Appendix E Indicators selected for the assessment of Bucharest's URCs

The following pages present the indicators selected for the assessment of URC Dâmbovița and URC Colentina in Chapter 6, as summarised in Table.App.E.1. Each indicator includes: a definition, the results on the scale of the URC, an illustration of a corridor segment, and data- or implementation-specific notes.

	SELECTED INDICATORS	URC
Connectivity		
Longitudinal		
Social	A.1.1.1a Slow mobility routes - continuitiy	URC Dâmbovița
	A.1.1.1b Slow mobility routes - %	URC Dâmbovița
Ecological	A.2.1.1a Landscape connectivity - connected components	URC Dâmbovița
Lateral		
Social	A.1.2.1a Accessibility - network	URC Dâmbovița, URC Colentina
	A.1.2.1c Accessibility - visitors	URC Dâmbovița
	A.1.2.3a Crossability - linear density of crossings	URC Dâmbovița
	A.1.2.3b Crossability - river width	URC Dâmbovița
Ecological	A.2.2.1 Presence of transversal corridors	URC Dâmbovița
	A.2.2.3 Sinuosity	URC Dâmbovița
Vertical		
Social	A.1.3.1a Contact with water - points	URC Dâmbovița
Ecological	A.2.3.1 Presence of ecotones	URC Dâmbovița
Spatial capacity		
Diversity		
Social	B.1.1.1a Diversity of land uses—patch richness density	URC Dâmbovița
Ecological	B.2.1.1 Biodiversity—presence of species-rich areas	URC Dâmbovița
Quality		
Social	B.1.2.1a Visual permeability - % of visible river space	URC Dâmbovița
Ecological	B.2.2.4 Respect of natural dynamics	URC Dâmbovița
Porosity		
Social	B.1.3.2a Waterfront constitutedness - configuration	URC Dâmbovița
Ecological	B.2.3.1a Coverage - % open space	URC Dâmbovița
	B.2.3.1b Coverage - % green space	URC Colentina

TABLE APP.E.1 Indicators selected for the assessment of URC Dâmbovița and URC Colentina.

Continutiy of riverside slow mobility routes (A.1.1.1a)

Definition:

The presence and continuity of slow mobility routes along the river is measured at the scale of the corridor segment as **[1] absent**; **[2] discontinuous**; **[3] continuous**.

Input data:

- Corridor segment boundary
- Bike path network within the corridor segment (OSM)[79]
- Water polygon within the corridor segment (OSM)
- Buffer distance[80]

Implementation:

1. A buffer of 25m from the river polygon is created. To isolate the riverside slow mobility routes, the bike path network is clipped with the 25m buffer. If the clipped network is empty (NULL), then the value **[1] absent** is assigned to the corridor segment and the following steps are skipped.
2. Another buffer of 25m is created from the end edges of the water polygon, i.e. the edges which intersect the corridor segment boundary. To check the continuity of the bike path network across the corridor segment, the clipped bike path network is intersected with the end segment buffers. If at least one of the two end buffers does not intersect the bike path network, than the value **[2] discontinuous** is assigned and the following step is skipped.
3. If both end segments intersect the bike paths, then the network is checked for the number of connected components. If the number of components is >1, then the value **[2] discontinuous** is assigned. Otherwise, the bike path network is considered to be **[3] continuous**.

Results CS03:

- Geometry: **NOT NULL**
- No. of connected components: **1**
- No. of connected ends: **1**/2
- Continuity of riverside slow mobility routes: **discontinuous**

79 The OSM data used in this assessment needs to be confronted with the real-world situation, as some bike ways may not be in fact usable.

80 In case of River Dâmbovița, a buffer distance of 25m was considered to be sufficient for the selection of riverside bike paths. A larger buffer might be needed in other cases, therefore it needs to be determined according to the specific configuration of the riverfront that is being assessed.

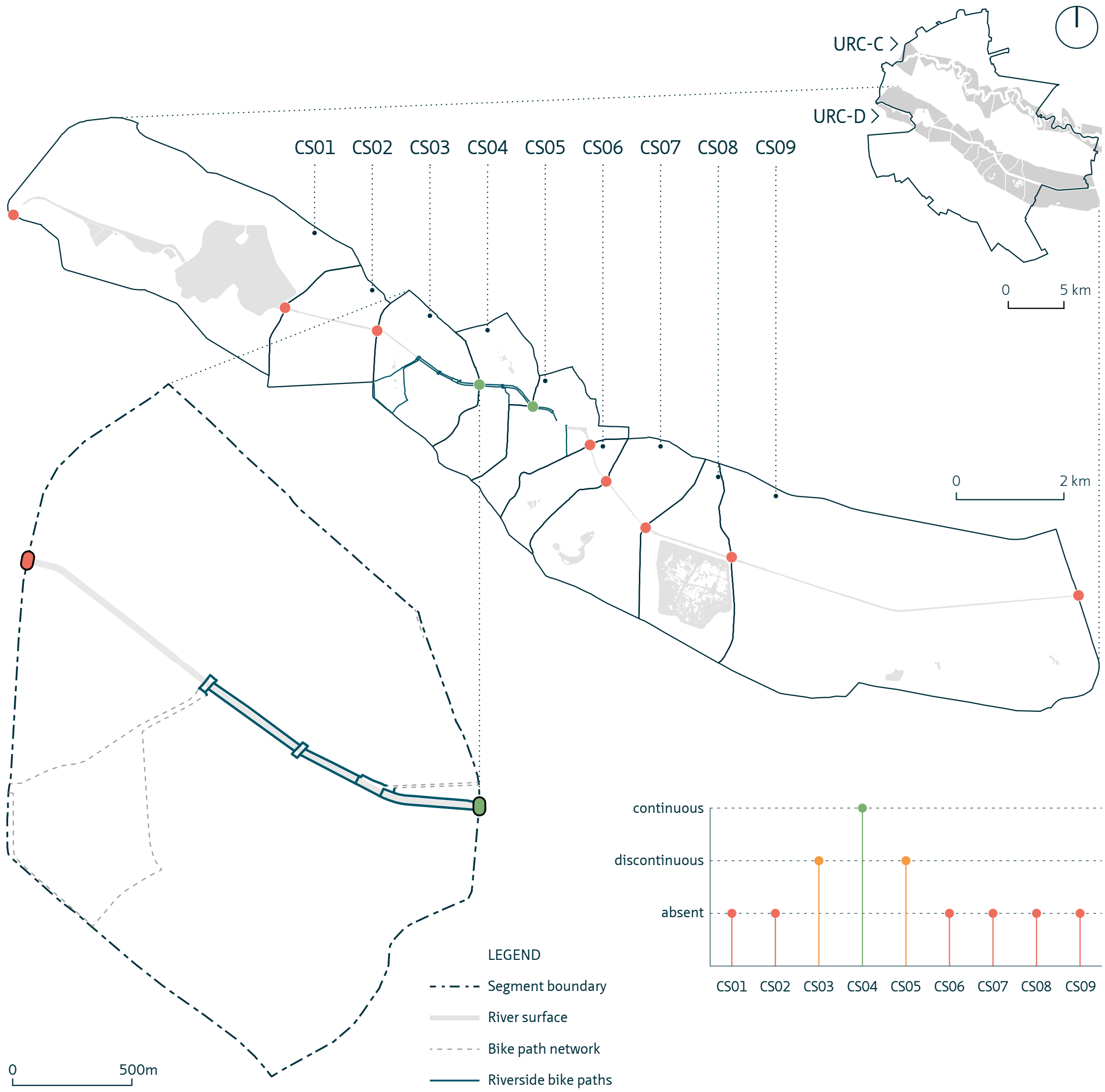

FIGURE APP.E.1 Continuity of slow mobility routes along URC Dâmbovița, with detail of CS03.

SEGMENT	VALUE	INDEX
CS01	absent	1
CS02	absent	1
CS03	discontinuous	2
CS04	continuous	3
CS05	discontinuous	2
CS06	absent	1
CS07	absent	1
CS08	absent	1
CS09	absent	1

TABLE APP.E.2 Results of indicator A.1.1.1a.

Percentage of riverside slow mobility routes (A.1.1.1b)

Definition:
This indicator measures the percentage of waterside slow mobility routes out of the total length of the riverside paths. The following three-point scale is used: **[1] <50%**; **[2] ≥50** or **<75%**; **[3] ≥75%**.

Input data:
- Corridor segment boundary
- River polygon (OSM: nature=water + waterway=riverbank)[81]
- Road network within the corridor segment (OSM: highway=*)
- Bike path network within the corridor segment (OSM: highway=cycleway OR highway=pedestrian OR highway=path OR highway=footway OR highway=bridleway)
- Buffer distance[82]

Implementation:
1. A buffer of 25m from the river polygon is used to clip the road segments.
2. In order to outline the riverbanks, the river polygon is transformed into lines and the end segments—that is, the lines intersecting the corridor segment boundary— are removed.
3. The bike paths are extracted from the clipped road segments. Both the clipped road segments and the extracted bike paths are buffered with 5 meters. The two buffers are then intersected with riverbanks.
4. The percentage of slow mobility routes is calculated from ratio between the lines resulted from the intersection of the clipped road buffer with the riverbanks ($\mathbf{L_R}$) and from the clipped bike path buffers with the riverbanks ($\mathbf{L_{BP}}$) respectively.

Results CS03:
- L_R = **4066,7m**
- L_{BP} = **2222,8m**
- Percentage of riverside slow mobility routes: **55%**

81 If the river polygon is interrupted by bridges, the polygon needs to be completed before it can be used as an input.

82 In case of River Dâmbovița, a buffer distance of 25m was considered to be sufficient for the selection of riverside bike paths. A larger buffer might be needed in other cases, therefore it needs to be determined according to the specific configuration of the riverfront that is being assessed.

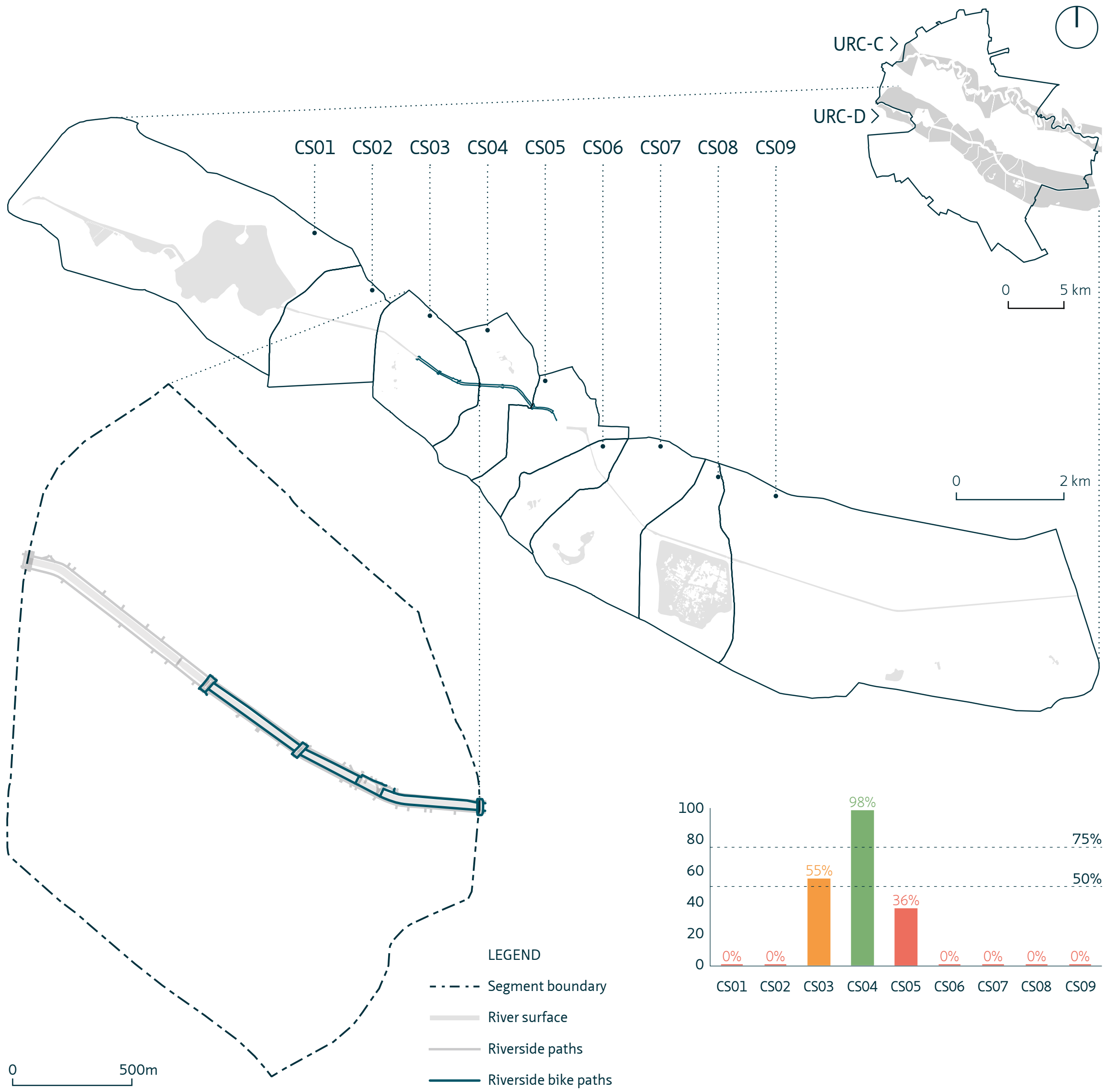

FIGURE APP.E.2 Percentage of slow mobility routes along URC Dâmbovița, with detail of CS03.

