONE TYPOLOGY	a simple classification about the zone typology that is broken down into 3 classes: most favorable Class 1: offices Class 2: commercial Class 3: allows to some extent the above	10
	Building Allowance	2	THE PARCEL AREA AS CALCULATED BY THE RESEARCHER'S TEAM	the parcel area, as calculated by the research team	10
		4	HOW MUCH SQM IT CAN BUILT	Building density defines how much total floor space can be constructed on a parcel. How important is maximizing buildable space when selecting a site for development?	10
		7	THE ALLOWED AND CALCULATED COVERAGE	Coverage percentage determines how much of the parcel's area can be built upon. Should parcels with higher coverage percentages be prioritized for more compact development, or should lower coverage percentages be preferred for open space and flexibility?	7
	Market Characteristics	3	LAND VALUE BASED ON 2021 PRICES	The economic feasibility of a site depends on land value. Should selection favor parcels with lower land costs to reduce investment, or should land value be weighed against other factors such as accessibility and zoning?	10
	Connectivity and Centrality Motorized Network	5	ANGULAR BETWEENNESS RADIUS 1200M, 5K, 10K, 20K FOR MOTORIZED NETWORK	How important is the parcel's role as a network hub within 1200M, 5K, 10K, 20K radius, influencing larger-scale connectivity?	10
		6	ANGULAR INTEGRATION RADIUS 1200M, 5K, 10K, 20K FOR MOTORIZED NETWORK	How important is this parcel in terms of overall connectivity within 1200M, 5K, 10K, 20K radius, impacting regional accessibility?	10
Experts	Population Reach	8	SERVICEABLE POPULATION FOR 200M, 400M, 800M, 1200M, 5K, 10K, 20K RADIUS	At 5km, the serviceable population includes a mix of city districts and suburban areas. Should site selection favor locations that cater to both central and peripheral populations?	7
	Transportation	9	COUNT OF REACHABLE BUS STOPS WITHIN 400M AND 800M	Proximity to public transportation is a key factor in accessibility. How important is it for the selected parcel to have multiple bus stops within a 400m walking distance to enhance convenience for daily users?	6
	Proximity to Amenities	10	TOTAL COUNT OF RETAIL AND SERVICES SHOPS WITHIN 400M AND 800M	The presence of retail and service amenities (e.g., supermarkets, pharmacies, bookstores, and beauty shops) can improve the accessibility and functionality of a location. How important is proximity to these amenities within an 400m radius in your decision-making process?	5
		11	TOTAL COUNT OF FOOD AND DRINKS SHOPS WITHIN A 400M AND 800M RADIUS	The presence of food and drink establishments, such as cafés, restaurants, and bars, can enhance the attractiveness and functionality of a location. How important is proximity to these amenities within a 400m radius, in your decision-making process?	5
	Geometry	12	UCY AREA TO BOUNDING REC AREA	a parameter that classifies higher more canonical parcels	5
	Connectivity and Centrality Non - Motorized Network	13	ANGULAR BETWEENNESS RADIUS of 200M, 400M, 800M, 1200M FOR NON-MOTORIZED NETWORK	How important is this location for pedestrian and bicycle flow across a 1.2 km radius, helping movement through the area?	4
		14	ANGULAR INTEGRATION RADIUS 200M, 400M, 800M, 1200M FOR NON-MOTORIZED	How accessible is this location for non-motorized movement within a 1.2 km radius, ensuring walkability and ease of travel?	4
	Existing Development	15	EXISTING BUILDING DEVELOPMENT	If the parcel has an existing development	2

PHASE C

7

SCORE CALCULATION



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Multi-Criteria Decision Analysis

Results (Sc1)

