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Polimi TIS

#TIS

THESIS INCUBATOR STUDIO

GO WITH THE PO

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MARTHA ANDREINA SERRA NAVAS

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THESIS INCUBATOR STUDIO

GO WITH THE PO

JUST
GO
WITH
THE
PO

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01

Exploration

“Water has been critical to the making of human history, to write history without putting any water in it is to leave out a large part of the story. Human experience has never been so dry as that.” Donald Worster

Methodology

Research methodology is aimed to gain a brother understanding of the river Po and multispecies design approach, with a particular attention to ecological impact that this can have in our ecosystems.
The research involves a systematic approach to investigate the environmental impact of pollution and propose mitigation measures. The study begins with a comprehensive literature review, examining existing knowledge on the River Po, including pollution sources, hydrology, ecology, and management strategies. The research conducted follows three investigate strands identified by questions:

1. **How can floating architecture be integrated into the River Po to address pollution issues and promote sustainable development while minimizing negative impacts on the environment?**

2. **How the river Po can create a connection between water, land, scape and human?**

3. **What role does the field of design have in facilitating the shift towards more bio-diverse human habitats?**

Abstract

Waterways are essential components of the living and non-living world. They shape landscapes and serve as demarcation lines as “natural borders”between states in many parts of the world. In addition to being lines that separate, rivers and streams are also lines that connect, and borderland territories are often particularly rich places of life, interaction, passage, porosity, cross-pollination and exchange.The Po Valley is one of the most important industrial and agricultural areas in Europe. However the cities eat the rural, and the rural eats the wilderness and exploits the river Po, creating a polluted space rather than being the lungs of the city.

For instance this research was born to address the River Po, the landscape and the agriculture in the city of Cremona through the recovery, re-valorisation, re-connection, re-integration of the river Po for the city. One of the main goals is to intermingling and blurring the distinction between land and water, between rural and urban, between Po and Cremona.

Go with the Po is a project that imagines the river as a new, active, social space for interrelating that operates across scales and programs. It defines how inhabitants of Cremona interact among themselves and with their surrounding ecosystem. On a community scale, it becomes a space for innovation for agriculture and ecosystem and reduction of the pollution. On a territorial scale, it connects the city of Cremona with every other territory watered by the Po as it flows.

Agenda 2030

The Global Goals and the 2030 Agenda for Sustainable Development aim to eradicate poverty and hunger, uphold the human rights of all individuals, promote gender equality and empower women and girls, and safeguard the planet and its natural resources for long-term sustainability. These Global Goals are interconnected and inseparable, encompassing the economic, social, and environmental dimensions of sustainable development.

The sustainable development objectives have worldwide applicability and involve all countries and societal sectors, including private companies, the public sector, civil society, and information and culture entities. The 17 Sustainable Development Goals (SDGs) encompass a range of significant development concerns, addressing the economic, social, and environmental dimensions of sustainability in a well-balanced manner. Their overarching aim is to eradicate poverty, combat inequality, address climate change, and foster peaceful societies that uphold human rights.

In Italy, the Agenda 2030 sets the framework for addressing major global challenges and encourages every country to develop its own National Strategy for Sustainable Development. To advance Italy's governance of the 2030 Agenda, the "Benessere Italia" steering committee was established at the Prime Minister's Office. This committee's role is to coordinate, monitor, measure, and enhance policies implemented by all Ministries to promote the well-being of citizens. It represents a significant step toward empowering Italy to pursue fair and sustainable well-being through new policies and approaches.

The policy lines in Italy focus on five macro-areas: sustainable and equitable regeneration of territories, mobility, territorial cohesion, energy transition, and quality of life, and circular economy. These macro-areas prioritize placing individuals at the center of action by promoting healthy lifestyles, defining a work-life balance, ensuring fair living conditions, supporting human development initiatives, and promoting lifelong learning and progress.

Agenzia per la Coesione Territoriale. The UN Agenda 2030 for Sustainable Development

Sustainable goals

1 NO POVERTY — No Poverty: End poverty in all its forms and dimensions.

2 NO HUNGER — Zero Hunger: Achieve food security, improve nutrition, and promote sustainable agriculture.

3 GOOD HEALTH — Good Health and Well-being: Ensure healthy lives and promote well-being for all at all ages.

4 QUALITY EDUCATION — Quality Education: Ensure inclusive and equitable quality education and promote lifelong learning opportunities

5 GENDER EQUALITY — Gender Equality: Achieve gender equality and empower all women and girls.

6 CLEAN WATER AND SANITATION — Clean Water and Sanitation: Ensure availability and sustainable management of water and sanitation for all.

7 RENEWABLE ENERGY — Affordable and Clean Energy: Ensure access to affordable, reliable, sustainable, and modern energy for all.

8 GOOD JOBS AND ECONOMIC GROWTH — Decent Work and Economic Growth: Promote sustained, inclusive, and sustainable economic growth, full and productive employment

9 INNOVATION AND INFRASTRUCTURE — Industry, Innovation, and Infrastructure: Build resilient infrastructure, promote in sustainable industrialization, and foster innovation.

10 REDUCED INEQUALITIES — Reduced Inequalities: Reduce inequality within and among countries.

11 SUSTAINABLE CITIES AND COMMUNITIES — Sustainable Cities and Communities: Make cities and human settlements inclusive, safe, resilient, and sustainable

12 RESPONSIBLE CONSUMPTION — Responsible Consumption and Production: Ensure sustainable consumption and production patterns.

13 CLIMATE ACTION — Climate Action: Take urgent action to combat climate change and its impacts.

14 LIFE BELOW WATER — Life Below Water: Conserve and sustainably use the oceans, seas, and marine resources for sustainable development.

15 LIFE ON LAND — Life on Land: Protect, restore, and promote sustainable use of terrestrial ecosystems, sustainably manage forests.

16 PEACE AND JUSTICE — Peace, Justice, and Strong Institutions: Promote inclusive societies, provide access to justice for all.

17 PARTNERSHIPS FOR THE GOALS — Partnerships for the Goals: Strengthen the means of implementation and revitalize the global partnership.

Agenzia per la Coesione Territoriale. The UN Agenda 2030 for Sustainable Development

Food crisis

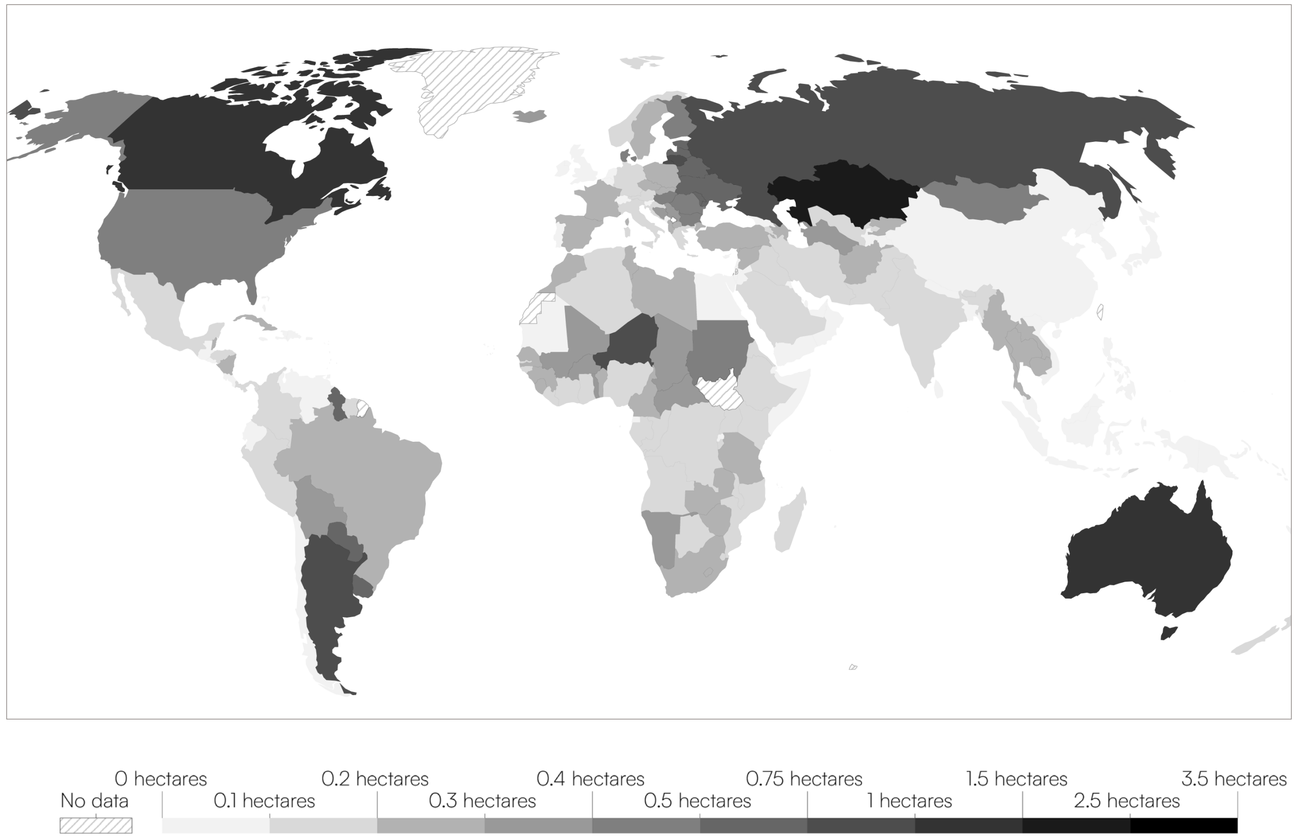
Factors with negative impact on food security

The majority of people affected by hunger live in rural areas of developing countries, for example in Asia or Africa. However the factors that have a negative impact on food are global rather than regional:

- Extreme weather and climate change: Rising temperatures, floods, droughts, and other extreme weather events are becoming more frequent occurrences. In the year 2016, weather-related events caused a staggering amount of damage, reaching US $44 billion in the United States alone (Munich Re 2017). Moreover, El Niño led to supply disruptions causing floods and affecting approximately 3.5 million people in El Salvador, Guatemala, Honduras, and Nicaragua (WMO 2017).
- Infertile soils, species diversity threatened: Soil degradation and declining species diversity pose significant challenges. Across the globe, fertile soil is being lost due to factors like deforestation, overgrazing, and mismanagement. Disturbingly, more than 200 million hectares of soil in Latin America are severely damaged (WRI 2016).
  The loss of fertile soil jeopardizes the survival of numerous mammal, bird, fish, and plant species, putting them at risk of extinction.
- Food Loss: Each year, over one billion tons of food are lost worldwide. In industrialized nations, consumers bear the primary responsibility for these losses. Shockingly, in Europe, 13 percent of purchased food ends up in the garbage, while in the United States, this figure reaches nearly 16 percent (FAO 2011).
- Agricultural productivity: The world's small-scale farmers, numbering over 500 million, contribute to half of the global food supply, with their impact rising to 80 percent in developing countries. However, their productivity falls behind that of agricultural operations in industrialized nations (FAO 2014).
- Growing world population and urbanization: By the year 2050, the global population is projected to reach almost 10 billion individuals. The majority, two-thirds of this population, will reside in urban areas. Furthermore, it is estimated that 90 percent of this population growth will occur in Asia and Africa (UN 2017).

Agriculture

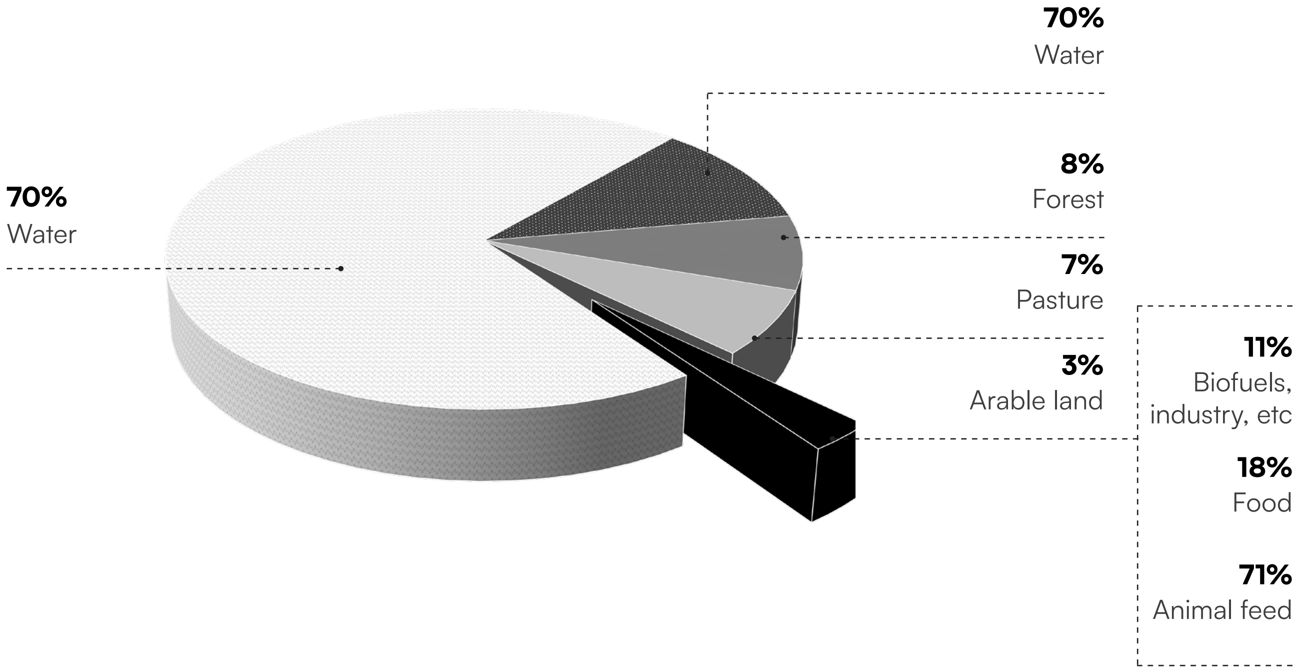
According to the FAO, arable land refers to land that is utilized for temporary crops, temporary meadows for mowing or pasture, market or kitchen gardens, and land that is temporarily left fallow. The measurement of arable land is expressed as the number of hectares per person.



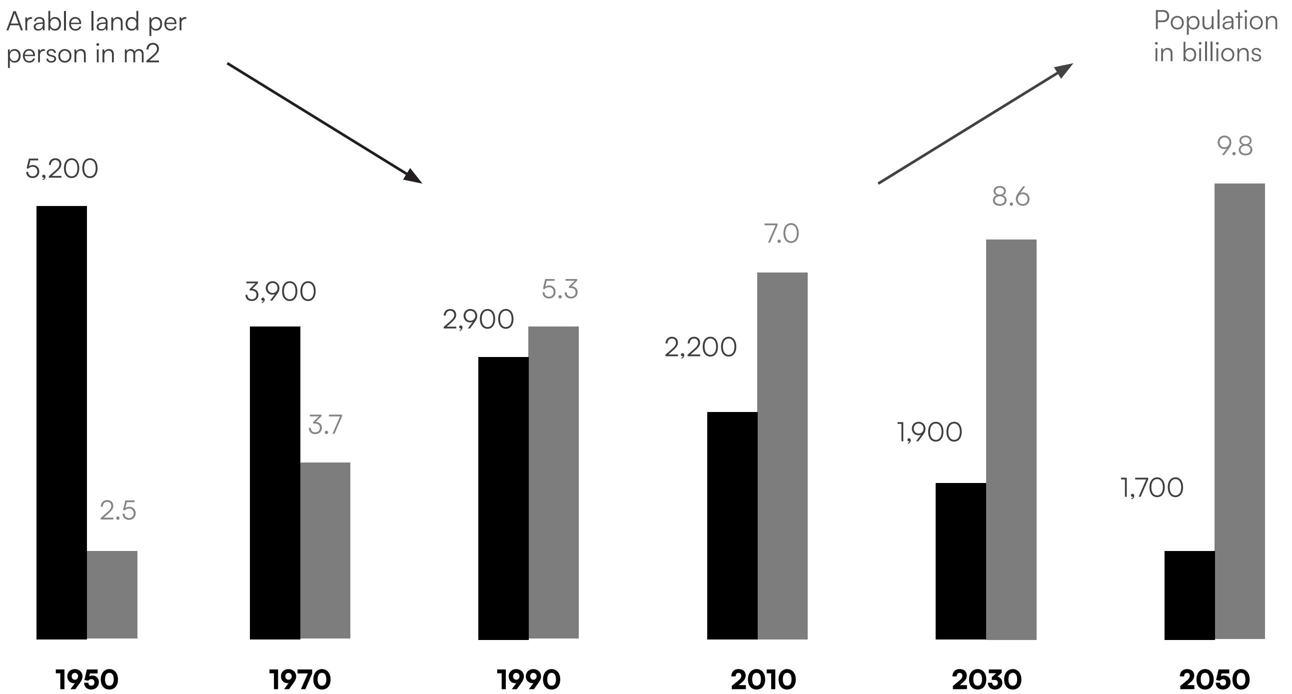
Source: Food and Agriculture Organization of the United Nations (via World Bank)

Arable land

The amount of arable land available for food production per person is limited and constantly decresing. This is due to population growth, but also factors such as erosion and desertification.



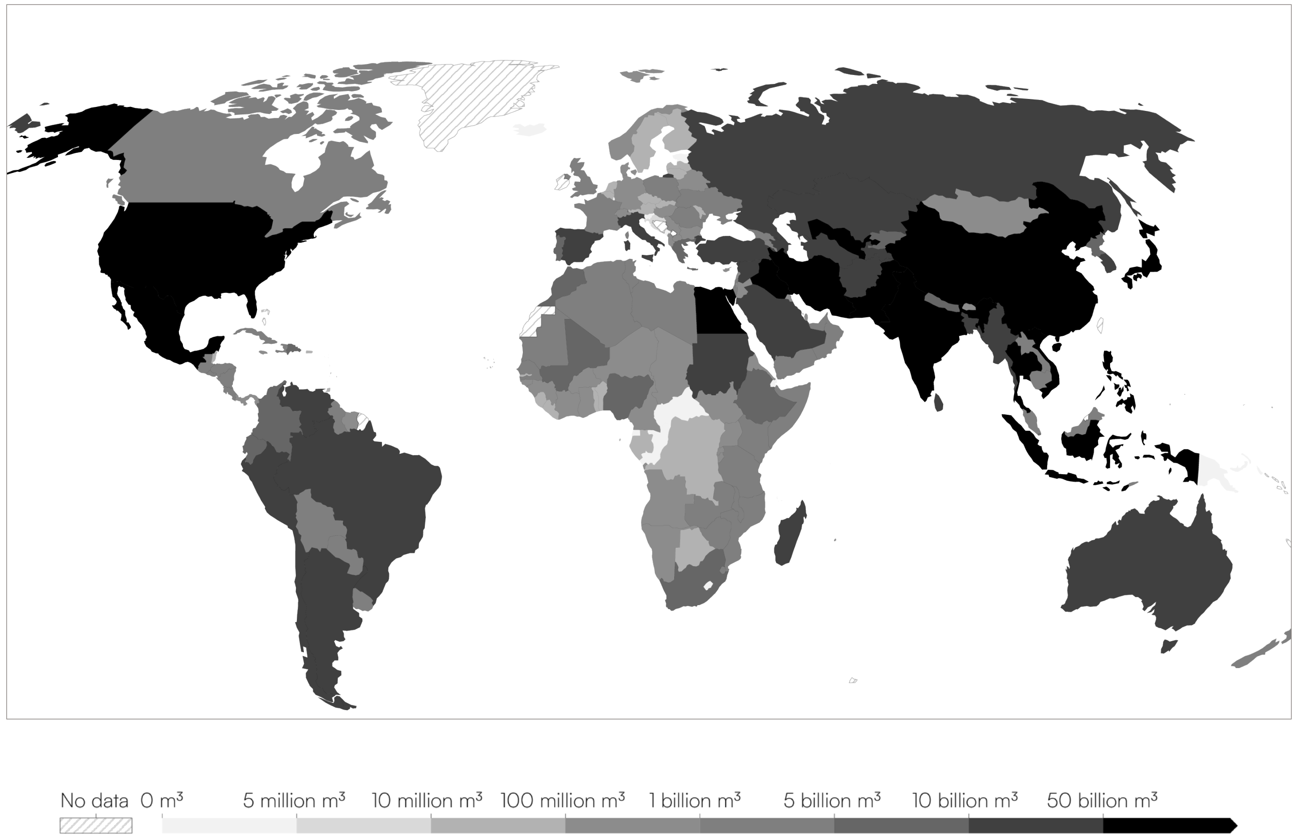
The population is growing, the amount of arable land per person is decresing. Source: UN 2017, FAOSTAT 2017, FAO 2012



Water for arable land

Water is a vital resource for global agriculture, being utilized through rainfed sources or pumped irrigation. The map shows the overall volume of freshwater withdrawals employed in agricultural activities, encompassing food crop production, livestock, biofuels, and other non-food crop production. It is important to note that data on agricultural water consumption is not typically reported annually but rather gathered over multiple-year periods.

In the year 2010, India emerged as the largest consumer of agricultural water worldwide, utilizing nearly 700 billion cubic meters per year. Over the years, India's agricultural water consumption has experienced rapid growth, nearly doubling between 1975 and 2010, driven by population growth and the increasing demand for food. China ranks as the second-largest agricultural water user, utilizing approximately 385 billion cubic meters in 2015.



Source: United Nations Food and Agricultural Organization (UN FAO) AQUASTAT Database

Consequences of climate change

Agriculture has a dual role in the context of climate change as both a contributor and a recipient of its effects. The escalating global temperatures are resulting in far-reaching consequences such as increased occurrences of droughts, floods, and storms. These climate-related events have substantial implications for natural resources and ecosystems on a global scale.

In the event of a 2°C temperature increase, several impacts can be anticipated.

- The availability of fresh water in the Mediterranean region is expected to decrease by approximately 17%.
- Agricultural yields in tropical regions are likely to undergo changes, with projected decreases of 16% for wheat, 6% for corn, and an increase of 6% for rice.
- The duration of hot spells is expected to extend by up to 1.5 months, exacerbating heat-related challenges.
- The intensity of heavy rainfall events is anticipated to increase by approximately 7%. As a result, sea levels are projected to rise by approximately 50cm, posing significant threats to coastal areas.
- It is estimated that 99% of coral reefs will face the risk of extinction from 2050 onwards.

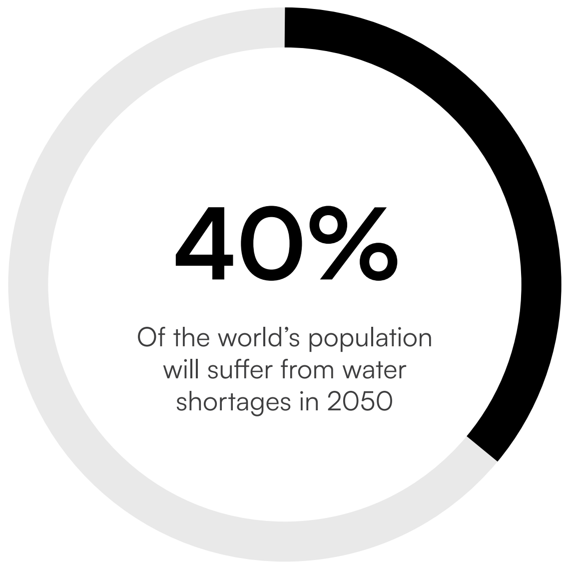
These projected changes underscore the critical need for proactive measures to mitigate and adapt to the impacts of climate change, particularly in the realm of agriculture and environmental preservation.

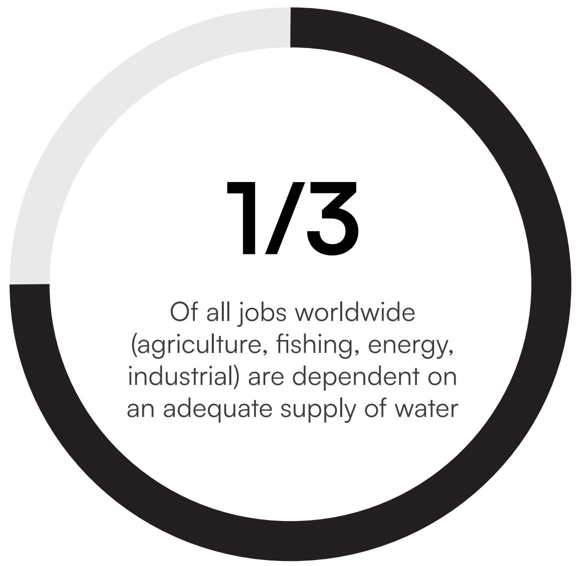
Source: Schleussner et al. 2016 in Earth System Dynamics 7: 327-351

Water a scarce resource

Water is a fundamental element that interlinks all aspects of existence. The availability of clean water and proper sanitation has the transformative power to convert challenges into opportunities. By granting individuals the freedom to allocate their time towards education and employment, it plays a pivotal role in enhancing the well-being of women, children, and families globally. Presently, a staggering 771 million people, equivalent to 1 in 10 individuals, endure the absence of safe water sources. Furthermore, a substantial 1.7 billion people, or 1 in 4 individuals, lack access to adequate toilet facilities.

Source: OECD 2012. UNESCO 2016





Soil loss

Soil serves as a habitat for more than a quarter of the Earth's biodiversity. Within each gram of soil, countless bacteria and fungi cells thrive, playing a vital role in various ecosystem services. However, the repercussions of soil degradation could lead to substantial losses amounting to $23 trillion by 2050 in terms of food, ecosystem services, and overall income worldwide, as stated by the United Nations Convention to Combat Desertification.

The United Nations further highlights that soil erosion has the potential to diminish crop yields by up to 10% by 2050, equivalent to the loss of millions of acres of farmland. This alarming trend not only jeopardizes our access to food and clean drinking water but also poses a significant threat to biodiversity. The loss of fertile soil poses a direct risk to global food security, as it undermines agricultural productivity and hinders the availability of essential resources.

Source: Grantham Center 2015, UNU 2014

1/3

Of the world's fertile soil is a risk, erosion, salinization and excessive fertilization are making increasing areas of arable land unusable for agriculture

62 mill ha

Of irrigated land are affected by this. This is equivalent to an area the size of France.

Species diversity loss

According to prominent United Nations experts, the decline in wildlife populations can be attributed to five primary factors: alterations in land and sea usage, unsustainable exploitation of natural resources, the effects of global warming, pollution, and the proliferation of invasive species. Between the years 1970 and 2018, wildlife populations have experienced a staggering average decline of 69%. The abundance of various animal groups, including mammals, birds, fish, amphibians, and reptiles, is rapidly diminishing, leading to the collapse of populations such as sea lions, sharks, frogs, and salmon.

Source: UNCCD 2016, Kew foundation 2016

27,000

Animals and plant species are lost globally every year

1 in 5

Plants species are at risk of extinction

Introduction Pianura Padana

Throughout the course of history, the Po River has played a pivotal role in the growth of human civilization and economic progress in Northern Italy. Originating from the Monviso Mount in the Western Alps and flowing all the way to the Adriatic Sea, the abundant waters of the river have provided nourishment for thriving crops such as maize, rice, and cereals. Additionally, these waters have been harnessed to generate crucial electric power, fueling the dynamic and prosperous industrial development that has positioned the Po Valley as the economic hub of Italy.

Since ancient times, the communities residing along the Po River have endeavored to manage its turbulent waters and mitigate the risk of floods. Their efforts aimed to safeguard the surrounding land for agriculture and human settlements. However, the Po River basin is currently confronted with significant challenges. Heavy pollution, inadequate management practices, and a growing population with limited environmental awareness and sensitivity pose a serious threat to the survival of the basin's unique ecosystems, which serve as vital reserves of biodiversity, economic and water accesibility.

This thesis aims to delve into the intricate interplay between the Po River and the landscape it traverses, offering a comprehensive exploration of its historical, ecological, and socio-economic significance that have shaped and continue to influence this vital watercourse. The Po River basin encompasses a rich reserve of unique ecosystems, teeming with diverse flora and fauna. Yet, these precious habitats are currently under severe threat due to factors such as rampant pollution, inadequate management practices, and a growing population with limited environmental awareness. Addressing these issues requires innovative approaches that not only restore the river's ecological balance but also foster sustainable coexistence between humans and nature. Contributing to a deeper understanding of the challenges faced by the Po River and proposing sustainable strategies for its preservation and future development. It is hoped that the findings of this research will contribute to a broader appreciation of the river's significance, foster environmental awareness, and inspire effective measures for the sustainable management. By exploring the potential of a floating platform as a transformative solution for integrating a multispecies design and regenerating the water quality and biodiversity of the Po River. By combining ecological restoration principles with innovative design concepts, the platform serves as a catalyst for fostering harmonious interactions among various species, including humans, flora, and fauna. Integrating a multispecies design approach not only enhances biodiversity but also promotes the regeneration of water quality. By leveraging the natural processes and interactions between species, the floating platform can act as a natural filtration system, improving water clarity, reducing pollutants, and restoring the health of the river.

Ultimately, this research aspires to contribute to the revitalization of the Po River ecosystem by proposing a holistic and sustainable approach that harmonizes human activities with the natural environment. By embracing a multispecies design and regenerating water quality and biodiversity, the floating platform represents a promising solution to address the challenges facing the Po River, fostering a resilient and thriving ecosystem for generations to come.


Fishing Structures, Guastalla, Reggio Emilia, Italy 2017 © Michael Kenna

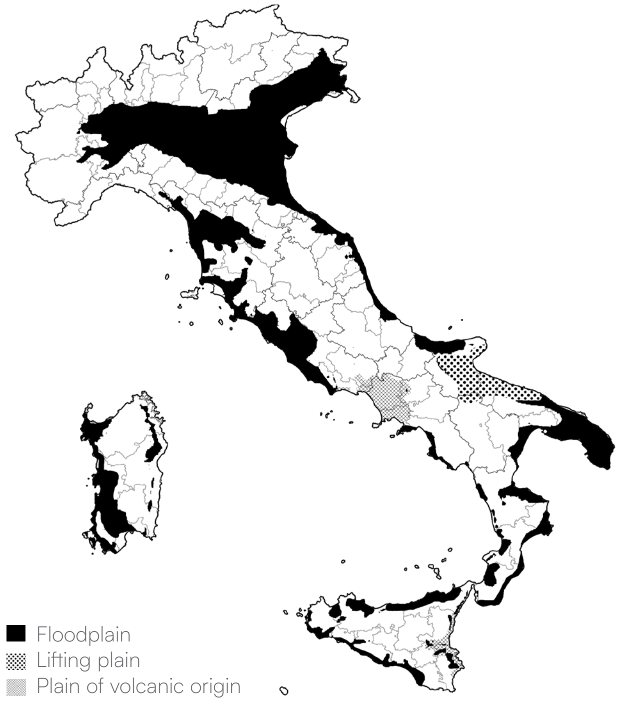

Ponti di Spagna, Bondeno, Ferrara, Italy, 2018 © Michael Kenna

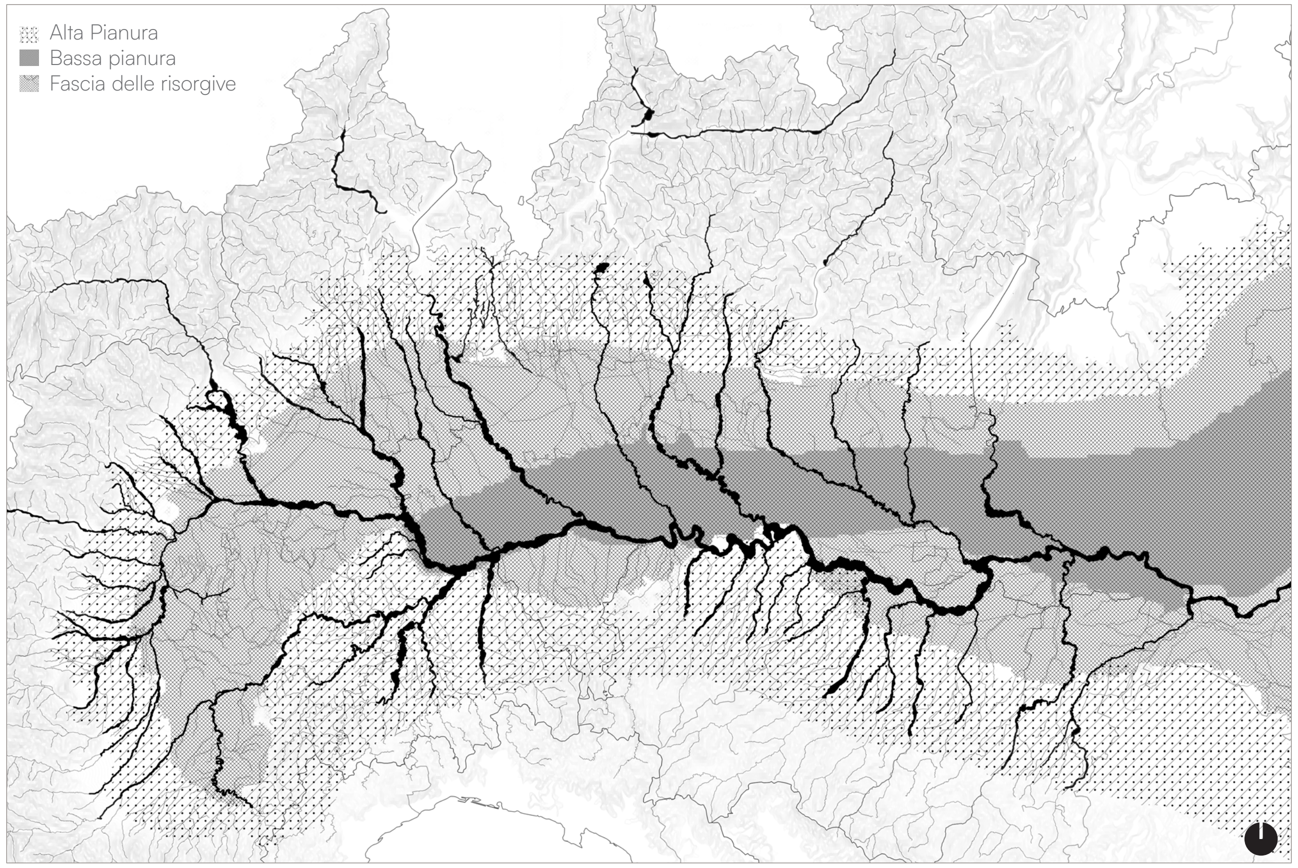
Location

Pianura Padana

The Po Valley, known as the largest plain in Italy, spans approximately 46,000 square kilometers. It is situated between the arc formed by the Alps, the Adriatic Sea, and the northern Apennines. This plain is characterized by its "alluvial" nature, lacking elevations higher than 300 meters above sea level. It was formed through the accumulation of sediment carried by various rivers that traverse the area, notably the Po, historically referred to as "Padus," from which the plain derives its name. The Po river has an expansive delta, contributing to the plain's designation as a nationally significant natural area.

The plain is the surface of an in-filled system of ancient canyons extending from the Apennines in the south to the Alps in the north, including the northern Adriatic. In addition to the Po and its affluents, the contemporary surface may be considered to include the Savio, Lamone and Reno to the south, and the Adige, Brenta, Piave and Tagliamento of the Venetian Plain to the north, among the many streams that empty into the north Adriatic from the west and north. Geo-political definitions of the valley depend on the defining authority.

