



## **2.SITE ATLAS**

21.The Po Valley Pianura Padana

Each year, millions of migratory birds follow the river system, using its directionality as a guideline between Northern Europe and the Mediterranean, Africa, and beyond. Yet the same geography that facilitates movement also creates vulnerability. The plain is dominated by agricultural fields, industrial clusters, and dense infrastructures.

"Map 1.11. Po Valley 1:500000 Infrastructure Map" on page 28, presents the central Po Valley as a territory shaped by strong contrasts.

To the north, Milan and its metropolitan satellites form a dense and highly connected infrastructural-urban system.

To the south, the Via Emilia corridor establishes another linear concentration of settlements and mobility.

Between these two high-intensity systems lies a visibly weaker zone, where settlement density decreases, infrastructural hierarchy becomes fragmented, and territorial connectivity shows a lower degree of cohesion.

Within this field, the Piacenza–Cremona segment does not behave as a corridor but rather as a perforated stretch — a zone that infrastructures cross without generating stable accumulation or

consolidation.

The Caorso nuclear site is positioned inside this diluted interstitial territory.

Its centrality is only cartographic: the plant occupies a low-density area shaped by long-standing agricultural use, limited urban expansion, and relatively low infrastructural anchoring.

This condition has been reinforced since 2013, when direct passenger rail service between Piacenza and Cremona was discontinued, leaving only freight-based operations — infrastructure designed for logistics rather than everyday regional life.

From a technical planning perspective, Caorso's location is rational: it offers access to the Po River for cooling, compatible geological conditions, and proximity to high-voltage transmission lines, all positioned at a safe distance from dense urban fabric.

However, this technically rational placement also reveals a deeper territorial condition: sites selected for large-scale infrastructure tend to coincide with areas where development pressure is weak and where socio-spatial consolidation has been limited.

In this sense, Caorso is not an anomaly within the landscape but a crystallization of a broader territorial logic

The "Map 11.2.Po Valley 1:500000 Green Infrastructure" on page 30 opposite highlights this contradiction. The green areas overlap with the Natura 2000 layer, which indicates regions registered for biodiversity. It is important to note that the areas covered by the Natura 2000 layer and the geoportal layers related to natural reserves and vegetation are smaller compared to the overall green areas. The River Po is still legible as a ribbon of green, but its continuity is fractured by agriculture and infrastructure.

The "Map 11.3.Po Valley 1:500000 Birds movement" on page 32 contains a layer of the birds' movement. Each year, millions of birds migrate along atmospheric corridors that parallel the general orientation of the Po River corridor. These routes connect Northern Europe to the Mediterranean and further to Africa. The valley operates as a continuous passage between two domains: the terrestrial system of soil and water, and the aerial system of circulation and flight.

Within this system, Caorso functions as a fixed reference point - a vertical structure in a landscape.

The "Map 11.3.Po Valley 1:500000 Birds movement" on page 32 records these movements of birds as an ecological infrastructure. Re-imagining through environmental design, this airspace becomes a shared territory in which species, structures, and atmospheric processes interact. As the ground is increasingly fragmented by human production, the aerial layer remains the last continuous landscape.

For many species, the distance between safe habitats is already at the threshold of what they can cross. Birds arrive exhausted and need to find food and shelter before attempting the Alpine arc. Without sufficient stopovers, the valley becomes less a corridor and more a barrier.

In this context, sites like Caorso become crucial. It lies directly along the migratory axis. If re-imagined as ecological refuges, they can help stitch together the grid, transforming the Po Valley from a fragmented bottleneck into a living bridge for bird migration.



## Po Valley 1:500000 Infrastructure Map

This map shows the central Po Valley as a dense network of infrastructures, settlements, and agricultural land. Three major structural conditions are immediately visible:

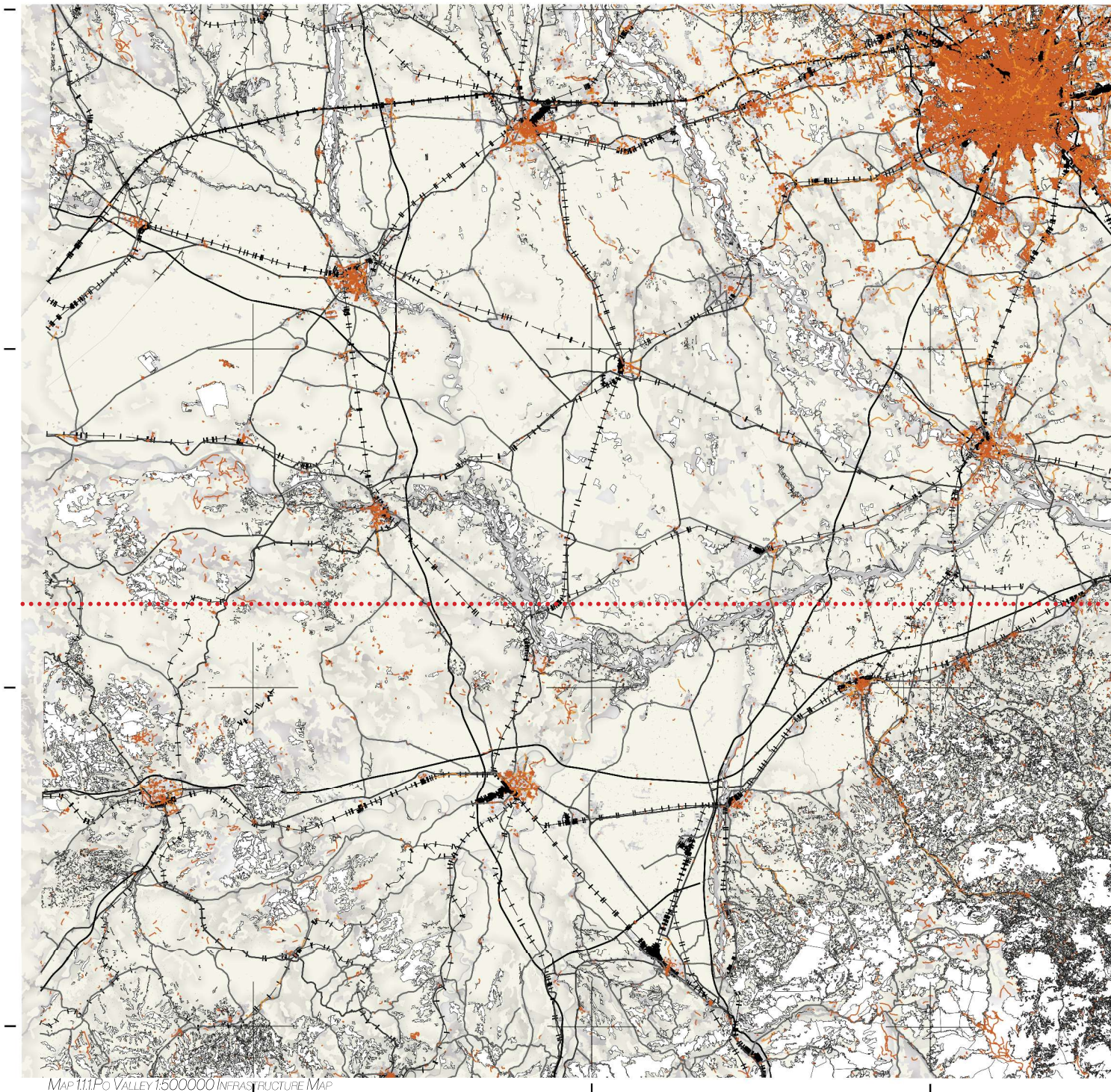
### 1. High-intensity urban clusters

In the north, the large orange mass represents Milan and its metropolitan settlements, forming a dense and highly connected urban system.

Other orange clusters mark medium-sized cities such as Brescia, Bergamo, Cremona, Parma, Reggio Emilia, and Modena.











These areas show concentrated development and strong infrastructural anchoring.

*Map produced in QGIS using regional Geoportale and landcopernicus.eu datasets. Data are official; visual representation and color classification were developed by the author.*





### Legends

- Boundary Protected Area I Transportation 
- Slow Mobility
  - Cycleway 
  - Pedestrian 
- Fast Mobility
  - Motorway 
  - Primary 
  - Secondary 
  - Railway-Line 
- Base Map
  - building-polygon 
  - water-polygon 
  - Agricultural Land 



WGS 84 / UTM zone 32N

In the (map1:1.2.)Are geoportals layers that identifies the main land morphologies - River, Natural Reserves, and Vegetation - which is defining the physical structure of the Po Valley.

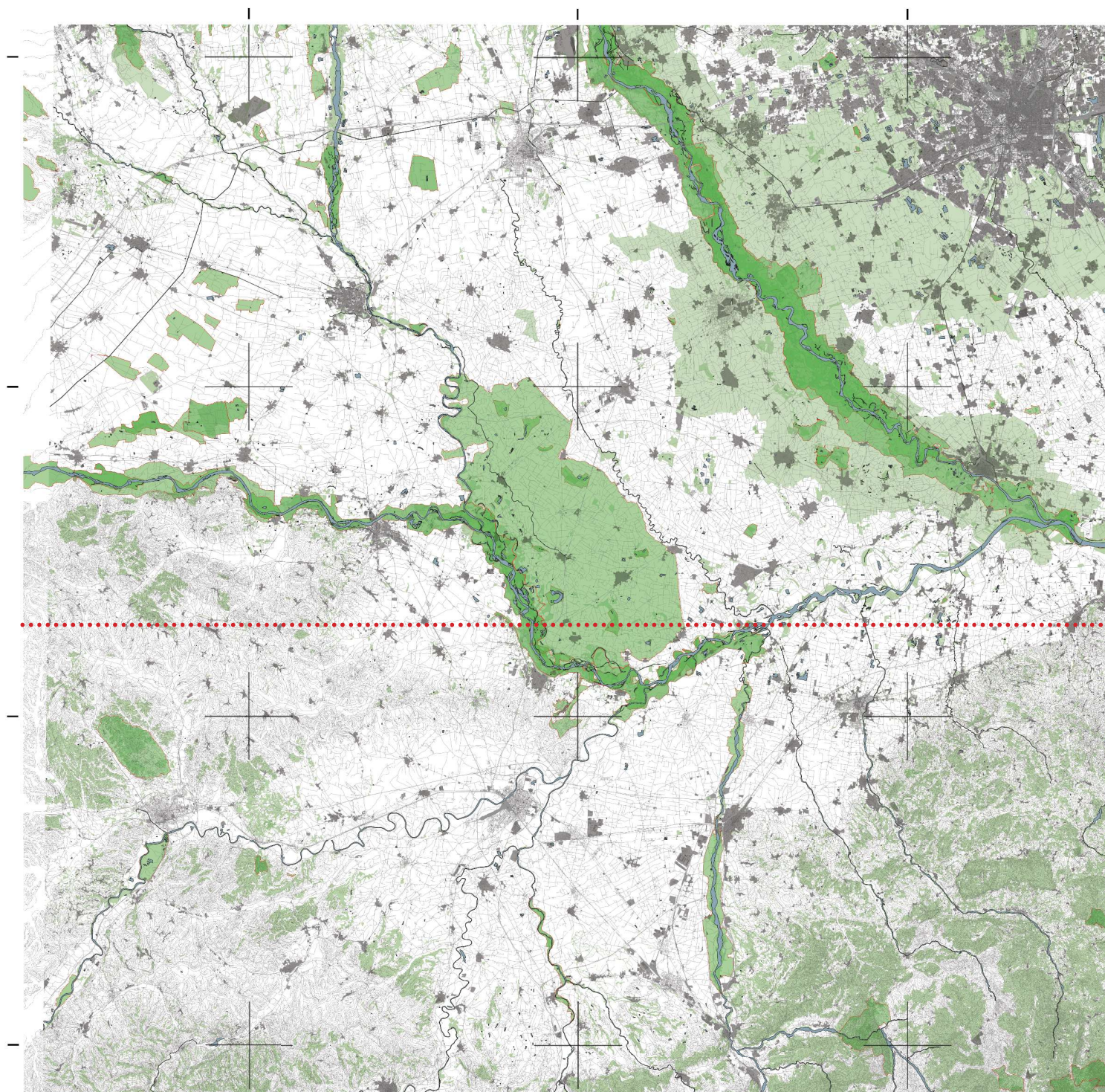
Natura 2000 layer reveals areas officially recognized for their biodiversity and ecological value. The overlap between these datasets is essential: it allows identifying zones where natural morphology already supports or could regenerate ecological functions, aligning with existing conservation priorities.

