Marcello Corradi - 4937422

MOSAIC

ENERGYSCAPES

TU Delft Faculty of Architecture
Department of Urbanism - Chair of Landscape Architecture

MSc Graduation Thesis

Graduation Studio: Flowscapes - Harvest

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Second Mentor: Ir. Annebregje Snijders

Delegate board of examiners: Dr. Ir. Franklin D. van der Hoeven

Academic year 2019 - 2020

1

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2

THEORETICAL & METHODOLOGICAL FRAMEWORKS

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STRATEGY & PRINCIPLES: POWER PARKS

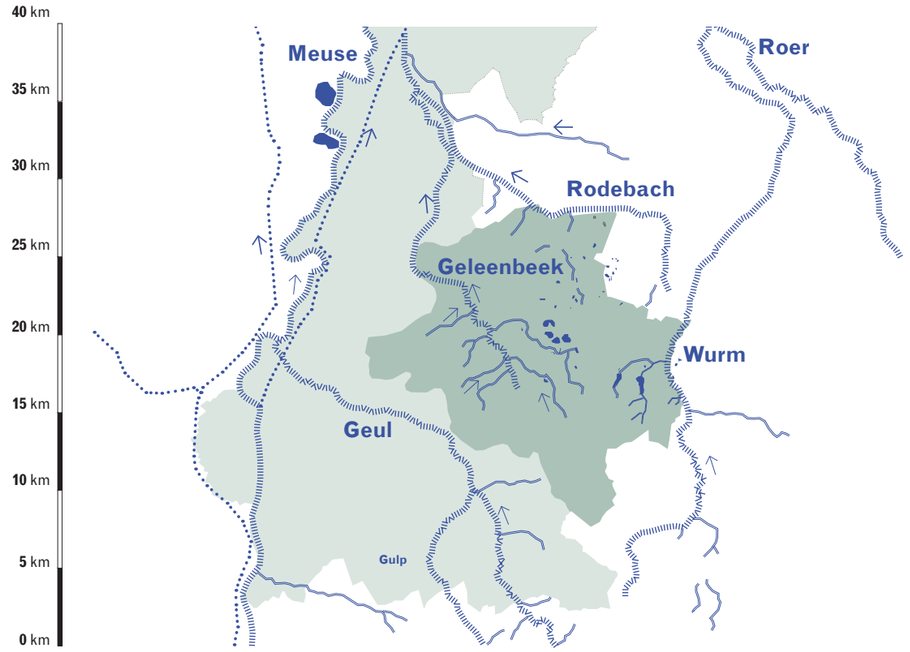
6

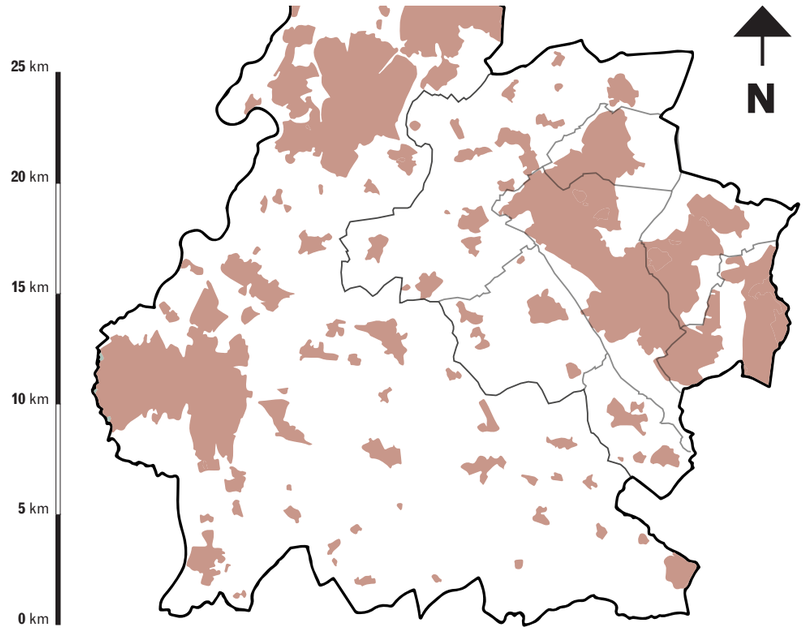
DESIGN: CARBON RECYCLING ESTATES

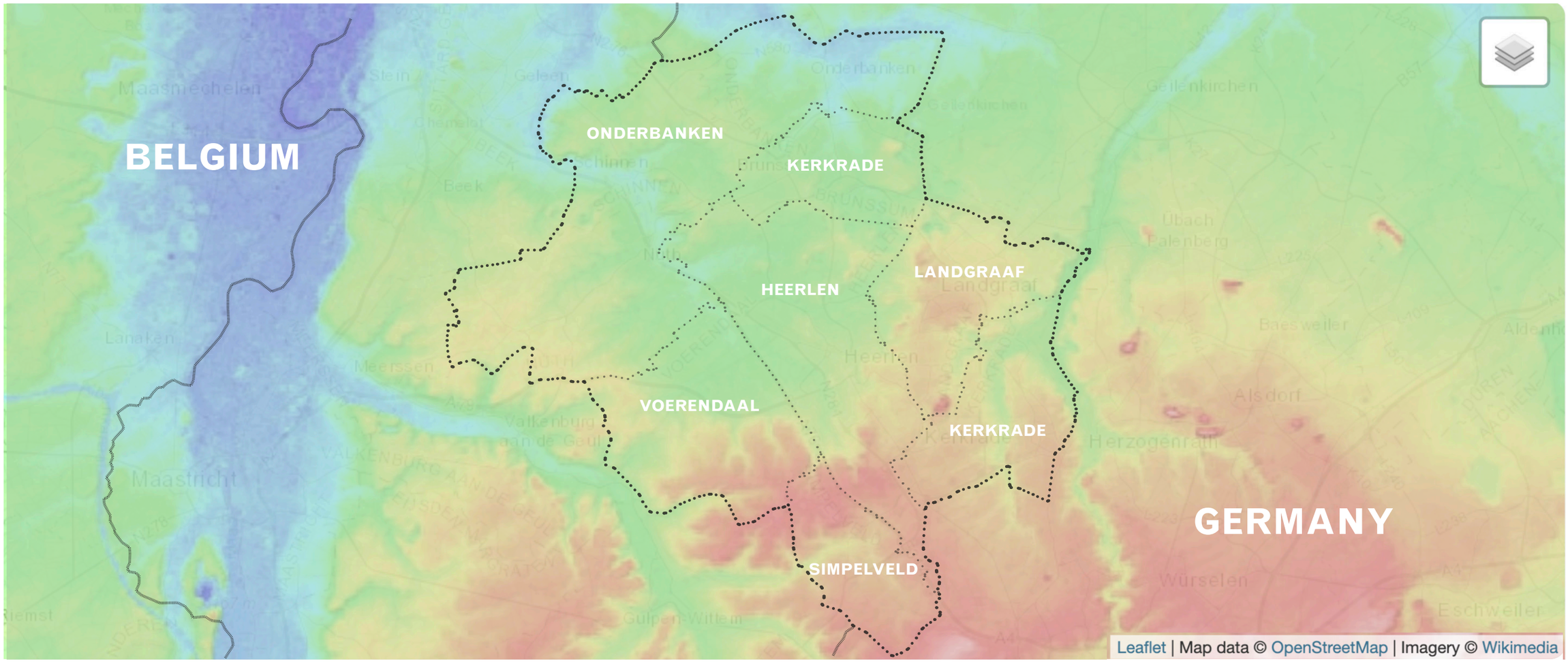
1

OVERVIEW, PROBLEM STATEMENT & RESEARCH QUESTION


300 km
250 km
200 km
150 km
100 km
50 km
0 km
Limburg
Parkstad


40 km
35 km
30 km
25 km
20 km
15 km
10 km
5 km
0 km
Meuse
Roer
Rodebach
Geleenbeek
Wurm
Geul
Gulp

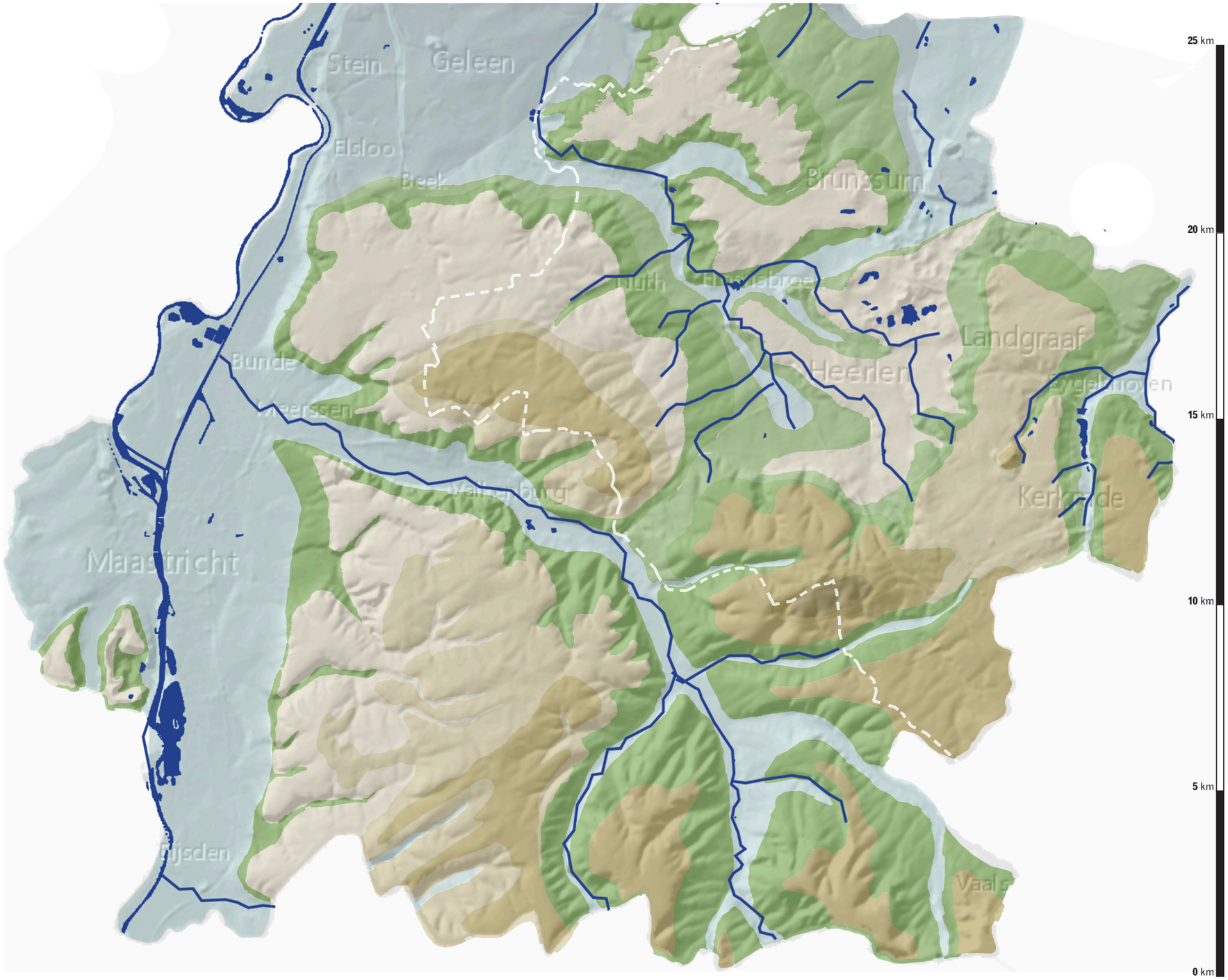

25 km
20 km
15 km
10 km
5 km
0 km
N


BELGIUM
ONDERBANKEN
KERKRADE
HEERLEN
LANDGRAAF
VOERENDAAL
KERKRADE
SIMPELVELD
GERMANY
Maastricht
Maasmechelen
Onderbanken
Leaflet | Map data © OpenStreetMap | Imagery © Wikimedia
899 ft
846 ft
794 ft
741 ft
689 ft
640 ft
594 ft
545 ft
502 ft
459 ft
417 ft
377 ft
338 ft
302 ft
269 ft
236 ft
207 ft
180 ft
157 ft
138 ft

Low to high Plateau

Soft to steep Ridge

Low to high Valley



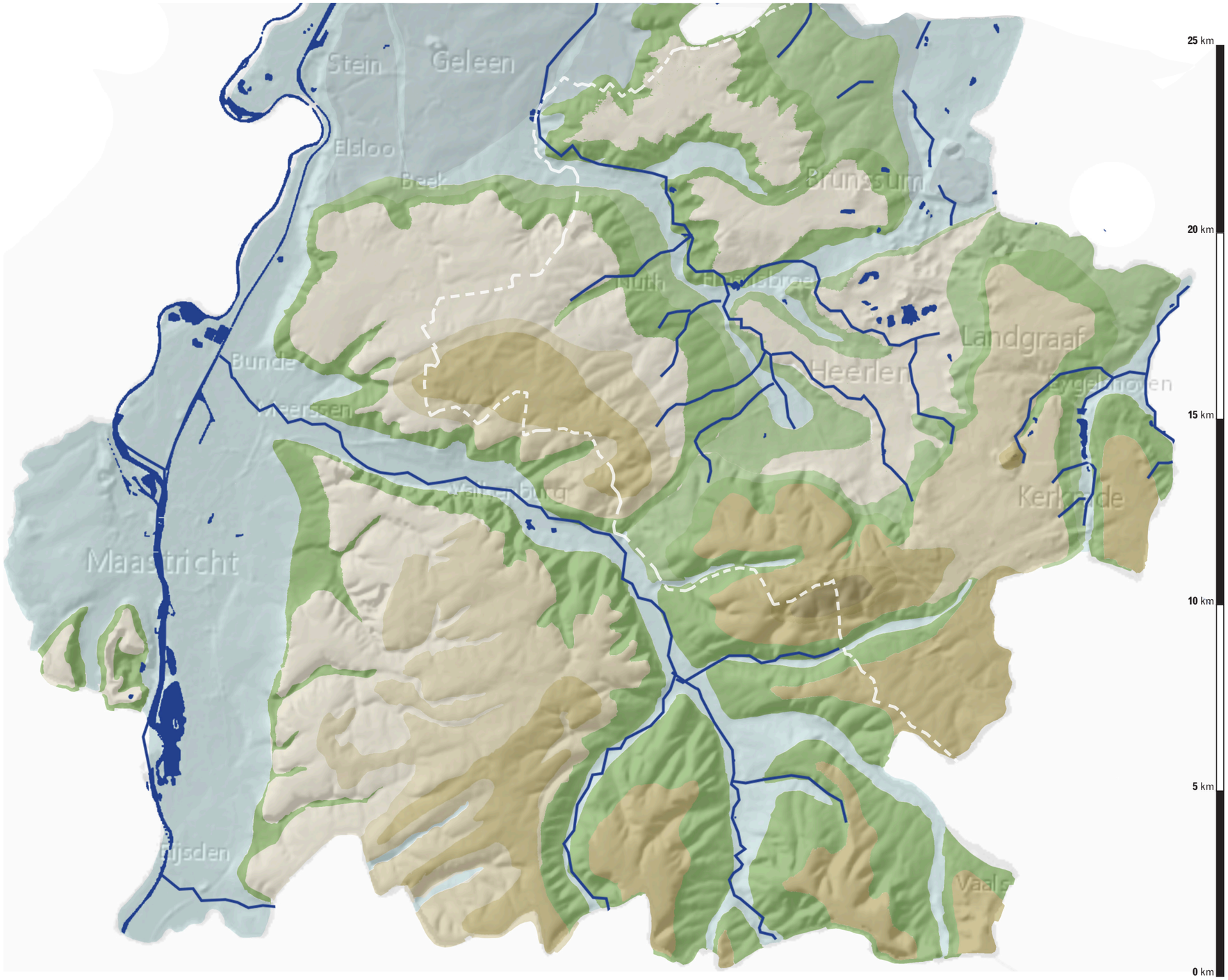
N

Low to high Plateau

Soft to steep Ridge

Low to high Valley

N







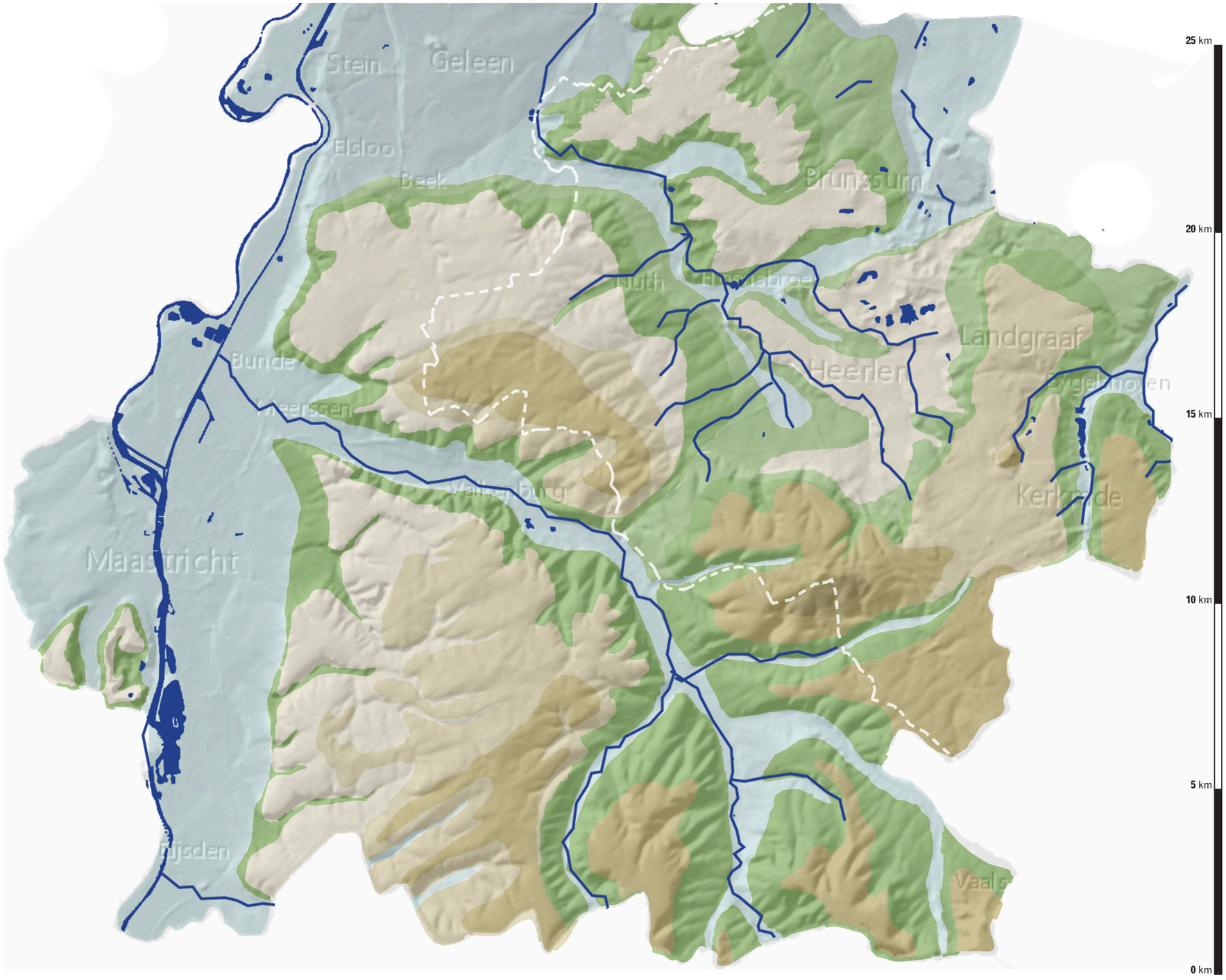


Low to high Plateau

Soft to steep Ridge

Low to high Valley

N









Simpelveld



Geleenbeek

SOURCE: Limburg24.nl

Anstelerbeek



SOURCE: Eropuit in Limburg

Jansgeleen



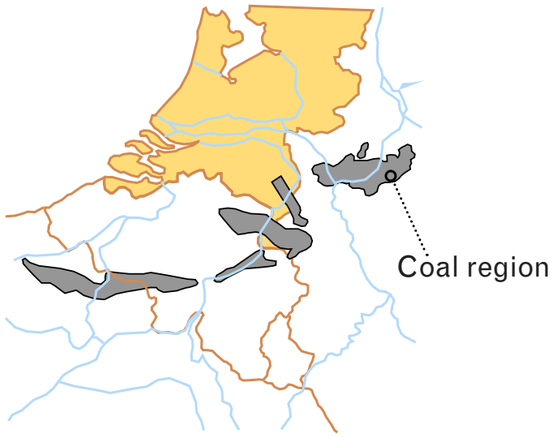
SOURCE:Google maps | Olaf

Kasteel Terborg



SOURCE: Google Maps | Richard Sun

PALEOZOIC From 359 to 299 Mya



LIMESTONES

↓

SANDSTONES

↓

SHALES

↓

COAL BEDS

MESOZOIC From 299 to 66 Mya



CARBONATES

↓

OIL SHALES

↓

LIMESTONES

↓

CHALK

CENOZOIC From 66 Mya



SAND + GRAVEL

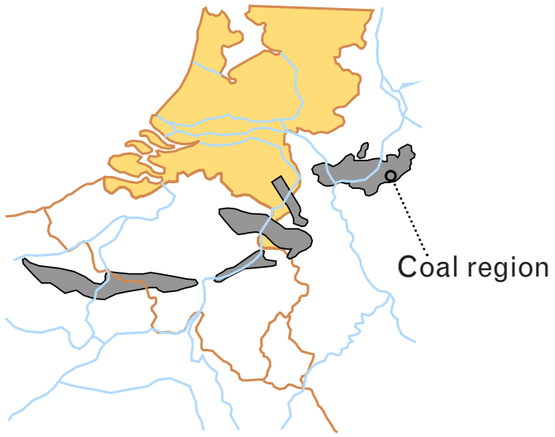
↓

CLAY

↓

SILT AND LOAM

PALEOZOIC From 359 to 299 Mya



MESOZOIC From 299 to 66 Mya



CENOZOIC From 66 Mya



LIMESTONES

SANDSTONES

SHALES

COAL BEDS

CARBONATES

OIL SHALES

LIMESTONES

CHALK

SAND + GRAVEL

CLAY

SILT AND LOAM

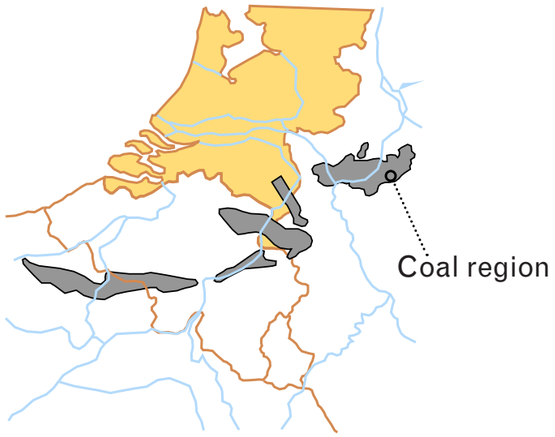
ROMAN TIMES

AGRICULTURAL SOCIETY

COAL MINING PERIOD

PARKSTAD

PALEOZOIC From 359 to 299 Mya



MESOZOIC From 299 to 66 Mya



CENOZOIC From 66 Mya



LIMESTONES
↓
SANDSTONES
↓
SHALES
↓
COAL BEDS
↓
CARBONATES
↓
OIL SHALES
↓
LIMESTONES
↓
CHALK
↓
SAND + GRAVEL
↓
CLAY
↓
SILT AND LOAM

ROMAN TIMES

AGRICULTURAL SOCIETY

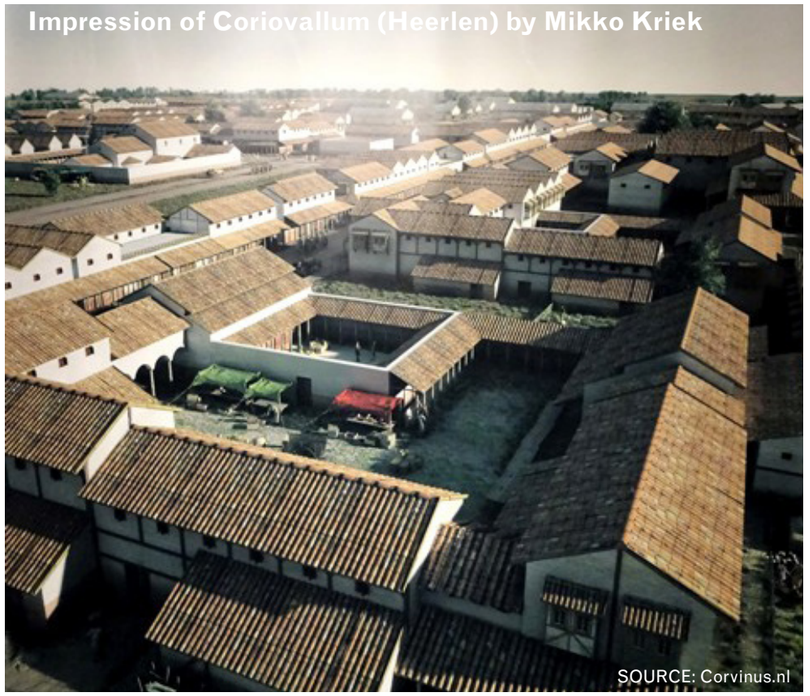
COAL MINING PERIOD

? **PARKSTAD**

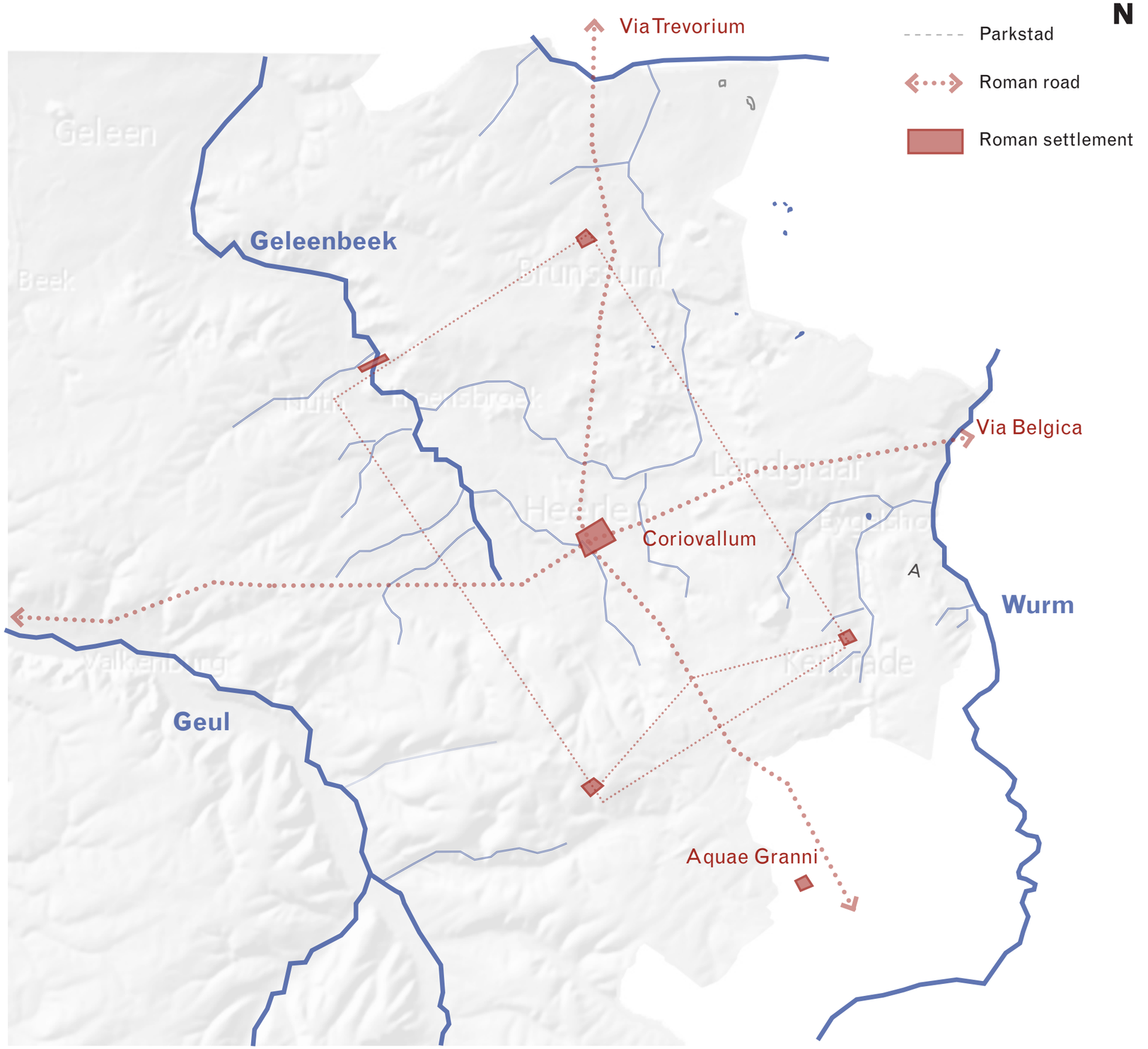
ROMAN TIMES // Limestone, clay, silt and loam