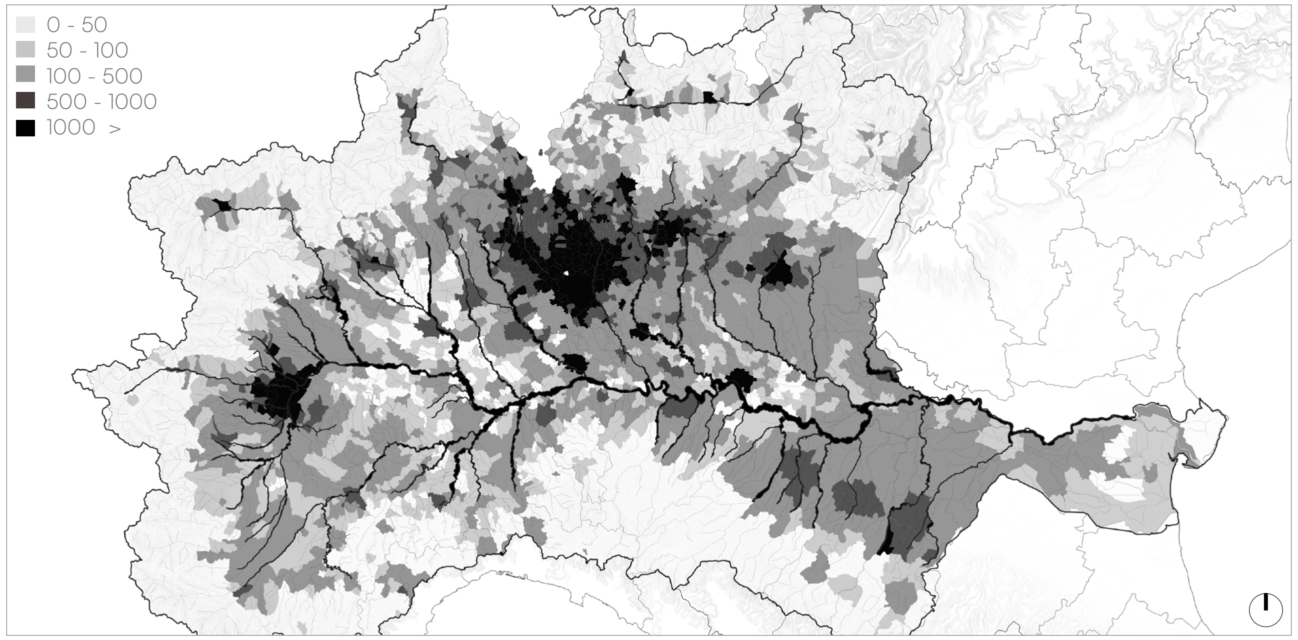




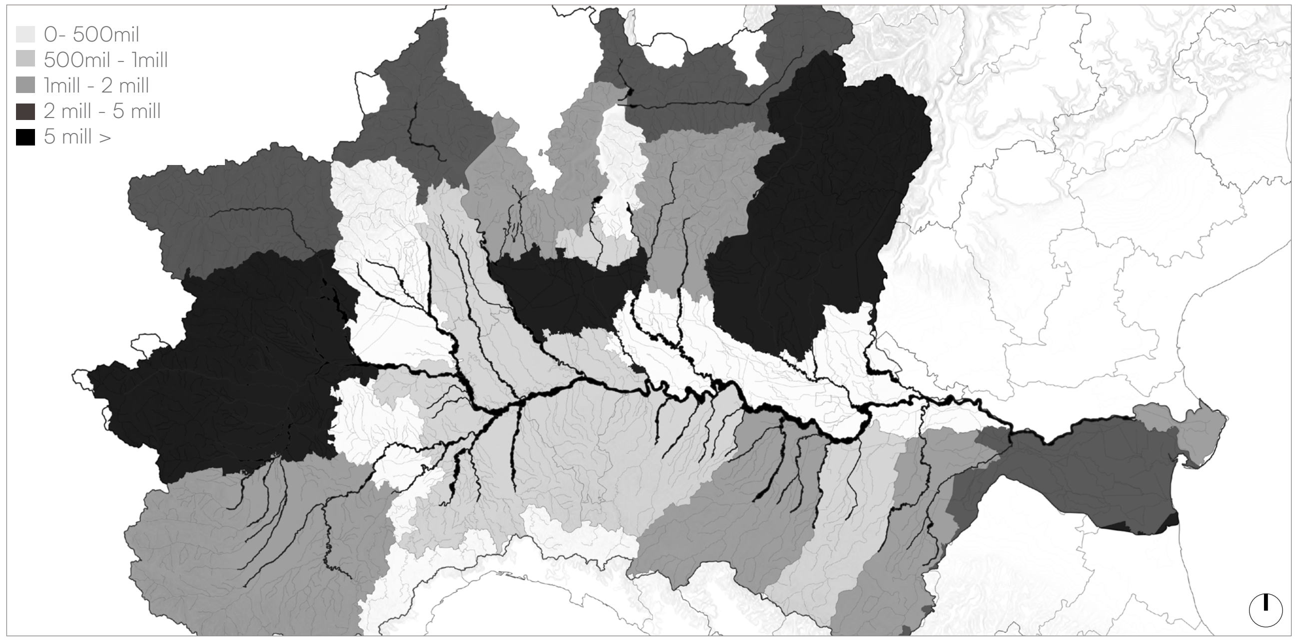
Pianura Padana

General Information

The Po valley has hot summers and severe winters (especially in the interior areas, far from the sea). It has a mild continental climate and a humid subtropical climate with annual precipitation ranging from 750 to 1,200 mm, the highest rains occur in springs. Upper Po receives more precipitations than Lower Po. The average temperature is about 5°C in high Alps, 5-10°C in medium mountains and 10-15°C in other areas. The average winter temperature is of about 3 °C and the summer average 23 °C. Extreme temperatures are more and more frequent. Rain falls mainly in the spring and autumn and increases with altitude. More than a third of all Italian citizens (about 23 million people), live in the Po Valley. In many areas, the population density (355 inhab. /km2) is almost double compared to the national average (203/km2.



Habitat density per kmq in the bacino del Po. Elaborazione dati regionali ISTAT 2011. Piano di Gestione Acque 2015 (PdGPO)



Tourist presence per province in the bacino del Po. Elaborazione dati regionali ISTAT 2010. Piano di Gestione Acque 2015 (PdGPo)

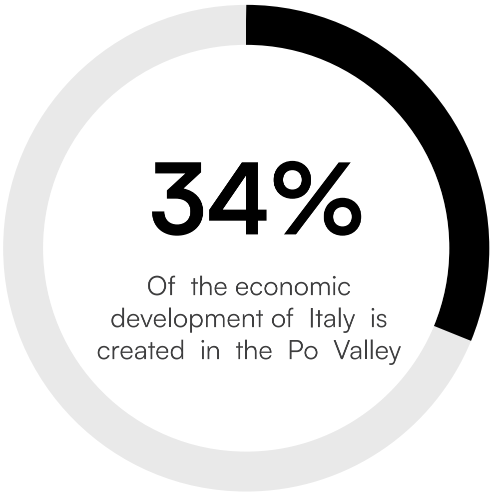
Economic importance

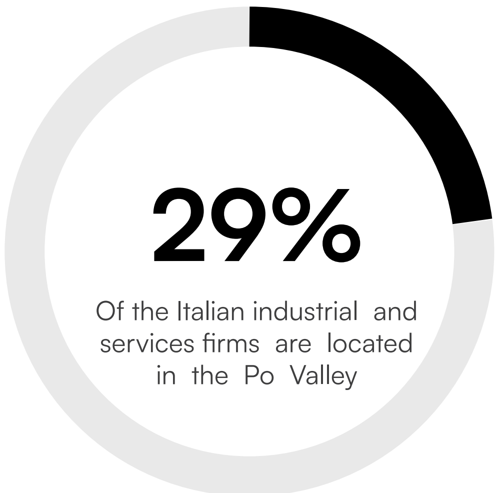
The level of economic development and economic vivaciousness in the Po river basin is very high: 34% of the value added of Italy is created in the Po river basin, due to a remarkable concentration of a wide range of agricultural, industrial and services activities; 29% of the Italian industrial and services firms are located there, spreading all over the basin, both in urban and rural areas. Most of the manufacturing firms are located out of the urban areas, in the industrial districts, the well known spatial model of economic development typical of the Italian economy. Some of the most important sectoral specializations in manufacturing of the Po basin are mechanics, textile and clothing, and food. The value added produced by this last sector in the Po basin accounts for 41% of the sectoral value added in Italy.

Some of the other most representative studies were carried out by Bagnasco (1977); Brusco (1982); and Garofoli (1991).

The Po Valley is the most important agricultural zone in the country. It produces some 40% of Italy's food including wheat, tomatoes and grapes. The Po basin hosts a large livestock population, approximately 3.1 M cattle (around 50 % of the national stock) and 6 M pigs (around 65 % of the national stock). ,700,000 hectares in the Po basin are classified as utilized agricultural area (about 40% of the total basin area): 59% of them are irrigated areas.

Calculations are based on Istat data about value added at current prices and number of active firms (2013; dati.istat.it).

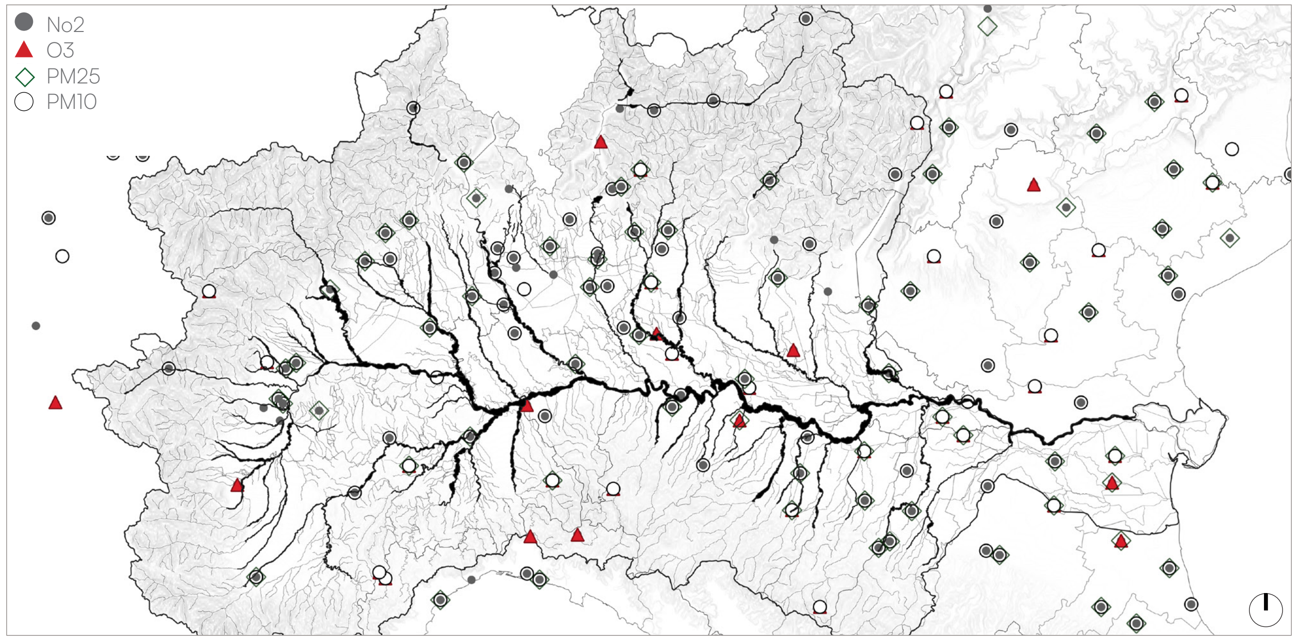




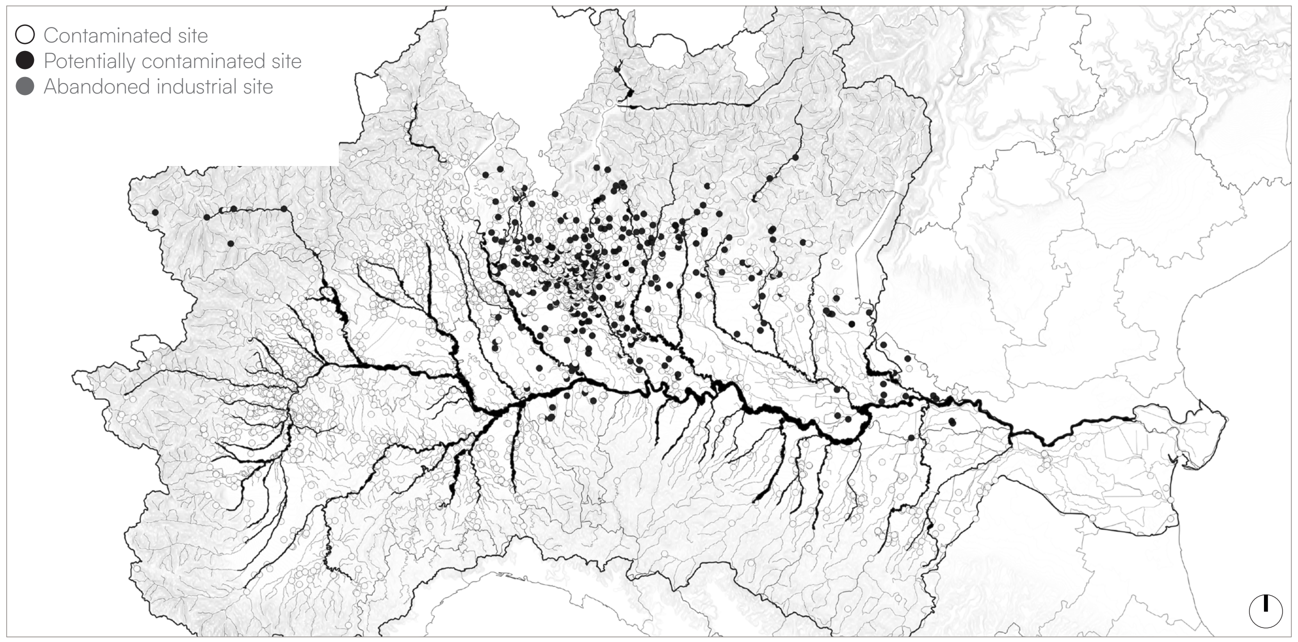
Pollution

The Po Valley represents an important exceedance zone of the air-quality limit values for PM (particulate matter), NO2 (nitrogen dioxide) and O3 (ozone). The area is densely populated and heavily industrialized. About 400.000 tons of NOx, 80.000 tons of PM, 250.000 tons of NH3 (ammonia) and only 50.000 of SO2 are emitted per year, into the atmosphere, by a wide variety of pollution sources, which are mainly related to traffic, industry and energy production and agriculture. Meteorological conditions and the resulting efficiency of the transport and dispersion of pollutants are strongly influenced by the morphological characteristics of the Po Valley and the Northern Adriatic Basin.

Improving Air Quality in the Po Valley, Italy: Some Results by the LIFE-IP-PREPAIR



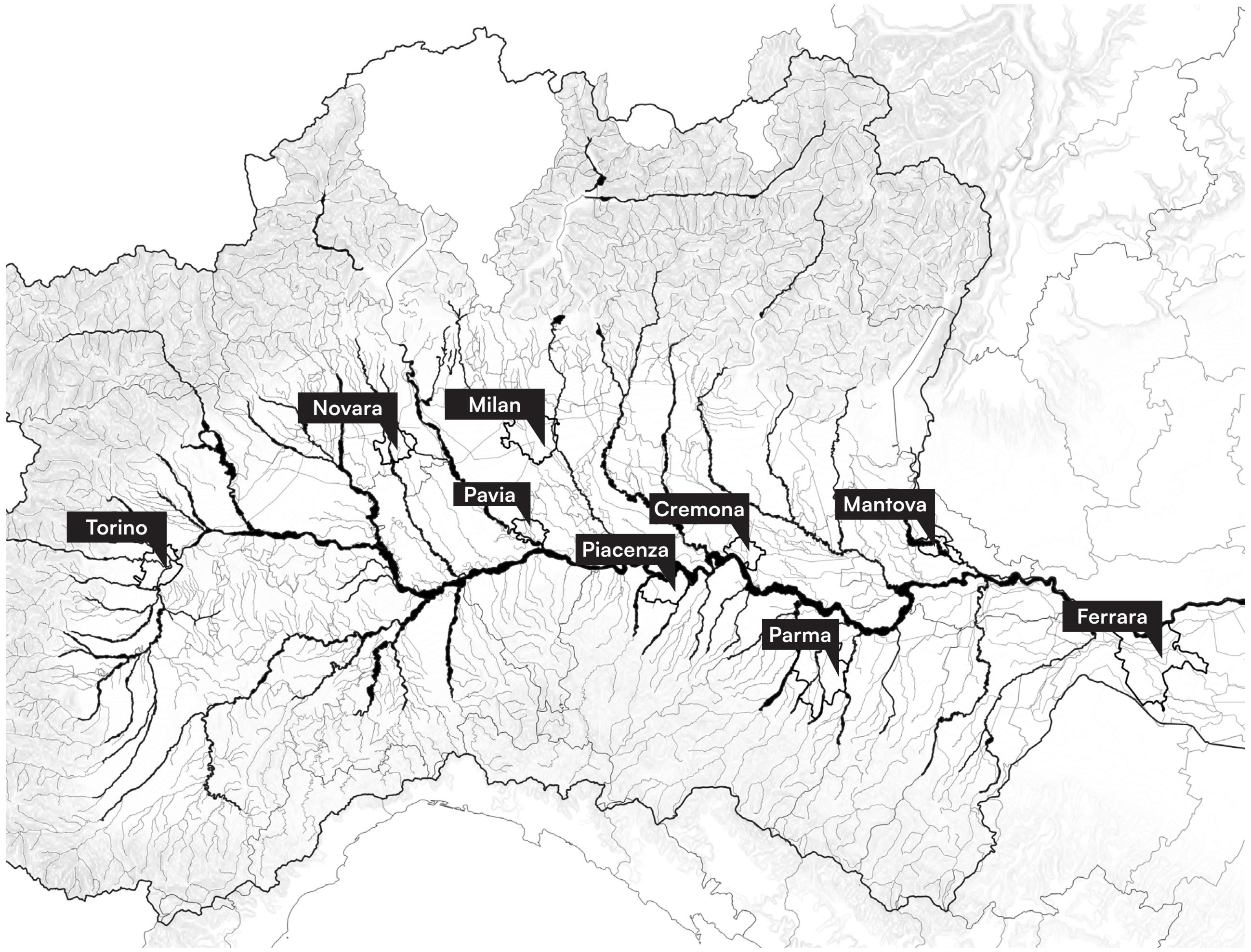
Classification of pollution sites in the Po basin. 2015 Water Management Plan (PdGPO)



Representation through theme of the characterization of contaminated sites in the Po basin. 2015 Water Management Plan (PdGPO)

Photo: European Union, Copernicus Sentinel-Deterioration of air quality in Northern Italy

River Po



The Po River Basin encompasses a mountainous watershed stretching from the Alps in the west to the Adriatic Sea in the east, covering a vast area of 74,700 km2. While a small portion, approximately 5%, of the basin extends into Switzerland and France, the majority lies within the northern regions of Italy. This region boasts the largest expanse of the basin, spanning 71,000 km2, as well as the longest main channel measuring 652 km and the highest discharge of 1,540 m3/s before reaching its delta. The river originates from the Monviso peak in the Cottian Alps and its delta, spanning 380 km2, empties into the Adriatic Sea north of Ravenna.

The Po River is nourished by a primary network of 141 major tributaries, collectively measuring 6,750 km. Additionally, it receives water from a secondary network comprising natural and artificial water bodies, irrigation and reclamation channels, which is approximately ten times larger, totaling around 50,000 km. The basin also encompasses about 600 km2 of glacier areas and is divided into 28 principal sub-basins, all characterized by varying and often substantial water discharge (AdBPo, 2006).

Covering approximately 71,000 km2, which constitutes around 24% of the Italian territory, the Po River basin stands as the largest single-river basin in the country. It is home to a population of 17 million inhabitants, accounting for approximately 28% of the national population. These inhabitants are distributed across seven regions (Piedmont, Valle d'Aosta, Lombardy, Veneto, Liguria, Emilia-Romagna, and Tuscany), as well as the autonomous Province of Trento, 24 provinces, and 3,210 municipalities. The downstream stretch of the Po River flows through the Padan Plain, a flat and fertile region that has attracted human settlement throughout history. Particularly in the 20th century, following the Second World War, this area experienced significant agricultural and industrial development.

History

The formation of the Po

Italy, geologically speaking, is a relatively young land that emerged predominantly as a result of the Alpine orogenesis, a recent tectonic upheaval. This orogenic event, although relatively mild, had a significant impact on the south-central Apennines. The consequences of this geological evolution were the complex tectonic movements and the formation of diverse geological features within a relatively small area. The physical landscape of Italy is shaped by the presence of the Alps and the Apennines, as well as the long, narrow shape of the peninsula, surrounded by the sea.

During the last glaciation, which occurred around 25,000 to 15,000 BC, fluvial systems in Italy experienced substantial changes. The Alps were extensively covered by glaciers during the Last Glacial Maximum, while the Apennines were only partially affected. Glaciers of considerable thickness filled the main alpine valleys, often reaching the present-day Po and Venetia-Friuli Plains. Additionally, the lowering of the sea level, approximately 120 meters below the current level, led to the emergence of a vast area of the Adriatic Sea, extending up to Ancona. Consequently, the river network developed across a vast plain that corresponds to the upper part of the present-day Adriatic Sea.

The response of fluvial systems to the transition from the last glacial period to the interglacial period varied across different river systems. However, during the Last Glacial Maximum, aggradation, the process of sediment accumulation, was the dominant process, resulting in the formation of large portions of the present-day plains. Subsequently, many rivers experienced a significant phase of incision, leading to the formation of terraces and downstream shifts in deposition zones. This phenomenon is well-documented in the Venetia-Friuli Plain, where the incision of the upper portion of the plain corresponds to sedimentation in the lower portion.

Sea levels rose rapidly during the early Holocene but slowed down over time, with rates of increase of approximately 10-11 mm per year between 10,000 and 6,800 years BC, and 1.5 mm per year in later periods. These changes in sea level initially caused upstream shifts of river mouths, while later on, sea protraction became the dominant process, resulting in the formation of the present-day Po River Delta.

In the past century, the Po delta has undergone a transformation, transitioning from a phase dominated by fluvial processes that resulted in advancement, to a phase where marine processes predominate, leading to retreat at rates exceeding 10 meters per year (Cencici, 1998).

Between 1807 and 2005, the flow rate of the Po river at Pontelagoscuro, which marks the endpoint of its hydrographic basin, experienced a gradual but steady decline, decreasing from approximately 1600 m3/sec to 1400 m3/sec (Zanchettin et al., 2008).

At present, the Po river forms a delta that stretches about 25 km into the sea, forming a meridian arc of approximately 90 km. It covers an area of about 400 km2 and is surrounded by a vast submerged prodelta area, extending around 6 km northward and approximately 10 km in the central-southern region (Biondani, 2008). The delta system is now composed of seven main branches: Po di Pila, Po di Maistra, Po di Tolle, Po di Gnocca, Po di Goro, Po di Volano, and Po di Levante.

Photos: Barlera, Luigi (notizie dal 1969)

Origins

The formation of the Po

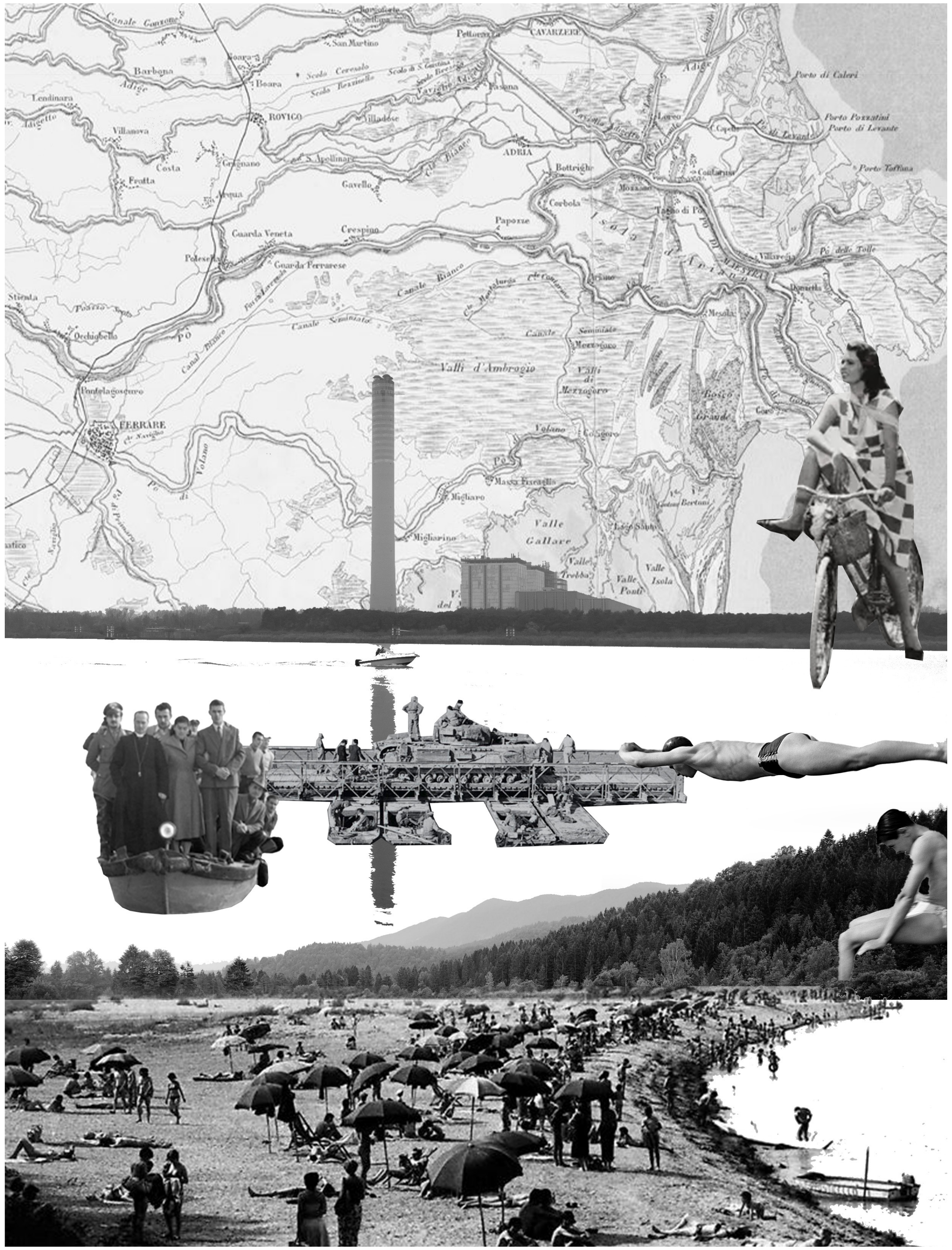
The formation of the Po Plain took place between the Pliocene, approximately 5-2 million years ago, when the sea reached the Alps and the Apennines, and the Wurm, the last glacial period, which occurred around 75,000-10,000 years ago. It was only around 5,000-6,000 years ago that the coastline along the Adriatic Sea stabilized, allowing for a more precise understanding of the evolutionary process of the Po River mouth.

- Bronze Age (5,000 years ago): During this period, the Po River bifurcated near Guastalla in the lower Reggiana plain, giving rise to two branches: the Po di Adria in the north and the Po di Spina in the south.
- 8th century BC: A major flood at Sermide led to the decline of the Po di Adria, and a new course was formed through Calto and Stellata, rejoining the Po di Spina.
- Etruscan Epoch (6th-5th century BC): The significant activity of the Po di Spina led to the creation of two branches beyond Ferrara: the Olana (later known as Volano) and the Padoa.
- Roman Age: The Delta developed south of Comacchio, while the town of Adria was situated within a gulf.
- 6th-7th century AD: The Po di Spina ceased to exist, and the marshes around Comacchio expanded. The Po di Volano in the north and the Po di Primaro in the south became more prominent, with the town of Ferrara emerging at their branching point.
- Year One Thousand: Reclamation activities conducted by the Benedictine monks of Pomposa around the Po di Volano, combined with subsidence, resulted in the brackish waters penetrating the marshes of the Po Plain. This significantly altered the landscape.
- 1152: A historical flood known as the “Rotta di Ficarolo” caused the river’s course to straighten towards the north. Over the following centuries, the Delta gradually extended in that direction.
- 1598: The Delta expanded towards the north, forming branches called Tramontana, Levante, and Scirocco. In particular, the Po di Tramontana began to raise the lagoon bed towards Chioggia with its sediments.
- 1600-1604: In the early 17th century, due to concerns that the Delta’s expansion to the northeast would lead to the silting up of the Venice lagoon, the river Po was diverted south towards Sacca di Goro through an artificial channel, which remains its current course.
- The Years after Porto Viro Cut-Off: Following the Porto Viro cut-off in 1604, new lands emerged within a few decades. The lands, cultivated with rice, were in precarious conditions due to low embankments that were periodically breached by water. This allowed for slow reclamation efforts and the accumulation of sediments but also resulted in crop destruction.
- 19th century: In the mid-19th century, significant investments were made in large estates in the Veneto region, driven by the initiative of landowners. Steam power was introduced to agricultural machinery and other instruments. Despite these efforts and innovations, sea floods and the channeling of the river persisted.
- The Unification of Italy: In 1882, the Baccarini law was enacted, marking the first instance of state funding granted to Reclamation Consortiums. This allowed for the drainage of certain territories, including the Isola di Ariano, where the Dewatering Pump of Ca’ Vendramin was created.
- The 1940s: During this period, the discovery and extraction of methane supplies from methane water resulted in a subsidence of over 3.5 meters below sea level. The extraction of water from the first 250/300 meters of non-consolidated sediments released methane gas at low pressure.
- 1951: Downstream from Ferrara, the river Po, which had been progressively enclosed by higher and higher embankments over the years, experienced an accelerated flow, leading to increasingly intense floods.
- 2000: The Po Delta is situated entirely below sea level, except for embankments, sandbars, and fossil dunes. The water management of the region is overseen by the “Consorzio di Bonifica Delta Po-Adige,” which manages a crucial drainage water system equipped with powerful dewatering pumps with a capacity of 6,000-7,000 kW. These pumps can lift up to one billion cubic meters of water per year, channeling it into drainage systems.

Source: Parco Delta Po Org

History

Collage of historical uses of the river



1735 map of the Po River Valley (Italy)

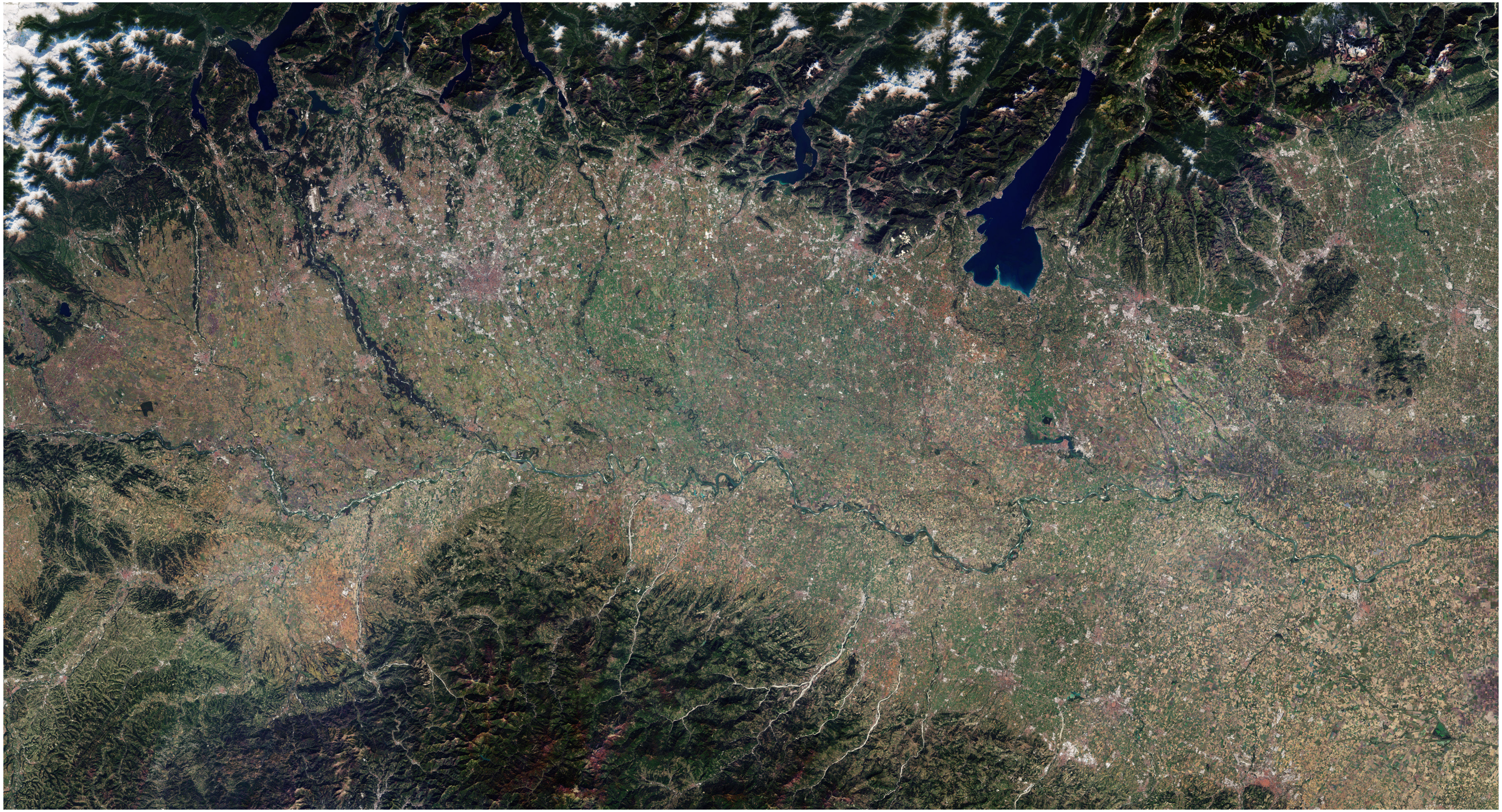
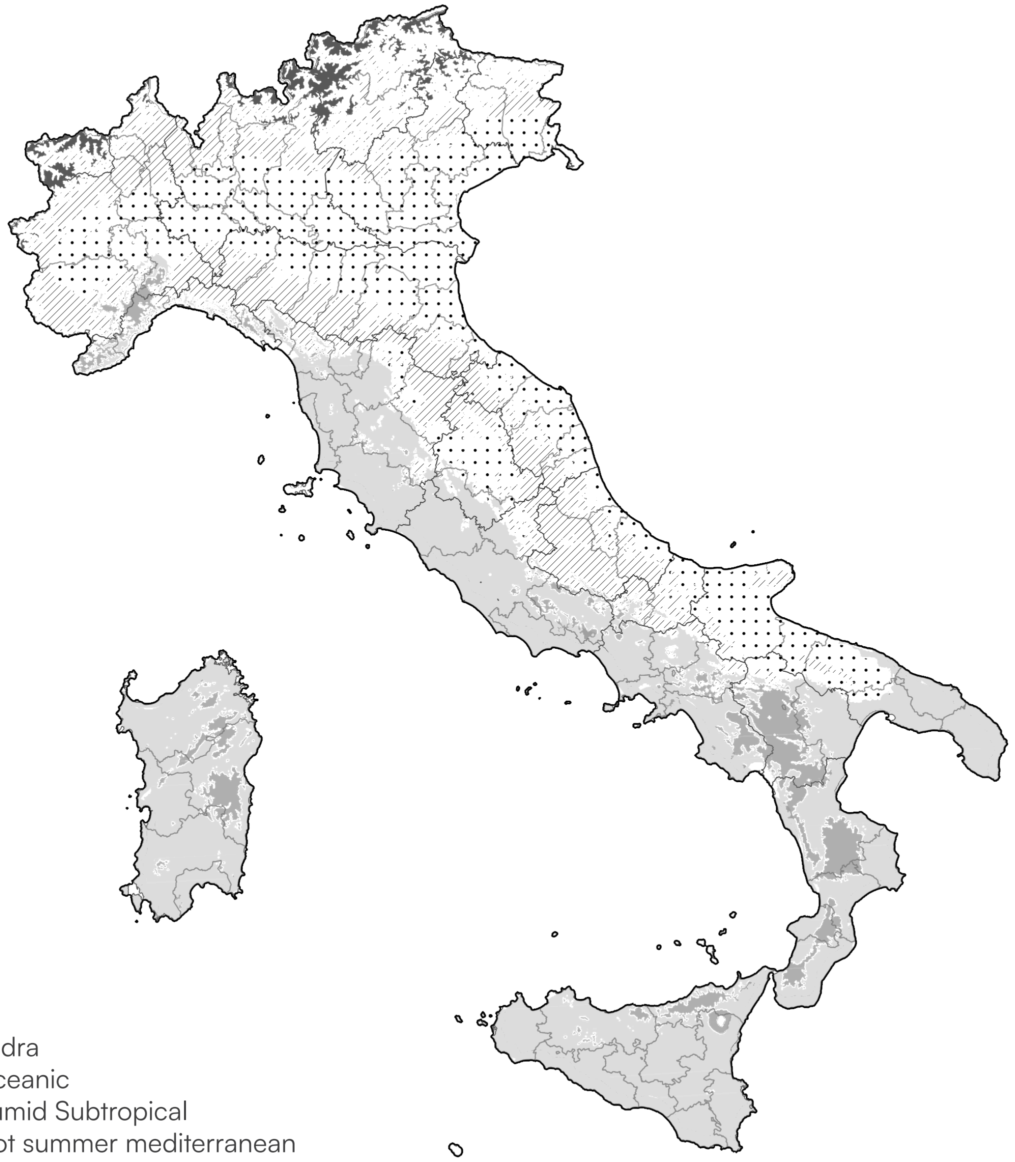


Photo: Po Valley, Italy Copernicus Sentinel data (2018—19), processed by ESA, CC BY-SA 3.0 IGO

Characteristics of the River Po

Climate



Koppen-Geiger climate maps with classification for Italy

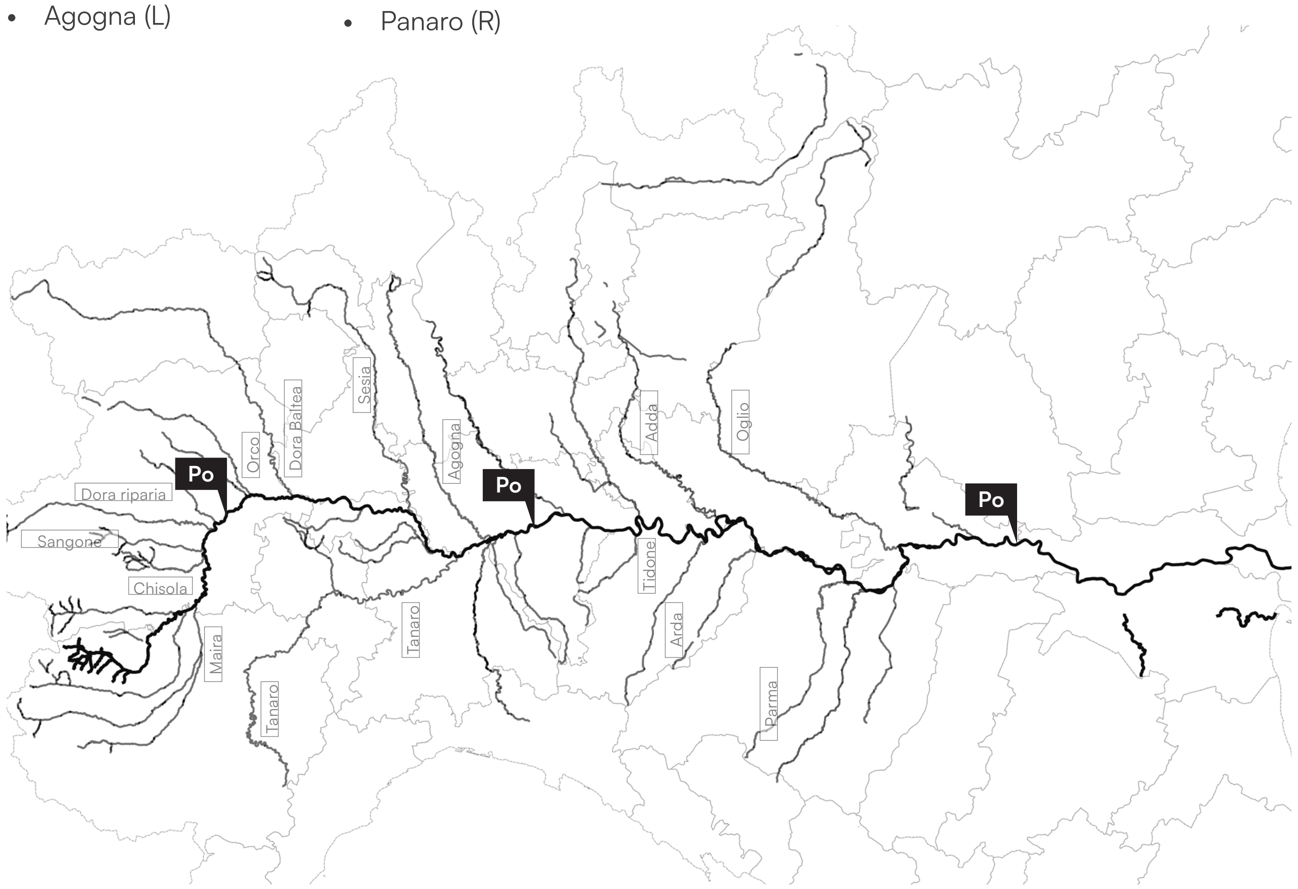
The Köppen climate classification system, established by Wladimir Köppen, a German botanist and climatologist in the late 19th century, classifies climate zones worldwide by taking into account the local vegetation. This system builds upon previous biome studies conducted by scientists. The climate of the Po Basin is characterized by its complexity and variation, which can be attributed to its geographical location and the diverse morphology of its different sectors.

