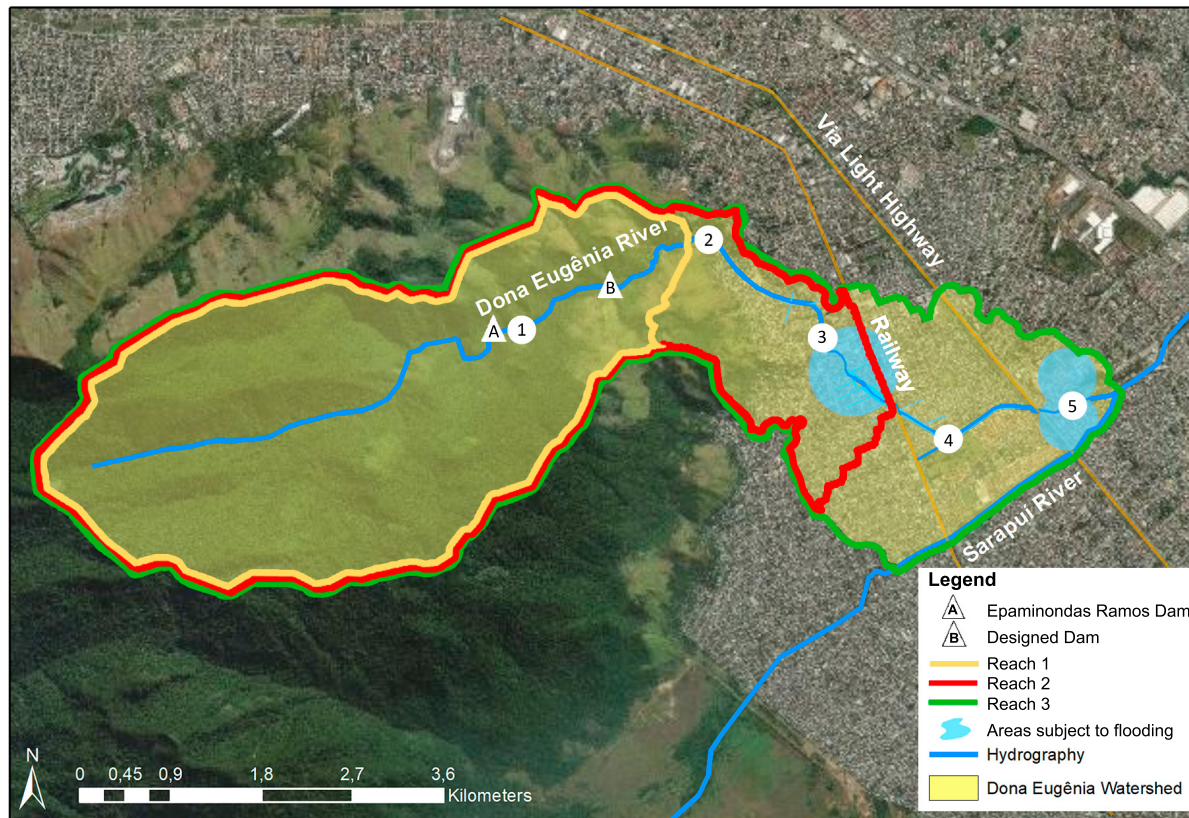
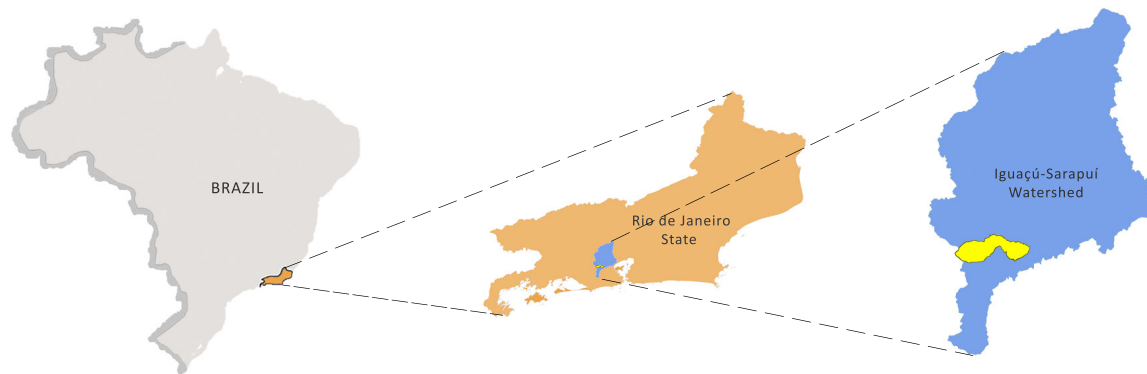


River Restoration Integrated With Sustainable Urban Water Management For Resilient Cities

Aline Pires Veról, Ianic Bigate Lourenço, João Paulo Rebechi Fraga, Bruna Peres Battemarco,
Mylenna Linares Merlo, Paulo Canedo de Magalhães and Marcelo Gomes Miguez

Urban and Landscape Design

Dona Eugênia Watershed
Brazil



Dona Eugênia Watershed

- Dona Eugênia watershed has a drainage area of 18 km².
- Dona Eugênia River is about 10 km long - the first 4 km are located inside an Environmental Protection Area called Gericinó/Mendanha, in the city of Nova Iguaçu and the subsequent 6 km are in the city of Mesquita, where it crosses the urban area until its outfall, on Sarapuí River.
- Inside the Environmental Protection Area, there is a park named Nova Iguaçu Natural Municipal Park, an area of 11 km², with an altitude between 150 m and 956 m, which is an important representative of the Atlantic Forest with several examples of natural local flora and fauna.
- Inside the park, there is a desactiveted dam called Epaminondas Ramos ("A"), used as a water supply in the past.
- In 2009 a revision of the Water Resources Master Plan of the Iguaçu-Sarapuí Watersheds pointed to a laminating dam ("B") for flood control.
- The critical points are the city center, where the city hall is located, and the areas along and upstream of the railway and at the river mouth, as indicated in the map.