Coriovallum (Heerlen) roman baths

SOURCE: Visit Zuid-Limburg


Impression of Coriovallum (Heerlen) by Mikko Kriek

SOURCE: Corvinus.nl

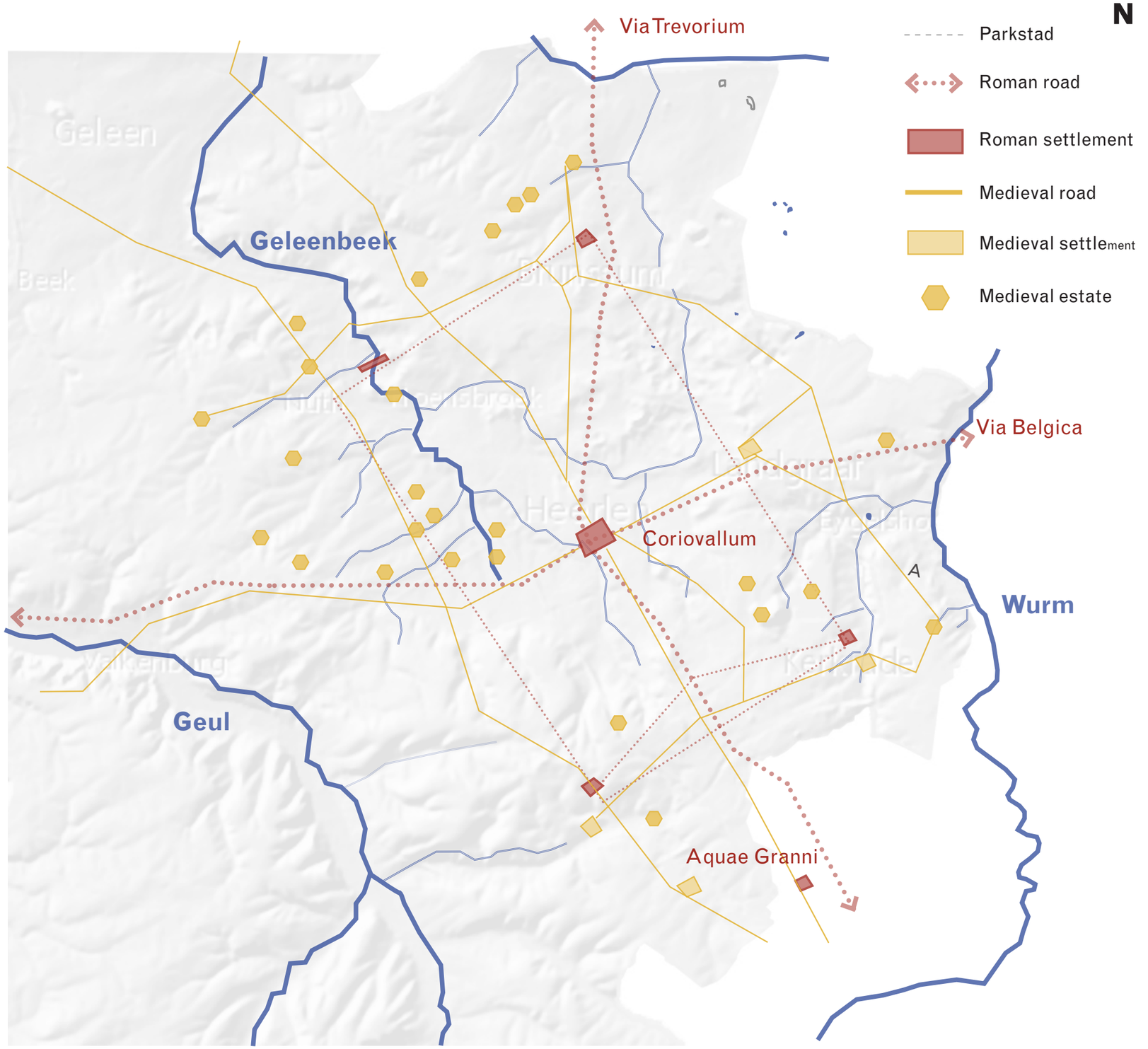


Sources: diagram made by author, information taken from Limburgemigrant.nl, Google maps and Wikipedia

AGRICULTURAL SOCIETY // Limestone, clay, silt and loam





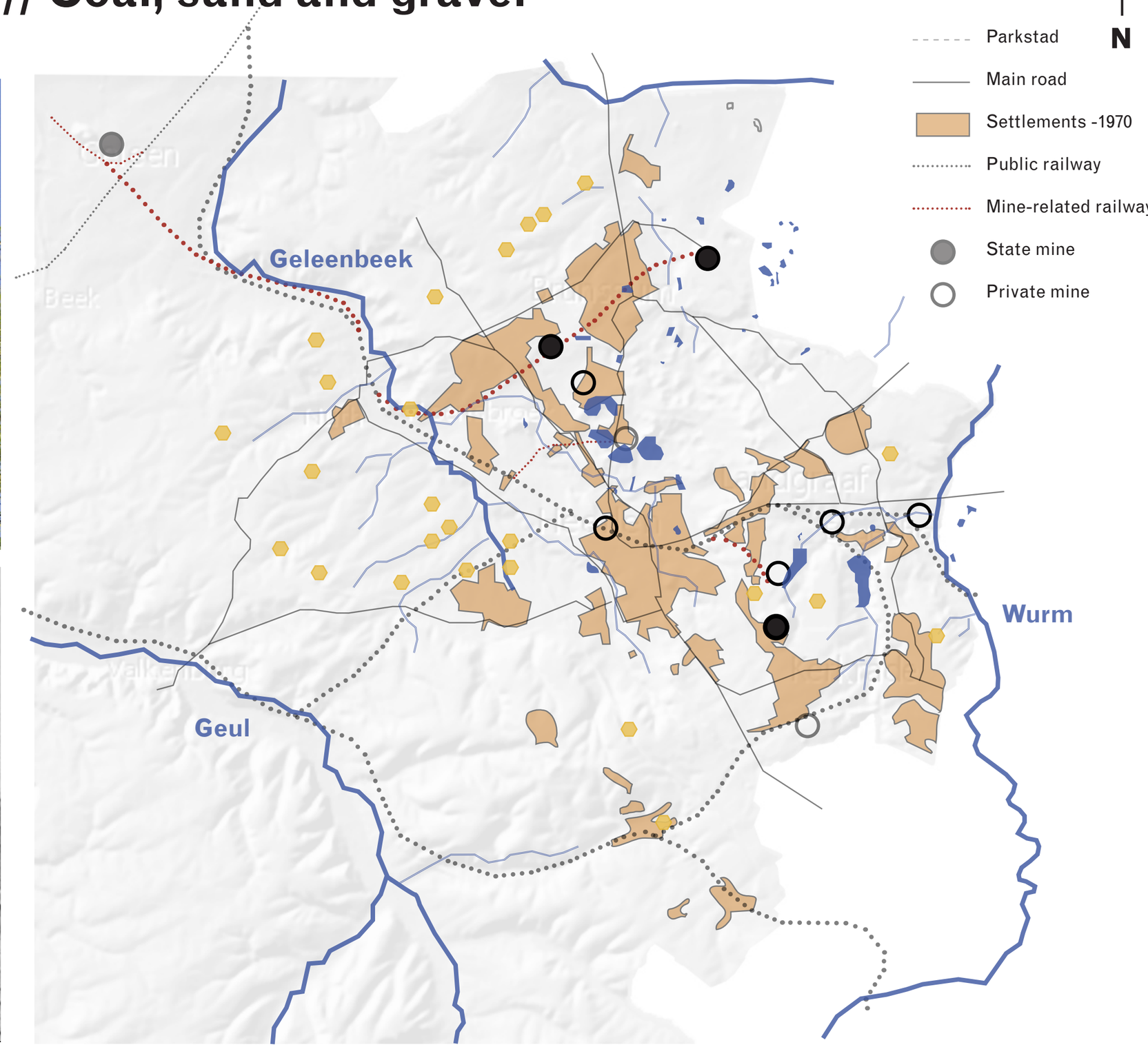


Sources: diagram made by author, information taken from Limburgemigrant.nl, Google maps and Wikipedia

COAL MINING PERIOD // Coal, sand and gravel



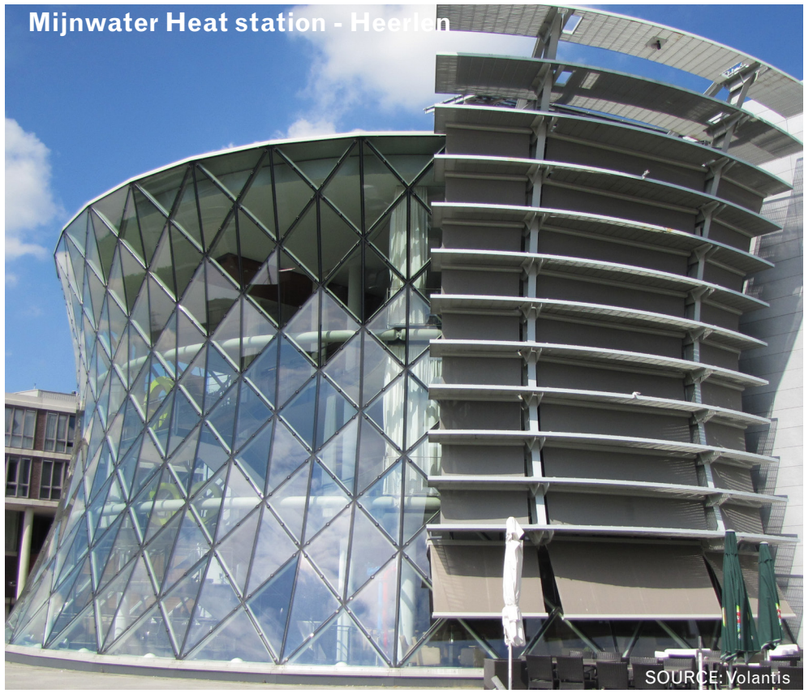


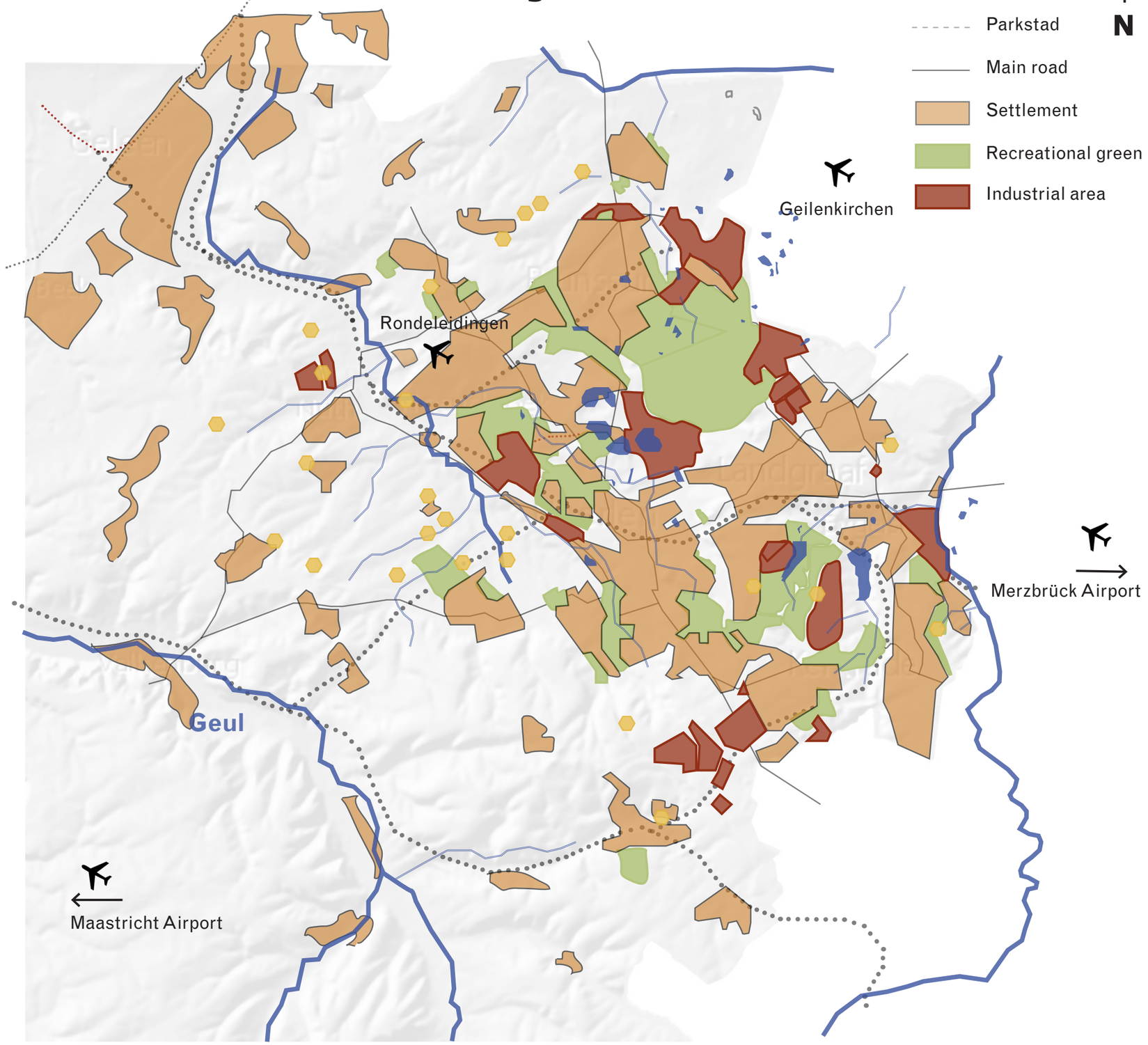


Sources: diagram made by author, information taken from Limburgemigrant.nl, Topotijdreis.nl and Wikipedia

