

Semantic Urban River Space Delineation and Typology

Defining and analyzing the space around the
urban river in the Netherlands

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and
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Introduction

- Context and motivation
- Existing 2D delineation

Context



(a) Before restoration. Canalized, artificial river.



(b) After restoration. Re-natured, lowering the flood risk. More natural river flow.

Urban planning solutions necessitate a **comprehensive overview** of the space, its **boundaries**, and its **characteristics**.

Regeneration of the urban river space

Motivation

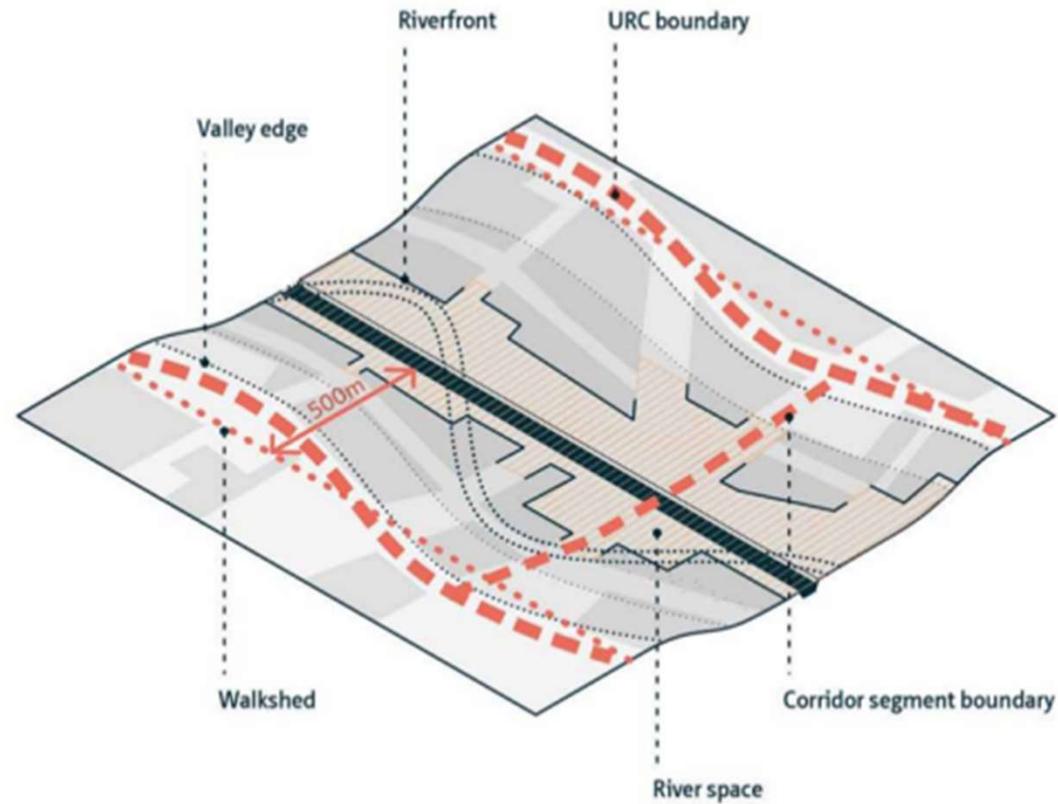
Urban river space is **ambiguously defined**.

→ Standardized approach to facilitate cross-case analysis

Existing river space typology based on **observation** and very **case-specific**

→ Scalable data driven river space typology

Related work: 2D River space delineation



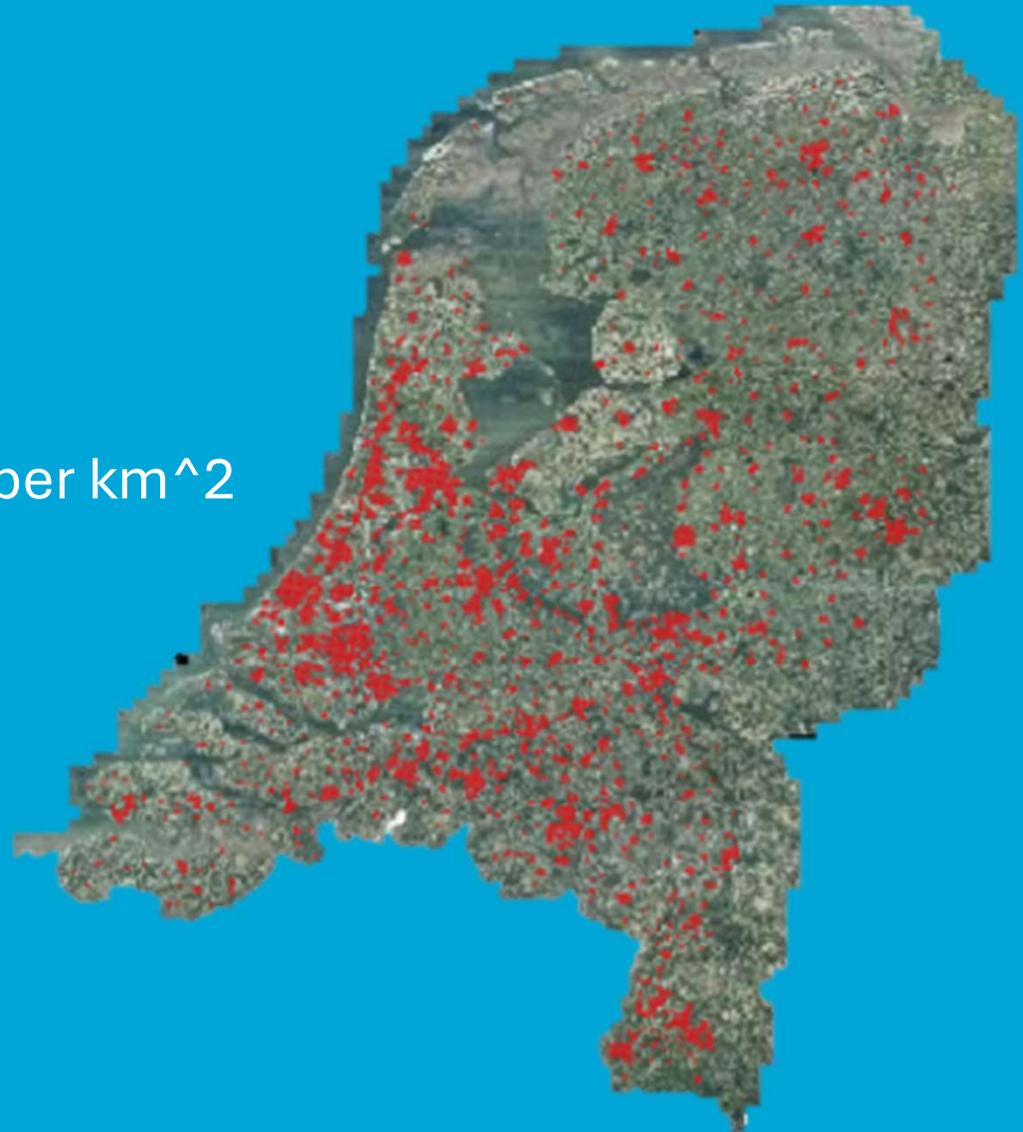
01

Methodology and implementation

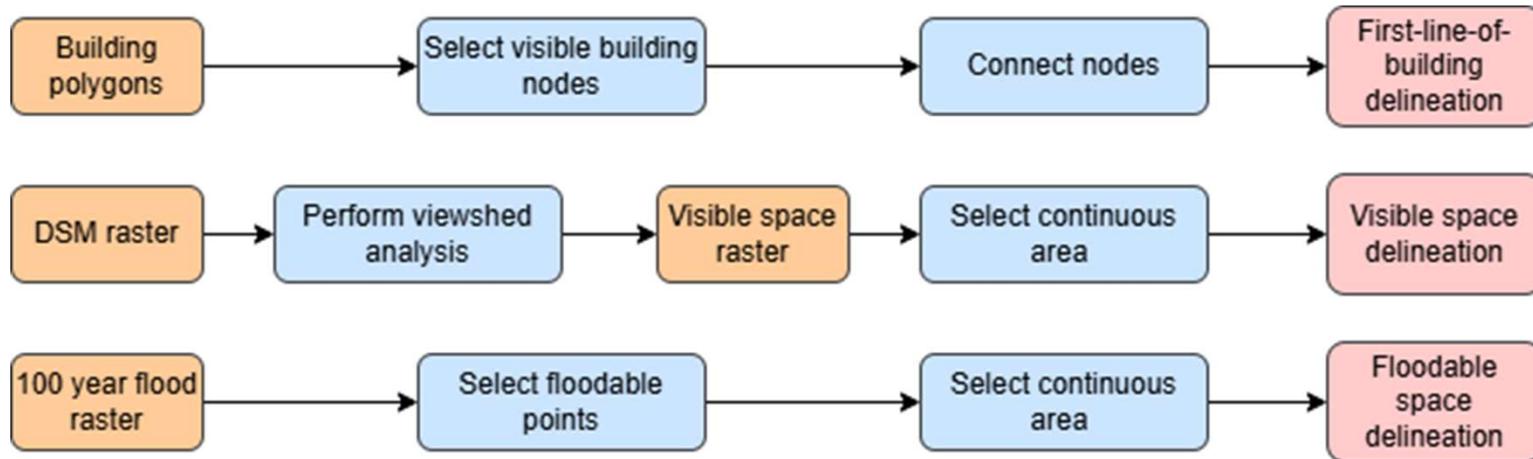
- Research areas
- Delineation
- Typology development