Epaminondas Ramos Reservoir



The first reach of Dona Eugênia River inside the urban area



Mesquita City Center – a Critical Area



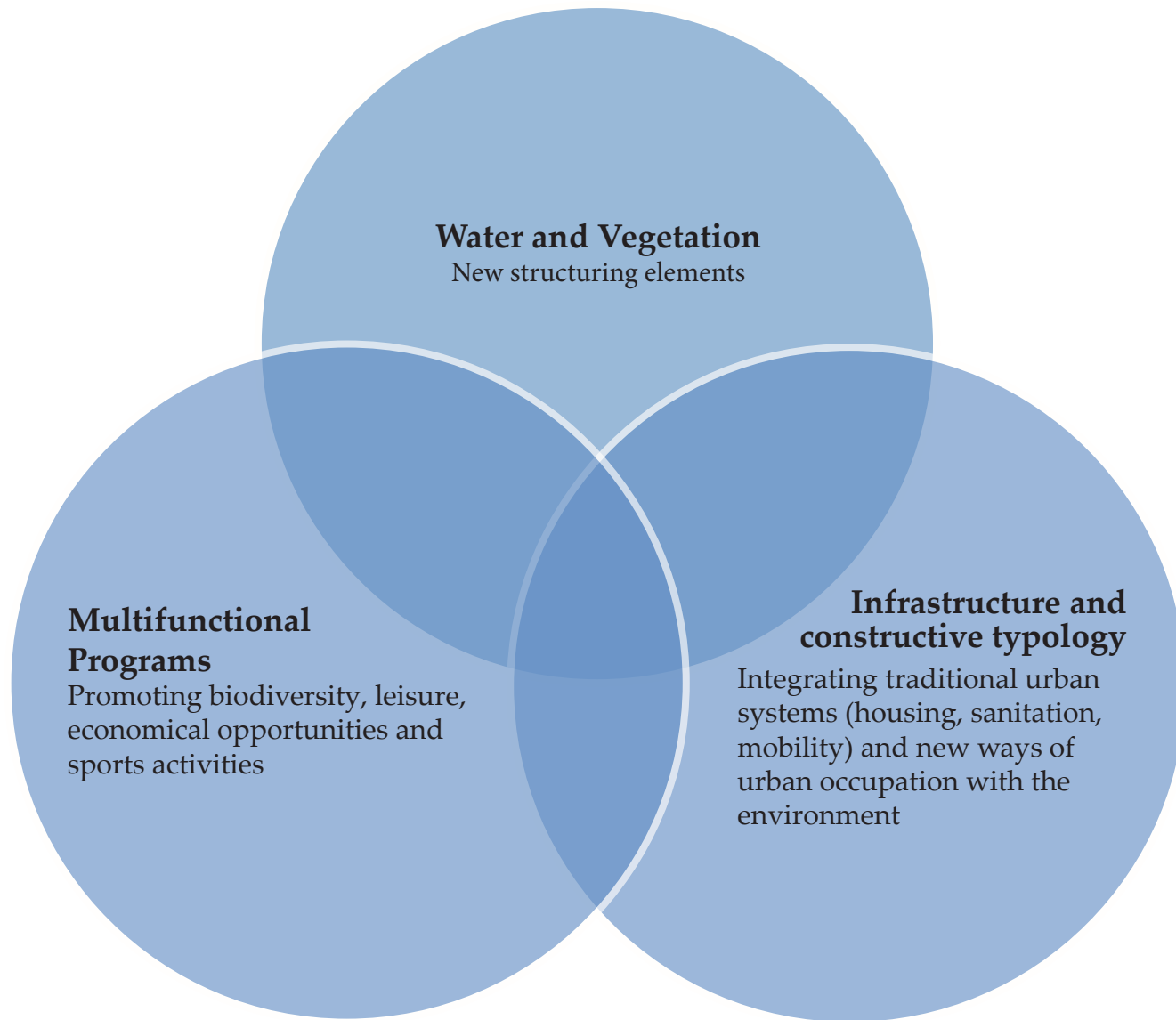
The river downstream the railway



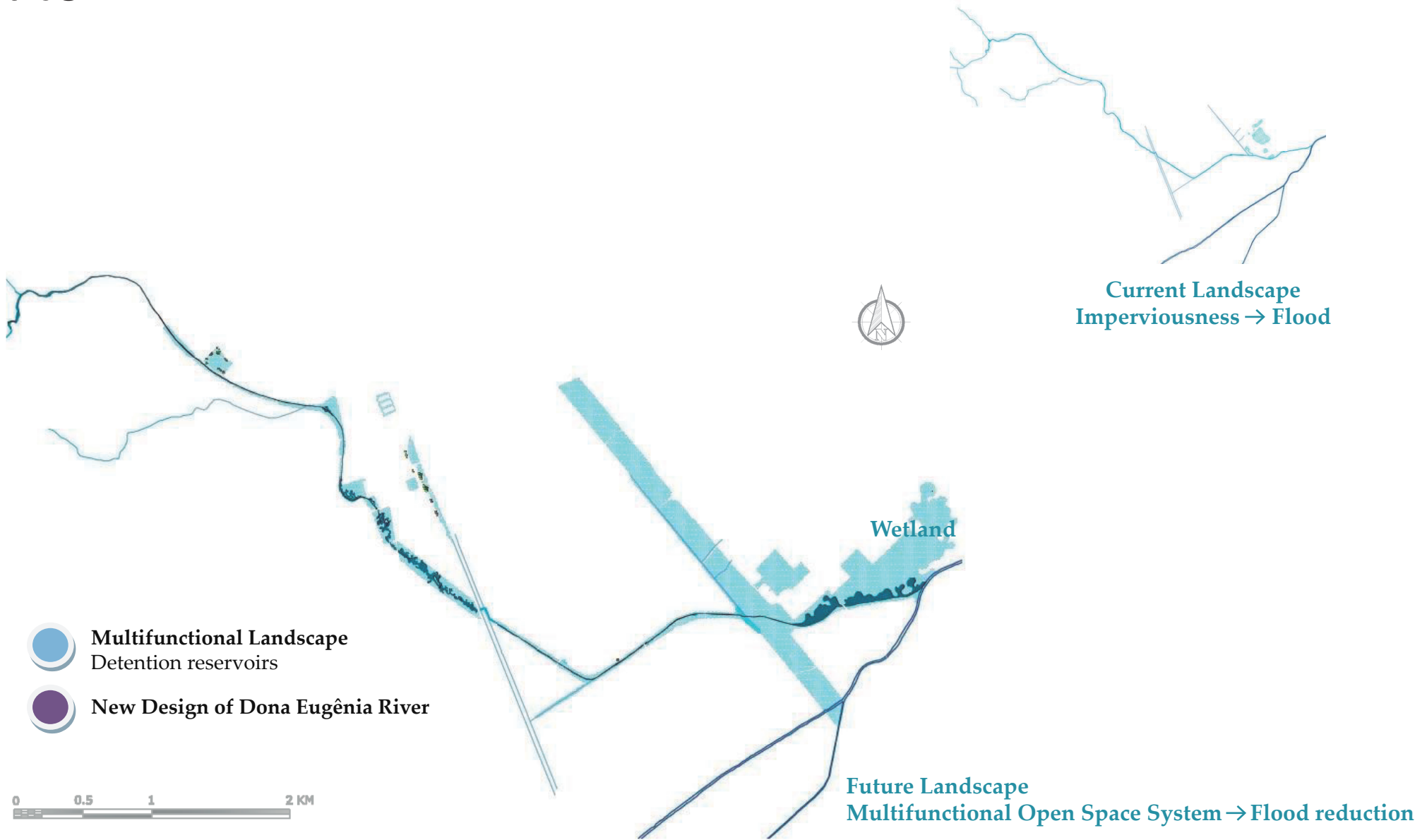
Dona Eugênia River Mouth



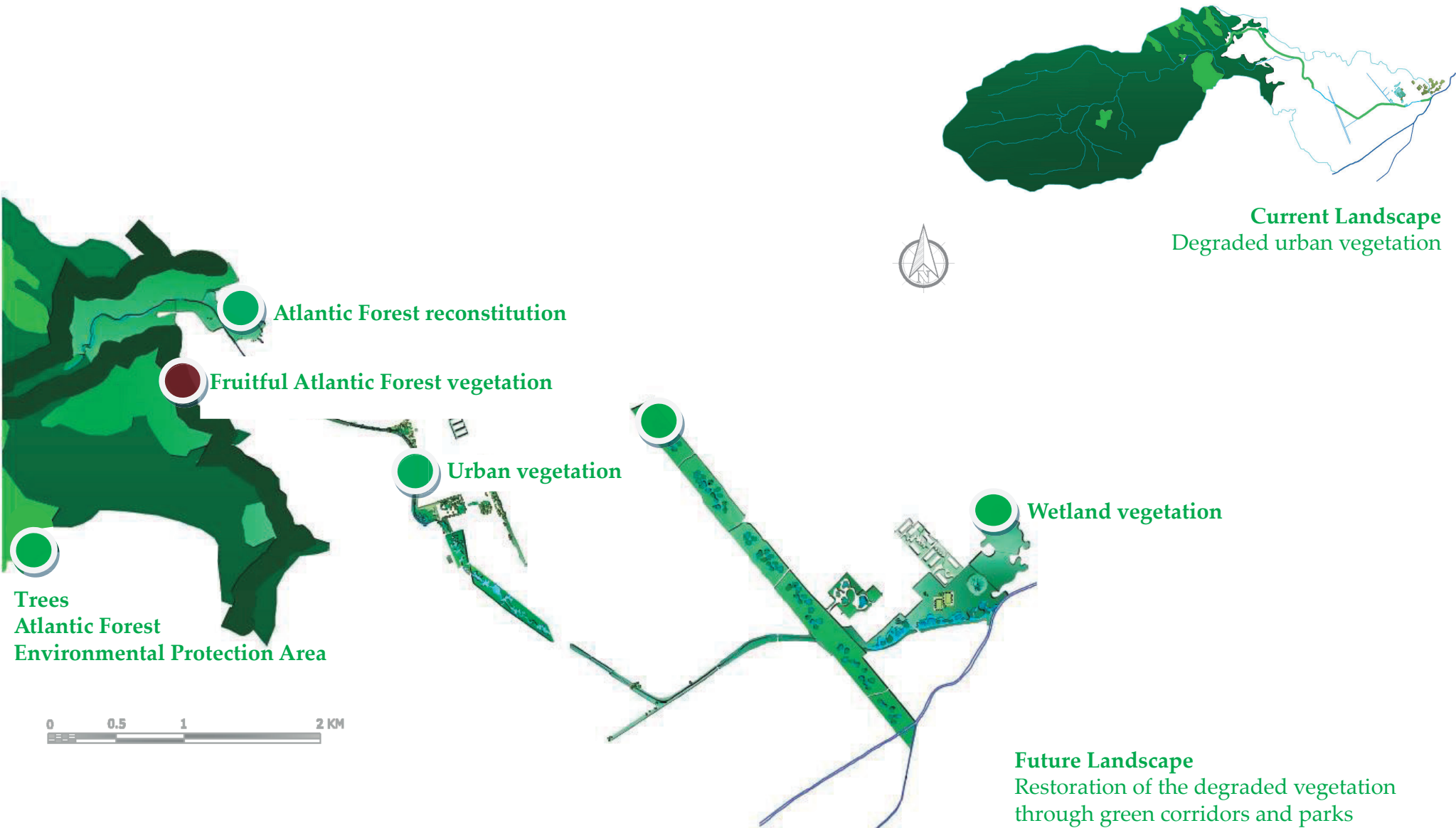
A Systemic View



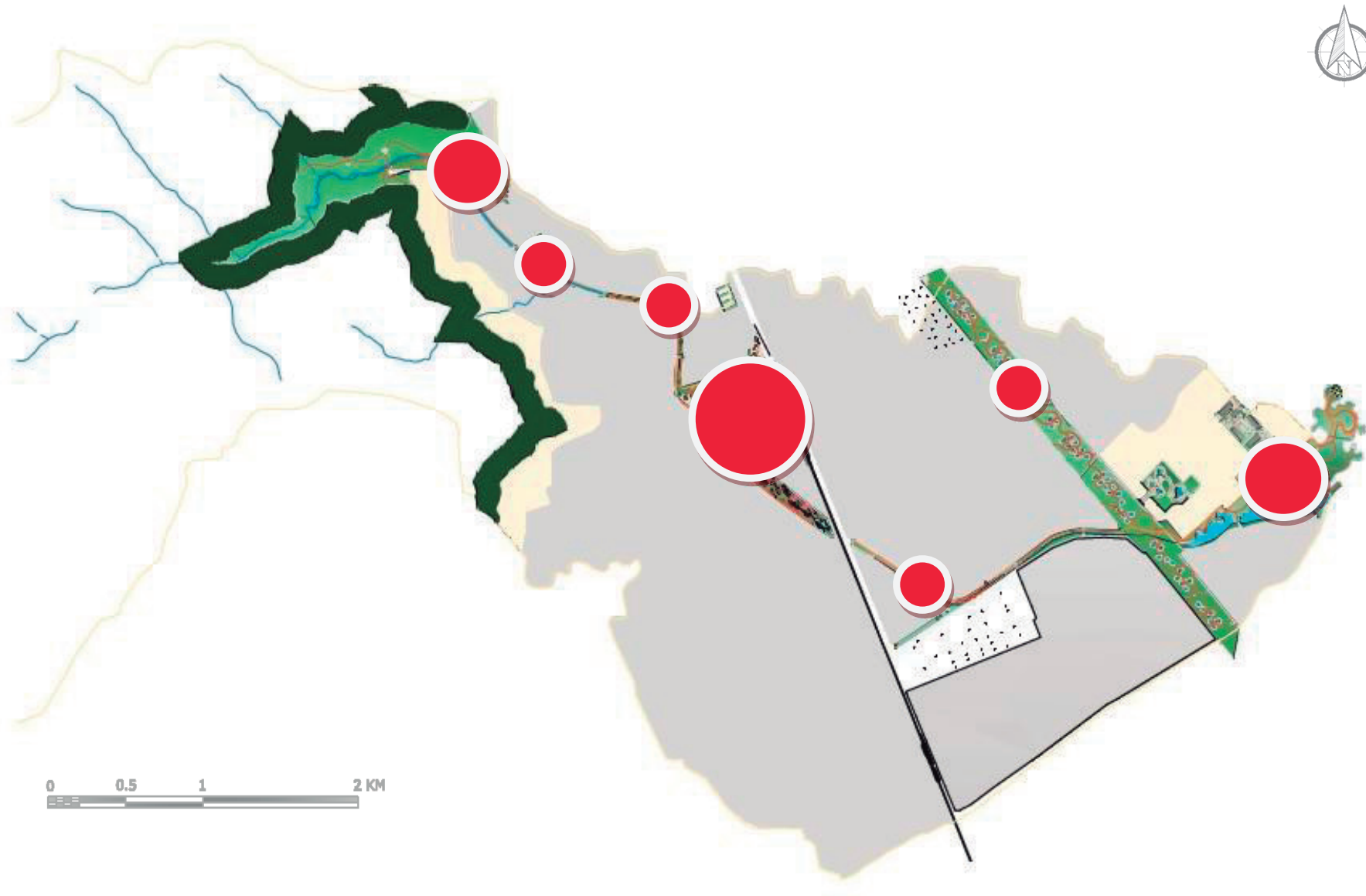
Water



Vegetation



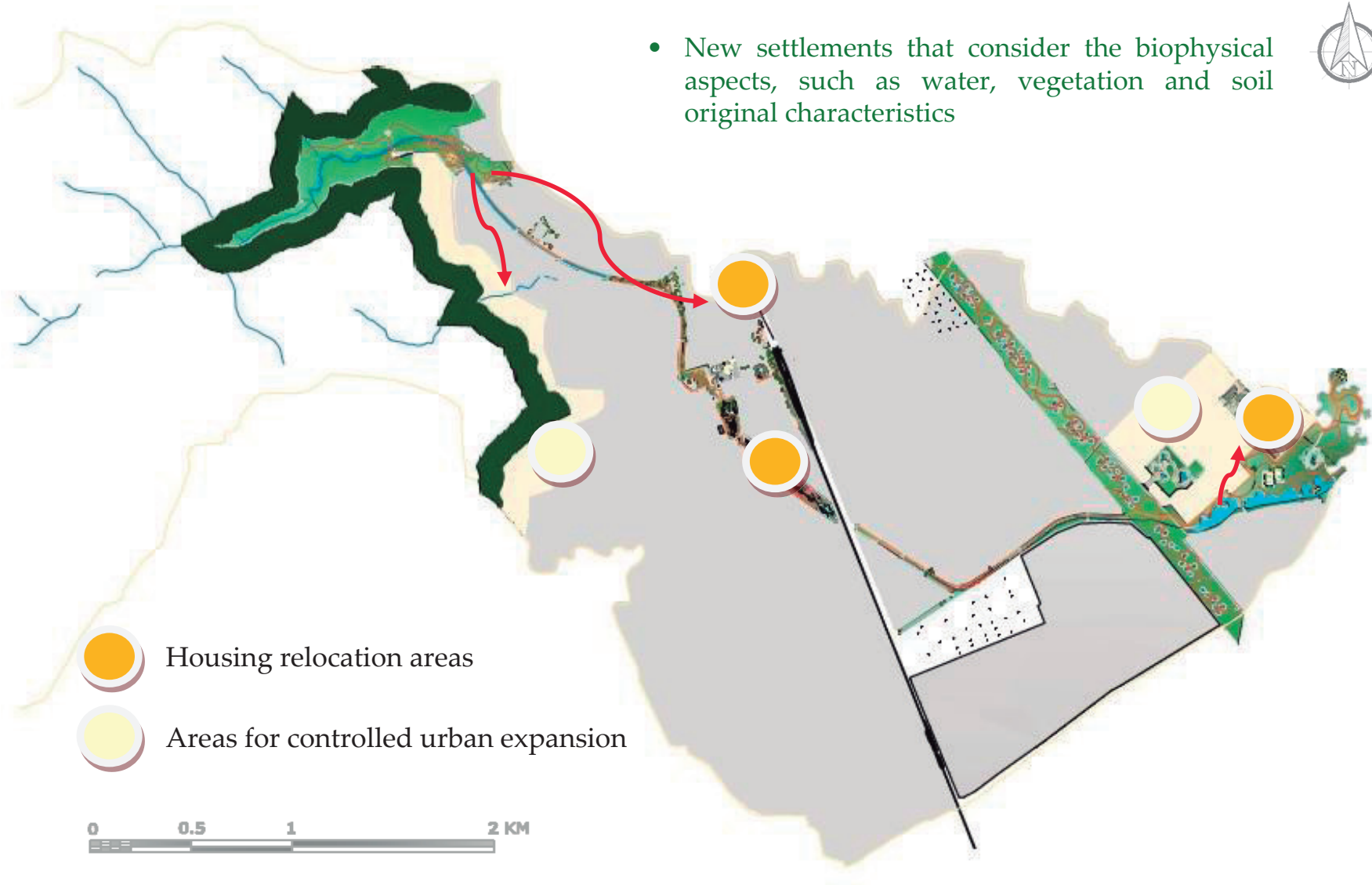
Infrastructure - Services



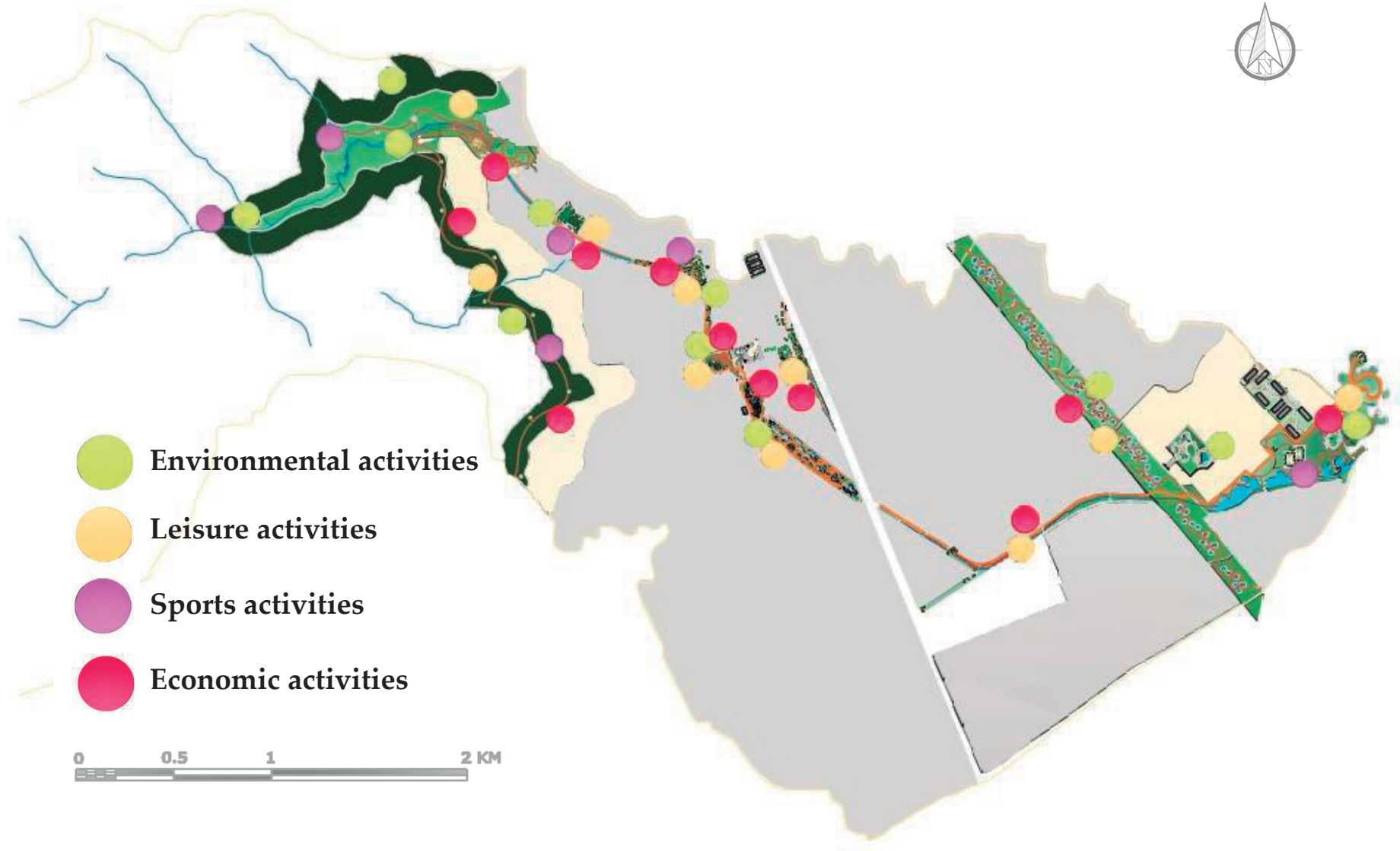
- Reestructuring of the comercial city center
- New business opportunities arising from revitalized city areas

Infrastructure - Housing

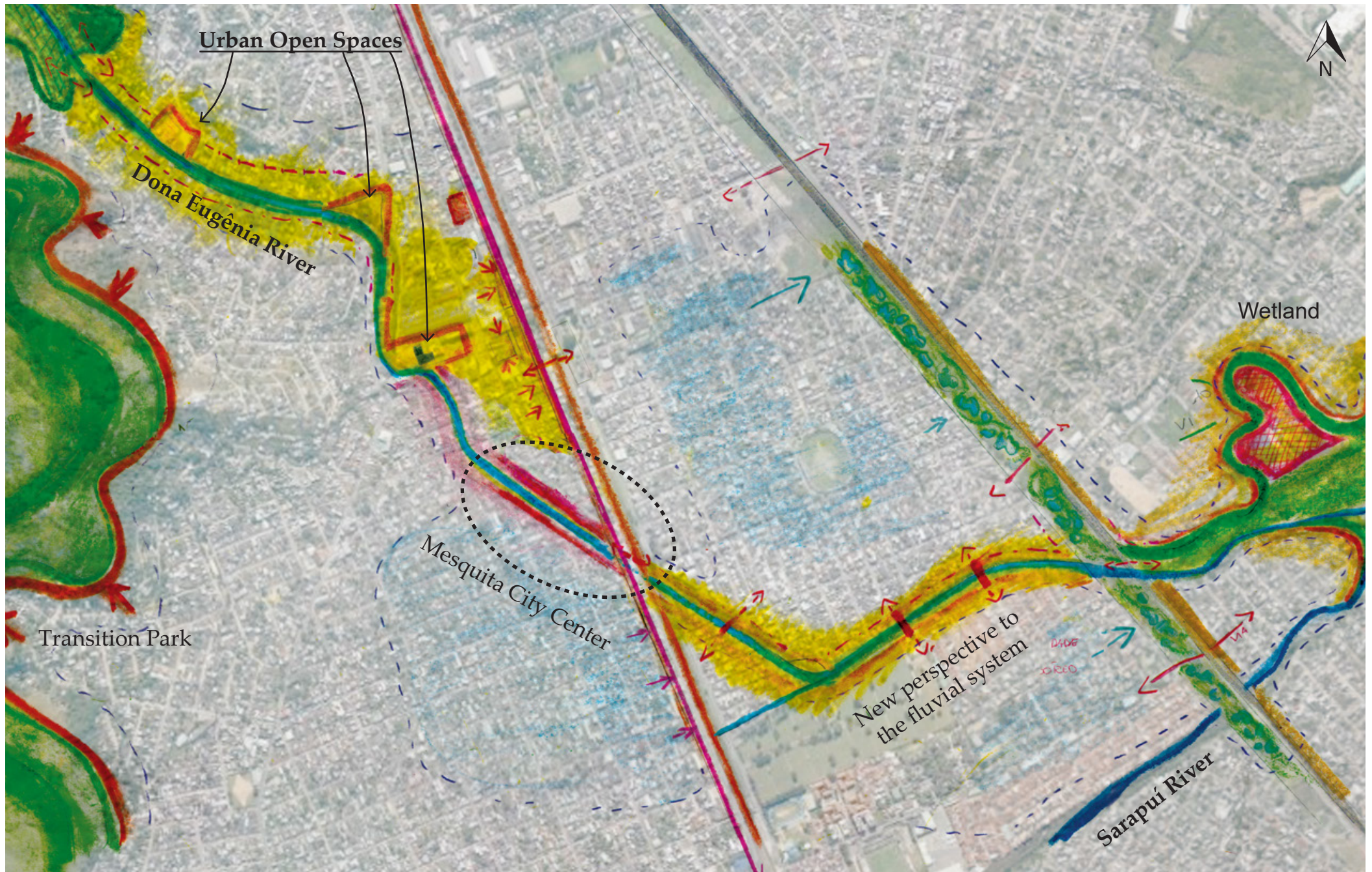
- New settlements that consider the biophysical aspects, such as water, vegetation and soil original characteristics