PARKSTAD // Nature, tourism and sustainability

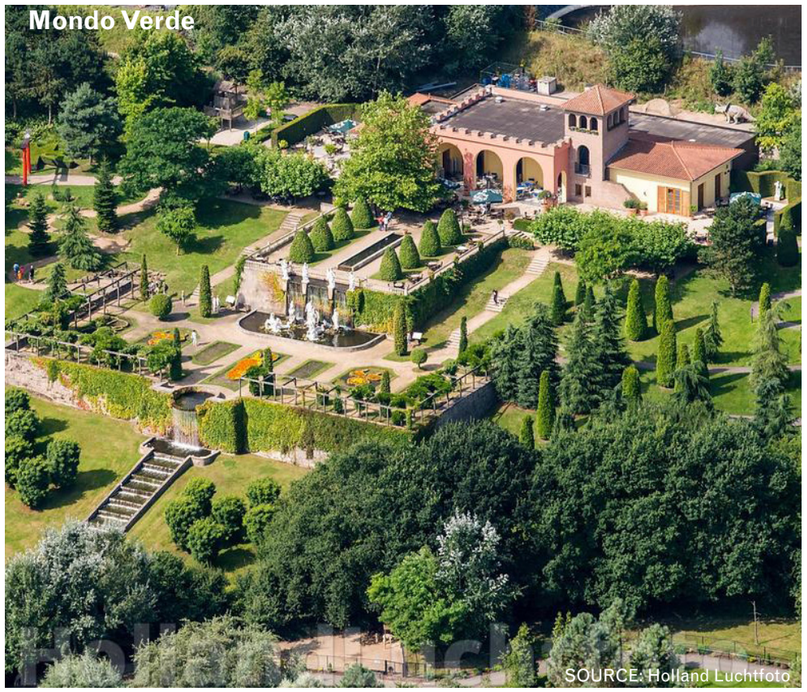


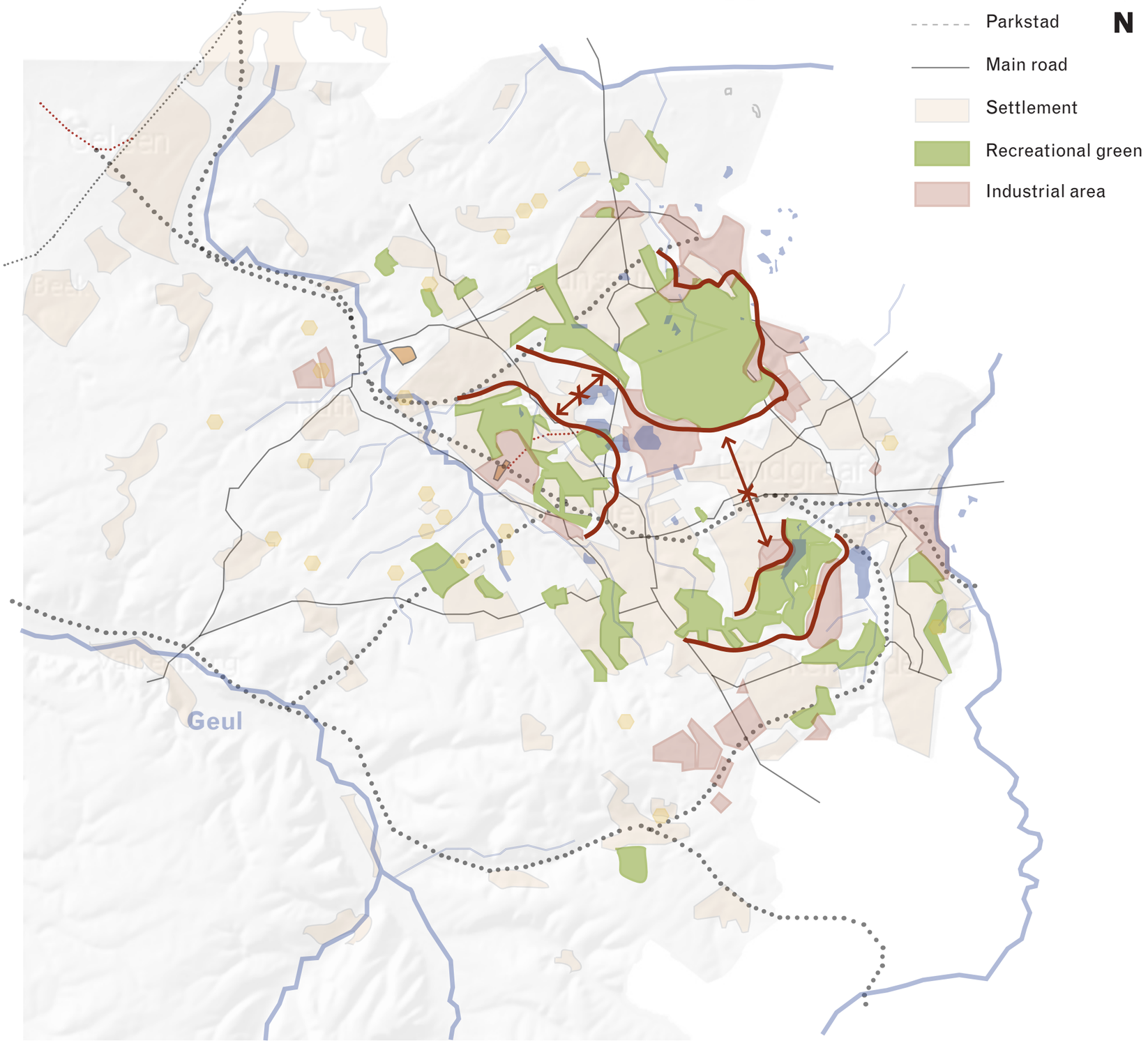




PARKSTAD // Disconnected islands of leisure and ecology







PARKSTAD // Two opposite kinds of tourism and nature



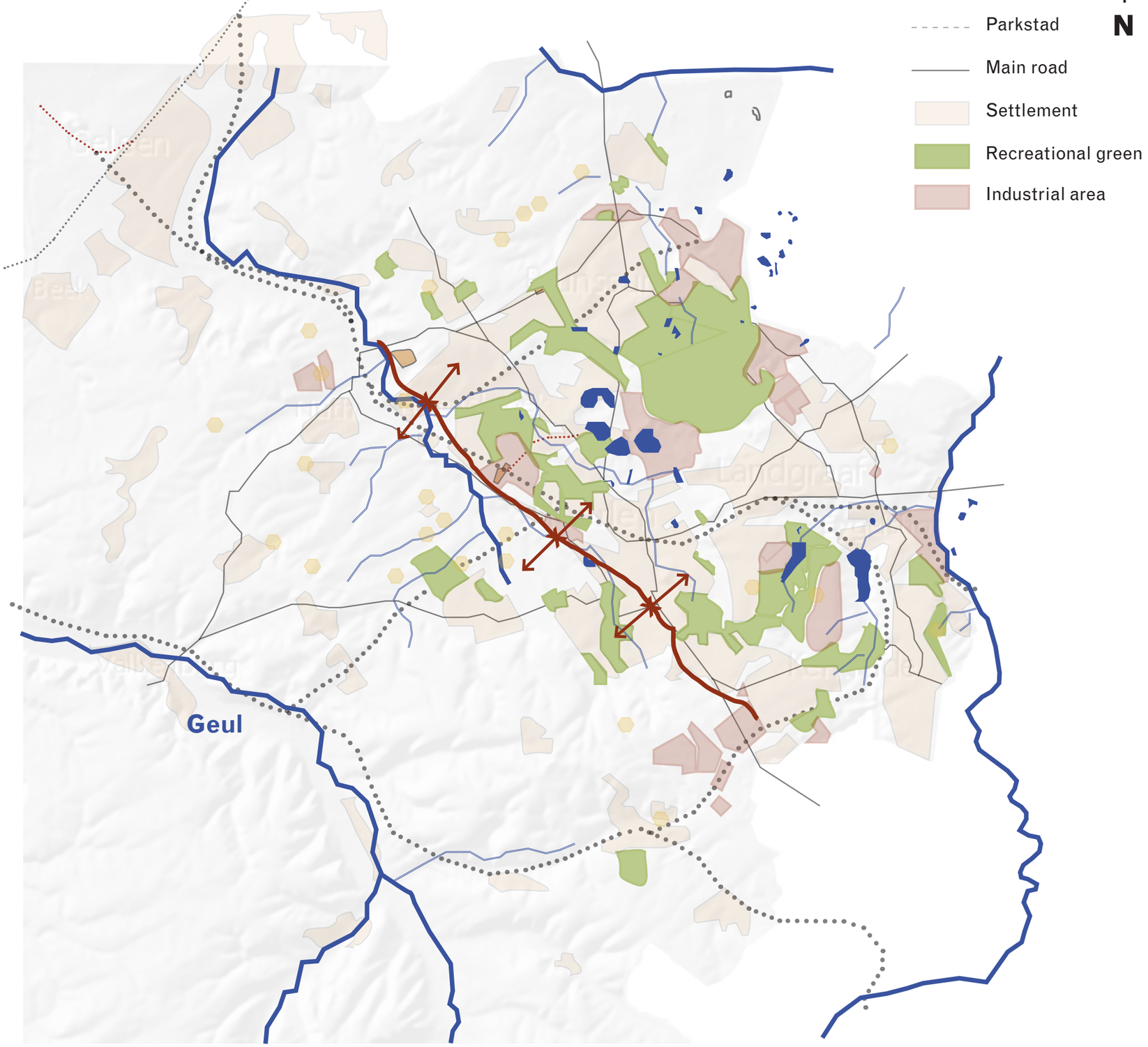
Agrotourism in Zuid Limburg

SOURCE: Vakantiehuis.nl

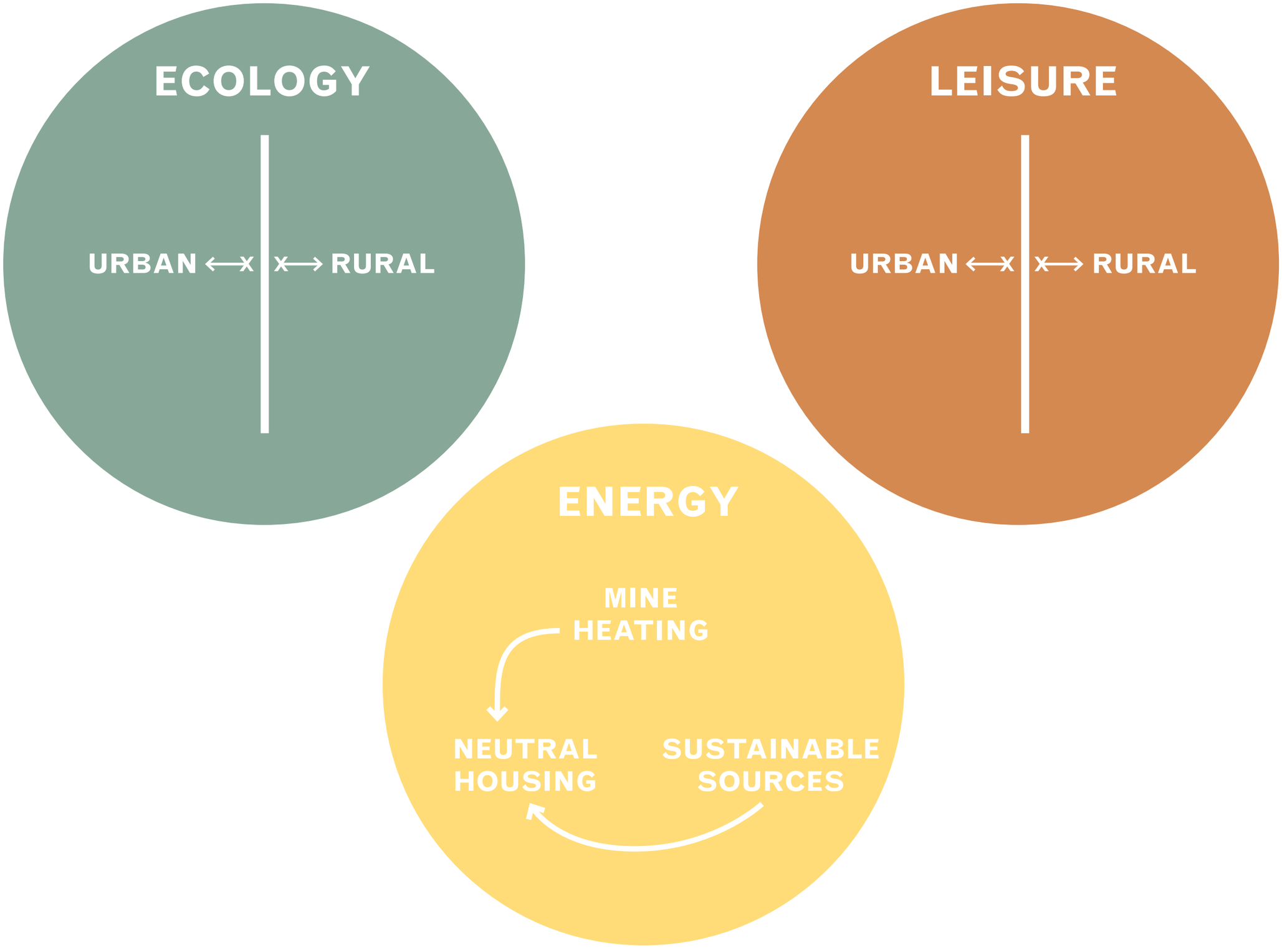


Pinkpop, 50th edition

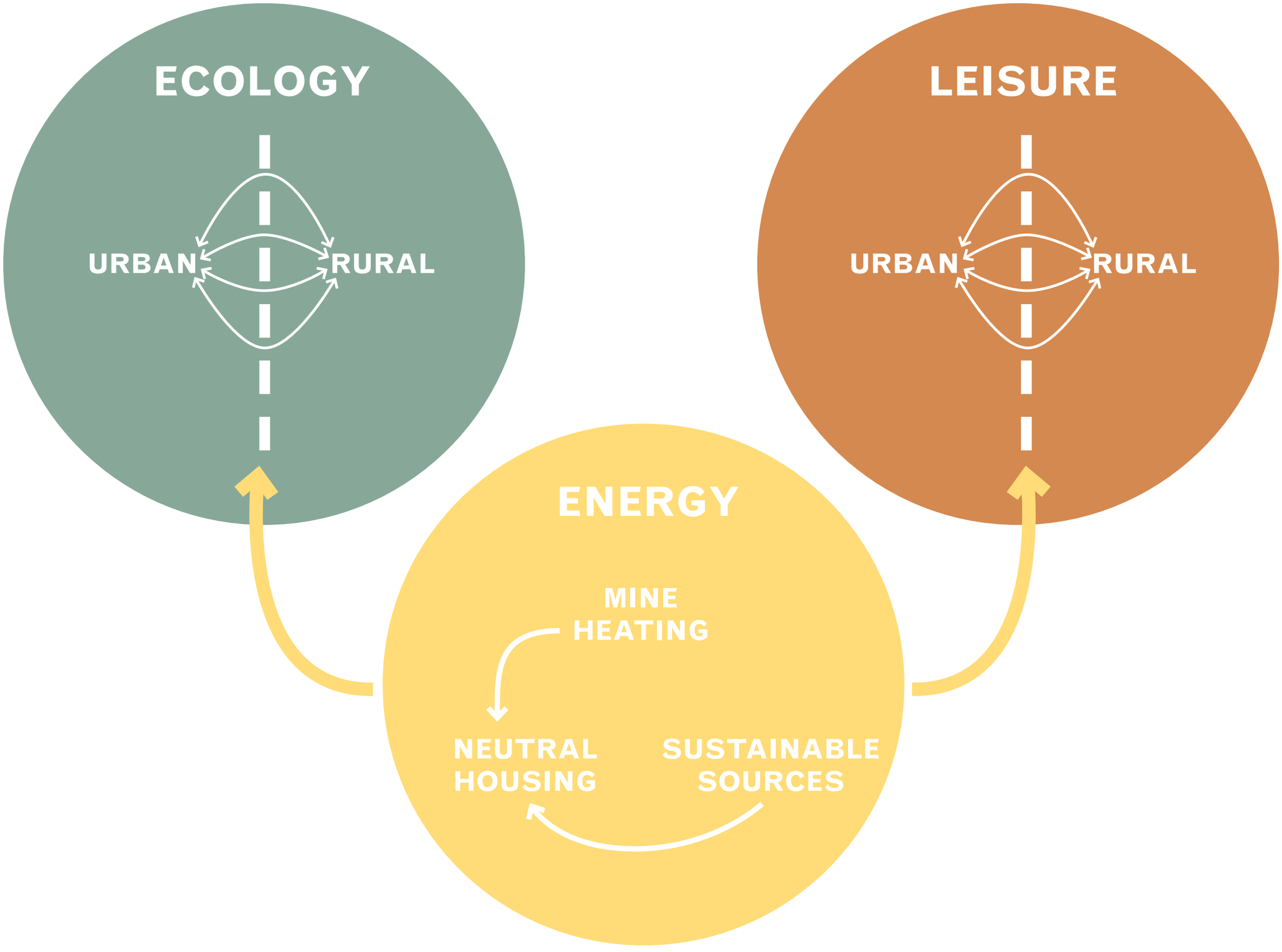
SOURCE: Pinkpop.nl



PARKSTAD


ECOLOGY
URBAN ⟷ x x ⟷ RURAL
LEISURE
URBAN ⟷ x x ⟷ RURAL
ENERGY
MINE
HEATING
NEUTRAL
HOUSING
SUSTAINABLE
SOURCES

PARKSTAD


ECOLOGY
URBAN
RURAL
LEISURE
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ENERGY
MINE
HEATING
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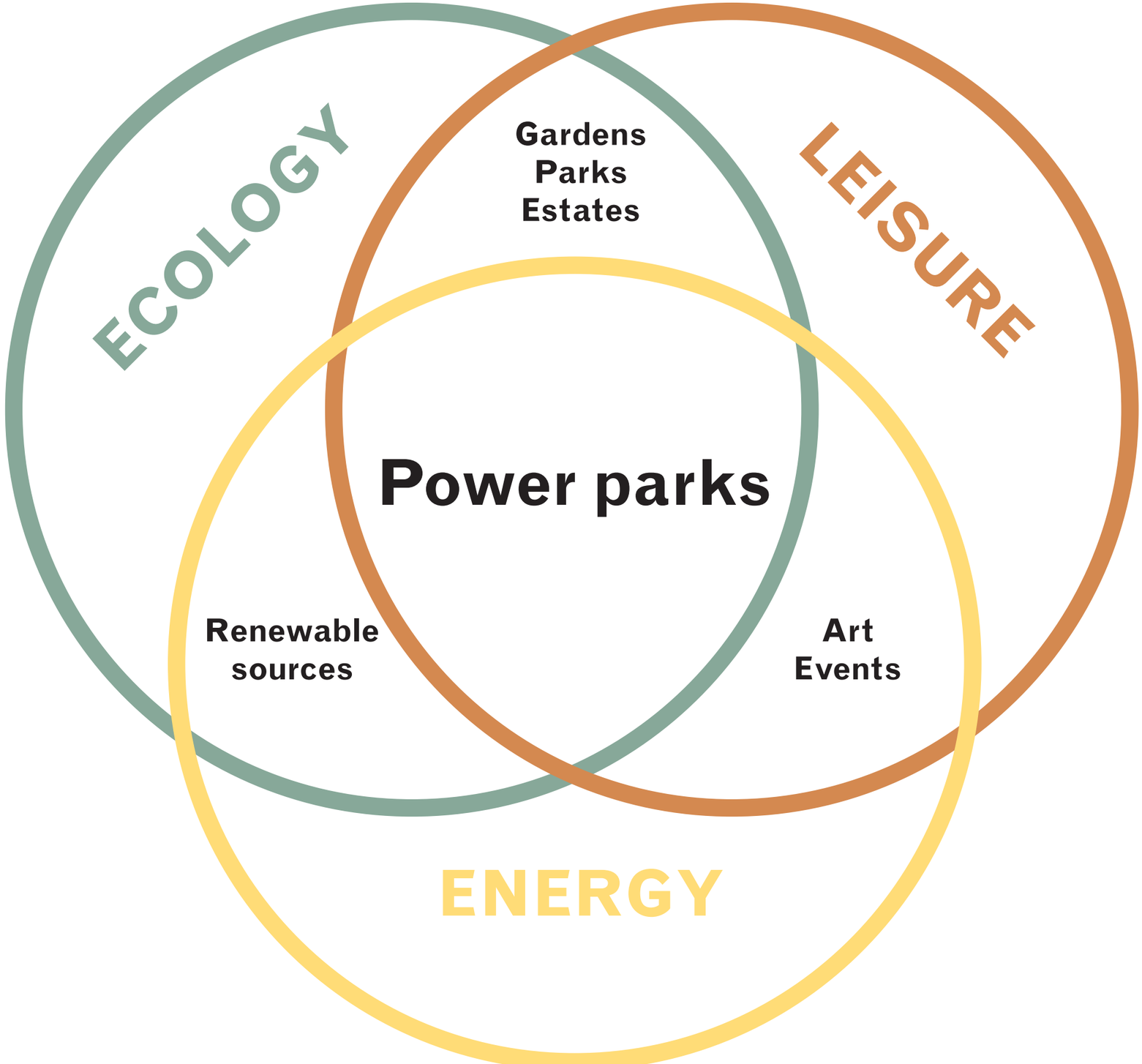
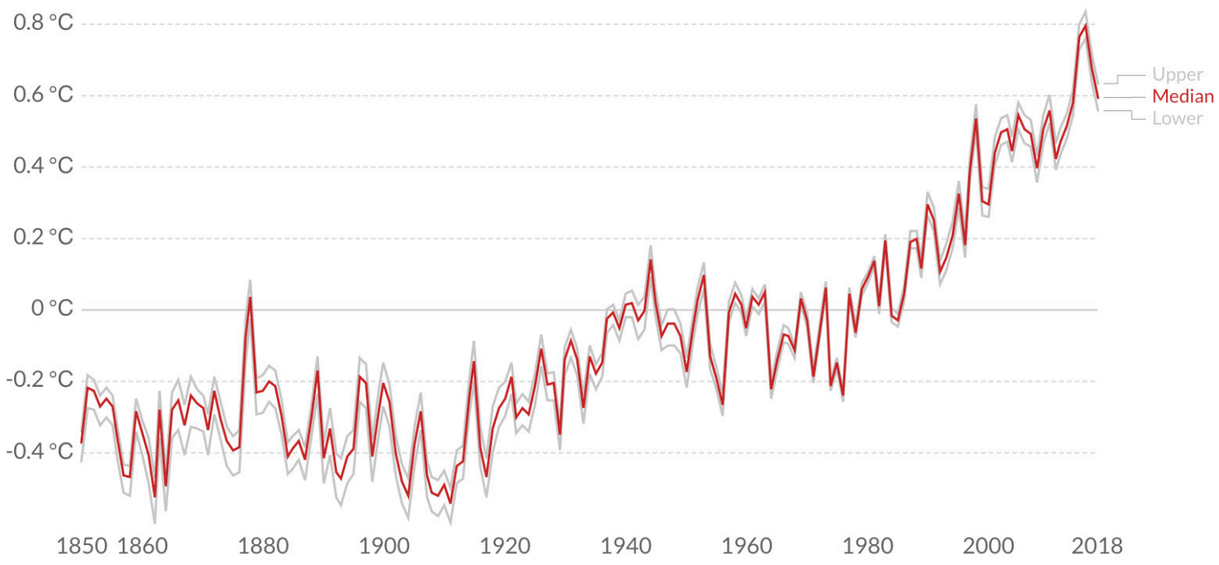
SOURCES


ECOLOGY
LEISURE
ENERGY
Gardens
Parks
Estates
Power parks
Renewable
sources
Art
Events

Average temperature anomaly, Global

Global average land-sea temperature anomaly relative to the 1961-1990 average temperature in degrees celsius (°C). The red line represents the median average temperature change, and grey lines represent the upper and lower 95% confidence intervals.

Our World in Data

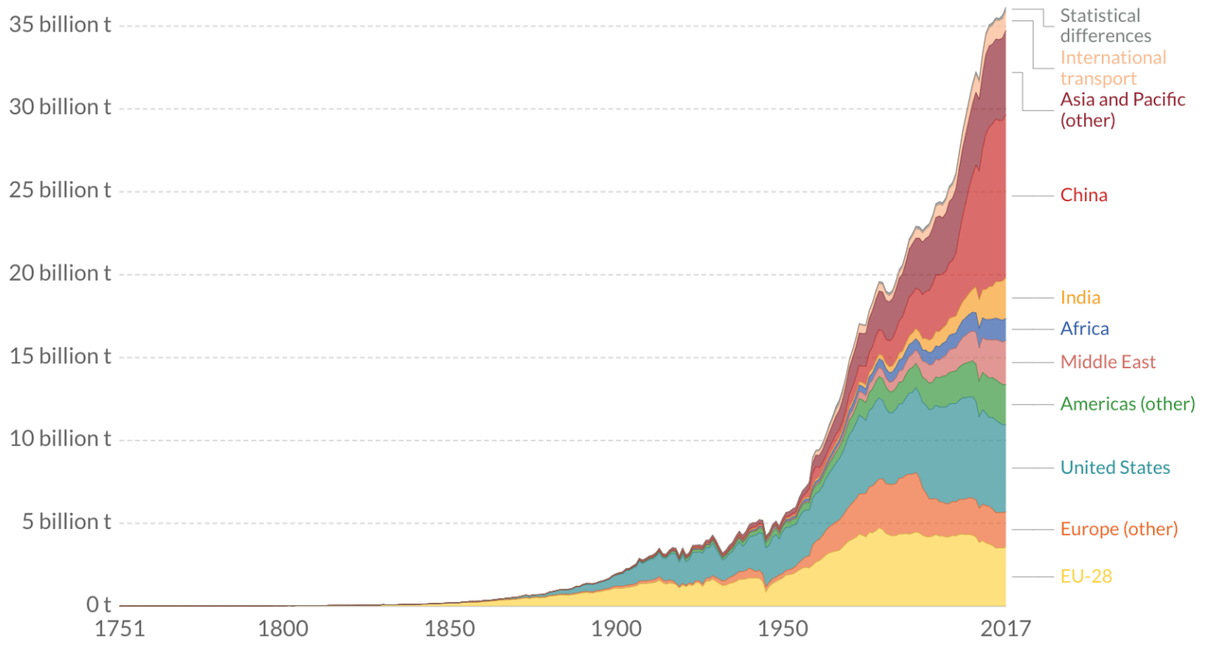


Source: Hadley Centre (HadCRUT4)

CC BY

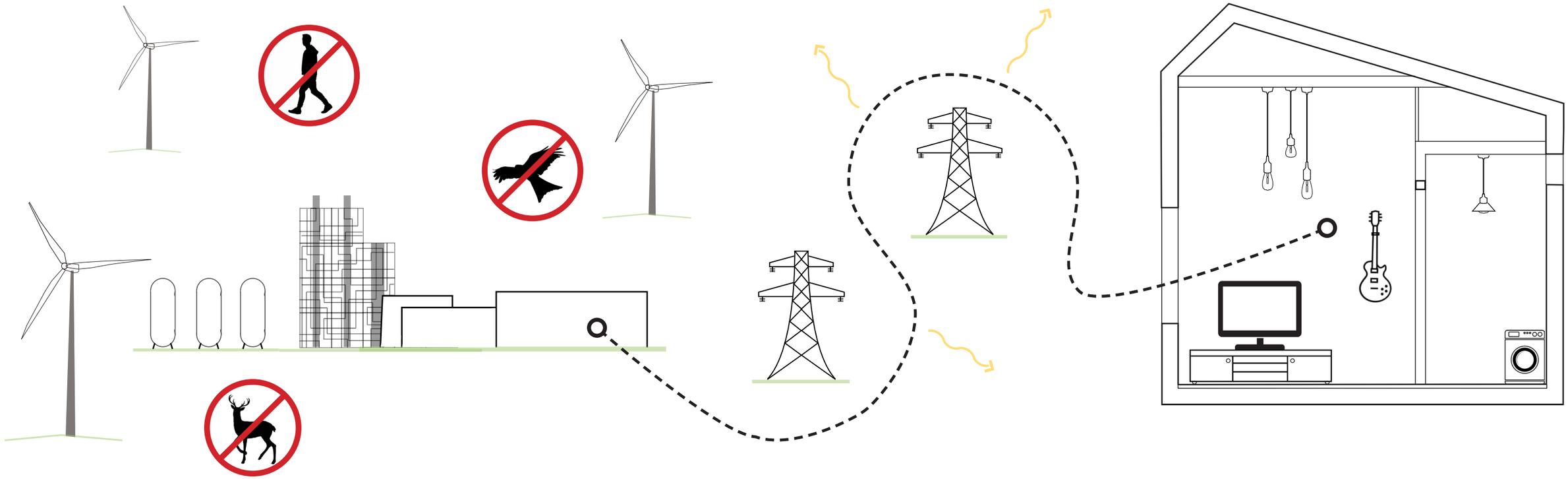
Annual total CO_2 emissions, by world region

Our World in Data



Source: Carbon Dioxide Information Analysis Center (CDIAC); Global Carbon Project (GCP)
Note: The difference between the global estimate and the sum of national totals is labeled "Statistical differences".

CC BY



RESEARCH QUESTION

CO_2



Peat energy period



Coal energy period



Gas energy period

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Carbon neutral energy period

"How can sustainable energy production landscapes be integrated with the natural and urban environment of Parkstad to generate employment and enhance leisure and biodiversity?"

2

THEORETICAL & METHODOLOGICAL FRAMEWORKS

THEORETICAL FRAMEWORK

URBANITY
ENERGY
ECOLOGY

Introduces new means and needs for

INDUSTRIAL SYMBIOSIS

Sustains and improves

ENERGY TRANSITION

Recovers and innovates, thus protects

Introduces new forms of

Improves attractiveness and raises awareness about

EMPLOYMENT

LANDSCAPE

Renews and affects

DENSIFICATION

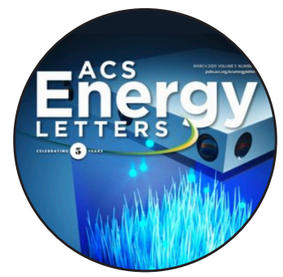
Cultural/economic role of the city as its defining character as a metropolis



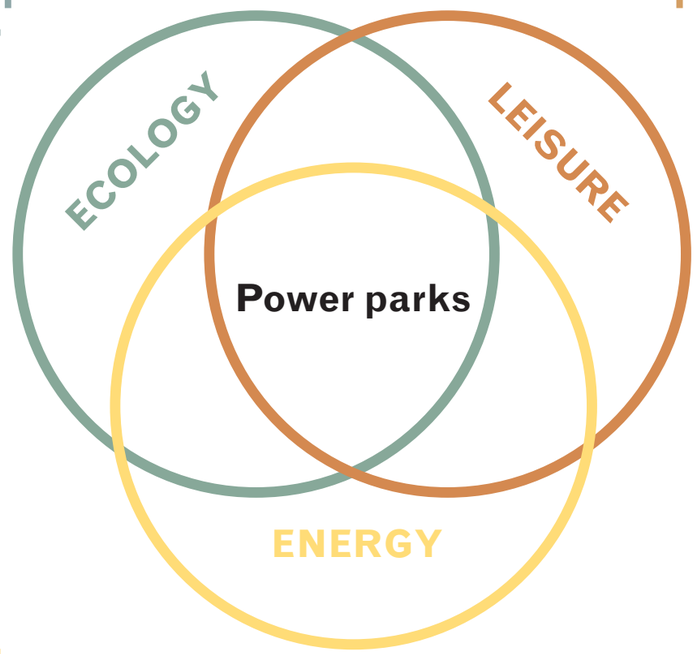












Understanding the site

Pattern study

Layer and desk analysis

Site visit

Understanding the objects

Pattern study

Desk analysis

Case studies

Vision and strategic design

Research by design ← Spatial footprint

↑ Pattern combination ↓

↑ Calculations

Detailed design

Research by design

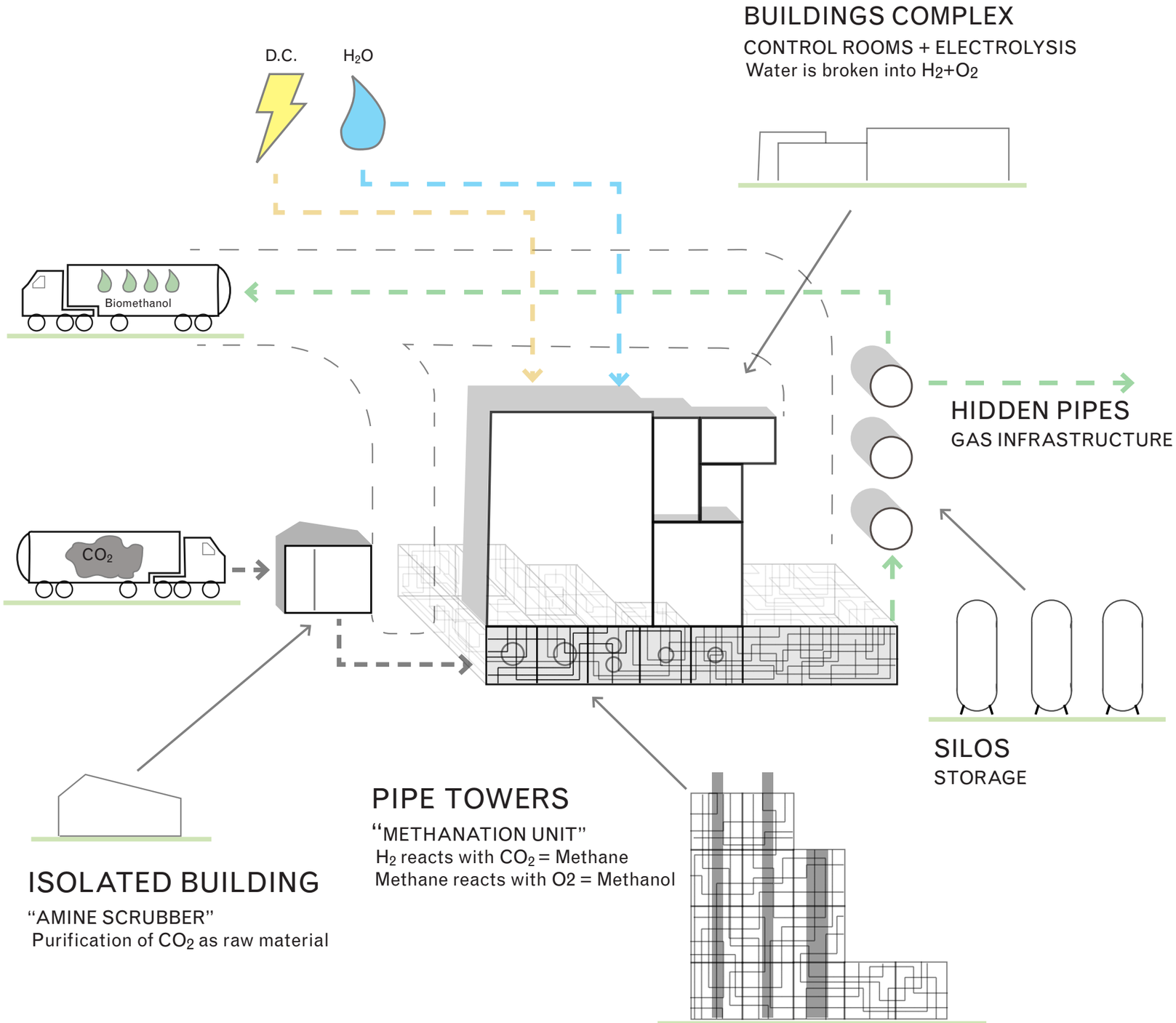
ENERGY ARTEFACTS

CARBON RECYCLING PLANT



SOURCE: LinkedIN | Carbon Recycling International


SOURCE: Carbon Recycling International



Source: All diagrams by author

KITE GENERATORS

TECHNICALITIES

- Altitude range: 70 - 450m
- Nominal power: 100 kW
- Peak power: 180 kW
- Yearly power output: 450 MWh/y
- Generation phase producing energy
- Retraction phase consuming energy

ISSUES AND OPPORTUNITIES

- Different combinations of kites
- Dynamic element
- Fabric easy to color
- Rope might be dangerous for birds
- Generation phase producing energy
- Retraction phase consuming energy
- Small scale and almost absent noise
- Possibility to have fixed or moving ground station