Research areas

Population density > 1000 per km²



Urban river space delineation



Visible space

Viewshed analysis
per riverline

→ SAGA GIS visibility
analysis

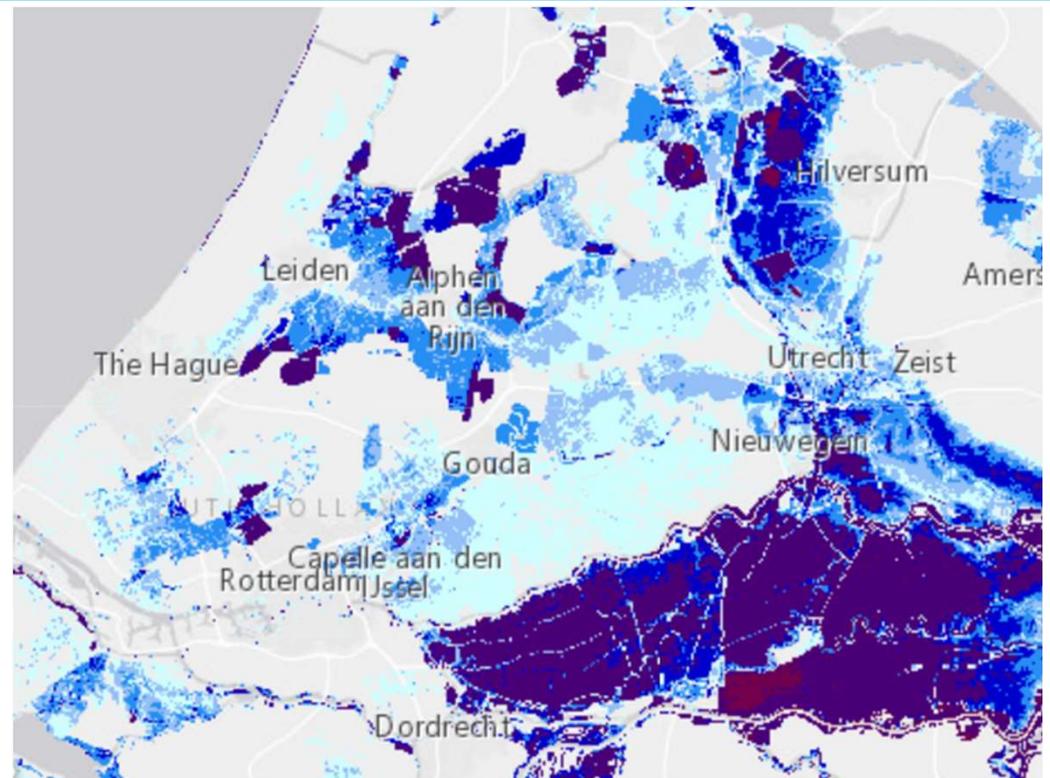
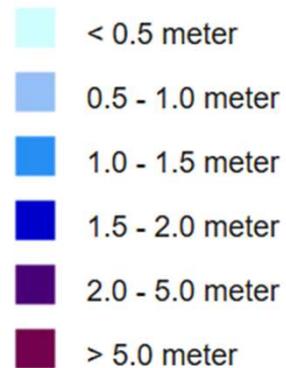
→ Radius 110m,
embankment
height + 1.75m,
5m DSM



Combine obtained viewsheds

Floodable space

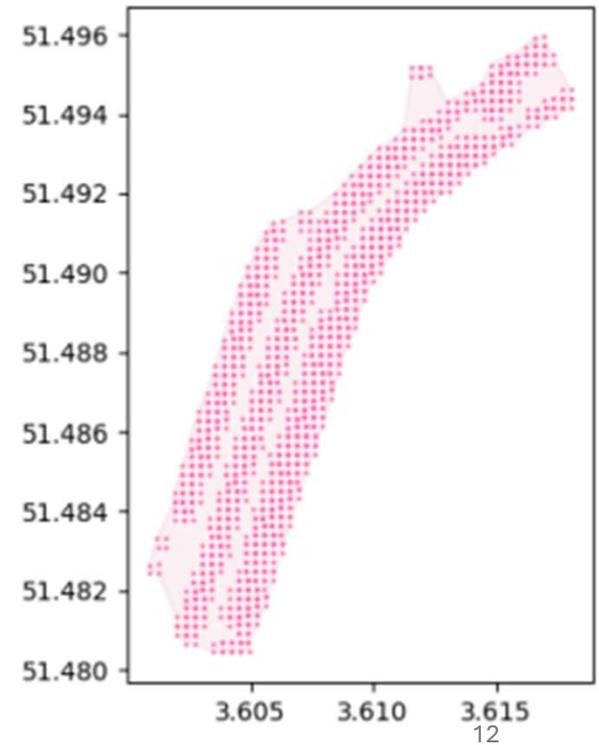
Medium chance
100 year flood depth



Delineation from raster

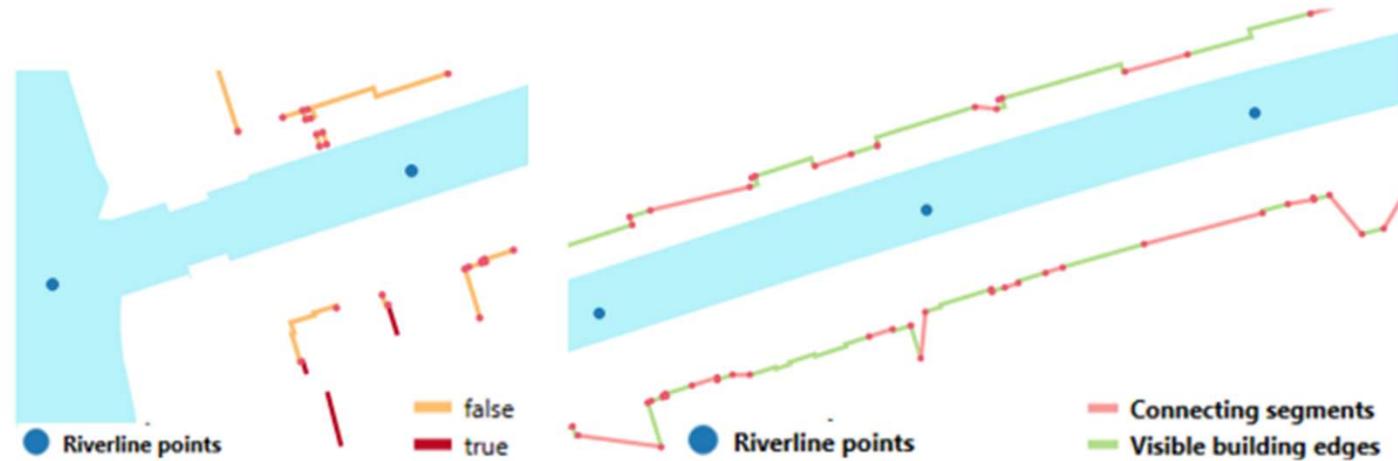
→ Alpha shape
around
floodable/visible
points per riverline