Why Natura 2000 is Important.

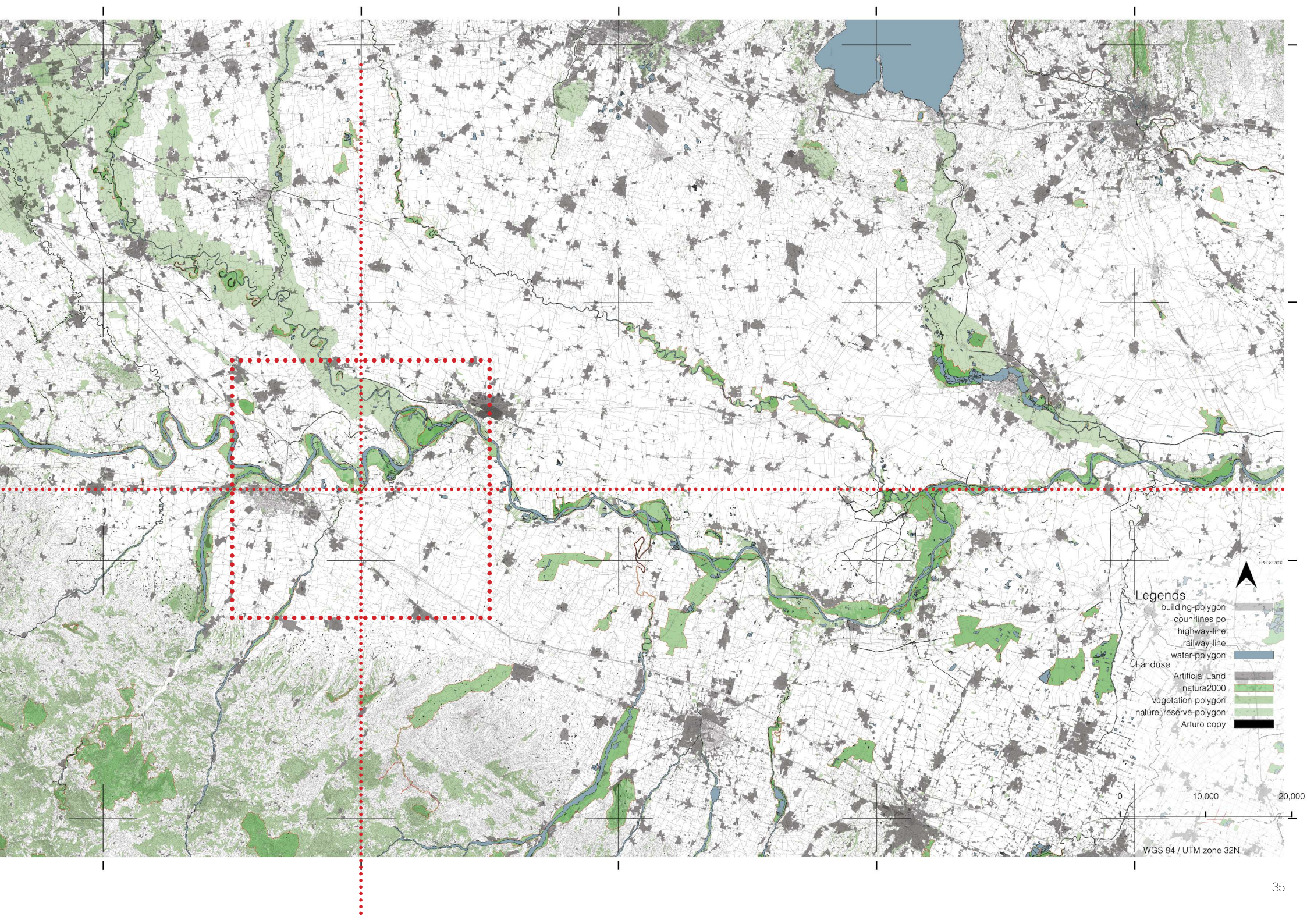
Natura 2000 is the European ecological network established under the Birds Directive (1979) and Habitats Directive (1992).

It protects areas that host species and ecosystems of community importance - many of them threatened, rare, or endemic.

*Map produced in QGIS using regional Geoportale and Natura 2000 datasets. Data are official; visual representation and color classification were developed by the author.*



MAP 11.2. PO VALLEY 1:500000 GREEN INFRASTRUCTURE



- Legends
- building-polygon
  - counrines po
  - highway-line
  - railway-line
  - water-polygon
  - Landuse
    - Artificial Land
    - natura2000
    - vegetation-polygon
    - nature\_reserve-polygon
    - Arturo copy



WGS 84 / UTM zone 32N

This map represents an interpretative visualization of bird movement across the Po Valley, based on GBIF occurrence data.

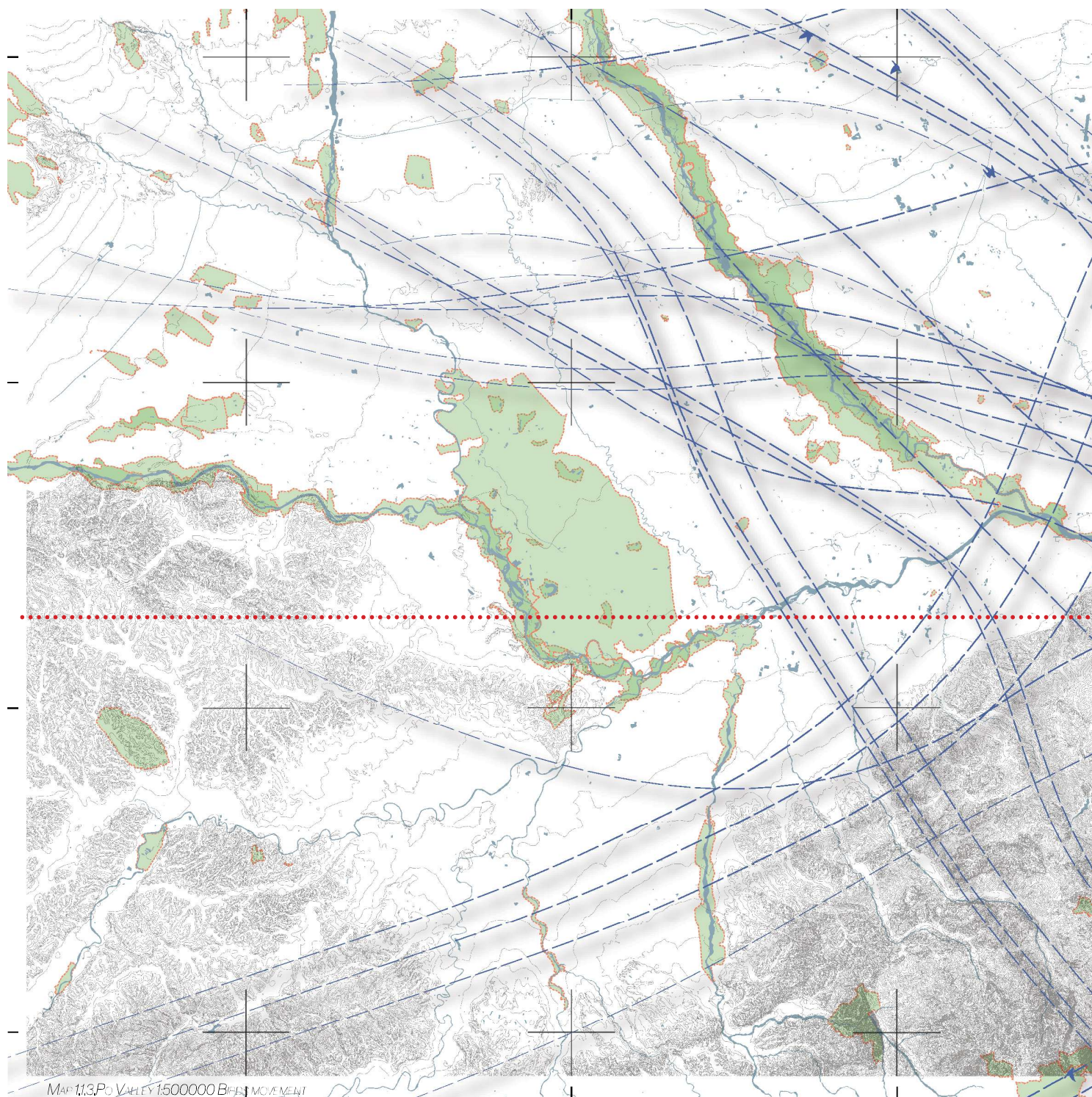
Each line connects georeferenced observation points of the same species recorded by different observers across Italy.