As a result, the climate in the Po River Basin falls within the transitional zone between the sub-continental climate of Central Europe (Alpine and Boreal) and a Mediterranean climate (Warm Temperate). This classification aligns with Köppen's classification as discussed in Strahler and Strahler (2000).

River as a system

The Po River is fed by a total of 141 tributaries. Here is a list of some of the major tributaries, with "R" indicating the right bank and "L" indicating the left bank when looking downstream:

- Pellice (L)
- Varaita (R)
- Maira (R)
- Chisola (L)
- Sangone (L)
- Dora Riparia (L)
- Stura di Lanzo (L)
- Malone (L)
- Orco (L)
- Dora Baltea (L)
- Stura del Monferrato (R)
- Sesia (L)
- Rotaldo (R)
- Grana del Monferrato (R)
- Tanaro (R)
- Scrivia (R)
- Agogna (L)
- Curone (R)
- Staffora (R)
- Ticino (L)
- Versa (R)
- Tidone (R)
- Lambro (L)
- Trebbia (R)
- Nure (R)
- Adda (L)
- Arda (R)
- Taro (R)
- Parma (R)
- Enza (R)
- Crostolo (R)
- Oglio (L)
- Mincio (L)
- Secchia (R)
- Panaro (R)



Internal navigation

Around the course of the Po, in the lower middle stretch (from the confluence of the Ticino to the sea, about 400 km), which is the historical axis of waterway navigation in the Po valley, the waterway network has developed over time along the lines of internal penetration, above all the pole of Milan, and outlet in the Adriatic Sea.
Today, commercial navigation on the Po is limited to Cremona, except for periods of high water (the basin of the Isola Serafini hydroelectric dam is no longer functional in low water conditions due to the substantial lowering of the riverbed that has occurred), and carries out:

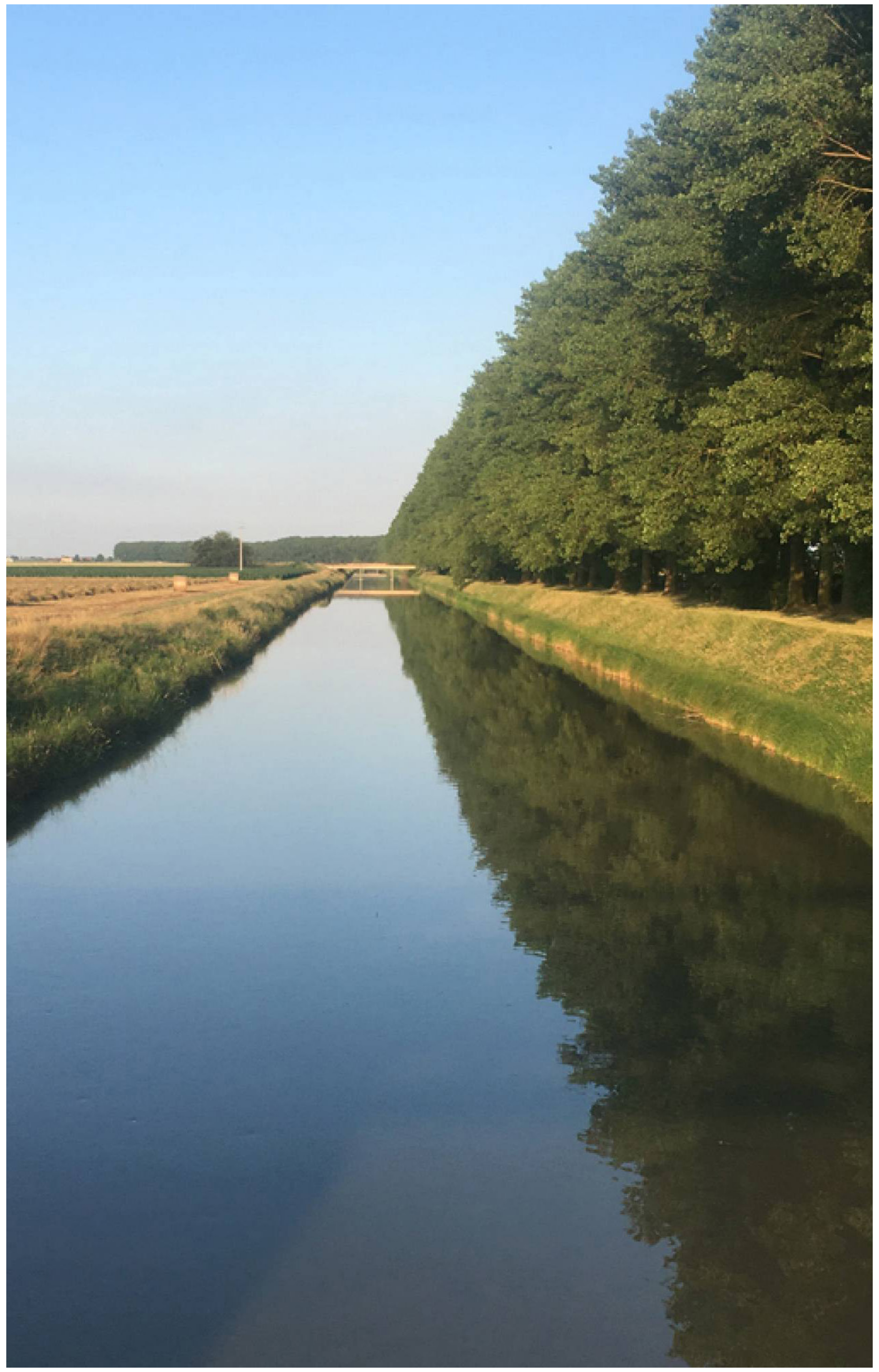
- on the Po and Mincio rivers (from the Po to Mantua), serving the ports of Cremona and Mantua, of the docks of Boretto (RE) and Casalmaggiore (CR), of the fluvial ports of Ostiglia, Sermide and Isola Camerini;
- on the Po Brondolo canal, connected to the Po by the Volta Grimana basin, and on the lagoon canals for the relationship with the ports of Venezia Marghera and Chioggia;
- on the Po di Levante for fluvial-maritime traffic with the ports of the lower Adriatic, Istria and from Dalmatia;
- on the Ferrarese waterway, limited to the relevant river-maritime relations.

Ferrara, given that the communication basin with the Po, in Pontelagoscuro, is undergoing reconstruction after the lowering of the river bed put it out of service. The overall traffic is modest and mainly involves: petroleum products, kaolin and clays, grains and flours, liquid petroleum gas, timber, chemicals, exceptional loads, goods. The current configuration of the waterway network is not adequate for the needs of commercial shipping in many respects; the most onerous limits come essentially from the presence of bottlenecks on the canals that connect the Po to the seaports and from the insufficiency of the Po seabed during lean periods.

In the following, we intend to briefly represent the aspects connected to the waterway network as a factor in the use of the water resource, which concern, in addition to the direct use of water, also the hydraulic and morphological structure of the Po river branch. Even the waterway system, like other water-using infrastructures, has gradually been created without an assessment, at a precise and overall level, of the aspects connected to the use of the water resource and to the interactions with the structure. physics and hydraulics of the natural and artificial hydrographic network; the systemic and punctual effects in fact have a different significance and a different weight at the basin level. The interventions on the auction, for example, can affect and modify, as a whole, the hydrogeological structure and the safety conditions of the surrounding territories. From this point of view, external interventions (specific infrastructuralisation, canals, basins, etc.) generally have a less marked interaction, allowing for easier impact mitigation interventions.

Source: Parco Delta Po Org

Photos: VENTO



Photos: VENTO

Photos: VENTO

Photos: Furio Chiaretta

Photos: Furio Chiaretta

Photos: Furio Chiaretta

Photos: Furio Chiaretta

Cultural and landscape heritage

So far, the Basin Authority has addressed the issues surrounding cultural heritage and the landscape by developing various informational tools. These tools aim to establish a knowledge framework and identify potential challenges that may arise from the interaction between hydraulic defense interventions and individual cultural assets or valuable environmental contexts. To begin with, a comprehensive synthesis has been created on a basin-wide scale, focusing on regional and provincial planning in the landscape field. Additionally, in collaboration with the Ministry of Cultural Heritage and Activities (ICCD), a census of the existing cultural heritage along the Po River branch has been conducted.

As part of the preparatory studies for the Hydrogeological Structure Excerpt Plan (PAI), a thorough census of naturalistic, landscape, and environmental emergencies in areas affected by hydraulic and/or hydrogeological instability has been carried out. This includes an analysis of risk factors in relation to conservation and safeguarding requirements. The plan also provides a historical and landscape overview of the basin, identifying key landscape systems and geographically homogeneous areas based on morphological, territorial, and historical-cultural characteristics.

It is important to note that both the census activity and the study of historical and landscape aspects rely on existing literature sources and documentary information databases provided by competent administrations and bodies, both functionally and territorially. Through these activities, a territory has emerged with significant landscape diversification, where areas of high environmental value coexist, such as Monte Baldo, renowned for its exceptional flora and fauna. In fact, it was already referred to as “Hortus Italiae” and “Hortus Europae” in the 17th century. However, this diversity is juxtaposed with large urban and metropolitan areas, such as Milan and Turin, which have experienced significant environmental alterations.

The basin’s areas of instability have approximately 13,500 landscape emergencies, including architectural and environmental assets, monuments, complexes, and archaeological sites. Moreover, about 300 areas of historical interest have been identified. Along the entire stretch of the Po River, covering the territory of 181 municipalities from Monviso to the Delta, a total of 6,307 architectural and environmental assets, 63,275 archaeological assets, 190,682 artistic and historical assets, as well as 726 book and archival assets have been documented.

Overall, the area of the basin has undergone serious degradation processes, especially in recent decades. The expansion of settlements and related infrastructures, the industrialization of the economic-productive base, have blurred or canceled specificities and differences, altered or destroyed many original landscapes. Today, despite the fact that there is almost no demographic growth and generally low other development parameters, land consumption continues, while the recovery of abandoned spaces rarely becomes an alternative to urban expansion; the agricultural landscape undergoes a progressive simplification and homologation; the mountain and hilly landscapes, historically inhabited and shaped by human action, are affected by the abandonment of agriculture and traditional forms of land use and management; the hydrographic network has undergone alterations of the geomorphology and the river environment; the coastal landscape is characterized by the degradation of the coasts and the typical vegetation, the historic network of connections is also characterized by a widespread degradation due to uses and transformations that have altered its meaning and value. Finally, further damage is caused by illegal building, whose main objectives today seem to be coastal areas and peri-urban agricultural areas.

In relation to the state of affairs as highlighted above, the conservation and enhancement of the building, infrastructural and landscape heritage of historical-cultural interest still present in the basin requires an effort in the direction of coordinating the policies for its management with those for soil protection, in particular by identifying the main critical links that can arise between enhancement requests and defense and security needs.

The information collected are the formal documents (inventories, catalog cards, constraints) produced by the entities individually competent for the types of assets considered, pursuant to the provisions of Laws 1089, 1497,431 and, where existing, by regional regulations.

San Giovanni in Croce, Cremona

Torricella del Pizzo, Cremona

Castello Sforzesco-resti, Mugarone

Villa della Regina, Torino

Palazzo Paleologo, Trino

Villa Torello-Malaspina, Gualtieri

Fauna & vegetation

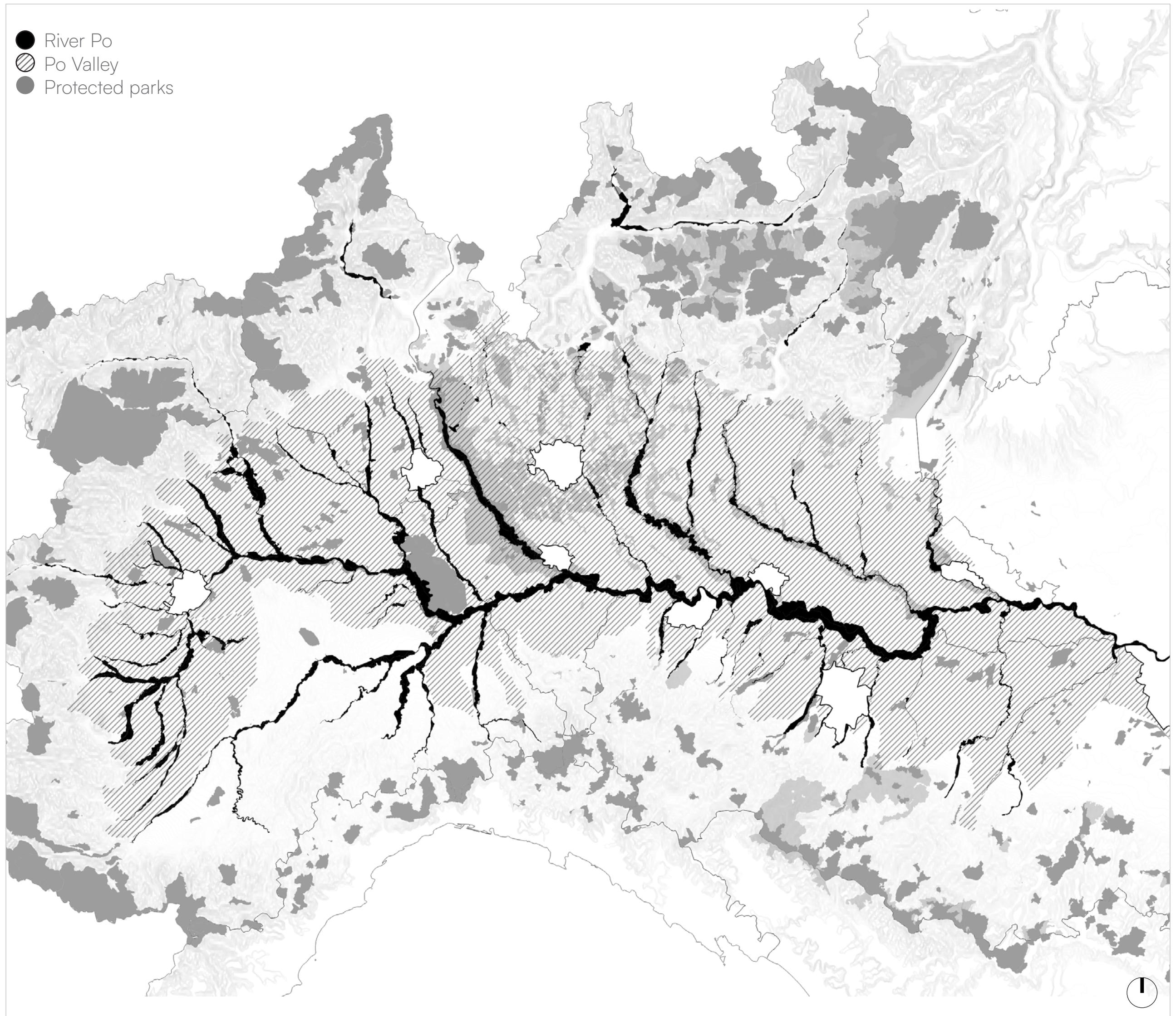
Characteristics

The Po Basin possesses significant ecological value primarily associated with its freshwater ecosystems. These ecosystems exhibit a remarkable level of biodiversity and provide crucial support for numerous plant species facing threats in Italy. Notable among these threatened species are the summer snowflake, European white waterlily, marsh fern, arrowhead, bladderwort, and various orchid species. The wetlands within this ecoregion serve as a vital breeding ground for herons, particularly the squacco heron, black-crowned night-heron, and little egret, making them the most important heron breeding area in Italy. The presence of waterbirds is also substantial, with a consistent population of over 20,000 individuals, including storks, ducks, terns, hawks, kites, and plovers.

Endemic fish species are prevalent in the area, and the valleys play a crucial role as nurseries for numerous rare and/or threatened species. Notably, the critically endangered Adriatic sturgeon, unique to the region, and the endangered Italian nase are reliant on these habitats for their survival. Despite being one of the most industrialized regions in Europe, the Po Basin has a history of substantial human impact. The remaining flora and fauna within the ecoregion have suffered recent degradation, largely due to pollution of water, soil, and air resulting from human activities. Another pressing issue is the increasing water scarcity and the consequent drying up of wetlands caused by excessive withdrawal of groundwater for irrigation and human consumption, surpassing the natural replenishment rate. Additionally, the River Po faces a significant threat from invasive species, notably the stone moroko fish and wels catfish, large-bodied predators introduced to the area, which pose a danger to native flora and fauna. The invasion of black locust trees in forested areas further exacerbates the challenges faced by the remaining natural forests.

Vegetation

Protected areas



Rete Natura 2000 - PdGPo 2021 (Distretto Po)

The existence of protected areas, both natural and semi-natural, serves as a significant indicator of the level of natural preservation within the Po basin. In total, there are 210 protected areas in this region, encompassing approximately 517,000 hectares. This area accounts for 7% of the basin's total land area and approximately 26% of Italy's entire protected territory.

The largest portions of protected areas consist of national and regional parks, which make up approximately 88% of the entire protected area in the basin. State and regional reserves cover around 9.4% of the area, while wetlands account for 0.7%. The remaining 1% encompasses other protected areas, such as oases, natural monuments, suburban parks, and similar classifications, which do not fall under the previous categories mentioned.

Sandbanks

The different environments that characterize the protected areas of the Po have a peculiar vegetation, mainly due to the existing ecological conditions, largely influenced by the river.

The sandbanks represent an ecological situation in continuous change, as they are governed by the annual flow rate of the river. During the lean period of the Po (summer and winter) the islands can be colonized by annual plants characteristic of the warmer areas of the plain such as paleothin (Vulpia myuros), knotweed (Polygonum lapathifolium), water pepper (Polygonum hydropiper), from buttercups typical of sandy environments with stagnant water, from perennial stoloniferous plants that manage to remain tied to the ground even during river floods. Generally in these environments the herbaceous plants have an advantage due to their minor biological needs, the trees encounter greater difficulties; only some willows manage to survive even on the sandy beaches.

Il giornale. Davide Bregola

Kulturtrek. Giovanna Bellandi e Craig Alexander

Vulpia myuros Sheldon Navie

Polygonum hydropiper by Show Ryu

Oxbow lakes

The oxbow lakes, originating from a stretch of river abandoned by the watercourse, are the areas where the river deposits large quantities of organic matter and nutritional salts during floods and for this reason they host a rich fauna of both invertebrates and vertebrates, that find food and places suitable for reproduction. The ecosystem of the oxbow lake is always threatened both by the artificial contributions of earthy material for the creation of new agricultural lands, and by the natural silting due to the progressive depositing of organic matter. In these areas there is no high current, therefore the plants have developed the ability to root on the bottom through large roots and rhizomes, here we find the nannufaro (Nuphar sp.) and the water lily (Nymphaea)

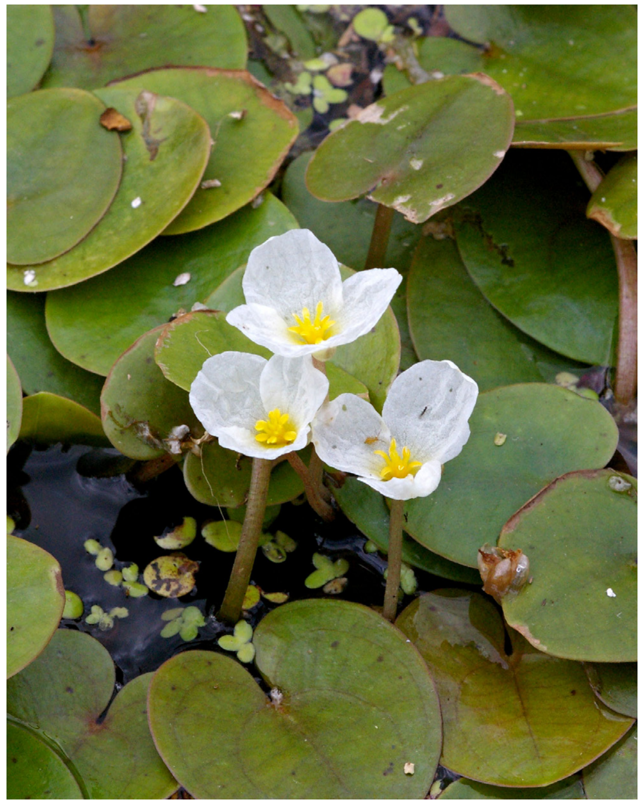
A similar situation is presented by the aquatic knotweed (Polygonum amphibium) which has characteristic elongated leaves lying on the surface of the water from which the flower spike emerges. The frog bite (Hydrocharis morsus ranae), on the other hand, does not root on the bottom but carries root tufts at the lower end of the stem which fish directly in the water; it loves clear and well-oxygenated waters and is characterized by kidney-shaped leaves that float on the water among which delicate white flowers with only three tepals emerge. The small floating salvinia fern or fish grass (Salvinia natans) has leaflets in whorls of three, of which the third has transformed into root filaments and is immersed in water from which it takes the dissolved mineral substances.

Ninfea gialla (Nuphar lutea (L.)
(foto di: Roberto Ostellino)

Fiume Po da Stellata a Mesola e Cavo
Napoleonico: Nicola Quirico/CC BY-SA 4.0

Polygonum amphibium By Svdmolen

Salvinia natans By Saratov Oblast



Hydrocharis morsus ranae by Christian Fischer

Reedbed

The reedbed comprises of herbaceous plants that establish their roots in the seabed in close proximity to wetland areas such as oxbow lakes, marshes, and ponds. These wetlands are predominantly dominated by mazzasorda (Thypha latifolia), accompanied by an undergrowth of water fern. Another common plant found in abundance is the common reed (Phragmites australis), which provides a nesting habitat for numerous bird species closely associated with this environment. Beyond the reeds, there is a zone characterized by shrubby willows. During spring and summer, this area becomes saturated with water, creating favorable conditions for the growth of ashen willows (Salix cinerea) in particular. However, due to the fluctuating water levels, the natural vegetation has recently been affected by the invasion of a weed called bastard indigo (Amorpha fruticosa), an American legume.

Typha latifolia

Phragmites australis

Salix cinerea by Paola Paiero

Amorpha fruticosa Lugana di Sirmione

Canals

The irrigation canals that flow into the Po River support a distinct type of aquatic vegetation that is well adapted to thrive in fast-flowing waters. These plants, belonging to the genus Potamogeton (pondweeds), are primarily submerged and firmly rooted to the canal bed. Their remarkable adaptation to an aquatic lifestyle is evident in their unique method of pollination, which takes place through water. Among the aquatic flora found in these habitats are the aquatic buttercups (Ranunculus fluitans and Ranunculus trichophyllus). These plants exhibit special adaptations in their submerged median and basal leaves, which transform into elongated and slender lacinias capable of withstanding the constant force of the water's current.

In addition to these species, there are also tiny plants that inhabit these environments, often measuring only a few millimeters in size. Duckweed (Lemna sp., Spirodela sp., Wolffia sp.) is one such example. These plants lack root structures that anchor them to the bottom, allowing them to float on the water's surface and be carried along by its movement. Furthermore, small aquatic ferns like azolla (Azolla sp.) can be found in these canals. With their intricately arranged leaflets, azolla can completely cover the surface of open water, creating a dense mat of vegetation.

Potamogeton (brasche) by Maksym Rudik

Ranunculus fluitans by M. Hassler / Karlsruhe - Alb

Common duckweed (Lemna minor)

Spirodela sp. Marais Poitevin

Azolla sp. Flora Fauna Web

Gerbids

In arid habitats such as gerbids, water is scarce and rarely present. These areas are typically found near large rivers, on terraces with highly permeable and gravelly soils. Water can only reach these habitats during exceptionally high floods. Despite these challenging conditions, hygrophilous tree species manage to survive by extensively rooting deep into the groundwater. Herbaceous species, on the other hand, face extreme drought conditions. Clearings within these habitats are often dominated by the cypress euphorbia (Euphorbia cyparissias), which thrives in arid environments thanks to its resilient rhizomes. Sedges, including the lustrous sedge (Carex liparocarpos), also proliferate due to their thin and lengthy rhizomes.

Certain bulbous plants, such as the blue grape hyacinth (Muscari botryoides) and the common onion (Leopoldia comosa), are favored in these habitats as their bulb structure enables them to flower during the more humid spring months. The wild asparagus (Asparagus officinalis), with its long and deeply rooted rhizomes, is widely distributed in these environments and possesses leaves that have undergone significant transformations, appearing as short filaments that minimize excessive transpiration. Additionally, these habitats can support various orchid species, including the minor orchid (Anacamptys morio) and the bug orchid (Anacamptys coriophora), which bloom during spring from April to May.

Carex liparocarpos,
Jarjayes, Hautes-Alpes

Euphorbia cyparissias, Hugh Knott Zermatt

Muscari botryoides 'Superstar' (Grape hyacinth) - Stinzenplant

Leopoldia comos by Jean-Claude Thiaudière

Anacamptys morio by R.M.Bateman, Pridgeon & M.W.Chase

Banks of the Po

The banks of the Po River are populated by trees such as white willow (Salix alba) and white poplar (Populus alba), which contribute to the stabilization of the riverbanks at risk of spring floods. Beneath the shade of these large canopies, an interesting flora can develop, including purple loosestrife (Lythrum salicaria), reed mace (Typhoides arundinacea), pendulous sedge (Carex pendula), and creeping bentgrass (Agrostis stolonifera), which covers extensive patches of the understory. Alongside native plant species, there are also many exotic species, including the butterfly bush (Buddleja davidii) from China, whose flower nectar is highly sought after by butterflies, the Jerusalem artichoke (Helianthus tuberosus), an exotic species originating from America with edible and highly appreciated roots, and the South African ragwort (Senecio inaequidens).

View of the bend of the Po
By Furio Chiaretta

Salix alba

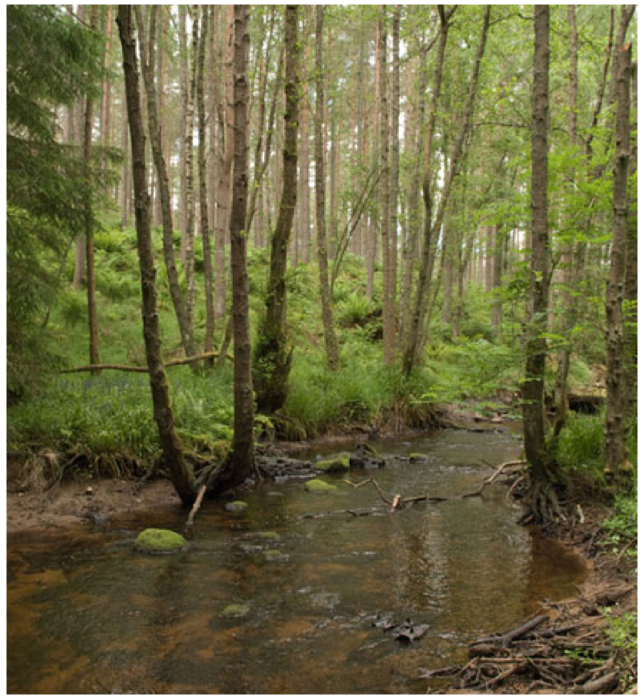
Typhoides arundinacea

Carex pendula by Riesen Wald Segge

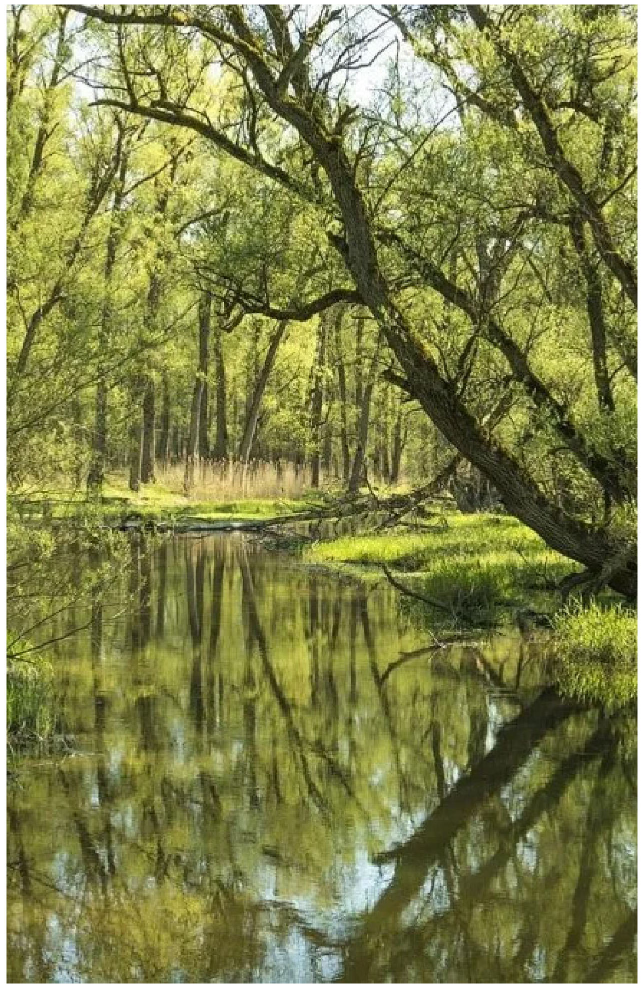
Helianthus tuberosus by Amarelo E Laranja

Hygrophilous forests

The moist forests of black alder (Alnus glutinosa), known as alders, are now rare and limited formations that have been spared from reclamation efforts. They exist as small clusters or linear patches along the main watercourses, wetlands, or sloping terrain, sometimes with solitary individuals rooted in the waterlogged areas. Among the most common species found in the understory are black elder (Sambucus nigra), bluish bramble (Rubus caesius), ivy (Hedera helix), ground elder (Aegopodium podagraria), bittersweet nightshade (Solanum dulcamara), lady fern (Athyrium filix-foemina), and green hellebore (Helleborus viridis). These environments are in a moderately conserved state, where the infiltration of species from neighboring habitats is frequent due to the degradation caused by aging, leading to the collapse of stumps and the subsequent invasion of nitrophilous species or black locust. These habitats are currently threatened by declining humidity levels and declining aquifers.



Alnus glutinosa



Hygrophilous forests

Sambucus nigra

Rubus caesius

Athyrium filix-femina by Françoise Alsaker

Mixed forest

The riparian mixed forest, located beyond the reach of periodic floods from the river, primarily consists of elm (Ulmus minor) and, further away from the water, English oak (Quercus robur). Unfortunately, most of these areas have been deforested and converted for agricultural use. In addition to these species, the tree canopy also includes black poplar (Populus nigra) and robinia (Robinia pseudoacacia), an exotic American species introduced to Europe in the 18th century. Within the shrub layer, common species encountered are black elder (Sambucus nigra), dogwood (Cornus sanguinea), and hawthorn (Crataegus monogyna).

Along the Po River, only fragmented strips of this forest type remain, which are significantly impoverished both in terms of plant diversity and structural complexity. The conservation challenges primarily stem from the extensive presence of Robinia pseudoacacia and the severe decline of Ulmus minor caused by elm yellows disease, which typically affects trees older than ten years.

Lowland forests

Bosco misto di pianuraRivista Natura

Robinia pseudoacacia

Quercus robur

Crataegus monogyna

Oak-hornbeam forest

The oak-hornbeam forest is predominantly found in the plains but also extends to the inner hills. It is characterized by the presence of common oak (Quercus robur), sessile oak (Quercus petraea), downy oak (Quercus pubescens), and white hornbeam (Carpinus betulus). In areas with higher moisture levels, such as watersheds, the undergrowth is dominated by herbaceous species like liverwort (Hepatica nobilis), primrose (Primula vulgaris), and Salvia glutinosa. In warmer regions, flowering ash (Fraxinus ornus), wild service tree (Sorbus torminalis), dogwood (Cornus mas), flaccid sedge (Carex flacca), and betony (Stachys officinalis) are more prevalent.

Historically, the oak-hornbeam forests covered much larger areas than they do now. They have been largely replaced by chestnut forests and robinia due to extensive exploitation or deforestation, particularly in the plains. The unsustainable use of forests can further reduce or degrade this habitat, making careful monitoring of silvicultural practices essential. One significant challenge for the conservation of oak and hornbeam forests is the succession of hot and/or dry summers experienced in recent decades, which poses a particular threat to mature oaks. However, white hornbeam and flowering ash appear to exhibit greater resilience to extreme weather.

The oak-hornbeam forest

Group of turkey oaks in the "Bosco Palli" near Rolasco (Casale Monferrato - AL).