→ Minimum area

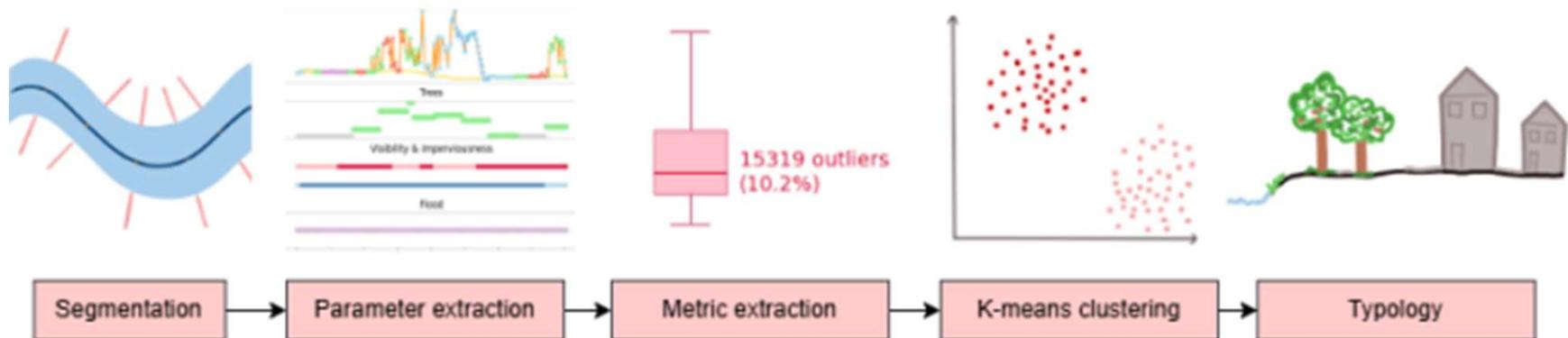


First line of buildings delineation

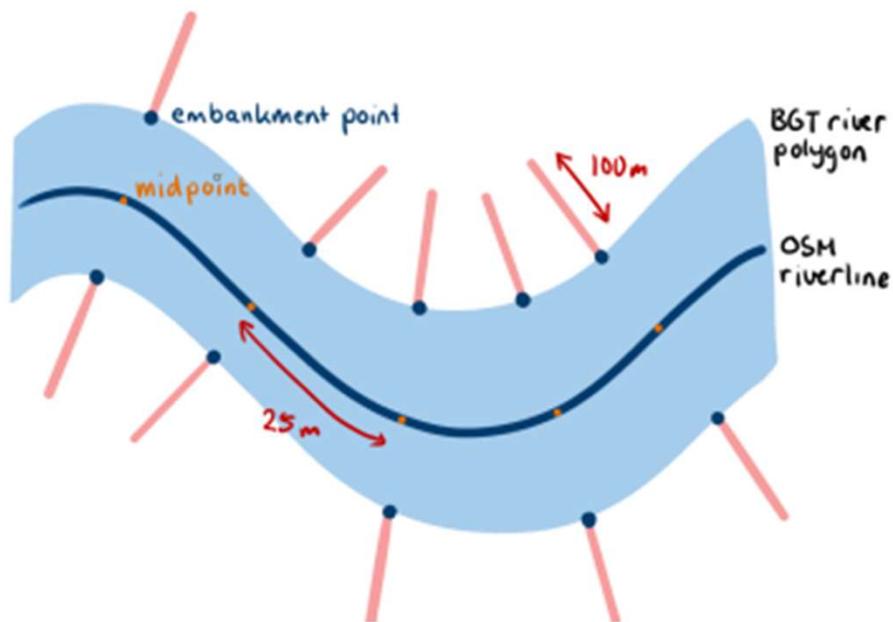
1. Visible building nodes
2. Remove hidden edges
3. Connect visible edges



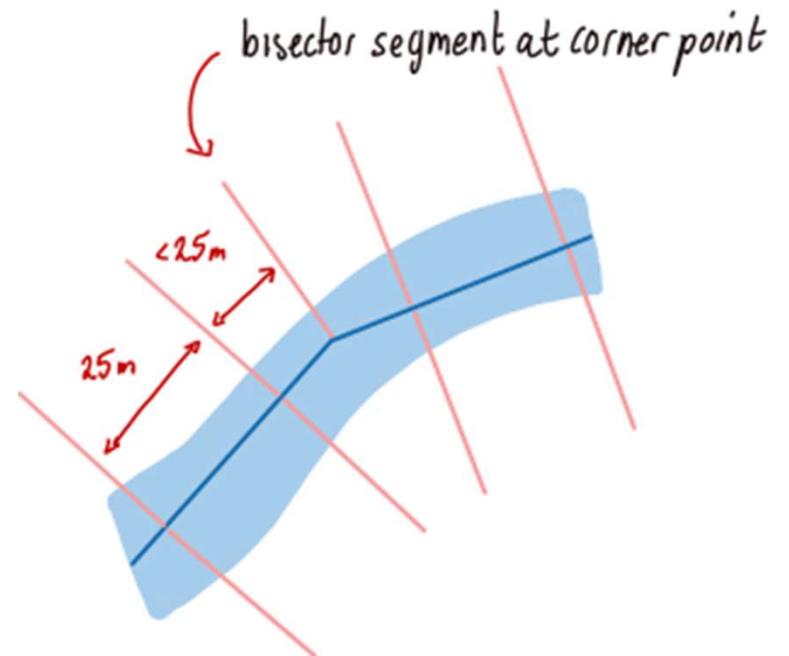
Urban river space typology



Cross-section segmentation



Overview



Bisector

Cross-section segmentation

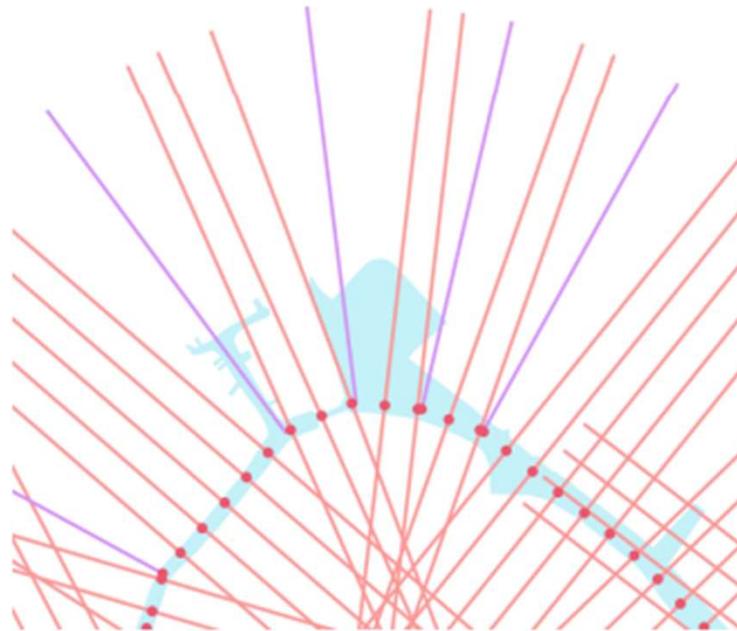


Figure 4.7.: Initial cross-section selection. Corner sections are shown in purple, normal sections in pink.

Cleaning sections



Figure 4.8.: Midpoints are removed if they intersect with a bridge polygon.