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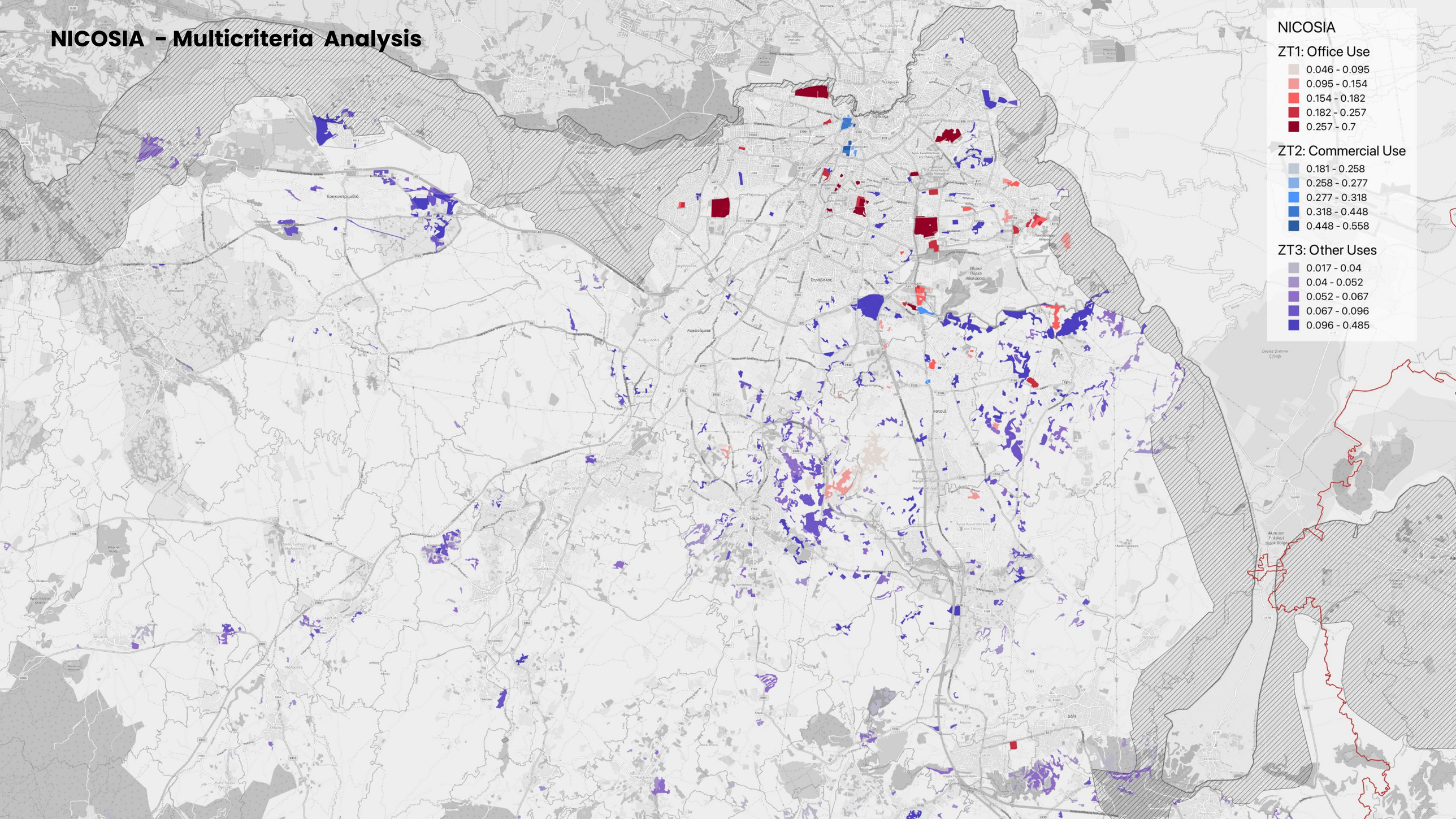