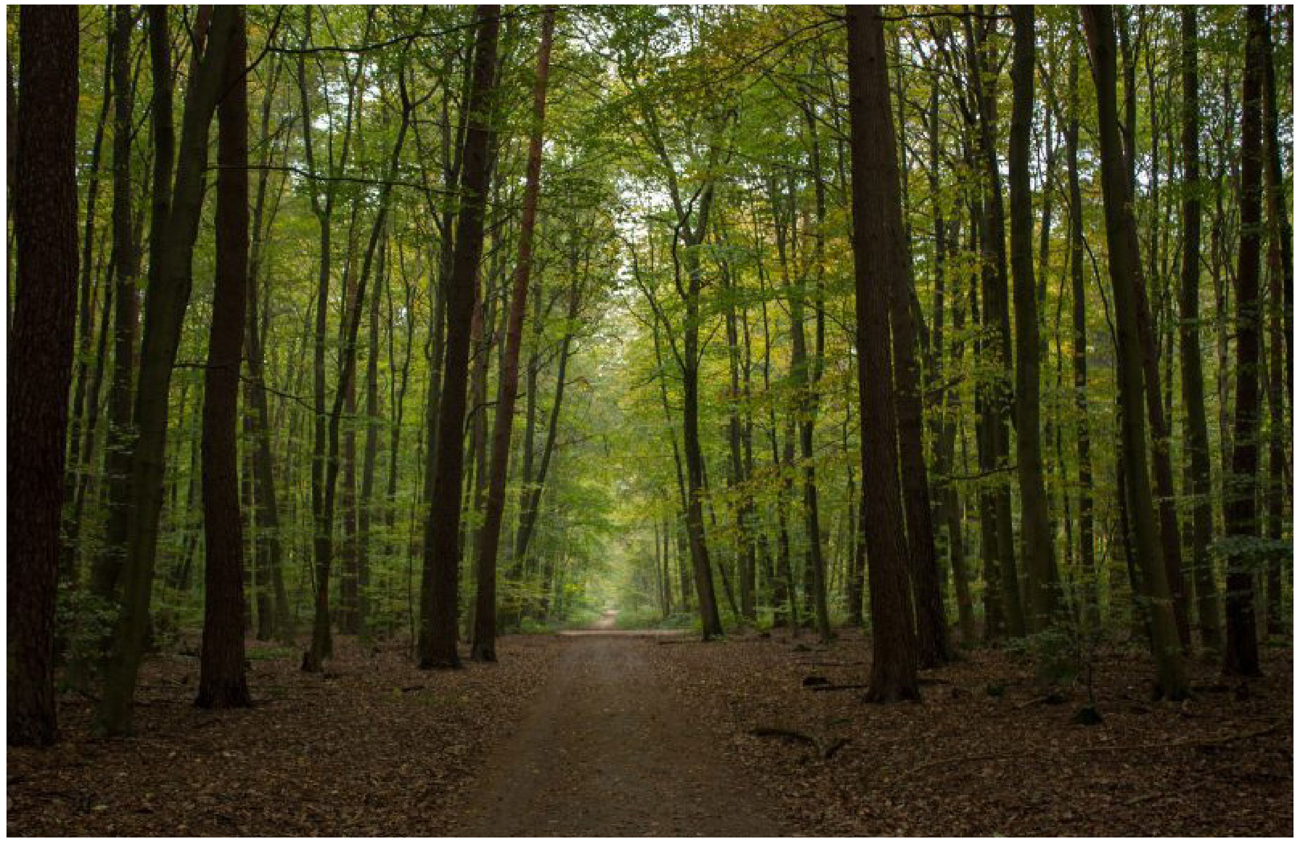
Hepatica nobilis by Laura Bennet

Stachys officinalis

Beech forests

The beech forests, or more commonly individual beech trees, can be found at relatively low altitudes in the Turin hills and are geographically distinct from the beech populations in the Alpine region. The presence of beech (Fagus sylvatica) in the central hills of Piedmont is a remnant from the post-glacial period when it sought refuge on the cooler slopes following the improvement in climate after the last ice age. However, the ongoing warming trend poses a critical threat to these relict populations. While sporadic occurrences of beech are still relatively widespread, they are under significant pressure from coppice management practices that favor species like chestnut (Castanea sativa) and black locust.

Beech trees are often accompanied by chestnut and oak (Quercus petraea) in their surroundings, along with other species such as white hornbeam (Carpinus betulus), field maple (Acer campestre), sycamore maple (Acer pseudoplatanus), common ash (Fraxinus excelsior), and occasionally linden (Tilia cordata). The undergrowth of these beech forests harbors characteristic species, including Physospermum cornubiense, a widespread umbrella-like plant, knotted geranium (Geranium nodosum), montane lettuce (Prenanthes purpurea), and fior di stecco (Daphne mezereum), which are typical of alpine beech forests.



The ancient beech woods of the Abruzzo, Lazio and Molise National Park have entered the UNESCO World Heritage List.

Fagus sylvatica

Acer pseudoplatanus

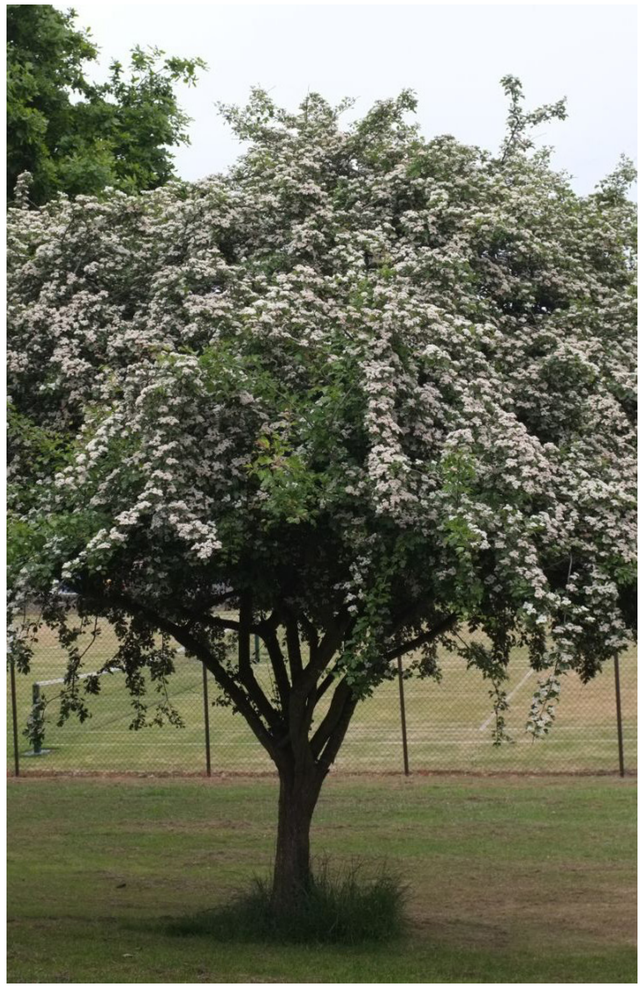
Tilia cordata

Turkey oaks

Despite its potential, Turkey oaks (Quercus cerris) are not widely distributed in Piedmont, although they can be sporadically found in other forest formations. Unlike other oak species in the protected areas of Piedmontese Po, Turkey oaks appear to be unaffected by water shortages, making them a potentially expanding species. Currently, they occupy smaller areas than their potential range, which can be attributed to past negative selection by humans due to the lower value of their wood and the inedibility of their acorns compared to other oak species.

In Turkey oak woods, the Turkey oak is often associated with characteristic shrubs such as scotane (Cotinus coggygria), hawthorn (Crataegus oxyacantha), butcher's broom (Ruscus aculeatus), rocking cornet (Emerus major), horse rose (Rosa arvensis), and hairy cytisus (Chamaecytisus hyrsutus). A separate discussion is warranted for cerrosughera (Quercus crenata), which is considered a hybrid between Turkey oak and cork oak (Quercus suber). In all of Piedmont, only around fifty rare isolated specimens of cerrosughera exist, and they do not produce fertile acorns, preventing the establishment of new plants from them.

Quercus cerris



Crataegus oxyacantha by Owen Johnson.

Cotinus coggygria

Ruscus aculeatus

Chamaecytisus hyrsutus

Fauna

Characteristics

Due to its diverse environments and the prominent presence of the river, the territory of the Protected Areas of the Piedmontese Po supports a rich variety of fauna species, with avifauna being a readily observable representation of biological diversity. The diversion of the river in the lowland areas creates a complex of environments, including banks, secondary river branches, dead arms, oxbow lakes, and sheltered woods, each harboring characteristic species.

Oxbow lakes, characterized by slow water flow, low oxygen levels, high summer temperatures, and humid soil and atmosphere, provide a rich trophic potential due to the substantial organic sediment. These areas serve as nesting grounds, refuges, and feeding grounds for numerous bird species. It is here that reed thickets and hygrophilous shrubs, typical of many wetlands, can thrive.

Sheltered woods, consisting of willow and alder groves along the river's edge, feature the growth of white willow and black alder. The dense shade greatly influences the development of undergrowth flora and maintains high humidity even in the summer months. These conditions favor the presence of various amphibian species and hygrophilous insects. During spring and autumn, the river serves as a migration route for numerous bird species, offering them an important source of food. Lastly, the presence of water mitigates temperature variations, making the area attractive to many species during winter when food availability in surrounding territories is minimal.

Fauna

Mammals

Among the native mammal species found in the protected areas of the Po, the wild boar (Sus scrofa) stands out. Its high population density, influenced by hunting introductions, has led to significant challenges due to its impact on human activities and biodiversity. Roe deer (Capreolus capreolus), with their surprising nocturnal presence, badgers (Meles meles), and foxes (Vulpes vulpes) can also be encountered in these areas.

In the woodland areas, it is not uncommon to come across the squirrel (Sciurus vulgaris), which unfortunately faces increasing threats from the presence of the American gray squirrel (Sciurus carolinensis).

Although rare, sightings of the hare (Lepus europeus) with its distinctive tracks, the wood mouse (Apodemus sylvaticus), the water vole (Arvicola terrestris), and occasionally the water shrew (Neomys fodiens), a small mammal that inhabits streams and torrents in search of invertebrates and occasionally small fish, may occur.
In addition to the aforementioned badger, the beech marten (Martes foina), an elusive species with a stable population, and the pine marten (Martes martes), which has been observed in lowland areas since the early 2000s, are also present among the mustelids. Unfortunately, the hedgehog (Erinaceus europaeus) is increasingly seen on roads as a result of fatal collisions with vehicles.

Caprioli

Cinghiale by Alessandro Calabrese

Tasso (Meles meles)

Volpi (Vulpes vulpes).

Scoiattolo comune in fase scura by M. Berito

Lepre (Lepus europeus)

Toporagno d'acqua (Neomys fodiens)

Faina (Martes foina)

Birds

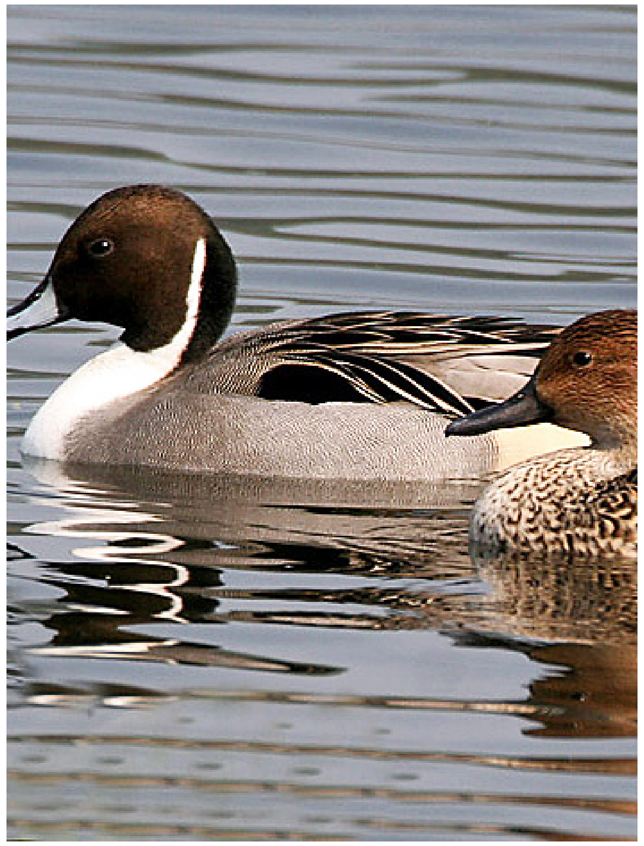
The avian fauna found along the Po River, including the Piedmontese Po Natural Park and the adjoining areas protected under the Natura 2000 network, boasts a remarkable diversity. The river has always served as a favored location for many bird species, providing them with abundant food sources, nesting grounds, and wintering habitats. The river's environment offers a sheltered haven from drastic temperature fluctuations and is rich in fish fauna.

During the winter season, various species of dabbling ducks, such as teals (Anas crecca), pintails (Anas acuta), wigeons (Anas penelope), and gadwalls (Anas strepera), can be regularly observed. Among the reed-dwelling species are the little grebe (Podiceps ruficollis), the great crested grebe (Podiceps cristatus), the mallard (Anas platyrhynchos), and the moorhen (Gallinula chloropus). Heronries, such as the one at Meisino in Turin, are found along the river, serving as nesting sites even within urban settings. Ardeidae species like the gray heron (Ardea cinerea), night heron (Nycticorax nycticorax), little egret (Egretta garzetta), and great white heron (Egretta alba) thrive in these ideal river habitats for feeding and reproduction.

The oxbow lakes harbor a diverse and intriguing avifauna, including uncommon species such as the little grebe (Podiceps nigricollis), bittern (Botaurus stellaris), purple heron (Ardea purpurea), black-winged stilt (Himantopus himantopus), penduline tit (Remiz pendulinus), and black-tailed godwit (Limosa limosa). Nesting birds in these areas include the garganey (Anas querquedula), little grebe (Tachybaptus ruficollis), water rail (Rallus aquaticus), coot (Fulica atra), and river nightingale (Cettia cetti). Artificial earthworks also provide habitats for colonies of burrowing insectivorous birds like bee-eaters (Merops apiaster) and sand martins (Riparia riparia). Cormorant roosts (Phalacrocorax carbo) can be found on the edges of the oxbow lakes.

Poplar groves near the Po River serve as nesting grounds for the hobby falcon (Falco subbuteo) and the long-eared owl (Asio otus), utilizing the old nests of numerous hooded crows (Corvus corone cornix). Other notable bird species in the area include woodpeckers such as the lesser spotted woodpecker (Dendrocops minor) and the green woodpecker (Picus viridis). Forest ecosystems are home to birds such as the honey buzzard (Pernis apivorus), tawny owl (Strix aluco), wood pigeon (Columba palumbus), oriole (Oriolus oriolus), and jay (Garrulus glandarius).

The broad riverbanks attract little terns (Sterna albifrons), common terns (Sterna hirundo), and little ringed plovers (Charadrius dubius) during spring and summer. Riparian environments with unbanked banks and wide scree host species such as the kingfisher (Alcedo atthis), common sandpiper (Actitis hypoleucos), and wagtails (Motacilla cinerea)



Anas acuta

Podiceps ruficollis

Podiceps cristatus. Steve Garvie

Gallinula chloropus

Nycticorax nycticora by Melissa James

Himantopus himantopus

Limosa limosa by Arie Buurman

Fulica atra by Thomas Hochebner

Reptiles

Within the protected areas of the Po, there are only a few species of significant naturalistic importance, especially among amphibians. These include the crested newt (Triturus carnifex), common newt (Triturus vulgaris meridionalis), tree frog (Hyla arborea), common frog (Rana latastei), and the pelobate or Cornalia brown toad (Pelobates fuscus). Notably, the presence of the pelobate, which is the focus of a conservation project by WWF Italy, and some thriving populations of the Lataste frog, a species currently limited to a few locations in the Piedmontese Po valley, should be emphasized. These amphibians, like the newts, have relatively low populations here due to the presence of predatory fish. To promote an increase in the populations of various amphibian species that compete with fish, it would be beneficial to create marshy vegetation-filled loops or isolated ponds within the oxbow areas.

Among reptiles, it is noteworthy to mention the pond turtle (Emys orbicularis), which was once more widespread but is now highly localized and likely extinct in the mountainous areas of Turin where it was present until recently. On the other hand, reports of the exotic North American Trachemys scripta, commonly known as the pond slider, being released into the environment by unaware private individuals have become increasingly frequent. Such releases can create serious ecological imbalances. Regarding snakes, the most frequently encountered species include the collared snake (Natrix natrix), the rat snake (Coluber viridiflavus), and the smooth snake (Coronella austriaca).

Triturus carnifex

Triturus vulgaris meridionalis by Kristian Peters

Rana latastei

Pelobates fuscus

Emys orbicularis by Wolfgang Simlinger

Trachemys scripta by Grendelkhan

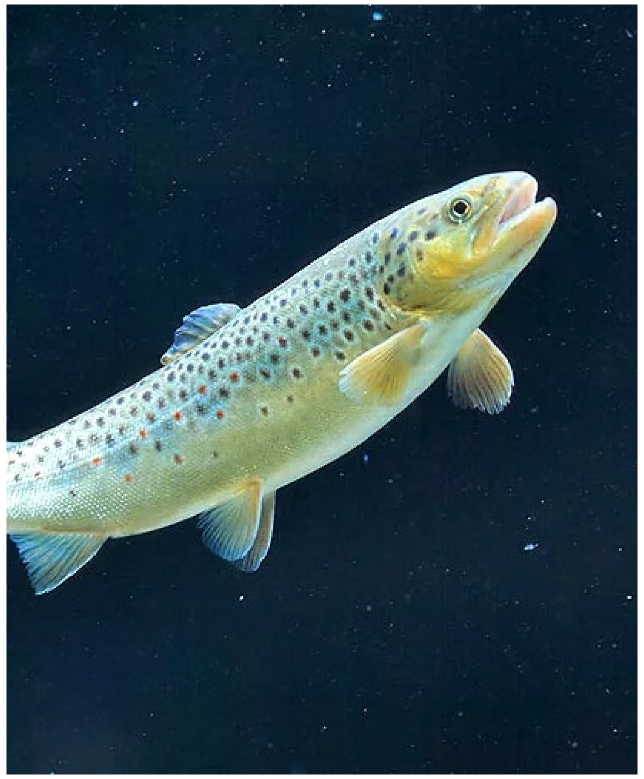
Natrix natrix

Fish

The section of the Po River that stretches between Casalgrasso and Crescentino displays a wide range of water types and qualities. Undoubtedly, the most ecologically intact and ichthyologically diverse portion lies between the confluence with the Pellice River and the territory of the Municipality of Carignano. The Carmagnola segment, holds great importance from an ichthyological and overall naturalistic perspective. The unpolluted waters and stagnant oxbows found here provide an optimal habitat for various species. Noteworthy is the presence of a robust population of grayling (Thymallus thymallus) and marble trout (Salmo trutta marmoratus), although the latter is facing a decline due to the introduction of brown trout (Salmo trutta) for fishing purposes. The marble trout, which is characteristic of alpine waters, hybridizes with the brown trout, resulting in fertile offspring. This genetic pollution threatens the marmorata, an endemic salmonid and may lead to its disappearance from the Po River in the future.

The urban section of the river hosts numerous limnophilous cyprinids such as carp (Cyprinus carpio), chub (Leuciscus cephalus), rudd (Scardinus erythrophthalmus), and bleak (Alburnus a. bleak). A common characteristic of the slow-flowing stretches downstream of Moncalieri is the invasive presence of exotic species, particularly golden crucian carp and bluegill. The occurrence of salmonids and thymallids significantly decreases immediately upstream of Turin, with only a modest trout population found at the Emanuele I bridge within the city. Downstream, these fish are sporadic or absent. After the confluence of the Dora Baltea, there is a recovery in the density of salmonids and thymallids due to improved water quality and increased flow.

Downstream of Turin, in the Chivasse and Alessandria areas, the situation remains similar. Native species are becoming increasingly scarce, while alien species thrive and expand upstream. For instance, the torpedo, originally from the Danube basin, was previously found downstream of Chivasso until about a decade ago. However, recent sampling data has identified it upstream of Turin, in the Moncalieri area, at the confluence of the Chisola River. On the other hand, the asp, another species native to the Danube, currently inhabits only the slow-moving waters of the Alexandrian plain. Rapid and fast-flowing environments are now dominated by European barbels, resulting in the displacement of native species as the habitat becomes saturated.



Salmo trutta by Giuseppe Mazza

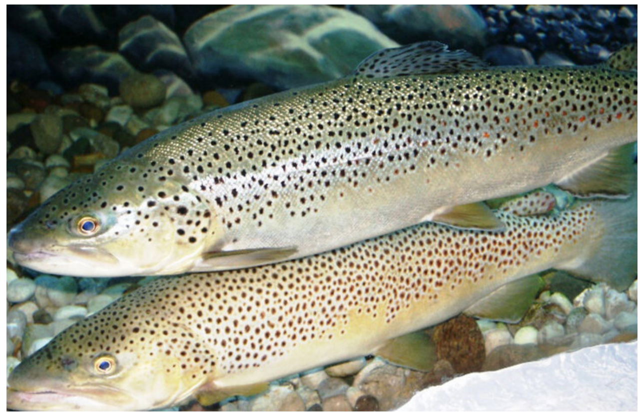
Leuciscus cephalus by Florenci Vallès

Thymallus thymallus

Salmo trutta marmoratus by Lorenzo Piovesan

Scardinus erythrophthalmus

Alburnus a. alborella

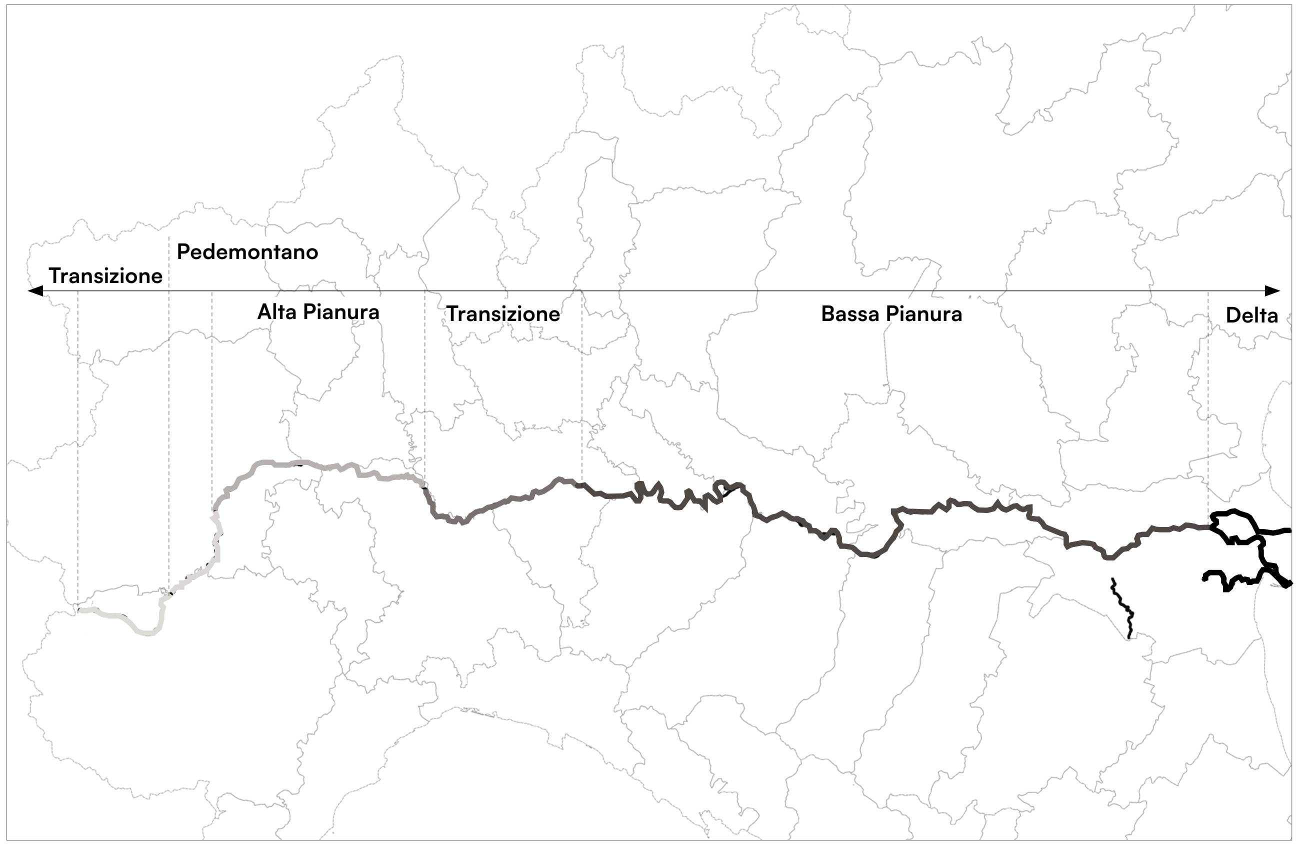


Trota fario by USFWS Fish and Aquatic Conservation

Scazzone (Cottus gobio) by Hans Hillewaert

Carta Ittica

Fish zoning of the river



The specific composition and structure of fish communities strongly depend on the physical characteristics of the watercourse that hosts them. The fish fauna adapted to mountain watercourses has as its main characteristics stenothermy due to low temperatures, high metabolism, high oxygen requirements, modest size and reproduction on gravelly substrates (lithophilia).

Moving downstream as the environmental conditions change, the characteristics of the fish fauna also gradually change towards a preference for a slower current, increasing eurythermia, lower metabolism, lower oxygen requirements, variable sizes, different reproductive substrates (gravel, macrophytes , sand, etc.) and also increases the specific diversity. Due to these characteristics, it is possible to divide the different stretches of a watercourse, from the origin to the mouth, on the basis of their suitability for hosting and developing a fish population made up of a specific association of species.

Carta Ittica del fiume Po, Adbpo

Fish zoning

Fish zoning of the river

LOCATION	SPECIE	COMUN NAME	SCIENTIFIC NAME
Tratto di transizione pedemontano alto	Extraordinary species	Barbo comune	Barbus plebejus
	Extraordinary species	Cavedano	Squalius cephalus
	Extraordinary species	Lasca	Chondrostoma genei
	Extraordinary species	Sanguinerola	Phoxinus phoxinus
	Extraordinary species	Trota marmorata	Salmo trutta marmoratus
	Extraordinary species	Vairone	Telestes muticellus
	Ordinary species	Barbo canino	Barbus meridionalis
	Ordinary species	Scazzone	Cottus gobio
	Ordinary species	Trota fario	Salmo trutta fario
Tratto pedemontano alto	Extraordinary species	Barbo comune	Barbus plebejus
	Extraordinary species	Cavedano	Squalius cephalus
	Extraordinary species	Cobite comune	Cobitis bilineata
	Extraordinary species	Ghiozzo padano	Padogobius bonelli
	Extraordinary species	Lampreda padana	Lethenteron zanandreai
	Extraordinary species	Pigo	Rutilus pigus
	Ordinary species	Barbo canino	Barbus meridionalis
	Ordinary species	Cobite mascherato	Sabanejewia larvata
	Ordinary species	Sanguinerola	Phoxinus phoxinus
	Ordinary species	Anguilla	Anguilla anguilla
	Ordinary species	Trota marmorata	Salmo trutta marmoratus
Tratto di alta pianura	Extraordinary species	Alborella	Alburnus arborella
	Extraordinary species	Barbo canino	Barbus caninus
	Extraordinary species	Cagneta	Salaria fluviatilis
	Ordinary species	Vairone	Telestes muticellus
	Ordinary species	Trota marmorata	Salmo trutta marmoratus
	Ordinary species	Storione cobice	Acipenser naccarii

Fish zoning

Fish zoning of the river

LOCATION	SPECIE	COMUN NAME	SCIENTIFIC NAME
Tratto di transizione pedemontano alto	Extraordinary species	Barbo comune	Barbus plebejus
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	Extraordinary species	Vairone	Telestes muticellus
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	Ordinary species	Scazzone	Cottus gobio
	Ordinary species	Trota fario	Salmo trutta fario
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	Ordinary species	Anguilla	Anguilla anguilla
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	Extraordinary species	Cagneta	Salaria fluviatilis
	Ordinary species	Vairone	Telestes muticellus
	Ordinary species	Trota marmorata	Salmo trutta marmoratus
	Ordinary species	Storione cobice	Acipenser naccarii

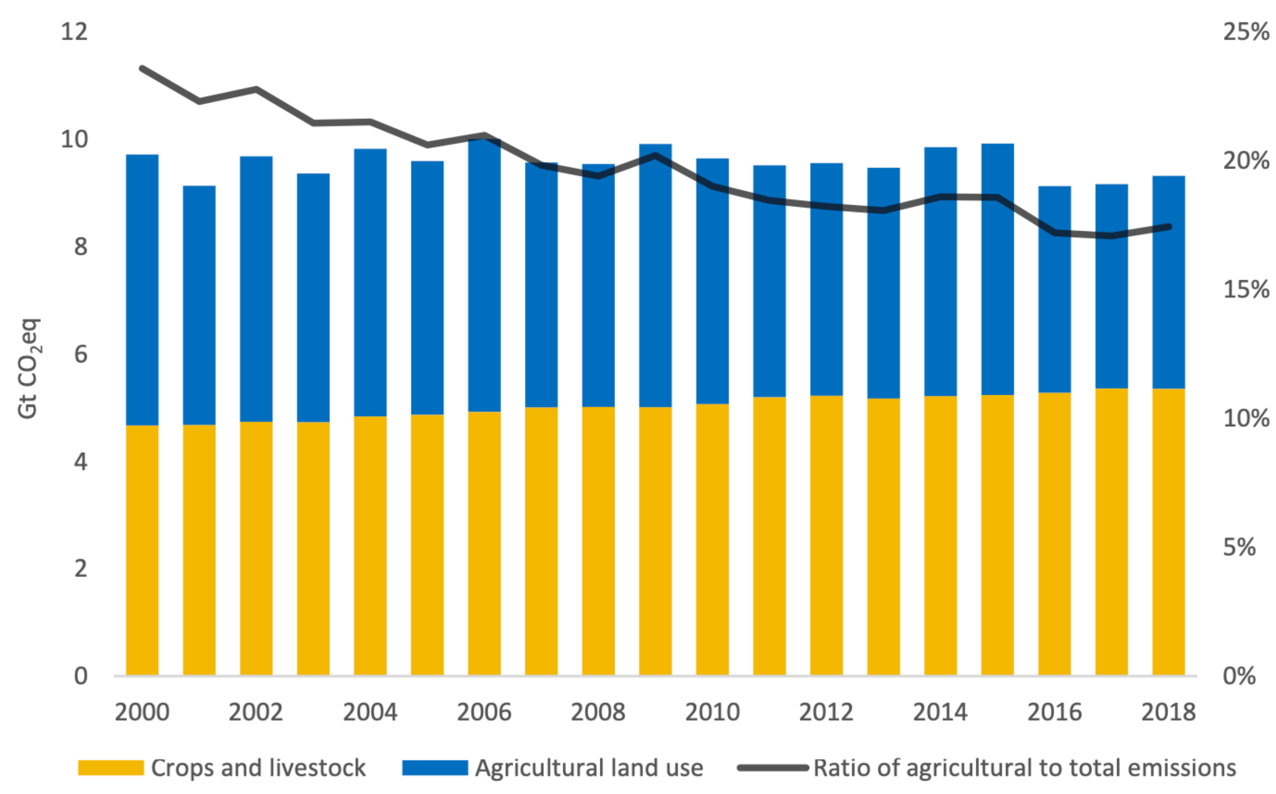
Agriculture

Pollution

In 2018, world total agriculture and related land use emissions reached 9.3 billion tonnes of carbon dioxide equivalent (Gt CO2eq). Crop and livestock activities within the farm gate generated more than half of this total (5.3 Gt CO2 eq), with land use and land use change activities responsible for nearly 4 Gt CO2 eq. These components were respectively 4.6 and 5.0 Gt CO2 eq in the year 2000. During the 2000s, emissions from within the farm gate and those from land use both increased, and then trends in these two components began diverging. Emissions from crops and livestock activities kept growing over the entire 2000—2018 period and were 14 percent larger in 2018 than in 2000.

Conversely, emissions from land use and land use change decreased over the study period, consistently with observed decreases in deforestation. As a result, the combined farm gate and land emissions due to agriculture were about 4 percent lower in 2018 than in 2000. In 2018, agriculture and related land use emissions accounted for 17 percent of global GHG emissions from all sectors, down from 24 percent in the 2000s. In addition to the noted slight decrease in absolute emissions, this reduction in 2018 was also the result of emissions from other economic sectors growing at relatively faster rates during 2000—2018 Yearly emissions from crops and livestock and related land use, and share of agriculture in global GHG emissions from all sectors, 2000—2018. Agricultural activities from crops and livestock production release significant amounts of non-CO2 emissions such as methane and nitrous oxide, both powerful greenhouse gases, totaling 5.3 Gt CO2eq in 2018, with livestock production contributing two-thirds of this total (Figure 2). In particular, in 2018 CH4 emissions from enteric fermentation in digestive systems of ruminant livestock continued to be the single largest component of farm-gate emissions (2.1 Gt CO2eq).

FAOSTA 2020

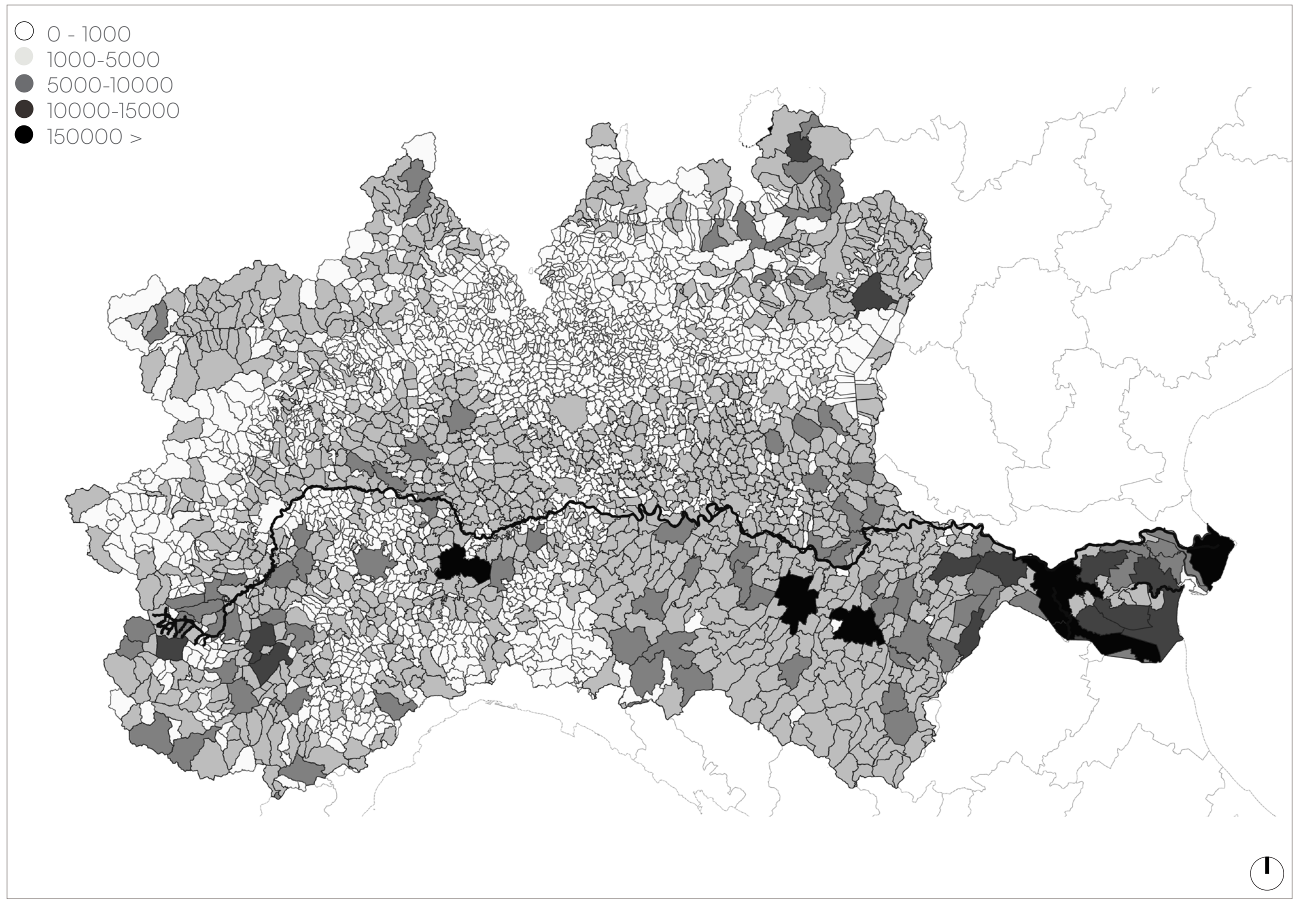


Crops and land use

The Po Valley stands out as the most developed region in the country when it comes to the agro-food industry and its associated agricultural sectors. The agricultural sector demonstrates a high level of productivity, primarily due to the widespread use of irrigation and mechanization. The region boasts a diverse range of agricultural productions, with the most common crops being cereals intended for human consumption (such as wheat, corn, and rice) and forage crops (including maize).