Spatial footprint



Efficiency



Lifespan

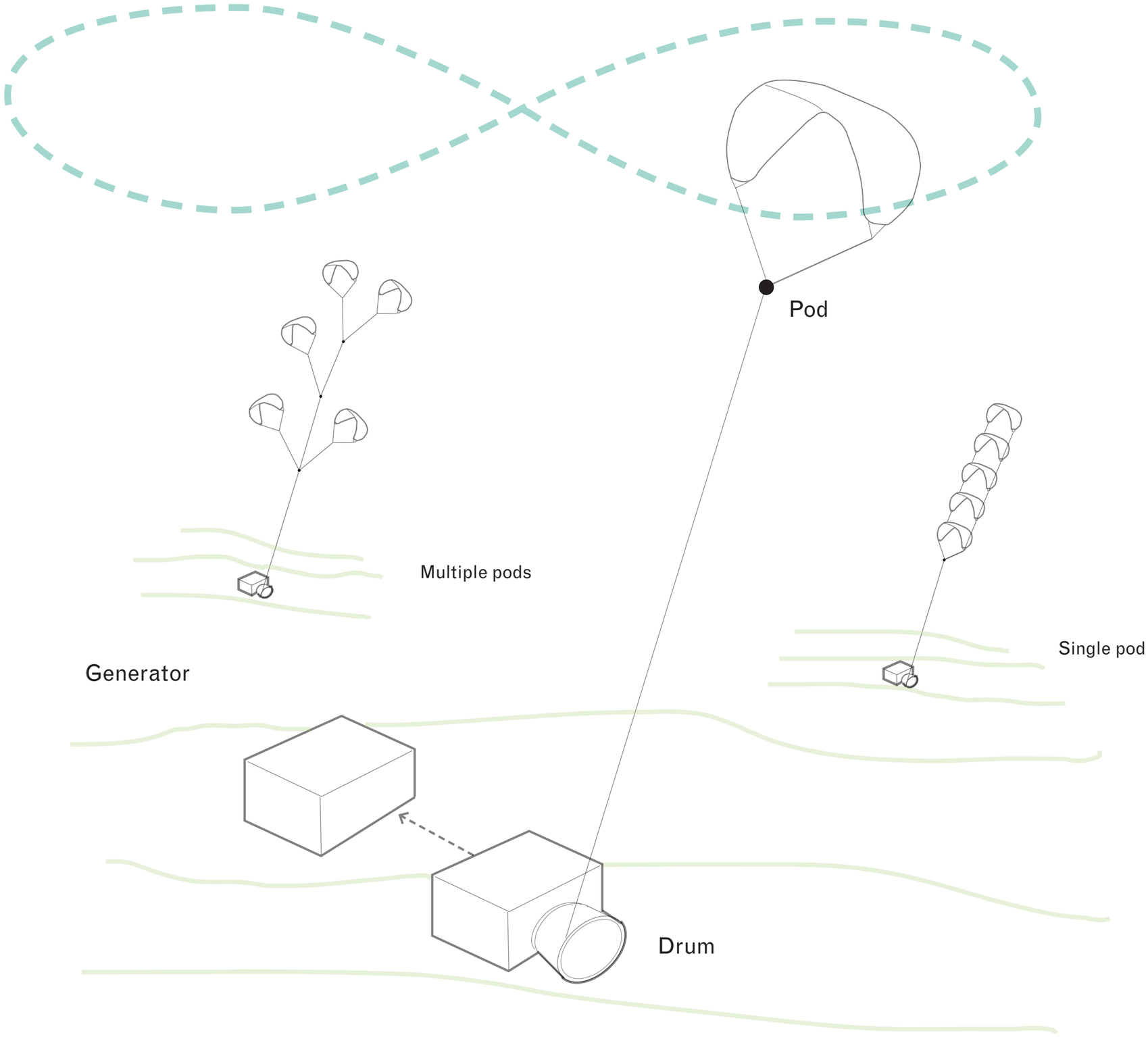


Recyclability



Labor intensity





WIND TURBINES

TECHNICALITIES

Horizontal axis:
- Blade length: 20 to 80 meters
- Altitude: 70 to 160 meters
- Noise: 5-60 dB

Vertical axis:
- Darrieus
- Giromill
- Savonius (works with slow winds

For h=1 m and r=0.5 m, wind v=10 m/s the maximum power would be of 180 W
- Noise: 0-10 dB

ISSUES & OPPORTUNITIES

- Wind intermittency
- Relatively short lifespan
- Need for a low ground surface roughness
- Tower as design element
- Dangerous for migrating birds
- Enormous scale

Spatial footprint



Efficiency



Lifespan

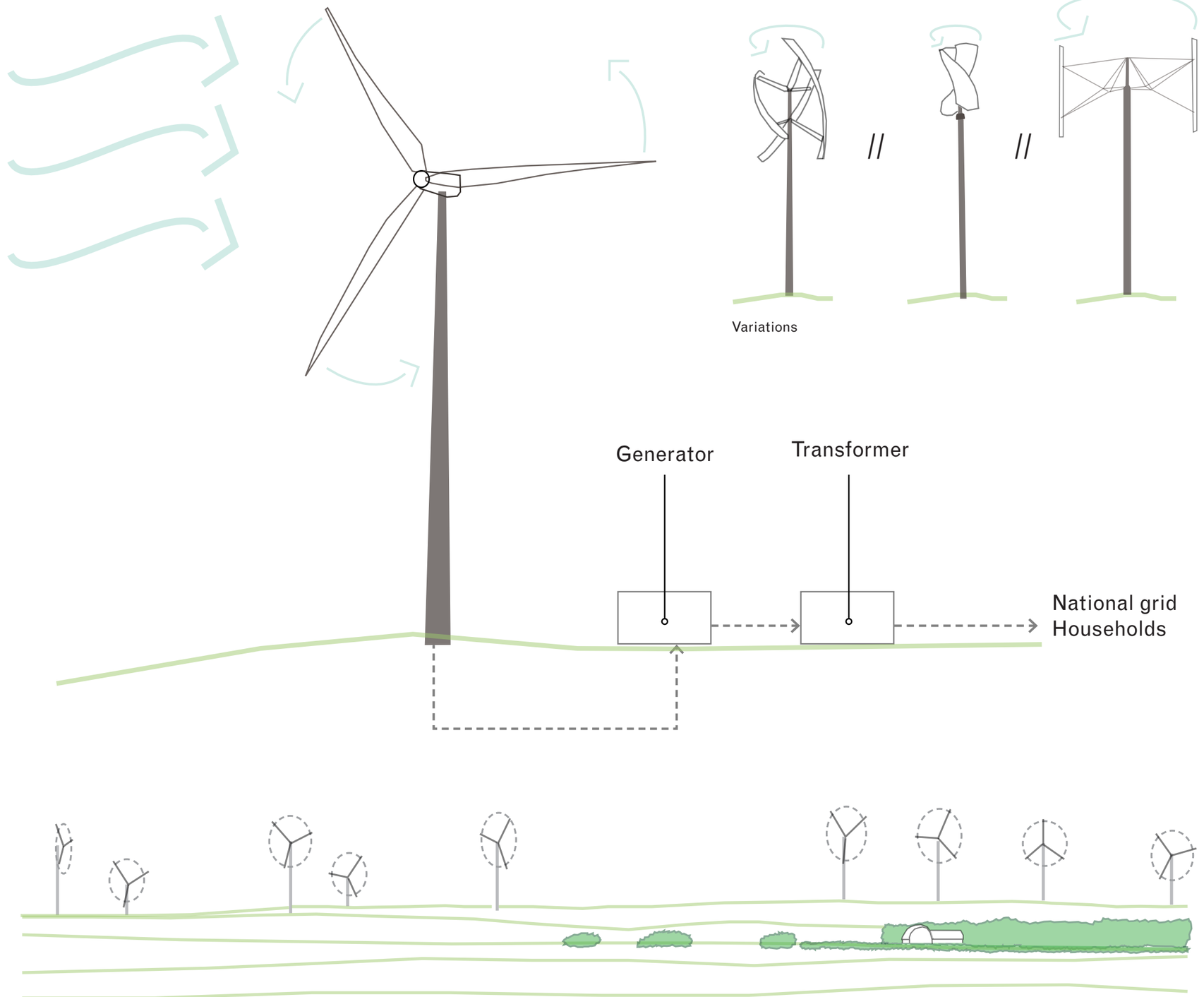


Recyclability



Labor intensity





Variations

Pattern analysis of Gull Lake power facility

Source: All diagrams by author

WATERMILLS

TECHNICALITIES

- “Vertical axis”, horizontal, usually underwater
  [Low efficiency]
- “Undershot”, vertical, hit by water at 1/4 height
  [50-60% efficiency]
- “Breastshot”, vertical, hit by water above 1/4 height
  [50-60% efficiency]
- “Overshot”, vertical, hit by water from above
  [80-90% efficiency]

ISSUES AND OPPORTUNITIES

- Iconic link with area
- Multiscalar
- Low impact on native species
- Possibility to build with wood or aluminum
- Visible icon of flowing water even from far
- Need for artificial canals

Spatial footprint



Efficiency



Lifespan

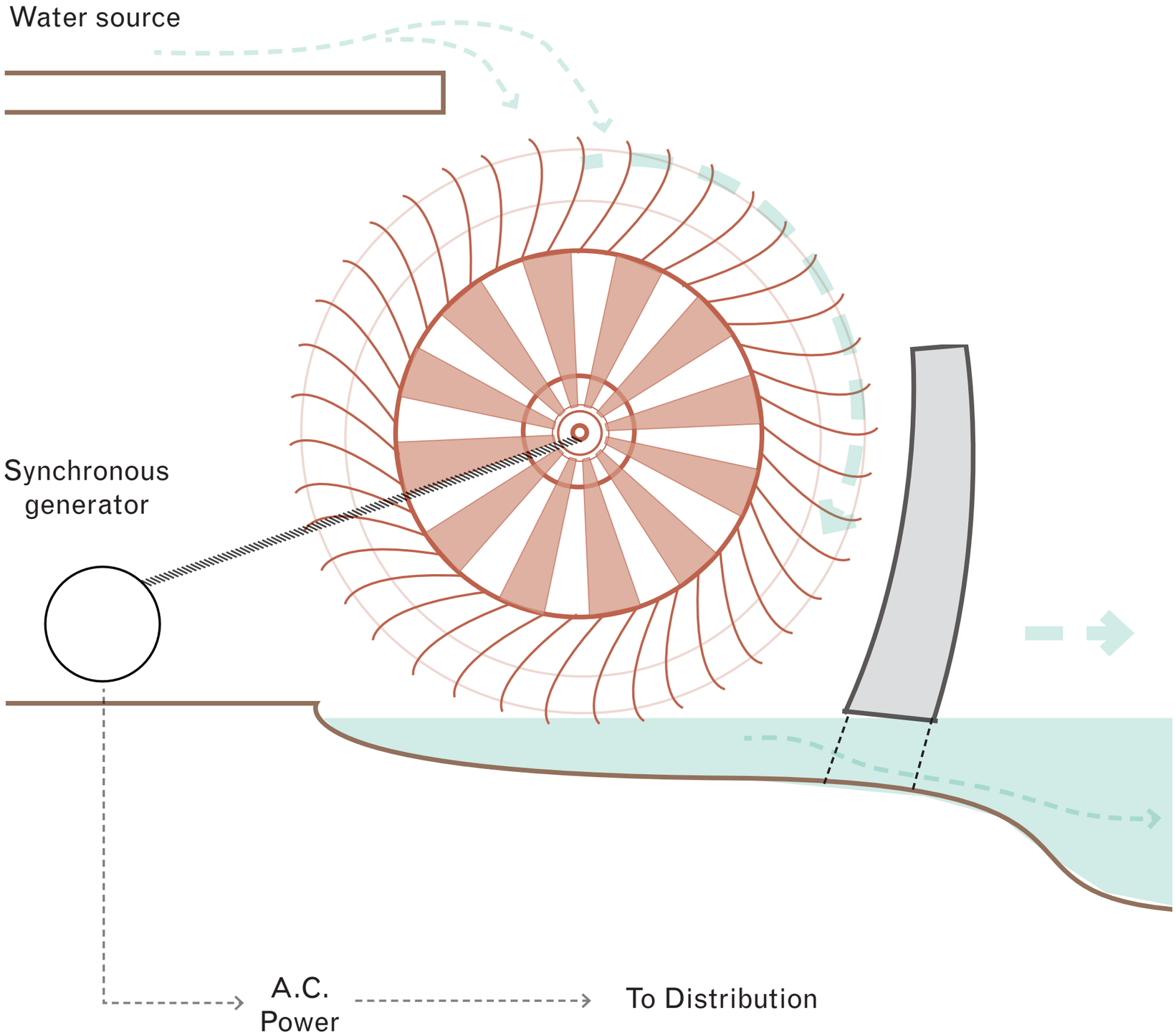


Recyclability



Labor intensity





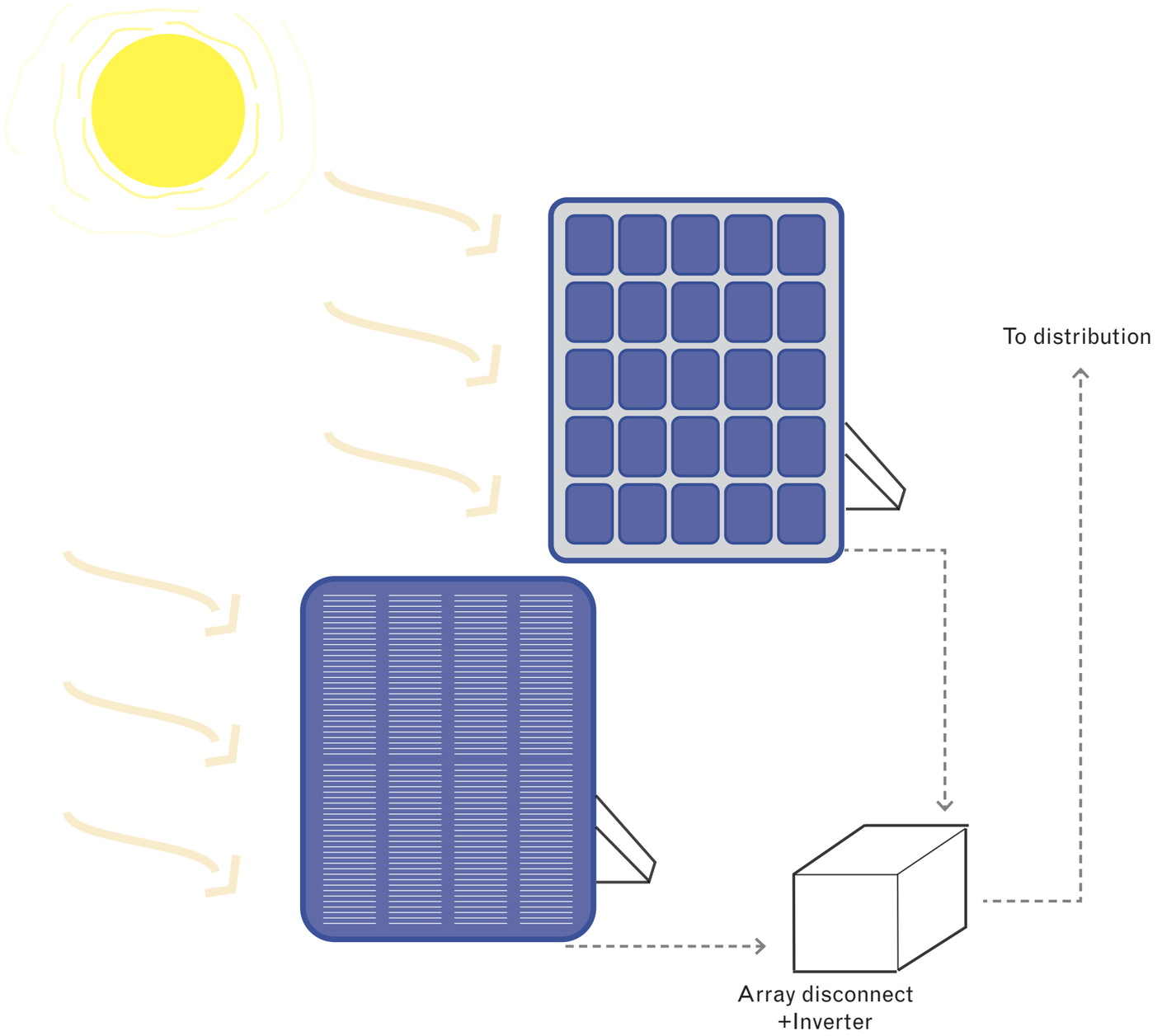
SOLAR PANELS

TECHNICALITIES

- Specialised construction
- Need for cabling
- Direct exposition to sunlight
- High construction cost

ISSUES AND OPPORTUNITIES

- Flexible disposition
- Core geometry: Surface
- Reflectivity / Heat irradiation
- Already inserted and normalised in housing
- Multiscalar
- Thin film solar cells usable over curved surfaces



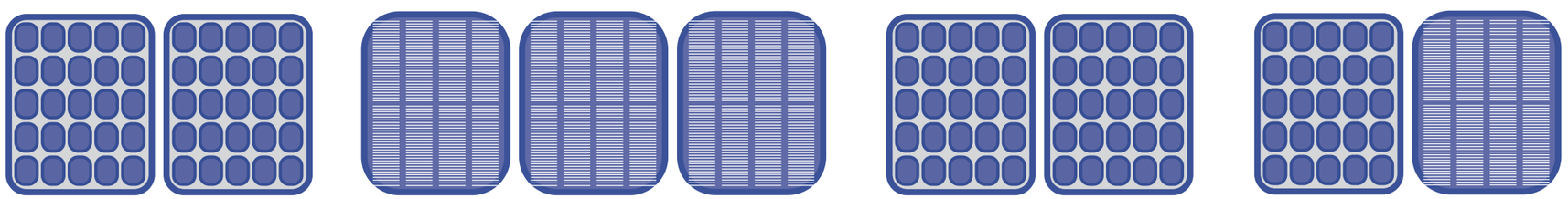
Spatial footprint

Efficiency

Lifespan €

Recyclability

Labor intensity



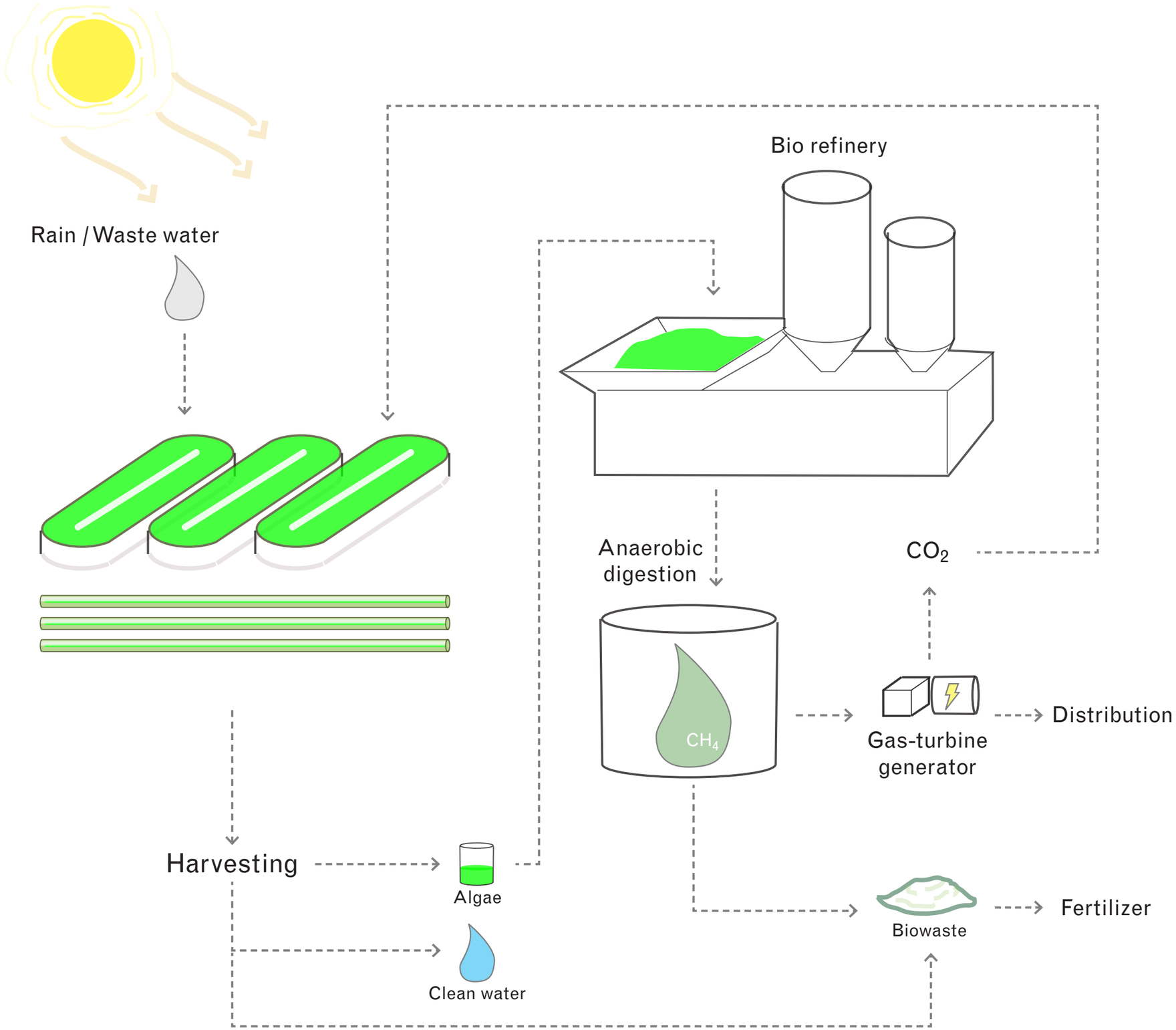
ALGAE FARMING

TECHNICALITIES

- Need for incinerators
- Need for storage and collectors
- Input : Water, Sunlight, Soil
- Output : O_2 , CO_2, Energy, Ashes

DESIGN ISSUES & OPPORTUNITIES

- Designing with plants
- Extreme design flexibility
- Multiscalar
- Wide range of species
- Un-specialised job opportunities
- Natural CO_2 capture
- Re-use and purification of wastewater
- Food source
- High cost if used for fuel production
- Usable for medic purposes
- Easy to place along highways



Spatial footprint

●●●●●●●●●● X3

Lifespan €

●●●●●●●●●●

Recyclability

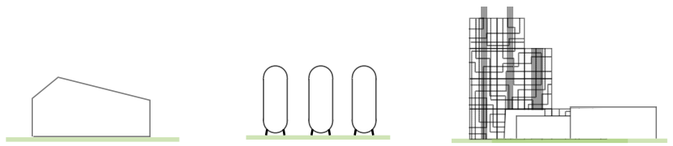
●●●●●●●●●●

Labor intensity

●○○○○○○○○○

SELECTION & FLOWS:

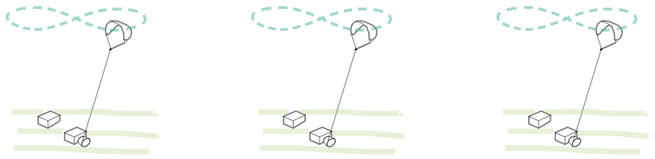
- **Carbon recycling plants,**



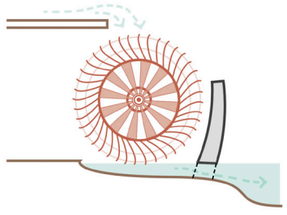
- **Savonius wind turbines,**



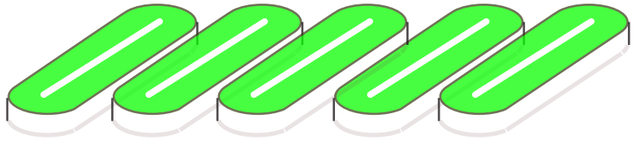
- **Kite generators,**



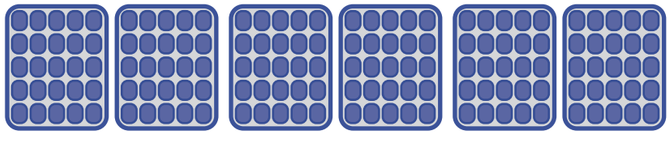
- **Overshot watermills,**

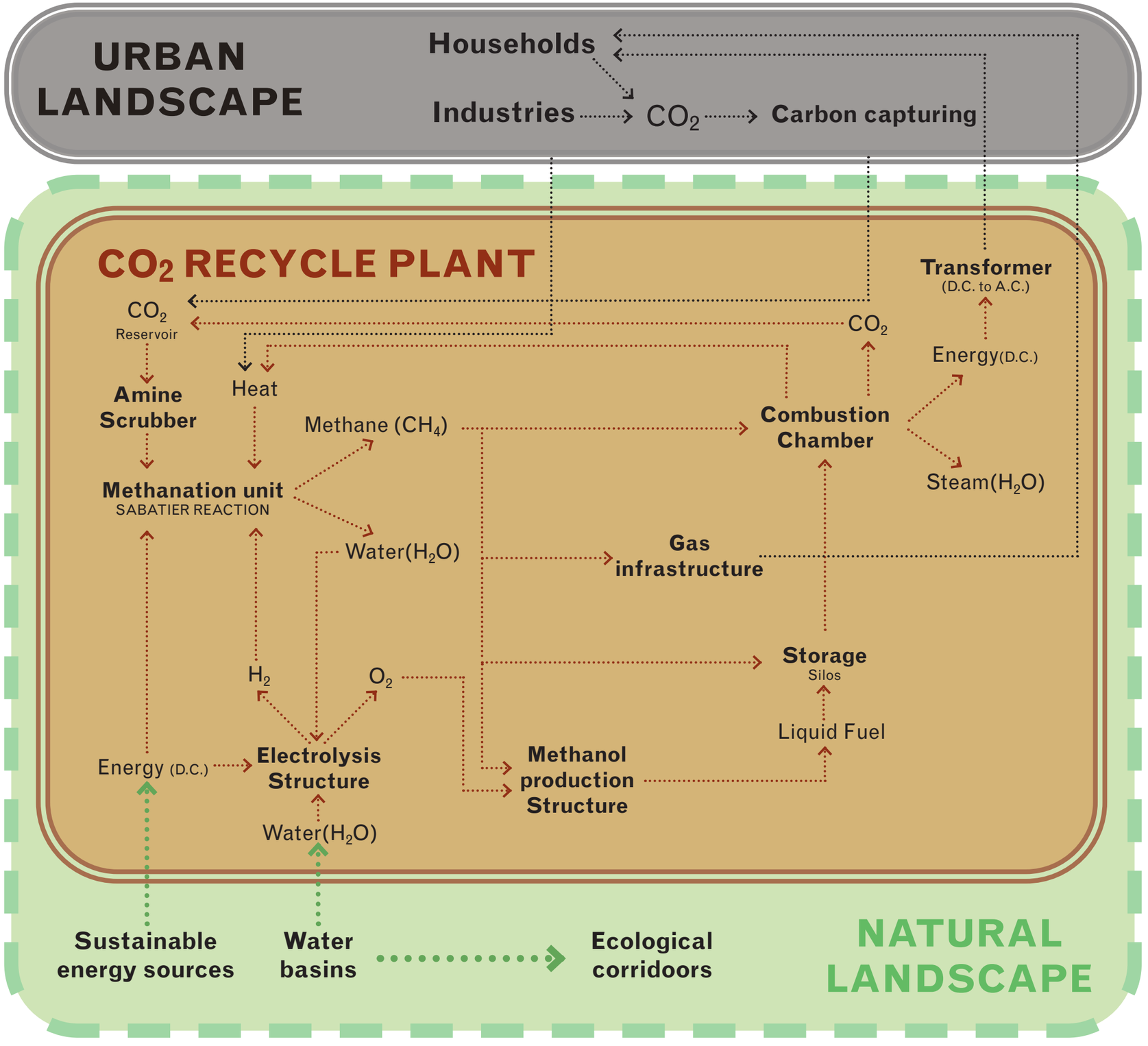


- **Algae pools,**



- **Thin film solar panels,**

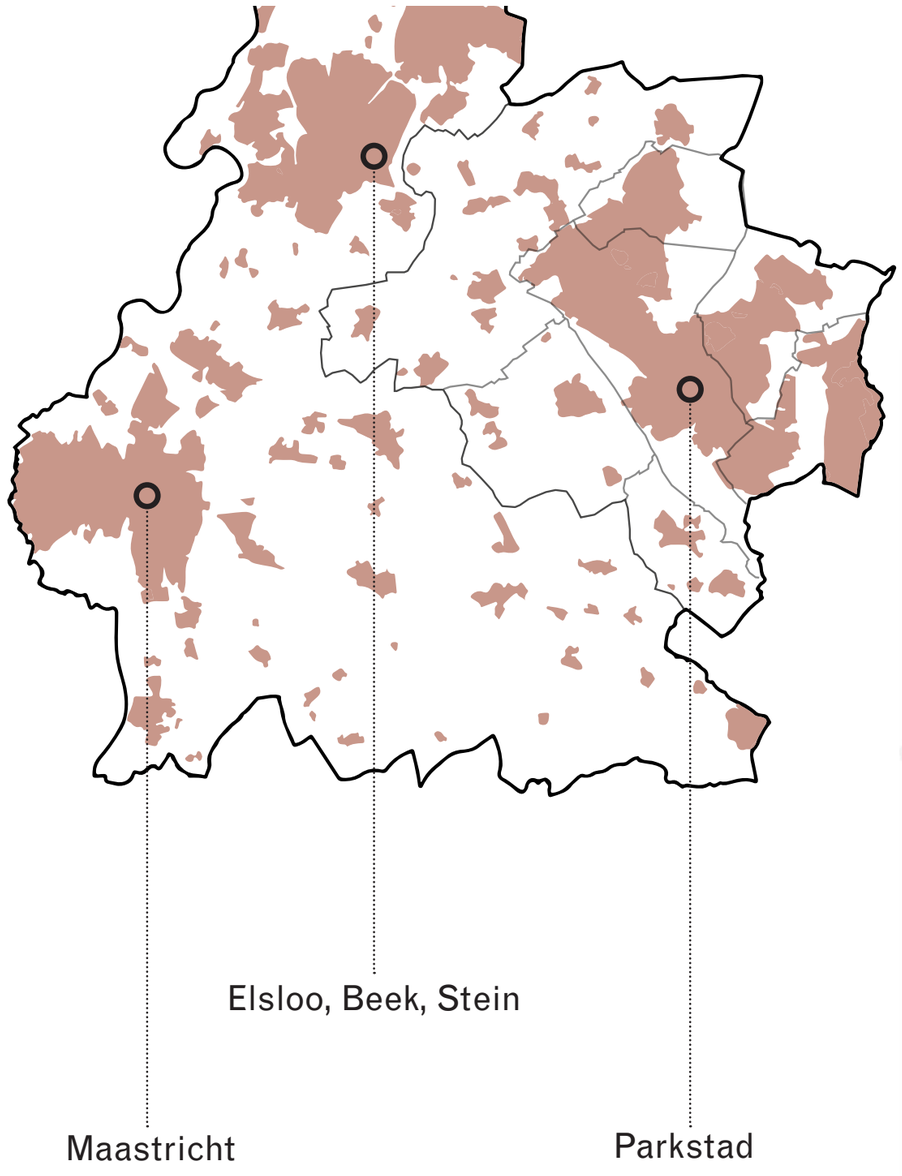


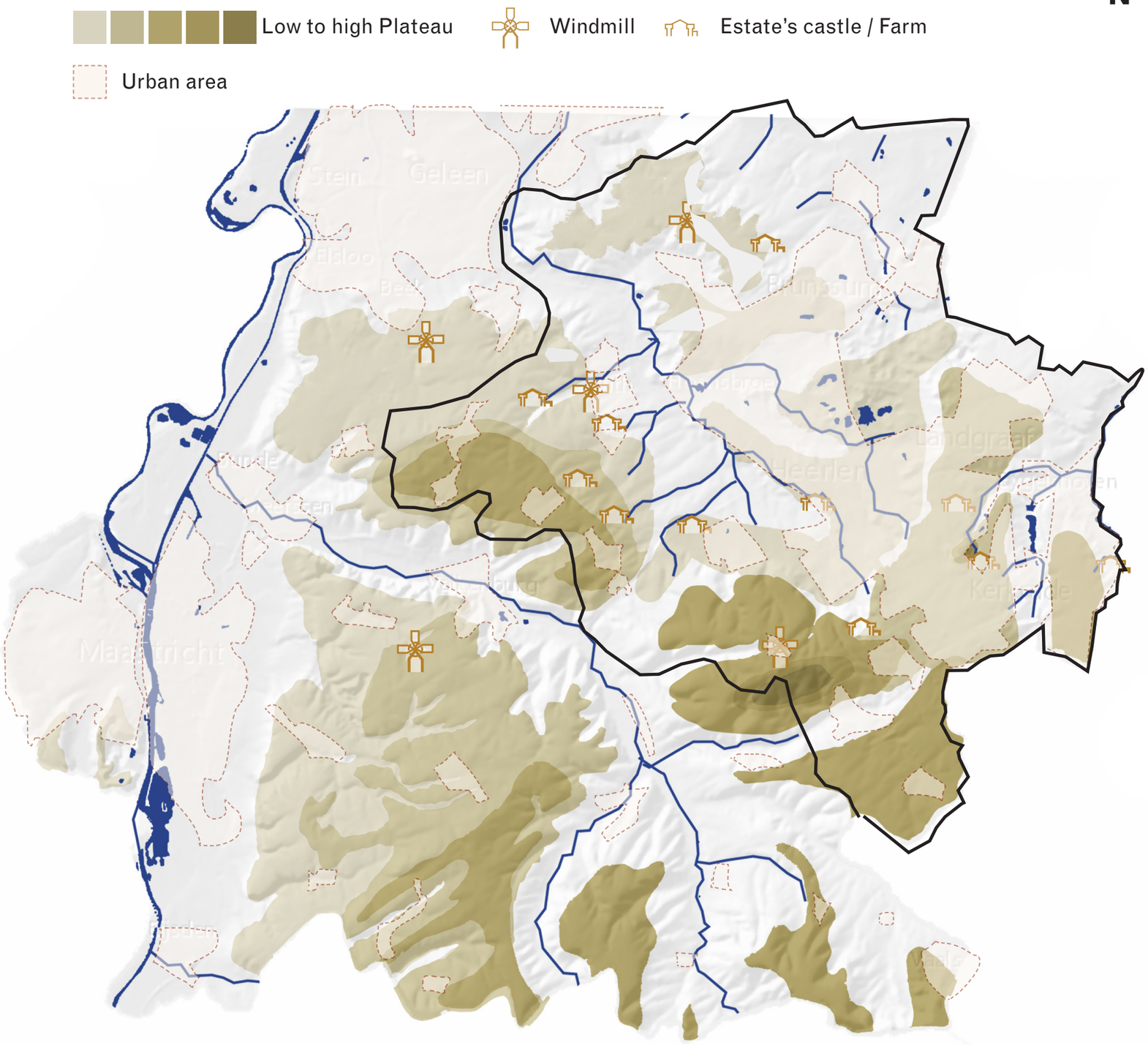


4

LANDSCAPE TYPOLOGIES

PLATEAUS


Elsloo, Beek, Stein
Maastricht
Parkstad


Low to high Plateau
Windmill
Estate's castle / Farm
Urban area
N
Stein
Geleen
Beek
Elsloo
Maastricht

