Resilient İzmir Project

Sub-Deliverable 1.1 — Data Review & Urban Systems Vulnerability Analysis

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Table of Contents

Executive Summary

This deliverable fulfills the requirements of Tasks 1 through 5 of the Terms of Reference (ToR). It presents a rigorous critical review of existing building stock, urban systems, and infrastructure data; assesses their adequacy and usability (Grades A/B/C); investigates structural damage patterns from the 30 October 2020 Samos–İzmir earthquake; compiles a 1980–2025 multi-hazard disaster catalogue; models topological vulnerabilities across the metropolitan road network; and synthesises systemic failure points in a SWOT framework.

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1. Introduction & Conceptual Framework

Disaster risk across metropolitan İzmir is modeled as the interaction of Hazard (H), Exposure (E), Vulnerability (V), and Capacity (C). The operational synthesis establishes an indicative spatial prioritization in which institutional and spatial capacity acts as a risk-reducing denominator.

Metropolitan İzmir faces complex multi-hazard threats: active fault lines, deep alluvial basin resonance in Bayraklı and Bornova, coastal storm surge, pluvial flooding, urban heat stress, and wildland-urban interface (WUI) wildfires. To address data heterogeneity, a two-tiered spatial approach is employed: * **Tier A (Metropolitan Screening):** Indicator-based screening across all 1,317 neighbourhoods in 30 districts. * **Tier B (High-Resolution Deep-Dive):** Building- and street-level assessment in Bayraklı, Bornova, and Konak.

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2. Data Review, Usability & Gap Analysis (ToR T1)

2.1. Institutional Data Spine & Provider Attribution

All spatial layers are maintained in controlled local working copies. In all external and public deliverables, the data provider is uniformly identified as **İzmir Büyükşehir Belediyesi**. The analytical Coordinate Reference System (CRS) is verified as **EPSG:5253 (TUREF/TM27)**.

2.2. Data Adequacy Matrix (Grades A/B/C)

Available datasets are classified by decision-grade reliability (**Table 1**):

Table 1: Data Adequacy and Usability Matrix | Dataset | Source Provider | Coverage | Evidence Grade | Analytical Role & Known Limitations | |—|—|—|:—:|—| | Neighbourhood Boundaries | İzmir BB | 1,317 Units | **A** | Primary spatial aggregation unit; verified topology | | Building Footprints | İzmir BB | 868,140 Polygons | **A** | Building footprint density (E_2); footprint area | | Road Network Spine | İzmir BB | 207,257 Segments | **B** | Road coverage density (N_1); topological connectivity | | 5 m DSM (Elevation) | İzmir BB | Metropolitan | **A** | Slope analysis (H_3); low-elevation coastal proxy (H_4) | | Population (2024) | TÜİK | 804 Units | **B** | Population density (E_1); disclosure threshold >= 500 | | Vs30 Soil Support | Support Raster | 1,317 Centroids | **B** | Relative soil softness proxy (H_2); not microzonation | | Emergency Shelters | İzmir BB / AFAD | 71 Polygons | **B** | Euclidean distance catchment bands (C_3) | | Structural Fragility | Municipal / TMMOB | 3 Districts | **C** | Authorised records pending; omitted from Tier-A | | Lifeline Networks | İZSU / GDZ / İzmirgaz | Missing | **C** | Vector layers absent; treated via qualitative scenarios |

2.3. Census Population Join & Quality Assurance

The 2024 neighbourhood census dataset suppresses records for units below 500 residents. Exactly 804 of the 1,317 neighbourhood polygons matched census records via normalized spatial joins. The remaining 513 rural or sparsely populated units are preserved as missing values (NA) to prevent distortion.

3. Multi-Hazard Profile & Historical Disasters (ToR T4)

3.1. 30 October 2020 Samos–İzmir Earthquake Damage

Official post-disaster assessments in IRAP 2025 demonstrate that 718 buildings suffered critical failure (**Table 2**):

Table 2: Building Damage Distribution from 30 October 2020 Earthquake (IRAP 2025) | Damage Classification | Building Count | Dwelling / Unit Count | Percentage (%) | |—|:—:|:—:|:—:|:—:| | **Collapsed (Yıkık)** | 65 | 602 | 0.04% | | **Emergency Demolition** | 35 | 425 | 0.02% | | **Heavily Damaged** | 618 | 7,240 | 0.34% | | **Critical Damage Total** | **718** | **8,267** | **0.39%** | | **Moderately Damaged** | 660 | 9,204 | 0.36% | | **Lightly Damaged** | 7,671 | 68,322 | 4.18% | | **Undamaged** | 173,735 | 689,314 | 94.69% | | **Total Inspected** | **183,484** | **775,107** | **100.00%** |

3.2. Historical Disaster Catalogue (1980–2025)

Analysis of 444 historical events across metropolitan İzmir indicates that 41.2% were floods/flash floods, 22.3% were severe windstorms/gales, and 14.4% were wildfires. The 2025 Sındırgı (Balıkesir) $M_w 6.1$ sequence underscored ongoing seismic hazards along the northern perimeter.

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4. Lifelines & Urban Systems Vulnerability (ToR T2, T3)

4.1. Road Network Graph Topology & Failure Points

The road graph comprises 149,798 nodes and 207,257 edges. Fourteen major highway bridges and overpasses along Altınyol, Ankara Asphalt, and Yeşildere constitute critical single points of failure.

4.2. Emergency Shelter Accessibility

Analysis of 71 designated emergency shelter polygons demonstrates that **50.4% of neighbourhoods lie outside the 15-minute walking catchment (1,200 m)**. Dense historic quarters in Konak and Karşıyaka suffer from acute open space deficits ($< 1.5\ \mathrm{m}^2$/capita).

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5. SWOT Matrix for Urban Systems Resilience (ToR T5)

Table 3: SWOT Matrix for Urban Resilience in İzmir | Strengths (S) | Weaknesses (W) | |—|—| | • Comprehensive municipal GIS database and 5 m DSM.• Substantial institutional memory via AFAD IRAP.• High-calibre academic and professional DRM expertise. | • Complete absence of citywide building-level structural data.• Lack of utility and lifeline vector GIS models.• Critical deficits in emergency shelter capacity in urban cores. | | **Opportunities (O)** | **Threats (T)** | | • World Bank TAFF technical assistance framework.• Tiered (A/B) design directing resources to verified hotspots.• Integration of digital-twin and early-warning systems. | • Deep alluvial basin resonance during regional earthquakes.• Climate-driven compound pluvial and storm surge flooding.• Cascade failure of critical transport viaducts. |