Industrial plants are predominantly comprised of beetroot, potato, and tomato, which are used for processing. However, textile crops like flax and hemp, which were once significant, have nearly disappeared. In peri-urban areas and specialized regions, horticulture is thriving, while fruit cultivation flourishes in Romagna.

State of play analyses for Po River Basin, Italy SUWANU Europe



Utilized agricultural area in hectares per Municipality falling within the Po Basin. Processing of ISTAT 2010 regional data. 2015 Water Management Plan (PdGPO)

Livestock

Livestock farming, including cattle (approximately 4,188,000 heads) around 50% of the national stock, pigs (around 2,791,000 heads) around 65% of the national stock, and poultry, holds immense importance as a primary source of agricultural income across extensive areas. This thriving livestock sector supports various activities related to preservation and processing. However, the application of livestock manure (pig, poultry and cattle) together with mineral fertilizers largely exceed crop uptake contributing to 85% of nitrogen reaching aquifers (Mantovi et al., 2006; Bartoli et al., 2012; Perego et al., 2012; Lasagna and De Luca, 2019).

State of play analyses for Po River Basin, Italy SUWANU Europe

Density of total reared animals (cattle, pigs, horses, sheep and goats, poultry, rabbits, buffaloes) in the Po basin. ISTAT 2010 regional data processing. 2015 Water Management Plan (PdGPO)

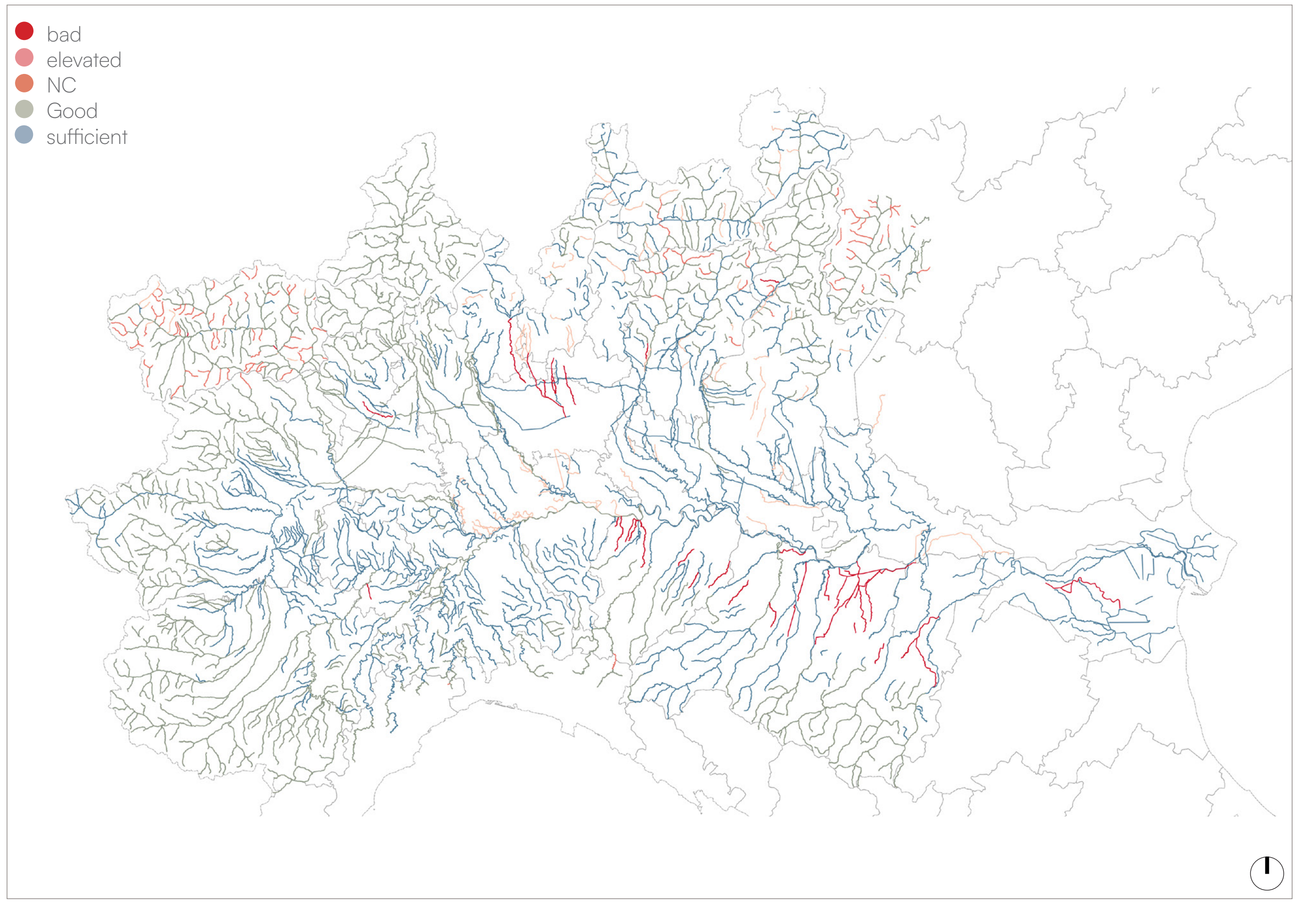
Water quality

Fiume Po

The hydrological equilibrium of the Po basin relies on the movement of approximately 80 billion cubic meters of water annually, which accounts for roughly 40% of the entire country's water volume. A portion of this quantity, which is not lost to evaporation, nourishes the natural waterways and groundwater systems until it eventually reaches the sea, ensuring the continuation of its natural cycle.

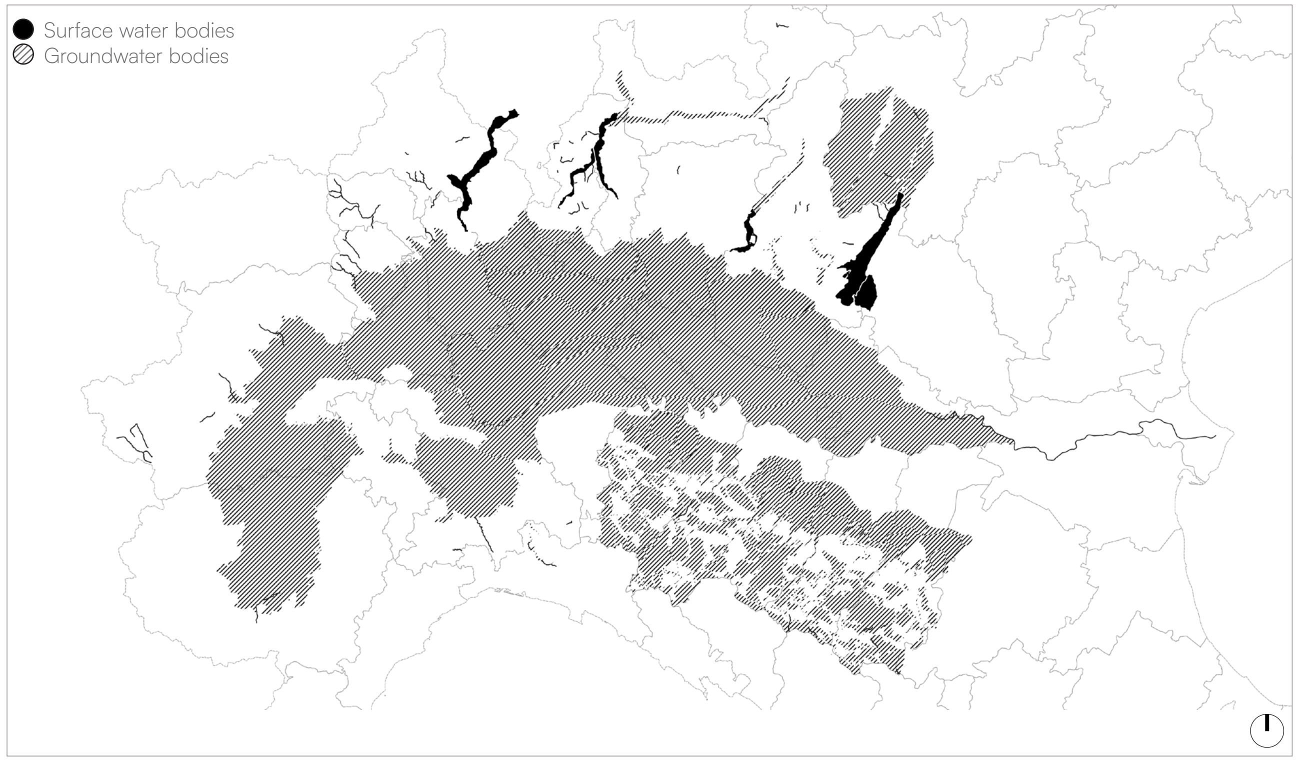
The main cause of the alteration on a basin scale of the natural quality of water resources is represented by the enrichment of organic substances, in particular of nutrients, of surface and groundwater. In basins with a low turnover (lakes, estuaries, wetlands and coasts) this enrichment of nitrogen and phosphorus causes the phenomenon of eutrophication, which involves the overproduction of aquatic plants and algae, the impoverishment of the structure of the biotic components and other effects that reduce and preclude the use of water.

The control of eutrophication becomes fundamental for the qualitative recovery of the waters of the Po river basin and for the decisive influence of the contributions of nutrients from the Po basin on the coastal strip of the Adriatic Sea, where the trophic levels of the waters can cause damage to fishing and to tourism. The rehabilitation and protection of the system of large pre-Alpine lakes, a unique natural heritage due to its high environmental value, are also priorities due to the positive repercussions they can have on the availability of water resources for the irrigation of the plains, for the tourist-recreational use and for the supply of drinking water in the area of the Po basin.

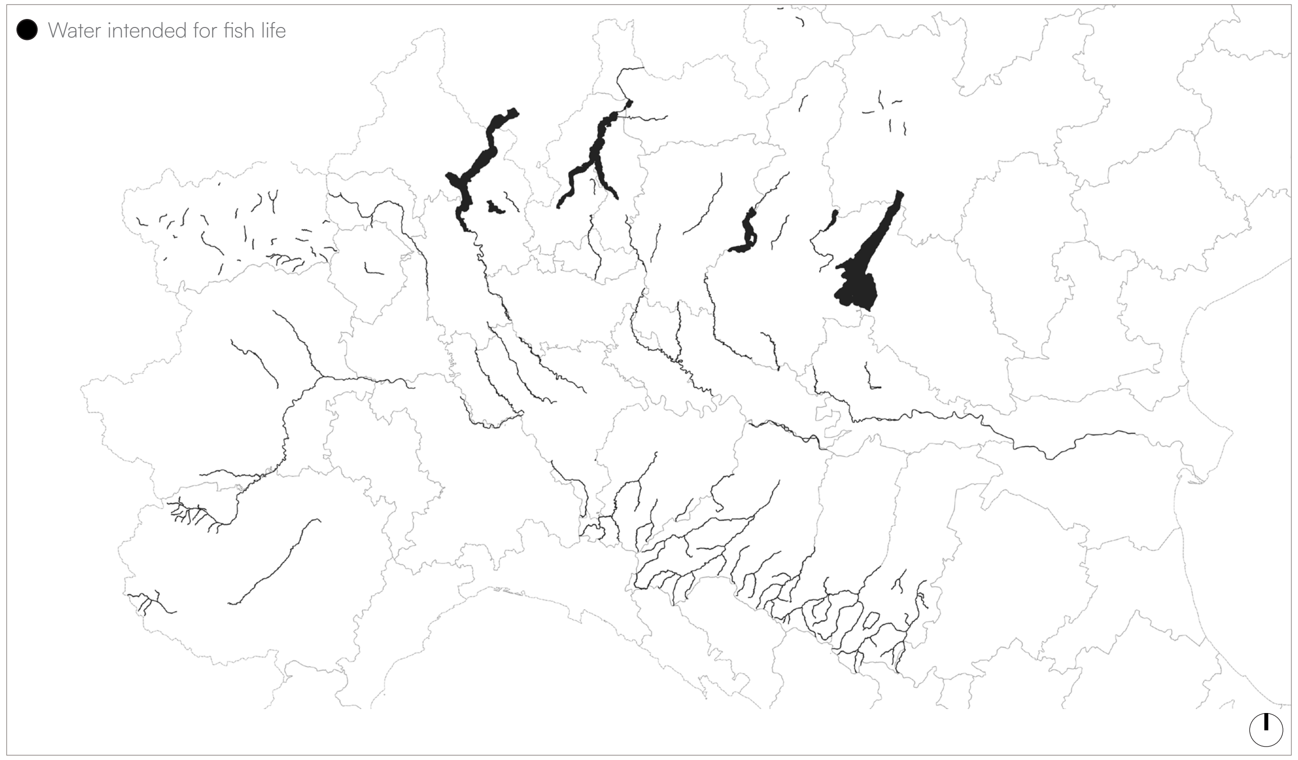


Representation of the ecological and chemical status of the river water bodies of the Po basin. 2015 Water Management Plan (PdGPO)

Water protected



Protected Areas - Bodies of water intended for the production of drinking water Po Basin 2015 (Po District)



Protected areas - Water intended for fish life. Po Basin 2015 (Po District)

Risk

Flooding

For over 2000 years, the protection of the floodplains in Northern Italy from the floods of the River Po has been a continuous effort. Since Roman times, flood retaining levees have been constructed to mitigate the impact of the river's floods. Presently, the River Po's watercourse is regulated by a flood corridor that extends for 420 km, starting from its mouth at the Adriatic Sea. The flood corridor exhibits varying widths between the two levee alignments, which were influenced by the topography of the adjacent lands along the river. These levee alignments have been adjusted over time to accommodate changes in the river's course and to facilitate social development projects. Throughout history, the failure of these levees has resulted in inundations, causing swift floodwaters to pour through the breaches and impact the protected territories. Such events have led to casualties and extensive damage to urbanized areas.

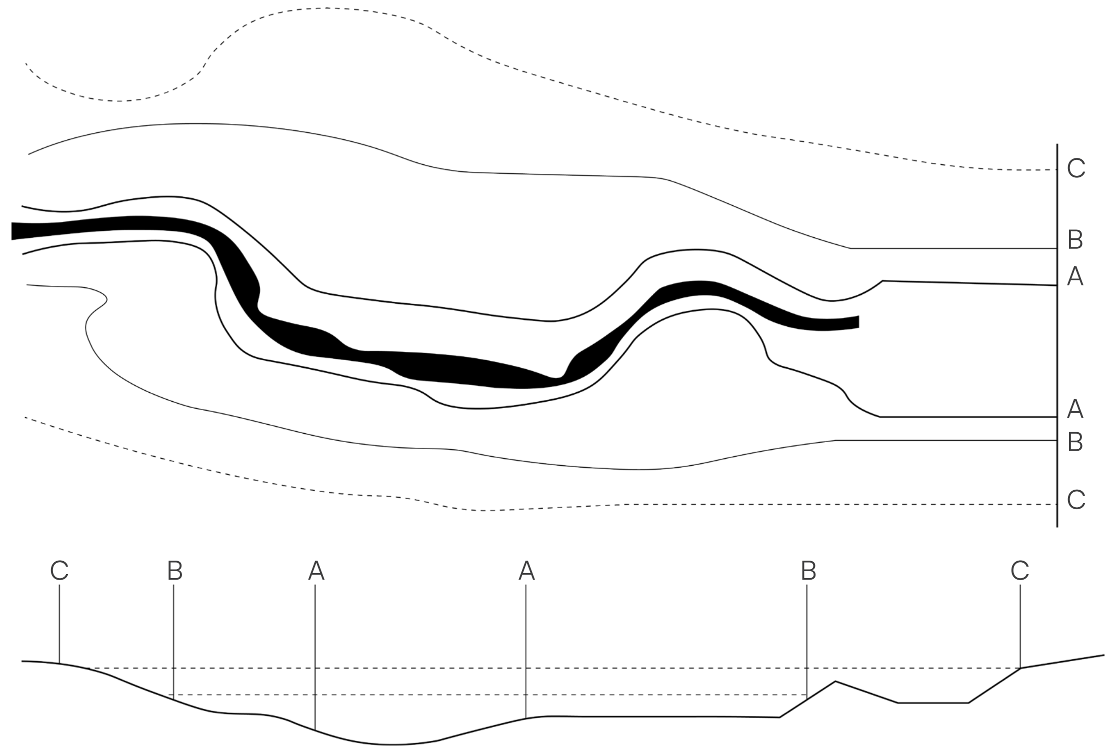
The Po river basin exhibits a diverse hydrographic configuration, with a range of stream types flowing through varied landscapes, including alpine lakes and low-lying plains. As a result, the hydrological regimes differ significantly, leading to a variety of flood situations along the water network during periods of intense rainfall. To understand these flood patterns, historical flood information is being utilized to define four major typical scenarios:

- The first type of flood, known as the Piedmont type, primarily originates from substantial contributions by the Sesia, Ticino, and Tanaro rivers. This flood type typically affects the western or central-western part of the catchment area. Historical records indicate that floods of this nature have occurred in autumn during various years, including 1705, 1755, 1857, 1907, 1994, and 2000.
- The second type of flood, known as the Lombard type, occurs when the Ticino, Lambro, Adda, and Oglio rivers all contribute to the flooding. This flood type primarily affects the central sector of the basin. Historical records attribute floods of this type to specific years, such as 1807, 1812, and 1868, all of which took place during the autumn months. These floods can be classified under the Lombard type due to the simultaneous participation of these rivers in causing the inundation.
- The third type of flood, known as the Piedmont-Lombard type, occurs when the Sesia and Tanaro rivers contribute to the flooding. Additionally, high flow rates from the Belbo, Bormida, and Orba rivers, along with the Adda and Oglio rivers, further contribute to these floods. Other rivers, such as the Scrivia, Dora Baltea, Olona, and Lambro, may also participate in these events. The central and western alpine slopes are primarily affected during floods of this type. Notable historical floods, including those in 1801, 1917, and 1926, fall into this scenario.
- The fourth type of flood, which encompasses the entire Po basin, is characterized by the combined contributions of numerous streams within the Po river network. This flood type typically begins with the systematic inflow from various groups of tributaries in the western sector, with the Sesia and Tanaro rivers playing a consistent role. As the flood progresses downstream, the left side of the Po river experiences flooding from rivers such as the Olona and Lambro, often occurring alongside floods from the Adda and Oglio rivers. Representative floods of this type include the events of 1839, 1872, 1879, and 1951. These floods primarily occurred in the autumn months, with the exception of 1879, which took place in late spring.

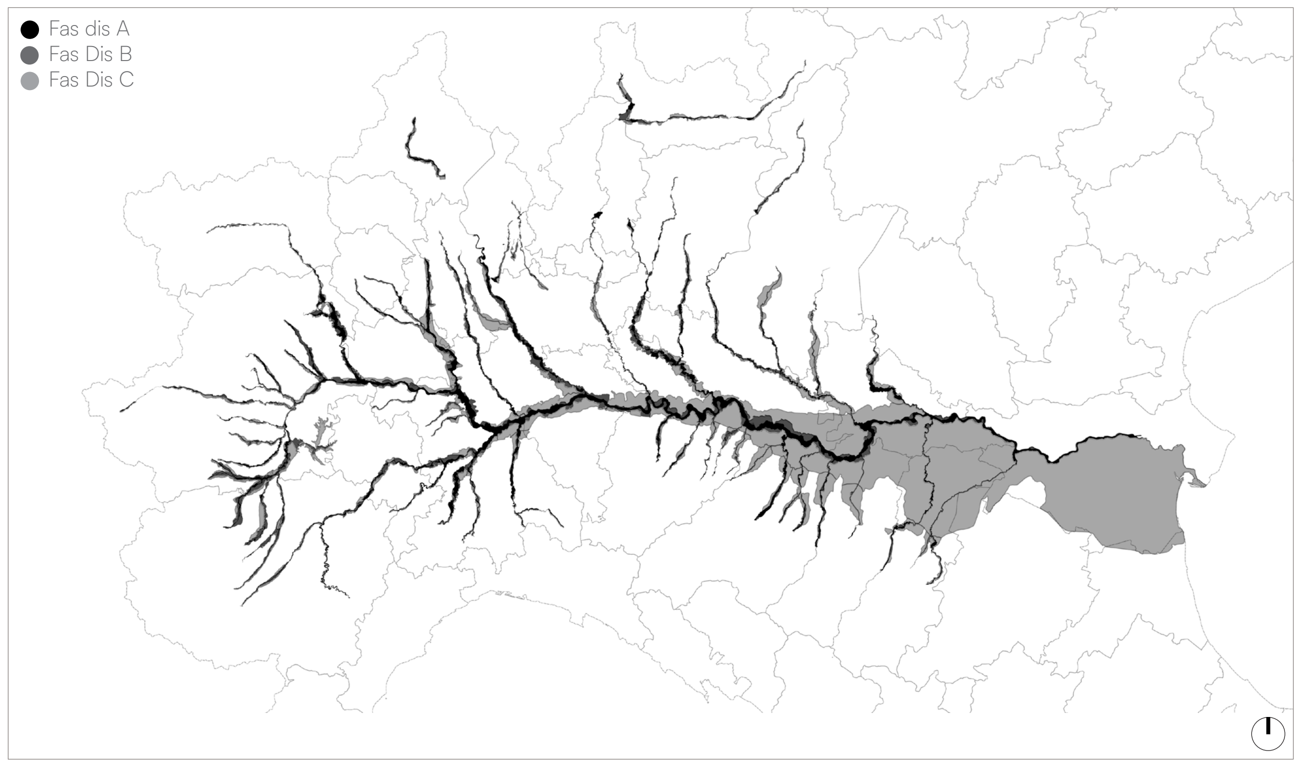
The Hydrogeologic Arrangement Plan (PAI) calls for the establishment of three flood zones or "fasce." These zones play a crucial role in determining the severity of a flood event and the corresponding area that is likely to be affected by flooding.

- Zone A: This zone represents the ordinary floods area, where the frequency of flood events is relatively higher. It encompasses areas that are projected to experience floods with a return time of up to 50 years. These floods are considered more frequent but less severe compared to those in other zones.
- Zone B: The flood area in Zone B is associated with less frequent but more intense flood events. It covers the area confined by the embankment system, which is designed to provide flood protection. The floods in this zone are expected to occur with a return time of up to 200 years.
- Zone C: This zone designates the catastrophic flood area, characterized by exceptionally rare and severe flood events. It includes the areas outside the embankment system that are susceptible to flooding during these exceptional events. Floods in Zone C have a return time of up to 500 years.

AdBPo, 2005



Schematic representation of a river flood zones (AdBPo, 2001).



PAI River strips 2008 UoM Po (District Po)

1951. Polesine. ANSA - Frittoli, Edoardo

May 2023, Emilia Romagna

Risk

Drought

The Po River, in 2022 was experiencing its lowest flow rate on record for this period. This is a cause for concern not only among experts but also among the population residing in the river's hydrographic basin, which spans nearly 90,000 km2 across 8 regions: Piedmont, Valle d'Aosta, Liguria, Lombardy, Veneto, Emilia-Romagna, Tuscany, Marche, as well as the Autonomous Province of Trento and parts of France and Switzerland.

The flow rates recorded monthly average values below the historic minimum in the period 1991-2020 and comparable only with those observed in 2022, remembered by all as the worst year on the drought front. The critical conditions throughout the basin show extreme points of decline especially in Piacenza (flow at 31 March 2023: 214 m3/s; monthly average: 860 m3/s; minimum monthly average: 279 m3/s in 2022), Cremona (flow at 31 March 2023: 291 m3/s; monthly average: 1020 m3/s; minimum monthly average: 344 m3/s in 2022) and Pontelagoscuro, FE (flow at 31 March 2023: 398 m3/s; monthly average: 1374 m3 /s; minimum monthly average: 534 m3/s in 2022) where the most marked drop in outflows reached the highest deficits in the first ten days of April and what aggravates the situation the most is that no future changes are expected worthy of particular note.

The 2023 season indicate that the situation will be even worse than 2022, and recent rainfall is unlikely to be sufficient to recover the water deficit accumulated since 2022. This situation poses a significant risk to agricultural production, as there are over 3 million hectares of usable agricultural land in the Po basin, as well as to hydroelectricity generation, as approximately 55% of Italy's hydroelectric energy is produced in the Po river basin.

The absence of humid flows originating from the Atlantic since November 2021, which typically brought heavy rains and snowfall to the Alpine region, has resulted in a severe deficit of water resources over the past two years, surpassing previous lows. Legambiente highlights that the overall Snow Water Equivalent in the entire Alpine region indicates a loss of approximately 60% of the water resource. This means that during the irrigation season, the typical contribution of snowmelt to surface water outflows will be lacking. As a result, the main sections of the Po river are likely to continue experiencing exceptionally low average monthly flow values.

n. 03 Bollettino Osservatorio 13 aprile 2023 AdBPo.

Photos: Satellite Sentinel 2 di Copernicus, pubblicate dall'Agenzia Spaziale Europea (Esa)

February 2023 © Agenzia Nova

March 2022 By mario bonotto

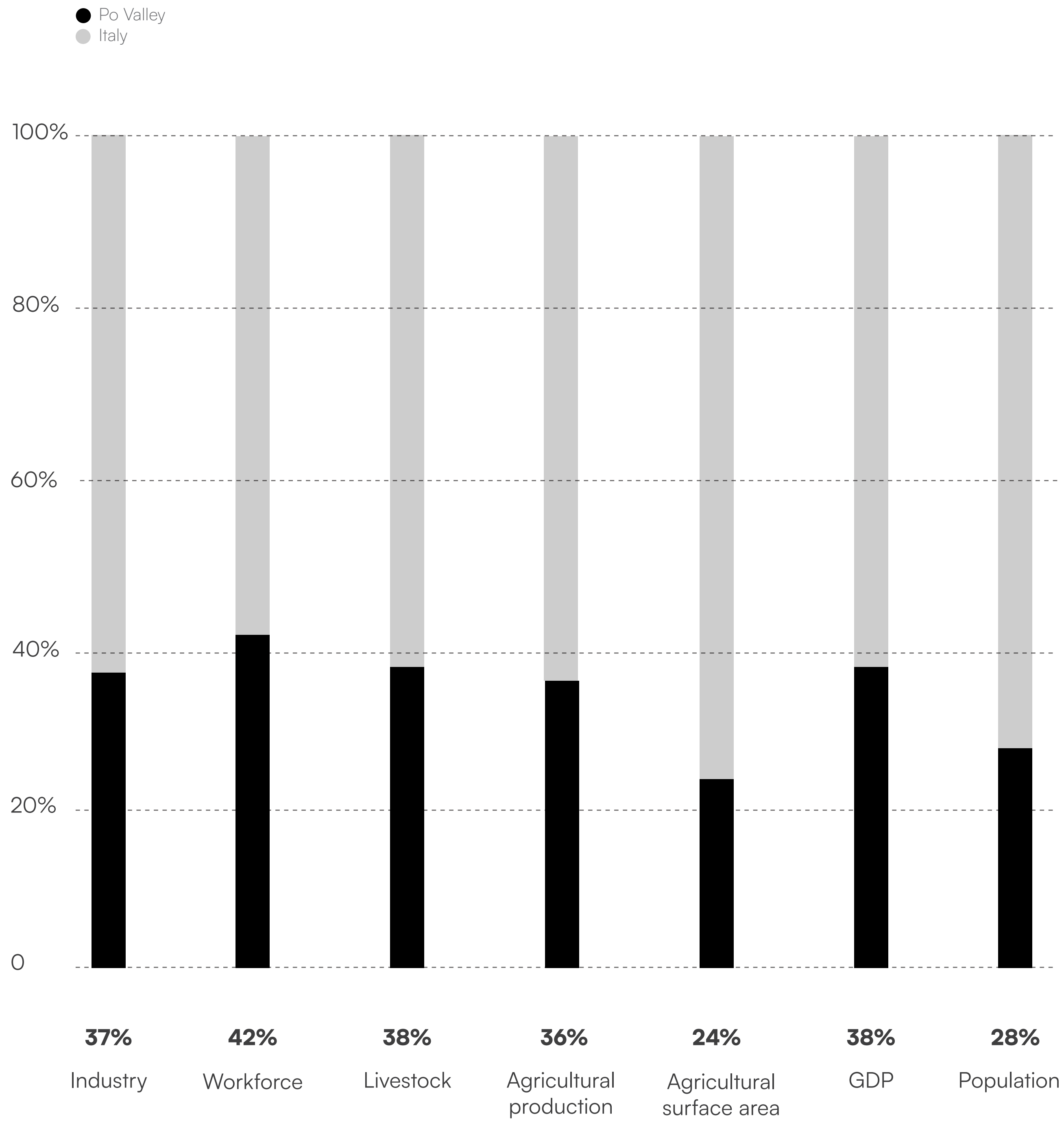
Importance

Po Valley general overview

The Po Valley is an important region due to its geographical, environmental, and cultural significance. Here is a summary of why the Po Valley holds importance:

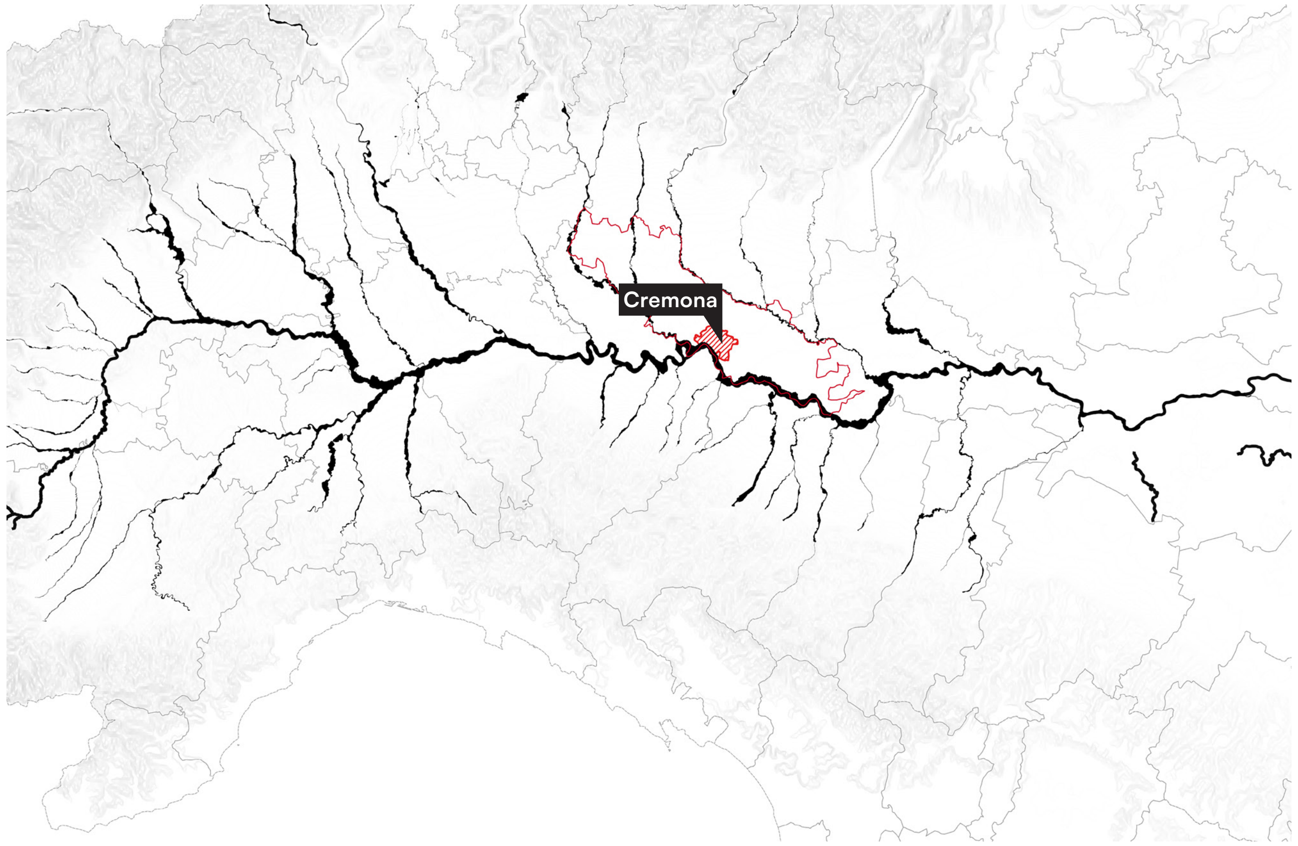
- Geographical Significance: The Po Valley is a vast plain located in northern Italy, spanning over several regions. It is bordered by the Alps to the north and the Apennine Mountains to the south. The Po River, the longest river in Italy, flows through the valley, shaping its landscape and providing water resources for irrigation and hydroelectric power.
- Agricultural Productivity: The Po Valley is known as the "breadbasket of Italy" due to its fertile soil and favorable climate. It is a major agricultural region, producing a significant portion of Italy's food, including grains, fruits, vegetables, dairy products, and wine. The agricultural activities in the Po Valley contribute to the country's food security and economy.
- Biodiversity and Natural Habitats: The Po Valley is home to diverse ecosystems, including wetlands, forests, and riverine habitats. These habitats support a wide range of plant and animal species, including migratory birds, fish, amphibians, and reptiles. The preservation and conservation of the Po Valley's biodiversity are crucial for maintaining ecological balance and protecting endangered species.
- Cultural Heritage: The Po Valley has been inhabited since ancient times and has a rich cultural heritage. It has witnessed the rise and fall of various civilizations, including the Etruscans, Romans, and medieval city-states. The valley is dotted with historical towns, castles, and archaeological sites that showcase the region's cultural and historical significance.
- Economic Hub: The Po Valley is an economic hub of Italy, with industrial activities and trade centers. Major cities such as Milan, Turin, and Bologna are located within the Po Valley, contributing to the country's economic growth. The valley hosts various industries, including manufacturing, automotive, fashion, and technology, driving employment opportunities and economic development.

Po Valley's importance stems from its geographical, agricultural, ecological, cultural, and economic significance.