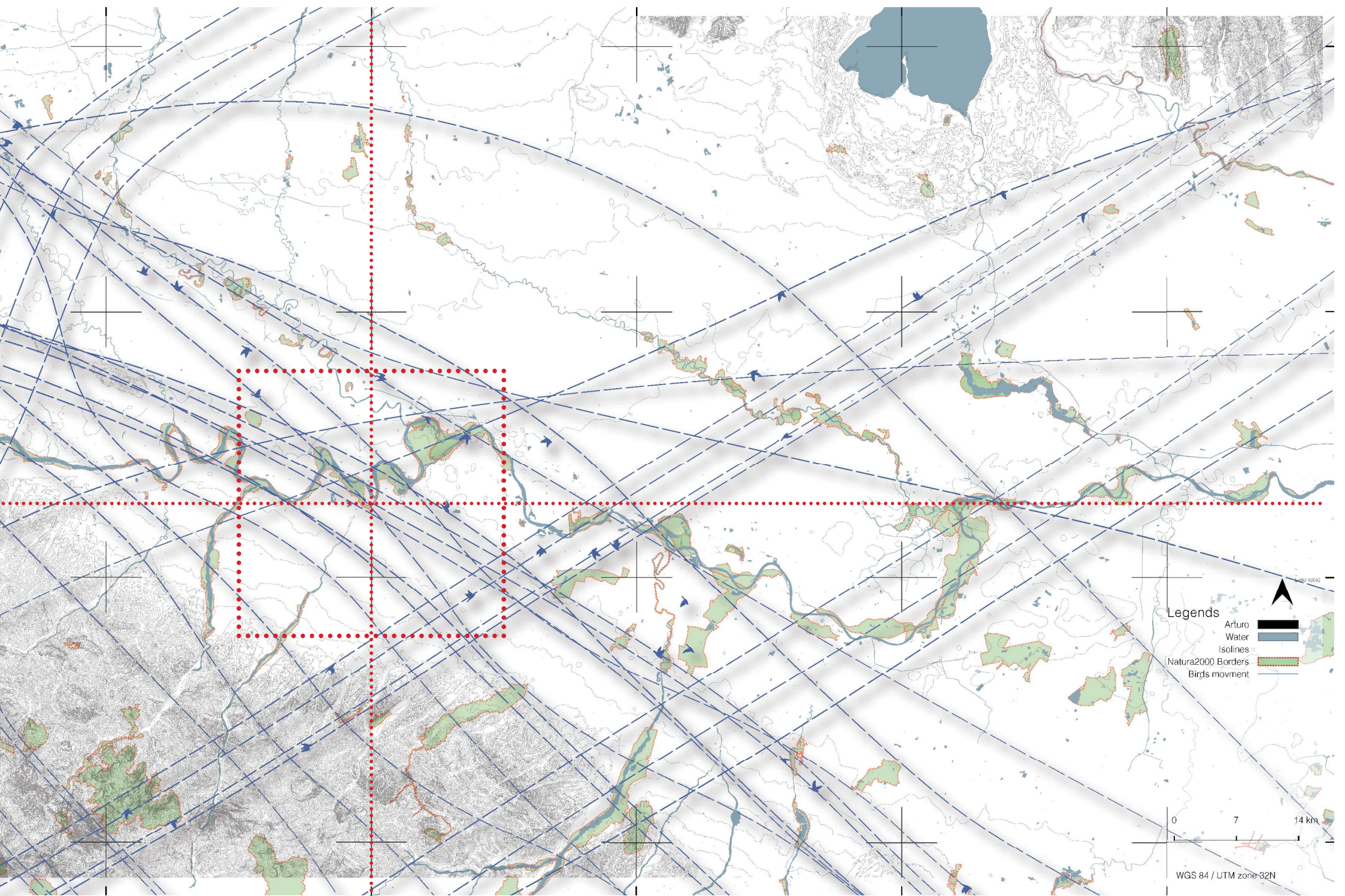
While the dataset does not track individual birds, the connections between occurrences of identical species across distant locations allow a speculative reconstruction of potential migration trajectories.

These reconstructed lines visualize the spatial continuity of species presence rather than confirmed flight paths - suggesting how migratory birds may use the Po Valley as a transitional corridor.

GBIF.org (26 February 2025) GBIF Occurrence Download <https://doi.org/10.15468/dl.3at5y3>

*Map produced in QGIS using GBIF species occurrence data. The dataset represents observation points, not tracked individuals; the connecting lines are interpretative reconstructions by the author to visualize potential migratory continuity.*





## 2.2. Avian Networks of the Piacenza-Cremona Corridor

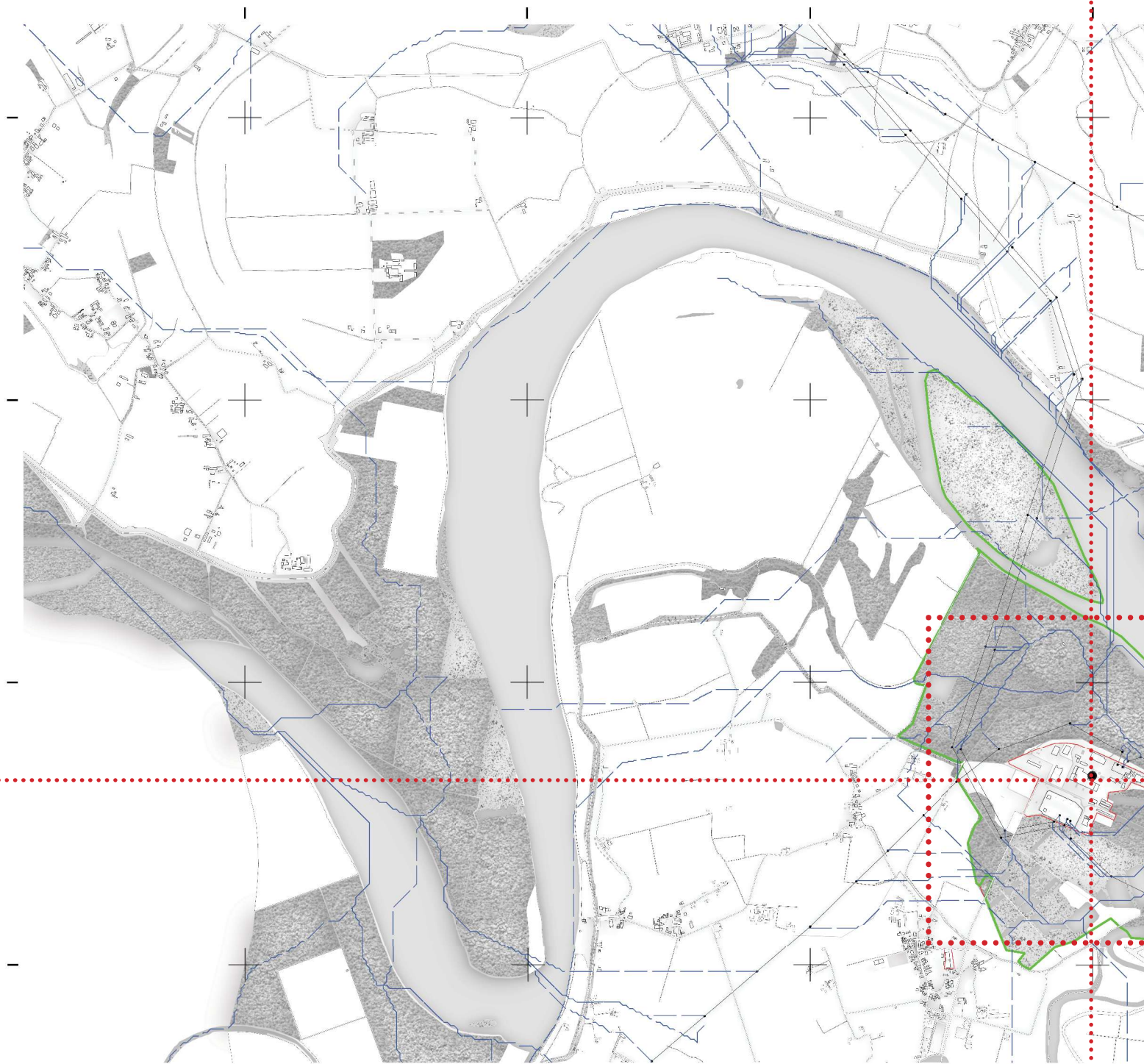
This paired mapping sequence investigates the ecological and infrastructural entanglements of the territory between Piacenza and Cremona, a corridor where the Po River, its floodplain, and the remnants of industrial infrastructure intersect. Through two complementary operations—one analytical, one empirical—the drawings reveal how birds inhabit, interpret, and reconfigure this engineered landscape.

The first map operates as a model of potential movement. Using least-cost path analysis, it simulates the routes of minimal resistance through a surface built from land-use, hydrological, and infrastructural data. The resulting network of blue lines delineates the probable corridors through which avian species can traverse the fragmented plain. It renders visible the latent geometry of permeability within a territory historically defined by control—irrigation grids, power lines, and transport systems. The analysis translates the logic of infrastructure into an ecological reading: a field of possible passages negotiated by non-human mobility.

The second map transforms empirical observation into spatial intensity. Based on GBIF bird-occurrence data, the grid of blue squares represents the density of recorded presence, where

darker tones mark zones of higher frequency. Beneath this layer, a three-level altitude model differentiates vertical habitats—high (forest canopies, built forms), middle (wetlands, shrublands), and low (open fields, river surface). The superposition of density and elevation converts the map from a planar record into a volumetric field of flight, describing how the structure of the ground conditions aerial occupation.