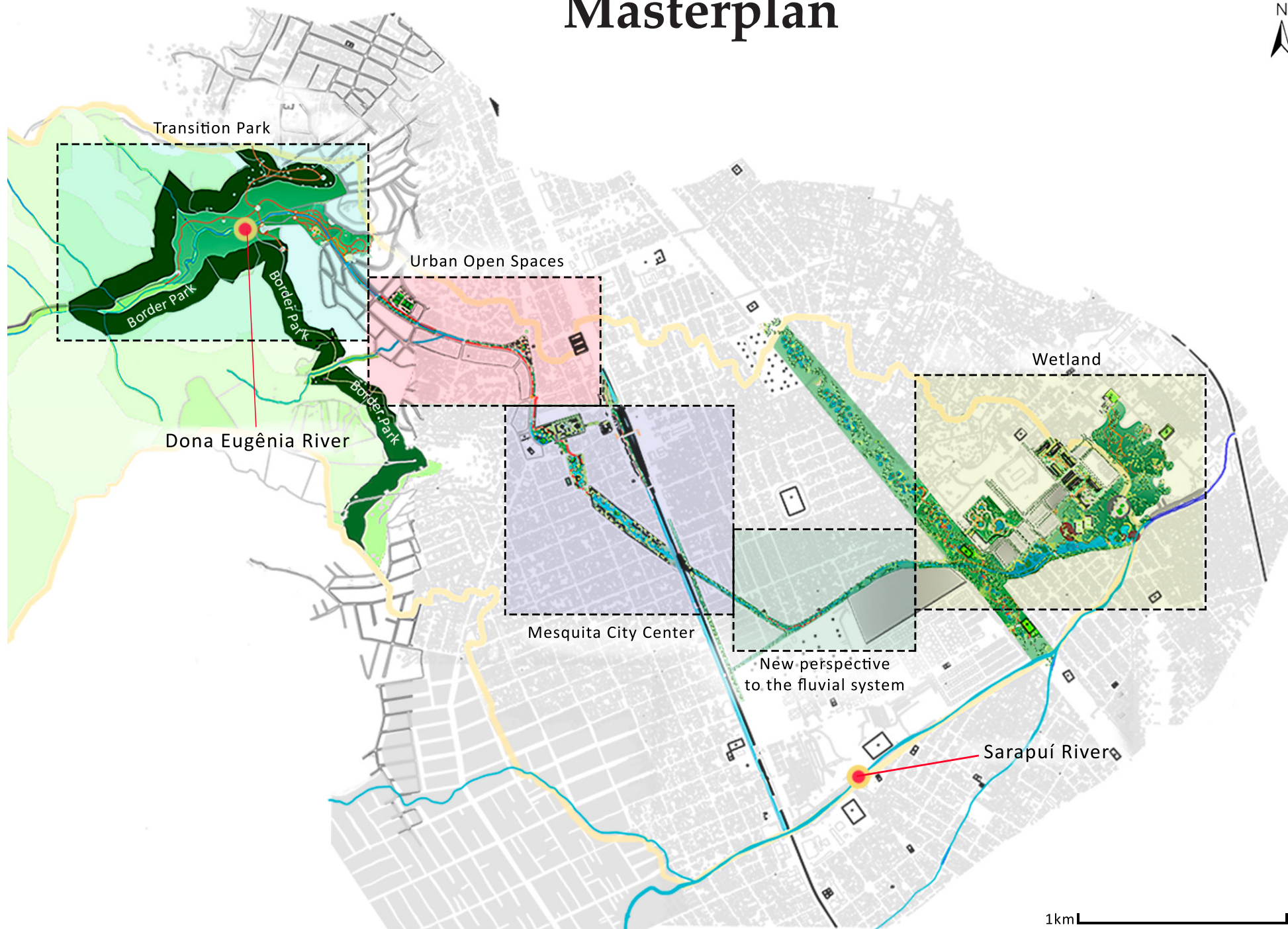
Multifunctional Systems



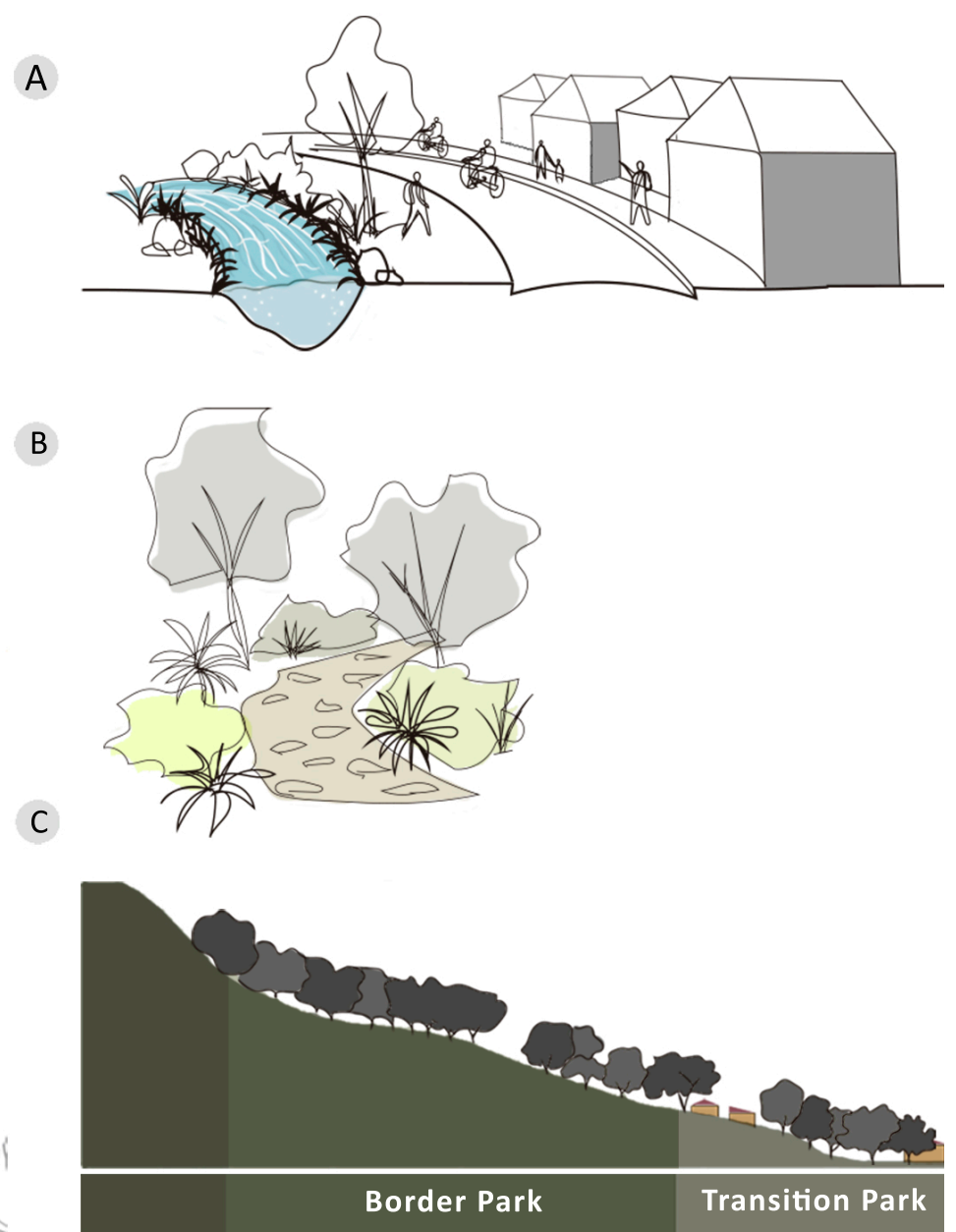
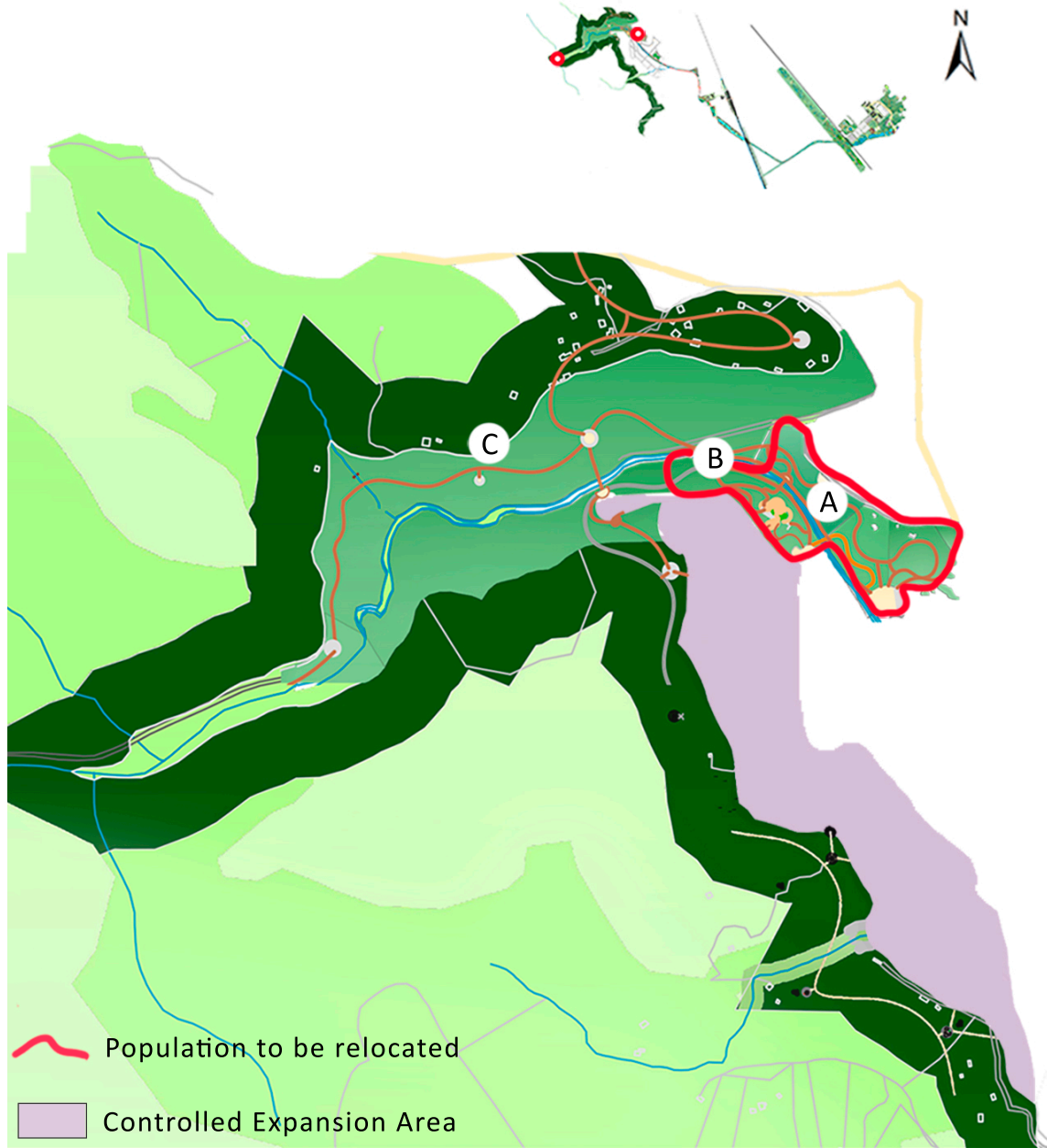
Design Concept