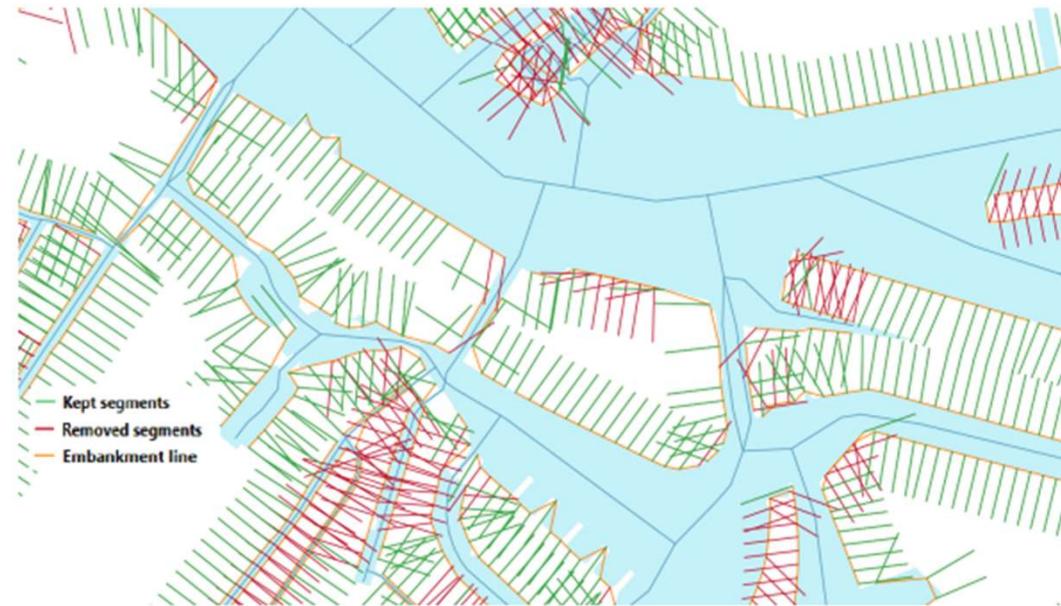
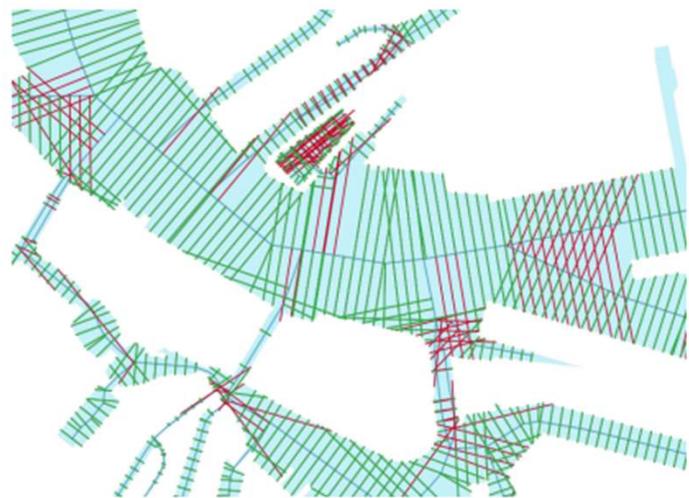
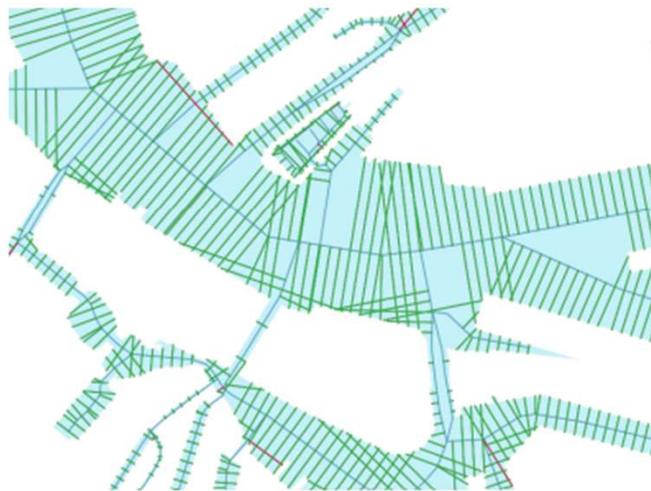