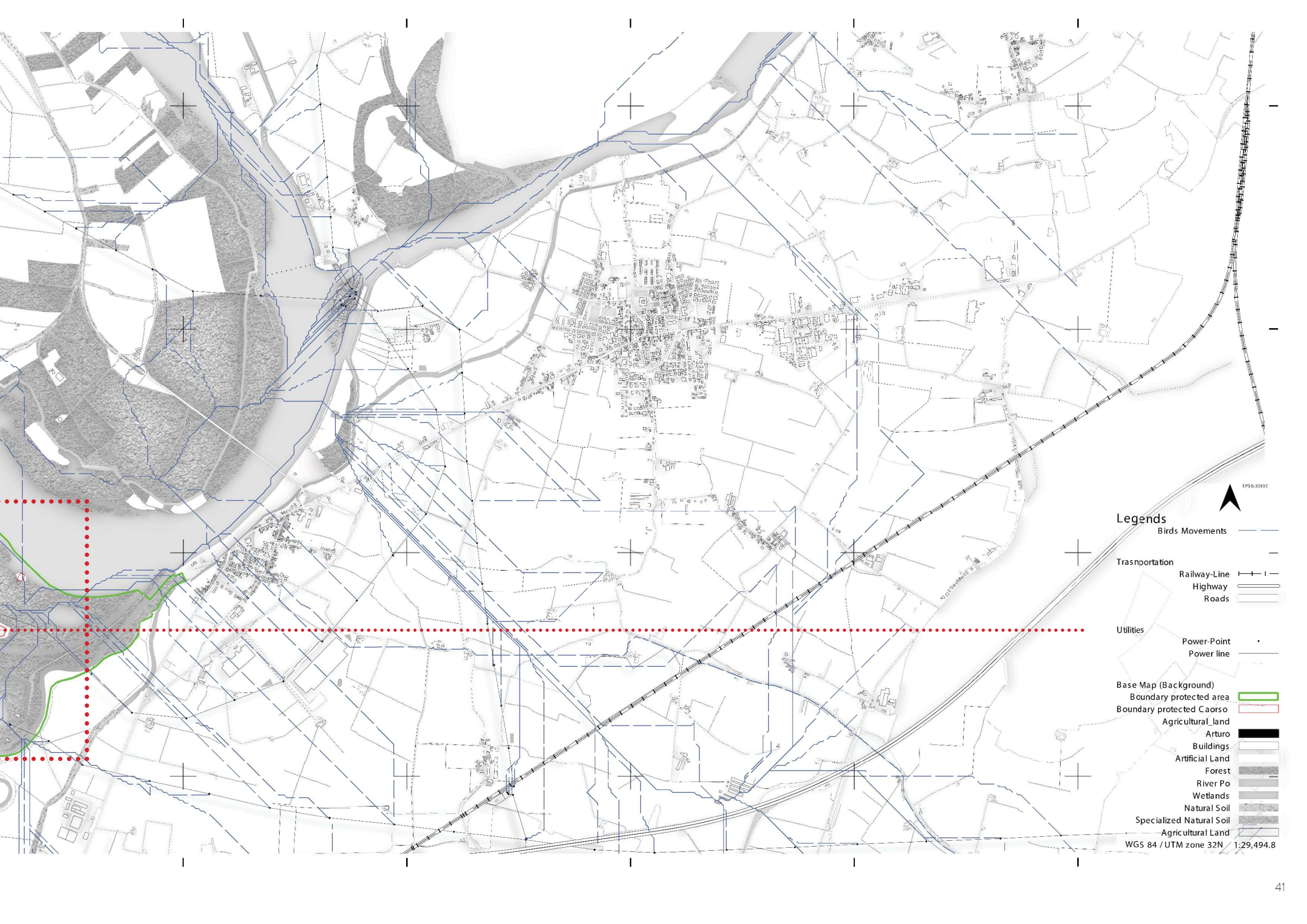
Together, the two maps articulate a dialogue between simulation and observation, between algorithmic potential and ecological fact. They recast the Piacenza–Cremona corridor not as an infrastructural void but as a thickened aerial landscape—a hybrid environment where the residues of industry, the logics of migration, and the morphologies of the river converge to form a new, dynamic ecology of movement.



GBIF.org (26 February 2025) GBIF Occurrence Download <https://doi.org/10.15468/dl.3at5y3>

*The resulting network of blue lines indicates the most probable avian movement corridors, connecting wetlands, forests, and agricultural edges. The base map integrates existing infrastructure and ecological layers to contextualize these simulated paths within the current territorial framework.*

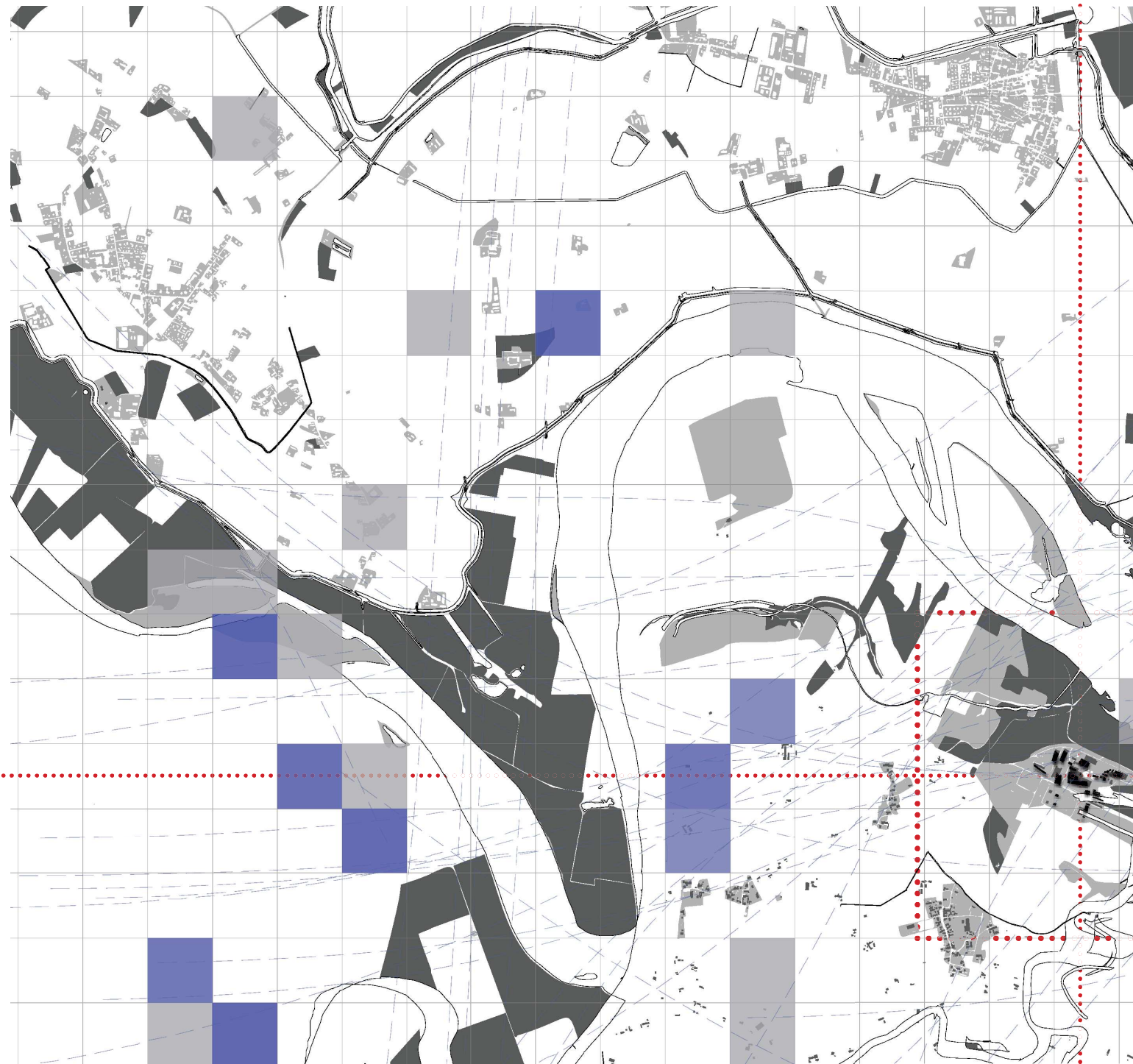
MAP 11.4 AVIAN MOVEMENT | PIACENZA–CREMONA CORRIDOR



**Legends**

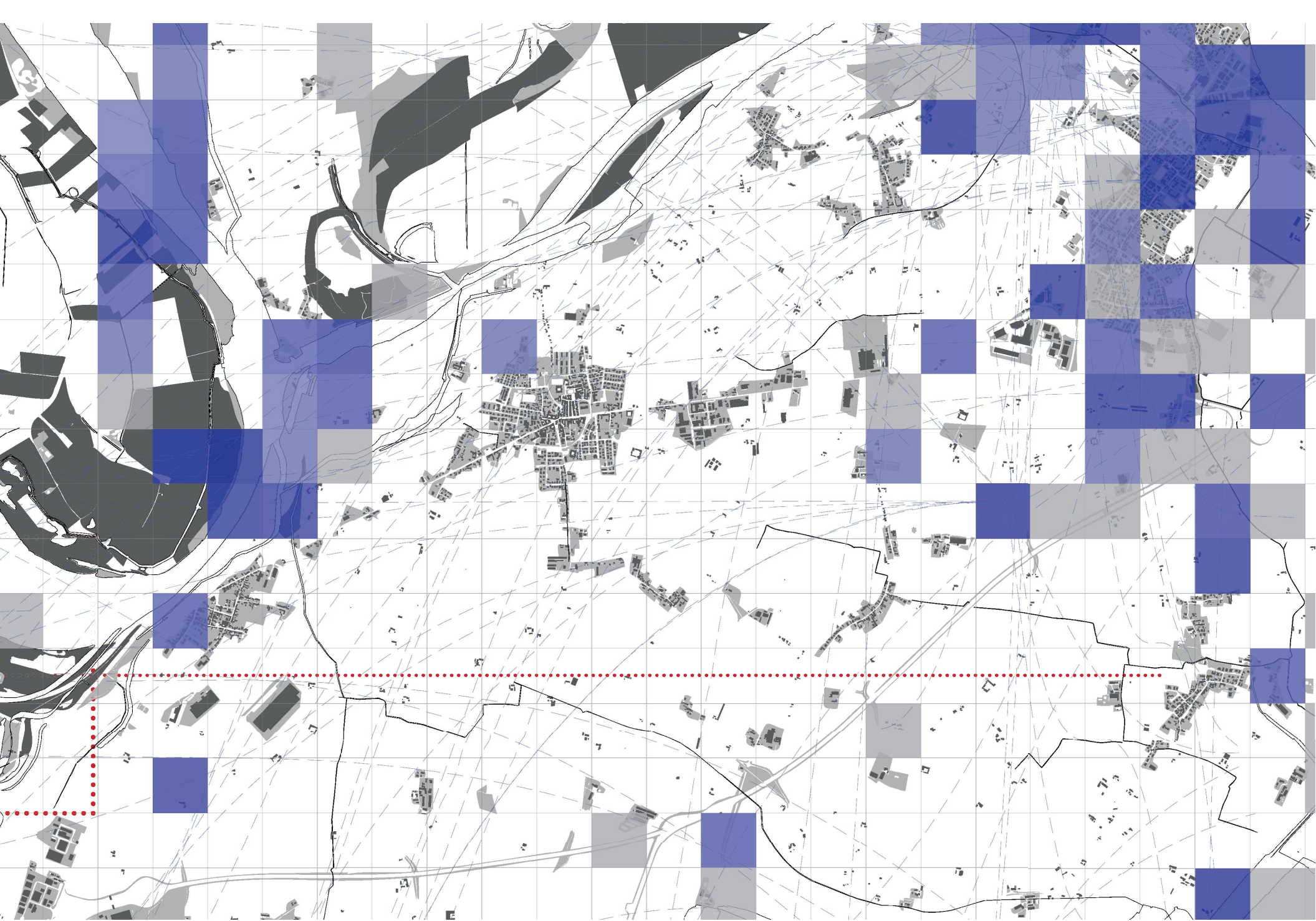
- Birds Movements
- Transportation
  - Railway-Line
  - Highway
  - Roads
- Utilities
  - Power-Point
  - Power line
- Base Map (Background)
  - Boundary protected area
  - Boundary protected Caorso
  - Agricultural\_land
    - Arturo
    - Buildings
    - Artificial Land
    - Forest
    - River Po
    - Wetlands
    - Natural Soil
    - Specialized Natural Soil
    - Agricultural Land

WGS 84 / UTM zone 32N 1:29,494.8



The map combines GBIF bird-occurrence data with a three-level altitude classification of the Piacenza–Cremona corridor to visualize patterns of avian density and habitat height. Observation points were aggregated into a grid, and color intensity (light to dark blue) indicates the number of recorded occurrences per cell. The underlay represents spatial altitude—high (

MAP 11.5 AVIAN DENSITY AND VERTICAL HABITAT



## 2.3. Caorso ecology and barriers

Analyzes the dual ecological condition of the Caorso landscape:

The areas that function as barriers to bird movement and presence, and the spaces that hold potential to evolve into viable habitats.