SEGMENT	VALUE	INDEX
CS01	0.00%	1
CS02	0.00%	1
CS03	54.66%	2
CS04	98.25%	3
CS05	35.72%	1
CS06	0.00%	1
CS07	0.00%	1
CS08	0.00%	1
CS09	0.00%	1

TABLE APP.E.3 Results of indicator A.1.1.1b.

Network accessibility (A.1.2.1a)

Definition:

Network accessibility[83] is indicated by the percentage of the total length of riverside segments classified into low, medium and high local integration (R500m), compared to local integration (R500m) of the road network of the whole city. Values: **[1] low**, when medium and high values of local integration are below city low values; **[2] medium**, when medium values are higher than city values, and high values are lower than city values; **[3] high**, when high values are higher than city values.

Input data:

- Corridor segment boundary
- River polygon (OSM: nature=water + waterway=riverbank)[84]
- Road network of the city (OSM: highway=*)
- Buffer distance[85]

Implementation:

1. Before performing the analysis on the road network on city scale, isolated components are excluded from the network and the OSM road centrelines are simplified using the ArcGIS tools for Topological Inconsistency and Line Simplification proposed by Kimon Krenz (2017).[86]
2. Space Syntax analysis of local integration R500m is performed for the city with the *SS toolkit* in QGIS.
3. The result of the analysis is classified in quantiles into [1] low; [2] medium; and [3] high values.
4. A buffer of 25m from the river polygon is used to isolate riverside paths from the classified network.[87]
5. Network accessibility in the corridor segment is evaluated as follows:

- If the total percentage of the total length of riverside paths classified as high is more than the percentage of all road segments of the city with high value, than the score is **[3] high**;
- Else if the total percentage of the total length of riverside paths classified as medium is more than the percentage of all road segments of the city with medium value, than the score is **[2] medium**;
- Else the score is **[1] low**.

Results for CS03:

- Percentage of road segments with high value: **8,68%** < city high value 15,50%
- Percentage of road segments with medium value: **43,63%** > city medium value 23,95%
- Percentage of road segments with low value: **47,69%** < city low value 60,56%
- Network accessibility: **2**

83 In Space Syntax theory integration is a measure of accessibility (e.g. Hillier, 2012).

84 If the river polygon is interrupted by bridges, the polygon needs to be completed before it can be used as an input.

85 In case of River Dâmbovița, a buffer distance of 25m was considered to be sufficient for the selection of riverside bike paths. A larger buffer might be needed in other cases, therefore it needs to be determined according to the specific configuration of the riverfront that is being assessed.

86 The workflow presented by Krenz (2017) includes two more steps: Dual Line Removal and Road Detail Removal. The algorithms used in those steps haven't given satisfying results and were excluded from this workflow. On the other hand, the algorithms addressing Topological Inconsistency and Line Simplification have reduced considerably the amount of road segments without altering the results of the analysis.

87 In case of River Dâmbovița, a buffer distance of 25m was considered to be sufficient. The buffer is case specific and needs to be determined according to the specific configuration of the riverfront that is being assessed.

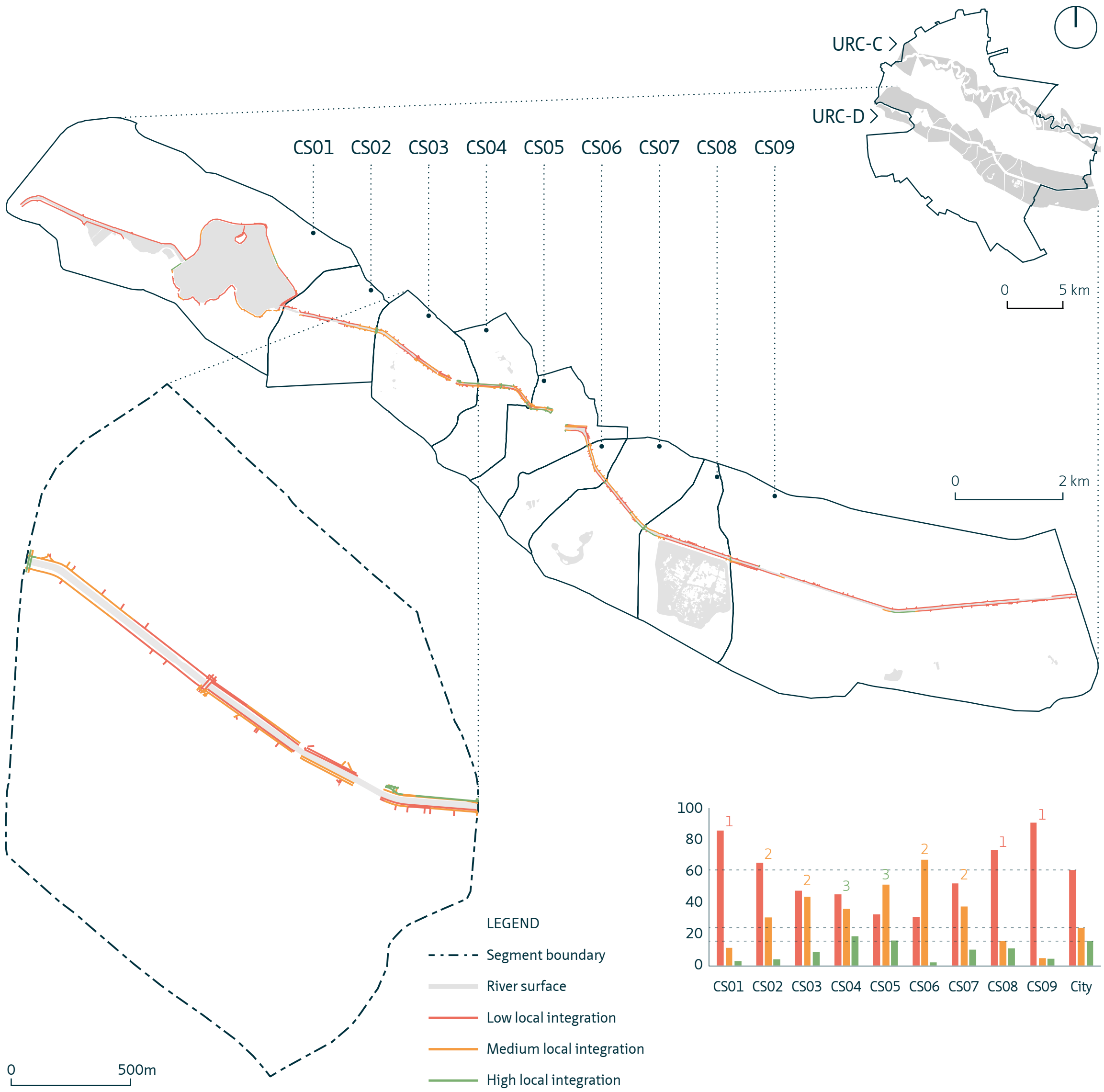

FIGURE APP.E.3 Network accessibility along URC Dâmbovița, with detail of CS03.

SEGMENT	PLEN1	PLEN2	PLEN3	INDEX
CS01	85.86%	11.39%	2.75%	1
CS02	65.36%	30.70%	3.94%	2
CS03	47.69%	43.63%	8.68%	2
CS04	45.31%	36.15%	18.54%	3
CS05	32.71%	51.46%	15.82%	3
CS06	30.90%	67.10%	2.00%	2
CS07	52.26%	37.51%	10.23%	2
CS08	73.54%	15.41%	11.05%	1
CS09	90.84%	4.72%	4.45%	1

TABLE APP.E.4 Results of indicator A.1.2.1a.

Public transport accessiblitiy (A.1.2.1c)

Definition:

Accessibility of the river space by pedestrians from public transport stops (bus, tram, metro) per corridor and river segment. This indicator shows the percentage of the total river length accessible by public transport in a 500m distance. Values: **[1] below 50%**; **[2] medium 50%-75%**; **[3] above 75%**.

Input data:

- Corridor segment boundary
- River polygon (OSM: nature=water + waterway=riverbank)[88]
- Road network within the corridor segment (OSM: highway=*)
- Metro, bus and tram stops (OSM: railway=station + highway=bus_stop + railway=tram_stop)
- Radii for bus/tram stops and metro stations
- Buffer distance[89]

Implementation:

1. Metro stops in a search distance of 500m and bus/tram stops in a search distance of 250m around the corridor segment boundary are selected as potential access points from the public transport network to the river.[90]
2. Riverside paths are clipped from the road network with a buffer of 25m from the water polygon.
3. Service areas are calculated from the bus and tram stops (250m) and from the metro stops (500m). The two service areas are merged. The percentage of the riverside paths which are included in the merged service area provides the value of this indicator, as follows: **[1] < 50%**; **[2] 50-75%**; **[3] > 75%**.

Results for CS03:

- Length of riverside paths inside the compond service area: **4066,7m**
- Length of riverside paths inside the compond service area: **4066,7m**
- Public transport accessibility: **100%**

88 If the river polygon is interrupted by bridges, the polygon needs to be completed before it can be used as an input.

89 In case of River Dâmbovița, a buffer distance of 25m was considered to be sufficient for the selection of riverside bike paths. A larger buffer might be needed in other cases, therefore it needs to be determined according to the specific configuration of the riverfront that is being assessed.

90 These values represent distances that people are willing to walk to/from public transport stops. Search distances outside the boundaries of the corridor segment were selected accordingly.

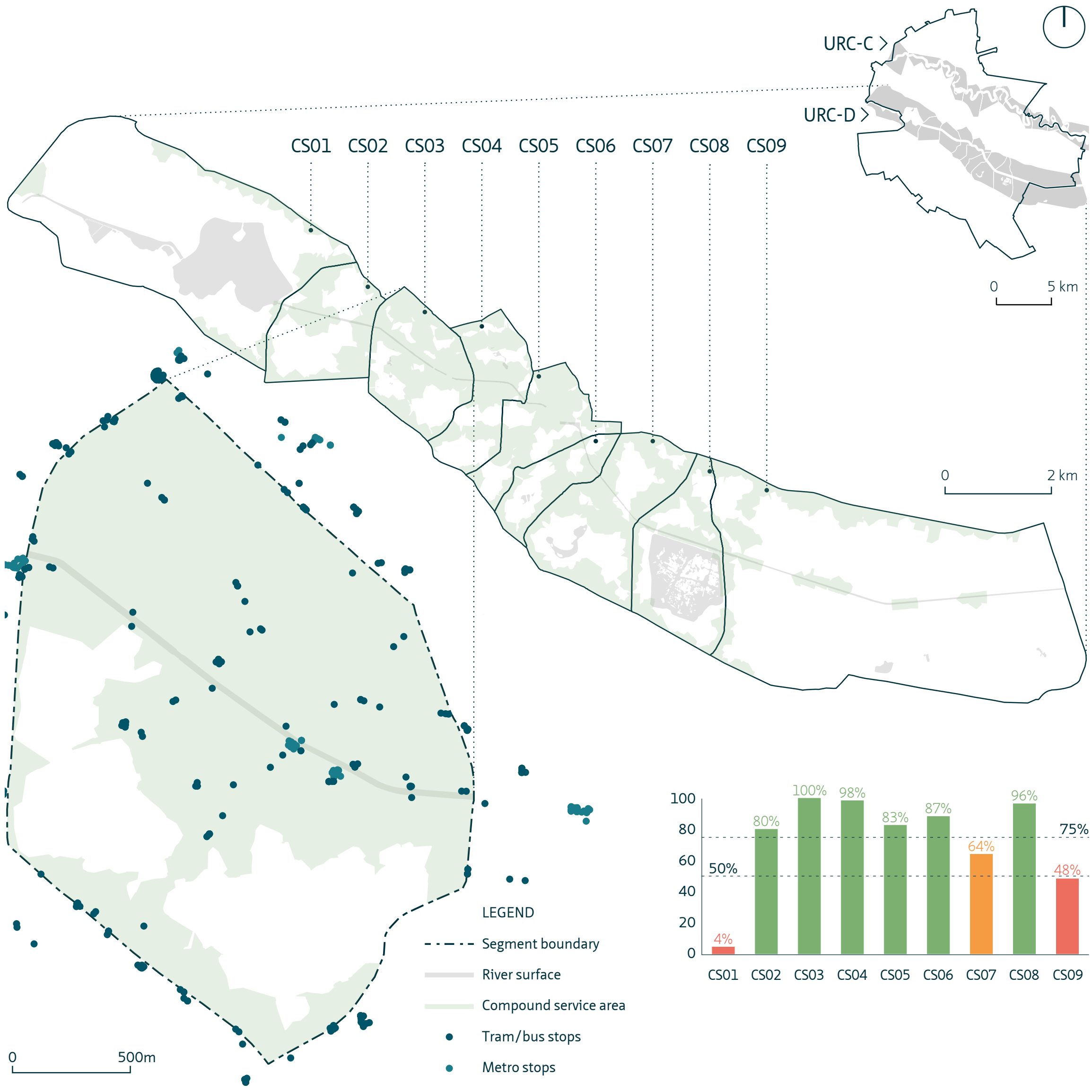

FIGURE APP.E.4 Public transport accessibility along URC Dâmbovița, with detail of CS03.