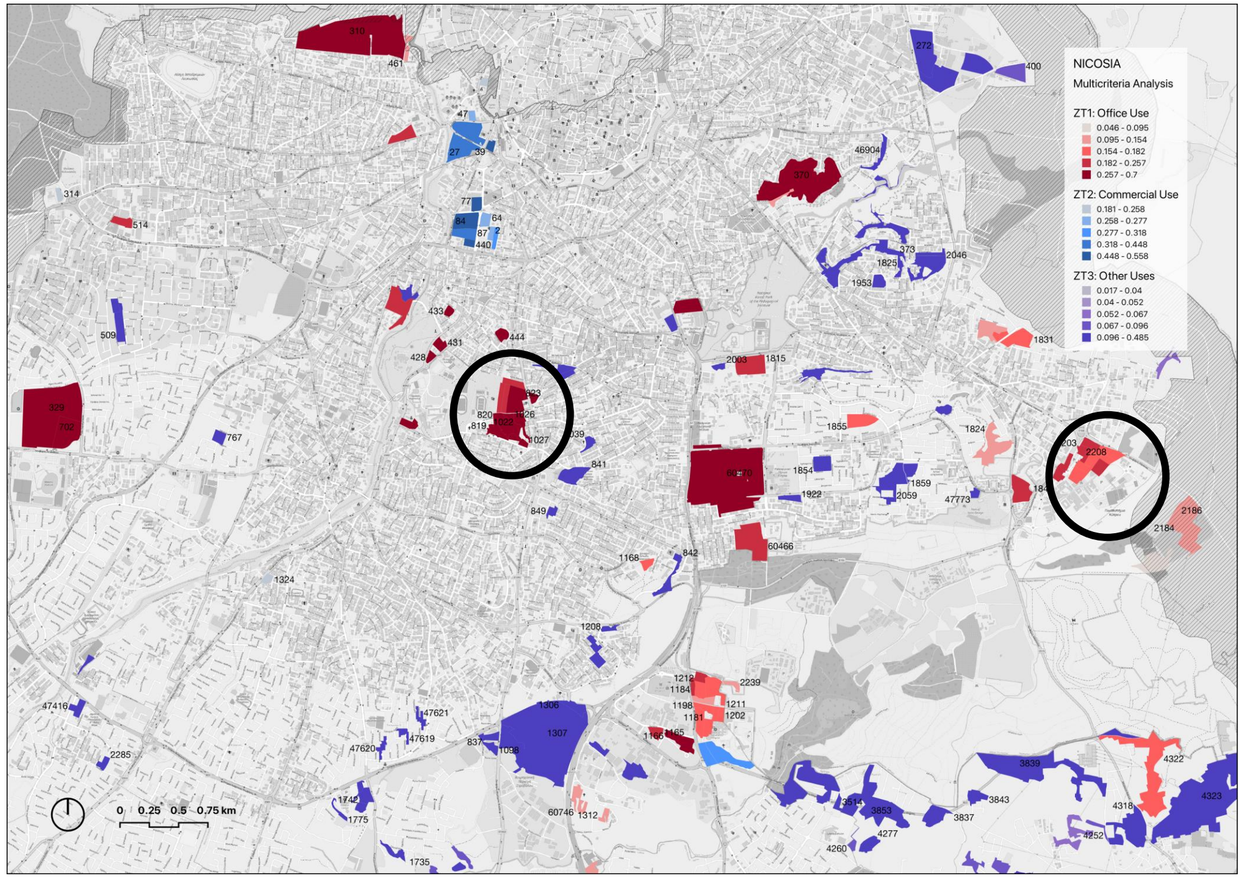
NICOSIA - Multicriteria Analysis