Together, they form the groundwork for identifying how the post-industrial site can transition toward a continuous bird corridor.

The *"Map 11.6.Vegetation & Ecological Framework"* on page 46 identifies the main vegetation typologies and their spatial relationships with the industrial site, river system, and agricultural matrix of the Po Valley.

The green zones correspond to existing forested and riparian vegetation, primarily following the Po River banks and secondary canals. These areas consist of mixed deciduous and riparian species, such as *Populus alba*, *Salix alba*, and *Alnus glutinosa*, which form narrow corridors of ecological continuity within fragmented agricultural landscape.

South of the river, near the power plant, the terrain

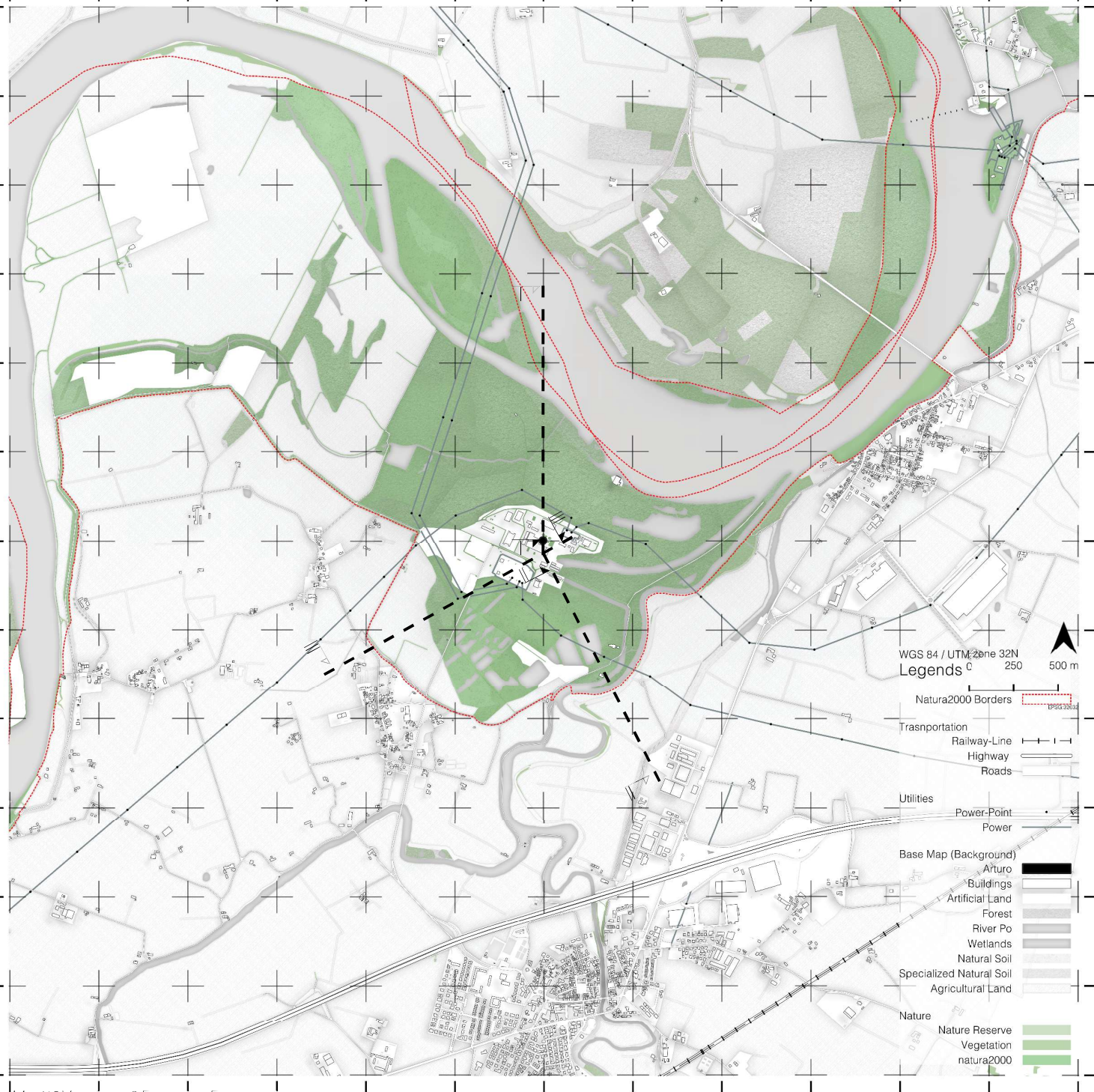
transitions through natural soil patches, special vegetation formations, and remnant wetlands.

These environments still support of early-successional habitats important for small mammals, amphibians, and resident bird species.

The surrounding is dominated by intensive agriculture, offering low ecological permeability and high disturbance.

The sections (*"Drawing 11.1.SECTION I-I"* on page 47, *"Drawing 11.2.SECTION II-II"* on page 47, *"Drawing 11.3.SECTION III-III"* on page 47) reveal the spatial and ecological gradient extending from the industrial site of the former power plant toward the river corridor. They highlight the contrast between artificial land and naturally vegetated areas - from compact, transformed ground within the plant boundary to Bosco and wetland systems closer to the Po floodplain.

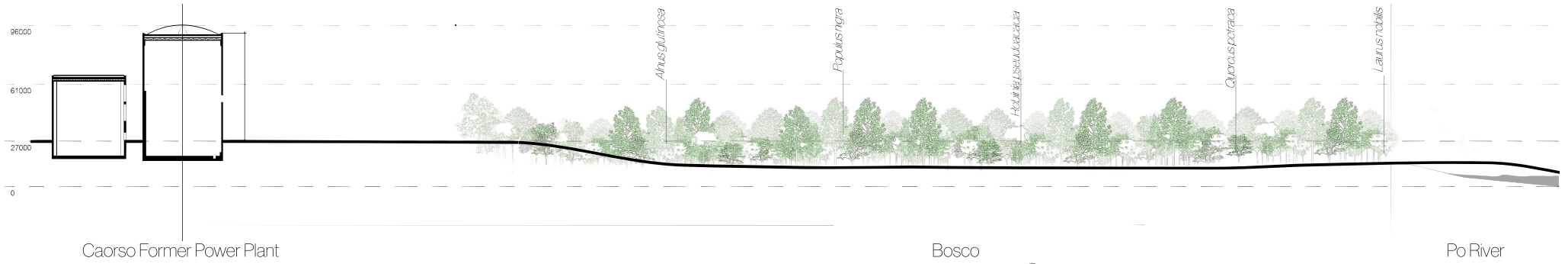
This profile clarifies the site's existing hydrological hierarchy, vegetation layers, and ecological transitions, providing the analytical basis for future habitat restoration and rewinding strategies.



MAP 1.16: VEGETATION & ECOLOGICAL FRAMEWORK

Map elaborated by the author in QGIS to define the existing and potential ecological structure of the Caorso site. It visualizes vegetation typologies, Natura 2000 areas, and hydrological connections shaping the Po River corridor. This framework establishes the base for habitat zoning and section analysis.

DRAWING 1.11. SECTION H



DRAWING 1.12. SECTION II-II



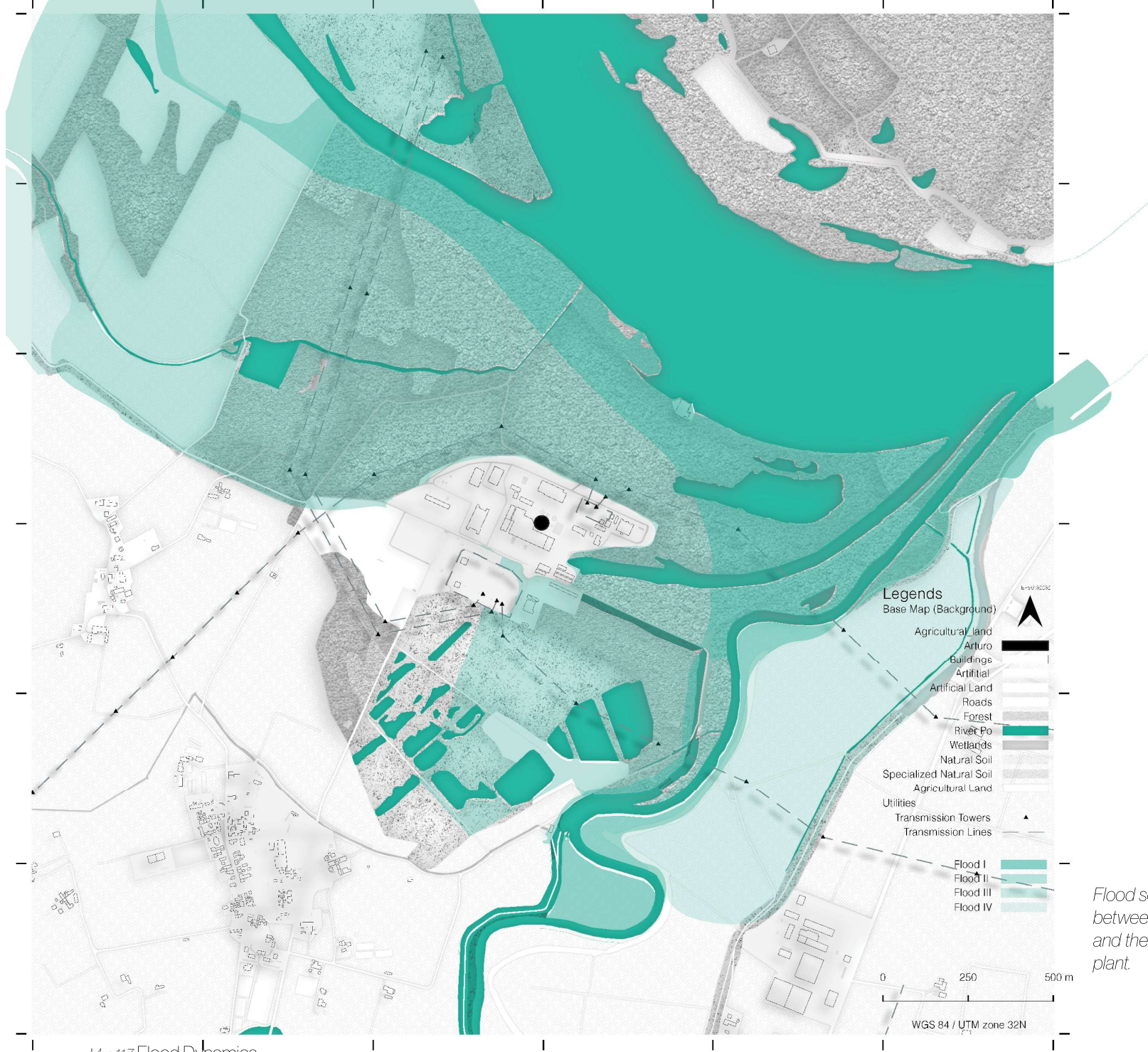
DRAWING 1.13. SECTION III-III



Sections drawn by the author showing transversal ecological relations between the former power plant, Po River, wetlands, and agricultural fields

Flood Dynamics This map examines the Caorso site within the broader Po River floodplain, illustrating flood scenarios. The colored areas indicate varying levels of flood, from high-exposure zones along the river to transitional areas extending toward agricultural land and the former power plant platform. The elevated platform appears as a protected enclave within this fluctuating hydraulic system. Originally engineered for flood resistance, it disrupts natural retention patterns and accelerates runoff. The contrast between engineered dryness and periodically inundated floodplain conditions becomes visible.