Figure 4.10.: Segments crossing another river's embankment line are removed

Cleaning sections



(a) Riverwidths crossing another riverline are removed

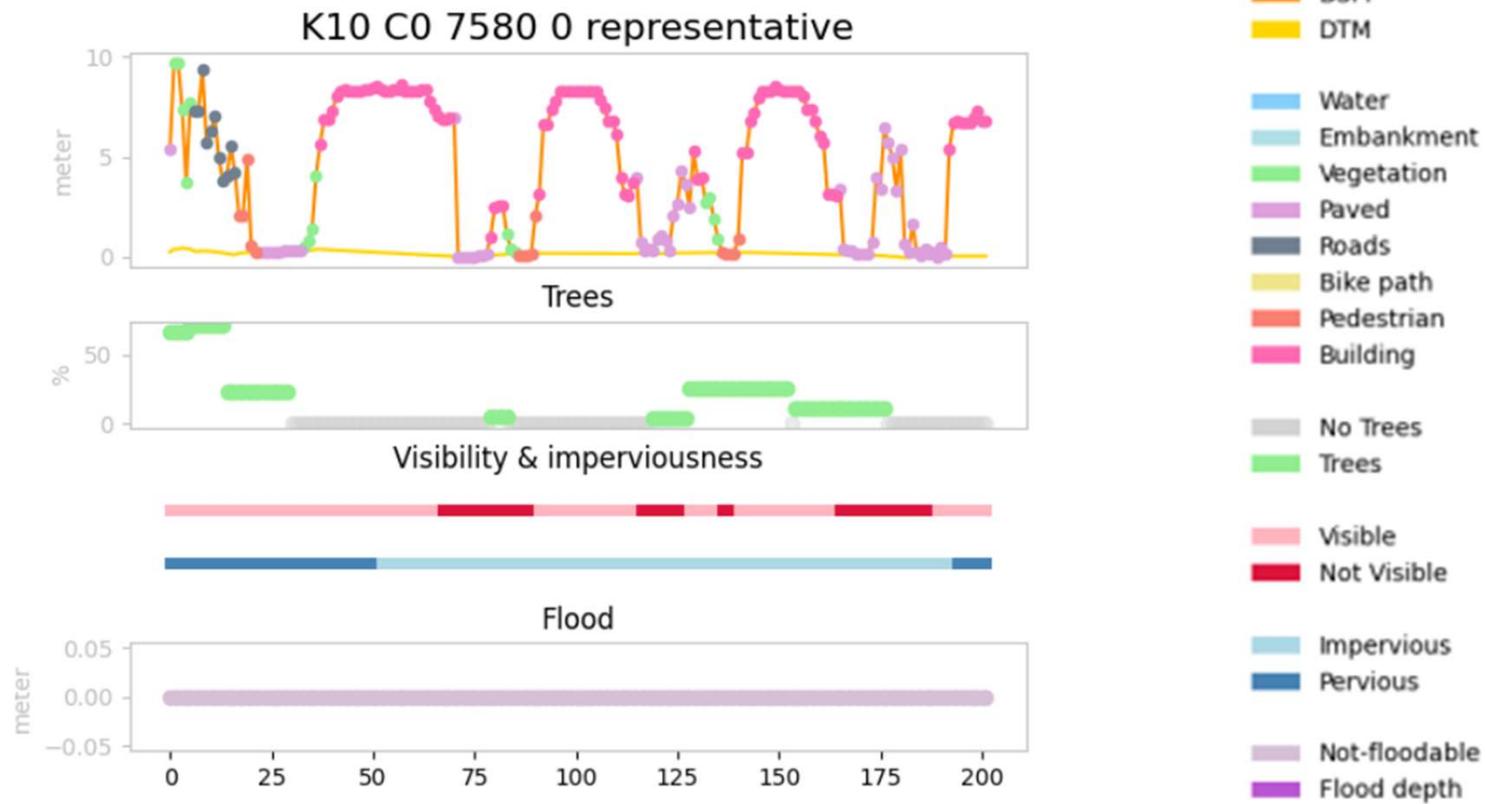


(b) Relatively large riverwidths are removed

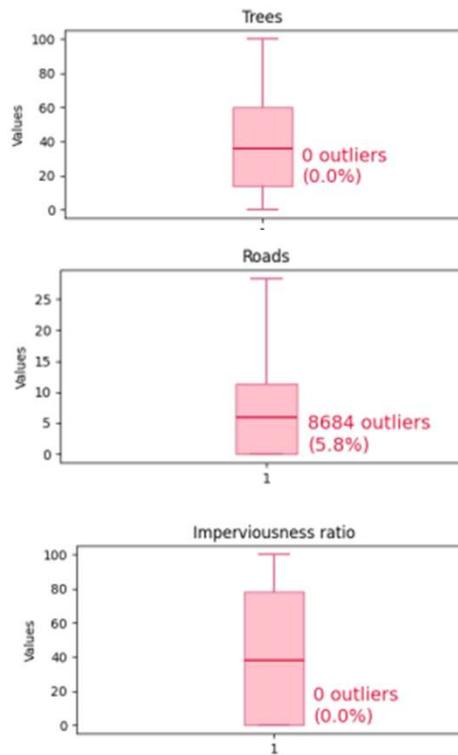


(c) Riverwidth intersections are taken care of

Parameters



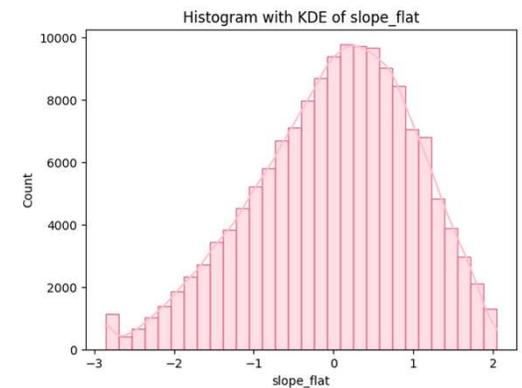
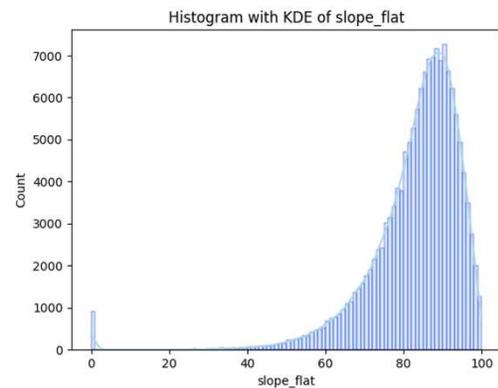
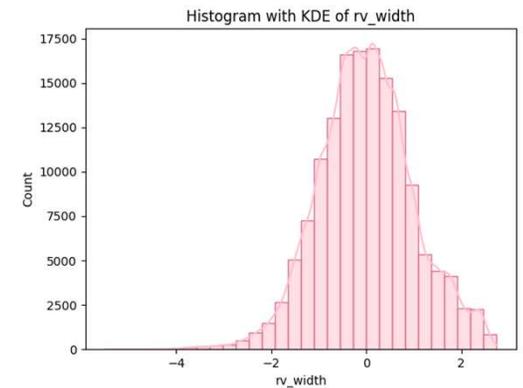
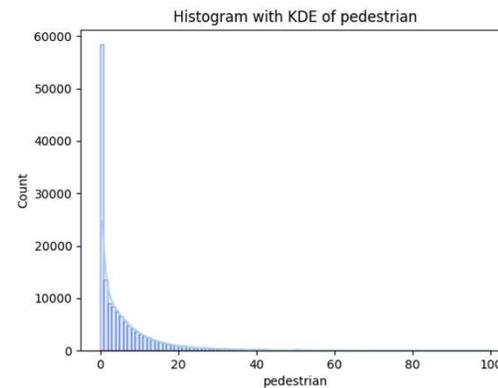
Metrics



1. Geometry
2. Landcover
3. Flood
4. Open space

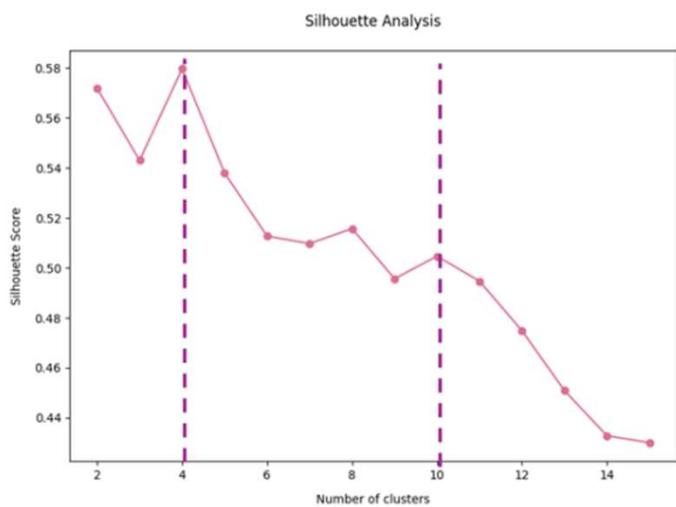
K- means clustering: Transforming metrics

1. High skewness values
2. Yeo-Johnson transform

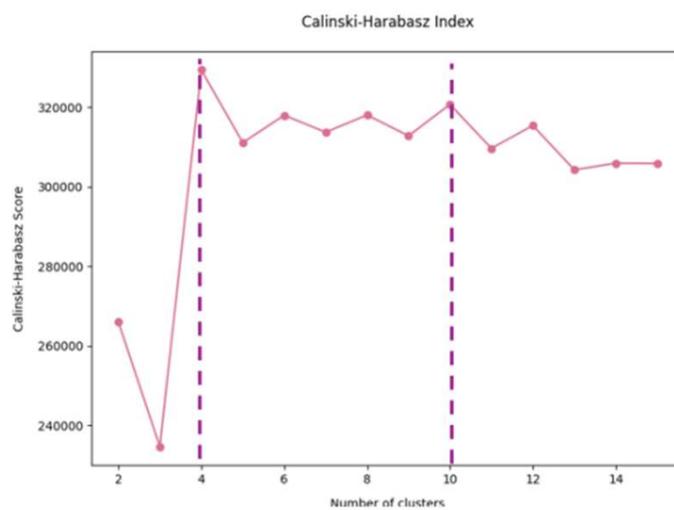


K- means clustering: Choosing k

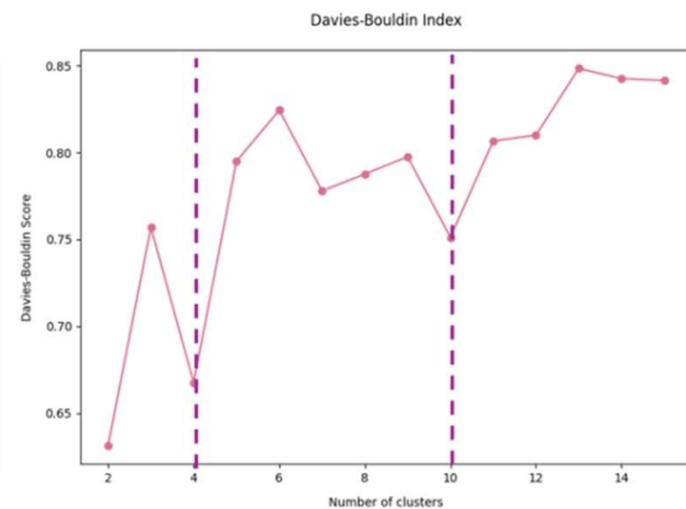
1. Goodness-of-fit scores
 1. Silhouette score: Higher is better
 2. Calinski-Harabasz score: Higher is better
 3. Davies-Bouldin score: Lower is better
2. Clustergram