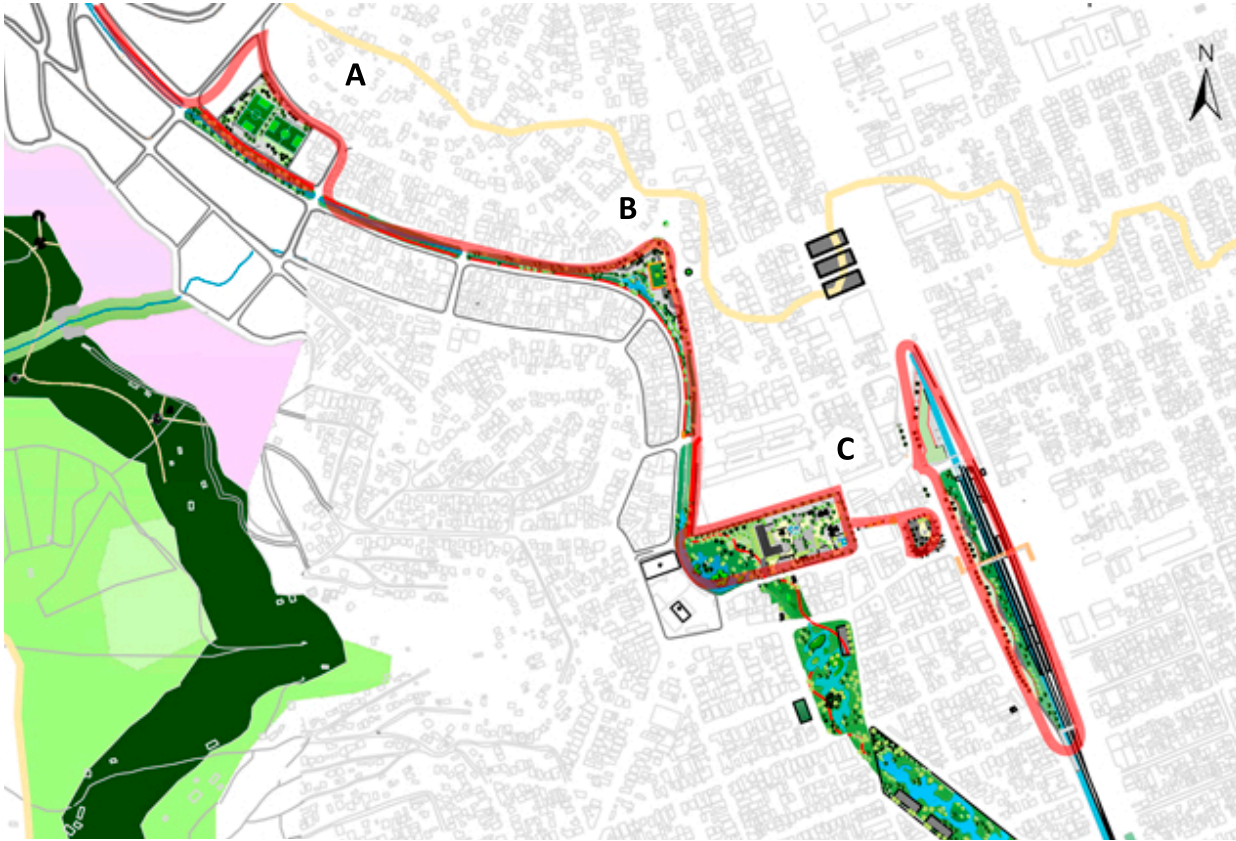
Masterplan



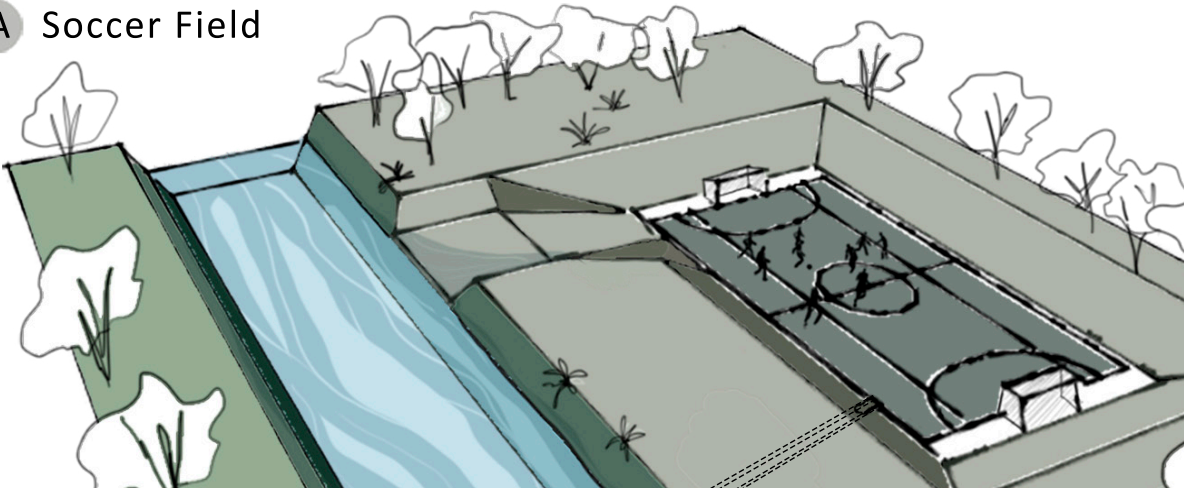
Border Park/Transition Park Project



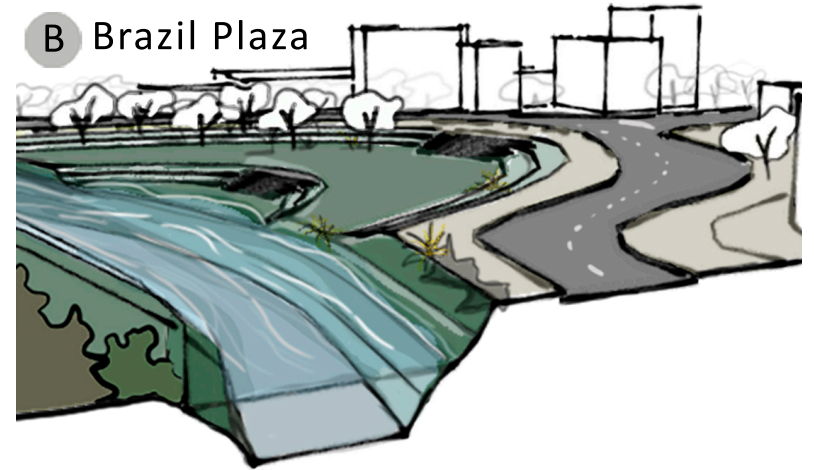
Urban Open Spaces



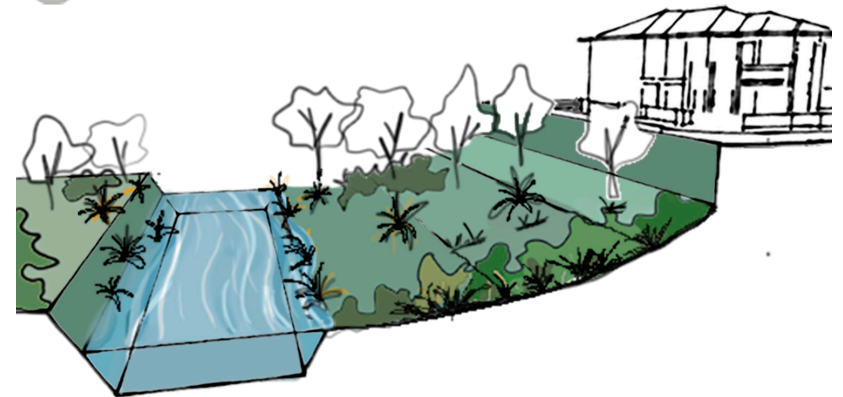
A Soccer Field



B Brazil Plaza

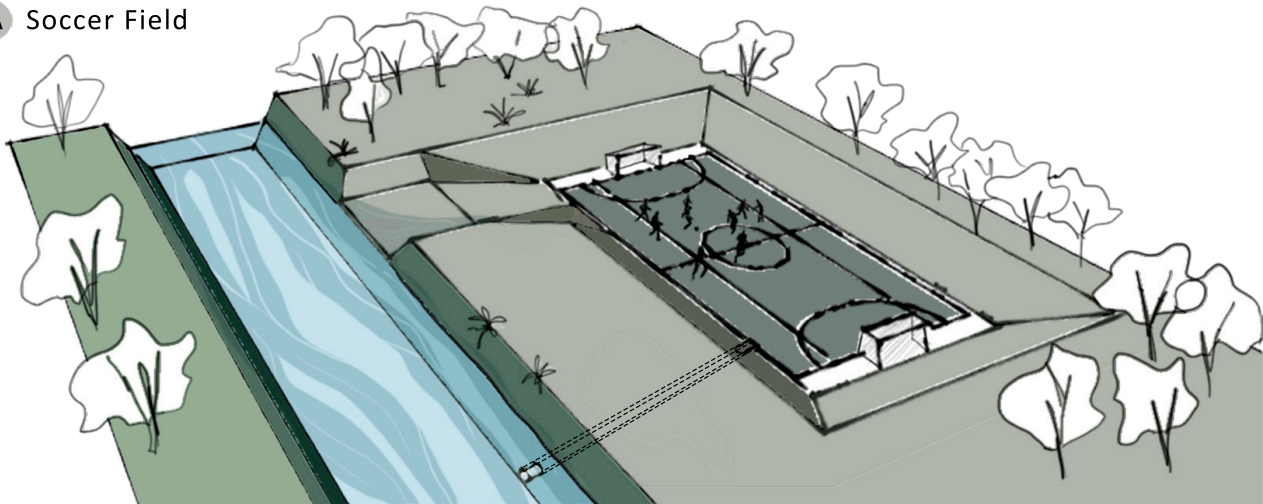


C Municipal Government Complex



Urban open Spaces - Soccer Field

A Soccer Field

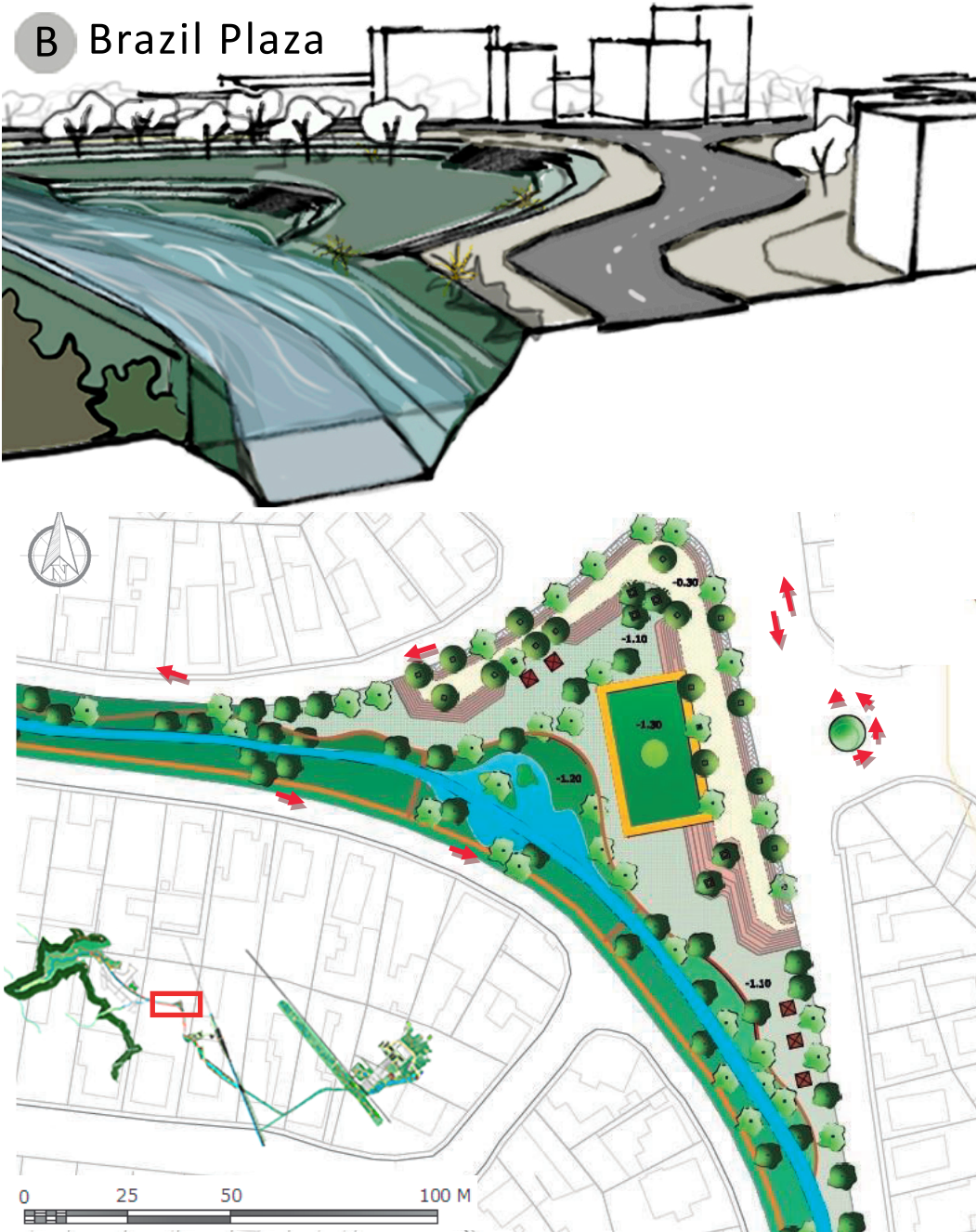


- The proposal calls for lowering the soccer field by 1.86 m concerning its original level, so it can function as a detention reservoir in high water periods.
- The water would exit the reservoir through a large pipe connected to the downstream reach. The river would be widened in this segment to handle the water from the reservoir in case of upstream overflow.
- The *depth x area x volume* curve of this reservoir is presented in the Table above, where the functional strip of the reservoir is indicated.

Depth x Area x Volume Curve – Soccer Field

Depth (m)	Area (m ²)	Volume (m ³)
26.34	5,819	0
26.80	8,622	3,321
27.40	10,033	8,917
28.20	12,366	17,877
28.45	16,778	-
30.00	16,778	-

Urban open Spaces - Brazil Plaza



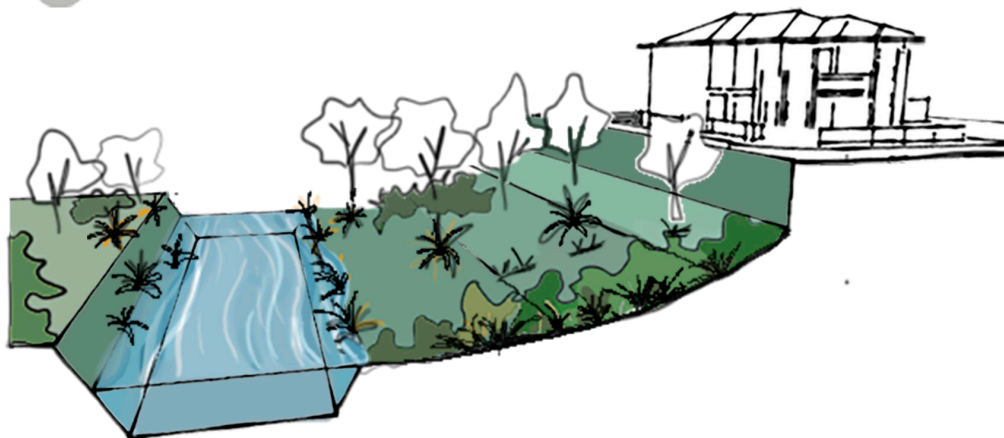
- The project also envisions the implementation of another detention reservoir, through lowering an existing public plaza called Brazil Plaza. It would not fill with water during light precipitation, would start to be flooded during stronger and/or more prolonged rainfall, and would fill almost totally during heavy rainstorms (design precipitation).
- This configuration facilitates the multifunctionality of the plaza, which would be unaffected by rain most of the time, providing a landscaped space for leisure, so that it would only require cleanup after sporadic events with large magnitude.
- The *depth x area x volume* curve data of this reservoir is presented in the Table above, with a highlight on the functional strip of the reservoir.

Depth x Area x Volume Curve – Brazil Plaza

Depth (m)	Area (m ²)	Volume (m ³)	Remarks
19.80	2,080	-	River bottom
20.80	4,480	0	Limit of the channel
21.30	6,600	2,770	Limit of the plaza
21.90	8,650	-	Level of urbanization

Urban open Spaces - Municipal Government Complex

C Municipal Government Complex



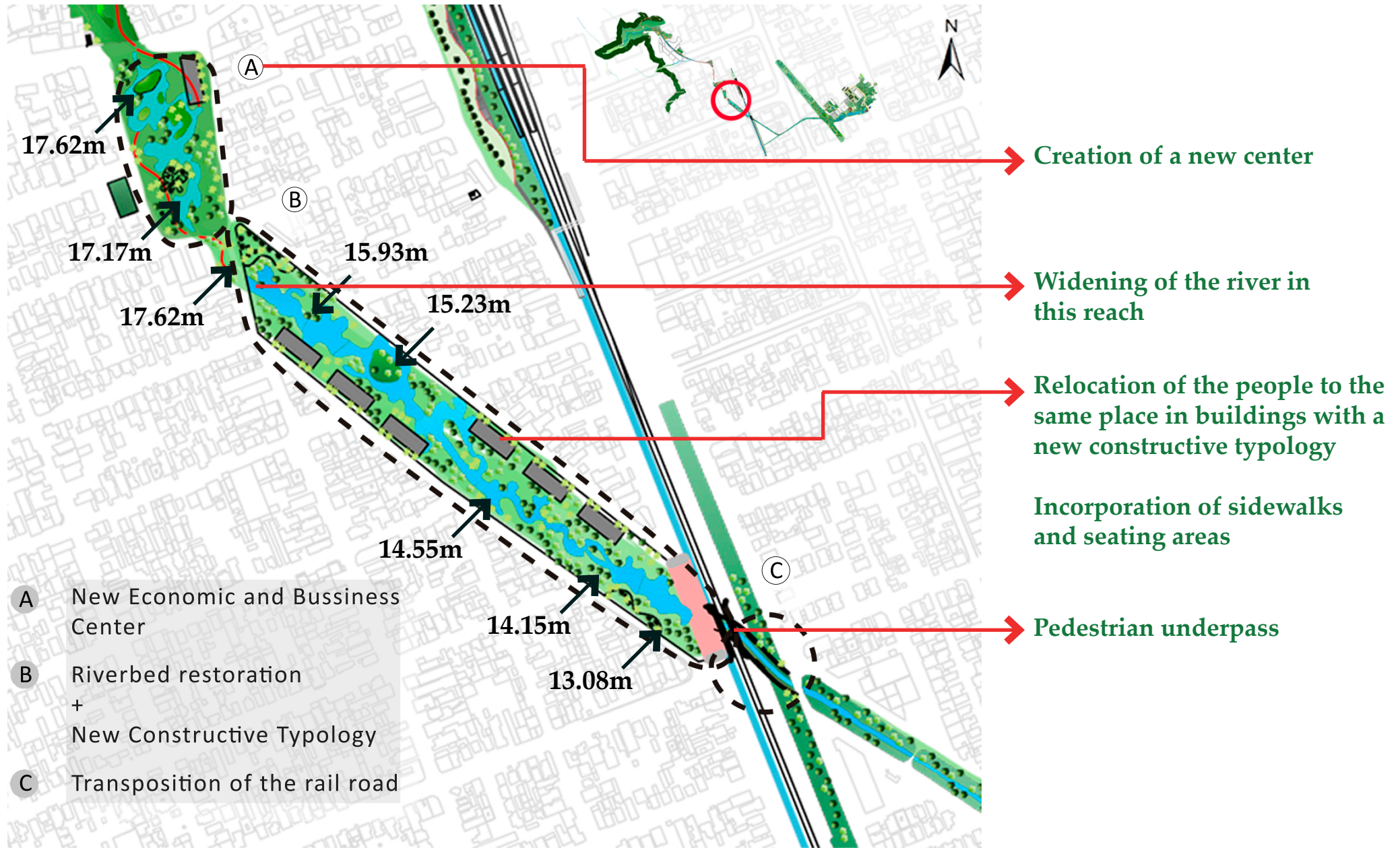
- The region where the buildings of the Mesquita municipal government are located, in the downtown region, would be beautified through landscaping in the front areas, also to increase infiltration.
- The reach of the river in this region, which is now channeled, would be opened to allow it to overflow on the left bank, where there is uninhabited land.
- The final depth x area x volume curve data is reported in the Table above, where the functional strip of the reservoir is highlighted.

Depth x Area x Volume Curve – Municipal Government Complex

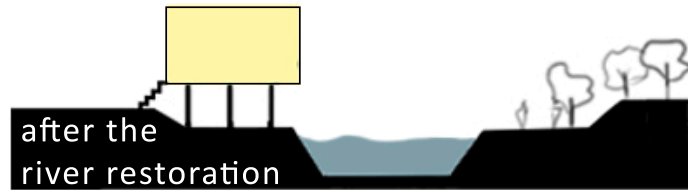
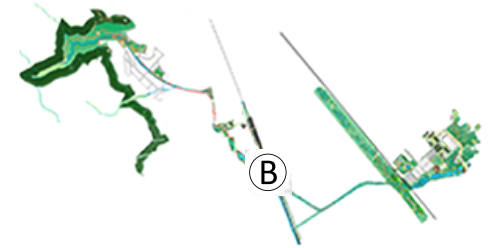
Depth (m)	Area (m ²)	Volume (m ³)	Remarks
17.38	3,481	-	River bottom
18.38	6,962	0	Limit of the channel
20.00	6,962	11,278	Overflow to the urban area