Flooding is represented not as a threat to eliminate, but as an active environmental process shaping soil, vegetation, and ecological relations. Wetlands, fields, and infrastructural traces are understood as interconnected components within a dynamic alluvial system. The map establishes a foundation for strategies based on slowing, retaining, and redistributing water rather than opposing it.

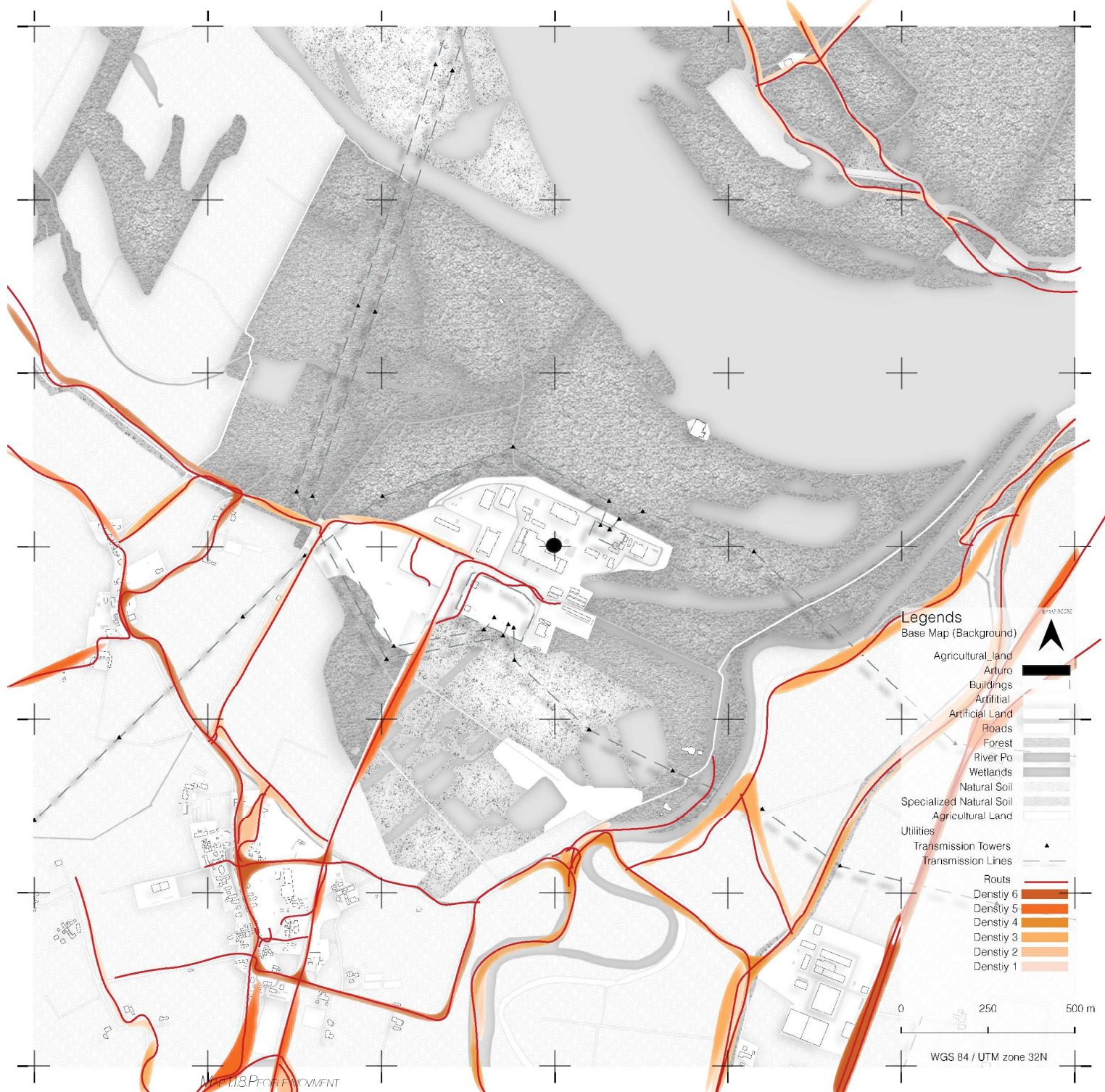


*Flood scenarios illustrating hydrological gradients between the Po River, wetlands, agricultural fields, and the engineered platform of the former power plant.*

MAP 11.7: Flood Dynamics

This map visualizes patterns of informal movement and sport activities around the Caorso site, based on aggregated Strava heatmap data. The highlighted lines indicate intensity of use, revealing routes frequently occupied by cyclists and runners. The diagram captures actual behavioral traces. The data shows that movement concentrates along existing roads and river-adjacent paths, while the former power plant platform remains largely bypassed. The site operates as a gap within an otherwise active territorial network. The intensity gradient illustrates degrees of engagement: stronger lines mark primary routes connecting settlements and regional corridors,

while lighter traces indicate secondary or occasional paths. The absence of activity inside the restricted area reinforces the condition of exclusion embedded in the platform's design. This map does not position sport as a programmatic objective. Instead, it reveals latent connections and existing patterns of use that may inform future spatial permeability. Movement is understood as one process among others, operating within the territorial system rather than defining it.



Strava-based movement intensity map showing cycling and running routes around the site and its current condition of partial exclusion.

*"Map 1:19:130000 Barriers and Non-Quite zones" on page 54* visualizes the non-habitable zones - spaces of high disturbance, noise, and human activity that act as barriers to bird movement.

The hatched areas correspond to:

- Industrial surfaces of the former power plant,
- Dense settlements and infrastructure
- Intensively cultivated fields with low vegetation cover.

These zones fragment the territory and limit ecological continuity, forming a dense network of visual, acoustic, and spatial obstacles that most

bird species tend to avoid.

Only narrow, unhatched interstices remain relatively permeable, indicating the few potential quiet zones where natural conditions still persist. The map therefore defines the negative ecological image of Caorso.

*"Map 1:10:130000 Potential bird habitat" on page 55* identifies the habitat types currently used by birds within and around the Caorso site. The ecological remnants where birds can live, rest, feed, and breed.

Three primary habitat categories are represented:

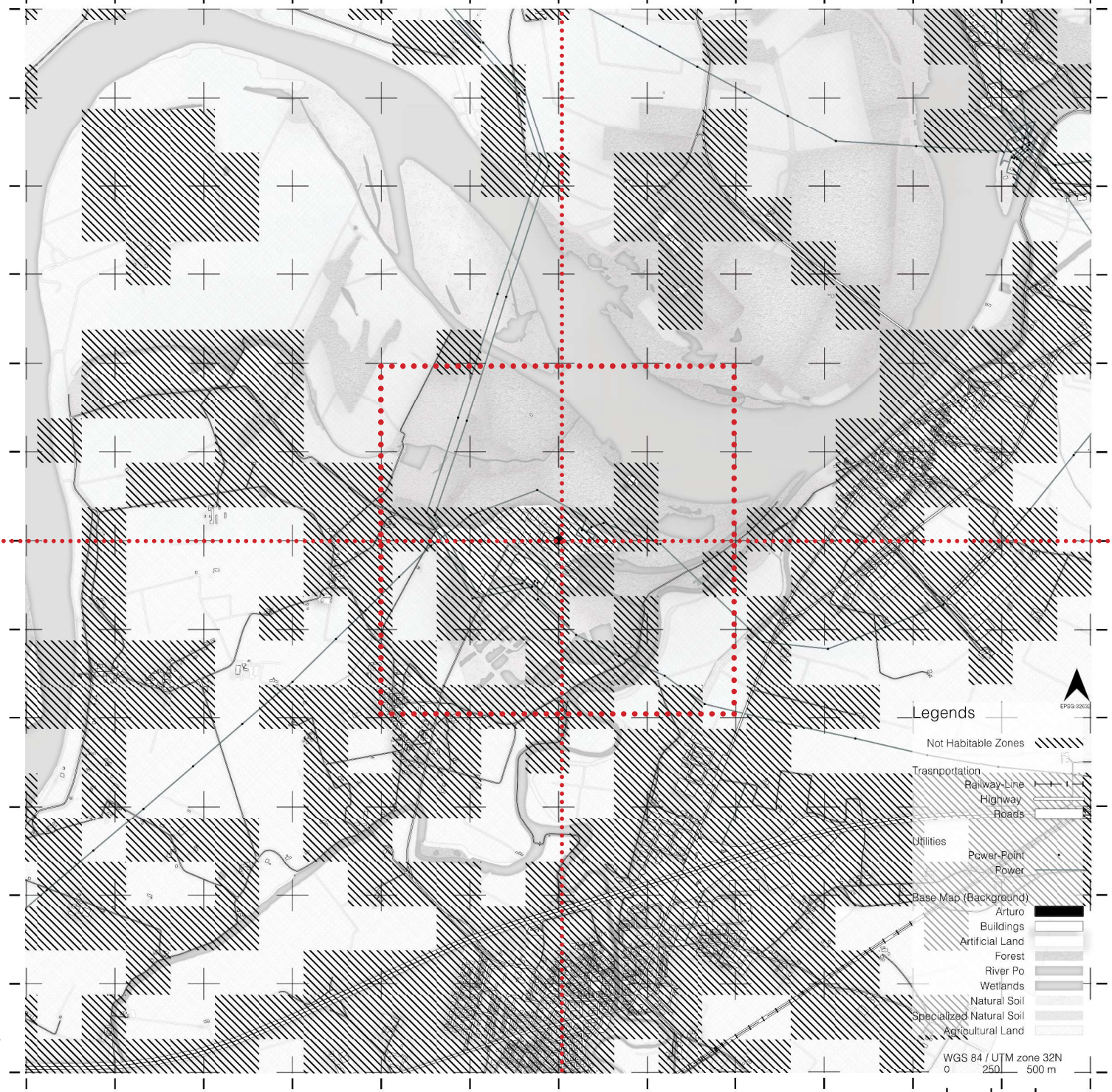
- Forest (Bosco) - densely vegetated areas that provide nesting and shelter.
- Specialized Natural Soil - zones with distinct plant communities shaped by hydrology or soil composition, supporting waders and ground-nesting birds.
- Natural Soil - open, semi-vegetated terrain suitable for foraging and movement between habitats.
- Electrical Pylons, which serve as perching and observation points. Despite their artificial origin, they have become part of the birds'

In conclusion spatial system, forming a linear sequence of elevated resting structures across

open fields and river margins trying to show a thin ecological framework: not yet a stable habitat, but a latent ecological structure - a mosaic of conditions that could be reactivated through targeted restoration.