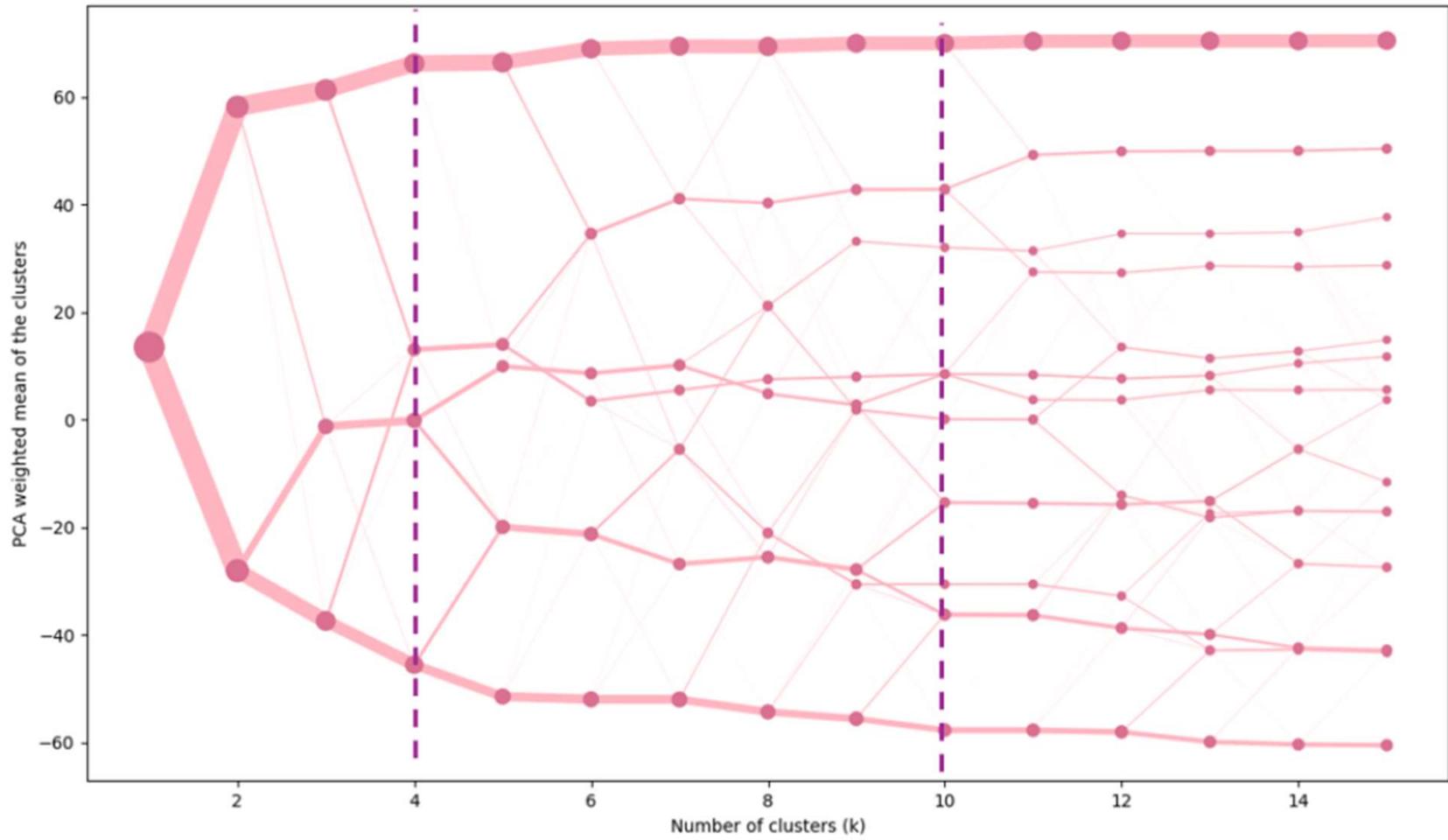
(b) Silhouette score



(c) Calinski-Harabasz score



(d) Davies-Bouldin score



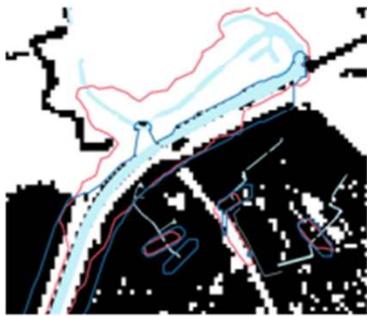
(a) Clustergram

→ K = 10

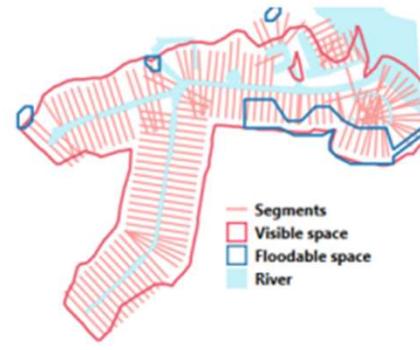
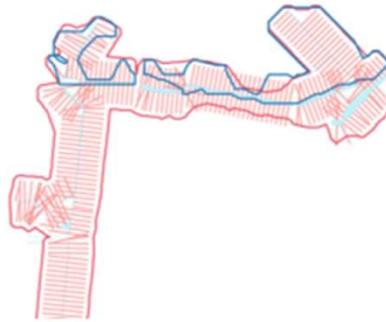
02

Results

- Delineation
- Clusters
- Urban river space typology of the Netherlands



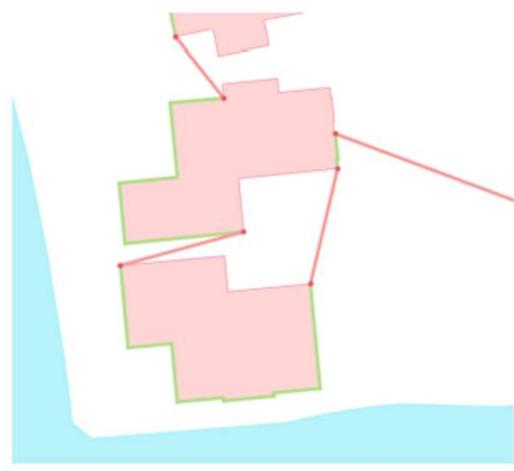
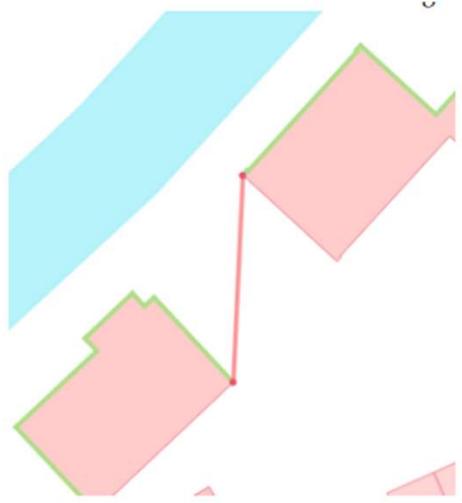
(a) Flood raster



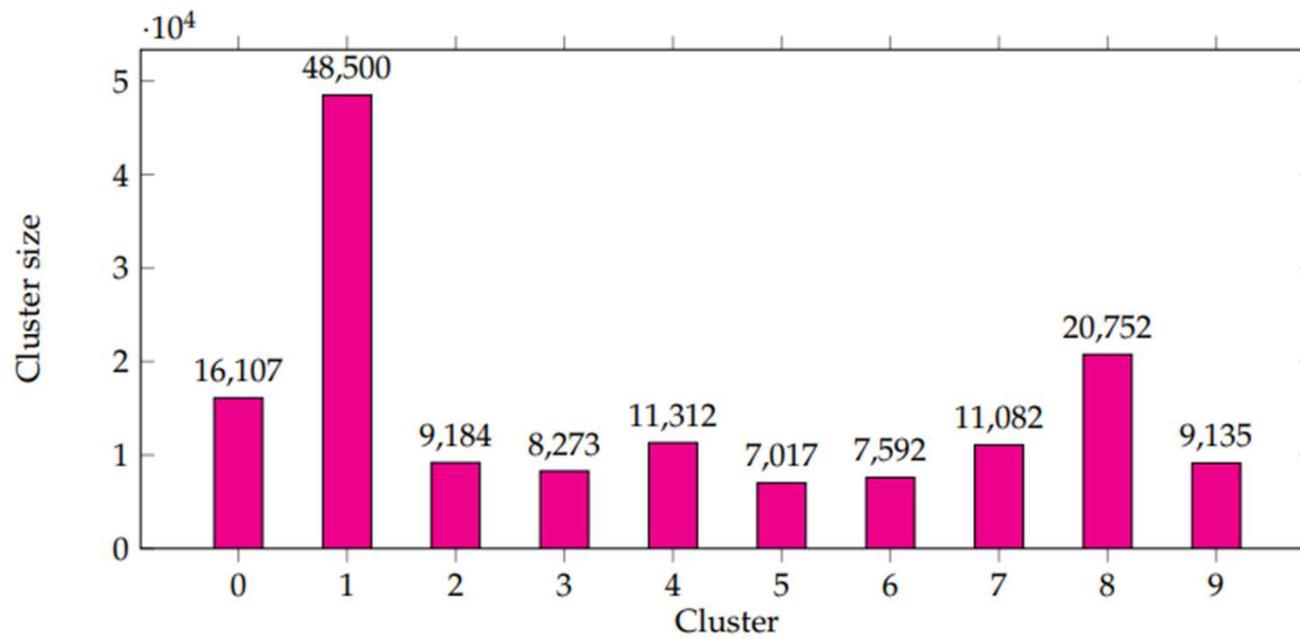
(b) Delineations and segments



(c) Visible space raster



Clusters



Typology

Cluster	Building		Vegetation		Trees	
	Median	Mean	Median	Mean	Median	Mean
0	31.68	33.94	5.94	8.69	37.13	37.08
1	0	0.38	79.70	69.74	34.65	40.39
2	0	3.25	7.43	13.40	22.28	27.43
3	15.35	18.75	14.36	21.13	56.93	52.53
4	22.77	25.04	9.90	14.19	49.01	47.15
5	12.87	14.71	28.71	29.19	58.42	54.85
6	29.21	31.02	4.95	7.68	21.78	24.65
7	0	2.52	34.16	34.55	46.04	44.73
8	43.07	44.86	0.50	3.30	20.30	22.77
9	20.30	22.31	19.80	20.20	43.56	42.87

6 main types based on building/vegetation/tree metrics

1. 0, 6 and 8
2. 1
3. 2
4. 3 and 5
5. 4 and 9
6. 7

Typology

Type	Building cover	Tree percentage	Vegetation cover
1	High	Low	Low
2	Low	Low	High
3	Low	Low	Low
4	Low	Medium	High
5	Medium	Medium	High
6	Low	Medium	Medium