NICOSIA - Multicriteria Analysis



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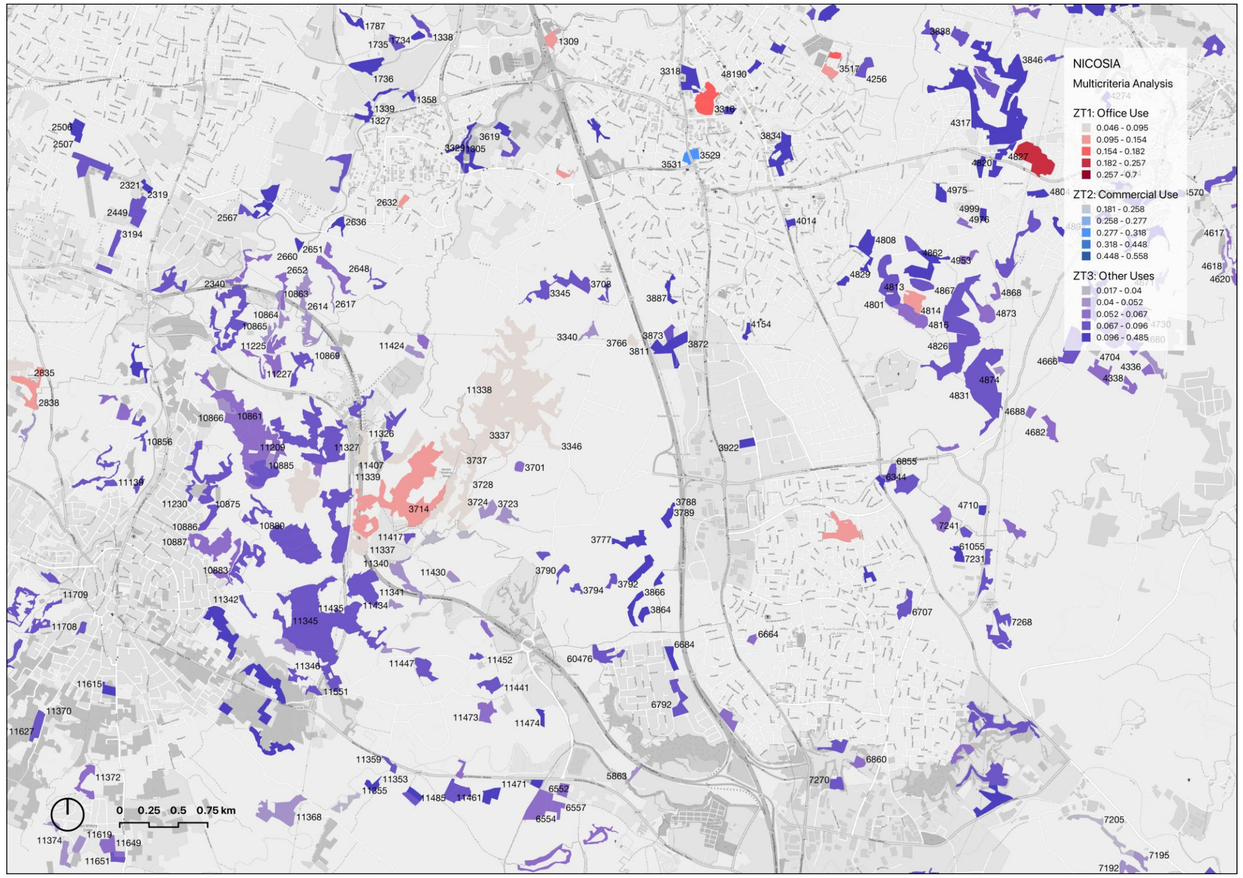