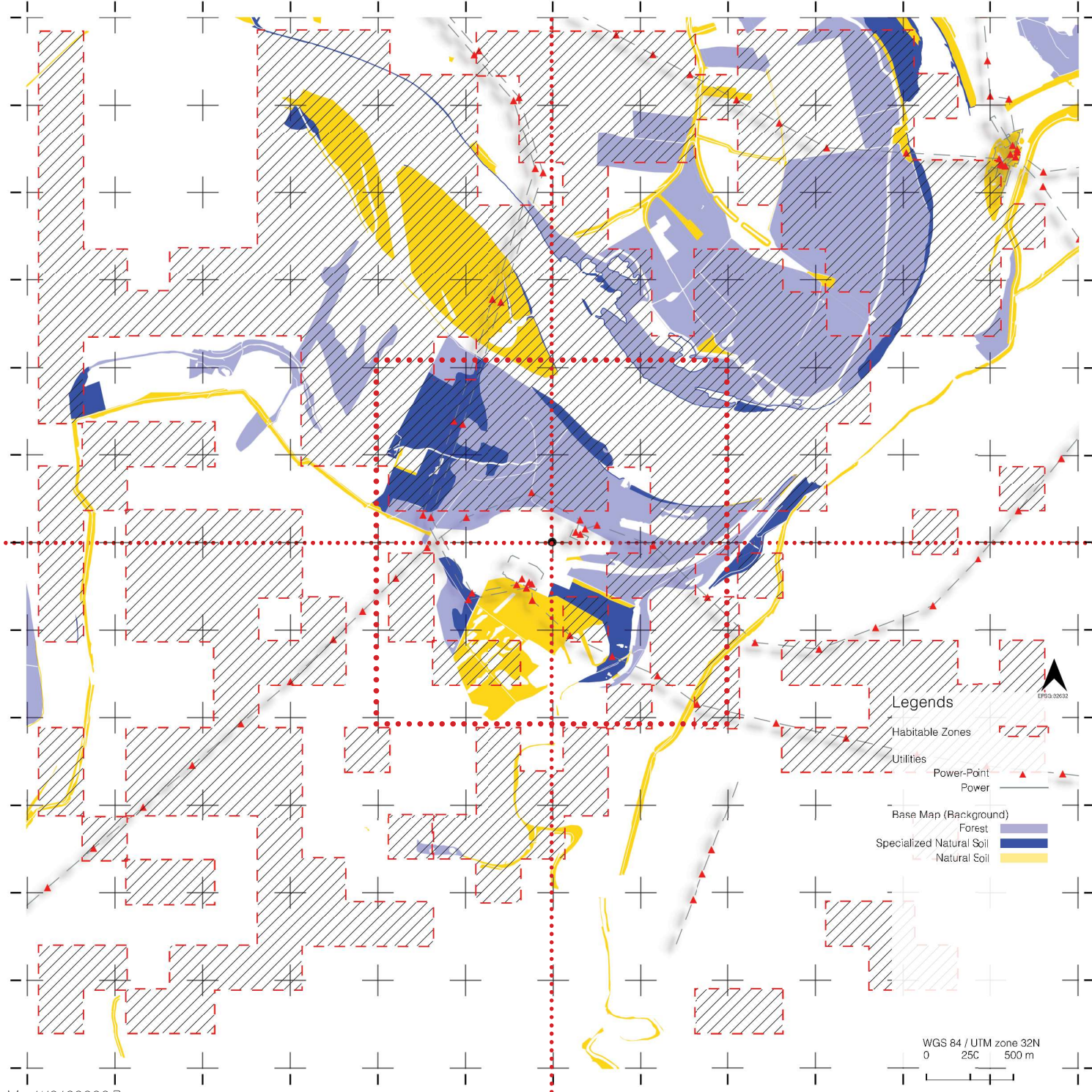
It visualizes where the existing physical typologies already host elements of life and where the potential for regeneration is highest.

This overlap reveals how different soil and vegetation typologies intersect, defining potential but incomplete habitats.



Map produced by the author in QGIS identifying areas of high disturbance across the Caorso territory. The diagram overlays infrastructural, agricultural, and urban noise sources to delineate "non-quiet zones," where bird presence and nesting potential are limited due to acoustic and visual disruption

MAP 1.19 1:300000 BARRIERS AND NON-QUIET ZONES



MAP 1110130000 POTENTIAL BIRC HABITAT

Map elaborated in QGIS combining vegetation, and land-use data to highlight areas suitable for habitat restoration. By integrating forest, wetland, and special vegetation typologies, the analysis defines potential zones for reprogramming the Caorso exclusion area into an ecological continuum along the Po River corridor.

## 2.4. Ecological Resistance and Connectivity Mapping

This sequence compares two ecological scenarios to explore how the Caorso landscape could shift from resistance to permeability. Using QGIS, a multi-layer raster model was created to represent the cost of bird movement across the Po Valley. Each pixel expresses a gradient of suitability — from dark red, indicating artificial and disturbed areas with high energetic cost, to light zones representing low-resistance habitats such as wetlands, forests, and natural terrain. In the first scenario, the industrial site of the Caorso Nuclear Power Plant retains its current values as an obstacle within the landscape. In the second, the same area is re-classified as a potential habitat: caorso site is given lower cost values to simulate their ecological reprogramming. The new model demonstrates a redistribution of corridors: areas

once fragmented by industrial activity now reveal a network of accessible routes. This transformation is clearly depicted in map 11.6 (Simulated Bird Movement Corridors with New Condition), which shows how formerly disconnected regions are now linked by new pathways, enabling birds to traverse the landscape more freely.

Together, these maps visualize both constraint and possibility. They do not trace exact routes of individual species but interpret the potential of terrain to host movement. Through the comparison between current and revalued conditions, Caorso is reframed from a place of exclusion into a connective field — an infrastructural void capable of becoming habitat, corridor, and signal within the geography of migration.

The "Map 1.11: Caorso 1:30000 Bird Landscape Permeability Map" on page 60 visualizes the cost raster model developed for the Po Valley and Caorso, where each land cover type has been assigned a numerical value (1–100) corresponding to its resistance or attractiveness for bird movement. Light tones (low values 1–5) represent habitats with high ecological value, such as wetlands, the Po River, forests, and designated regeneration areas.

Mid-tones (10–40) represent modified landscapes such as agriculture or artificial surfaces, which have limited ecological function and higher disturbance. Dark tones (60–100) represent infrastructures and urbanized areas, such as roads, barriers, and buildings.

The map shows the current cost raster classification of the Caorso exclusion zone, where the nuclear plant and its infrastructures are treated as high-resistance surfaces. In this configuration, the site functions as a barrier within the ecological network, interrupting connectivity between

the Po River corridor and surrounding habitats. It remains ecologically barrier blocking movement for birds.

The "Map 1.17: Flood Dynamics" on page 49 shows the future value for the Caorso exclusion zone, where the nuclear plant and its infrastructures are treated as low-resistance surfaces. In this configuration, the site is not functioning as a barrier within the ecological network.

The cost raster analysis reveals a fragmented ecological matrix where high-resistance infrastructures interrupt connectivity along the Po River corridor. Caorso, in particular, emerges as both a barrier and an opportunity: today it blocks bird movement, but its position at the center of the migratory axis gives it unique potential. If reprogrammed from exclusion zone to habitat, the site could transform from an ecological void into a critical stepping stone, reconnecting wetlands, forests, and agricultural mosaics into a functional network for migratory species.

"Picture 1.1.35. Google sattelline of Caorso power plant station" on page 102 shows the cumula-

Land Cover / Feature	Value	Interpretation
Wetlands	1	Optimal habitat, stopover/refueling zone
Po River	1	Major corridor / attractor
Caorso Building (reprogrammed)	1	Site as future ecological core
Bosco (forest)	2	High habitat value, nesting/cover
Caorso Land (planned regeneration)	2	Designed as new habitat patches
Special Vegetation (formazione vegetale particolare)	3	Semi-natural, transitional habitat
Natural Terrain (forma naturale del terreno)	5	Medium habitat quality, transitional matrix
Agriculture	10	Low habitat value, high disturbance
Artificial Surfaces	40	Very high resistance, low ecological function
Road Barriers	60	Strong barrier effect, fragmentation
Roads	85	Severe barrier, high mortality risk
Buildings (general, urban fabric)	100	Maximum resistance, no habitat value

FIGURE 1.1.1. TABLE OF THE LAND FEATURES' VALUE EXISTING SITUATION

The tables defines resistance grades for each land cover category, developed by the author to model bird movement through the landscape. Values were elaborated in QGIS based on ecological interpretation

Land Cover / Feature	Value	Interpretation
Wetlands	1	Optimal habitat, stopover/refueling zone
Po River	1	Major corridor / attractor
Caorso Building (reprogrammed)	1	Site as future ecological core
Bosco (forest)	2	High habitat value, nesting/cover
Special Vegetation (formazione vegetale particolare)	3	Semi-natural, transitional habitat
Natural Terrain (forma naturale del terreno)	5	Medium habitat quality, transitional matrix
Agriculture	10	Low habitat value, high disturbance
Caorso Land (planned regeneration)	40	Same value as artificial
Artificial Surfaces	40	Very high resistance, low ecological function
Road Barriers	60	Strong barrier effect, fragmentation
Roads	85	Severe barrier, high mortality risk
Buildings (general, urban fabric)	100	Maximum resistance, no habitat value

FIGURE 11.2. TABLE OF THE LAND FEATURES' VALUE AND POTENTIAL UPDATE

The tables defines resistance grades for each land cover category, developed by the author to model bird movement through the landscape. Values were elaborated in QGIS based on ecological interpretation

tive cost analysis of bird movement across the Caorso territory under current conditions. Each blue trajectory represents a least-cost path, calculated by combining land cover resistance values with the regional ecological context. In this configuration, the Caorso exclusion zone and its infrastructures act as high-resistance surfaces, forcing migratory flows to curve around the site. The result is a fragmented corridor, where birds expend more energy to bypass barriers, increasing the ecological distance between wetlands, forests, and agricultural mosaics. The analysis highlights the ecological inertia of the exclusion zone: rather than functioning as a stepping stone, Caorso interrupts the continuity of the Po Valley flyway, weakening the resilience of the corridor as a whole.