Mesquita City Center



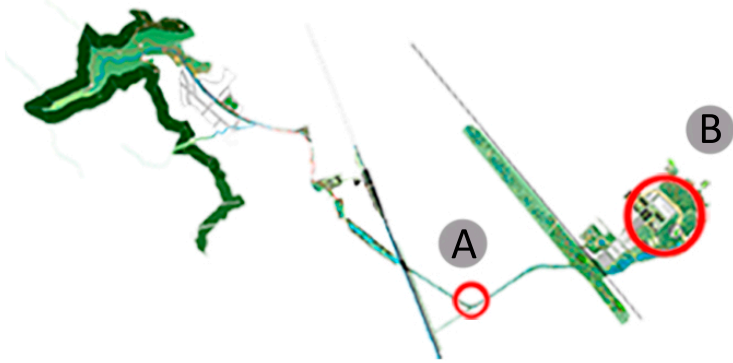
Mesquita City Center



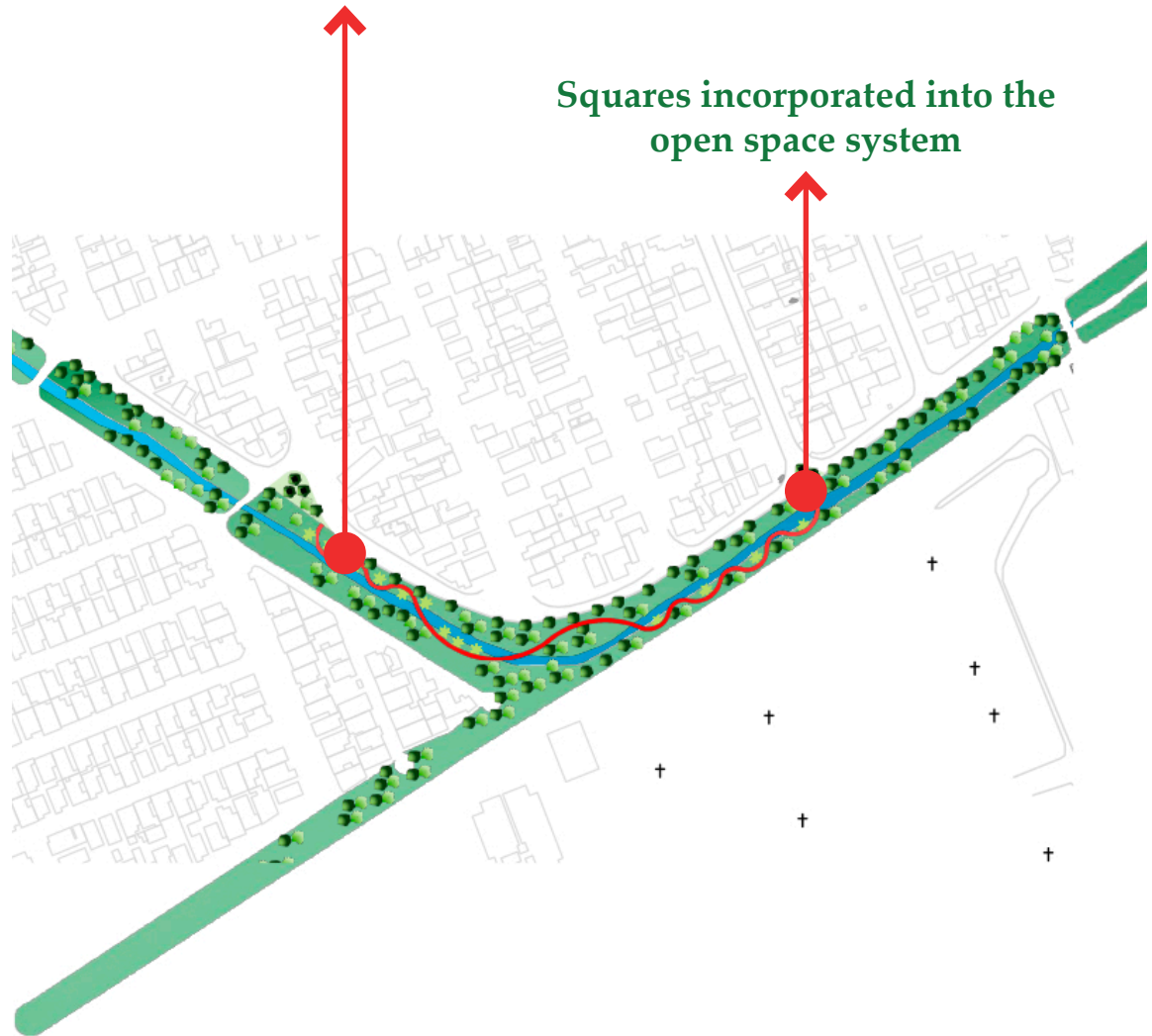
B



A new perspective for the fluvial system



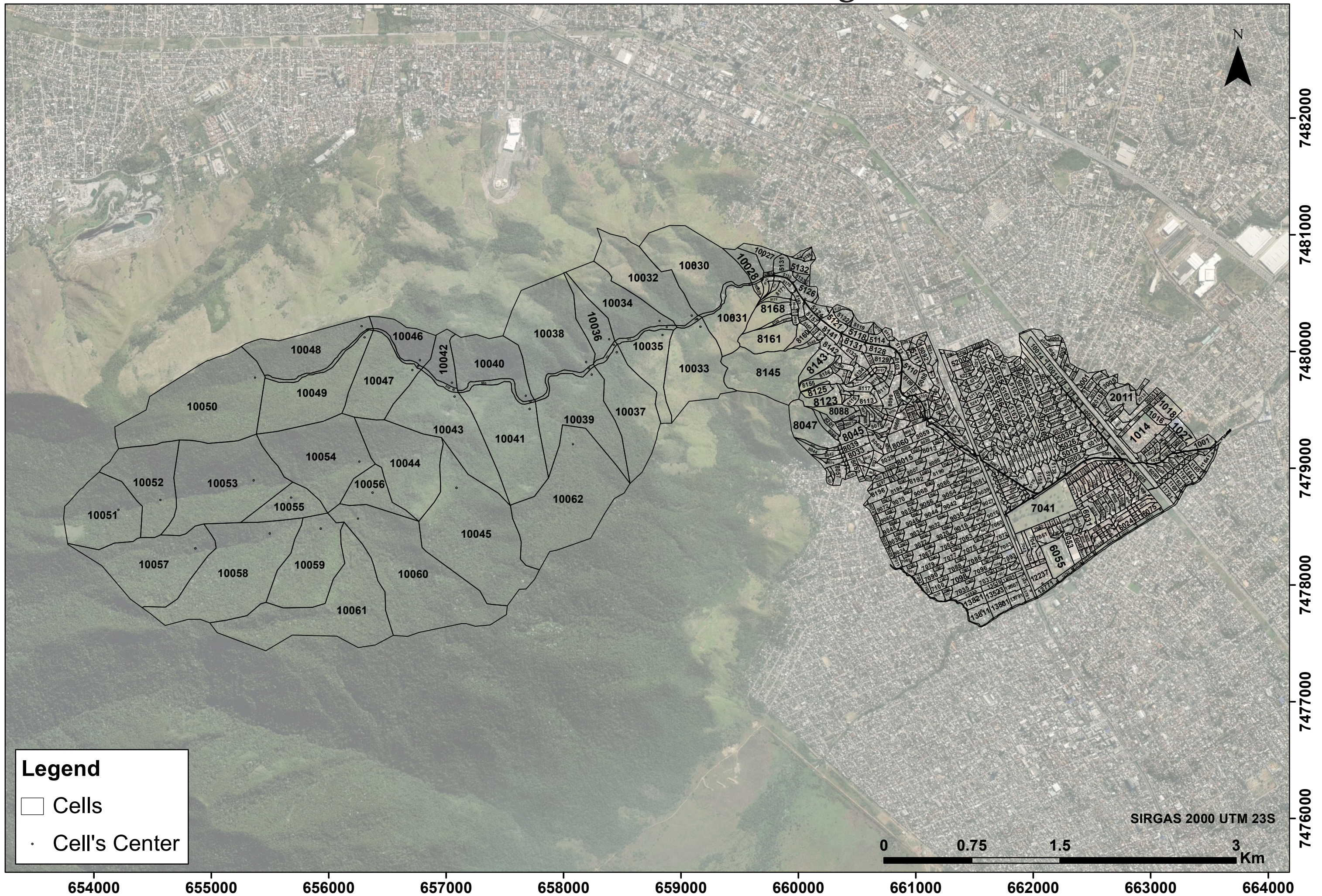
Suspended walkway allowing
the observation and perception of
the river from above - a different
perspective from everyday life



Wetland



Mathematical Modelling

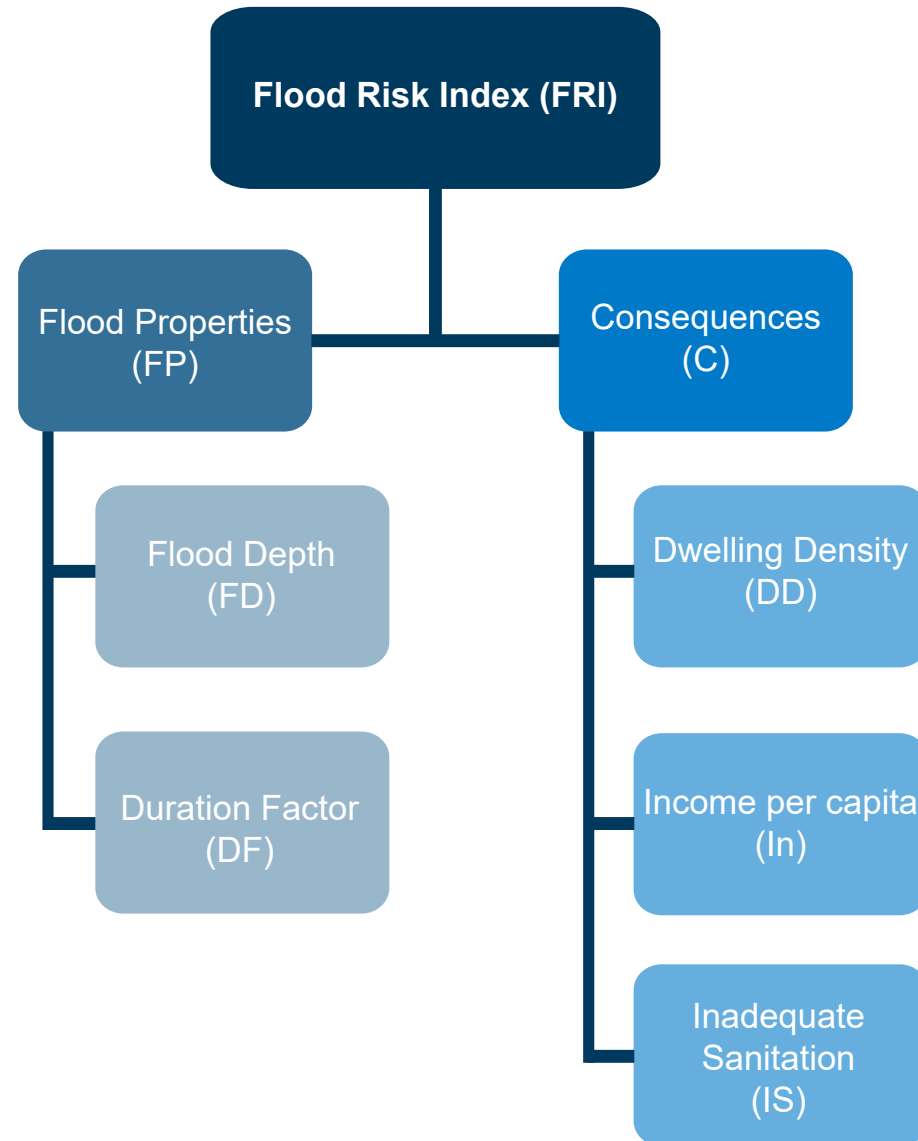


Mathematical Modelling



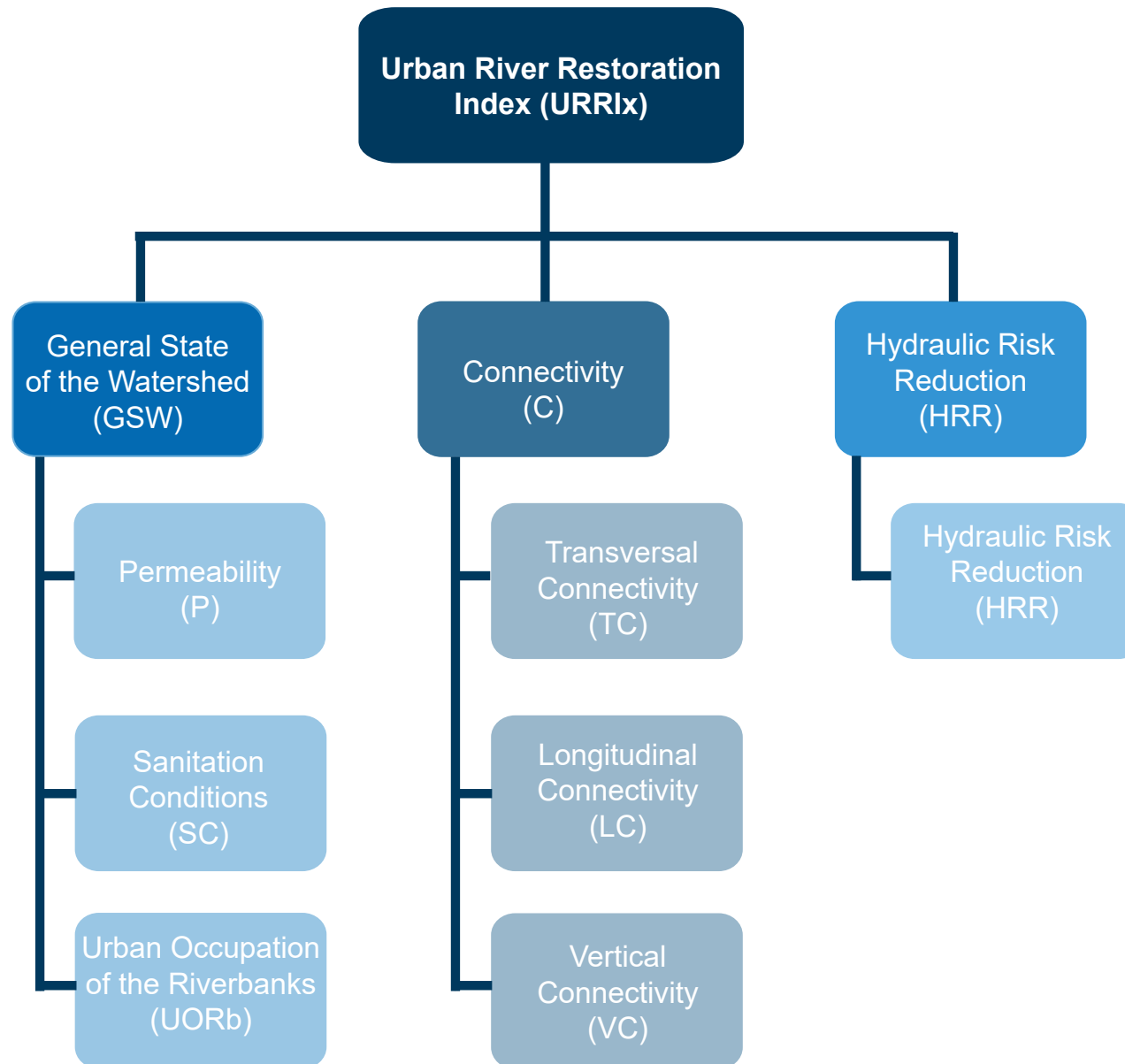
Multicriteria indexes

Flood Risk Index



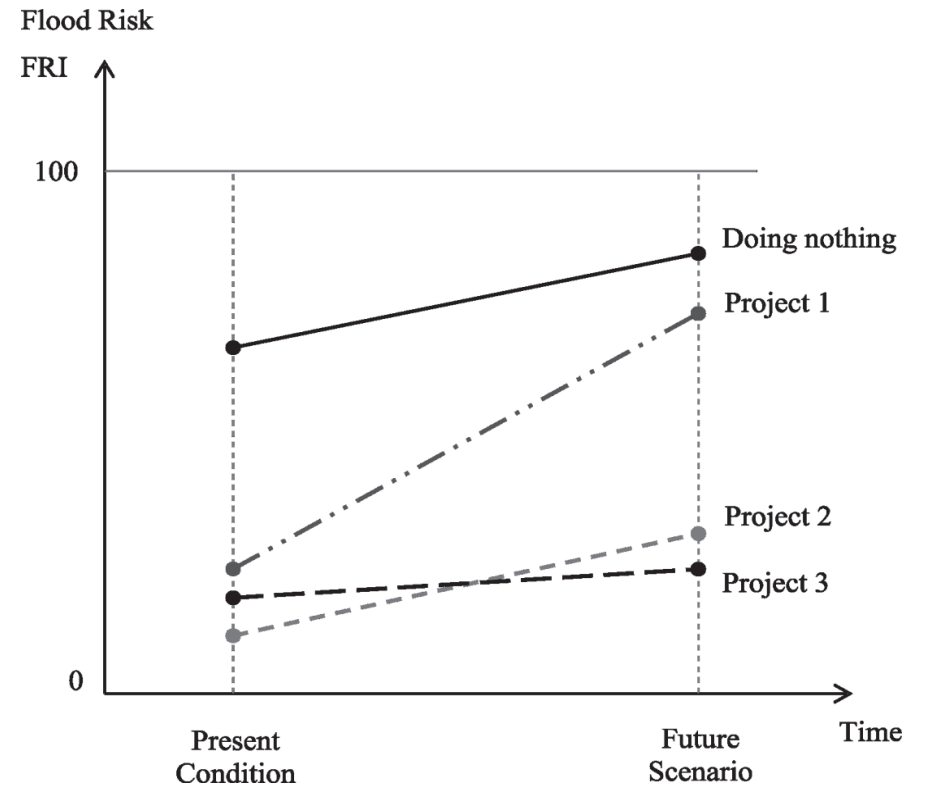
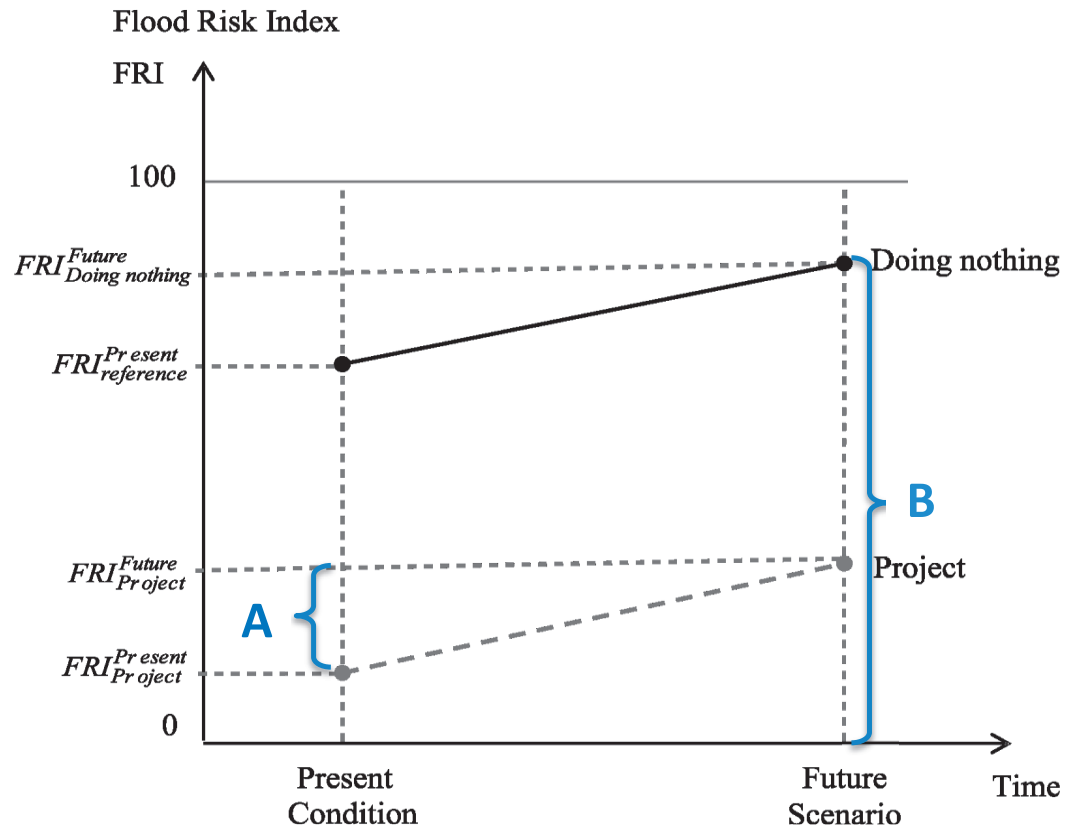
Multicriteria indexes