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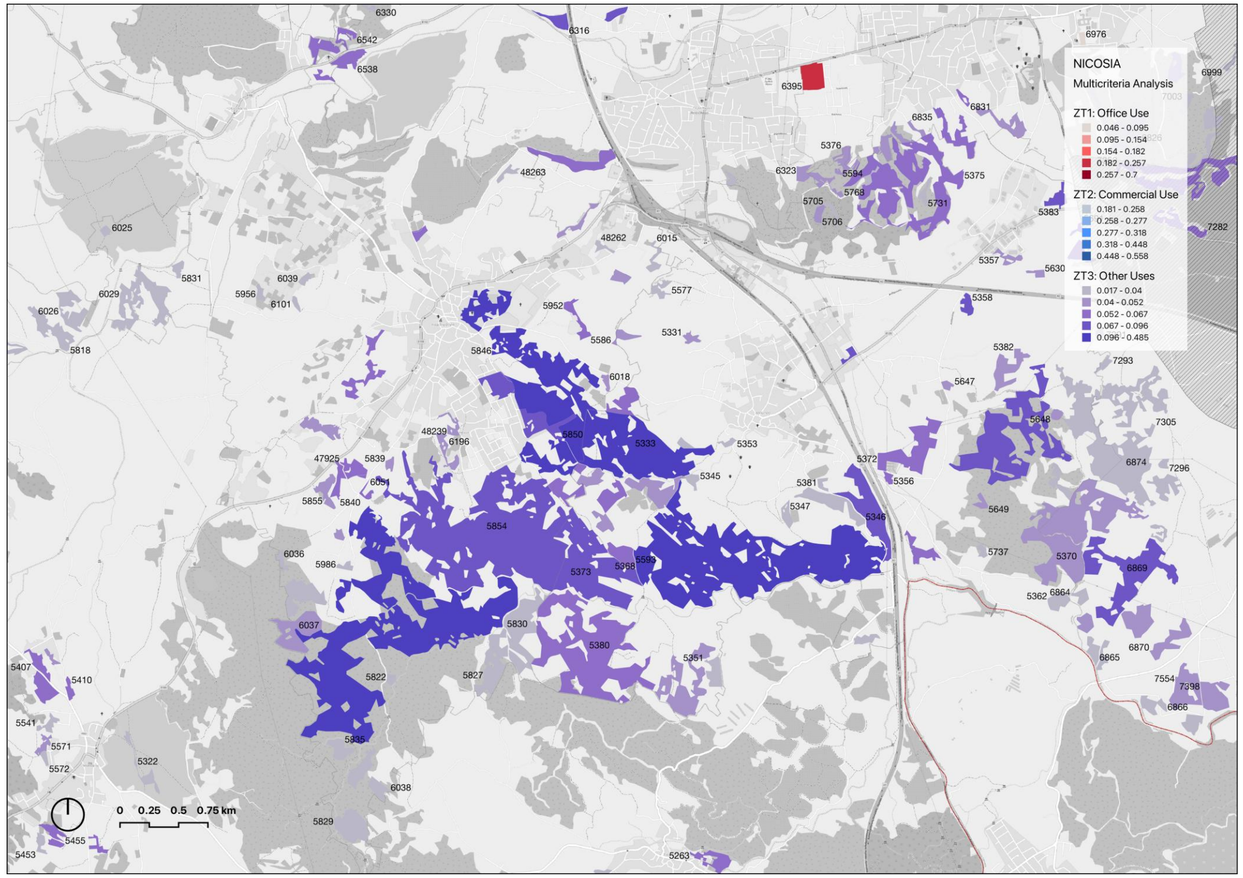