Urbanized riverbanks



Lush natural floodplains



Barren paved land



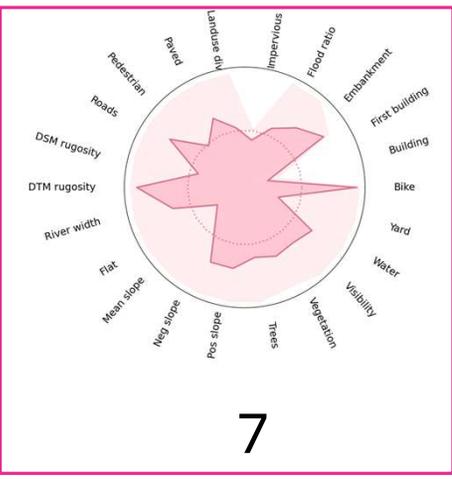
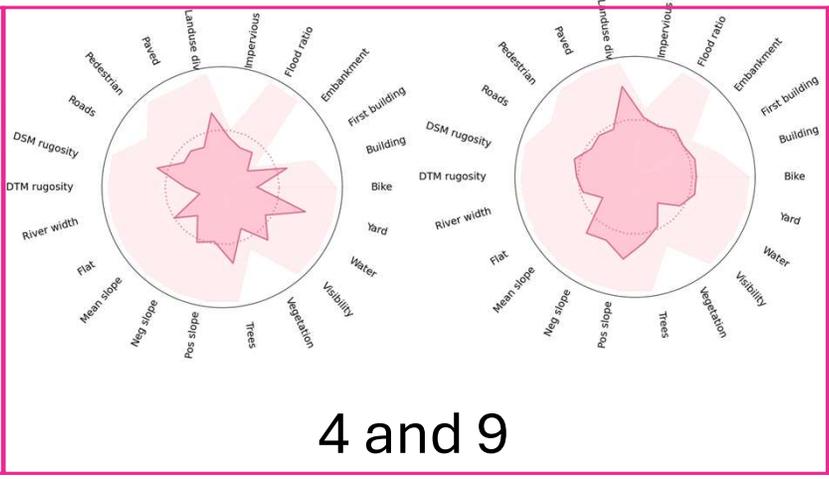
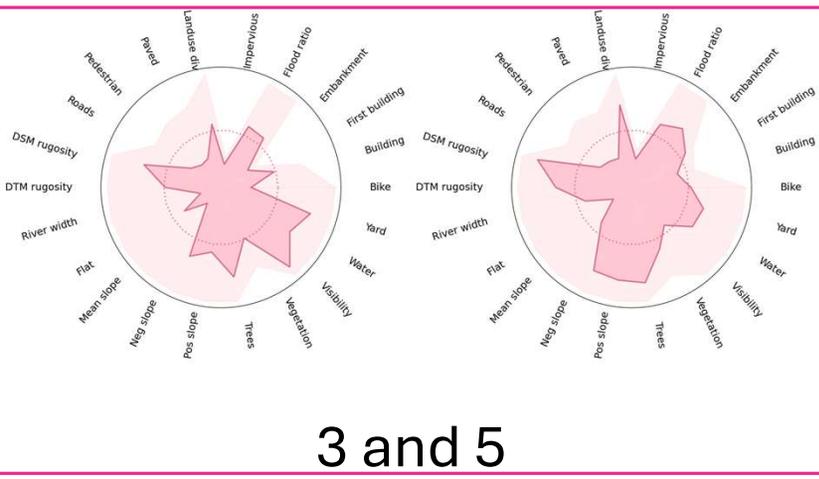
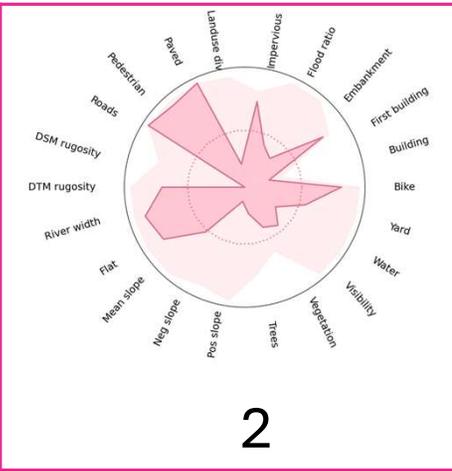
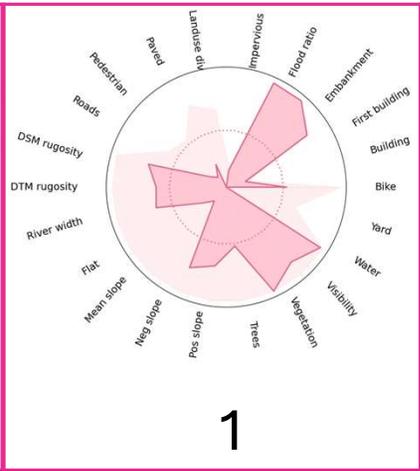
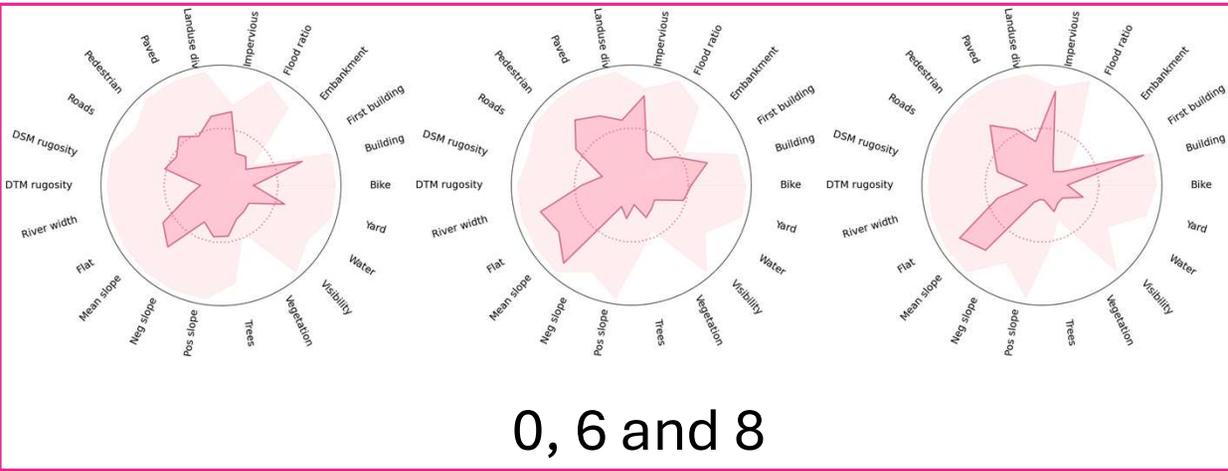
Residential tree-covered river space



Balanced riverside corridors



Mixed green strips

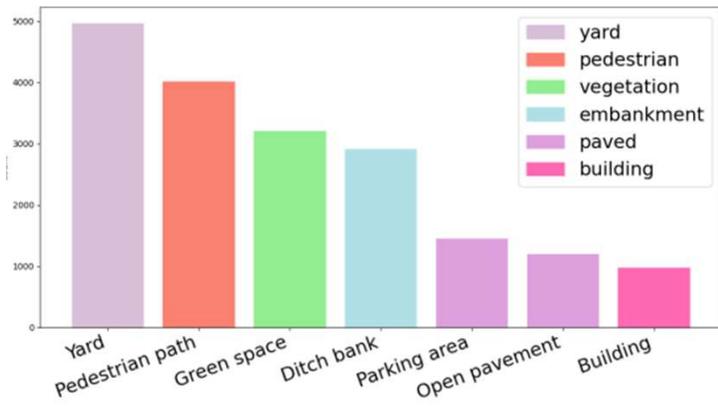
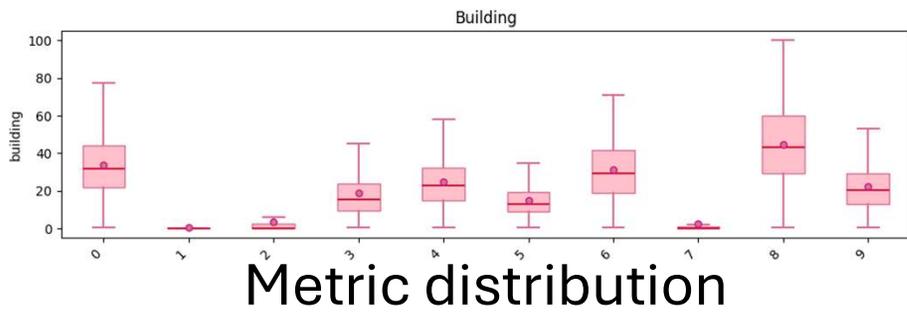


Spiderplots of metric values per cluster

Subtypes

- 1. Urbanized banks**
 - A. Mixed hardscape greenway
 - B. Open-edge urban river space
 - C. Dense built-up river space
- 2. Lush natural floodplains**
- 3. Barren paved land**
- 4. Residential tree-covered river space**
 - A. Visible areas
 - B. Sloped areas
- 5. Balanced riverside corridors**
 - A. Buildings and yards
 - B. Set-back buildings and green riverbanks
- 6. Mixed green strips**

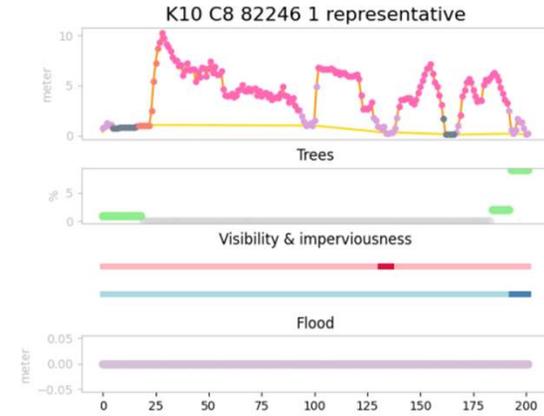
From cluster 8:
Type 1C: Urbanized riverbanks, Dense built-up river space