Urban River Restoration Index



Multicriteria indexes

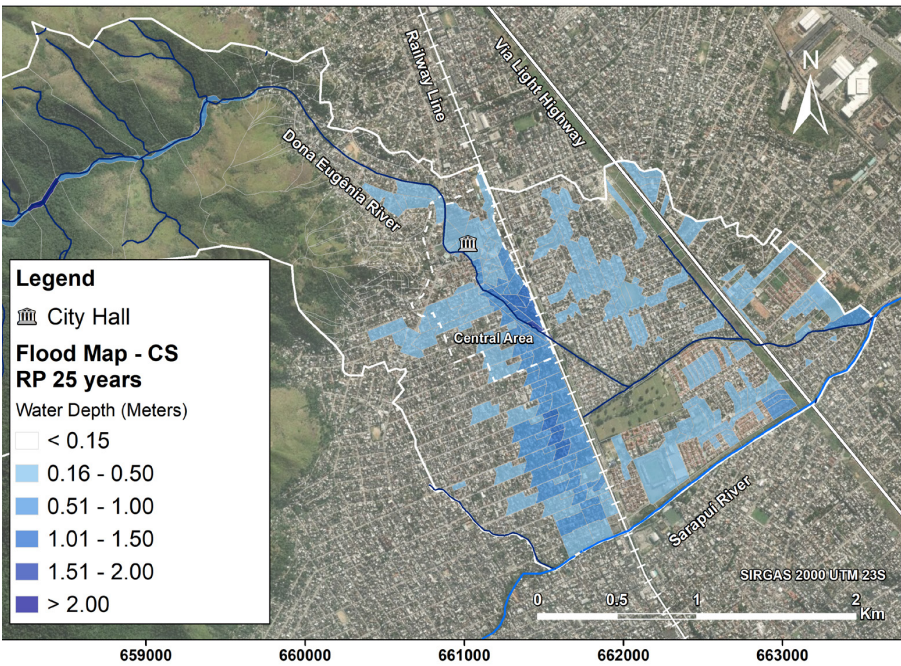
M-FResI



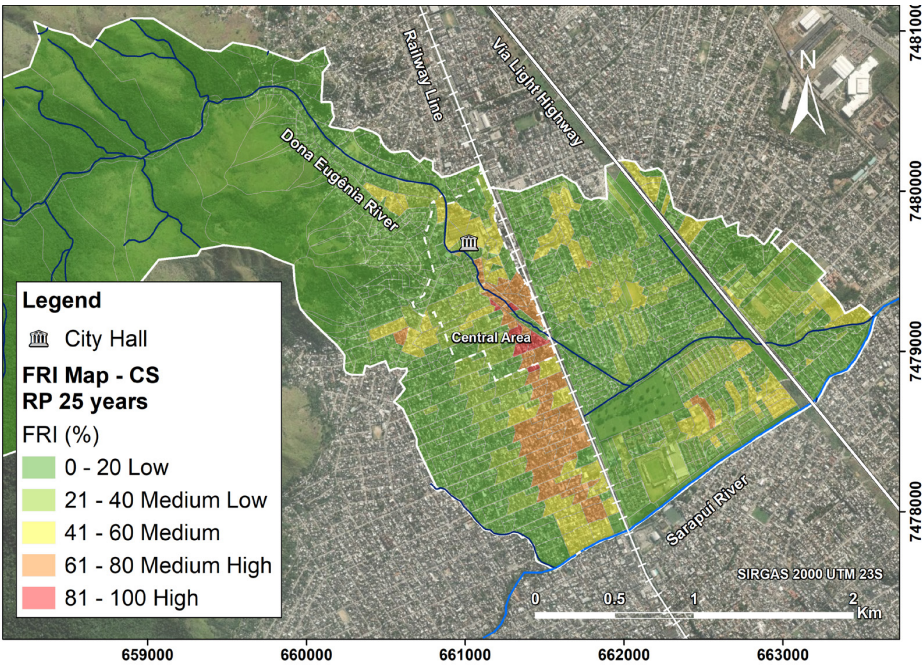
$$mFResI = 1 - \frac{(FRI_{Project}^{Future} - FRI_{Project}^{Present})}{FRI_{Doing nothing}^{Future}}$$

A
B

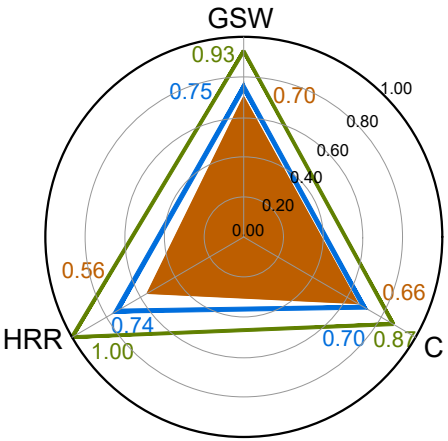
Current Situation (CS)



(a) Flood Map

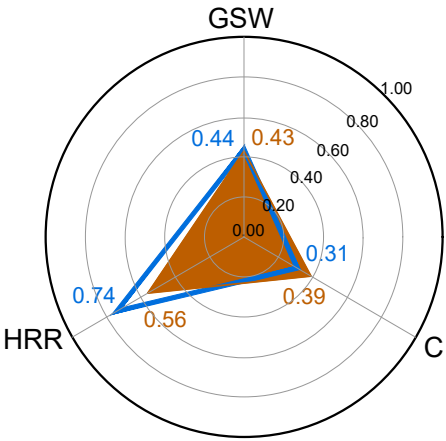


(b) FRI Map



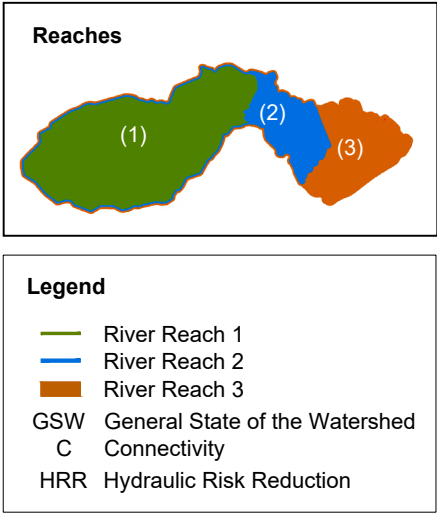
URRIx:
Reach 1: 0,93 | Reach 2: 0,73 | Reach 3: 0,64

(c) URRIx Graph
Dona Eugênia Watershed

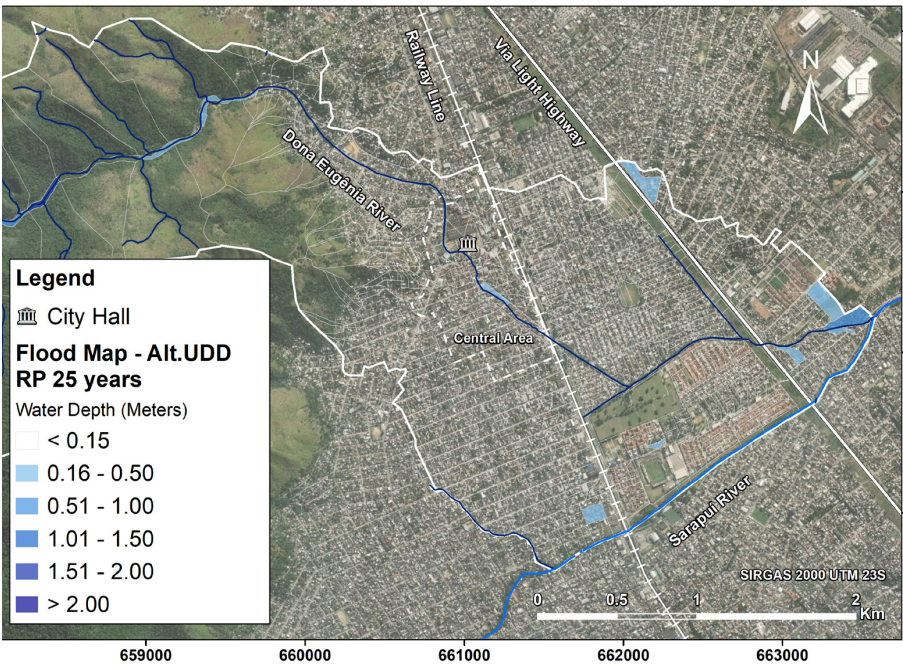


URRIx:
Reach 2: 0,50 | Reach 3: 0,46

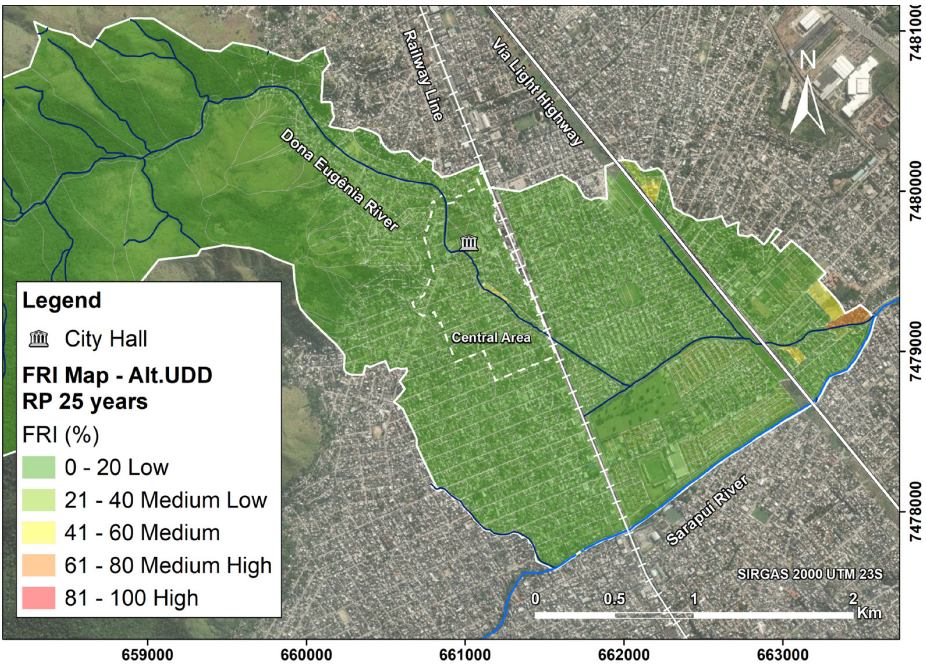
(d) URRIx Graph
Urban Watershed



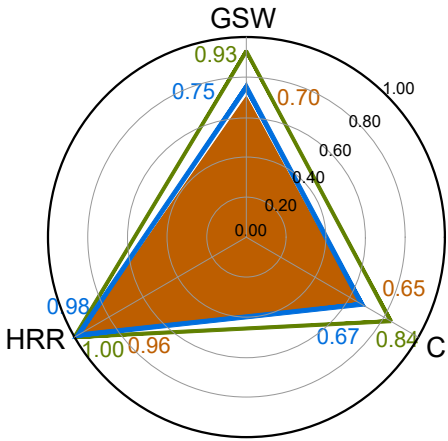
Usual Drainage Design Alternative (Alt.UDD)



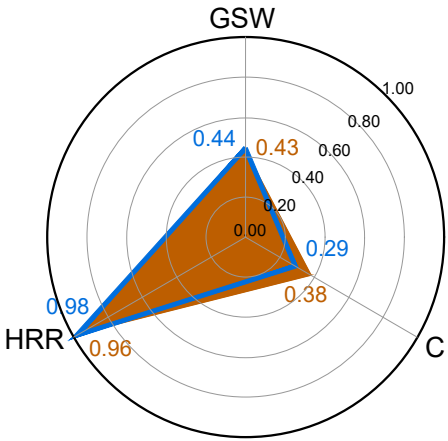
(a) Flood Map



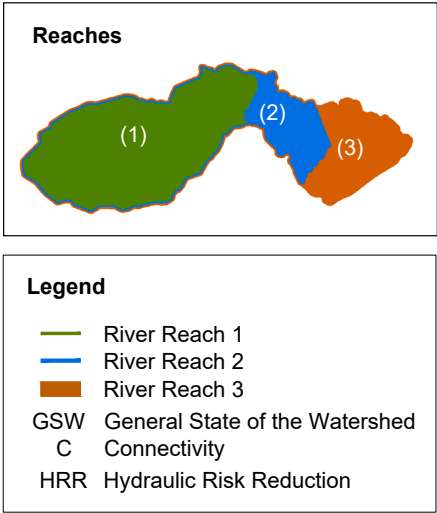
(b) FRI Map



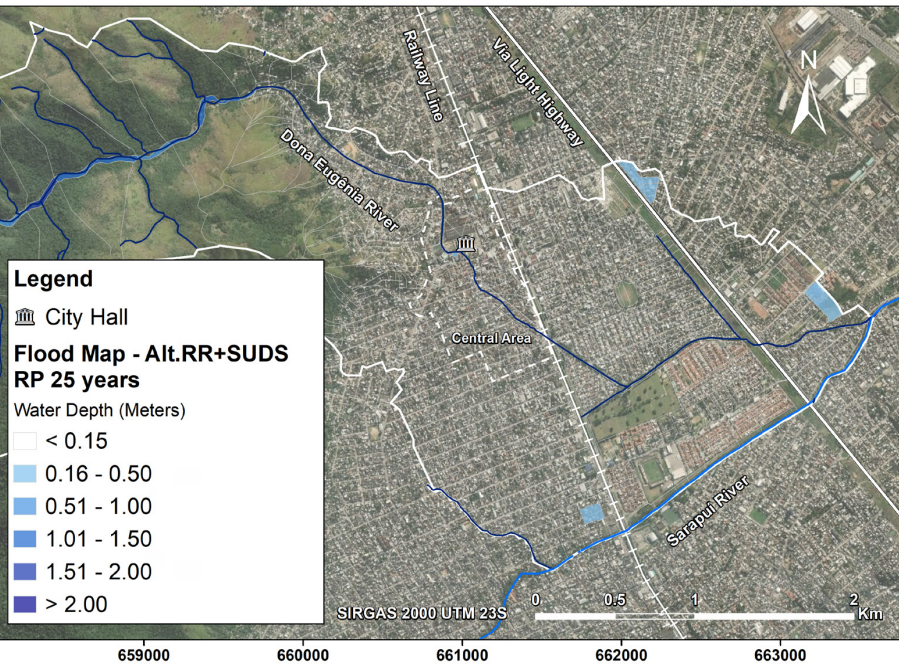
(c) URRIx Graph
Dona Eugênia Watershed



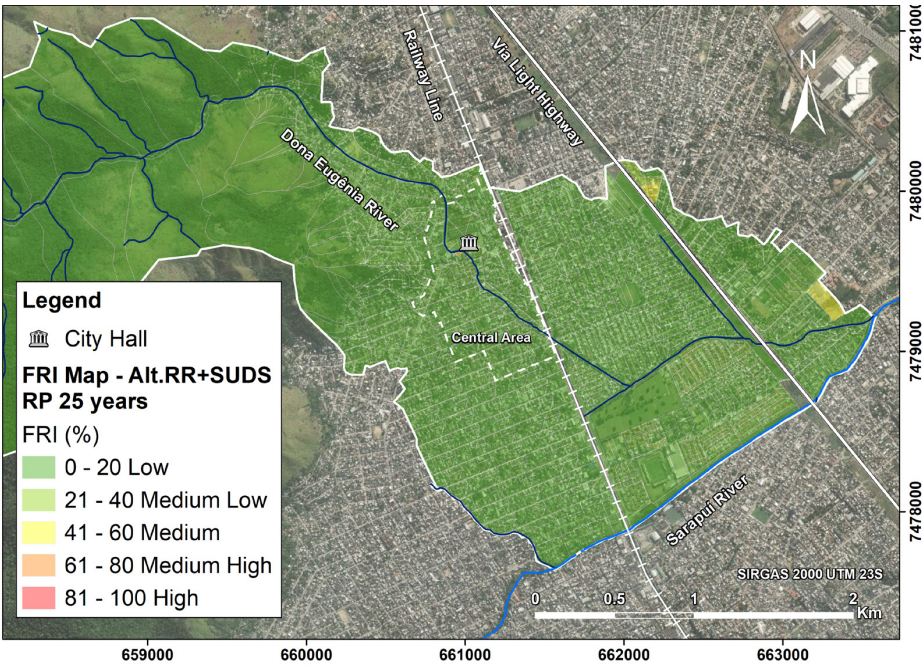
(d) URRIx Graph
Urban Watershed



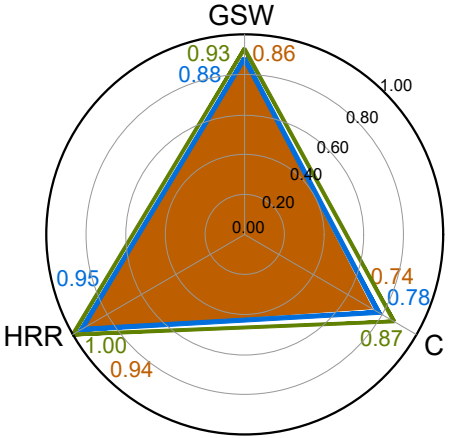
River Restoration+Sustainable Urban Drainage Alternative (Alt.RR+SUDS)