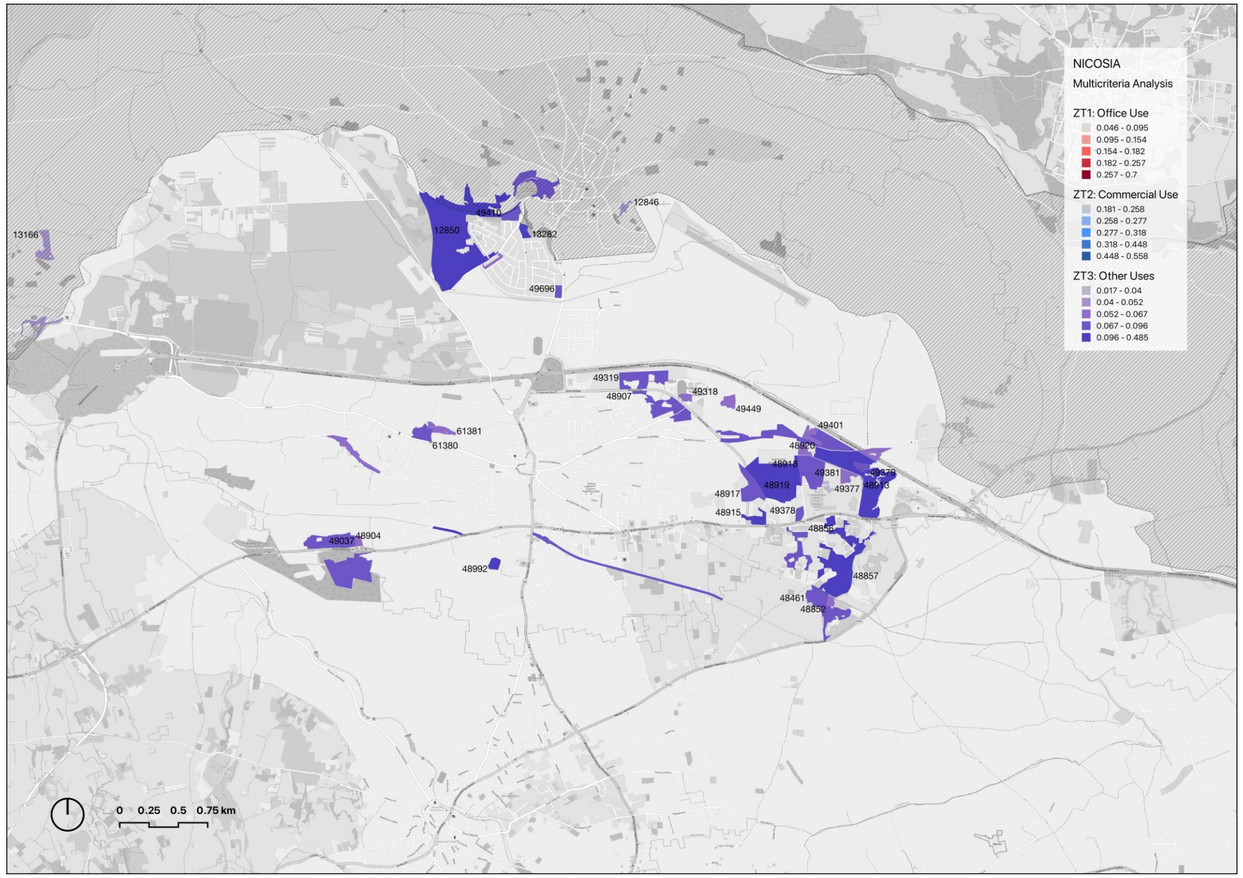
NICOSIA - Multicriteria Analysis