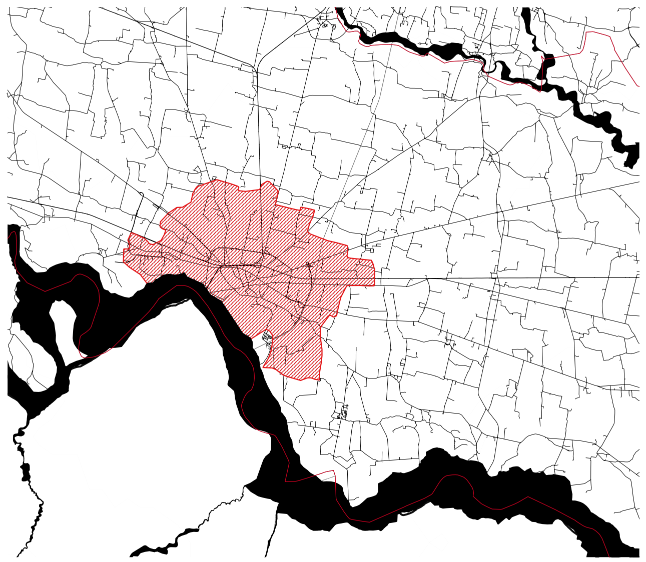
Data from ISTAT - 2003

Cremona

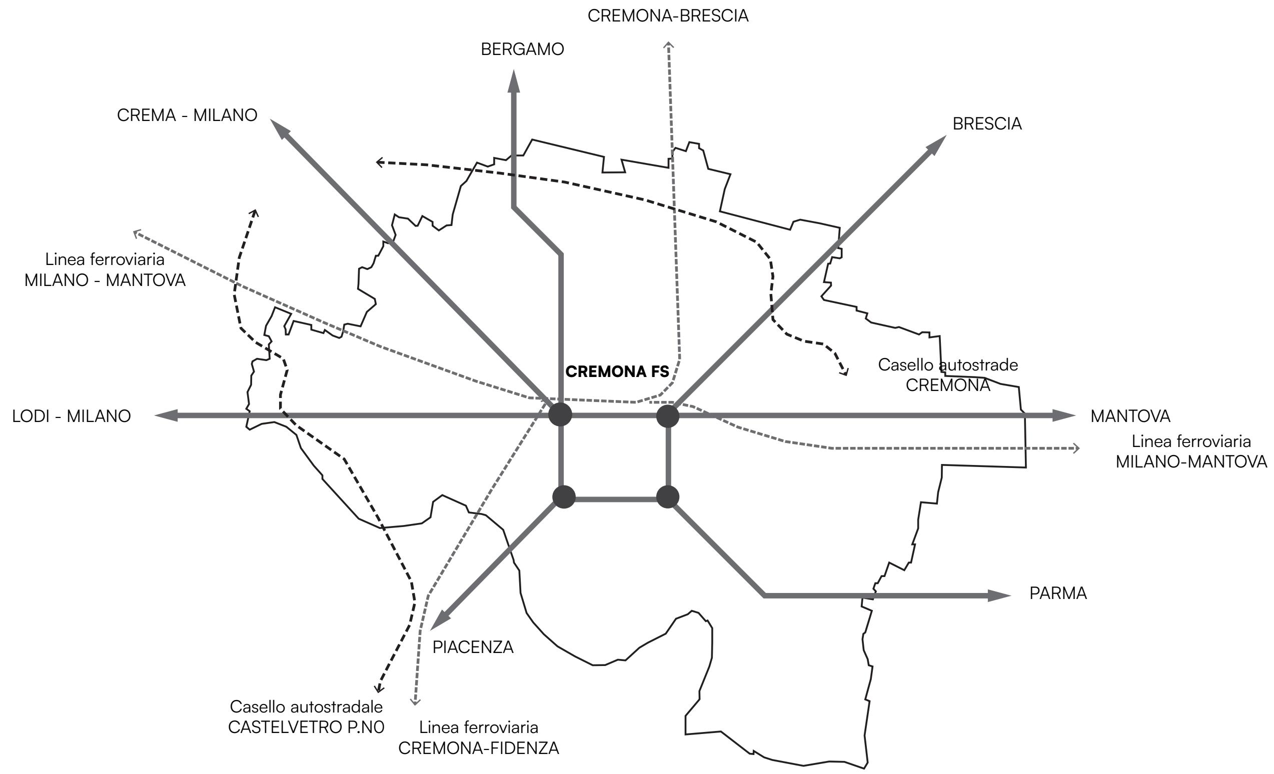


Cremona is located in the Lombardy region of northern Italy. It is situated in the Po Valley, approximately 90 kilometers southeast of Milan. The city is positioned on the banks of the Po River, which runs through the region. The population of Cremona, Italy, was estimated to be around 72,000 people.

The fertile lands surrounding the River Po have allowed for agricultural activities, including the cultivation of crops such as corn, rice, and wheat. Cremona's agricultural industry benefits from the river's water supply and fertile soil, contributing to the city's economy and culinary traditions. Cremona's relationship with the River Po reflects the interconnectedness between the city and its natural environment. The river's presence has shaped the city's economy, culture, and historical development, while also posing challenges that require ongoing management and conservation efforts.



Infrastructure



Cremona, located in the Lombardy region of northern Italy, has connections with various cities through transportation networks. Here are some key connections:

Cremona has good transportation links with Milan, which is approximately 90 kilometers to the west. There are regular train services connecting the two cities. Brescia sisituated to the east of Cremona. The two cities are connected by road networks. Mantua is located to the southeast of Cremona, Mantua is a historical city known for its Renaissance architecture. Cremona and Mantua are well-connected by road, and there are bus services that operate between the two cities. Piacenza lies to the south of Cremona and is easily accessible by road. Parma is situated southwest of Cremona. The transportation infrastructure facilitates travel and enables residents and visitors to explore and access different destinations in the region.

Importance

The city's rich historical and cultural heritage, particularly its renowned tradition of violin making, has made it a symbol of craftsmanship and musical excellence. Cremona's agricultural sector, with a focus on livestock activities such as pig farming, plays a crucial role in the local economy and provides employment opportunities.

The city is also known for its culinary delights, including nougat production and traditional dishes that tantalize the taste buds. Architecturally, Cremona showcases impressive landmarks such as the Cremona Cathedral and its iconic Torrazzo bell tower. The presence of educational institutions, including the University of Pavia's Cremona campus, contributes to the intellectual and cultural development of the city.

Moreover, it is characterized by the presence of livestock activities primarily located in the provinces of Lower Padana, namely Brescia, Mantua, Cremona, Lodi, and Bergamo. This region is home to the majority of Lombard farms, with pig farming being the dominant activity. These farms play a significant role in the economic and social development of the area but also exert considerable pressures on the territory. These pressures manifest in the form of anthropization and construction, resulting in interactions with the local population, as well as the emission of substances into the water, air, and soil. It is worth noting that cattle farms are the largest contributors to nitrogen production, accounting for nearly 60% of the total annual nitrogen output, followed by pigs at 28%, and poultry at approximately 11%.

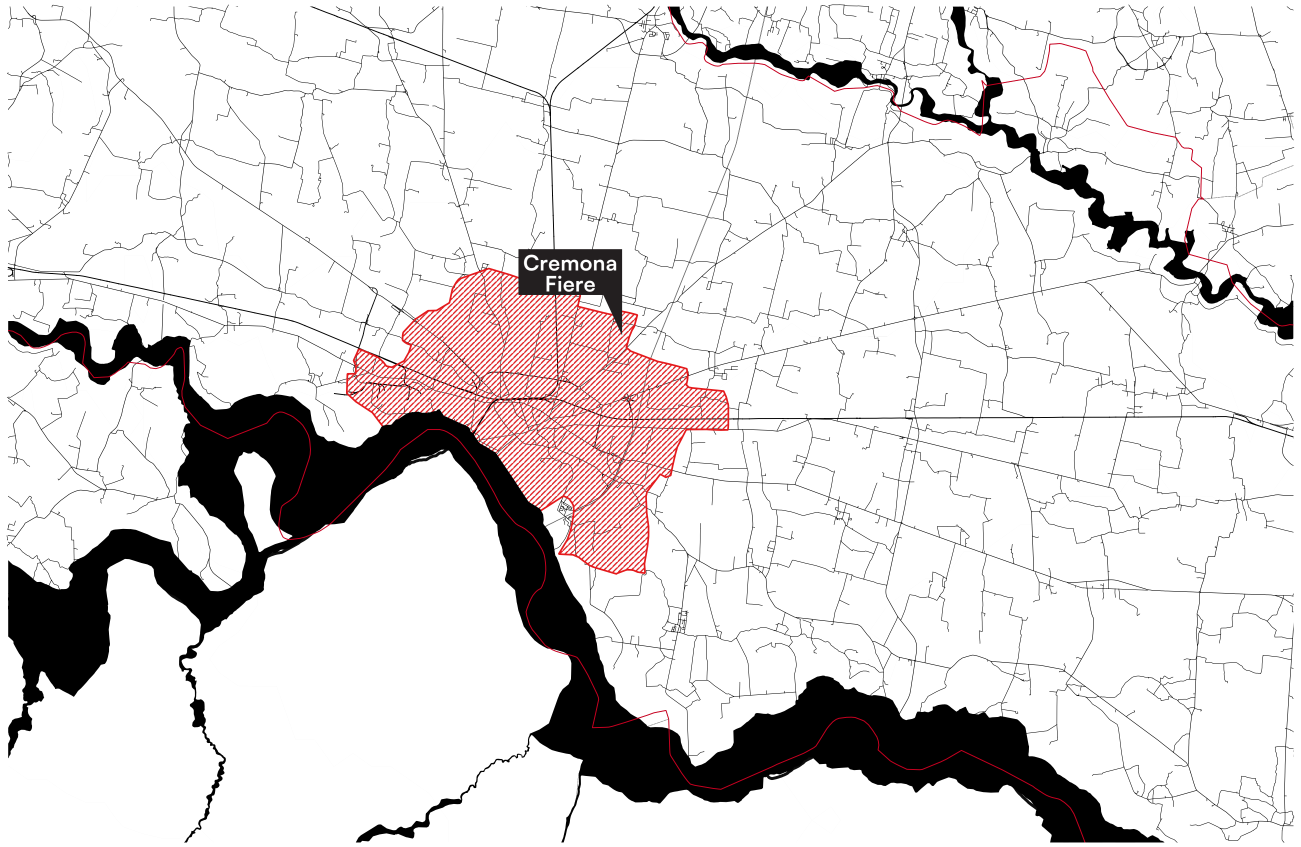
In summary, Cremona and its surrounding provinces is characterized by livestock activities, primarily pig farming, which have both positive and negative impacts on the region's economic and social development, as well as the environment. The production of nitrogen, the demand for irrigation, and the presence of nitrate pollution are significant aspects of this cluster's agricultural landscape.

13%
Italian agro-industrial production

16%
of national agricultural production

44%
Of italian milk

CremonaFiere



A dynamic and multi-purpose Exhibition Centre. CremonaFiere is the second largest exhibition center in Lombardy and has an exhibition center with covered and uncovered areas and a functional congress center suitable for events of all kinds.

- 50000 sq of covered exhibition areas
- 3500 parking spaces
- 100000 of uncovered exhibition areas
- 4 pavilions

150,000

visitors from 40 countries

Importance

Cremona Fiere is an important institution in the city of Cremona, Italy. It is a trade fair and exhibition center that plays a significant role in promoting economic development and showcasing various industries.

It hosts a wide range of exhibitions, trade fairs, conferences, and events throughout the year. These events attract both national and international participants, including businesses, professionals, and visitors from different sectors. The diverse range of exhibitions covers various industries such as agriculture, livestock farming, food and beverage, crafts, manufacturing, and more.

The importance of Cremona Fiere lies in its ability to foster business connections, networking opportunities, and knowledge sharing among industry professionals. It serves as a platform for companies to showcase their products and services, launch new initiatives, and establish partnerships. The exhibitions provide a space for industry professionals to exchange ideas, stay updated on the latest trends, and explore business opportunities. It is committed to sustainability and environmental responsibility. It seeks to minimize its ecological footprint by implementing eco-friendly practices in its operations, such as energy efficiency measures, waste reduction, and promoting sustainable initiatives among its exhibitors and participants. Cremona Fiere contributes significantly to the local economy by attracting visitors from outside the region, which boosts tourism, hotel occupancy, and local businesses. The events hosted by Cremona Fiere also have a positive impact on the city's image and reputation as a hub for trade and commerce.

Cremona fiere can create a connection between the important cities (urban), and (rural) using the sport thought all the river Po. Creating a system and making the Po an ecotone. A transitional space from urban to rural, using sport as a territorial marketing.

SWOT analysis

CremonaFiere general overview

S

- Infrastructure: Cremona Fiere has well-established exhibition facilities and infrastructure, providing a suitable venue for hosting various events and exhibitions.
- Experience and Expertise: With years of experience, Cremona Fiere has developed expertise in organizing and managing exhibitions, ensuring smooth operations and successful outcomes.
- Regional Importance: Cremona Fiere holds significant importance in the region, attracting exhibitors and visitors from both Italy and abroad, contributing to the local economy and promoting business opportunities.

W

- Size and Capacity: Depending on the scale of events, the size and capacity of Cremona Fiere's exhibition space may pose limitations in accommodating larger exhibitions or simultaneous events.
- Limited International Reach: While Cremona Fiere attracts regional and national exhibitors, its international exposure and participation may be relatively limited, affecting its ability to attract a diverse range of exhibitors and visitors.

SWOT analysis

O

- Industry Collaboration: Cremona Fiere can explore opportunities to collaborate with industry associations, organizations, and businesses to host specialized exhibitions and events, catering to specific sectors and target audiences.
- Technological Advancements: Embracing technological advancements such as digital platforms, virtual exhibitions, and online marketing can expand the reach and accessibility of Cremona Fiere's events, attracting a wider audience and exhibitors.

T

- Competition: The exhibition industry is highly competitive, with other exhibition centers and venues vying for exhibitors and visitors. Cremona Fiere faces the challenge of standing out and maintaining its position in the face of competition.
- Economic Factors: Economic fluctuations, changes in market conditions, and financial uncertainties can impact the willingness of exhibitors and visitors to participate in events, potentially affecting the success of Cremona Fiere's exhibitions.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PROEL SPA


357

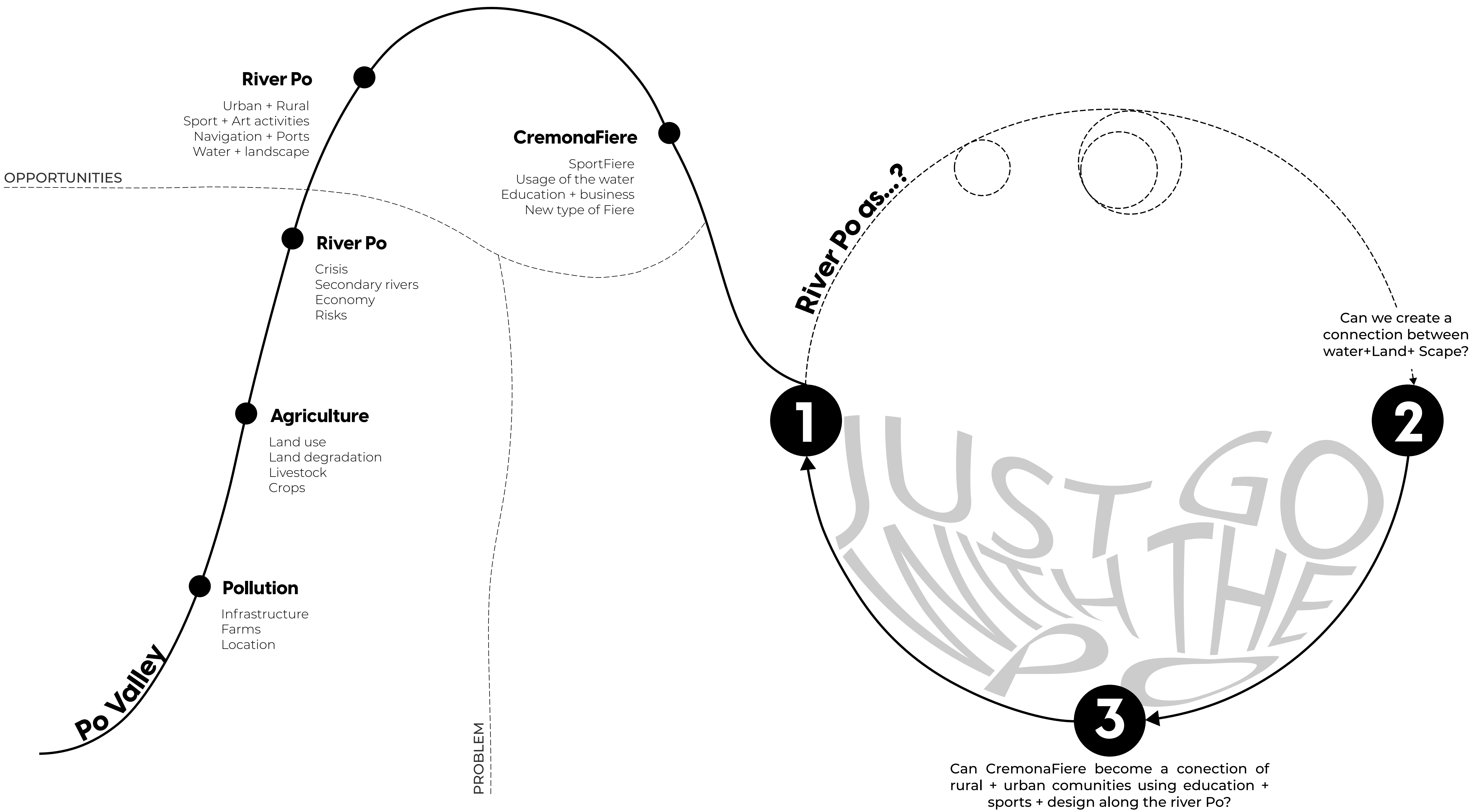
02

Creation

The Po River basin holds immense economic significance, making it the most vital region in Italy. Throughout history, people have celebrated the abundance provided by the Po River. However, in their pursuit of exploiting its resources, they have inadvertently jeopardized the delicate balance of the ecosystem by overusing its waters. The Po River Basin represents more than just water and land; it embodies the collective impact of human activity and the transformation that has occurred within its boundaries.

Research summary

Po Valley general overview



SWOT analysis

Po Valley general overview

S

- Fertile Agricultural Land: The Po Valley is renowned for its highly fertile soil, making it one of the most productive agricultural regions in Europe. The area supports a wide range of crops, including rice, corn, wheat, vegetables, and fruits.
- Industrial Base: The Po Valley is home to several industrial centers and manufacturing hubs. It has a well-developed infrastructure, including transportation networks and logistics, which facilitates trade and commerce.
- Cultural and Historical Significance: The Po Valley has a rich cultural and historical heritage. It boasts numerous UNESCO World Heritage Sites, ancient cities, and architectural landmarks, attracting tourists and contributing to the local economy.

W

- Environmental Concerns: The Po Valley faces challenges related to pollution, particularly air pollution. Industrial activities and intensive agriculture contribute to high levels of smog, impacting the quality of life and the environment.
- Vulnerability to Flooding: The Po Valley is prone to flooding due to the presence of the Po River and its tributaries. Floods can cause significant damage to infrastructure, agriculture, and settlements in the region.
- Depopulation of Rural Areas: Many rural areas within the Po Valley have been experiencing depopulation as younger generations move to urban centers in search of better opportunities. This trend can lead to social and economic imbalances.

SWOT analysis

O

- Sustainable Agriculture: There is an opportunity to promote and implement sustainable agricultural practices in the Po Valley. This can help reduce environmental impact, enhance productivity, and meet growing demands for organic and locally sourced food.
- Renewable Energy: The flat landscape and favorable weather conditions in the Po Valley make it suitable for the development of renewable energy sources, such as solar and wind power. Investing in renewable energy infrastructure can reduce reliance on fossil fuels.
- Tourism and Cultural Promotion: The Po Valley can further capitalize on its rich cultural heritage and historical sites to attract more tourists. Promoting tourism can stimulate the local economy and create job opportunities.

T

- Climate Change: The Po Valley is susceptible to the impacts of climate change, including extreme weather events, changing rainfall patterns, and rising sea levels. These factors can exacerbate flooding risks, affect agriculture, and disrupt the region's ecosystem.
- Economic Competition: The Po Valley faces competition from other regions, both within Italy and internationally. To maintain its economic vitality, it needs to adapt to changing market dynamics and invest in innovation and technological advancements.
- Urbanization Pressure: The demand for urban development and expansion can put strain on the region's natural resources and agricultural land. Balancing urban growth with the preservation of environmental assets is crucial to ensure sustainable development.

Concept

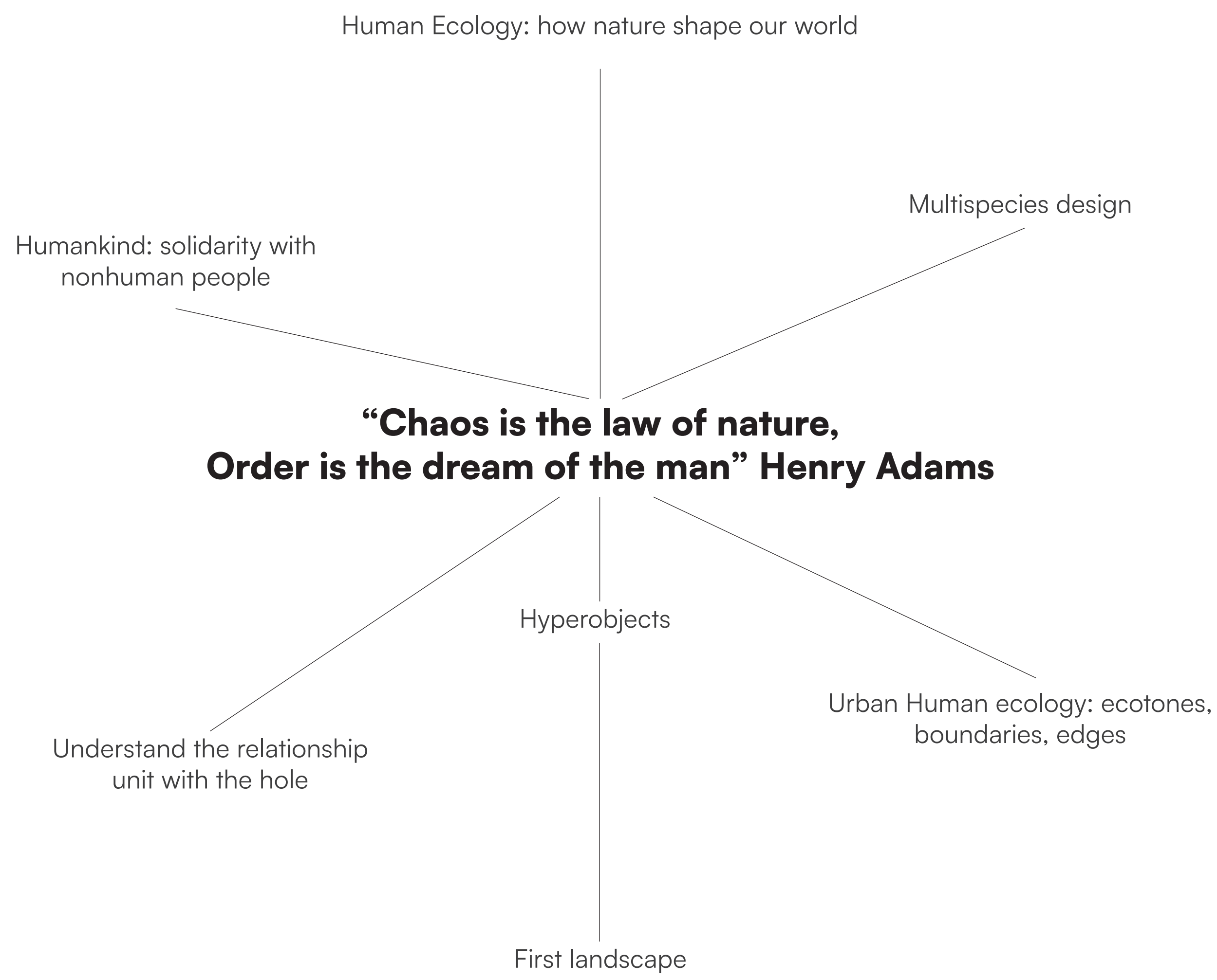
Beyond human-centred design

The impact of human activity on the natural world extends globally, with modified ecosystems becoming more prevalent than natural ones (Green, 2013). Even the remaining natural ecosystems coexist within the same altered atmosphere and changing climate as the rest of the planet, and are subject to these same human-induced influences (Hannah, 2015).

Traditionally, nature conservation has focused on protecting pristine wilderness areas from human impact. However, there is a growing recognition of the ecological and social value of natural systems that exist in proximity to human settlements and overlap with human habitats. Some of these systems are remnants of ancient ecosystems that existed in the area long before human presence. Others are emergent and novel systems, comprising a mix of species from different origins, set within landscapes shaped by human activities. Unfortunately, these systems are often overlooked in the planning and development of human habitats, and their maintenance is often neglected (Phemister, 2010).

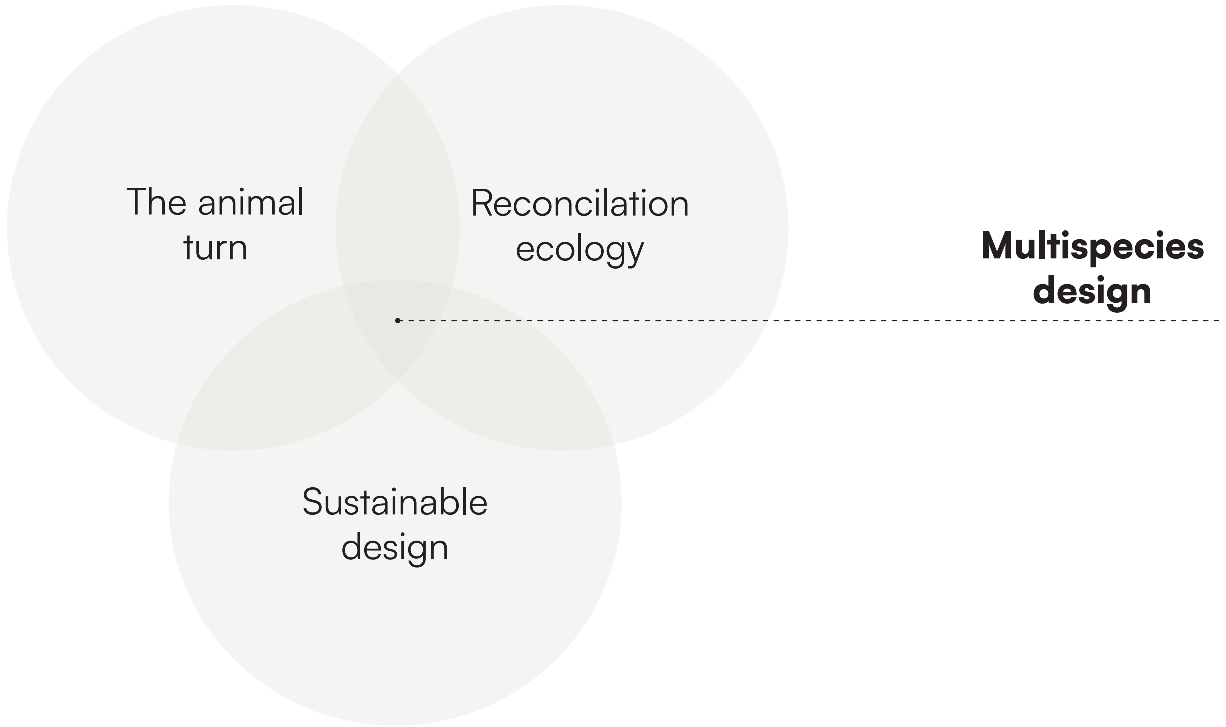
The separation of human habitats from natural ones has been driven by a preference for predictability and simplicity in urban planning, while assuming that nature will persist elsewhere. However, this separation comes at a cost. We continuously engage in a battle against nature, considering certain species as weeds or pests. We also lose out on the ecosystem services that these emergent ecosystems could provide. Additionally, the disconnect from the natural world leads to the alienation of people. Furthermore, this separation results in the loss of habitat for numerous species that still manage to survive in the margins and shadows of our built environments, as well as species that could potentially thrive within these environments under the right conditions.

In summary, the disregard for the ecological value of natural systems that coexist with human habitats comes with several consequences. It entails constantly fighting against nature, losing out on ecosystem services, alienating people from the natural world, and diminishing habitat for various species. Recognizing the significance of these emergent ecosystems and integrating them into our design and development processes can lead to more sustainable and harmonious coexistence between humans and the natural world.



Multispecies design

To improve river po



Multispecies Design emerges from the convergence of sustainable design with two significant contemporary paradigm shifts in the humanities and natural sciences. The Animal Turn in the humanities, as discussed by Ritvo (2007), has led to a growing emphasis on animals within disciplines that were primarily focused on other subjects. This shift has given rise to hybrid fields like animal geography and multispecies ethnography, which explore the intersections between nonhuman animals and human societies, as well as the influence of political, economic, and cultural factors on the livelihoods of various organisms (Urbanik, 2012; Kirksey and Helmreich, 2010). These emerging fields challenge the artificial separation between nature and culture and highlight the interconnectedness and interdependencies between humans and other species on our planet.

Simultaneously, there has been a shift in the focus of conservation, expanding from pristine wilderness areas to a more comprehensive approach encompassing conservation efforts everywhere. Conservation strategies now aim to improve the ecological value of diverse habitats that were previously overlooked, including agricultural fields, private lands, abandoned industrial sites, and heavily developed terrestrial and marine landscapes. These areas possess the potential for ecological enhancement and acquiring conservation value (Marris, 2011; Rosenzweig, 2003). The concept of reconciliation ecology encompasses the strategies employed to modify anthropogenic systems to support biodiversity without compromising their primary functions (Francis, 2011).

At the intersection of these paradigm shifts lies the exploration of human-animal interactions and the potential transformation of anthropogenic systems, encompassing physical infrastructure as well as cultural and belief systems, to foster greater species diversity. This transformation holds numerous design implications and necessitates an “Animal Turn” within the field of design. Multispecies Design is an integral part of this transformative process, incorporating considerations of human-animal relationships and designing environments that support and promote a multitude of species.

More-than-Human Ethics

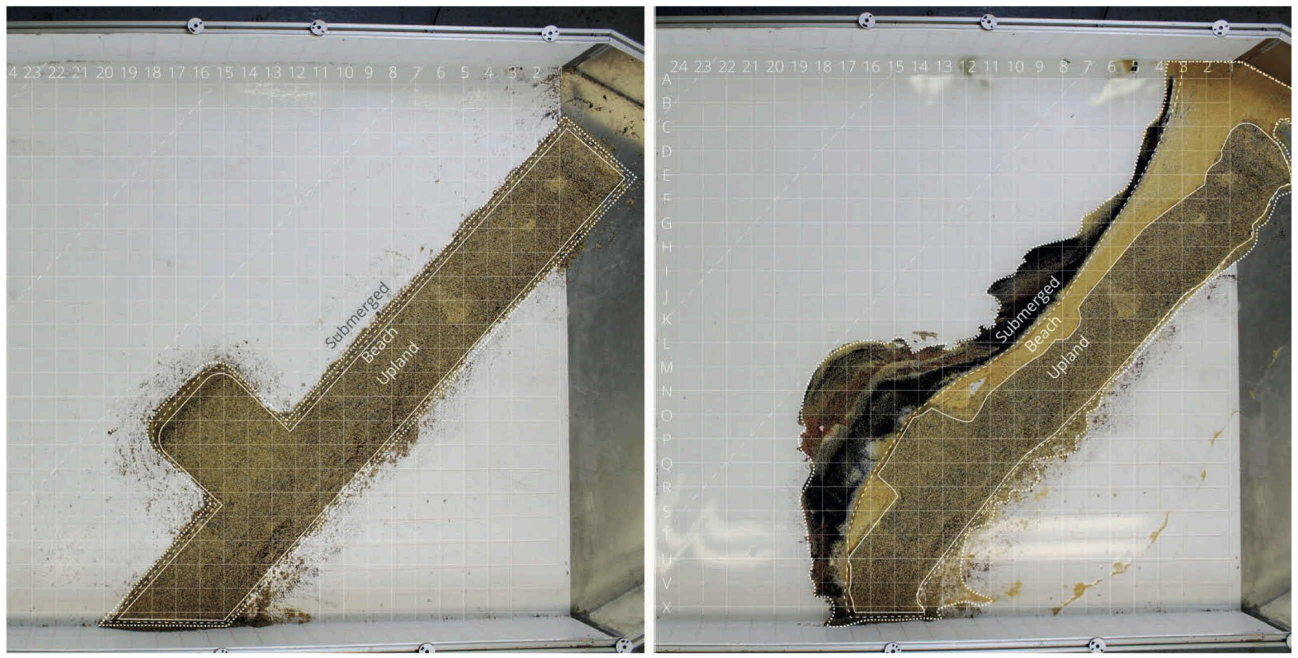
Anthropologists such as Ingold (2000) and Descola (2013) have demonstrated that certain human societies perceive nonhuman lifeforms as integral to their cultural fabric. These societies view the human self as part of a broader nature-culture continuum (Harvey, 2013). Typically found in nonindustrial or indigenous communities, these attitudes often result in more caring (though sometimes still exploitative) approaches towards nonhuman beings. However, such communities are becoming increasingly rare, and their perspectives and practices often relate to highly localized environments that no longer exist or are rapidly disappearing.

Addressing future environmental challenges requires incorporating relationships and phenomena beyond these local traditions. Examples include the distant sources of pollution and the resulting climate impacts, as well as the remote consequences of production and consumption chains that exploit resources from and deposit waste in distant regions, such as the vulnerable and poorly protected Global South (Gould et al., 2008), or even extraterrestrial bodies like the Moon and asteroids. Additionally, the ongoing and anticipated migrations of both human and nonhuman lifeforms in response to environmental changes will present novel and complex conditions (Higgs, 2017). The reintroduction of nonhuman life into areas inhabited by humans necessitates a consideration of principles governing interactions between species and individuals, raising challenging questions about the exercise of human power.

Hyperobjects

Hyperobjects thinking, introduced by philosopher Timothy Morton, refers to a conceptual framework that addresses the complex and interconnected nature of large-scale phenomena, often beyond human comprehension. It surpasses the grasp of human perception and understanding. It exists on a scale that is often immense, intricate, or dispersed, making it challenging for any individual or specific field to fully comprehend.

Hyperobjects are entities or processes that are massive in time and space, such as climate change, ecosystems, or technological systems. These entities are distributed, non-local, and their effects transcend human perception and understanding. It encourages a shift from a narrow human-centric perspective to a more expansive and inclusive approach that acknowledges the complex web of relationships between humans, non-human species, and the environment.



IImage showing how large physical models can simulate sediment transport and shoreline morphology transformation through various water level and wave scenarios. (Source: image courtesy of Sean Burkholder, Theresa Ruswick, and the Healthy Port Futures project).

A shifting role of design

What should be the role of design and designers in addressing complex issues and contributing to a significant shift in thinking? Design has historically played a role in perpetuating a hierarchical anthropocentric perspective, promoting human-centered models of production and consumption that have led to unsustainable changes in ecosystems. However, design research and practice are now recognizing the need for an ontological shift and assuming a different role within this context.

Design for sustainability is emerging as a field that contributes to sustainable development by advocating for “designing for social equity and cohesion” and expanding the perspective from environmental considerations to socio-technical viewpoints. Approaches such as cradle-to-cradle design and biomimicry design emphasize a regenerative approach that encompasses not only future human generations but also non-human species. This shift challenges anthropocentric hierarchies and fosters a more inclusive consideration of non-human entities as sources of inspiration, participants in urban development, and even innovators. In other words, designers are adopting a posthuman perspective that acknowledges the non-hierarchical interrelationships between humans and non-humans, both living and non-living, while recognizing their agency. Human ecology is inherently intertwined with other entities, blurring the boundaries of the anthropocentric view. This recognition of the more-than-human connections between different species presents new opportunities, tools, and expertise that designers should engage with.

Moreover, a paradigm shift is necessary to facilitate the sustainable transition from a socio-technical and environmental standpoint, and design can serve as a catalyst for this change. The evolving role of design is being recognized at two interconnected levels:
1. The transition towards new sustainable models of production and consumption by adopting a non-human-centric perspective.
2. The interconnection of human and non-human entities for collaborative futures.

Regarding the latter aspect, speculative design holds significant potential in driving concrete shifts by enabling critical reflections on possible future scenarios. Speculative design allows for the exploration of alternative possibilities, raising awareness of the entanglements with non-human entities.

Case study

Water Way / EKA Sisearhitektuur

The Floating Wetlands project in Rotterdam, Netherlands is an innovative example of multispecies design that focuses on improving water quality and enhancing biodiversity in urban areas. The project involves the implementation of floating islands or rafts covered with a variety of wetland plant species. The floating islands are designed to float on the city's canals and water bodies, creating artificial wetland habitats. These habitats serve multiple purposes: they help filter and purify the water by absorbing nutrients and pollutants, provide a habitat for aquatic organisms, and contribute to the overall ecological health of the water system.

The design of the floating wetlands takes into consideration the specific plant species that are best suited for water-based environments. These plants have extensive root systems that help stabilize the floating islands and provide ample surface area for microorganisms to thrive, further enhancing the water purification process.

Additionally, the floating wetlands provide nesting sites for birds and attract other wildlife, creating opportunities for biodiversity in an otherwise urbanized landscape. The project not only improves the ecological function of the water bodies but also enhances the aesthetic appeal of the city, adding greenery and natural elements to the urban environment.

The Floating Wetlands project in Rotterdam showcases how design can be used to integrate natural systems into the built environment, promoting ecological resilience and creating opportunities for human-nature interactions. It serves as a model for sustainable urban development and inspires other cities to explore similar approaches to enhance their water systems and support biodiversity.

Case study

The Wildlife Crossings, Banff National Park, Canada

The Wildlife Crossings project in Banff National Park, Canada is a remarkable example of multispecies design aimed at mitigating the impacts of roads on wildlife populations and promoting habitat connectivity. Banff National Park is known for its diverse wildlife, including bears, wolves, elk, and other species that require large territories to thrive. To address the issue of wildlife-vehicle collisions and habitat fragmentation caused by highways, the park implemented a system of wildlife crossings, including overpasses and underpasses. These crossings are strategically designed to allow wildlife to safely traverse the roads and maintain their natural movement patterns across the landscape.