(a) Flood Map

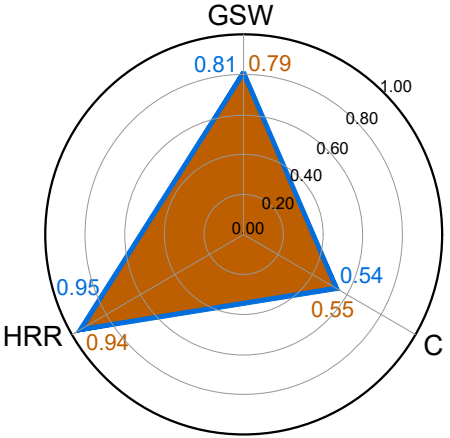


(b) FRI Map



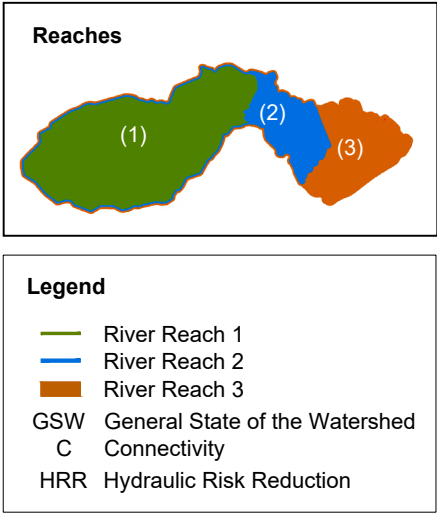
URRIx:
Reach 1: 0,93 | Reach 2: 0,87 | Reach 3: 0,85

(c) URRIx Graph
Dona Eugênia Watershed

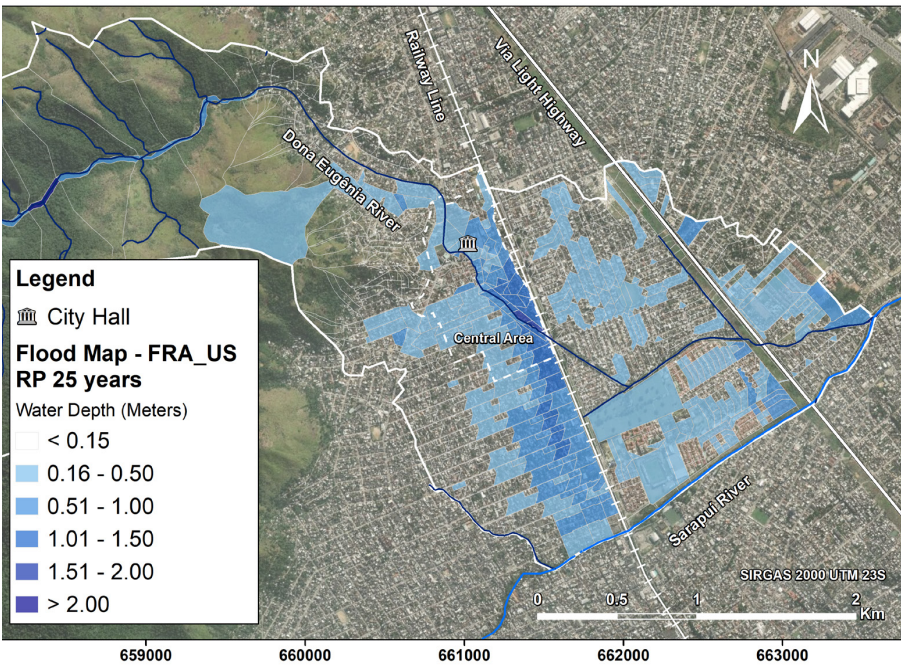


URRIx:
Reach 2: 0,77 | Reach 3: 0,76

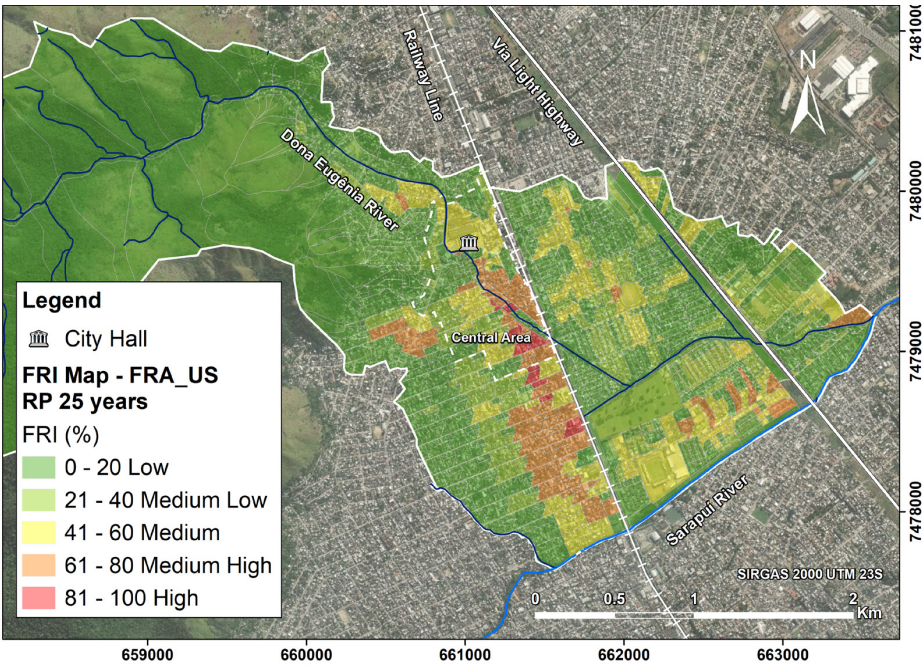
(d) URRIx Graph
Urban Watershed



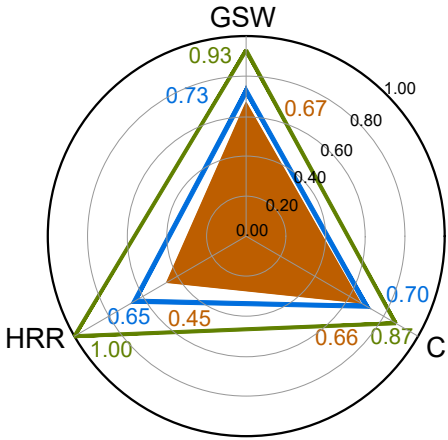
Current Situation evolving to Urban Saturation (FRA_US)



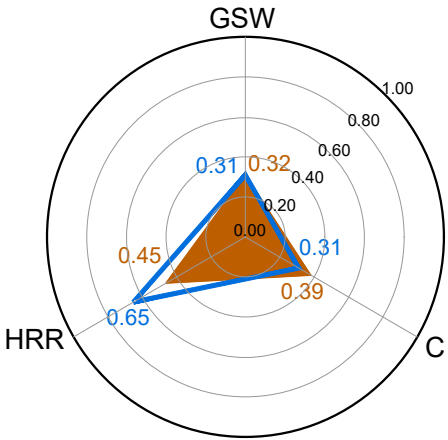
(a) Flood Map



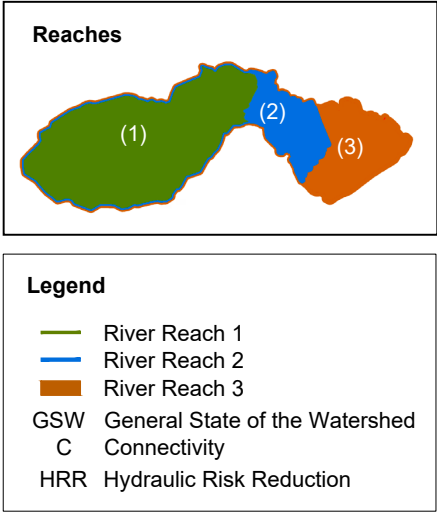
(b) FRI Map



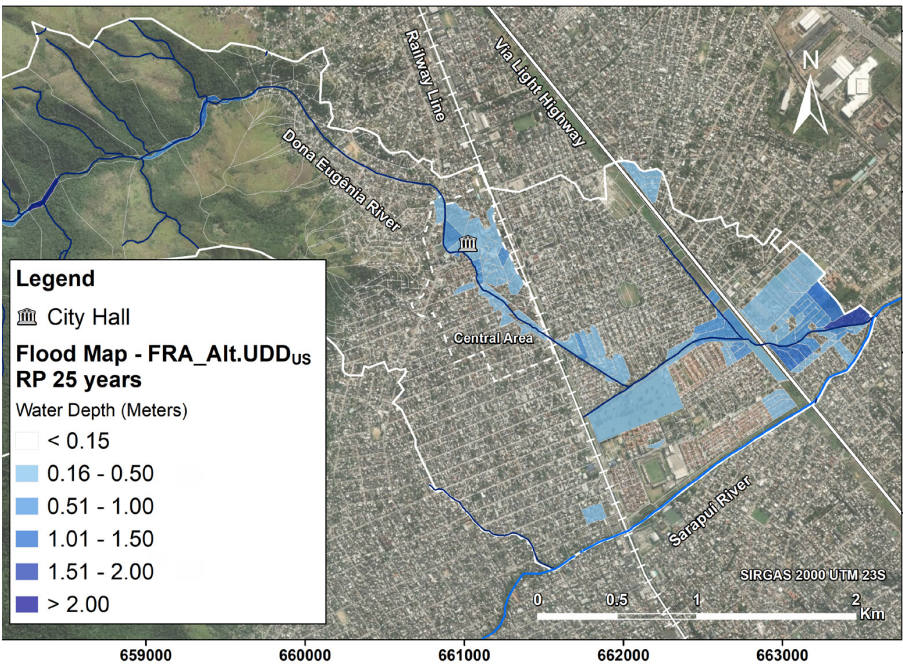
(c) URRIx Graph
Dona Eugênia Watershed



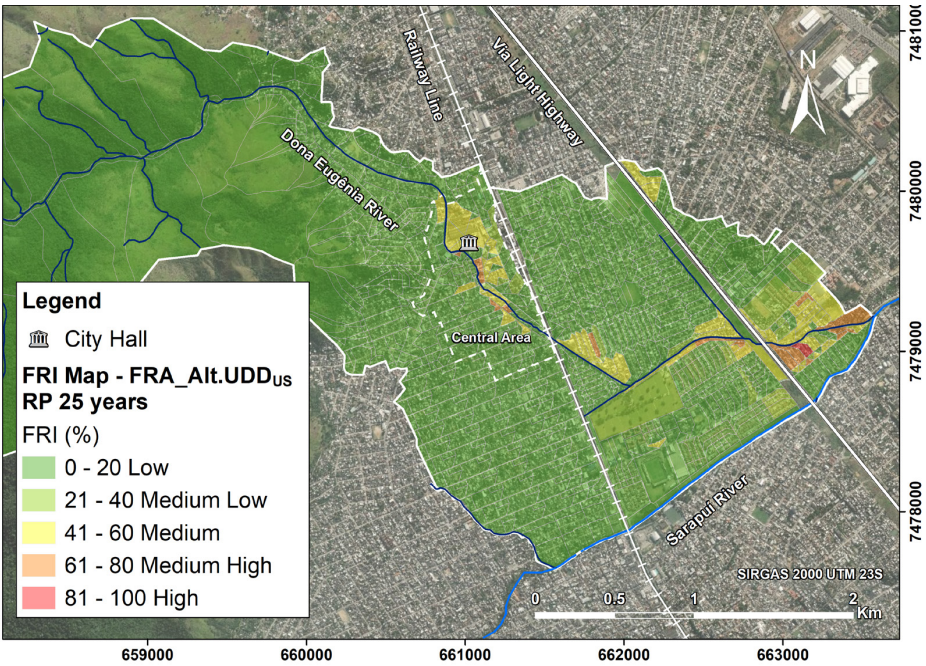
(d) URRIx Graph
Urban Watershed



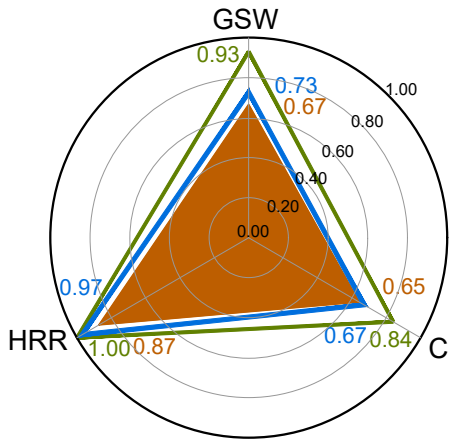
Usual Drainage Design Alternative under Urban Saturation (FRA_Alt.UDD_{US})



(a) Flood Map

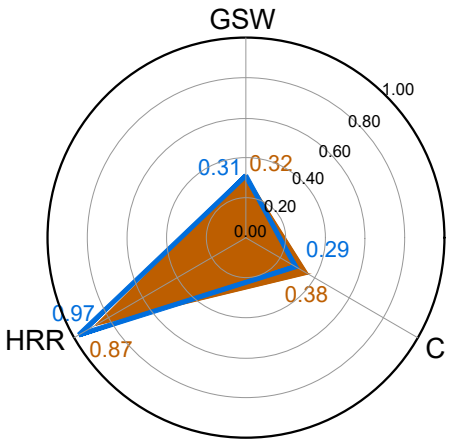


(b) FRI Map



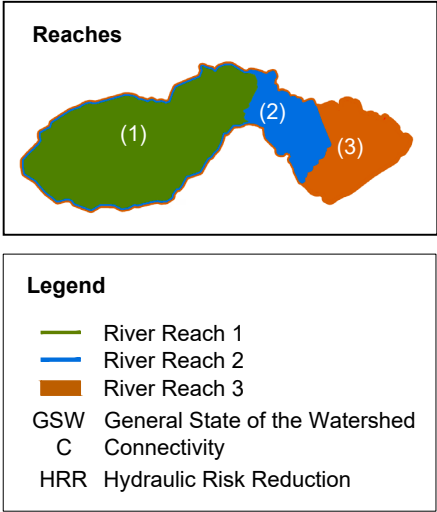
URRIx:
Reach 1: 0,92 | Reach 2: 0,79 | Reach 3: 0,73