SEGMENT	VALUE	INDEX
CS01	3.674%	1
CS02	79.94%	3
CS03	100.00%	3
CS04	98.49%	3
CS05	82.57%	3
CS06	86.96%	3
CS07	63.89%	2
CS08	96.45%	3
CS09	48.36%	1

TABLE APP.E.5 Results of indicator A.1.2.1c.

Crossability - linear density of bridges (A.1.2.3a)

Definition:

The linear density of pedestrian/bike bridges (number of crossings/km) (Silva et al., 2004; 2006; 2013) indicates to what extent the river is perceived as a barrier to transversal movement. The scale is determined based on the minimum plausible and maximum plausible number of pedestrian bridges per corridor segment. Silva et al. use a maximum plausible value of 4 bridges/km. Values: **[1] 0-1 bridge/km**; **[2] 2-3 bridges/km**; **[3] ≥4 bridges/km**.

Input data:

- Corridor segment boundary
- River centreline (OSM: waterway=river)[91]
- Bridge lines (OSM: bridges=yes)

Implementation:

1. To obtain the length of the river (L_R), the river centreline is dissolved and clipped to the corridor segment boundary.
2. The bridges are obtained from the OSM data as follows:
   - In order to simplify multi-lane roads the OSM road segments labeled with 'bridge=yes' are merged with the ArcGIS tool Merge Divided Roads. A merge distance of 5 meters is used.
   - The merged road lines are intersected with the river centreline. The resulting intersection points represent the bridges across the river. The number of bridges (**B**) is obtained by counting the bridges within the corridor segment boundary. Bridges on shared corridor segment boundaries are counted in both corridor segments.
3. The linear density of crossings is $\mathbf{B / L_r}$.

Results for CS03:

- B = **6**
- L_r = **2,2km**
- Linear density of crossings = **2,72 bridges/km**

91 In some cases the definition waterway=stream may need to be added to the selection. The river line must be dissolved before used as an input.

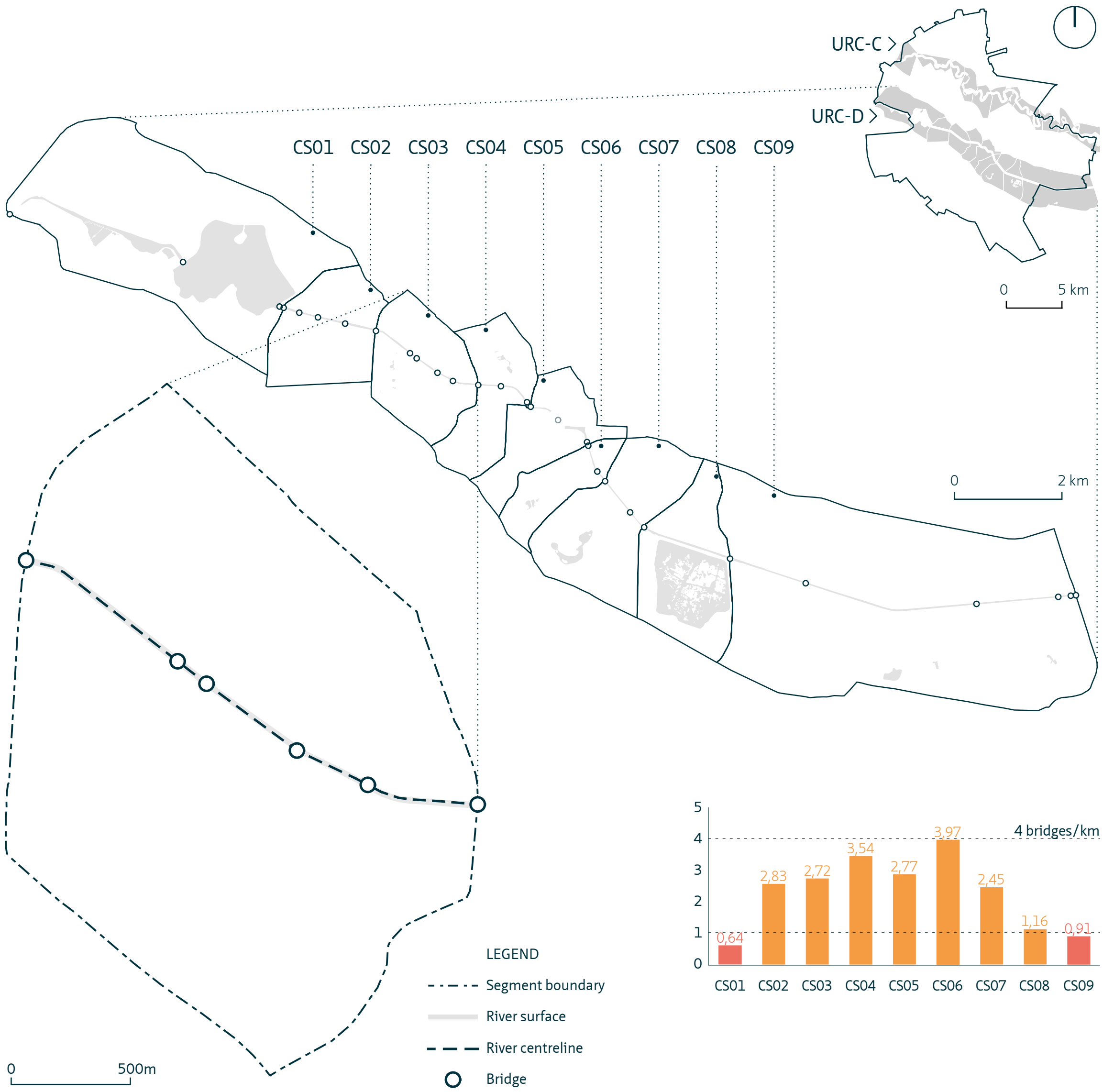

FIGURE APP.E.5 Crossability - linear density of bridges along URC Dâmbovița, with detail of CS03.

SEGMENT	VALUE	INDEX
CS01	0.64	1
CS02	2.83	2
CS03	2.72	2
CS04	3.54	2
CS05	2.77	2
CS06	3.97	2
CS07	2.45	2
CS08	1.16	2
CS09	0.91	1

TABLE APP.E.6 Results of indicator A.1.2.3a.

Crossability - river width (A.1.2.3b)

Definition:

Crossability is measured in function of the width of the river: **[1] rarely bridged** above 400m; **[2] hard to bridge** between 50-400m; or **[3] easily bridged** below 50m.

Input data:

- Corridor segment boundary
- River polygon (OSM: nature=water + waterway=riverbank)[92]
- River centreline (OSM: waterway=river)[93]
- Disaggregation step for width assessment: 50 m

Implementation:

1. The tool *Fluvial Corridor* for ArcGIS[94] is used to calculate perpendicular distances from the river centreline to the edge of the river polygon. The distances are recorded in points on the river centreline with a disaggregation step of 50m (i.e. river widths are calculated every 50 meters).
2. Each point is then classified on the three-point scale of the indicator. If all values are in one of the three classes, the corridor segment is classified accordingly. If the points are not in the same class (variable river width), then the average width (MEAN) determines the class of the corridor segment.

Results for CS03:

- MEAN: **27,19 m**

92 If the river polygon is interrupted by bridges, the polygon needs to be completed and dissolved before it can be used as an input.

93 In some cases the definition waterway=stream may need to be added to the selection. The river line must be dissolved before used as an input.

94 The tool is available at http://umrevs-isig.fr/node/34 Source: Roux, C., Alber, A., Bertrand, M., Vaudor, L., Piegay, H., submitted. "FluvialCorridor" : A new ArcGIS package for multiscale riverscape exploration. Geomorphology

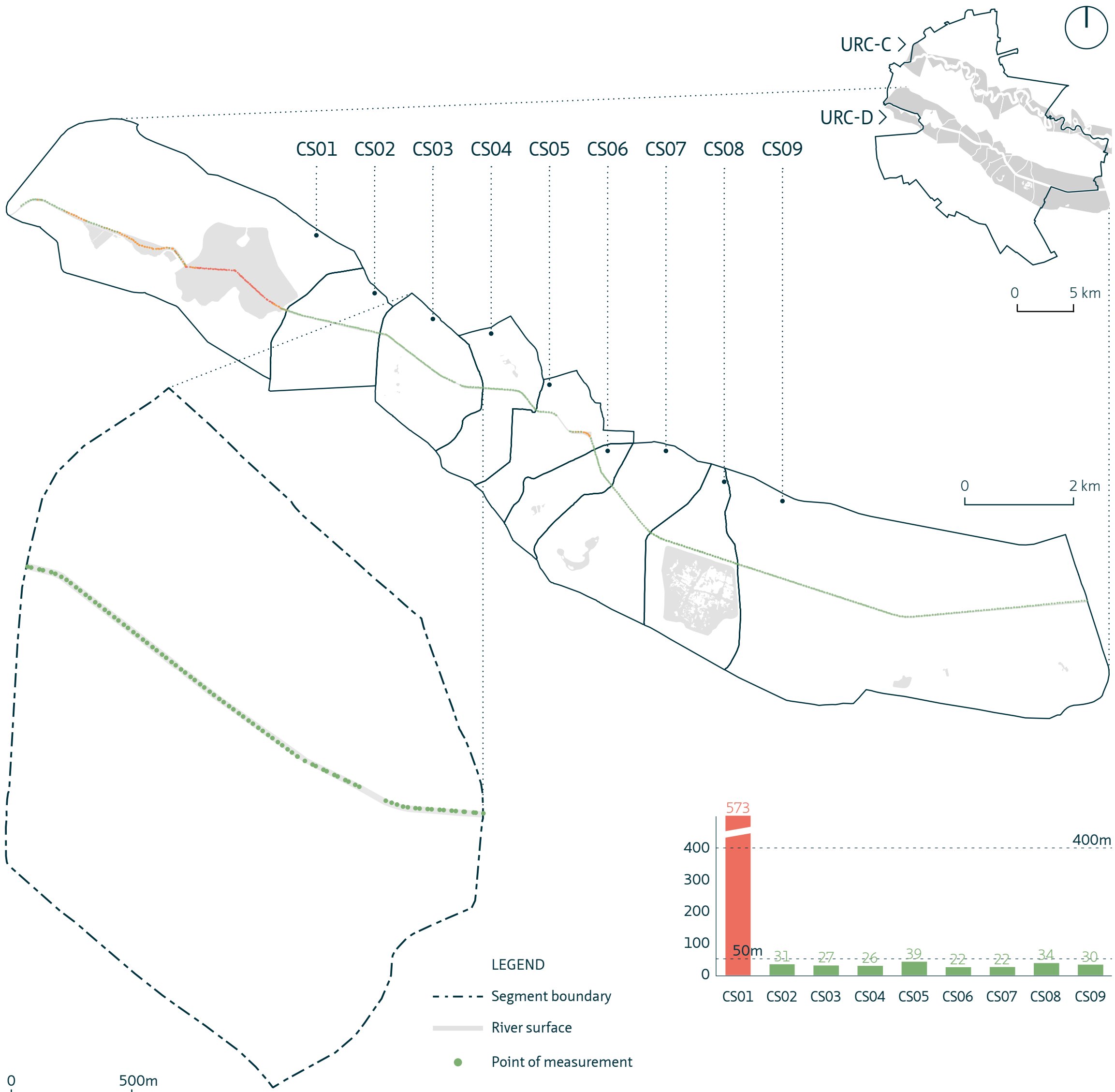

FIGURE APP.E.6 Crossability - river width along URC Dâmbovița, with detail of CS03.

SEGMENT	VALUE	INDEX
CS01	572.596	1
CS02	30.989	3
CS03	27.192	3
CS04	26.084	3
CS05	39.150	3
CS06	21.939	3
CS07	22.067	3
CS08	34.398	3
CS09	29.890	3

TABLE APP.E.7 Results of indicator A.1.2.3b.

Contact with water - linear density of points of contact with water (A.1.3.1a)

Definition:

This indicator measures the number of points of access to water (e.g. stairs, beaches, piers). Values: **[1] < 2 contact points per km**; **[2] 2-4 contact points per km**; **[3] >4 contact points per km**.

Input data:

- Corridor segment boundary
- River polygon (OSM: nature=water + waterway=riverbank)[95]
- River centreline (OSM: waterway=river)[96]
- Points of contact with water (Manually traced on satellite base map or collected via survey)

Implementation:

1. Using a satellite base map or a site survey, points of contact with water are located on open (uncovered) riverbank lines. The value of the indicator is given by the ratio of the total number of contact points ($\mathbf{P_C}$) divided by the total length of open riverbanks ($\mathbf{L_{RB}}$).