ALAMBRA



LYMPIA

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Web GIS
Online Platform

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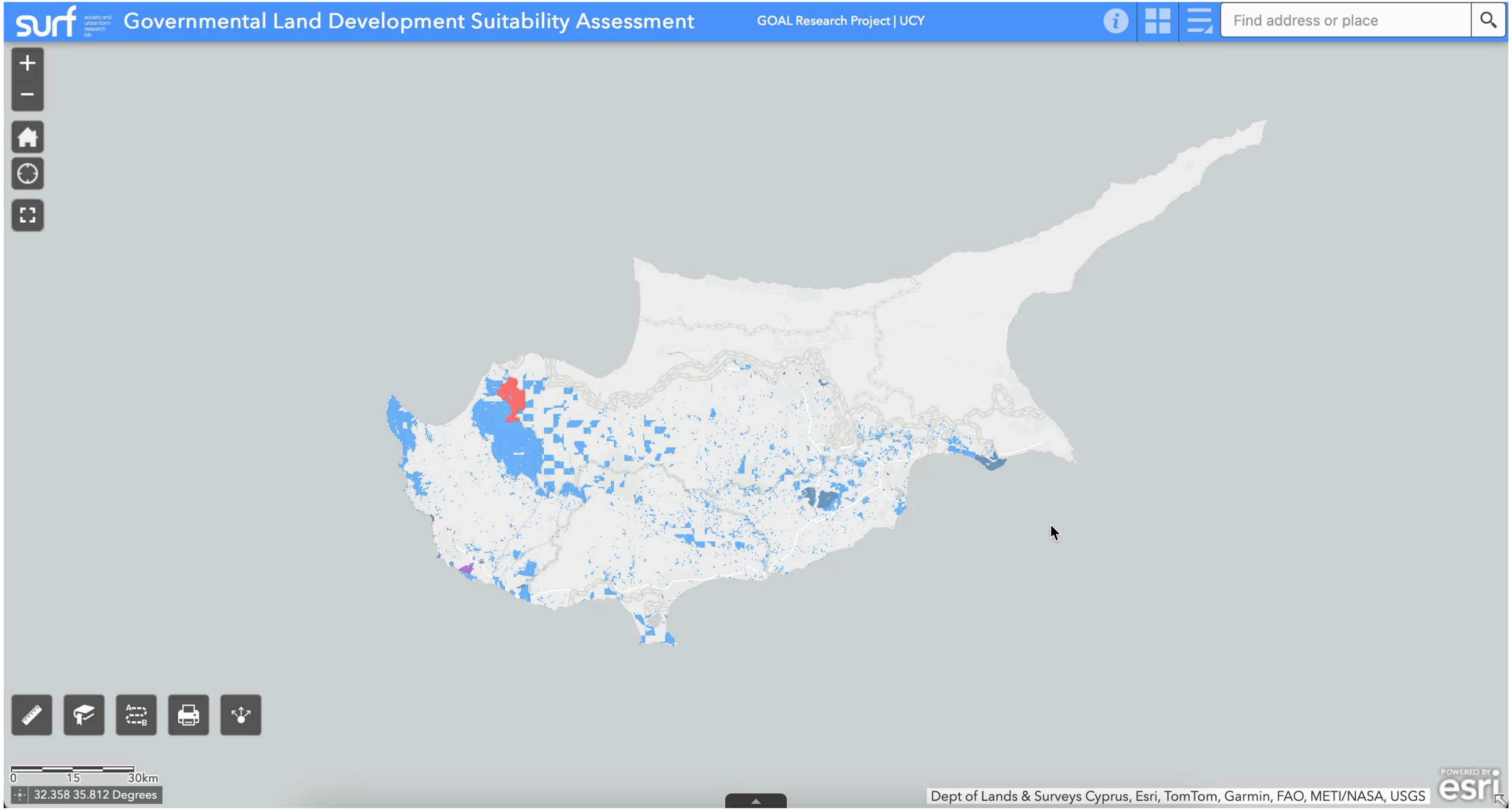
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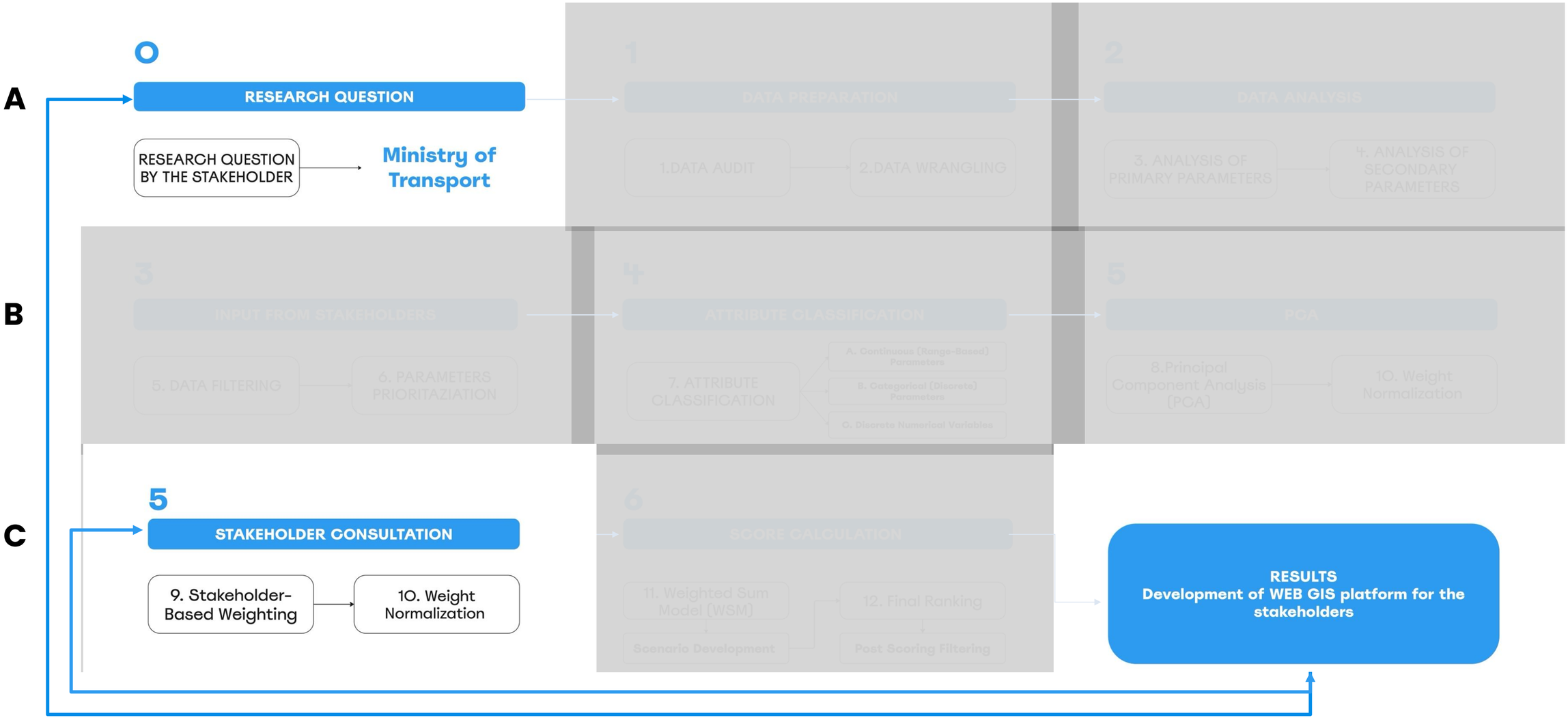
An Iterative Process



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Conclusions

Multicriteria Analysis with a Weighted-Sum Model as an Iterative Decision-Making Process

By combining the Weighted-Sum Model with multicriteria analysis, we developed an iterative workflow in which stakeholder-derived and PCA-driven weights can be adjusted and the model re-run on demand. This replicable methodology supports transparent “what-if” scenario testing, accelerates consensus among diverse stakeholders, and transforms spatial analysis into a dynamic, evidence-based planning tool.

Web GIS as Dynamic Database for stakeholders Decision making

By consolidating all spatial analysis outcomes into a single web-based GIS portal, we created a live, collaborative database. Non expert stakeholders can filter parcels by multiple parameters, switch between weighting scenarios, visualise connectivity or land-use layers on demand, and export customised reports without technical intermediaries. The platform eliminates version conflicts, democratises access to spatial analysis, and accelerates consensus-building across diverse agencies.

This iterative process empowered stakeholders to develop new research questions, demonstrating the adaptability and effectiveness of the developed decision-making model.

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Next steps

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