(c) URRIx Graph
Dona Eugênia Watershed

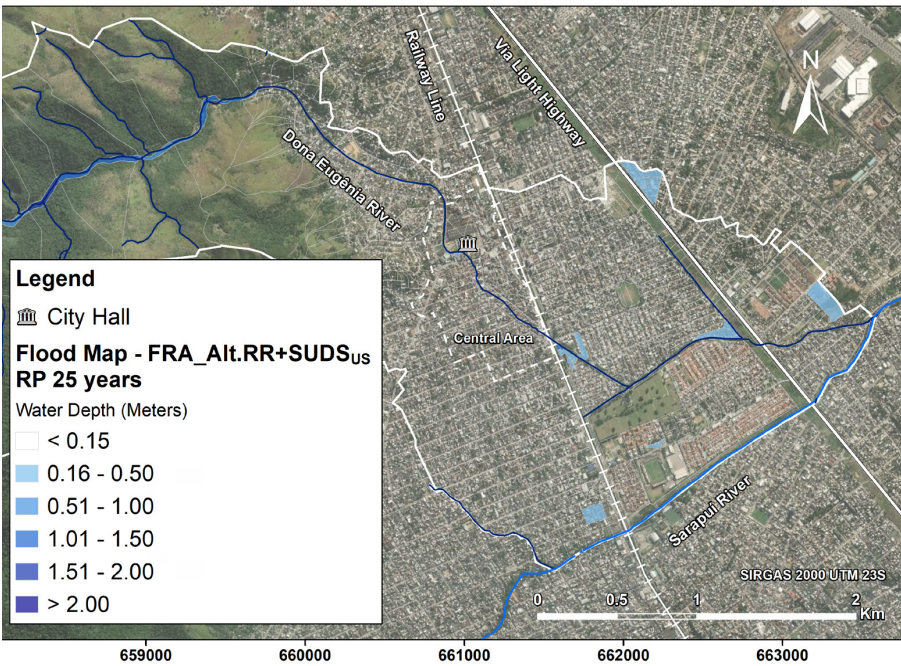


URRIx:
Reach 2: 0,52 | Reach 3: 0,52

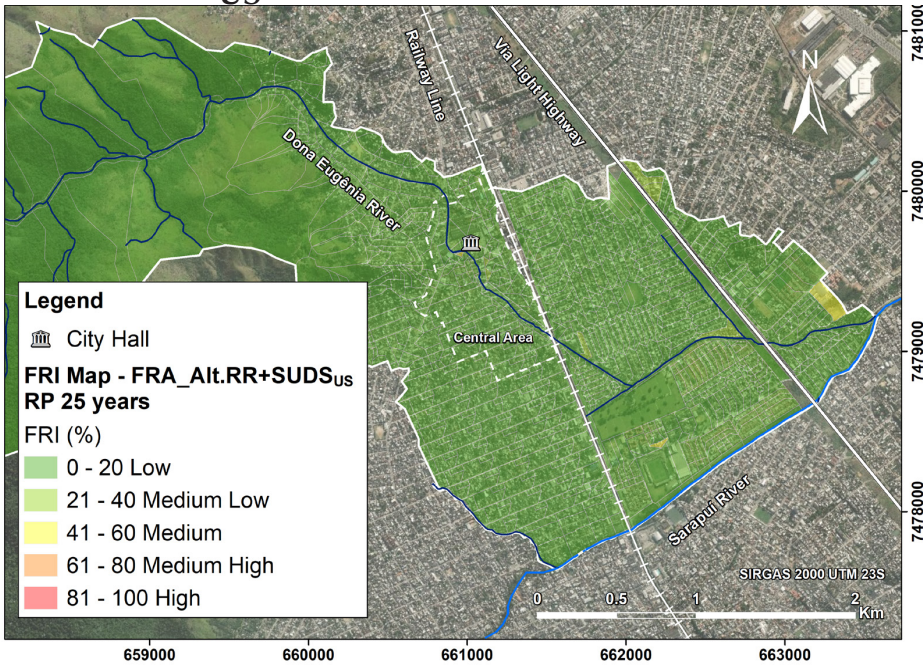
(d) URRIx Graph
Urban Watershed



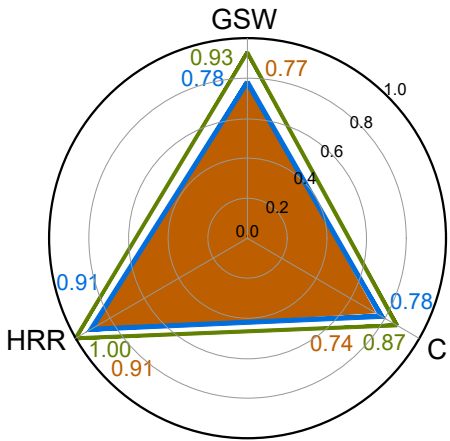
River Restoration+Sustainable Urban Drainage Alternative under Urban Saturation (FRA_Alt.RR+SUDS_{US})



(a) Flood Map

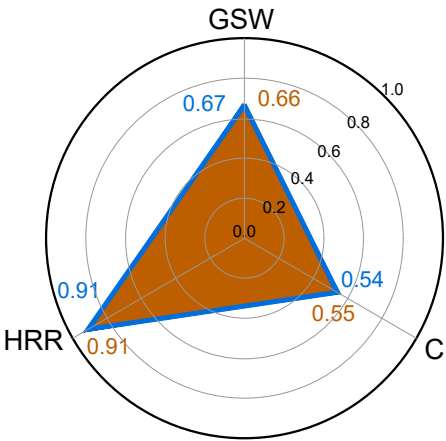


(b) FRI Map



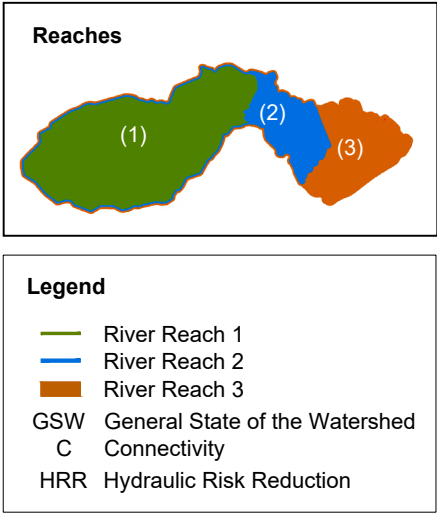
URRIx:
Reach 1: 0,93 | Reach 2: 0,82 | Reach 3: 0,81

(c) URRIx Graph
Dona Eugênia Watershed



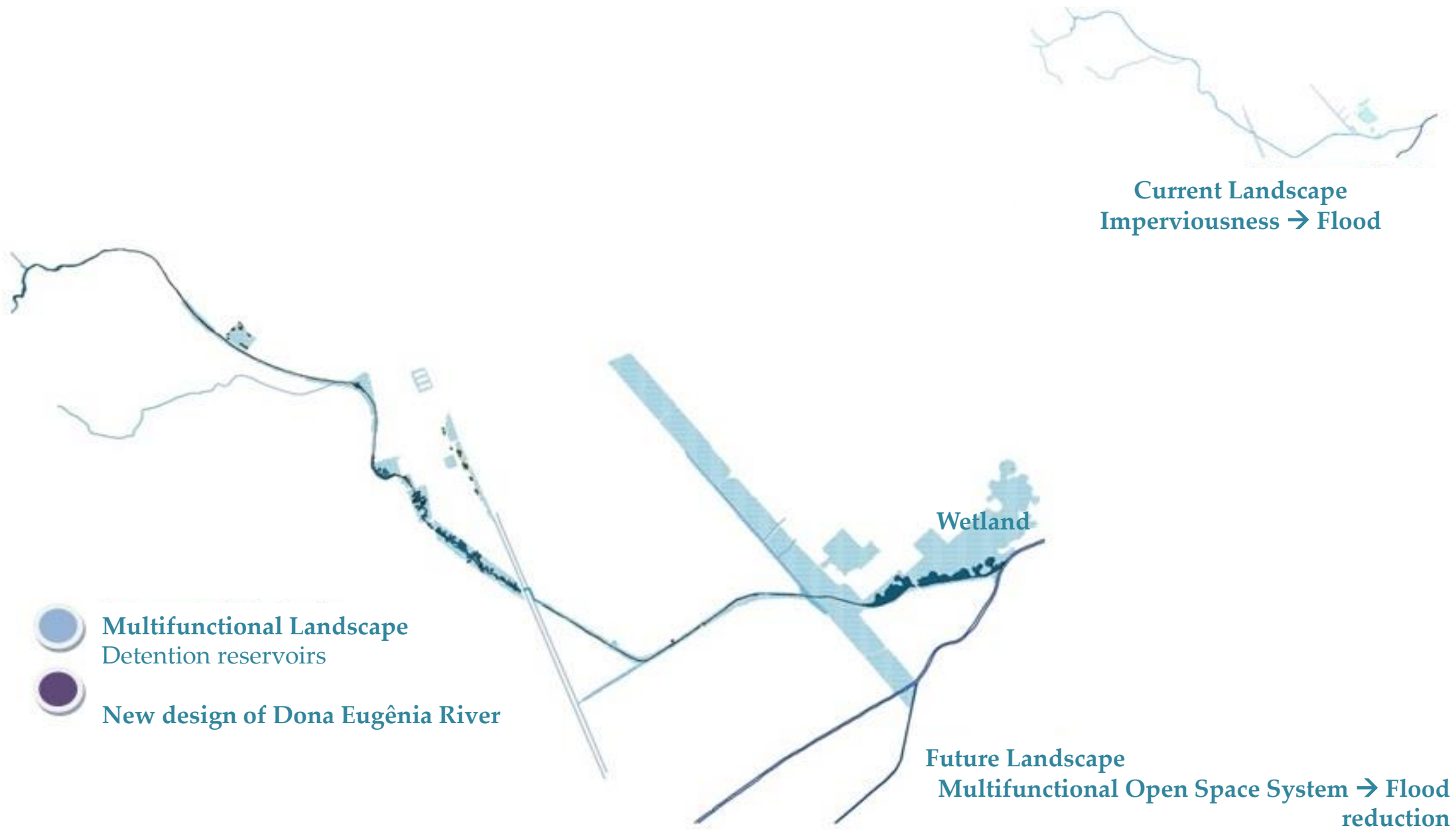
URRIx:
Reach 2: 0,71 | Reach 3: 0,71

(d) URRIx Graph
Urban Watershed



Legend
— River Reach 1
— River Reach 2
— River Reach 3
GSW General State of the Watershed
C Connectivity
HRR Hydraulic Risk Reduction

Water



Vegetation



Current Landscape
Degraded urban vegetation



Trees
Atlantic Forest
Environmental Protection Area

Atlantic Forest
reconstitution

Fruitful Atlantic Forest vegetation

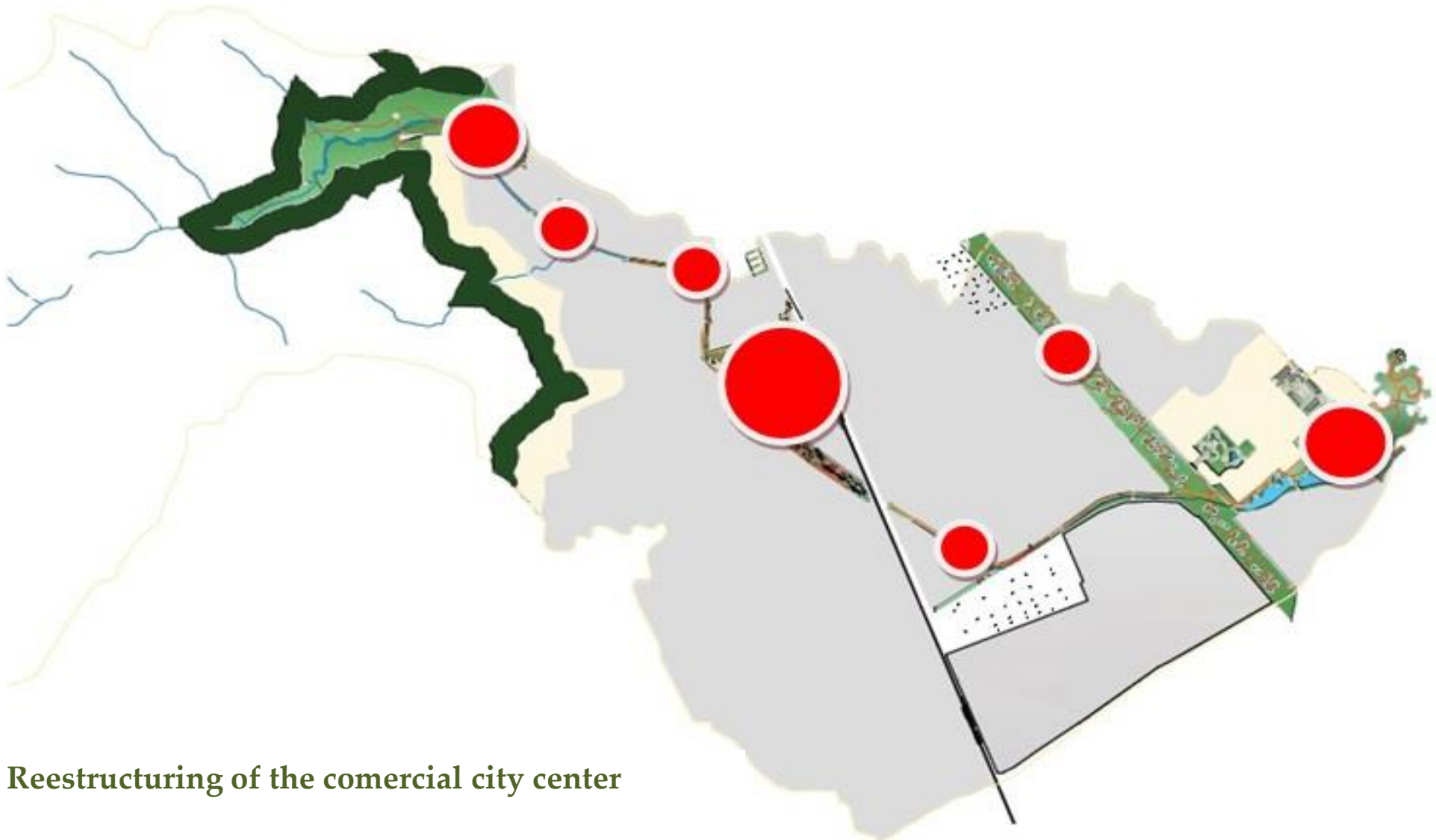
Urban
vegetation

Wetland
vegetation



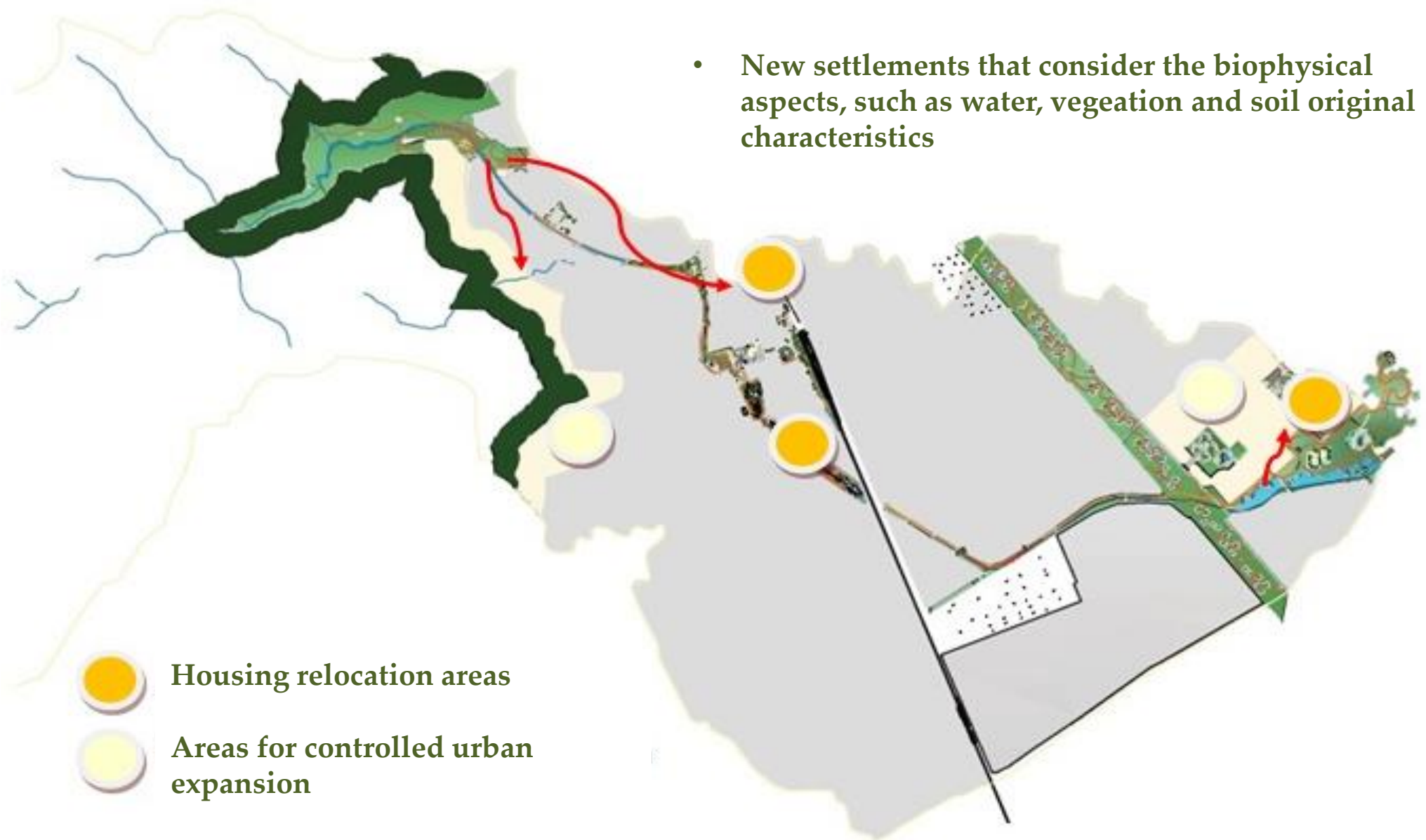
Future Landscape
Restoration of the degraded vegetation
through green corridors and parks

Infrastructure - Services



- Reestructuring of the comercial city center
- New business opportunities arising from revitalized city areas

Infrastructure - Housing



Multifunctional Systems