Results for CS03:

- P_C = **2**
- L_{RB} = **4,07km**
- Points of contact per km: **0,49**

95 If the river polygon is interrupted by bridges, the polygon needs to be completed and dissolved before it can be used as an input.

96 In some cases the definition waterway=stream may need to be added to the selection. The river line must be dissolved before used as an input.

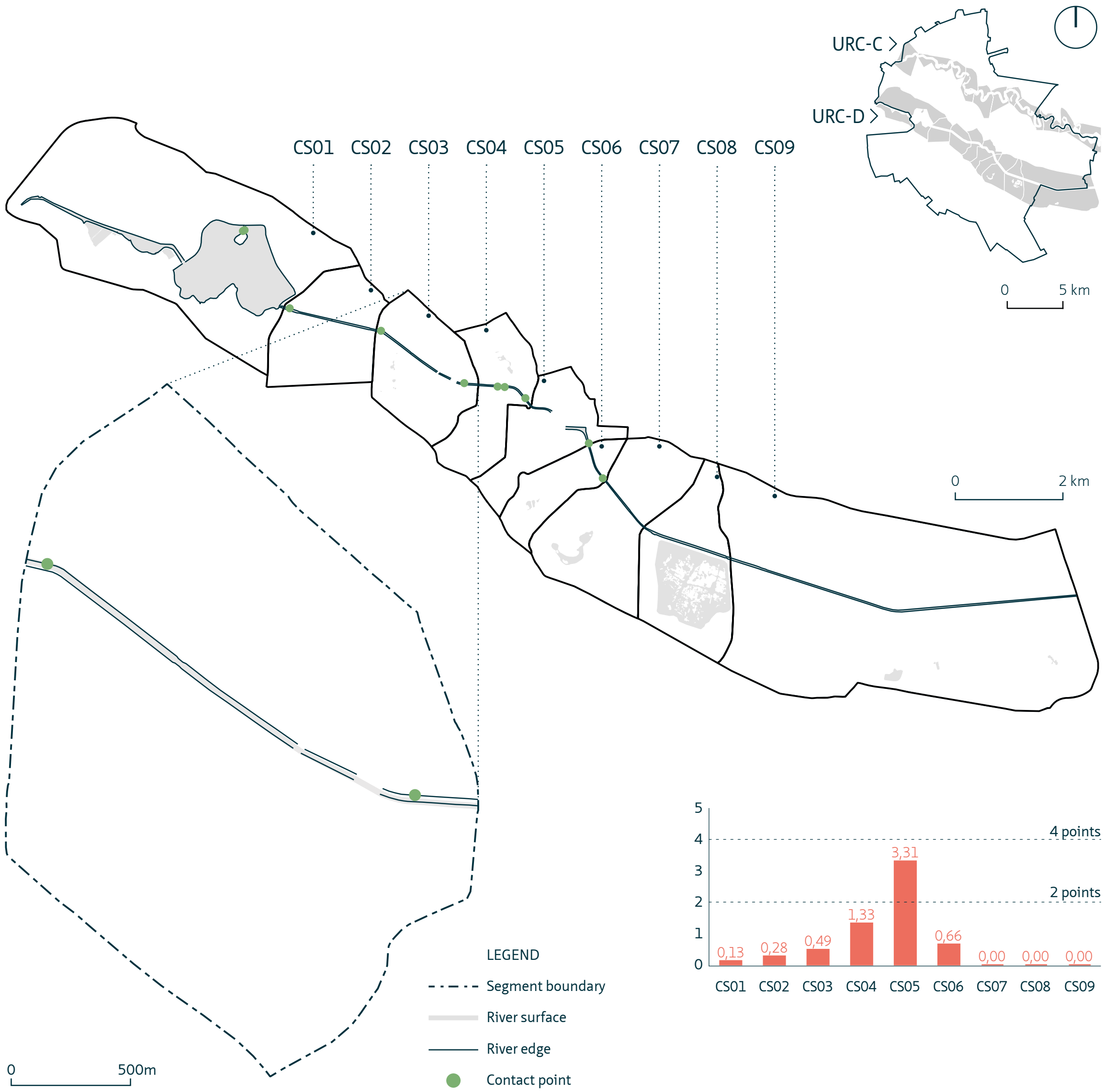

FIGURE APP.E.7 Linear density of points of contact with water along URC Dâmbovița, with detail of CS03.

SEGMENT	VALUE	INDEX
CS01	0.13	1
CS02	0.28	1
CS03	0.49	1
CS04	1.33	1
CS05	3.31	2
CS06	0.66	1
CS07	0.00	1
CS08	0.00	1
CS09	0.00	1

TABLE APP.E.8 Results of indicator A.1.3.1a.

Landscape connectivity - actual (A.2.1.1a)

Definition:
Landscape connectivity is indicated by the number of connected components formed by existing patches in the corridor. Values: **[1] disconnected**; **[2] fragments**; **[3] connected**.

Input data:
- Urban river corridor boundary
- Corridor segment boundary
- Land use data[97] (OSM: landuse=aeroway_polygon, amenity_polygon, landuse_polygon, leisure_polygon, natural_polygon, sport_polygon, and waterway_polygon)
- Edge-to-edge (EE) distance: 200m

Implementation:
The tool *MatrixGreen* for ArcMap is used to perform the component analysis (overall patch network performance), as follows:

1. Vegetated (ecologically functional) and non-vegetated (potential) patches are extracted from the following OSM layers: aeroway_polygon, amenity_polygon, landuse_polygon, leisure_polygon, natural_polygon, sport_polygon, and waterway_polygon. Isolated buildings and overlaps are removed.
2. The resulting patches are merged and converted into a patch set in MatrixGreen. Links with a maximum edge-to-edge (EE) distance of 200m[98] are created.
3. A component analysis of the resulting patch set and links determines the number of connected components in the corridor. If there is one major component crossing the whole corridor the URC is classified as **[3] connected**; if up to 5 largest components which do not cross the corridor could be connected if the EE distance would be increased to 300m, the corridor is classified as **[2] disconnected**; if the corridor is still disconnected after the EE distance is increased, it is classified as **[1] fragmented**.

Results for CS03:
- Number of actual connected components: **1**

97 Land cover data is currently only implied by other tags, such as some types of landuse=*, surface=* and natural=*. Landcover=* to directly tag land cover types is among the proposed features in OpenStreetMap. (Source: http://wiki.openstreetmap.org/wiki/Landcover)

98 The maximum distance of 200 m is based on Andersson, E, Bodin, O, “Practical tool for landscape planning? An empirical investigation of network based models of habitat fragmentation”, in Ecography 32: 123-132, 2009.

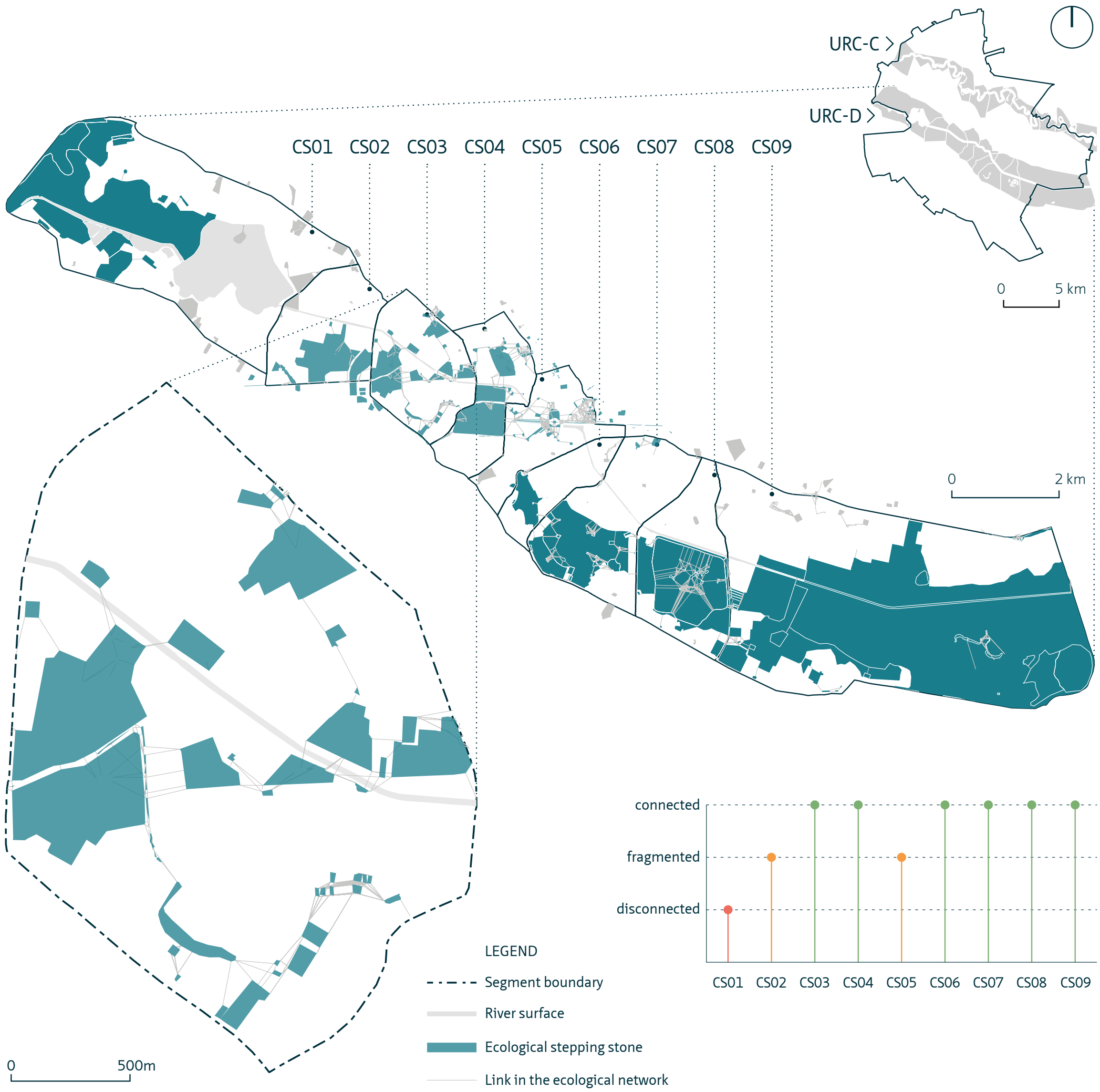

FIGURE APP.E.8 Landscape connectivity along URC Dâmbovița, with detail of CS03.

SEGMENT	VALUE	INDEX
CS01	disconnected	1
CS02	fragmented	2
CS03	connected	3
CS04	connected	3
CS05	fragmented	2
CS06	connected	3
CS07	connected	3
CS08	connected	3
CS09	connected	3

TABLE APP.E.9 Results of indicator A.2.1.1a.

Presence of transversal corridors (A.2.2.1)

Definition:
Lateral connectivity is measured through the presence of transversal corridors connecting the riverside vegetation to the surroundings. The vegetation on transversal corridors, from the river to the URC edge are mapped and classified into: **[1] absent**; **[2] intermittent**; or **[3] continuous**.

Input data:
- Corridor segment boundary
- Road network within the corridor segment (OSM: highway=*)
- Green spaces

Implementation:
1 All side streets that intersect riverside paths within the corridor segment are selected as follows:
- before running the analysis, create natural roads using *Axwoman* for ArcGIS;[99]
- all streets which partially overlap the streets clipped to the 25m buffer around the river polygon are selected, while streets which completely overlap are considered to be riverside streets and are excluded.

2 A buffer of 25m is created around green spaces in the corridor segments.
3 The length of transversal corridors is determined by intersecting the transversal roads (step 1) with the buffered green spaces (step 2).
4 The presence of transversal corridors is expressed as a percentage of the total length of transversal green corridors ($\mathbf{L_{tgc}}$) out of the total length of transversal roads ($\mathbf{L_{tr}}$).

Results for CS03:
- L_{tgc} = **6125 m**
- L_{tr} = **14597 m**
- Transversal green corridors: **42%**

99 Axwoman 6.3 for ArcGIS 10.3.1 was used. Source: Jiang B. (2015), Axwoman 6.3: An ArcGIS extension for urban morphological analysis, http://fromto.hig.se/~bjg/Axwoman/, University of Gävle, Sweden.