The overpasses are constructed as green bridges, blending with the surrounding natural environment. They are wide and vegetated, resembling natural habitats and providing a safe passage for animals over the highways. The underpasses, on the other hand, are constructed beneath the road surface, allowing wildlife to pass underneath without the risk of encountering vehicles. The design of these wildlife crossings considers the specific needs and behaviors of various species. For example, the vegetation on the overpasses is chosen to mimic the preferred habitats of different animals, attracting them to use the crossings. Additionally, fences and other wildlife-friendly measures are implemented to guide animals towards the designated crossings and prevent them from attempting to cross the highways at dangerous locations.

The project serves as a model for other regions facing similar challenges with wildlife and road infrastructure. It demonstrates the importance of considering the needs of non-human species in the design of transportation systems and showcases the potential for harmonious coexistence between wildlife and human activities.

Case study

The Bumblebee Highway, Oslo, Norway

The Bumblebee Highway project in Oslo, Norway is an inspiring example of multispecies design that aims to create a safe and supportive habitat for bumblebees within the urban landscape. Bumblebees play a crucial role in pollinating plants, including many food crops, but their populations have been declining due to habitat loss and pesticide use. To address this issue, Oslo implemented the Bumblebee Highway, a network of interconnected green spaces and flowering corridors throughout the city. These corridors consist of pollinator-friendly plants and flowers that provide nectar and pollen for bumblebees and other pollinators. The project focuses on creating continuous foraging opportunities and nesting sites for bumblebees, allowing them to move freely and access essential resources.

It demonstrates how cities can actively support and conserve biodiversity within urban environments. By creating pollinator-friendly habitats and promoting public engagement, the project not only benefits bumblebees but also raises awareness about the broader importance of preserving and restoring natural ecosystems.

This innovative approach to urban design showcases the potential for integrating nature and wildlife into urban landscapes, enhancing ecological resilience, and promoting a more harmonious relationship between humans and other species. The Bumblebee Highway serves as an inspiring model for cities worldwide to take action and create urban spaces that prioritize the needs of biodiversity and support pollinators.

Case study

Living Shorelines, Various Coastal Areas

Living shorelines are innovative approaches to coastal management that utilize natural materials and processes to protect shorelines from erosion while providing ecological benefits. Here are a few examples of living shoreline projects in various coastal areas:

1. Poplar Island, Chesapeake Bay, United States: Poplar Island, located in the Chesapeake Bay, is a restoration project that transformed a barren island into a thriving habitat using living shoreline techniques. The project involved the construction of stone sills and breakwaters, along with the planting of marsh vegetation, to stabilize the shoreline and create valuable habitat for fish, birds, and other wildlife.

2. Oyster Reef Restoration, Gulf of Mexico, United States: Along the Gulf of Mexico, oyster reef restoration projects are being implemented to protect and enhance coastal areas. Oyster reefs act as natural barriers, reducing wave energy and preventing erosion. These projects involve the placement of oyster shells or artificial structures to create new oyster habitats, which not only stabilize the shoreline but also provide crucial nursery grounds for various marine species.

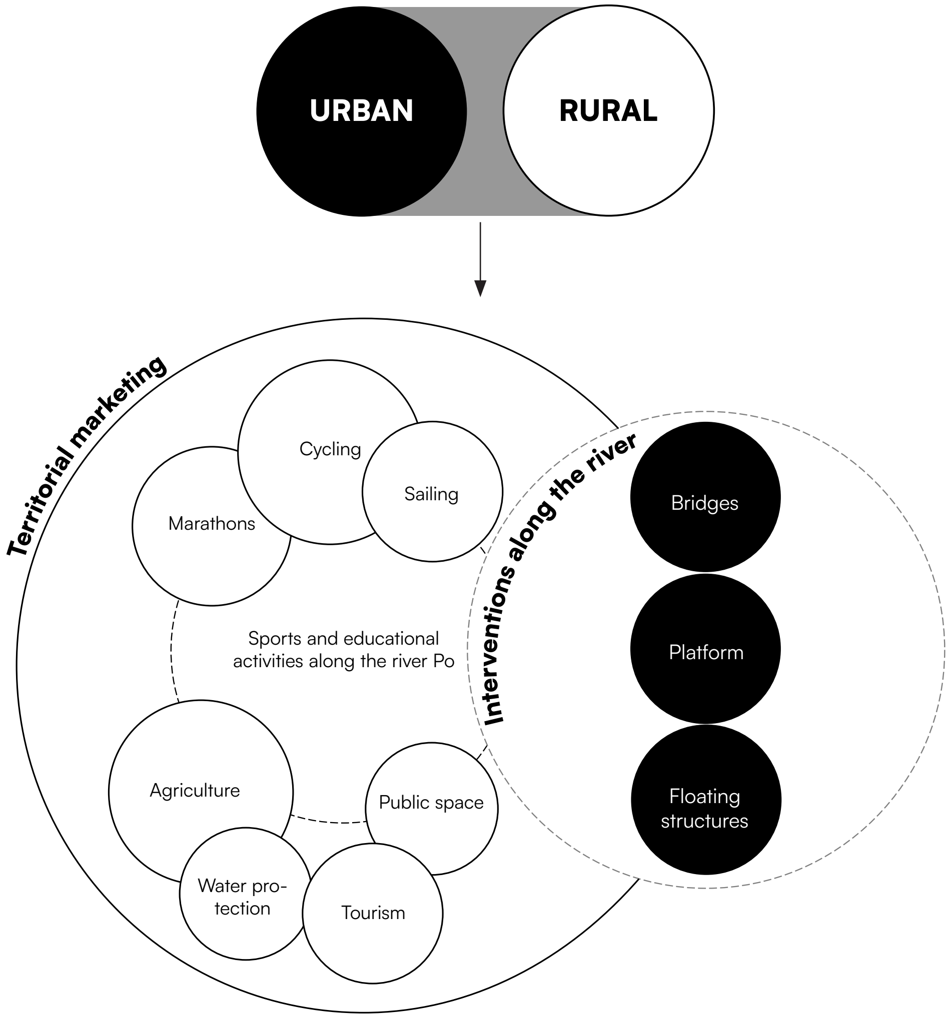
3. Zostera Marina Seagrass Restoration, Baltic Sea, Europe: The Baltic Sea has seen efforts to restore seagrass meadows, specifically Zostera marina, as a form of living shoreline. Seagrasses play a vital role in stabilizing sediments, improving water clarity, and providing habitat for numerous marine organisms. Restoration involves transplanting seagrass shoots or seeds into degraded areas to promote the recovery of these important ecosystems.

03

Reflection

The reflection chapter delves into the creation and design of a floating ecosystem and platform with a focus on its modular and flexible nature. It serves as a thoughtful examination of the solution, highlighting its strengths and challenges. Within this chapter, the emphasis is placed on the innovative approach taken to develop a floating ecosystem that harmonizes with the river's natural environment. The modularity and flexibility of the design are explored in-depth, emphasizing how these features contribute to the adaptability and versatility of the platform.

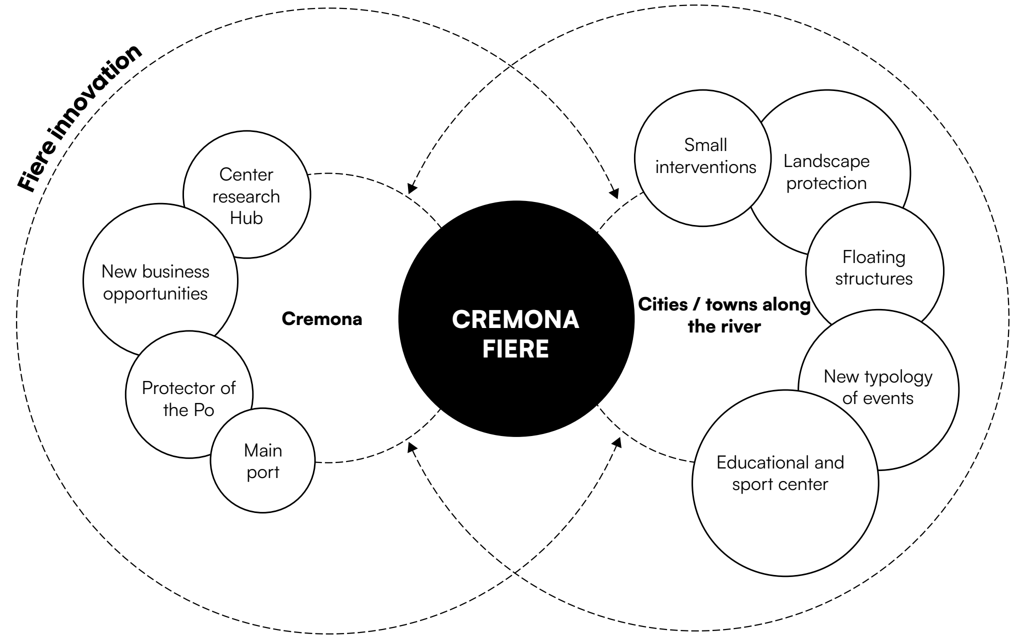
Research summary

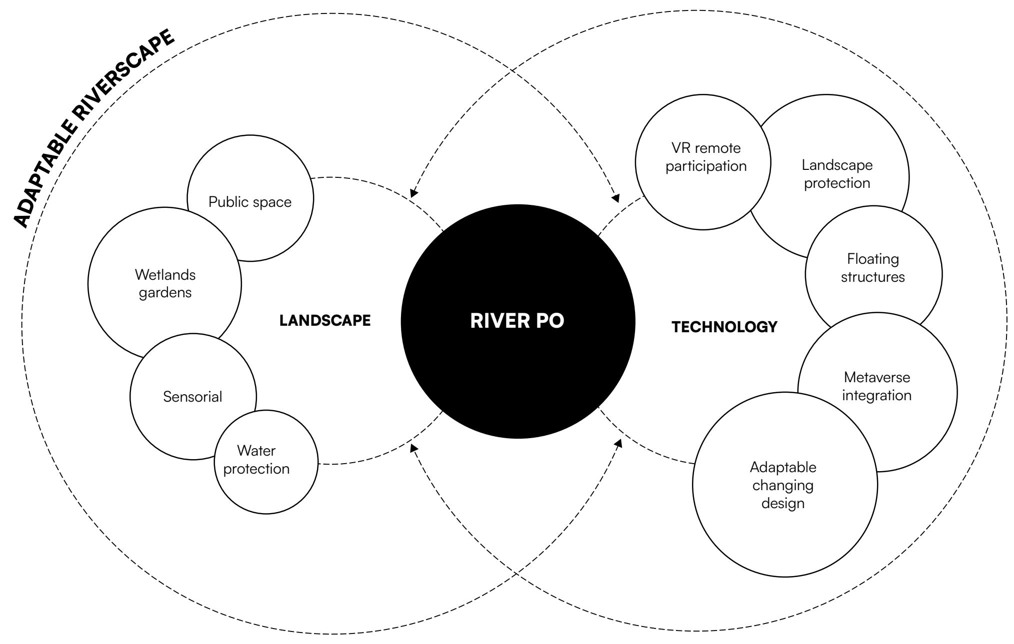


Implementing territorial marketing strategies that leverage both urban and rural areas along the Po River can create a unique and diverse experience for residents and visitors. One approach could be the development of sports activities and facilities that cater to both urban and rural populations. Urban areas along the river can host sporting events. Meanwhile, rural areas can offer outdoor sports such as hiking, cycling, and water sports, taking advantage of the natural landscapes and the river itself.

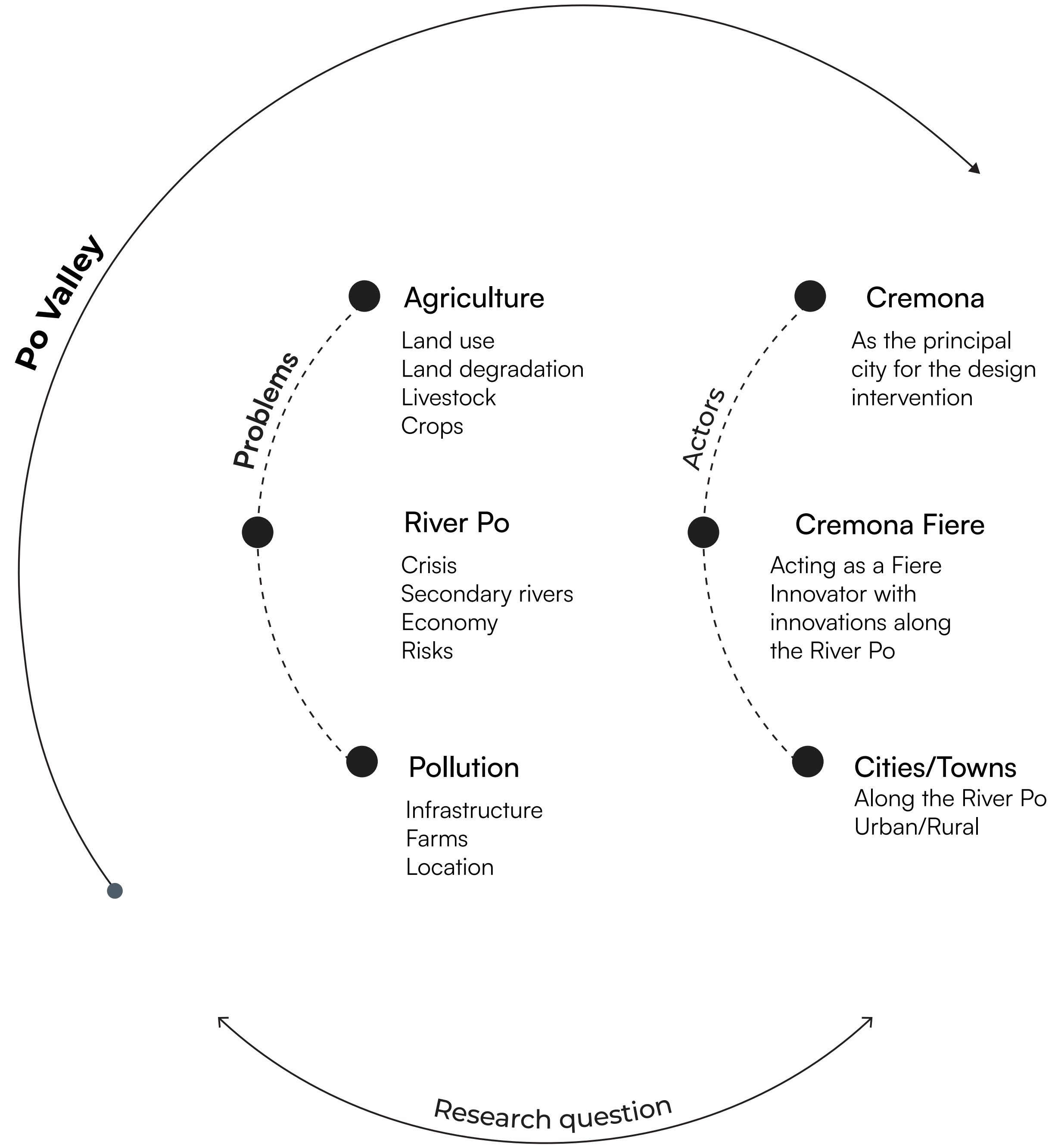
Another strategy could involve the creation of gardens and green spaces along the Po River, serving as recreational areas for people of all ages. In rural areas, botanical gardens, nature reserves, and agritourism farms can showcase the region's biodiversity, agricultural practices, and provide educational activities for visitors.

One innovative idea to explore is the use of floating platforms along the Po River. These platforms can serve multiple purposes, such as hosting cultural events, markets, exhibitions, and even floating classrooms. They can be mobile and flexible, allowing them to move along the river and reach different urban and rural areas, engaging communities and fostering a sense of shared identity and collaboration. By combining these strategies, urban and rural areas along the Po River can complement each other and create a cohesive territorial marketing approach. The urban areas can showcase modernity, innovation, and cultural offerings, while the rural areas can highlight the region's natural beauty, agricultural traditions, and opportunities for outdoor activities. This holistic approach can attract visitors, foster community engagement, and promote sustainable development throughout the entire Po Valley.

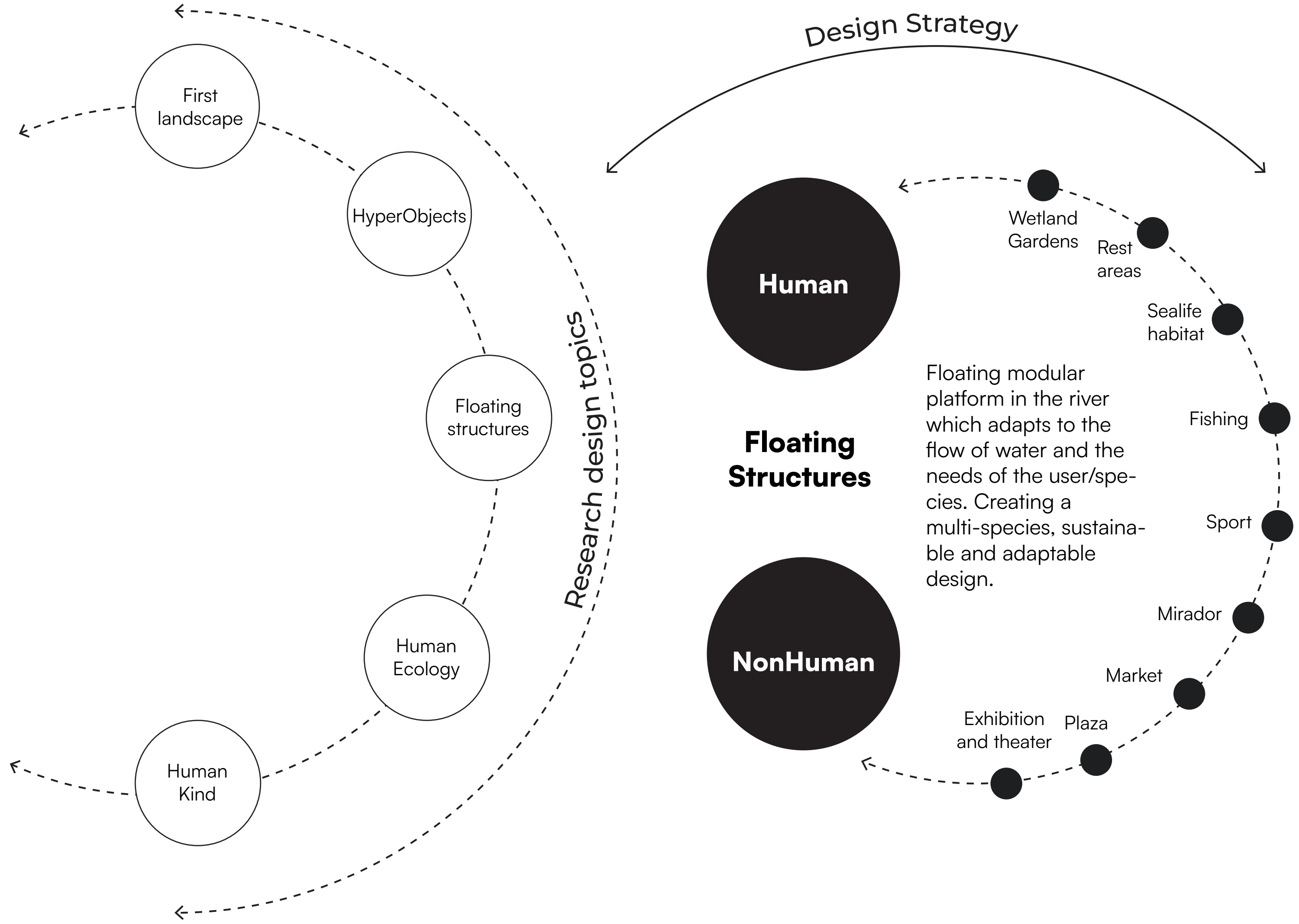




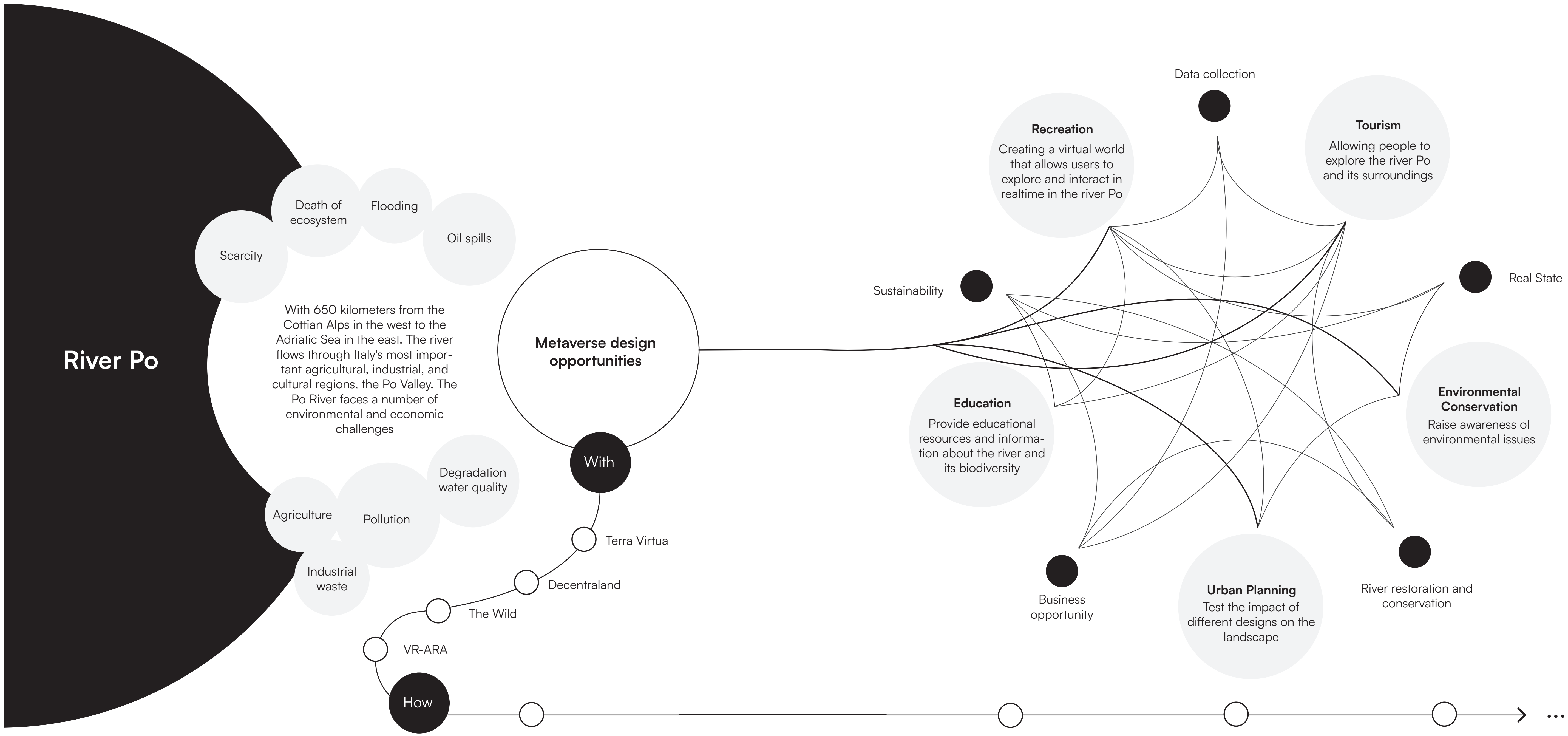
River Po strategy



Can CremonaFiere create a connection between water + Land + Scape + human + non-human using education + sports + design along the river Po ?



Metaverse strategy



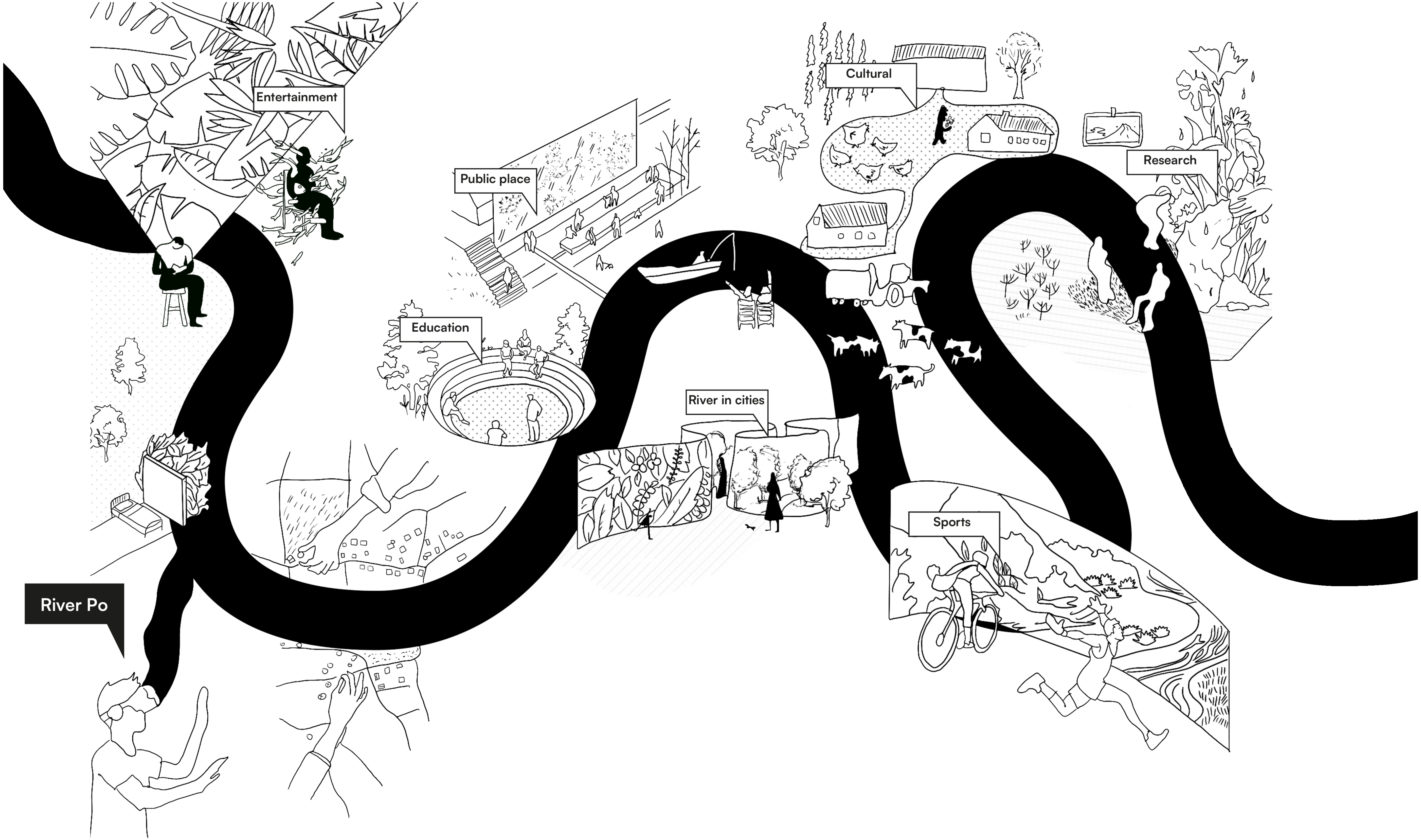
Allowing users to explore different sections of the river, learning about the rapids and hazards, and plan a safe and enjoyable trip. Users could also learn about the rules and regulations for using the river, such as fishing and boating licenses and sports events.

Simulating different ecosystems and showing how they are impacted by human activities like pollution and scarcity. Users could explore these environments and learn about the different species that live there, as well as the threats they face.

Showing how changes in land use and water management practices can improve water quality, restore habitats, and create healthier river ecosystems. Users could explore the river and learn about the different techniques and approaches used in river restoration.

Creating a virtual world that simulates the experience of exploring the river Po, users can have an enjoyable and immersive recreation experience, regardless of their physical location or abilities. Doing challenges that users can complete to earn rewards as Cremona-Fiere and Vento tickets.

Metaverse illustration

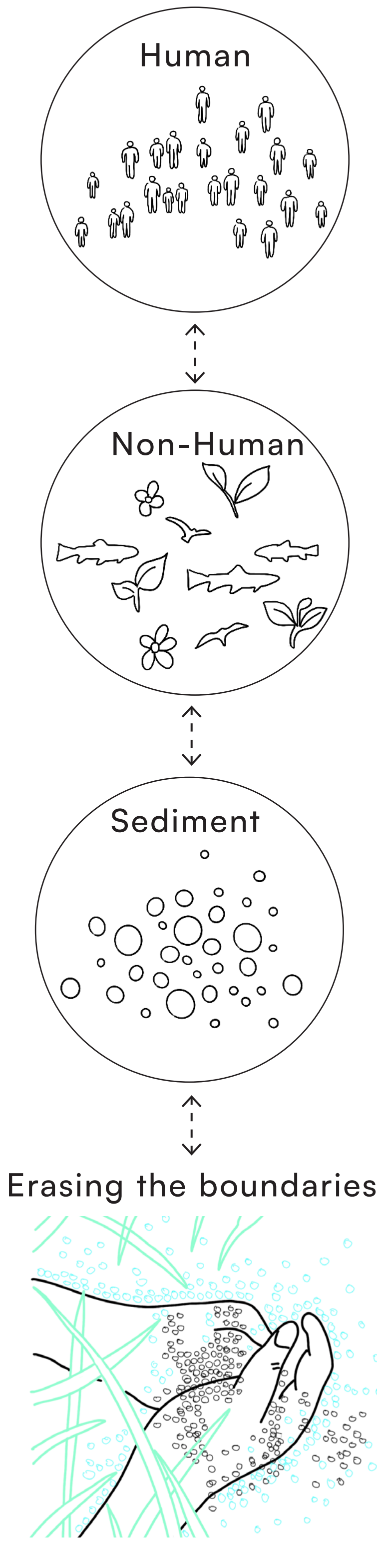


Blurring the line

Grasslands, wetlands, ravines, deserts, agricultural fields, cities, walls, pavements, and even the narrow space between the bathroom sink and mirror demonstrate their ability to support life. It is increasingly recognized that whether we consider urban environments or wilderness areas, the coexistence of wildlife and human communities is not only possible but necessary. They are interconnected components of a larger ecosystem, with humans and wildlife continually adapting and competing for space and resources.

In the common understanding, there appears to be a division, perceiving urban spaces as exclusively human domains and wilderness areas as solely for wildlife. However, as human populations expand into various landscapes, these boundaries overlap, leading to increased interactions between wild creatures and humans. The interactions within these blurred spaces are multifaceted, complex, and rich with experiences. They encompass elements of magic, mystery, tragedy, strategy, and innovation, both visible and hidden.

By creating a floating platform in the River Po serves as a multi-species design platform that blurs the boundaries between the non-human, human, and sediment elements. Its primary objective is to rehabilitate the water and create a thriving ecosystem for vegetation. By utilizing innovative design principles, this platform fosters a symbiotic relationship between different species and the surrounding environment.Through its floating nature, the platform enables the integration of various ecological components, including vegetation, aquatic life, and sediment. It acts as a catalyst for the restoration of the river's health and enhances the overall biodiversity of the area. The design ensures that the platform accommodates the specific needs of different species, promoting their growth and interaction within the ecosystem. It serves as a shared space where people can connect with nature, observe the diverse flora and fauna, and gain a deeper appreciation for the interconnectedness of all living beings.



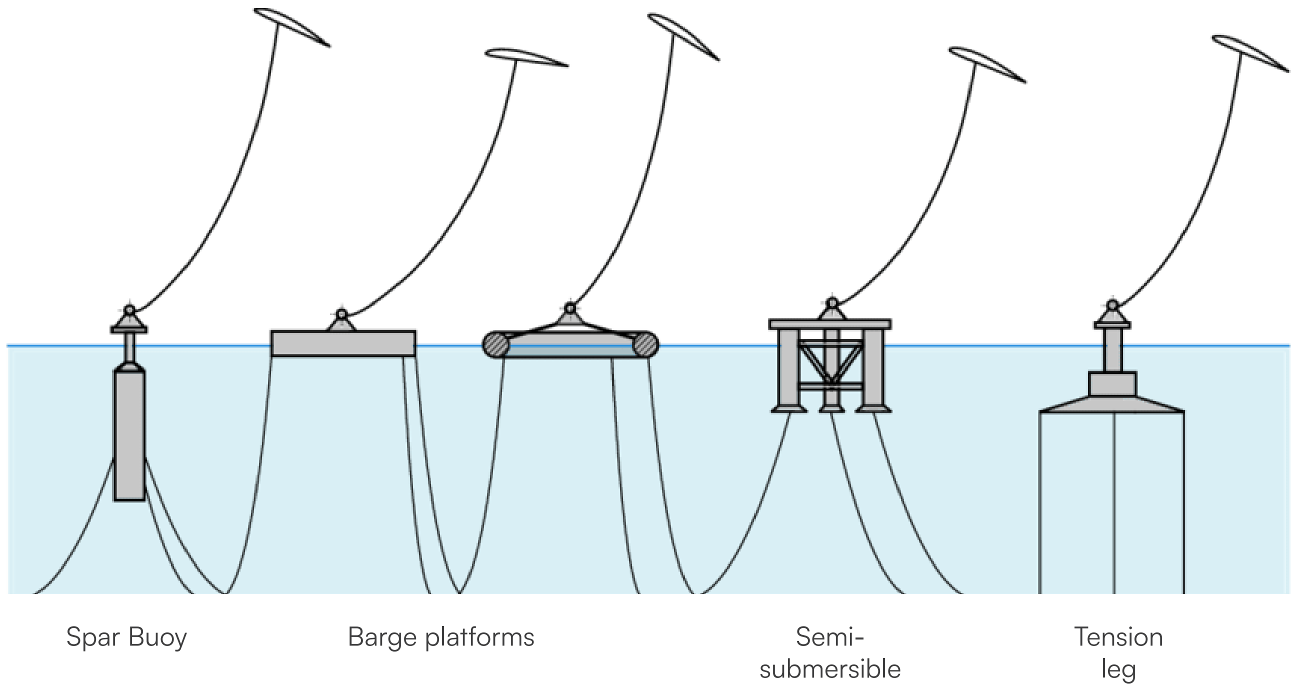
Floating plataform

A floating platform is a structure or platform that is designed to float on water without being anchored or fixed to the seabed or riverbed. It is typically constructed using buoyant materials or pontoons that provide the necessary buoyancy to keep the platform afloat.

Floating platforms offer several advantages, including their flexibility and adaptability to different water conditions, the ability to be easily moved or relocated, and their minimal impact on the seabed or riverbed. They provide access to water bodies where conventional fixed structures may not be feasible or desirable. This type of platform is capable of adjusting to the movement of water and accommodating various activities or functions. Its flexibility allows it to respond to changing conditions and serve different purposes in different locations.

By floating on water, the platform can blur the boundaries between land and water, offering opportunities for unique interactions and engagements with both natural and human-made environments. It provides a dynamic space that can be utilized for a range of activities, such as ecological restoration, recreational purposes, cultural events, or even as a living space.

The flexibility of the platform enables it to accommodate different ecological needs, such as creating habitats for aquatic plants and animals or supporting the growth of vegetation. It can serve as a tool for rehabilitating water bodies, improving water quality, and enhancing biodiversity in aquatic ecosystems. It allows for the coexistence of different species, providing a space where wildlife and human communities can interact and share resources. This integration of diverse elements fosters a deeper understanding of the interconnectedness between humans, wildlife, and the natural environment.