First landuse distribution

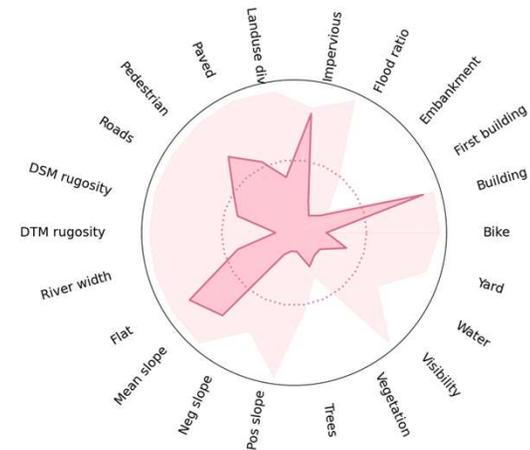


(e) Orthophoto cluster 8



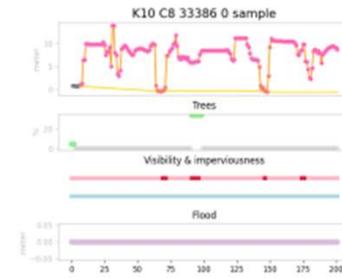
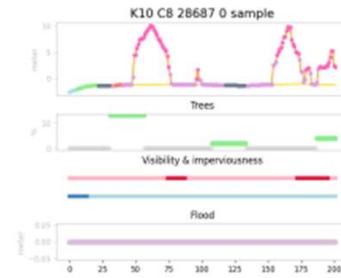
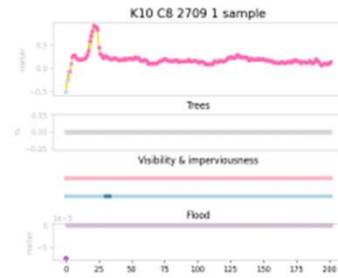
(f) Parameters cluster 8

Most representative segment



Metric values spiderplot

Randomly sampled segments



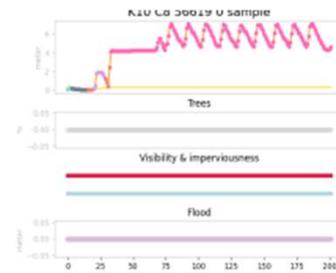
K10 CB 56619 0 sample



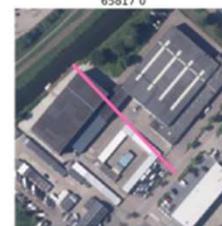
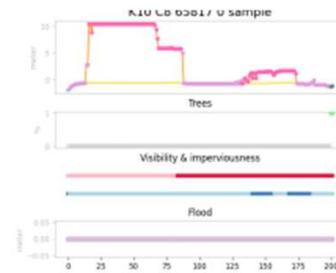
K10 CB 65817 0 sample



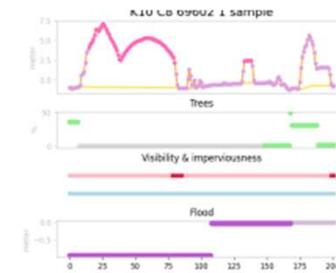
K10 CB 69602 1 sample



K10 CB 83564 0 sample



K10 CB 86030 1 sample

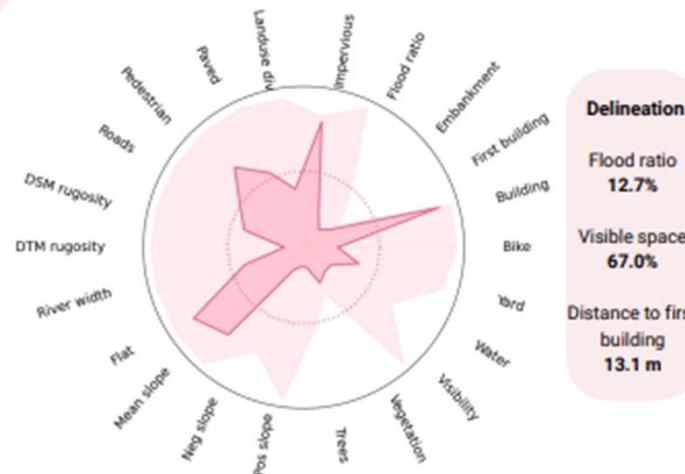
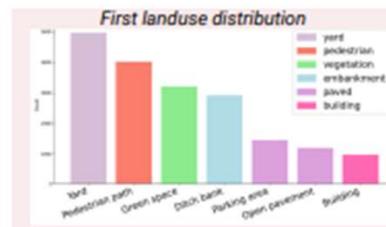


K10 CB 9133 1 sample

Urbanized banks

C: Dense built-up river space

A space almost completely covered in buildings, limiting the visible space, and offering very limited room for vegetation and trees.



03

Future development

1. Cut segments at delineation
2. Categorical metrics
3. Typology for whole river/corridor

Cut segments at delineation

Segments would be cut at visible space boundary

Difference in segments depending on delineation method

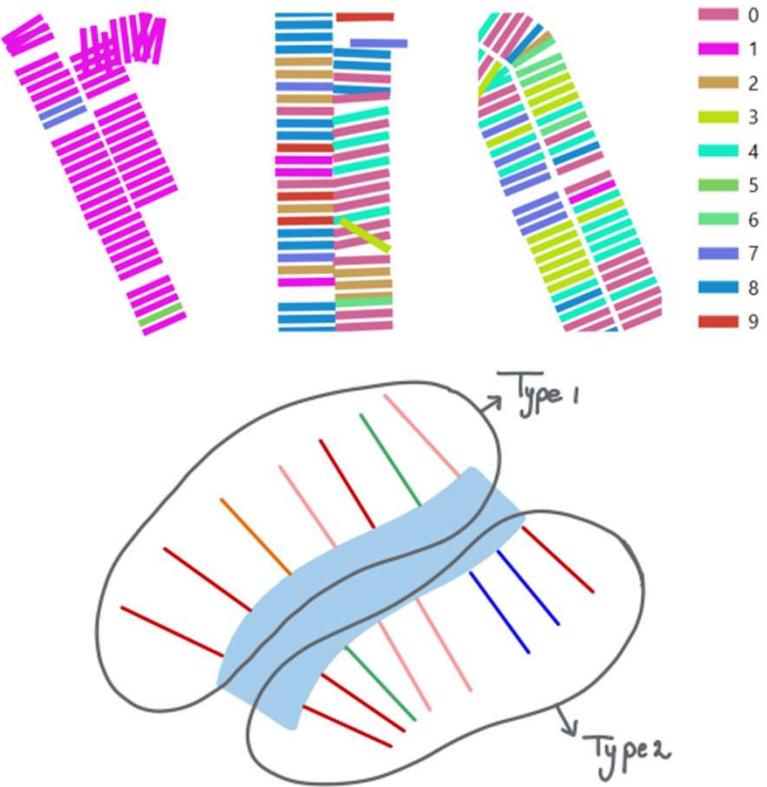
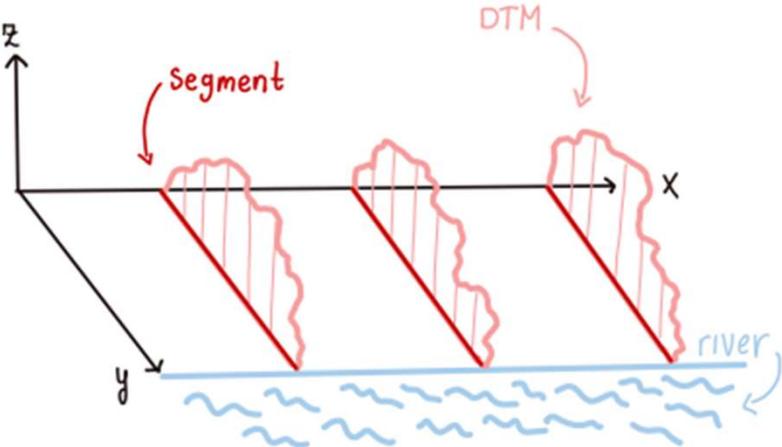
- Segments
- Visible space
- Floodable space
- River



Categorical metrics

Categorical metrics → different clustering

Whole river



05

Conclusion

Thank you for your attention!