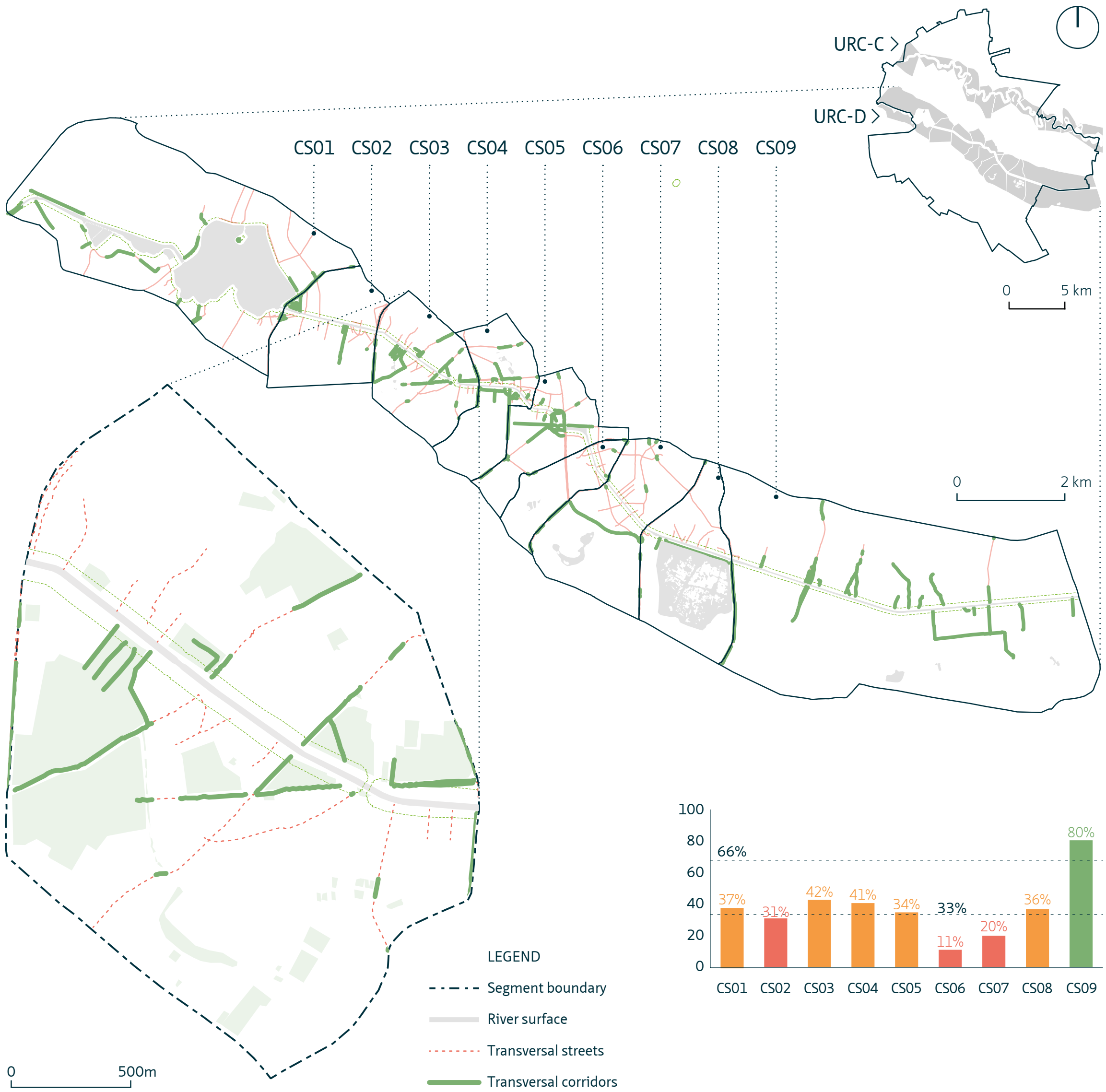

FIGURE APP.E.9 Presence of transversal corridors along URC Dâmbovița, with detail of CS03.

SEGMENT	VALUE	INDEX
CS01	36,86%	2
CS02	30,61%	1
CS03	41,96%	2
CS04	40,50%	2
CS05	34,38%	2
CS06	10,98%	1
CS07	19,97%	1
CS08	36,19%	2
CS09	80,35%	3

TABLE APP.E.10 Results of indicator A.2.2.1.

Sinuosity (A.2.2.3)

Definition:
Sinuosity is a measure of channel form complexity which may be used, within lateral connectivity, as an indicator of (not the presence of, but the spatial conditions for) biodiversity. Sinuosity is "the existence or absence of a meandering pattern in the landscape." (Silva et al., 2004, pp.34-6) Sinuosity can be determined by dividing channel length (L_r) with down-valley length (L_v). Values: **[1] almost straight** between 1,00-1,05; **[2] sinuous** between 1,05-1,50, and **[3] meandering** above 1,50.

Input data:
- Corridor segment boundary
- River centreline (OSM: waterway=river)[100]

Implementation:
1. The river centreline is clipped to the corridor segment boundary.
2. The down-valley length is determined by river centreline.
3. The sinuosity is determined with the formula L_r / L_v.

Results for CS03:
- L_r = **2,19km**
- L_v = **2,15km**
- Sinuosity: **1.02 (almost straight)**

100 In some cases the definition waterway=stream may need to be added to the selection. The river line must be dissolved before used as an input.

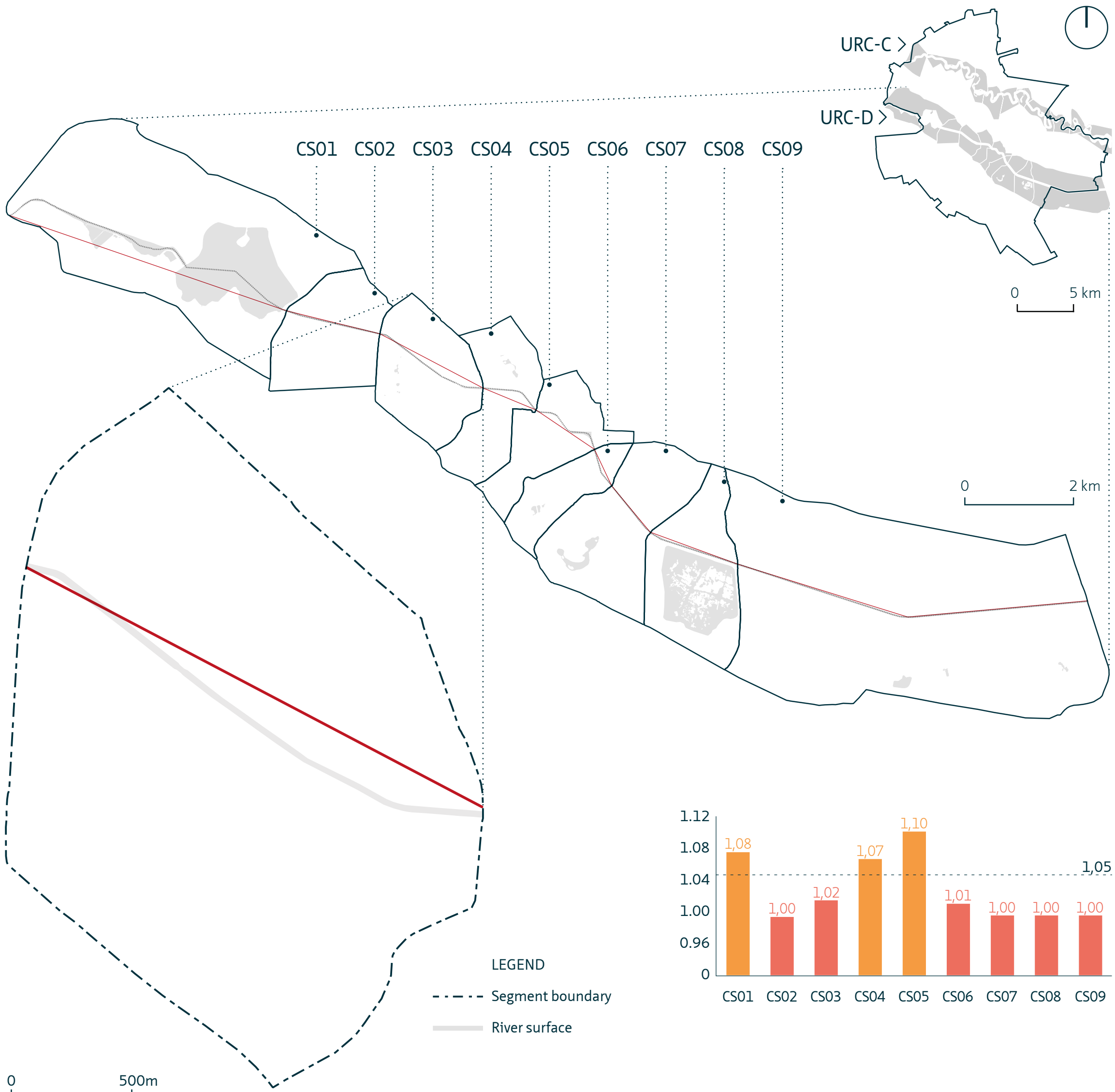

FIGURE APP.E.10 Sinuosity along URC Dâmbovița, with detail of CS03.

SEGMENT	VALUE	INDEX
CS01	1.08	2
CS02	1.00	1
CS03	1.02	1
CS04	1.07	2
CS05	1.10	2
CS06	1.01	1
CS07	1.00	1
CS08	1.00	1
CS09	1.00	1

TABLE APP.E.11 Results of indicator A.2.2.3.

Presence of ecotones (A.2.3.1)

Definition:

The presence of ecotones is determined on the edges of the river and it is expressed as a percentage of the total length of ecotones ($\mathbf{L_{ec}}$) out of the total length of river edges ($\mathbf{L_{re}}$). Values are classified as follows: **[1] low** for values below 25%; **[2] medium** for values greater than 25% but lower than 50%; and **[3] high** for values higher than 50%.

Input data:

- Corridor segment boundary
- Classified riverbanks[101]

Results for CS03:

- % L_{ec}/L_{re} = **0%**
- Presence of ecotones: **low**.

101 The present assessment is based on classification of the presence of ecotones on riverbanks as seen on satellite imagery and in photos. For a detailed and accurate classification of the riverbanks, a survey must be carried out.

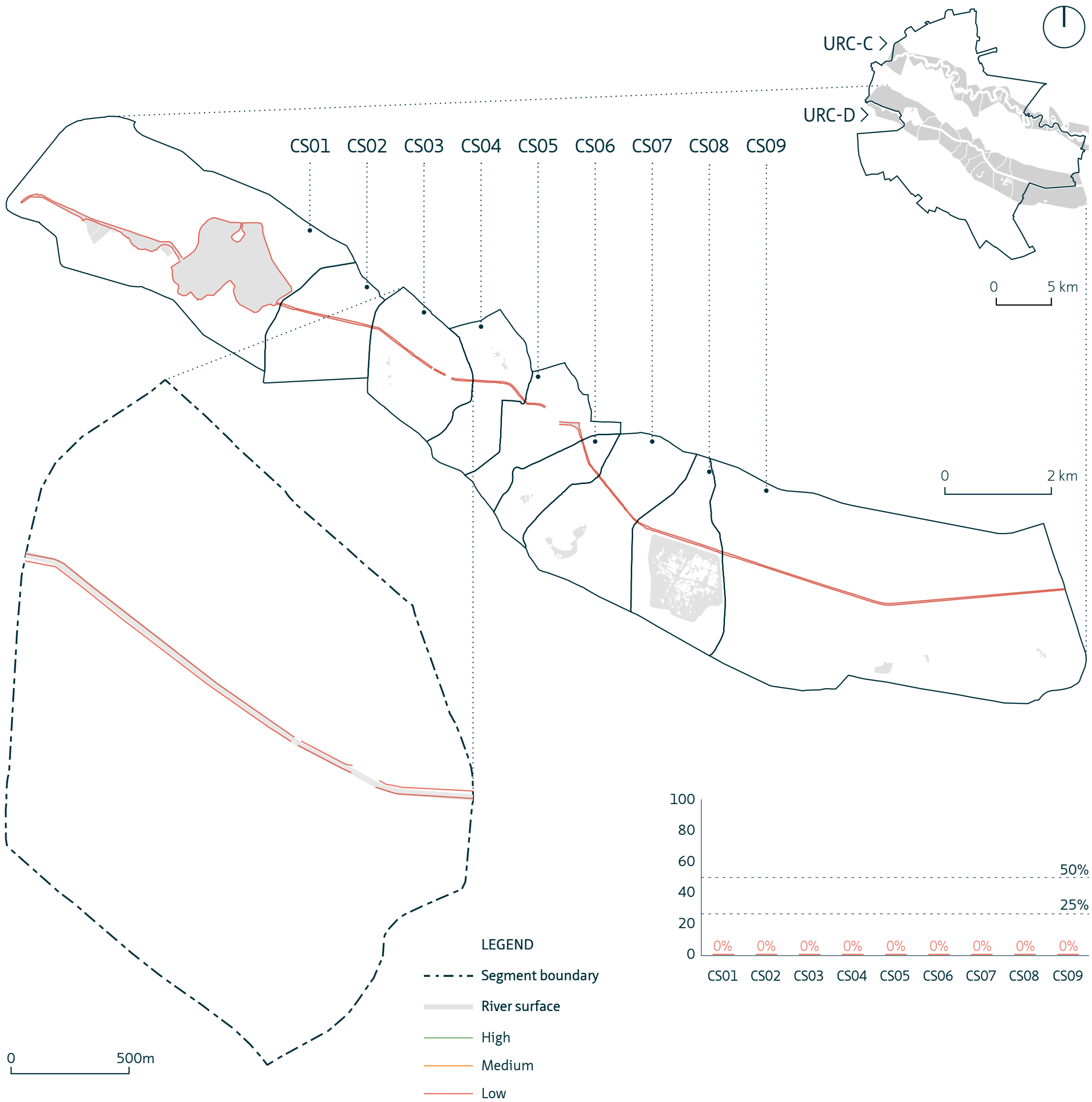

FIGURE APP.E.11 Percentage of ecotones along URC Dâmbovița, with detail of CS03.