RIDGES

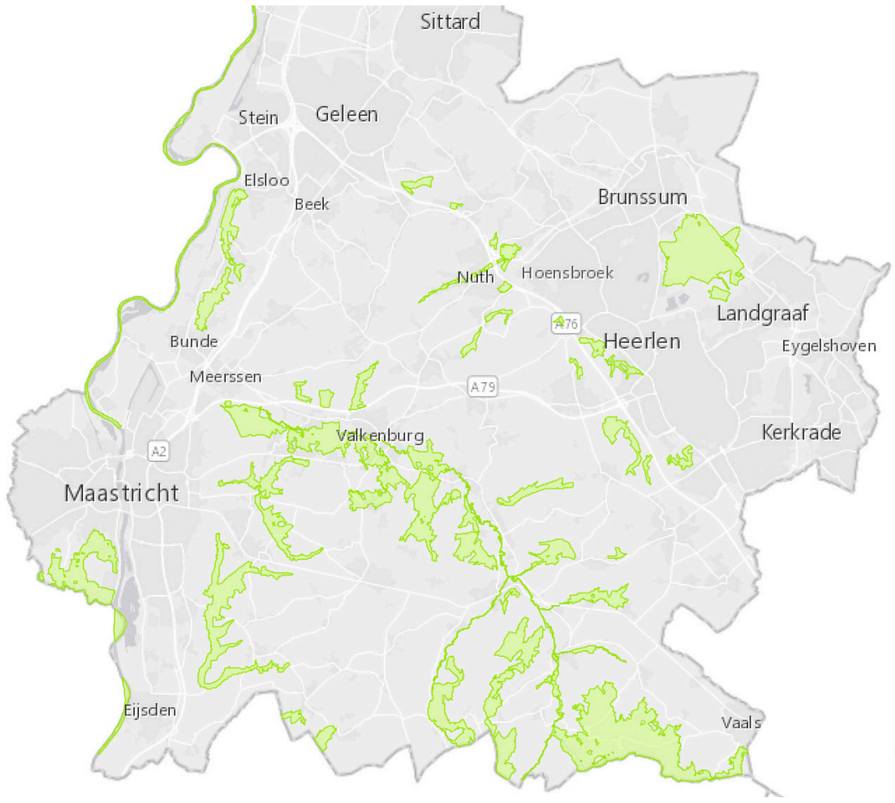
N

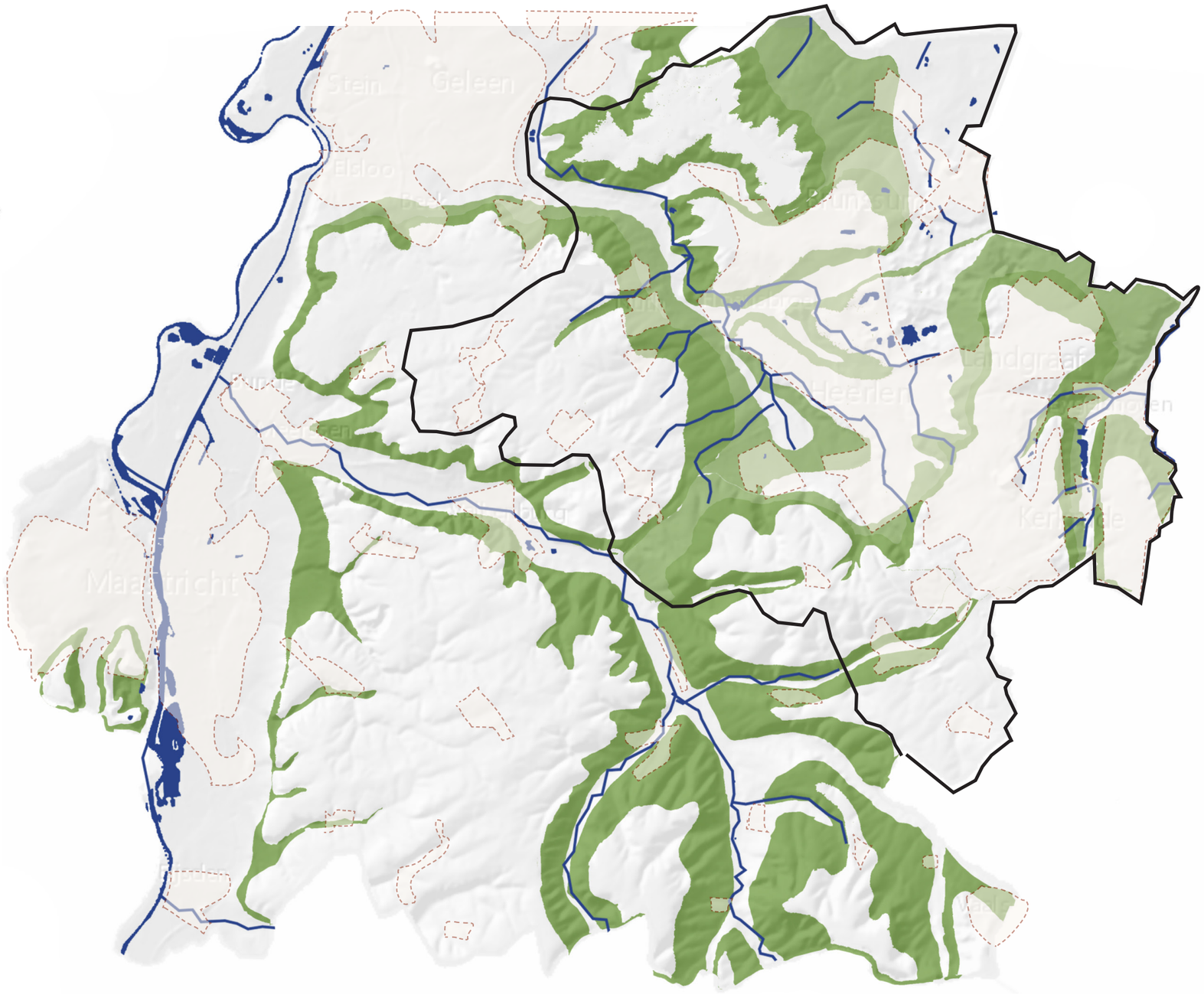
Protected areas

Soft to steep ridges

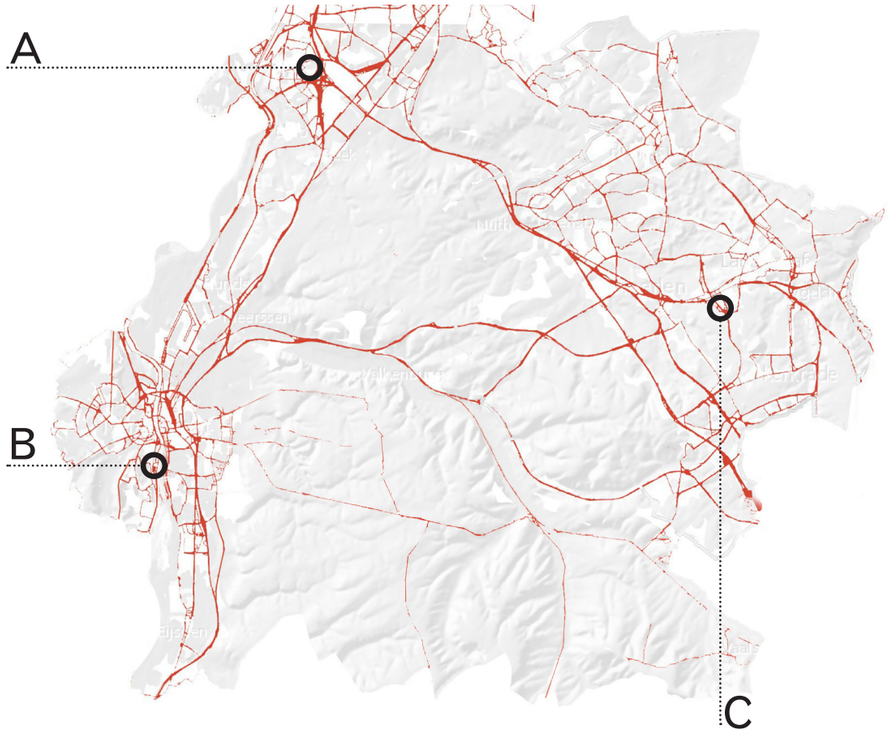
Estate's castle / Farm

Urban area





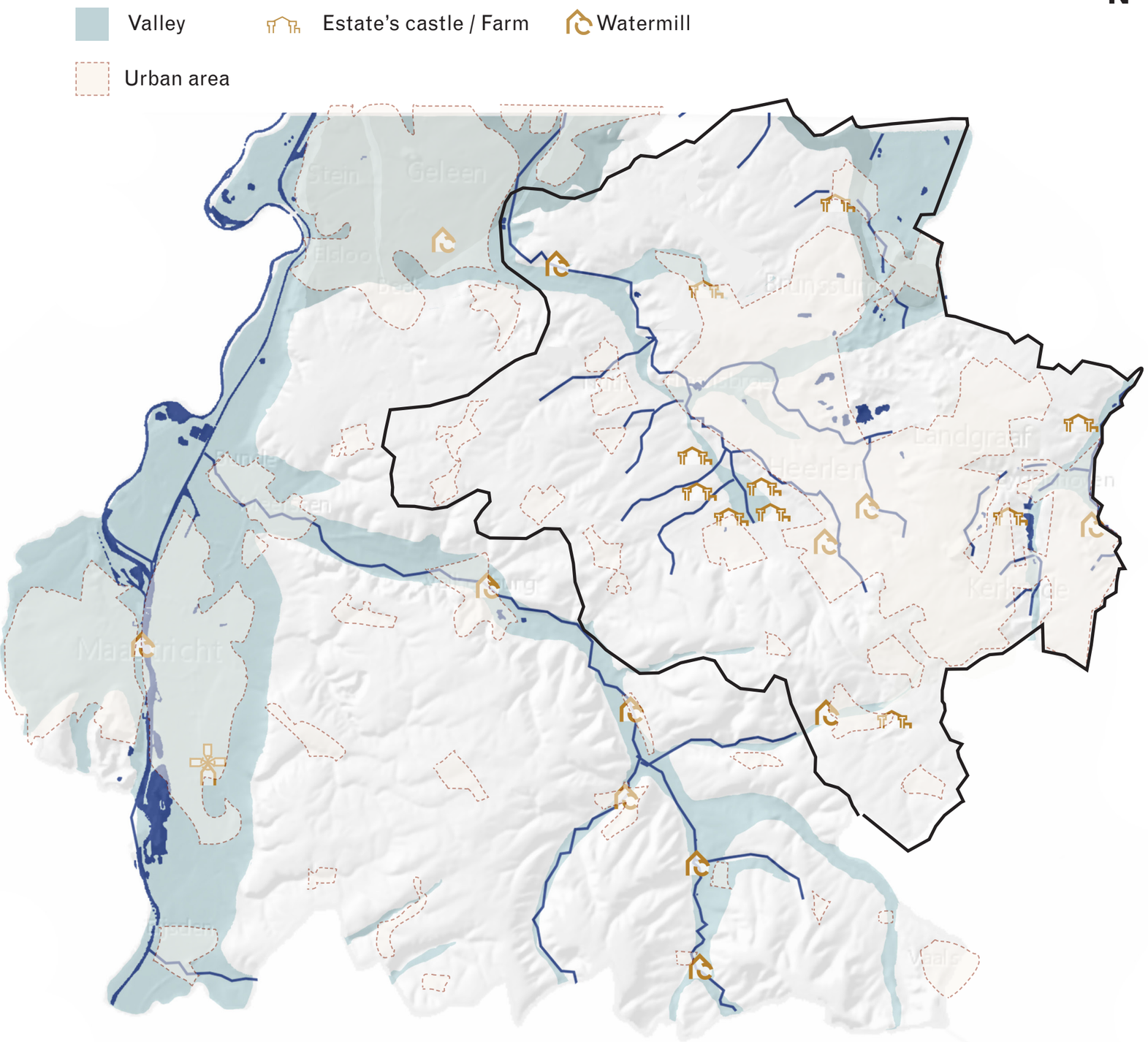
VALLEYS



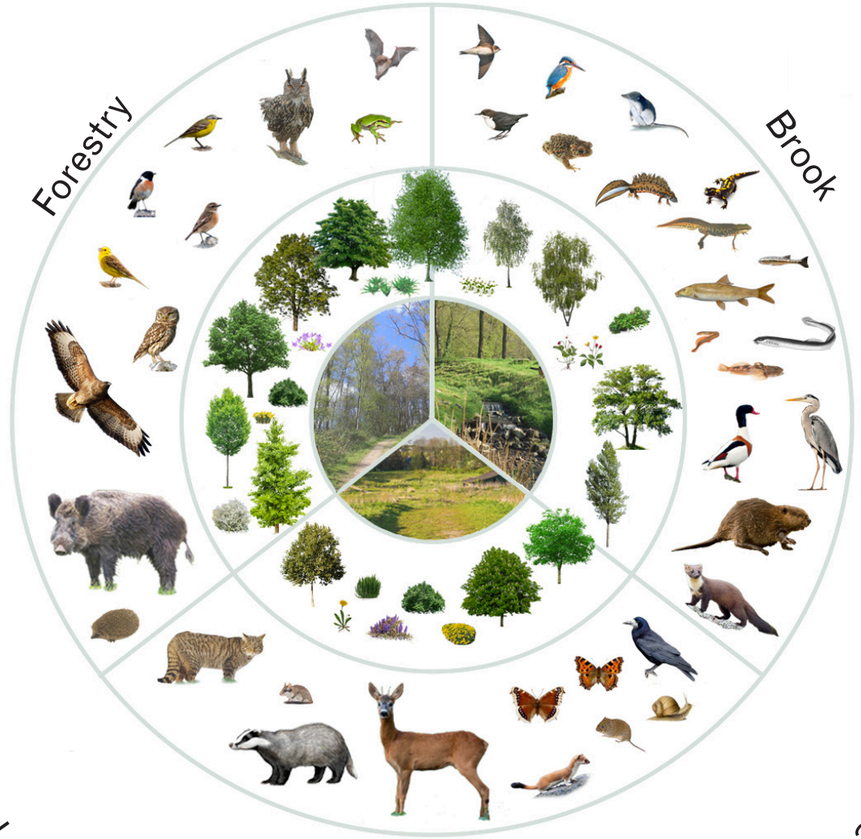
A - Industry based

B - Historic

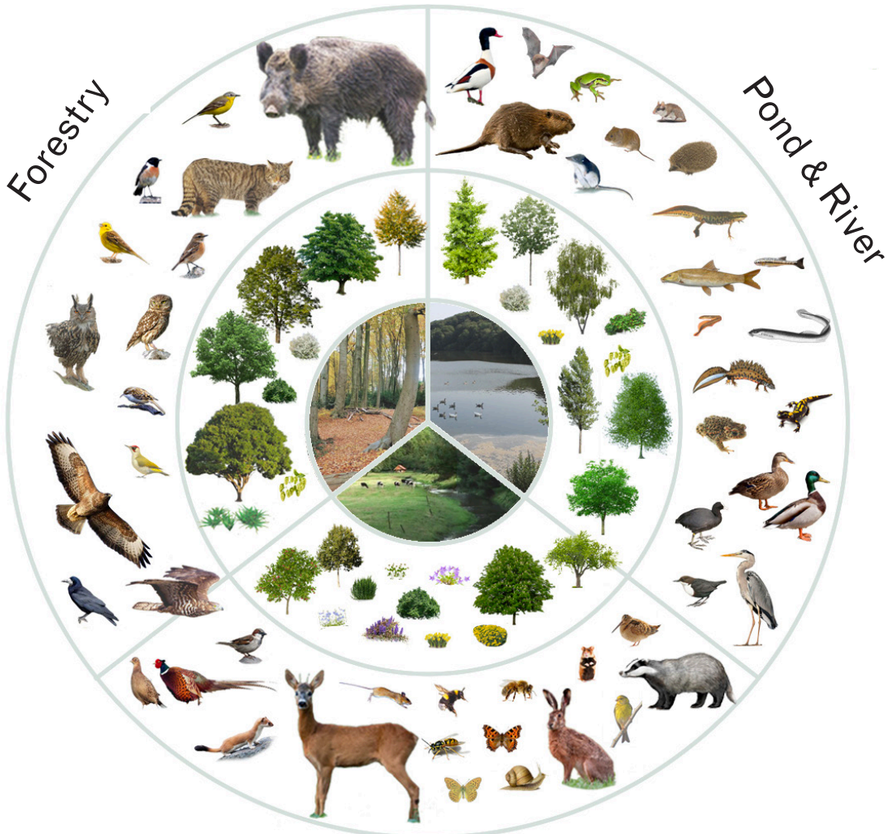
C - Polycentric



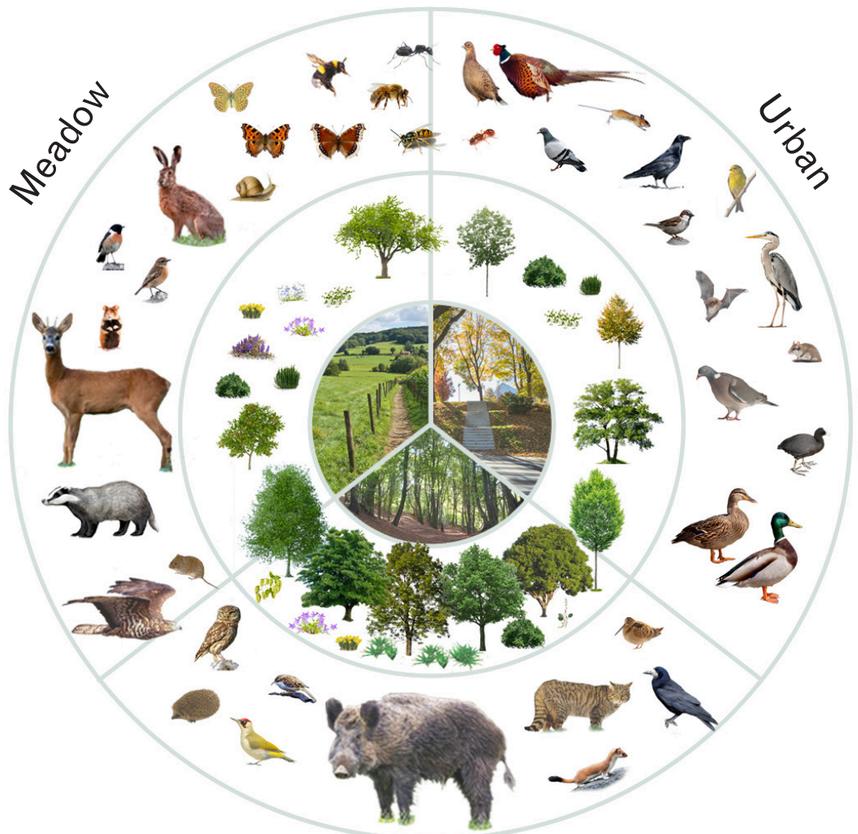
BIOTOPES



Plateaus



Valleys

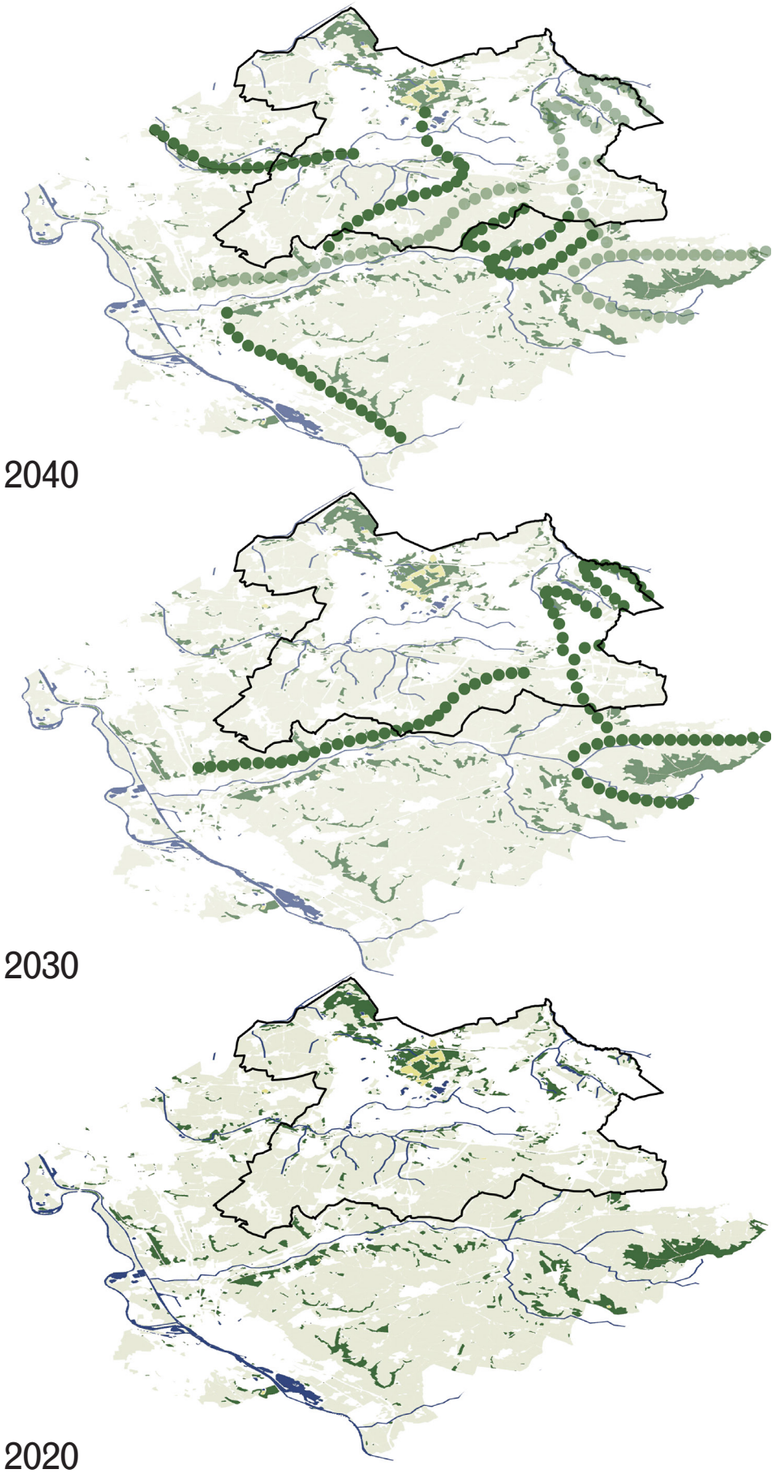


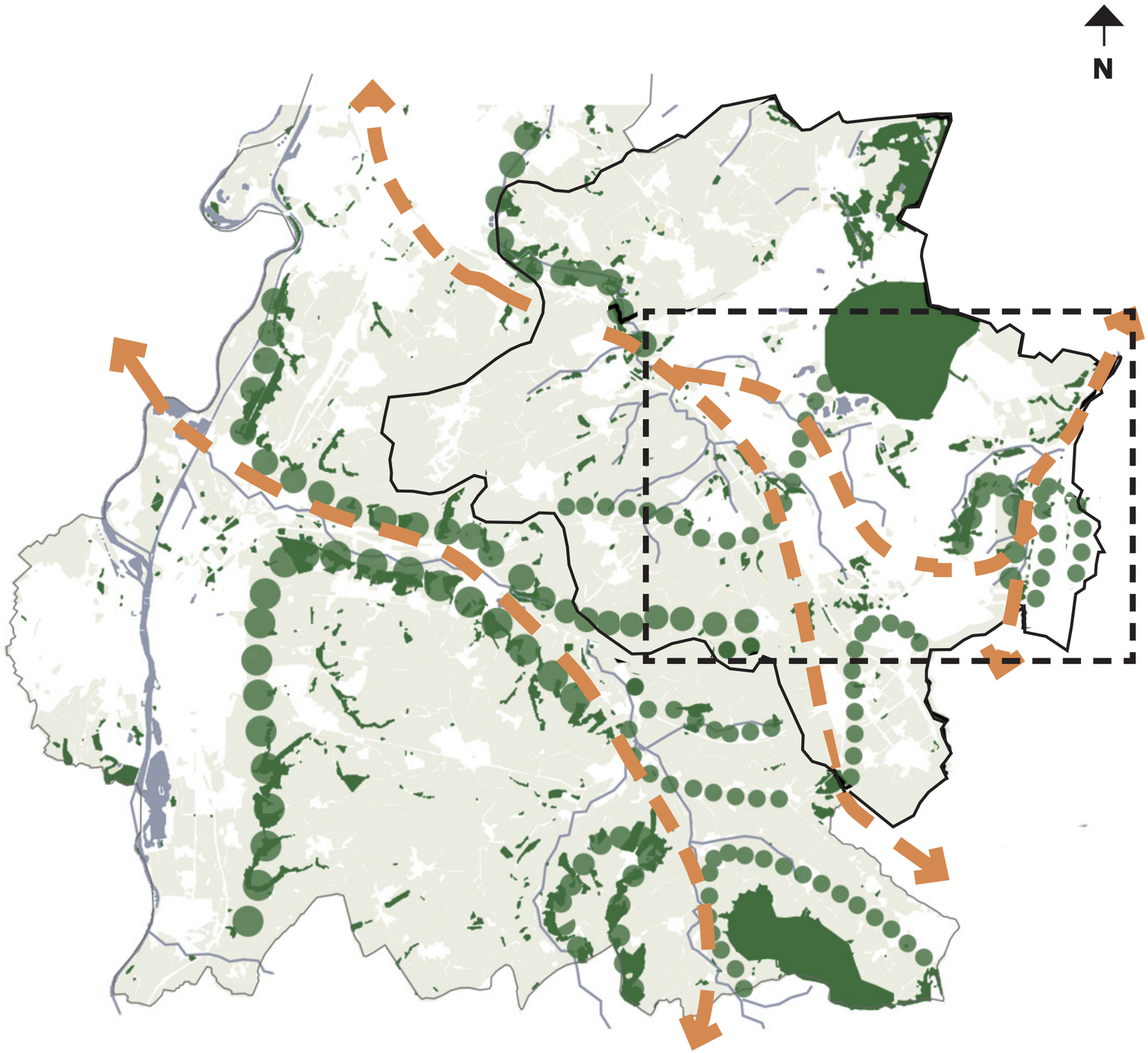
Ridges

5

VISION & PRINCIPLES

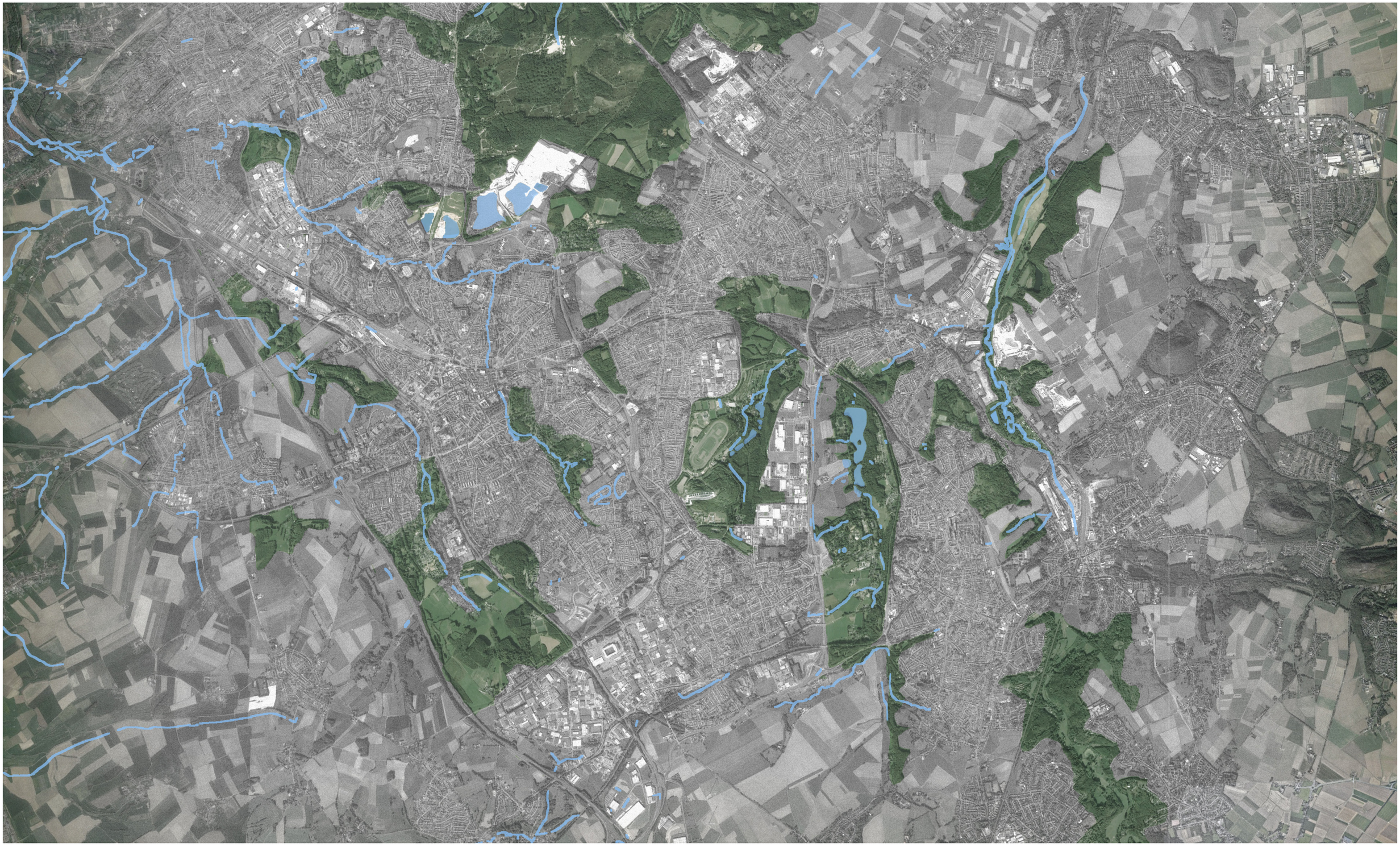
REGIONAL VISION





METROPOLITAN CONDITION

N



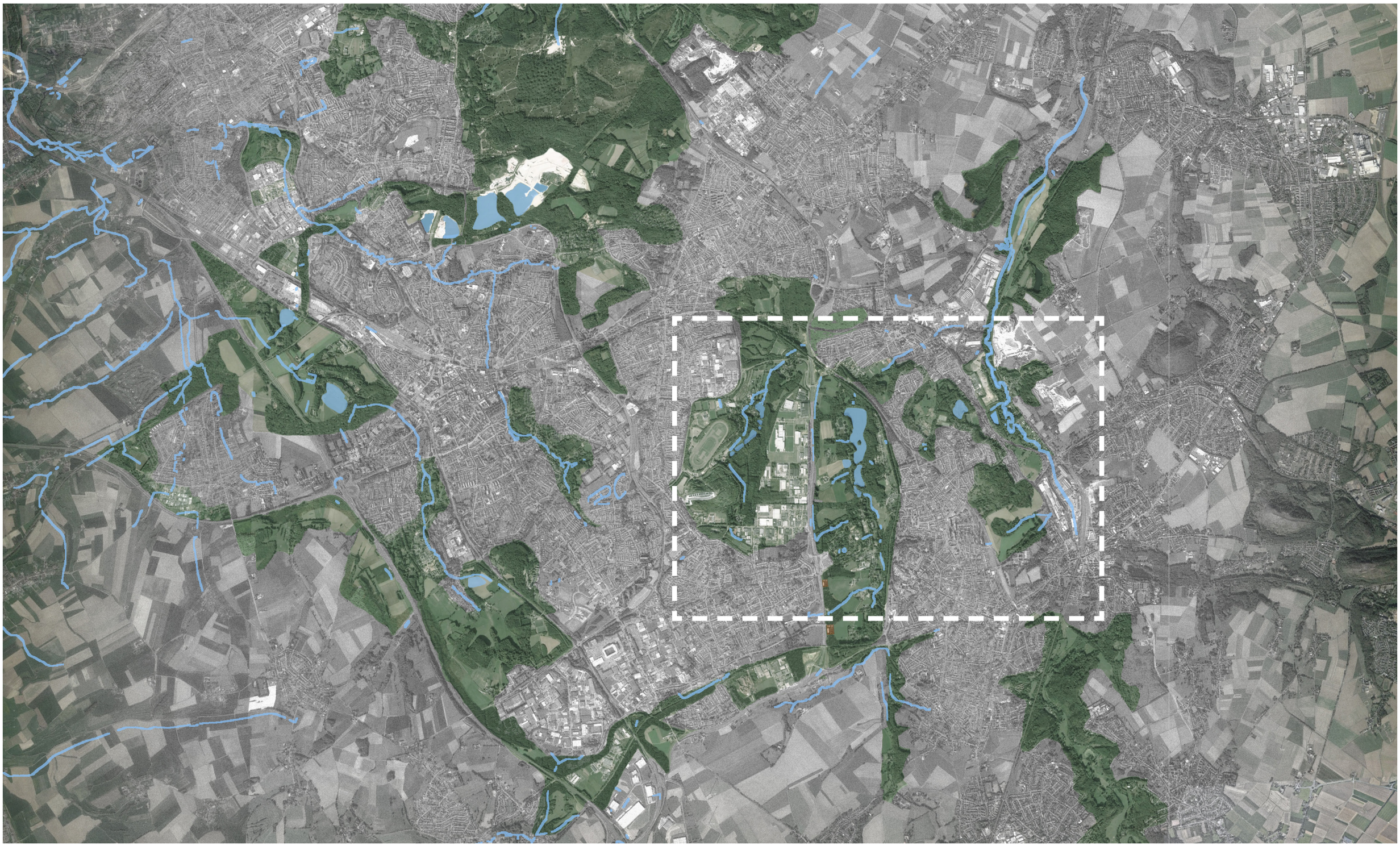
METROPOLITAN VISION - 2050

N

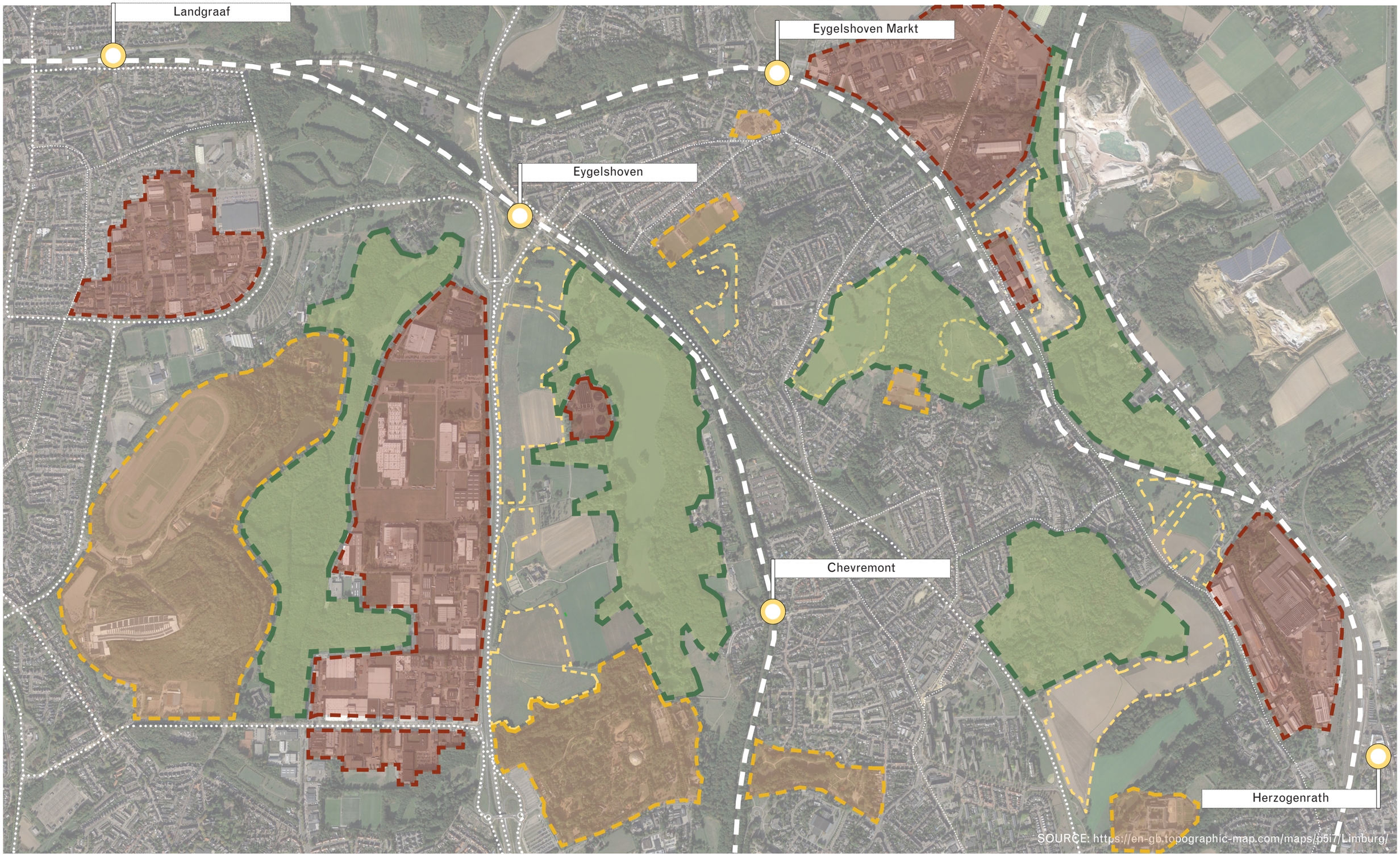


METROPOLITAN VISION - 2050

N

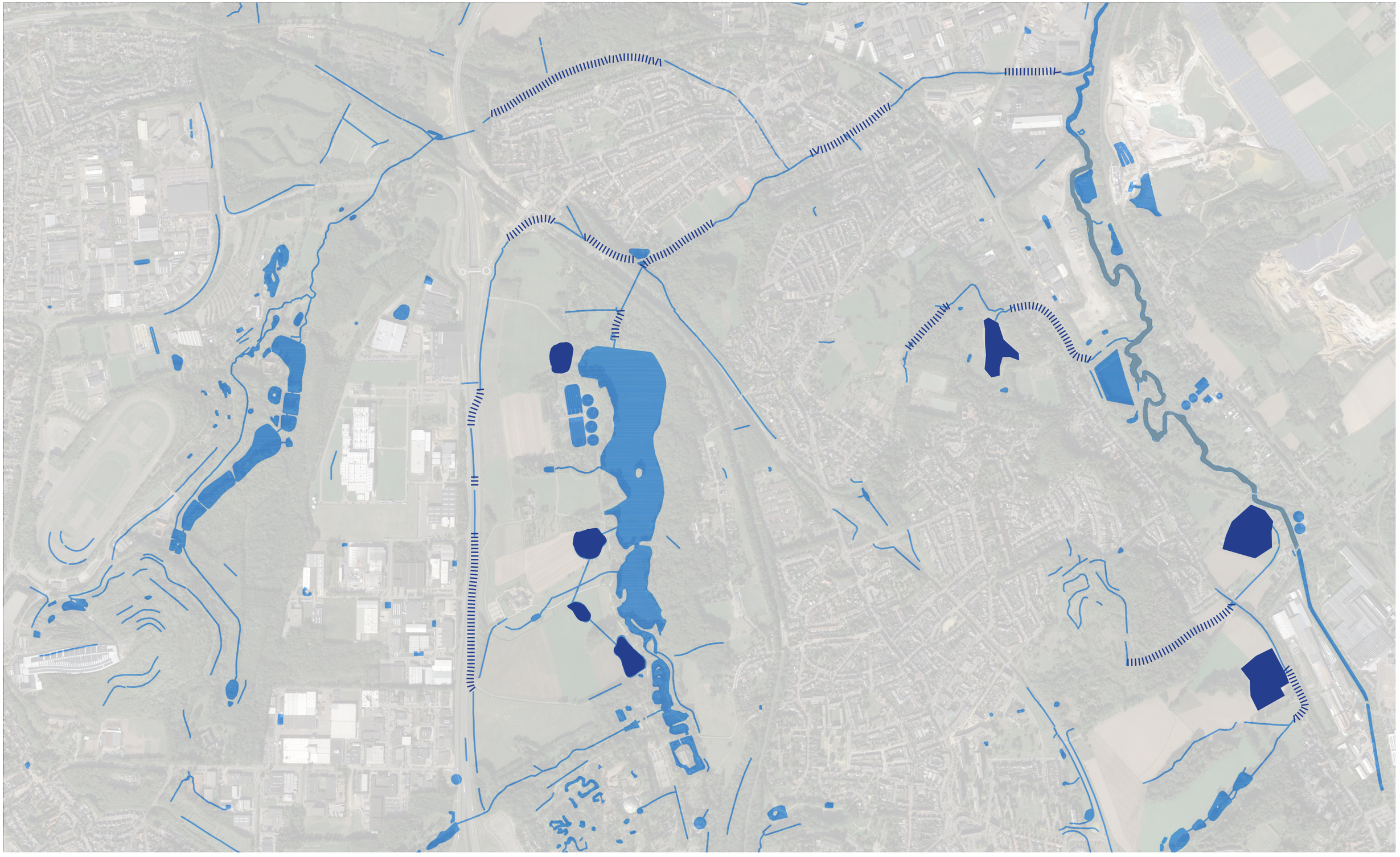


URBAN CONDITION



URBAN VISION - WATER SYSTEM

N

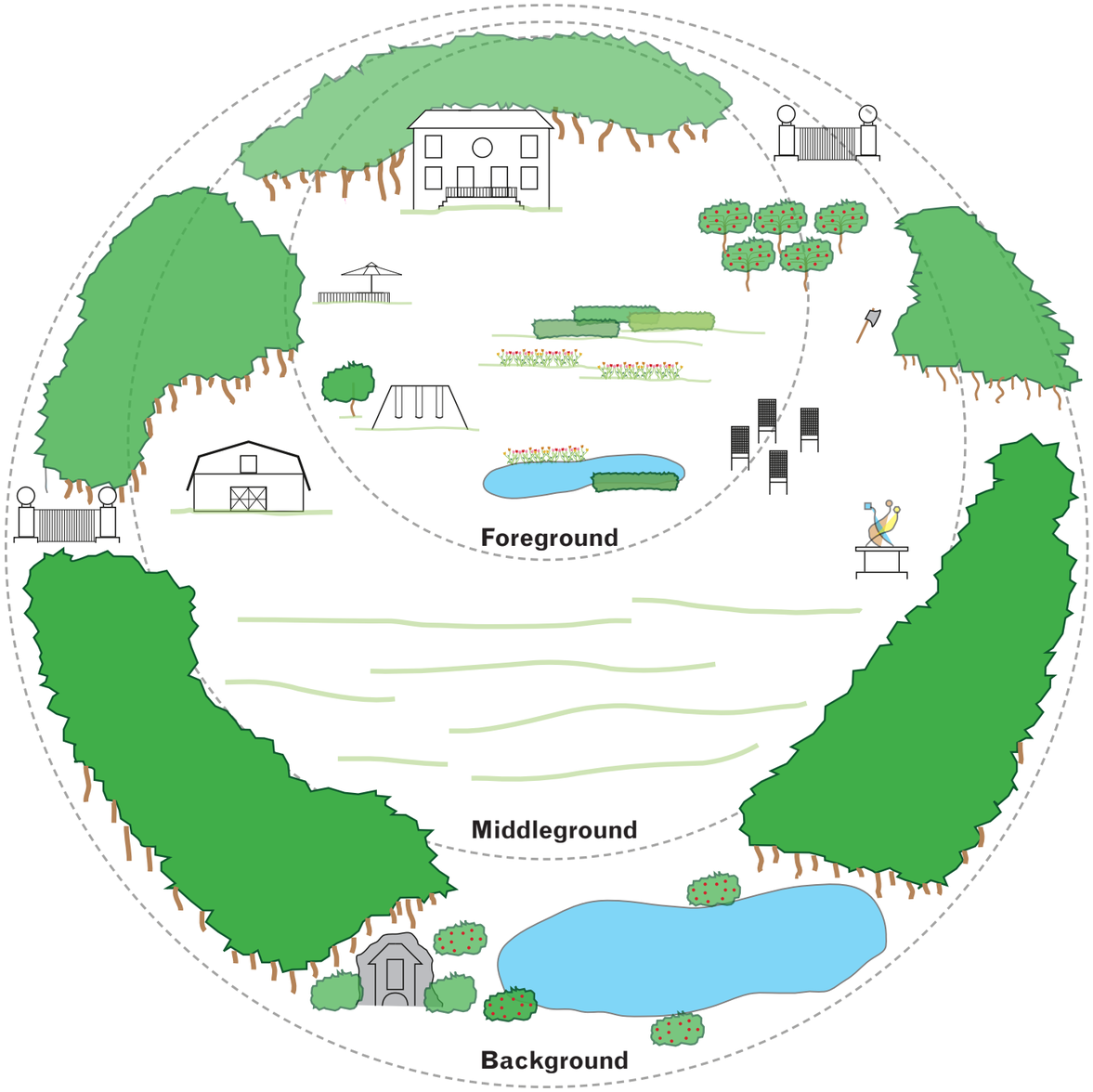


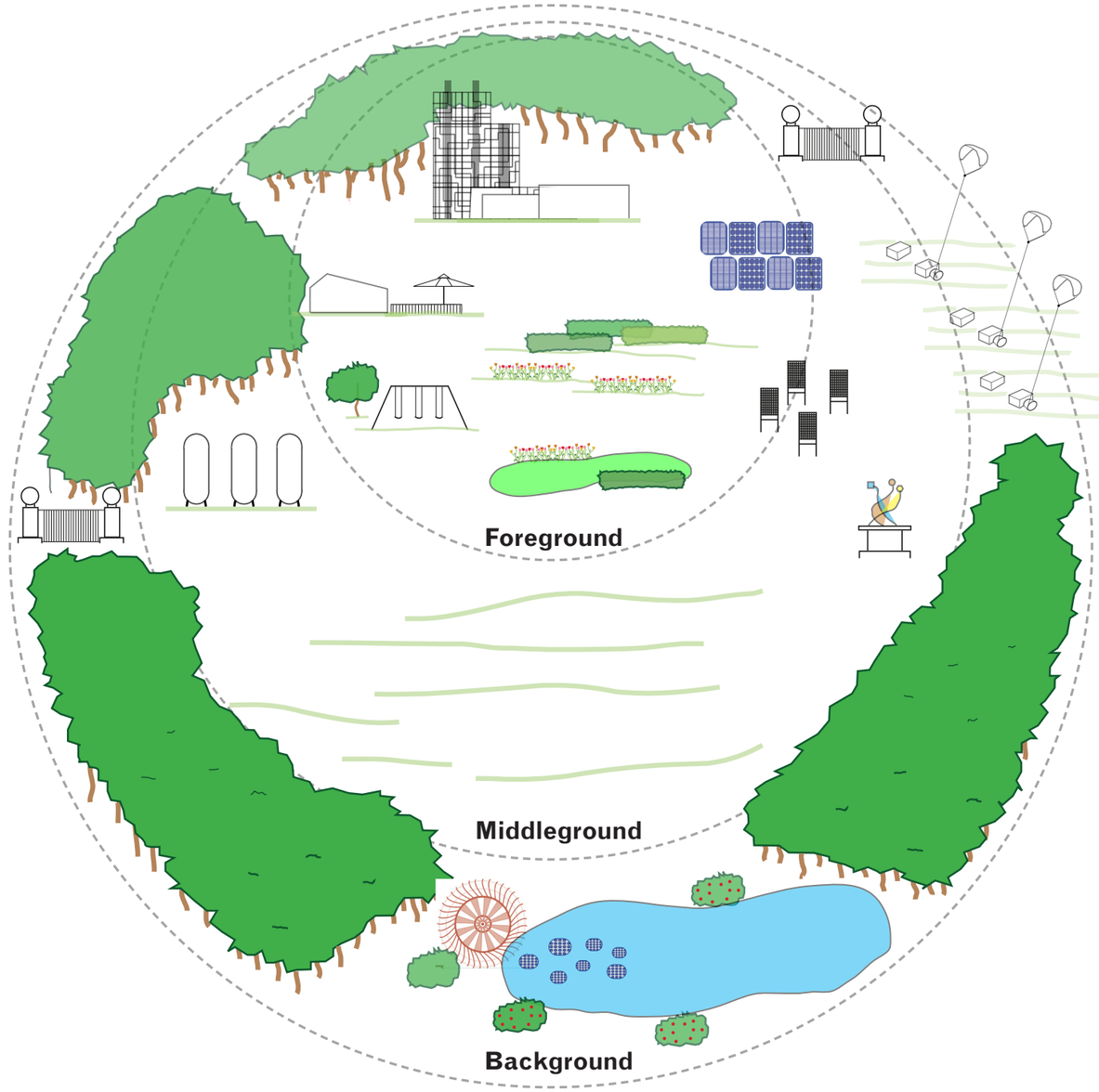
URBAN VISION - LEISURE, INDUSTRY AND ECOLOGY

N



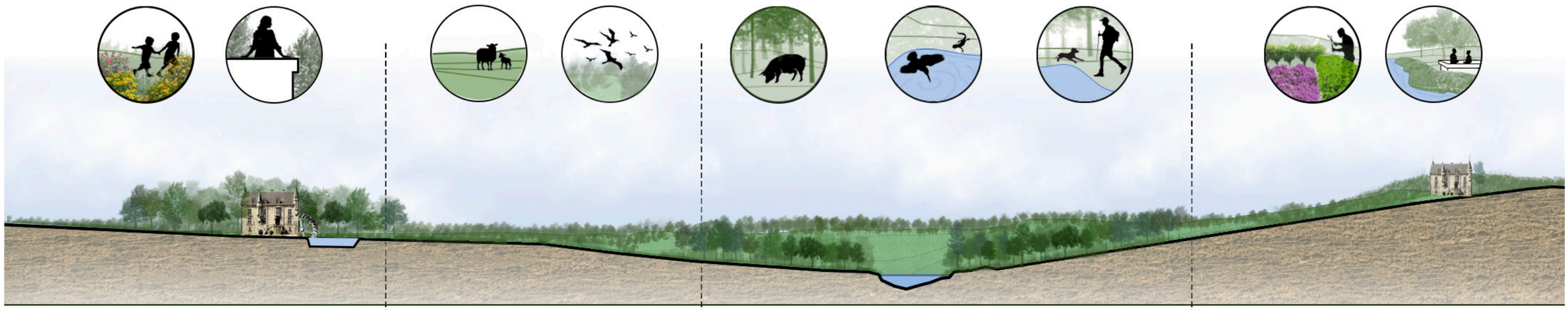
ENERGY ARTEFACTS IN THE LANDSCAPE





Traditional estate → **Carbon recycling estate**

CONCEPTUAL SECTION - CARBON ESTATE



Foreground

Estate and garden

Middleground

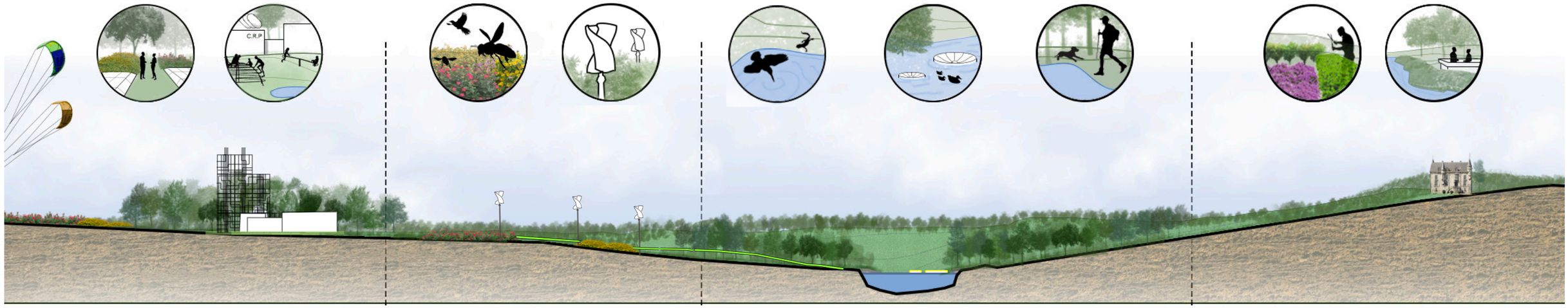
Open grassland

Background

River and forestry

Panorama

Further estate



Foreground

Carbon recycling plant
and energy playgrounds

Middleground

Flowery meadows and
savonius towers

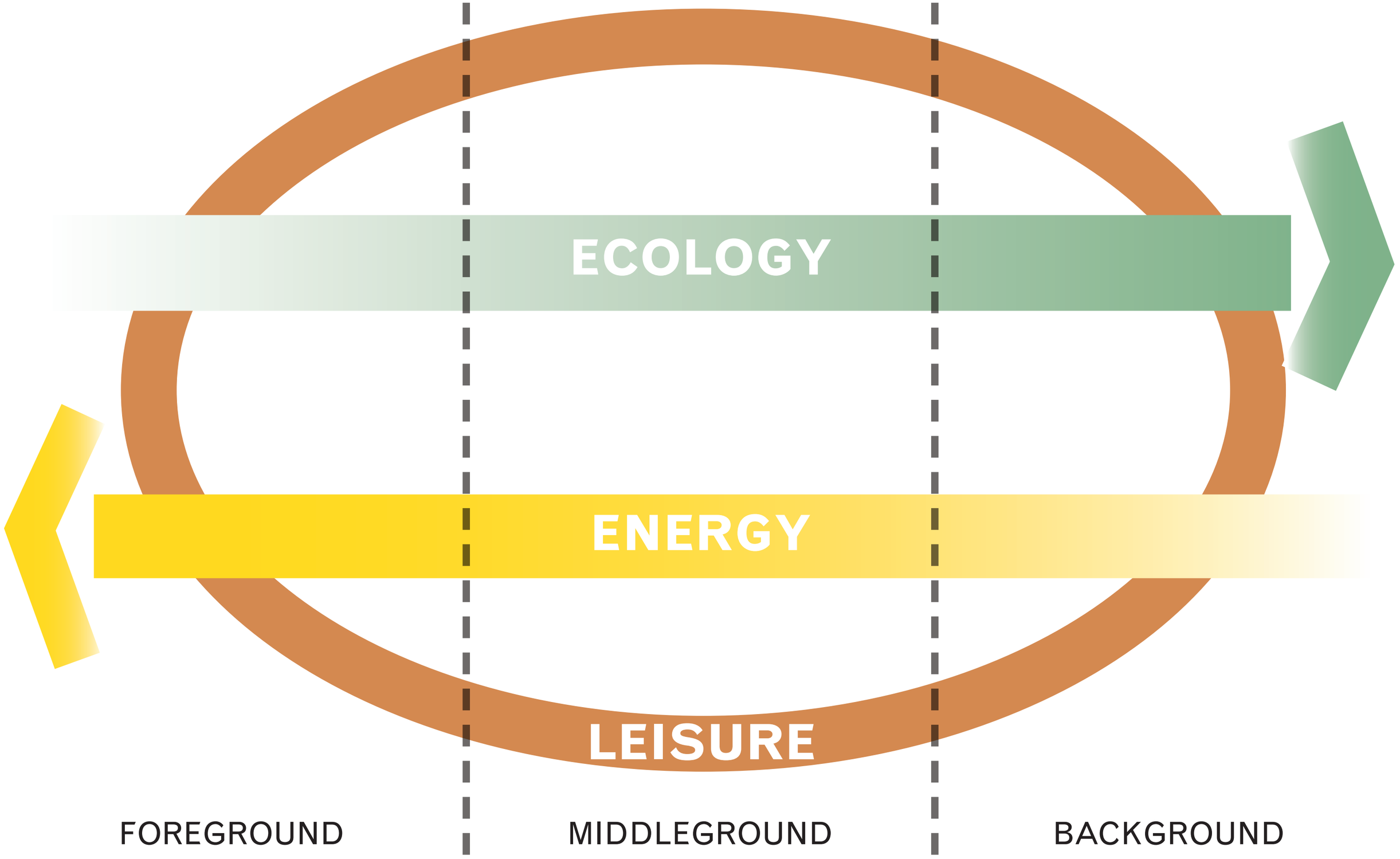
Background

Zodiac ponds and
Water lookouts

Panorama

Further estate

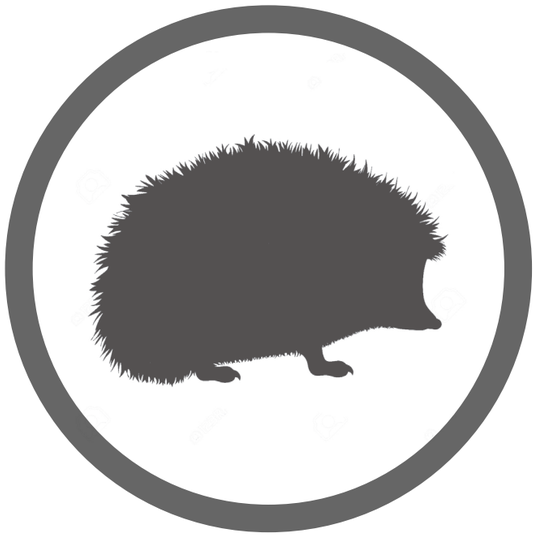
CARBON ESTATE LAND USE GRADIENT



INDICATOR SPECIES



FOREGROUND



MIDDLEGROUND



BACKGROUND

6 DESIGN