*Map 11.14: Caorso130000 Simulated Bird's Potential Movement Corridors* on page 63 is speculative model reduces the resistance value of the Caorso exclusion zone, simulating its transformation from barrier to habitat. Under this scenario, cumulative cost analysis produces new least-cost paths: a direct line now crosses the site,

linking the Po River with surrounding habitat. By reprogramming the site as low resistance Caorso could shift from ecological void to critical node within the migratory network. Instead of deflecting movement, it becomes an active bridge between fragmented habitats. The comparison reveals the potential of adaptive reuse, even heavily industrialized landscapes can be reinserted into migratory corridors. Caorso exemplifies how abandoned infrastructures may evolve from obstacles to indispensable stepping stones for biodiversity.



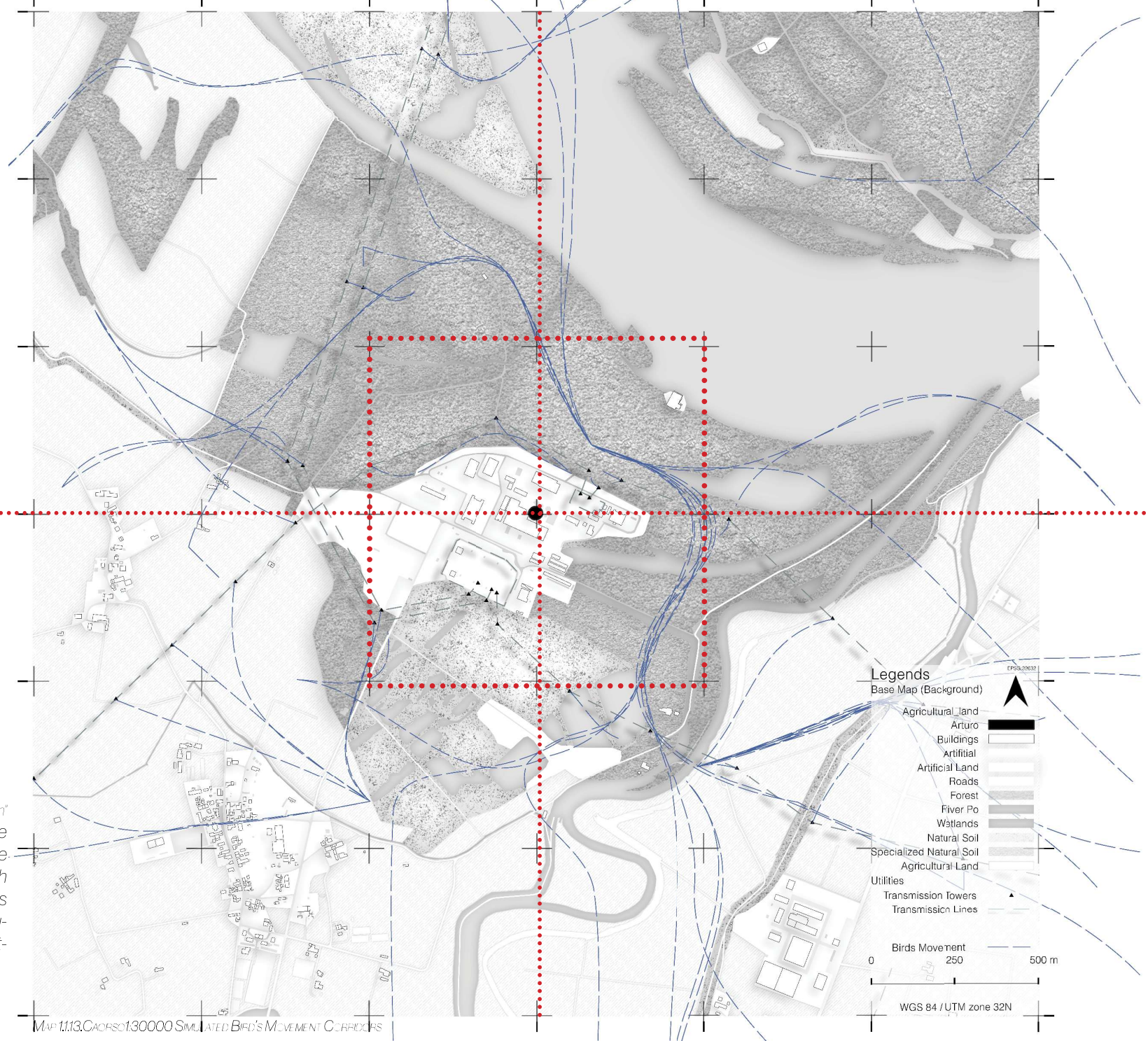
*"Map 1.111:Caorso1:30000 Bird Landscape Permeability Map" on page 60 developed by the author in QGIS using a cost raster model based on assigned resistance values (1-100) from "Figure 1.1:Table of the land features' value existing situation" on page 58 for each land-cover type. The current condition shows high-resistance zones*

MAP.1.111.CAORSO1:30000 BIRD LANDSCAPE PERMEABILITY MAP

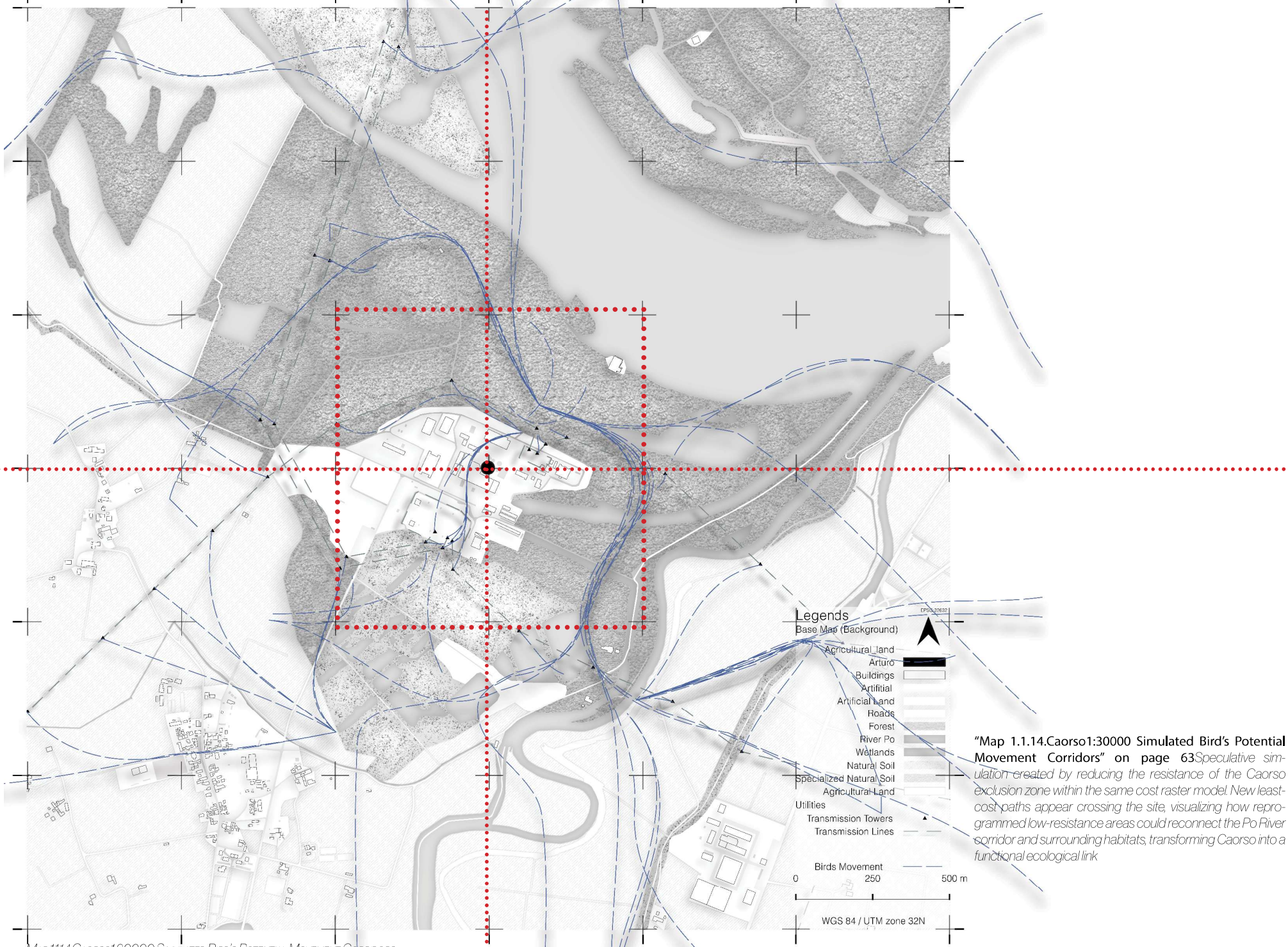


MAP 1112.CAORSO1:30000 POTENTIAL BIRD LANDSCAPE PERMEABILITY MAP

*Speculative map generated by reclassifying the same cost raster in QGIS, reducing resistance values for re-programmed areas within the Caorso exclusion zone. The simulation visualizes a future scenario where the former industrial site functions as a permeable landscape and reconnects with the Po River corridor.*



"Picture 11.35. Google satteline of Caorso power plant station" on page 102 generated in QGIS using cumulative cost analysis based on the assigned resistance values. Each blue line represents a least-cost path showing the most efficient bird movement across the current landscape, where the Caorso exclusion zone acts as a high-resistance barrier diverting flight routes around the site.



MAP 1.1.14. CAORSO 1:30000 SIMULATED BIRD'S POTENTIAL MOVEMENT CORRIDORS

**"Map 1.1.14. Caorso 1:30000 Simulated Bird's Potential Movement Corridors"** on page 63 *Speculative simulation created by reducing the resistance of the Caorso exclusion zone within the same cost raster model. New least-cost paths appear crossing the site, visualizing how reprogrammed low-resistance areas could reconnect the Po River corridor and surrounding habitats, transforming Caorso into a functional ecological link*