SEGMENT	VALUE	INDEX
CS01	0%	1
CS02	0%	1
CS03	0%	1
CS04	0%	1
CS05	0%	1
CS06	0%	1
CS07	0%	1
CS08	0%	1
CS09	0%	1

TABLE APP.E.12 Results of indicator A.2.3.1.

Diversity of land uses—patch richness density (B.1.1.1a)

Definition:
Patch richness density (PRD),[102] representing the number of different land use classes per 100 hectares within the study area, is used as a measure of land use diversity. Values: **[1] PRD < 0,25**; **[2] 0,25 ≤ PRD < 0,75**; **[3] PRD ≥ 0,75**.

Input data:
- URC and corridor segment boundaries
- Urban Atlas data for the study area[103]

Implementation:
1. Urban Atlas data is reclassified as shown in Table.App.E.13.
2. To isolate land uses interacting with the river space, polygons within a buffer of 150m from the river are selected from the Urban Atlas data.
3. The number of different classes (**n**) is recorded for each corridor segment.
4. The PRD values assigned to the corridor segments are given by the ratio **PRD = n / A_{rs} * 100**, i.e. the number of different classes per 100 hectares.
5. Final values are normalised[104] and classified as follows: **[1] PRD < 0,25**; **[2] 0,25 ≤ PRD < 0,75**; **[3] PRD ≥ 0,75**.

Results for CS03:
- Number of different classes: **4**
- PRD = 4 / 123,77ha * 100 = **3,232 classes/100 ha**
- Normalised PRD = **0,413** > 0,25 **[class 2]**

CLASS	NAME	UA CODE	SEALING
C1	Continuous urban fabric areas	11100	80-100%
C2	Discontinuous dense urban fabric	11121	50-80%
C3	Discontinuous urban fabric	11220, 11230, 11240, 11300	< 50%
C4	Industrial/commercial areas	12100	
C5	Transport infrastructure	12210, 12220, 12230, 12300,12400	
C6	Mine/Dump sites, Construction/Land without use	13100, 13300, 13400	
C7	Green areas and sport facilities	14100, 14200	
C8	Agriculture, Forest, Water	20000, 30000, 50000	

TABLE APP.E.13 Reclassification of Urban Atlas data (based on Prastacos et al., 2017).

102 PRD is a diversity measure of landscape composition.

103 Urban Atlas data is available for the Large Urban Zones of Europe (all urban areas above 100.000 inhabitants, according to the Urban Audit). Source: https://www.eea.europa.eu/data-and-maps/data/urban-atlas#tab-gis-data

104 In absence of a reference (maximum) value, PRD values of all corridor segments of the corridor are normalised, with the highest PRD value equal to 1.

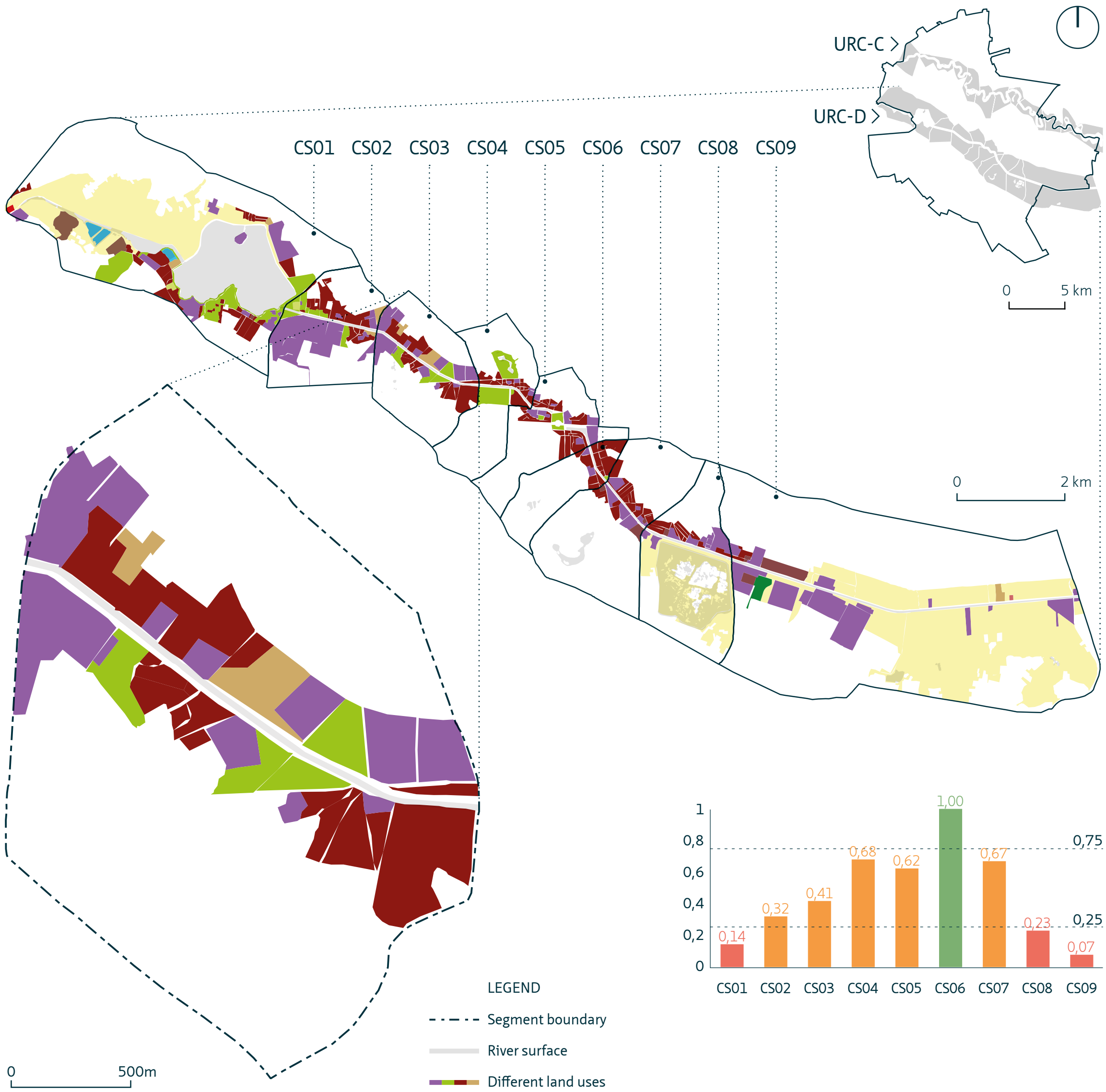

FIGURE APP.E.12 Diversity of land uses - patch richness density along URC Dâmbovița, with detail of CS03.

SEGMENT	VALUE	INDEX
CS01	0.138	1
CS02	0.316	2
CS03	0.413	2
CS04	0.678	2
CS05	0.620	2
CS06	1.000	3
CS07	0.667	2
CS08	0.225	1
CS09	0.071	1

TABLE APP.E.14 Results of indicator B.1.1.1a.

Visual permeability—% visible river space (B.1.2.1a)

Definition:
Visual permeability is an indicator of spatial quality that shows the percentage of visible open space within the river space. Values: **[1] low visibility**, when lower than 25%, **[2] medium visibility** between 25% and 75%, and **[3] high visibility** above 75%.

Input data:
- Corridor segment boundaries
- Digital elevation model[105]
- Buffer from river edges: 150m
- Buildings (OSM)

Implementation:
1. A digital elevation model (DEM) and buildings within the corridor are used as input to a viewshed analysis. The viewshed analysis is performed from the river edges.
2. A 150m buffer is created along the river edges.
3. The percentage of visible open space is given by dividing the total visibility area (A_{vis}) by the total area of the buffer (A_{tot}) within the corridor segment. Values are classified as **[1] low visibility**, when lower than 25%, **[2] medium visibility** between 25% and 75%, and **[3] high visibility** above 75%.

Results for CS03:
- A_{vis} = **331.866 m²**
- A_{tot} = **666.947 m²**
- Visible river space: **49,8%**

105 For the digital elevation model, 30m resolution SRTM data was used. (USGS, 2017)

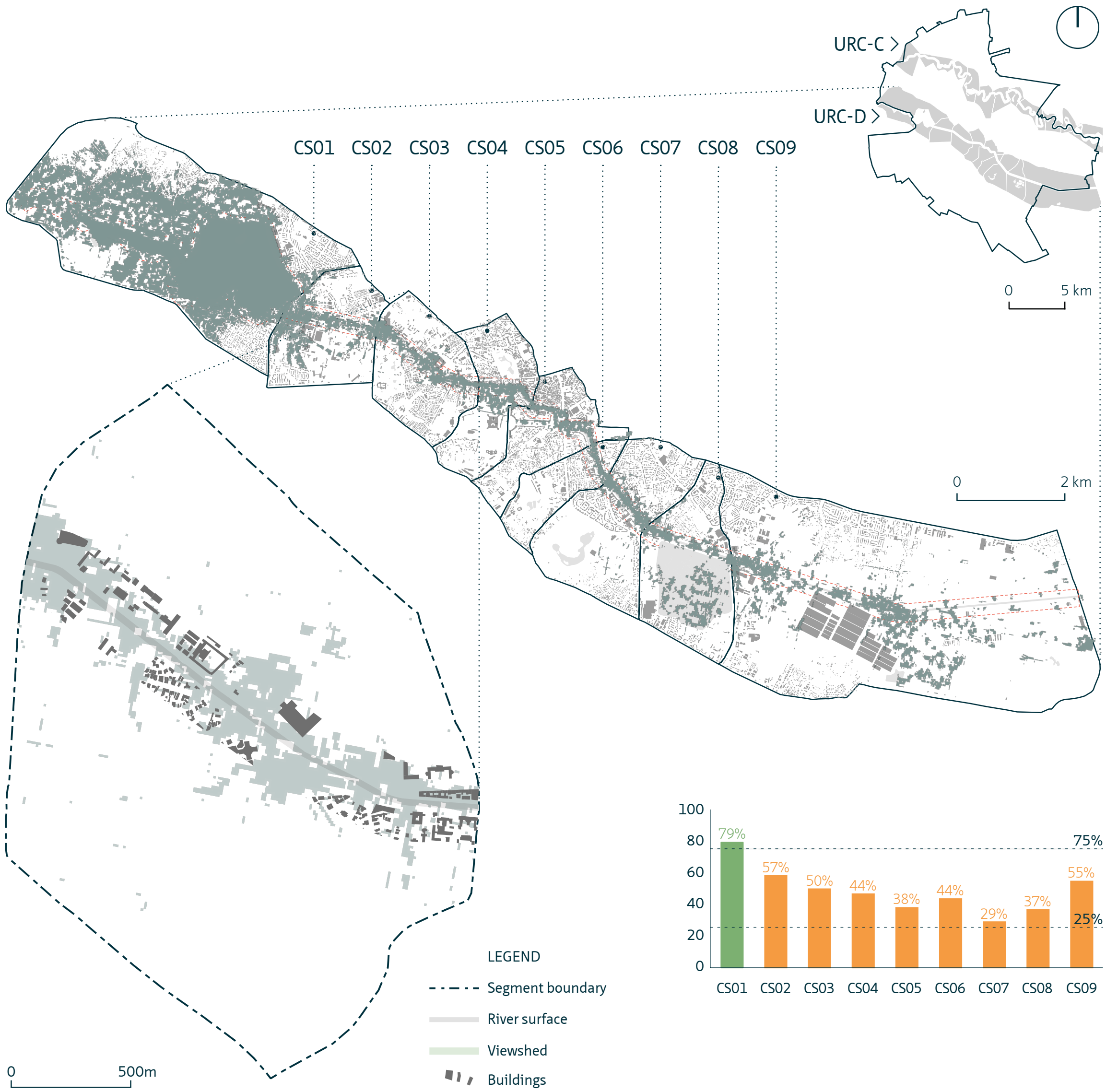

FIGURE APP.E.13 Visual permeability—% visible river space along URC Dâmbovița, with detail of CS03.

SEGMENT	VALUE	INDEX
CS01	79.198%	3
CS02	57.286%	2
CS03	49.759%	2
CS04	44.412%	2
CS05	37.922%	2
CS06	43.536%	2
CS07	28.944%	2
CS08	36.684%	2
CS09	54.605%	2

TABLE APP.E.15 Results of indicator B.1.2.1a.

Waterfront constitutedness—configuration (B.1.3.2a)

Definition:
Waterfront constitutedness is indicated by the percentage of the total length of built fronts projected on the river edges out of the total length of the river edges, corrected with a coefficient of fragmentation (standard deviation from maximum potential constitutedness). Values are standardized and classified as: **[1] value <= 50%**; **[2] 50% < value <= 75%**; **[3] value > 75%**.