DESIGN AREA

N



CONCEPTUAL MASTERPLAN

N



Water tower lookout
Dancing kite generator
Overshot water mill
C.R.P.
C.R.P. visitor areas
Solar path
Existing grassland
Existing forest
Added forests
Flowerfields and wind meadows

SYNERGIES

Carbonplant
+ Algae pools

excess O2, H2O and heat to feed algae

Algae pools
+ Flowerbeds

excess fertilizer used for cultivation

Water lookout
+ Watermill

excess water over mill

Water lookout
+Solarponds

excess water collection

CONCEPTUAL MASTERPLAN

N



Water tower lookout
Dancing kite generator
Overshot water mill
C.R.P.
C.R.P. visitor areas
Solar path
Existing grassland
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Added forests
Flowerfields and wind meadows

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excess fertilizer used for cultivation

Water lookout
+ Watermill

excess water over mill

Water lookout
+Solarponds

excess water collection


N



FOREGROUND:

- **RECYCLED CO_2 :** 18.000tonnes/year
  = 1/17 Kerkrade emissions

- **BIOMETHANOL PRODUCED:** 15.000tonnes/year

- **ENERGY OBJECTS:**

  - ALGAE PONDS x4

  - RATIONAL SOLAR GARDEN - 96m^2

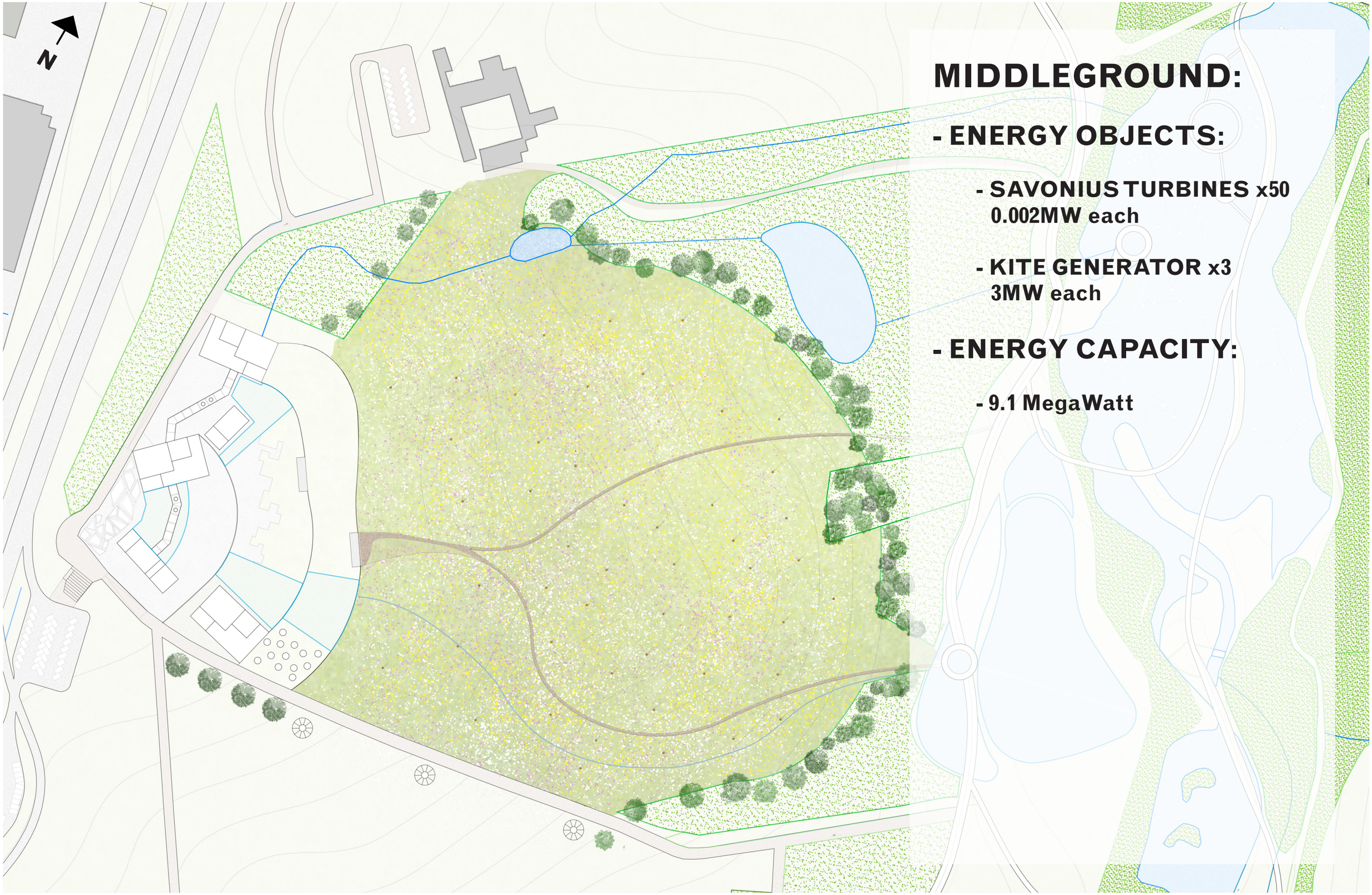
  - BIO REFINERY x1

  - CARBON RECYCLING PLANT x3

  - GAS TURBINE GENERATOR x1

- **ENERGY REQUIRED:** 15MW

- **ENERGY PRODUCED:** up to 110'009 MWh/year
  = 1/16 Kerkrade energy consumption



MIDDLEGROUND:

- ENERGY OBJECTS:

- SAVONIUS TURBINES x50
  0.002MW each

- KITE GENERATOR x3
  3MW each

- ENERGY CAPACITY:

- 9.1 MegaWatt

BACKGROUND:

- ENERGY OBJECTS:

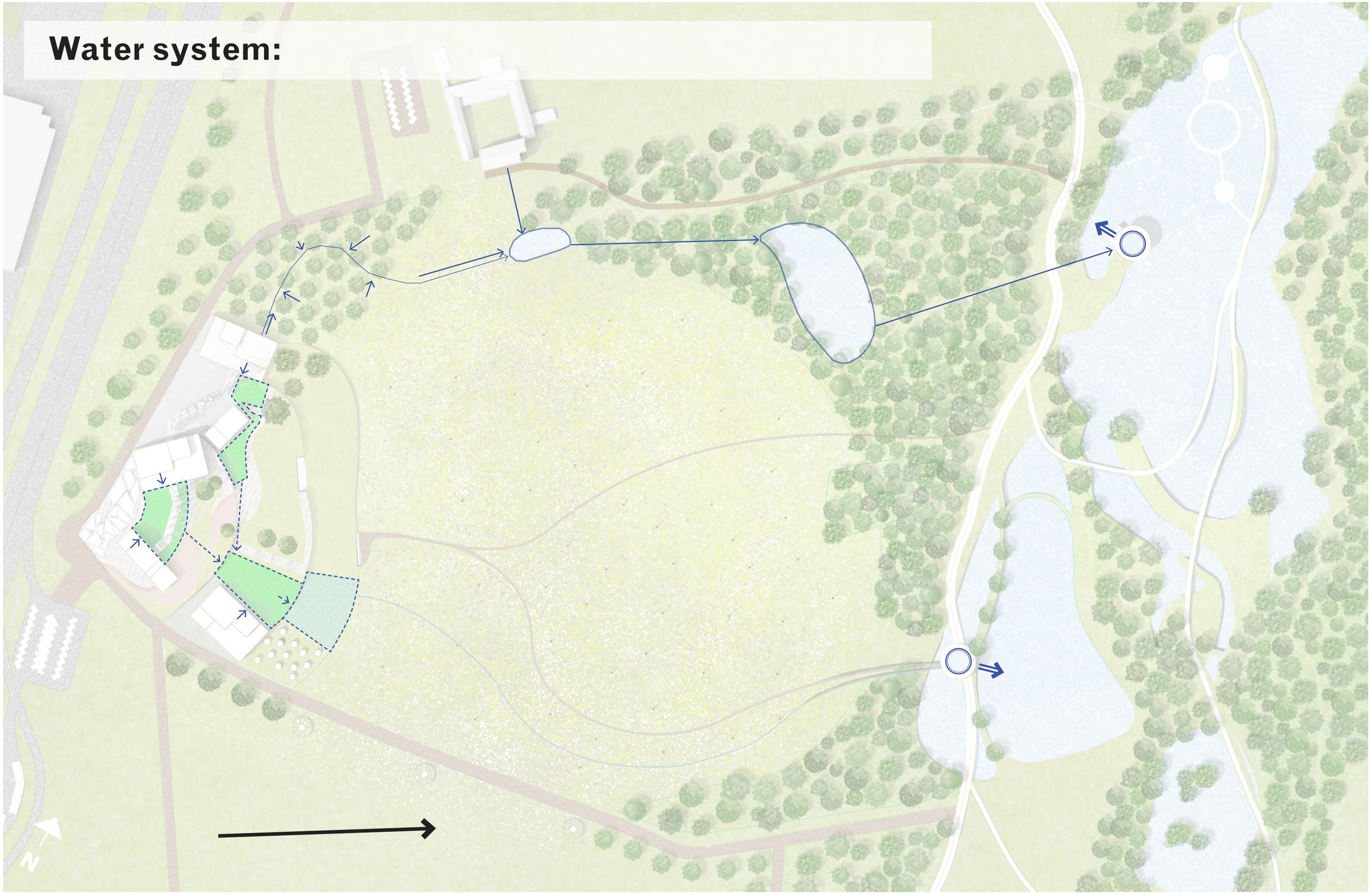
- WATERMILL x2
  2.5MW each

- SOLAR FLOATS x144
  0.02 to 0.04MW each

- ENERGY CAPACITY:

- 8 to 11 MegaWatt

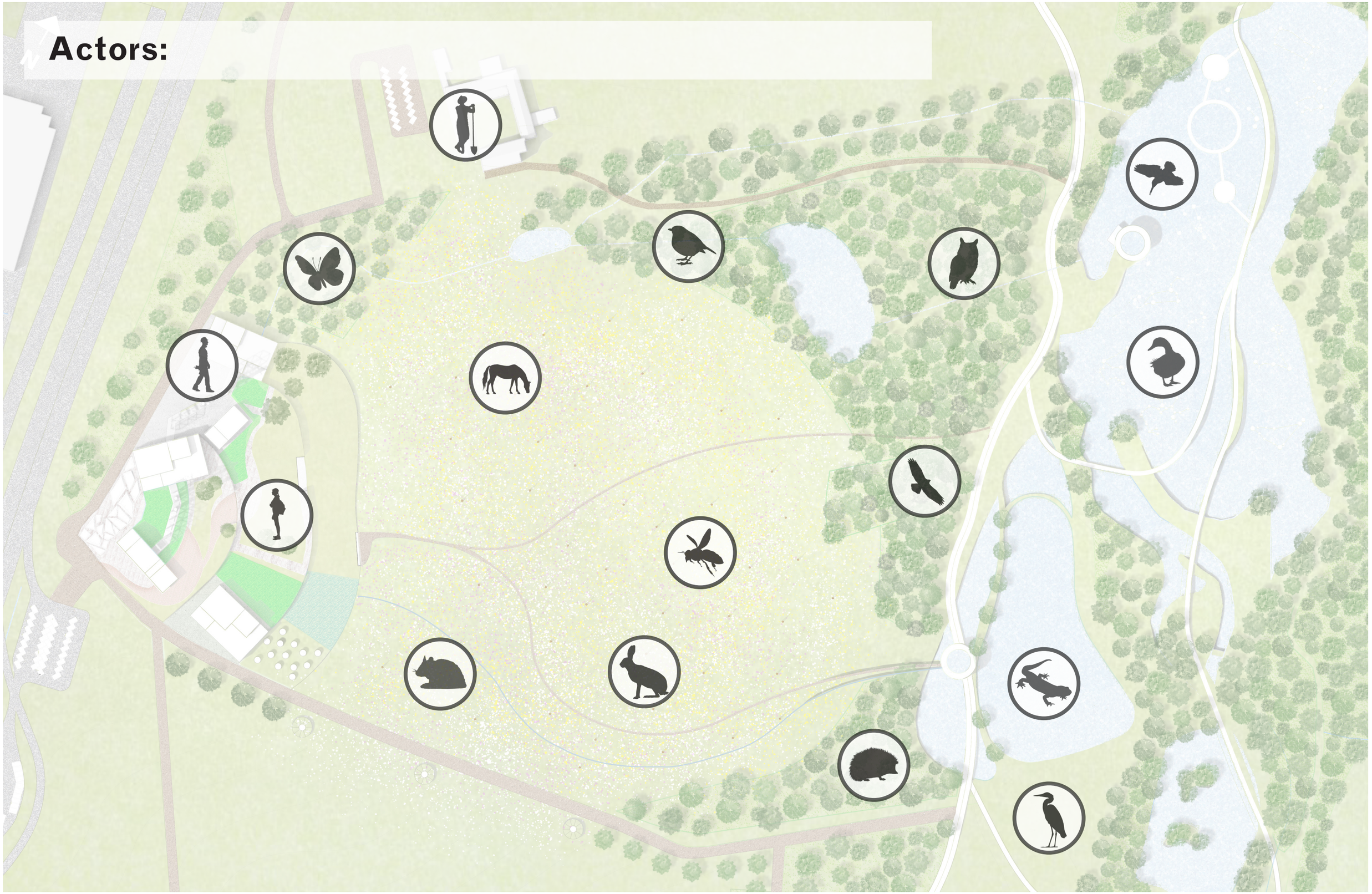
Water system:

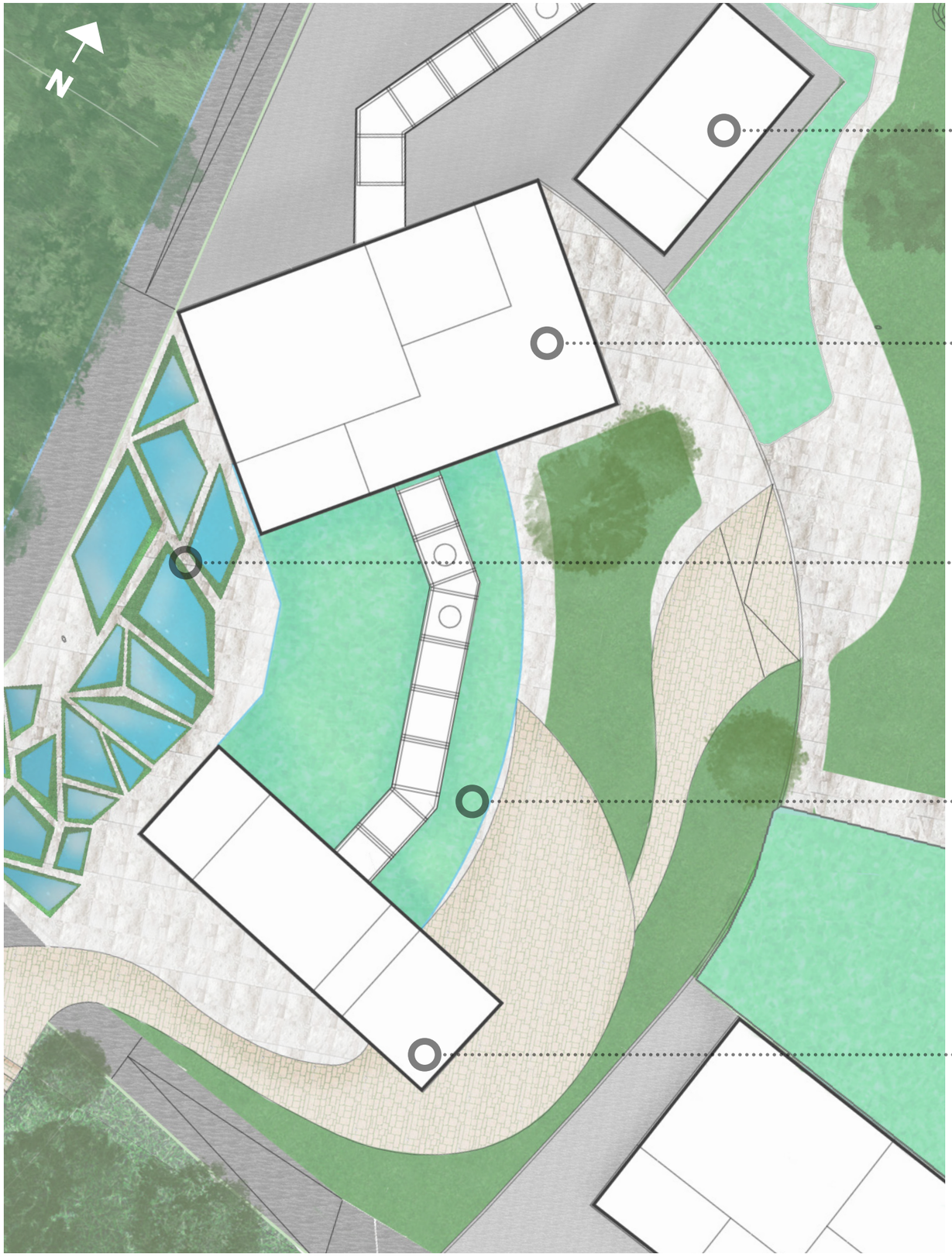


Routes and accessibility:



Actors:





BIOREFINERY

CARBON RECYCLING PLANT

RATIONAL SOLAR GARDEN

ALGAE POOL

HORECA AND INFOPOINT

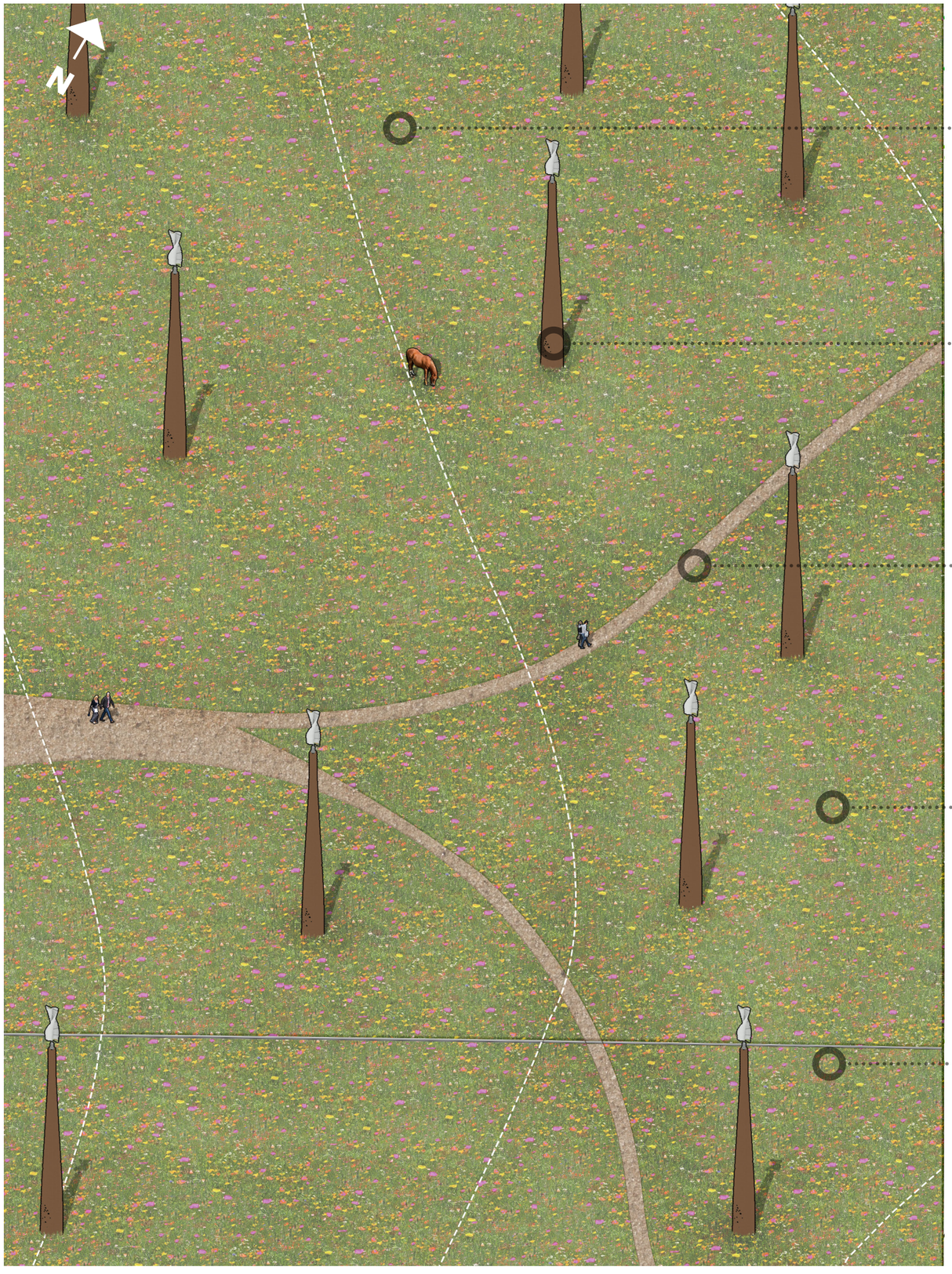

N
A
B

A - RATIONAL SOLAR GARDEN



B - DESCENDING TERRACES





FLOWERY MEADOW FOR HORSES' GRAZING

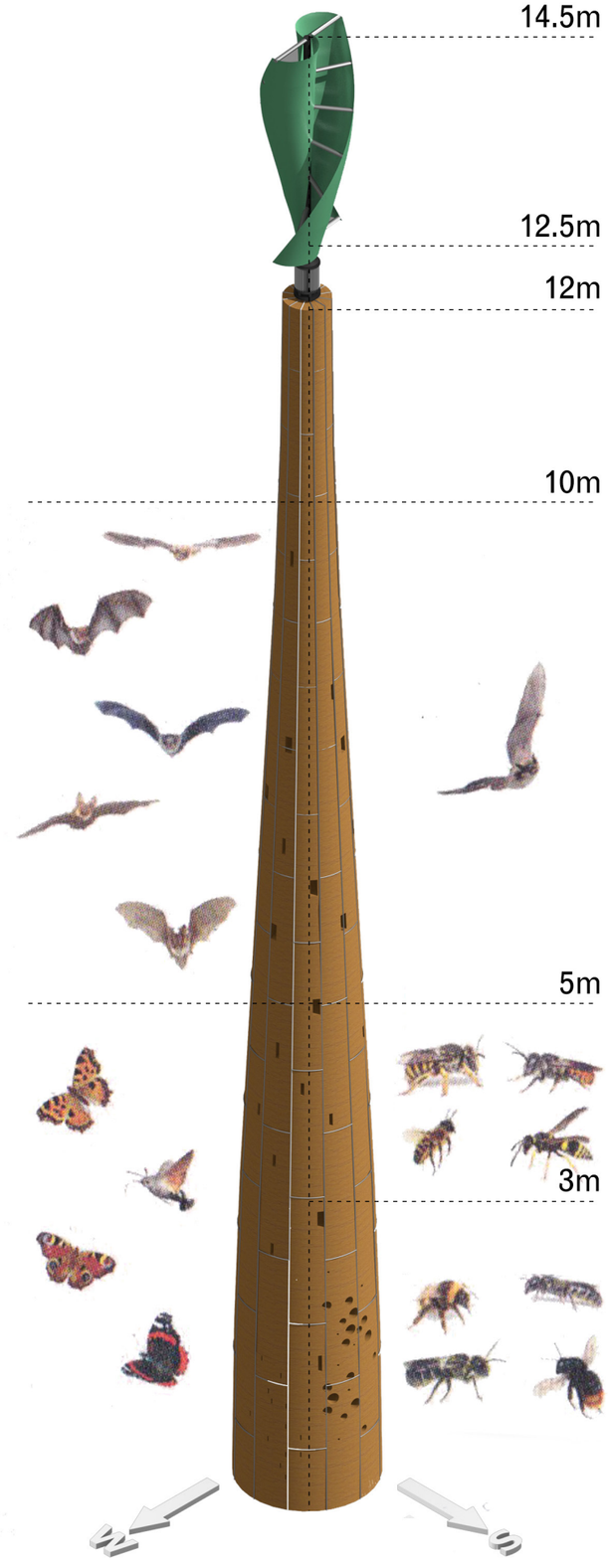
HELIX SAVONIUS TOWER + INSECT HOTELS

SANDY FOOTPATH

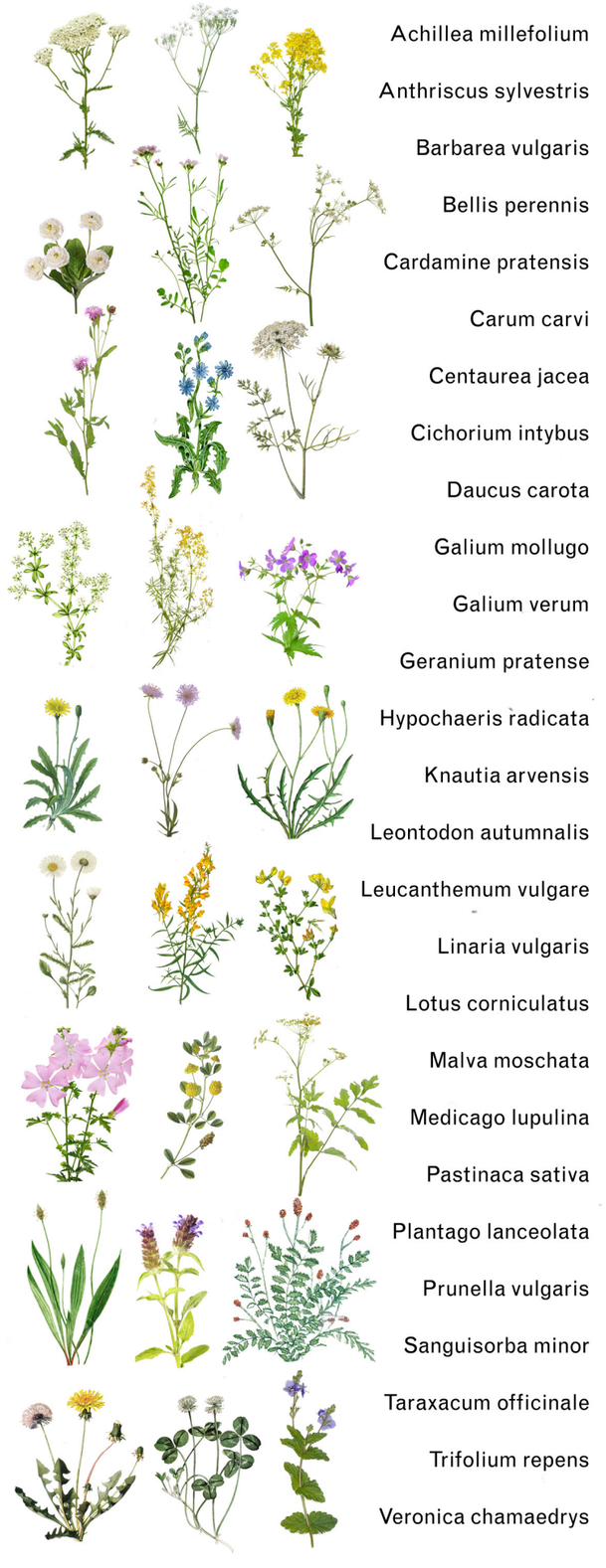
ANNUALLY MOWNED FLOWERY MEADOW

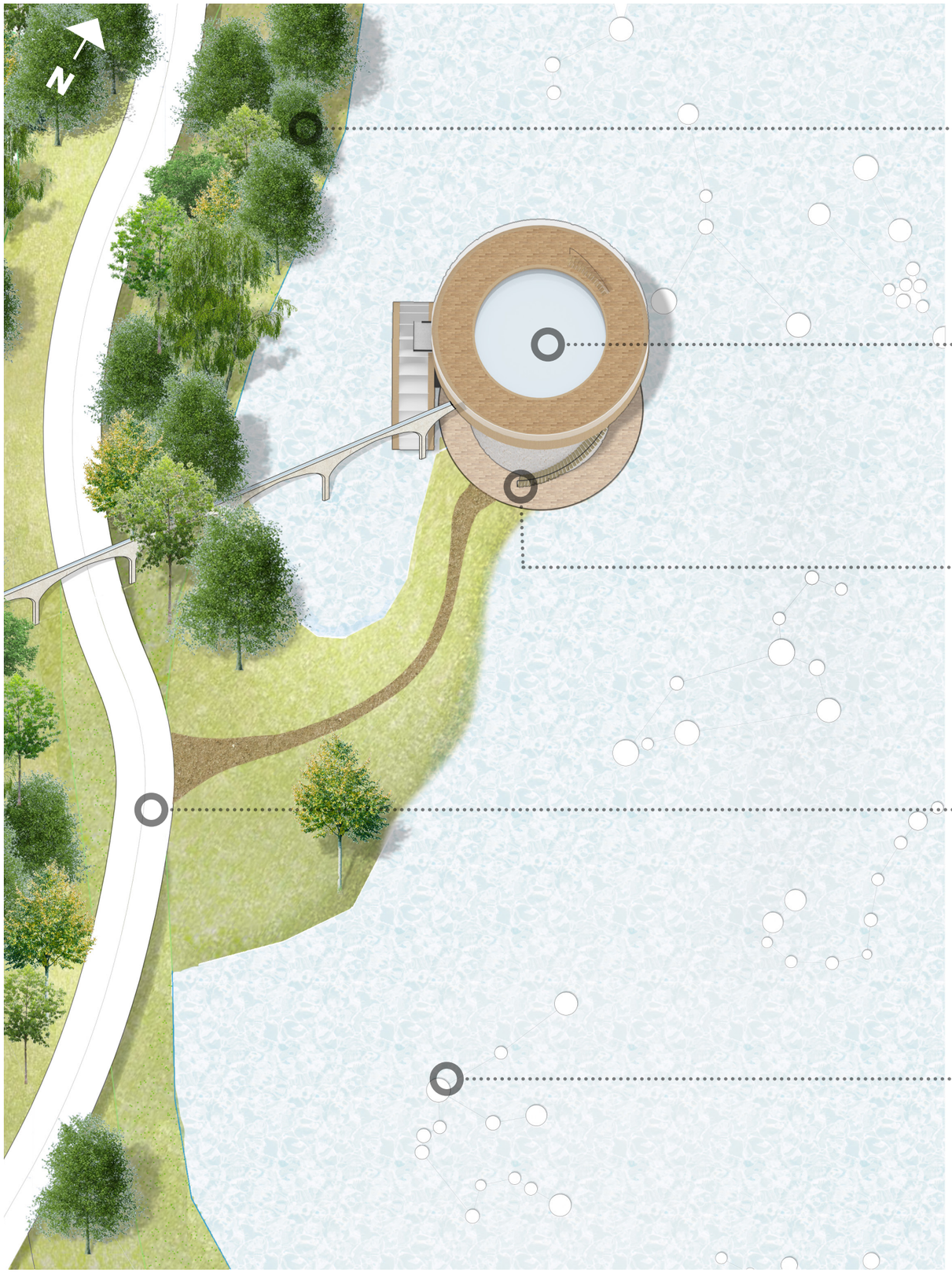
WATER COLLECTION





PLANTS PALETTE





ADDED FORESTRY

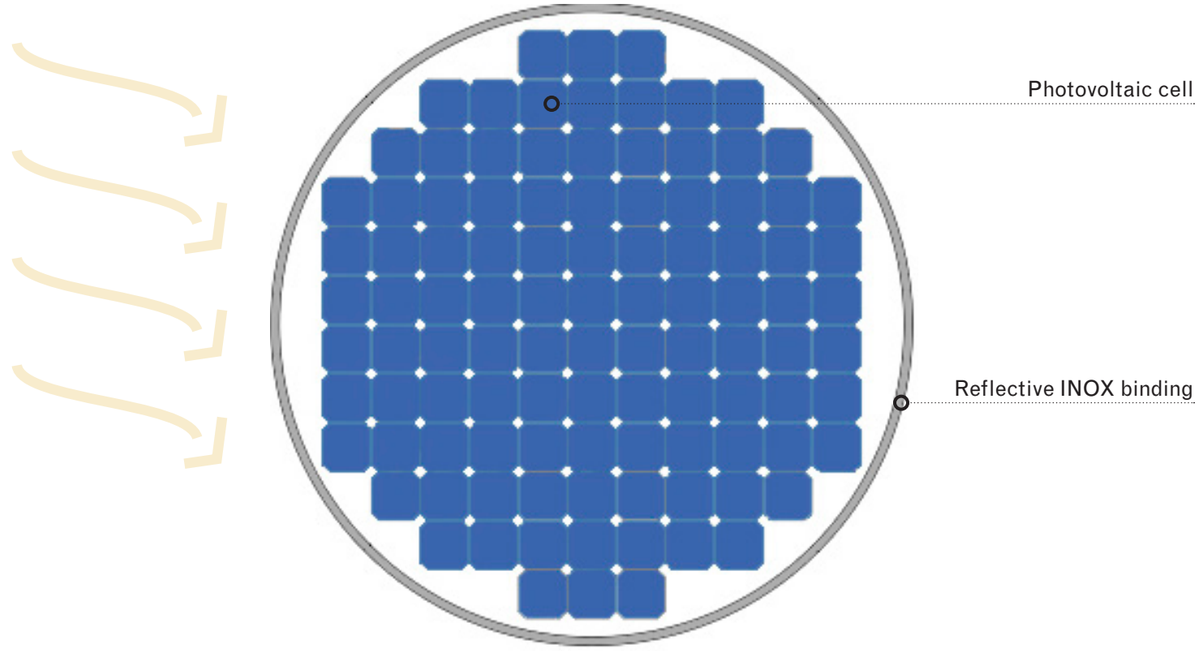
WATERMILL LOOKOUT

ACCESS TO LOOKOUT

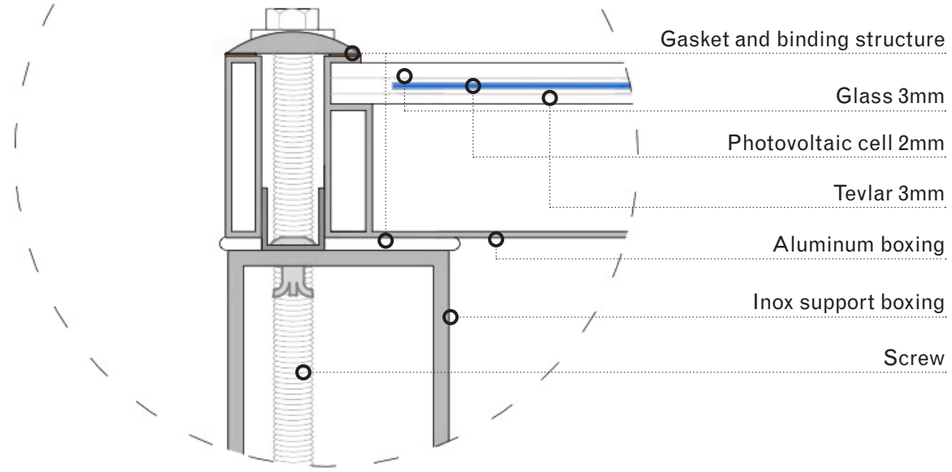
POWER PARK WATER ROUTE

SOLAR FLOATS

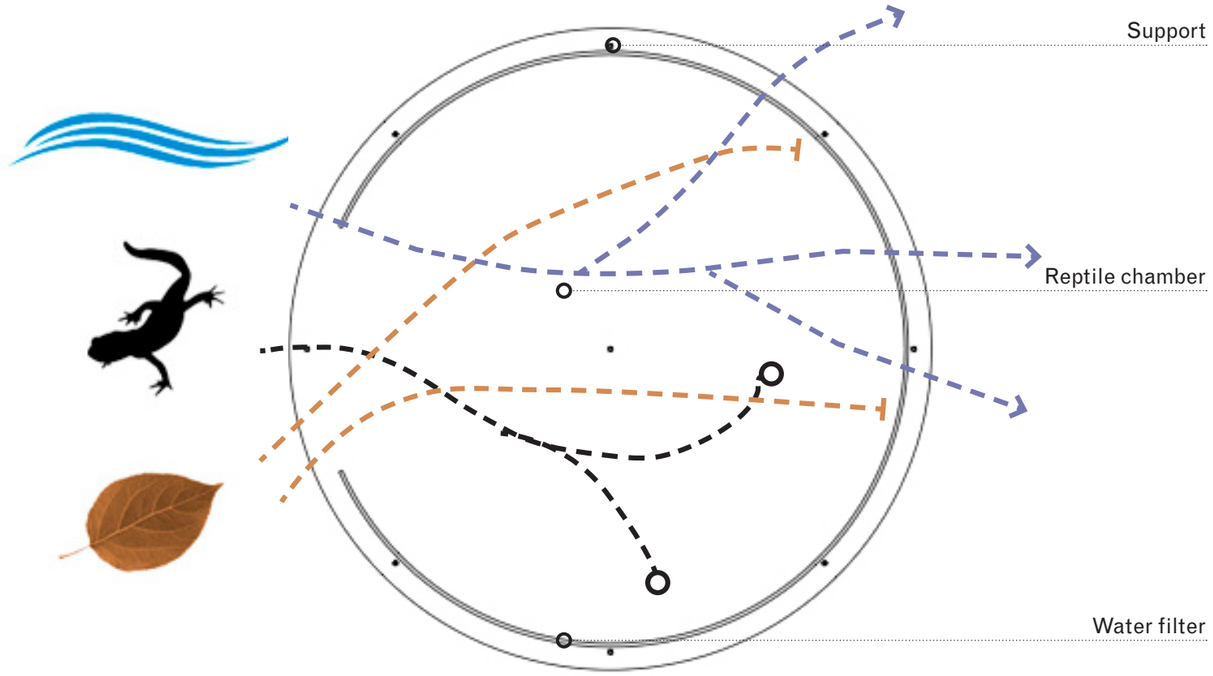




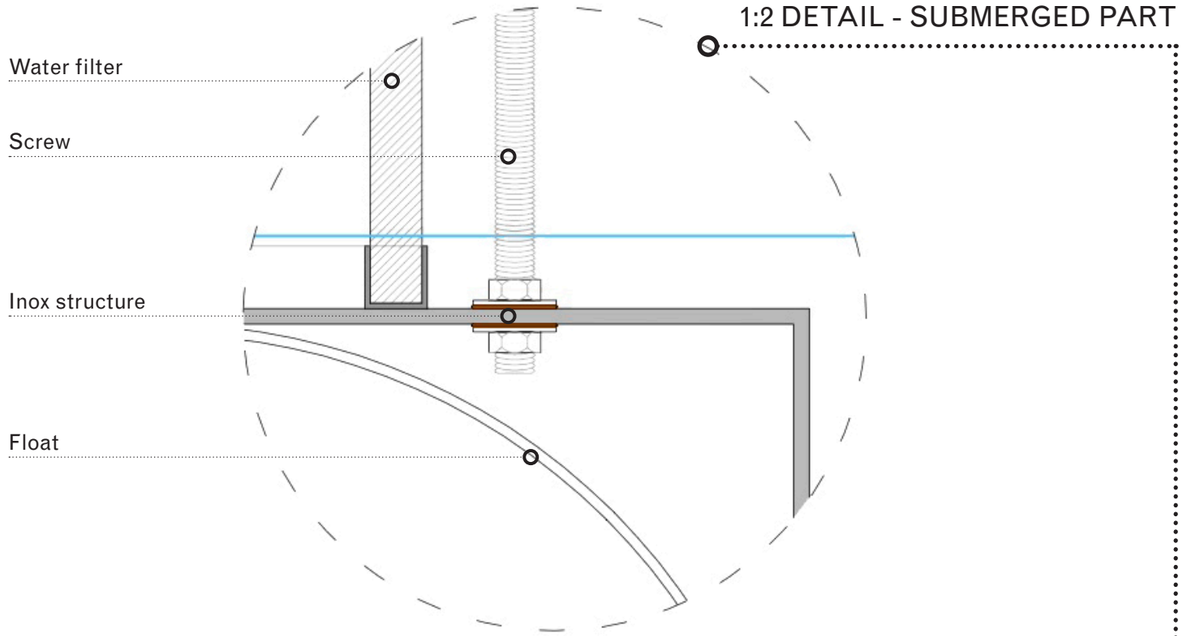
1:20 DETAIL - SOLAR PANEL

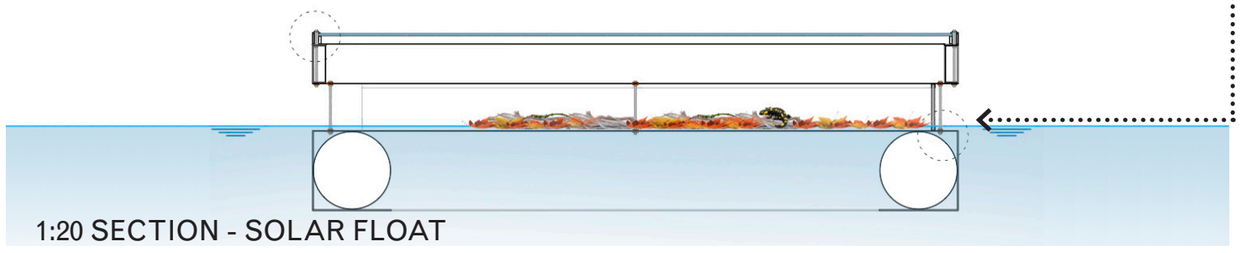






1:2 DETAIL - SUBMERGED PART





1:20 SECTION - SOLAR FLOAT

Bird-eye view of the carbon estate