Input data:
- River edges (obtained from OSM river polygon)
- Buildings (OSM)
- URC boundary (traced on OSM road network)
- RS boundaries (traced on OSM road network)

Implementation:[106]
1. Perpendicular lines of 150m are generated every 10m from the river edges.
2. To determine the distance of the built front from the river, the perpendicular lines are intersected with the buildings in the river front (i.e. buildings selected within a buffer of 150m from the river edges). Lines with a length equal to 150m, indicating absence of a waterfront, are excluded.
3. The remaining lines are aggregated into polygons with a dissolved buffer of the lines comprised between 45 and 50 meters (47.5 m). This has to be done when a distance of 100 m as considered to be a break in the waterfront. The resulting polygons are cut using the first and the last perpendicular lines of each waterfront.
4. The buffers are intersected with the riversides to calculate the length of each riverfront. The intersected lines and the perpendicular ones are spatially joined, summarizing the Standard Deviation (STD). A coefficient (c) is assigned as follows: 1 if the STD is below 30 (this means that the waterfront is constituted), 0.5 if the STD is more than 30.
5. Waterfront constitutedness for each corridor segment is calculated with the formula:

$$\frac{\sum\left(L_{wf} \times c\right)}{L_{tot}} \times 100$$

where $\mathbf{L_{wf}}$ is the length of each waterfront, $\mathbf{L_{tot}}$ is the total length of the riversides in each segment, and **c** is the coefficient described at point 4. The final score is determined by classifying the value using the following breaks: **[1] value <= 50%**; **[2] 50% < value <= 75%**; **[3] value > 75%**.

Results for CS03:
- Waterfront constitutedness: **76%**

106 For the following workflow ArcGIS 10.5.0 was used. All features must be in the ETRS89_LAEA_Europe coordinate system.

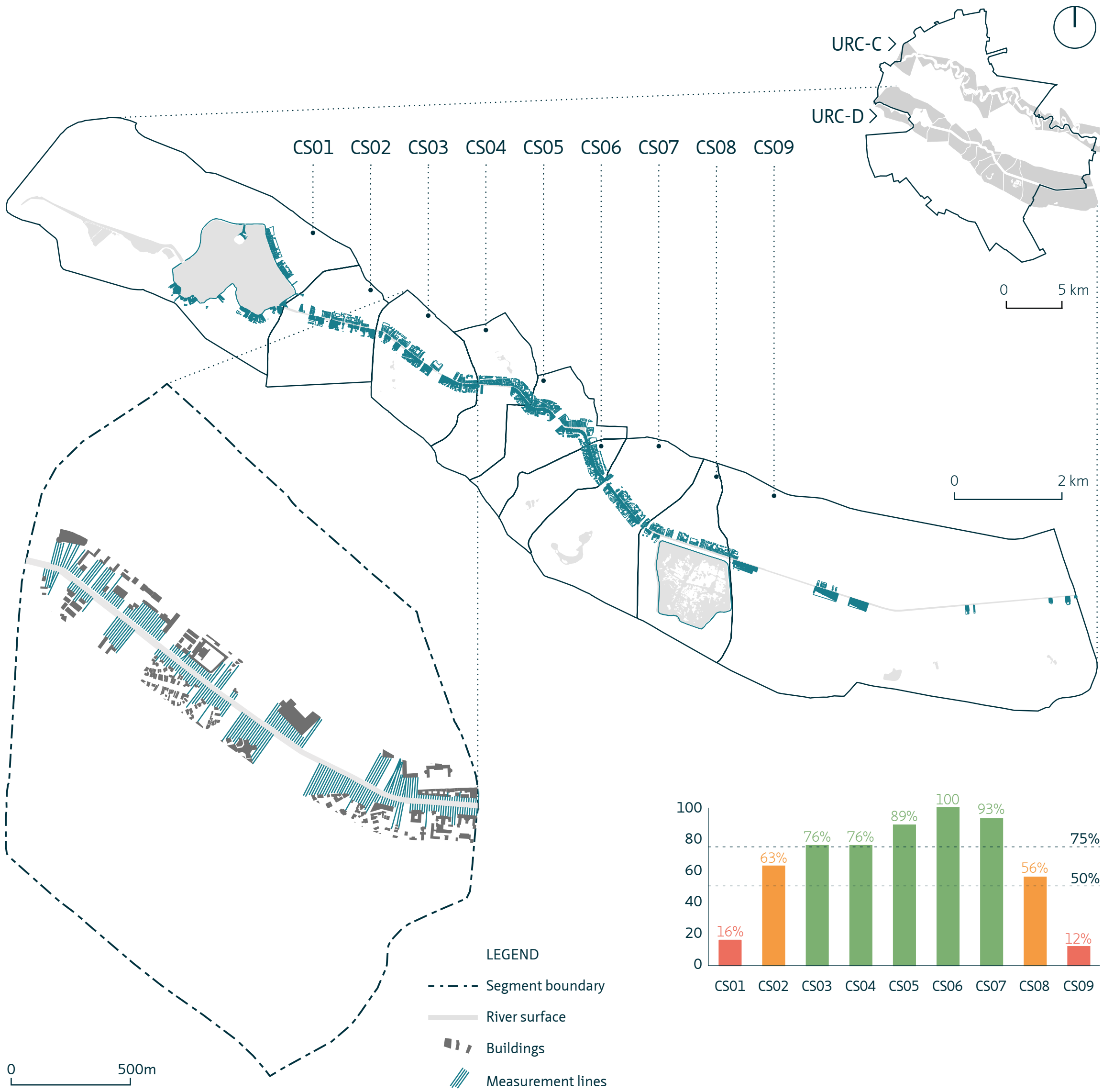

FIGURE APP.E.14 Waterfront constitutedness along URC Dâmbovița, with detail of CS03.

SEGMENT	VALUE	INDEX
CS01	16%	1
CS02	63%	2
CS03	76%	3
CS04	76%	3
CS05	89%	3
CS06	100%	3
CS07	93%	3
CS08	56%	2
CS09	12%	1

TABLE APP.E.16 Results of indicator B.1.3.2a.

Biodiversity—presence of species-rich areas (B.2.1.1a)

Definition:
Species-rich areas in the corridor are mapped and classified as follows: **[1] low**, when no such area is present, **[2] medium**, when they are present in the proximity of the river, or **[3] high,** when species-rich areas are in direct contact with the river, i.e. they constitute part of the riparian space.

Input data:
- Corridor segment boundary
- Species-rich areas[107]

Results for CS03:
- Biodiversity—presence of species-rich areas: **low**.

107 The present assessment is based on satellite imagery, literature and interviews. For a detailed and accurate inventory of species-rich areas, this classification must be confronted with local biodiversity studies. In this case, only areas with potential for biodiversity or direct contact with the landscape surrounding the city were taken into consideration.

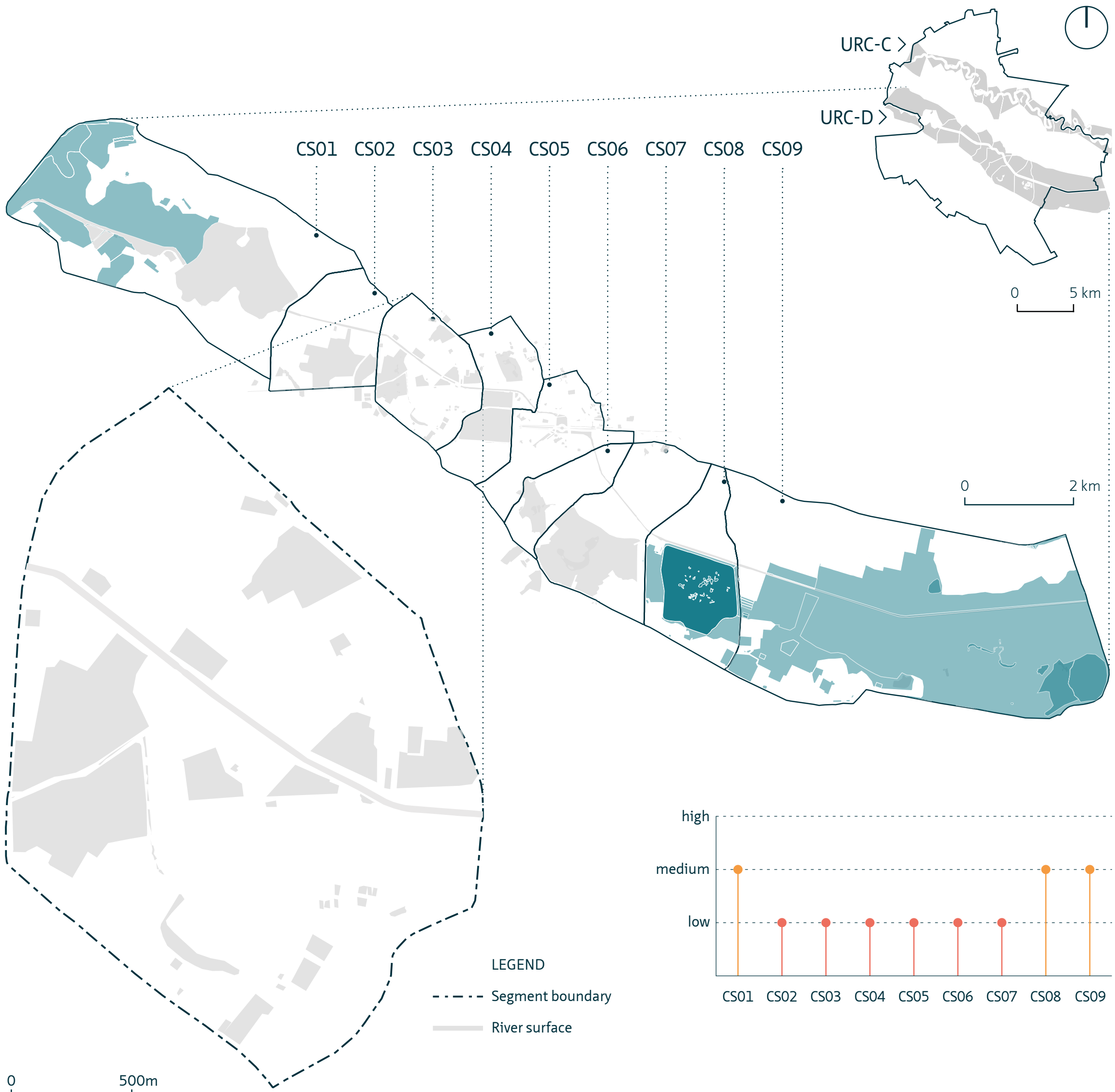

FIGURE APP.E.15 Presence of species-rich areas along URC Dâmbovița, with detail of CS03.

SEGMENT	VALUE	INDEX
CS01	medium	2
CS02	low	1
CS03	low	1
CS04	low	1
CS05	low	1
CS06	low	1
CS07	low	1
CS08	medium	2
CS09	medium	2

TABLE APP.E.17 Results of indicator B.2.1.1a.

Respect of natural dynamics[108] (B.2.2.4)

Definition:

The degree of disturbance to natural dynamics is indicated by the classification of river banks: **[1] highly disturbed** , i.e. very artificial, channelised, concrete bed and banks, **[2] moderately disturbed** i.e. artificial, channleised, concrete bed or banks, or **[3] undisturbed**, i.e. close to natural conditions.

Input data:

- Corridor segment boundary
- Classified riverbanks[109]

Results for CS03:

- Respect of natural dynamics: **highly disturbed**.

108 This indicator is based on Silva et al. (2004, p.34).

109 The present assessment is based on satellite imagery. For a detailed and accurate classification of the degree of disturbance on the riverbanks, a survey must be carried out.

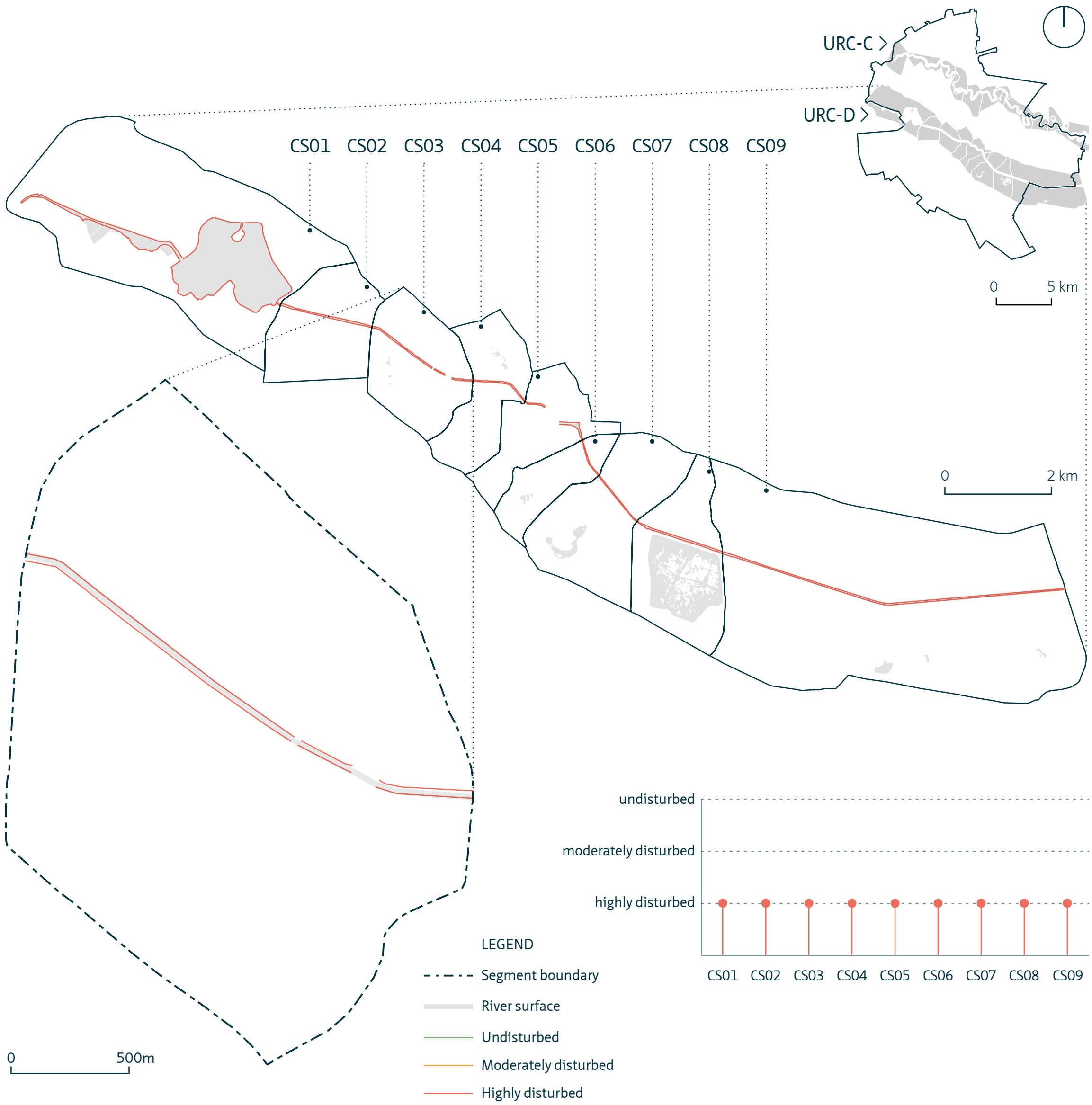

FIGURE APP.E.16 The degree of disturbance along the banks of URC Dâmbovița, with detail of CS03.

SEGMENT	VALUE	INDEX
CS01	highly disturbed	1
CS02	highly disturbed	1
CS03	highly disturbed	1
CS04	highly disturbed	1
CS05	highly disturbed	1
CS06	highly disturbed	1
CS07	highly disturbed	1
CS08	highly disturbed	1
CS09	highly disturbed	1

TABLE APP.E.18 Results of indicator B.2.2.4.

Coverage - % total open space (B.2.3.1a)

Definition:

The percentage of the total area of open spaces (**P_{os}**) in the corridor segment out of the total area of the corridor segment (**A_{rs}**). Open spaces are all unbuilt spaces (**A_{rs} - A_b**), excluding the area occupied by road infrastructure (**A_r**) and water (**A_w**). Values: **[1] below 50%**; **[2] medium 50-75%**; **[3] above 75%**.

$$P_{os} = \frac{A_{rs} - A_b - A_r - A_w}{A_{rs}} \times 100$$

Input data:

- Corridor segment boundary
- Buildings in the corridor segment (OSM: buildings=*)[110]
- Street polygons (UrbanAtlas)

Results for CS03:

- Built area: **97,2 ha**
- Open space: **282,1 ha**
- Coverage: **74%**

110 Buildings obtained form the OSM dataset may be incomplete. For a more accurate result, the analysis must be performed with municipal data sources.

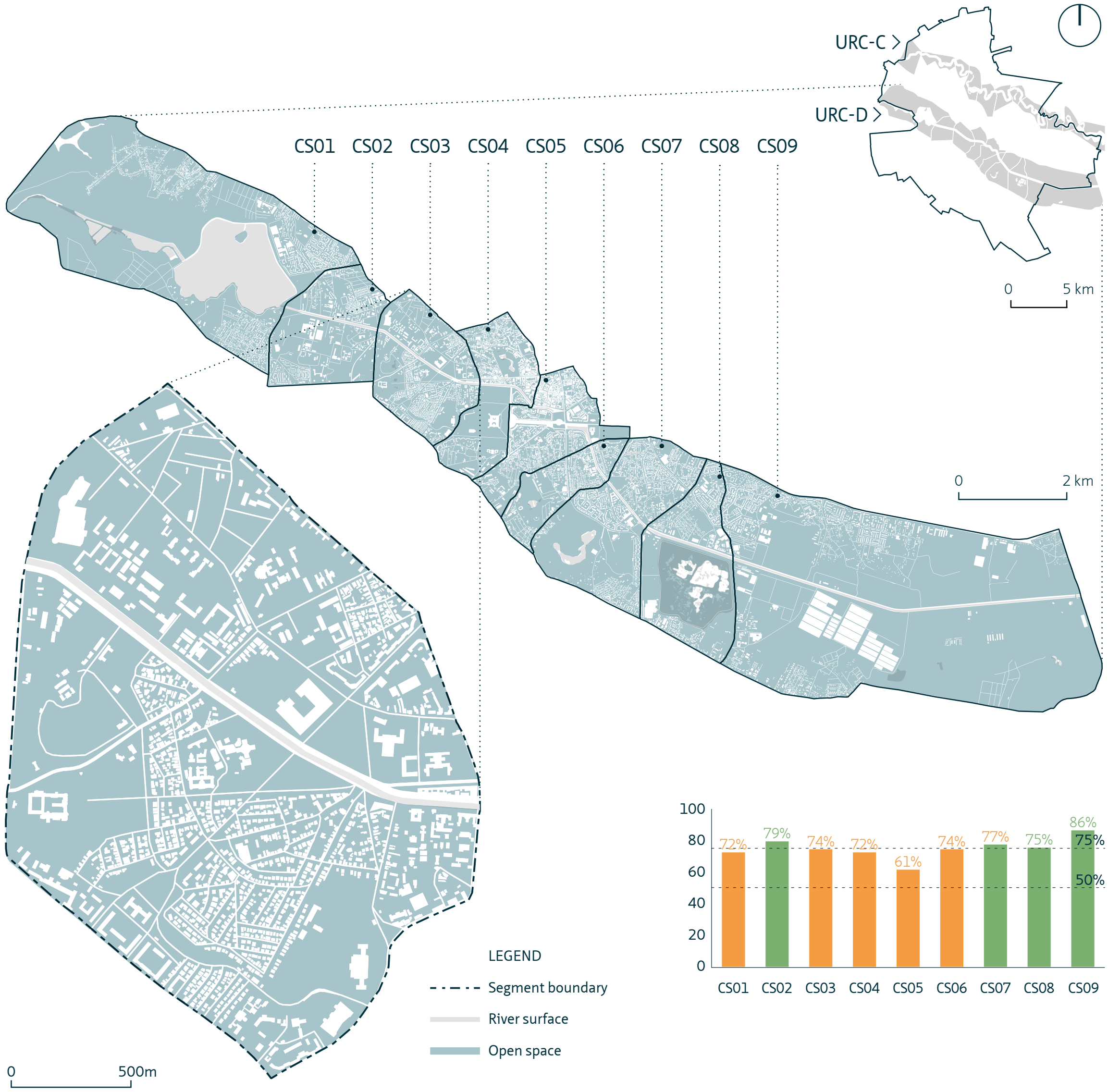

FIGURE APP.E.17 Open space coverage in URC Dâmbovița, with detail of CS03.

SEGMENT	VALUE	INDEX
RS01	72%	2
RS02	79%	3
RS03	74%	2
RS04	72%	2
RS05	61%	2
RS06	74%	2
RS07	77%	3
RS08	75%	3
RS09	86%	3

TABLE APP.E.19 Results of indicator B.2.3.1a.

Coverage - % total green space (B.2.3.1b)

Definition:
Green space coverage is indicated by the percentage (**P_{gs}**) of the total area of green spaces (**A_{gs}**) out of the total area of the corridor segment (**A_{cs}**):

$$P_{gs} = \frac{A_{gs}}{A_{cs}} \times 100$$

and it is classified as follows: **[1] low** below 20%; **[2] medium** between 20% and 40%; **[3] high** above 40%.

Input data:
- Corridor segment boundary
- Land cover from classified multispectral satellite image[111]

Results for CS04:
- A_{gs} = 1,71 **km²**
- A_{cs} = 4,05 **km²**
- Coverage: **42%**

Results for CS08:
- A_{gs} = 0,84 **km²**
- A_{cs} = 5,16 **km²**
- Coverage: **16%**

SEGMENT	VALUE	INDEX
CS01	33%	2
CS02	32%	2
CS03	29%	2
CS04	42%	3
CS05	29%	2
CS06	30%	2
CS07	27%	2
CS08	16%	1
CS09	22%	2
CS10	26%	2
CS11	28%	2

TABLE APP.E.20 Results of indicator B.2.3.1b.

111 For the classification, Sentinel-2 satellite imagery (Copernicus Sentinel data, 2017) was used. The land cover classification was carried out with the *Semi-Automatic Classification Plugin (SCP)* for *QGIS*. Out of the land cover classes used in the classification—'built-up', 'water', 'vegetation', and 'bare soil'—, the class 'vegetation' was used in this indicator.

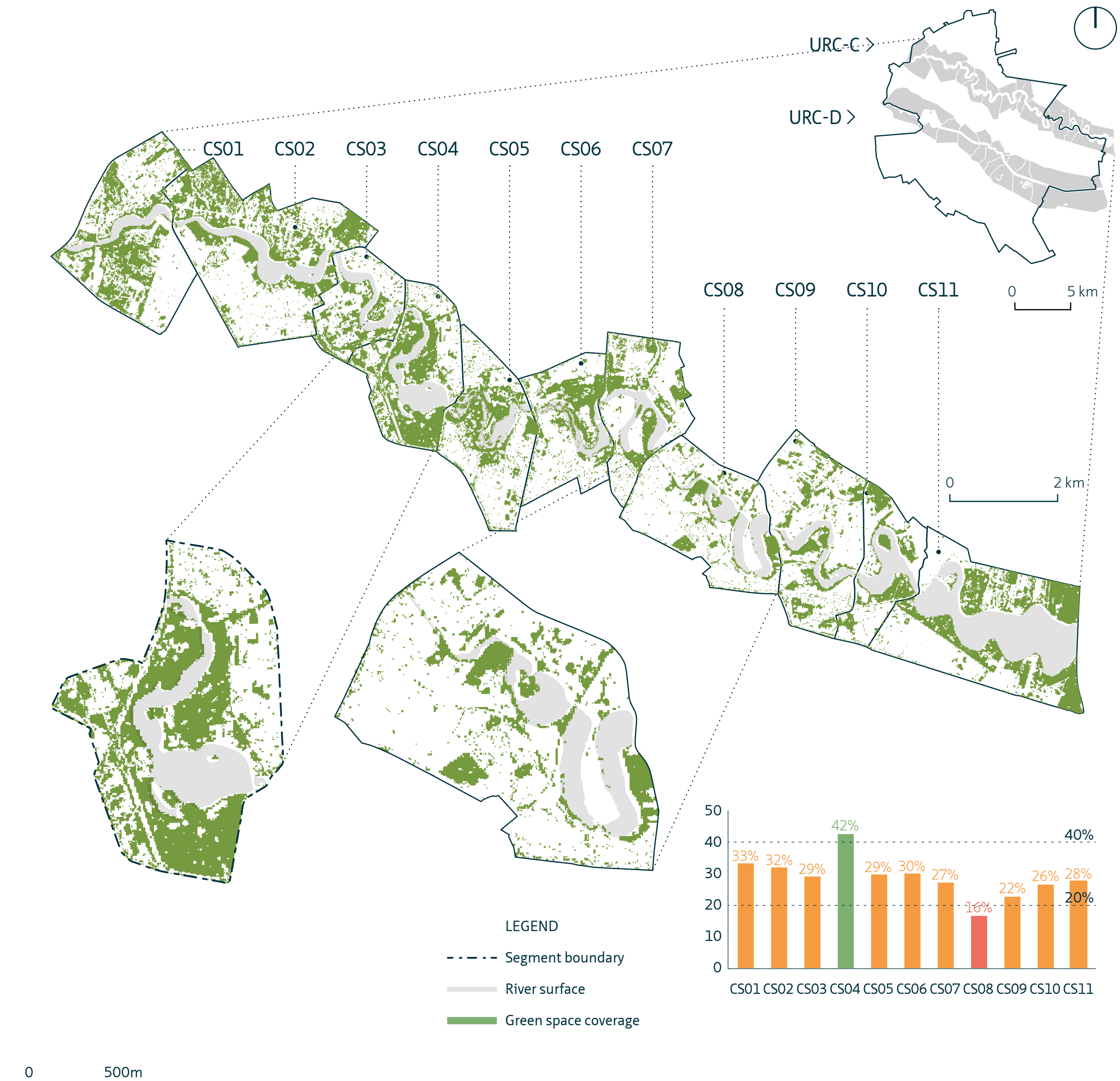

FIGURE APP.E.18 Green space coverage in URC Colentina, with detail of CS04 and CS08.