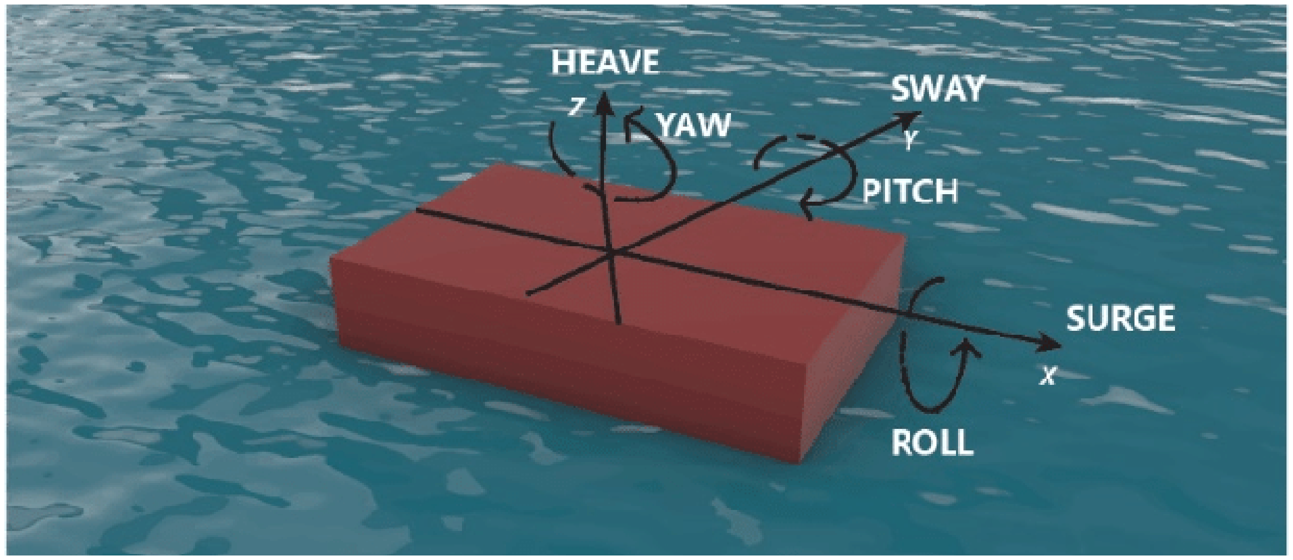
Movement, Stability, and forces

A floating structure operates based on the fundamental principle of buoyancy introduced by Archimedes. Archimedes' principle states that the upward buoyant force exerted on an object is equal to the weight of the water it displaces. This force must counterbalance the downward forces of the applied load and the weight of the structure itself. When an object freely floats in water, it is subject to translation movements and rotations in six different directions:

- Surge: Translation along the x-axis, representing forward and backward movement.
- Sway: Translation along the y-axis, indicating side-to-side movement.
- Heave: Translation along the z-axis, representing upward and downward movement.
- Roll: Rotation about the x-axis.
- Pitch: Rotation about the y-axis.
- Yaw: Rotation about the vertical z-axis.

To prevent these forces from causing the floating body to overturn or sink, it is often secured to the seabed and anchored using appropriate mooring techniques. This anchoring allows the sway, surge, and yaw movements to be minimized or disregarded.

Wang, 2015



Translation forces on a floating object

Floating landscape benefits

Artificial floating islands offer several advantages, including the purification of water, reduction of plankton proliferation, provision of habitat for fish and prawns, and additional vegetation cover. They have proven to be beneficial in improving water quality and enhancing habitats. Artificial floating islands find diverse applications, such as treating stormwater runoff to remove glycol. They also help mitigate the impacts of sewage overflow areas and sewage wastewater (Van Acker et al., 2005; Ash and Truong, 2003).

Artificial floating islands have been found to facilitate the biomineralization of metals from acid mines. They also contribute to increased pollutant removal, resource recovery, and improved pond treatment performance. These islands can serve purposes such as shoreline protection, wildlife habitat creation, enhancement of landscape aesthetics, water purification and filtration, biological disinfection, and provision of additional natural habitat in urban areas. Artificial floating islands align with the principles of ecological engineering, as they are cost-effective, require low maintenance, and assist in pollution control and nutrient removal (Zhou and Wang, 2010).

Floating landscape benefits

Improved water quality

The presence of submerged roots in a micro-wilderness fosters an optimal habitat for countless microorganisms. These microorganisms, utilizing algae, carbon, and excess nutrients present in the water, serve as a food source and effectively purify the water. The beneficial effects of these microbes extend beyond the floating ecosystem, contributing to the long-term improvement of water quality over a considerable area.

Increased water-front values

The implementation of floating islands enables the conversion of underutilized waterbodies into vibrant water parks without causing disruption to the existing infrastructure. This transformation not only enhances public amenities and recreational opportunities but also elevates the value of nearby properties.

Safespace for birds and fish

A submerged forest of roots offers a sanctuary for fish, creating favorable feeding grounds and ultimately improving fish populations. Custom-designed platforms provide optimal nesting and preening habitats for birds. In urban environments where habitat space is limited, these islands serve as protected refuges, shielded from disturbances. By incorporating a variety of habitat types, the islands can be tailored to give specific species' needs.

How floating docks works?

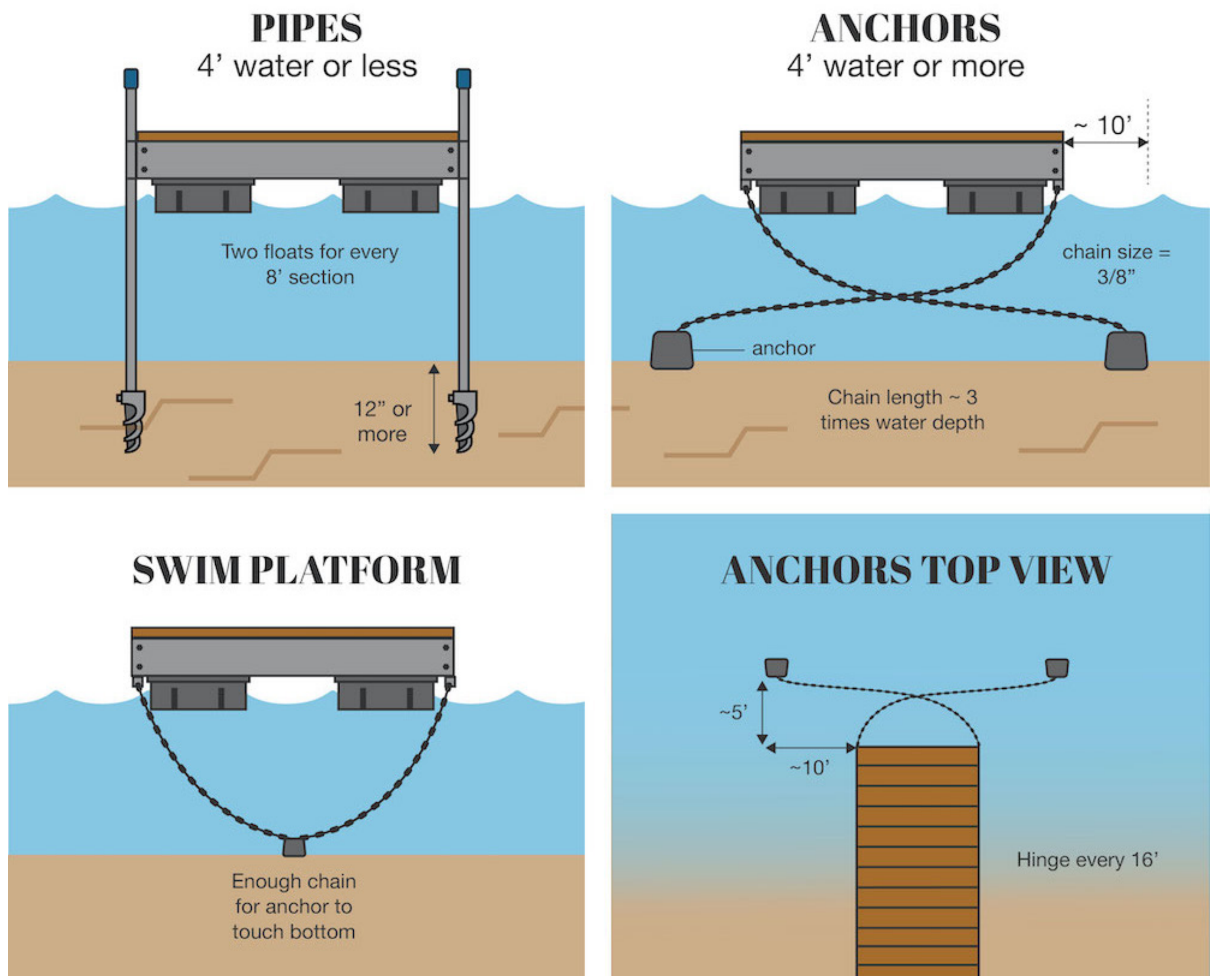
Floating docks remain buoyant because their density is lower than that of water, primarily due to the presence of air inside them. Floating docks are constructed using thick-walled linear low-density polyethylene (LLDPE) without a frame. These docks consist of LLDPE sections that enclose an air-filled chamber, ensuring stability and levelness during use. This design allows the floating dock to move harmoniously with the water, minimizing the impact of water forces that could cause damage.

Despite their ability to move, floating docks are often used as permanent docking solutions. The key distinction from stationary docks is their flexibility in terms of relocation, modification, and extension. To establish a connection with the shore, the dock can be secured using piles, brackets, or a gangway. Many owners of floating docks also opt to anchor them for enhanced stability and functionality.

There are several methods available for anchoring a floating dock, including:

- Galvanized poles.
- Full-size pilings.
- Dead weights.
- Stiff arms secured to the shore.
- A combination of one or more of the above options.

The individual sections of a floating dock are joined together using a coupler system. This system not only connects the segments but also ensures the dock can withstand different weights and levels of stress.



Case study

Public Sediment for Alameda Creek

The “Public Sediment for Alameda Creek” project presents a solution to address the scarcity of sediment in the vulnerable urban areas of Fremont, Union City, and Newark. The proposal extends beyond the tidal edge, encompassing four distinct landscapes: uplands, creek, baylands.

The core concept is to unlock the potential of Alameda Creek and establish a connection between the creek and the baylands. By doing so, the project aims to ensure a sustainable supply of sediment for baylands, enabling adaptation to sea level rise. This approach fosters an ethos of awareness and appreciation for our public sediment resources. The Living Levee is an innovative strategy for revetment design that integrates ecological principles into an interlocking concrete module. It serves multiple purposes, including erosion control, support for the surrounding ecosystem, and habitat enhancement. The inclusion of varying hole sizes allows vegetation to thrive, establishing root structures in the soil.

Case study

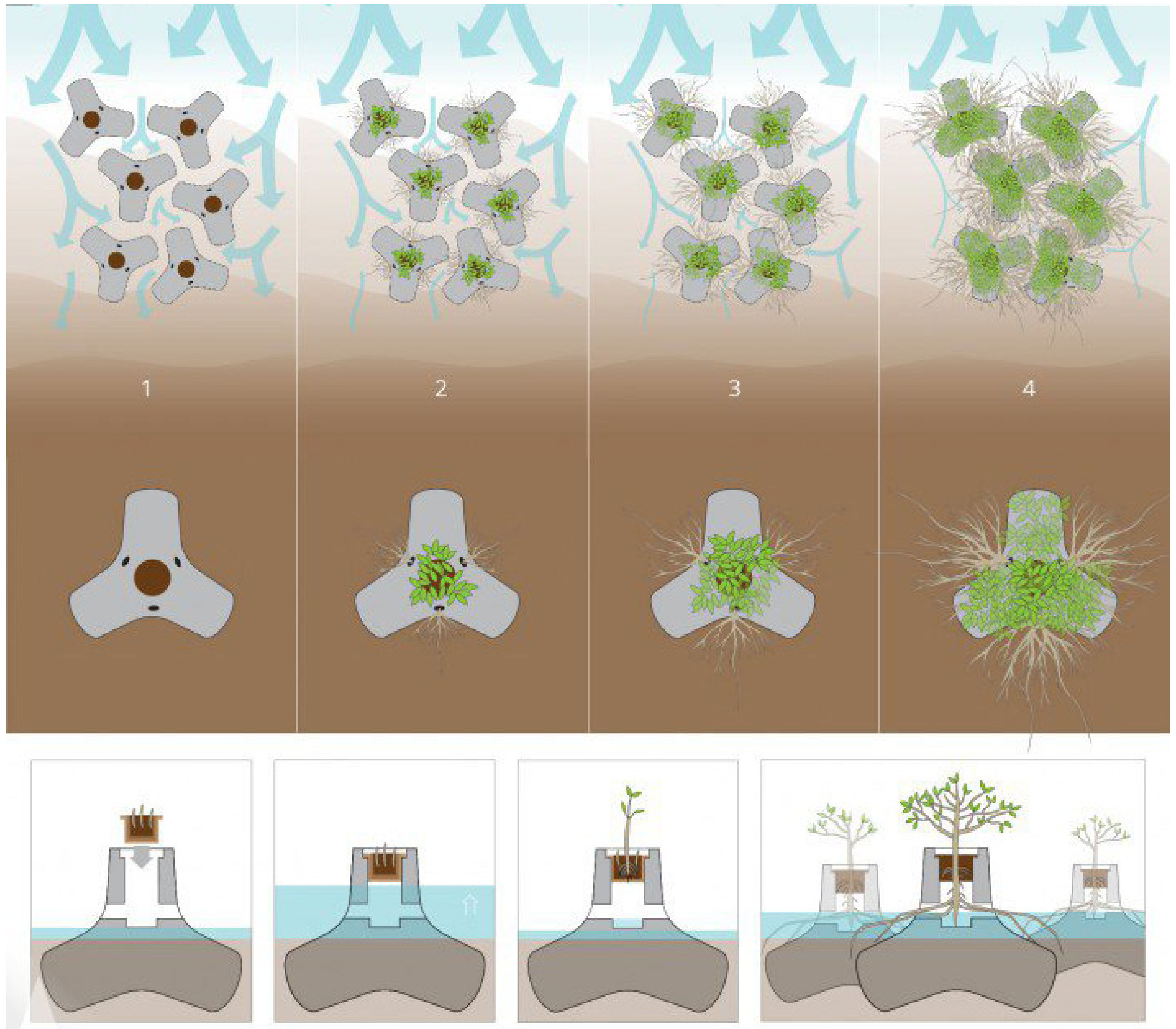
Floating island prototypes in the Delaware River in Philadelphia

Floating island prototypes in the Delaware River in Philadelphia, with PennDesign (University of Pennsylvania), 2013

In 2014, Balmori Associates was awarded a $20,000 grant to conduct research and develop a productive garden in the Gowanus Canal, known as the most polluted canal in the United States, located in Brooklyn, NY. Once a bustling center of maritime and commercial activities in Brooklyn, the Gowanus Canal has suffered from the accumulation of industrial waste from nearby factories, as well as pollution from surface run-off and sewage waste from the surrounding neighborhoods. Balmori Associates’ objective is to employ phytoremediation techniques to cleanse the water and utilize rainwater collection for irrigation purposes in the floating productive garden. Various buoyant construction materials, such as coconut fibers, water hyacinth, bamboo, Ecovative mycelium technology, and a matrix of recycled plastic, have been tested during the project.
The ultimate aim of the project is to demonstrate the feasibility of creating edible floating landscapes on a large scale in cities with polluted rivers, while exploring their potential as multi-functional green infrastructure.

Case study

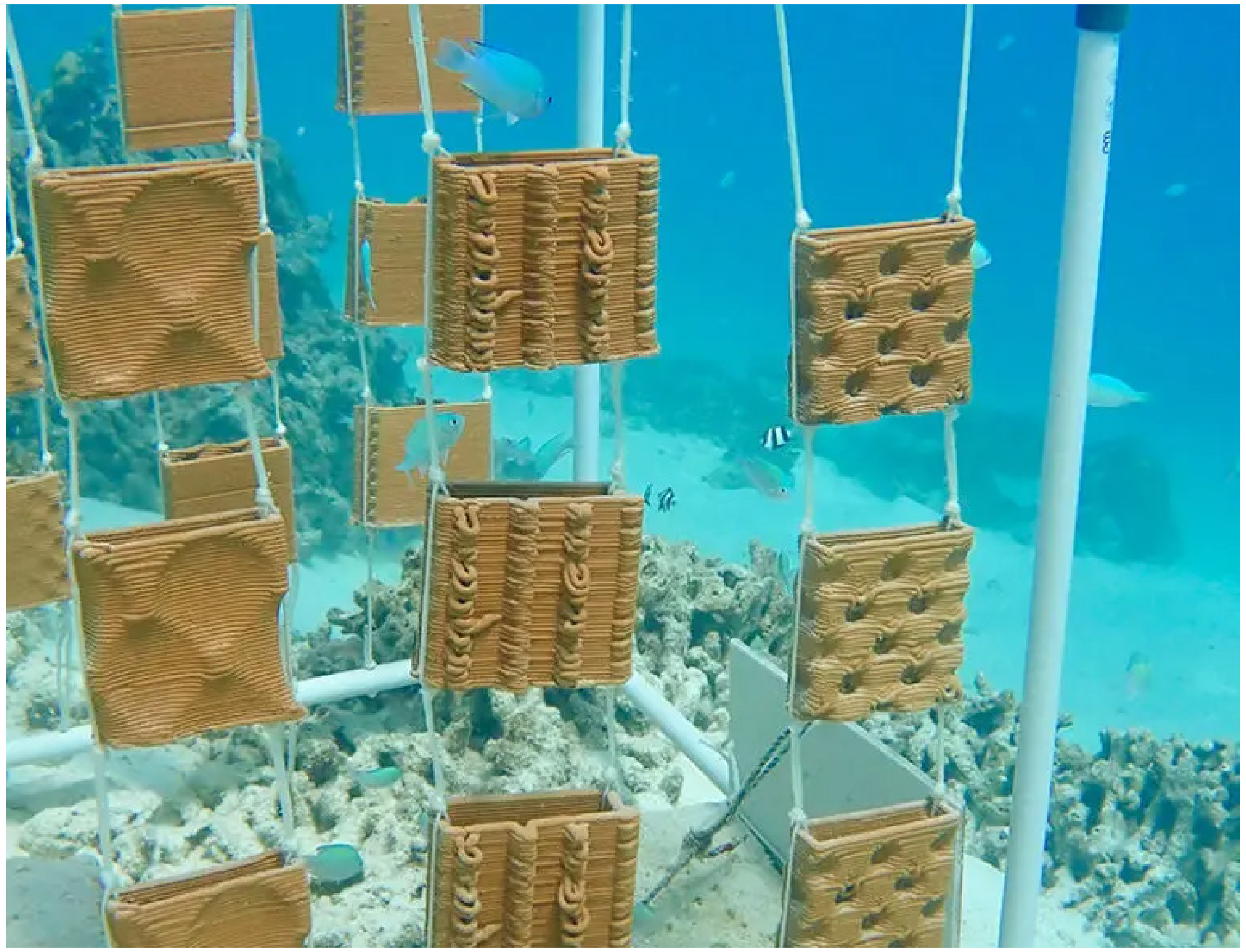
TetraPOT



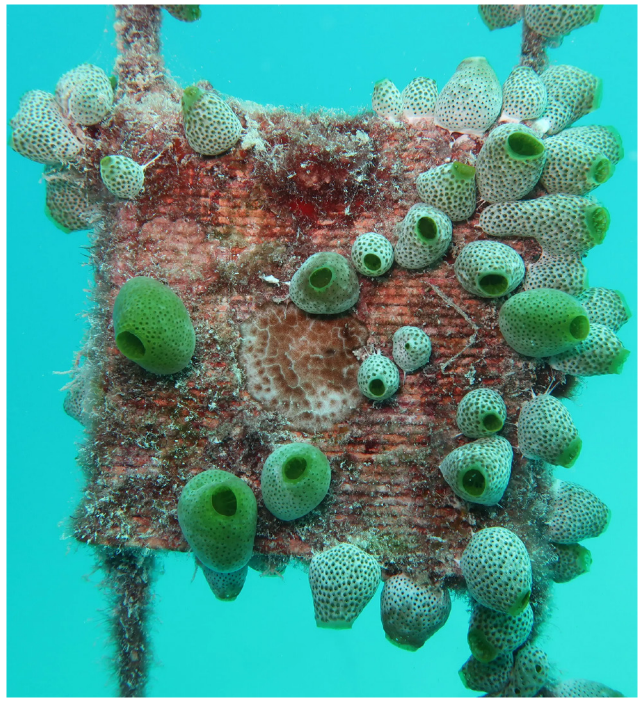
TetraPOT is an innovative and sustainable sea defence system composed of concrete, organic materials, and plants. Each one contains decomposable pots filled with plant seeds. By scattering TetraPOTs along coastlines in a random pattern, they will gradually interlock, forming a durable sea defence consisting of growing trees and interconnected roots that effectively anchor the blocks in place. As the plants inside continue to grow, their roots will intertwine, gradually transforming into a natural sea defence. The shape and positioning of the TetraPOTs allow them to interlock with one another, creating a structured web-like formation. This design not only safeguards against soil erosion but also contributes to the preservation and creation of a natural habitat.

Case study

Rrreefs



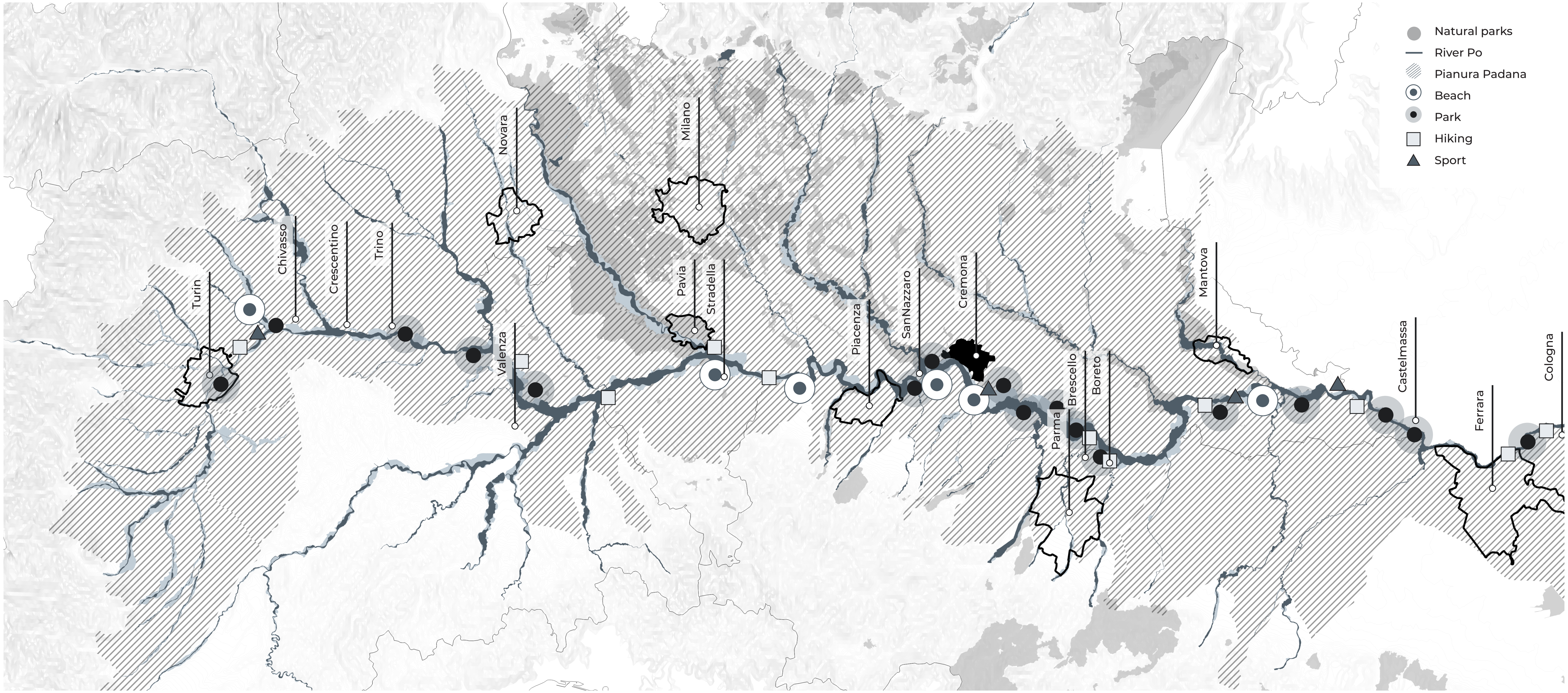
In December 2019, a total of 98 3D-printed clay tiles were successfully installed in the Maldives, featuring 12 distinct surface structures. The primary objective of this experimental project was to test two hypotheses. The first hypothesis aimed to determine if our unique 3D-printed terracotta clay material is conducive to the survival and growth of various calcifying organisms, including coral recruits. The second hypothesis sought to identify whether specific geometric features on the tiles were preferred by coral larvae. Preliminary analyses of the test tiles reveal that coral recruits predominantly thrived on vertical surfaces and within depressions, indicating their preference for these particular microhabitats.



Masterplan

In the master plan for the development along the scenic River Po, a meticulous identification process was undertaken to determine suitable locations for the integration of the design solution. Key areas, including ports, sports facilities, beaches, recreation zones, and hiking spots, were carefully assessed to ensure optimal placement of the proposed platforms. The design aimed to seamlessly blend with the natural surroundings. These platforms were envisioned as versatile spaces, capable of accommodating various activities and functions, both within the flowing waters and on the riverbed itself.

Consideration was given to the unique characteristics and requirements of each site. Factors such as accessibility, existing infrastructure, local ecology, and community preferences were carefully analyzed to maximize the potential of the design solution. The platforms were designed to respect the natural flow of the river and its surroundings while offering diverse opportunities for activities.



04

Implementation

The implementation chapter focuses on the detailed steps involved in developing a floating adaptable platform along the River Po with various functions. After extensive research and analysis of the river's characteristics, the locations are determined, conceptualization and design take place, aligning the platform's purposes with the specific requirements of each function. This includes considerations of aesthetics, modularity, adaptability, and sustainability, while incorporating amenities to enhance usability.

Modular pontoon system

A modular pontoon system is a versatile and adaptable structure consisting of individual pontoon units that can be assembled and interconnected to create a wide range of floating platforms. These platforms can serve various purposes, such as floating docks, marinas, recreational areas, or even temporary bridges.

The modular nature of the pontoon system allows for easy customization and scalability. Each pontoon unit is typically made of durable materials such as high-density polyethylene (HDPE) or aluminum, ensuring stability and longevity. These units can be easily connected using interlocking mechanisms or bolted connections, forming a solid and secure floating structure.

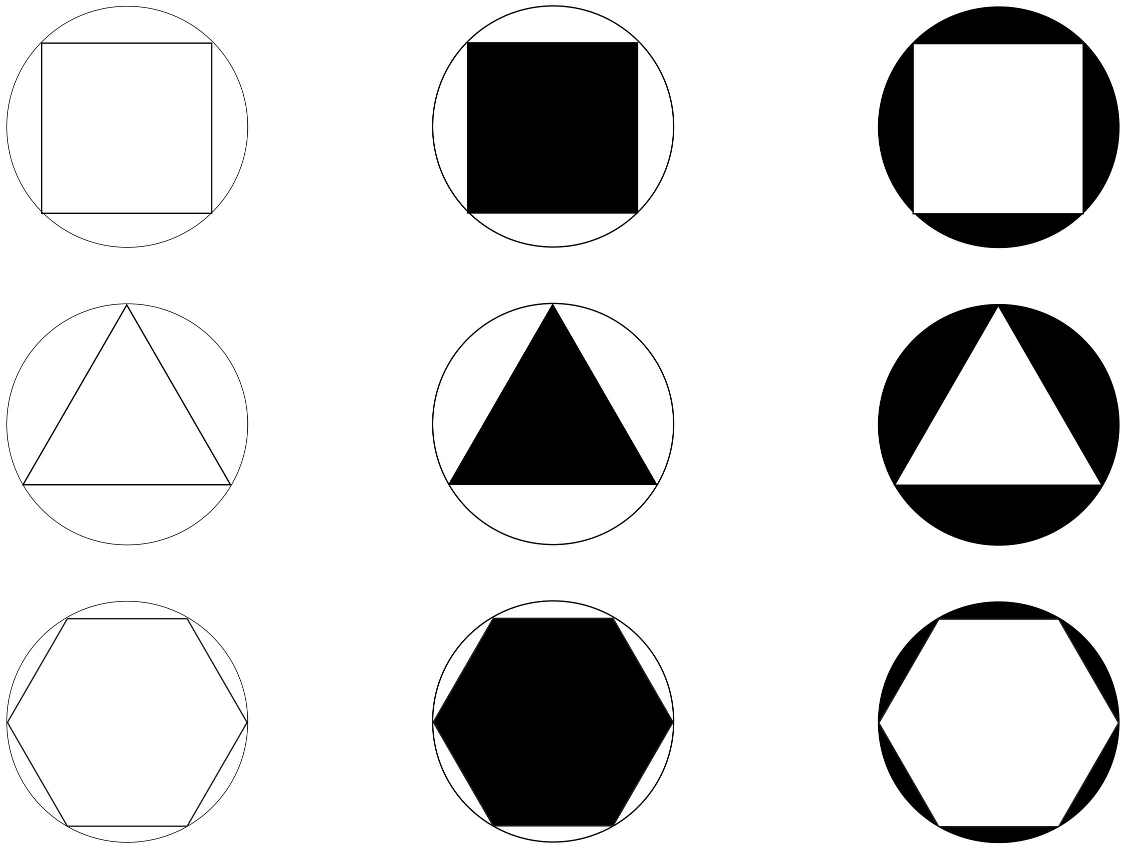
The modularity of the system enables the creation of platforms in different sizes and configurations, catering to specific needs and site requirements. It offers the flexibility to expand or reconfigure the platform as needed, allowing for future modifications or addition

- Ease of Installation: The modular design simplifies the installation process, as each pontoon unit can be transported and assembled efficiently, reducing construction time and costs.
- Adaptability: The system can be adjusted and reconfigured to suit various environments, water conditions, and functional requirements. It can be easily expanded or modified to accommodate changing needs over time.
- Stability and Safety: The pontoon units are designed to provide stability and buoyancy, ensuring a safe and secure platform for various activities. Features such as non-slip surfaces, handrails, and fender systems can be incorporated for enhanced safety.
- Low Maintenance: The materials used in modular pontoon systems are often resistant to corrosion and require minimal maintenance. Routine inspections and basic cleaning are typically sufficient to keep the structure in good condition.
- Eco-Friendly: Many modular pontoon systems are designed with sustainability in mind. They minimize environmental impact by utilizing recyclable materials and allowing for the integration of ecological features such as vegetation or wildlife habitats.

Grid system modules

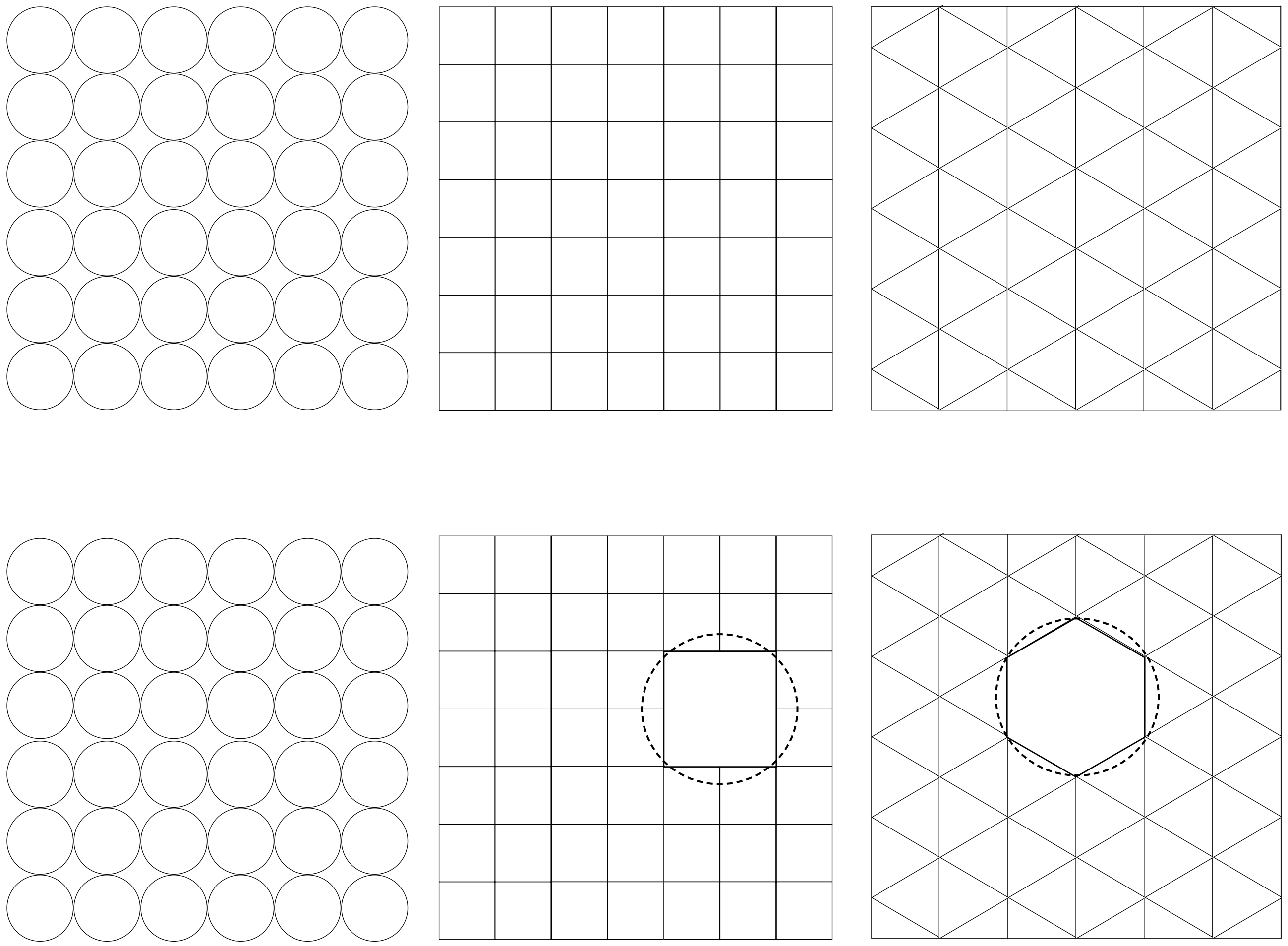
Drawing inspiration from the hexagonal arrangement of cells and the mesmerizing play of light through tree-lined pathways, our goal was to develop an architectural system that could adapt to environmental, structural, and programmatic considerations. By employing a parametric approach, we aimed to create a flexible system of interconnected hexagonal units, allowing for the formation of diverse assemblies and densities, thus shaping an urban landscape. This modular system is designed for effortless assembly and disassembly, enabling its replication across various locations. Serving as a communal gathering space, the structure fosters the enhancement of local identity and community spirit.

In the initial studies the circle is the figure that provides more cellular area. When aiming to completely fill a flat plane with identical cells, only three regular shapes are capable of achieving this: equilateral triangles, squares, and hexagons. Among these options, hexagonal cells require the least amount of wall length when compared to triangles or squares of equal area. Therefore, it is logical for bees to choose hexagons as they minimize the energy expenditure required for wax production.

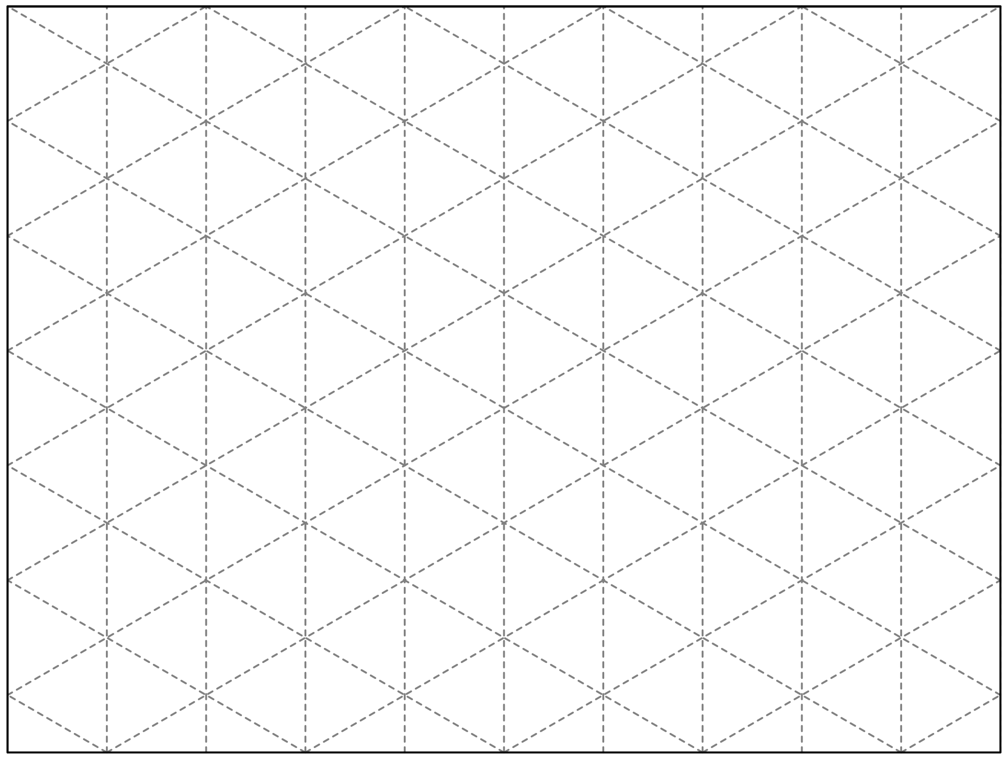


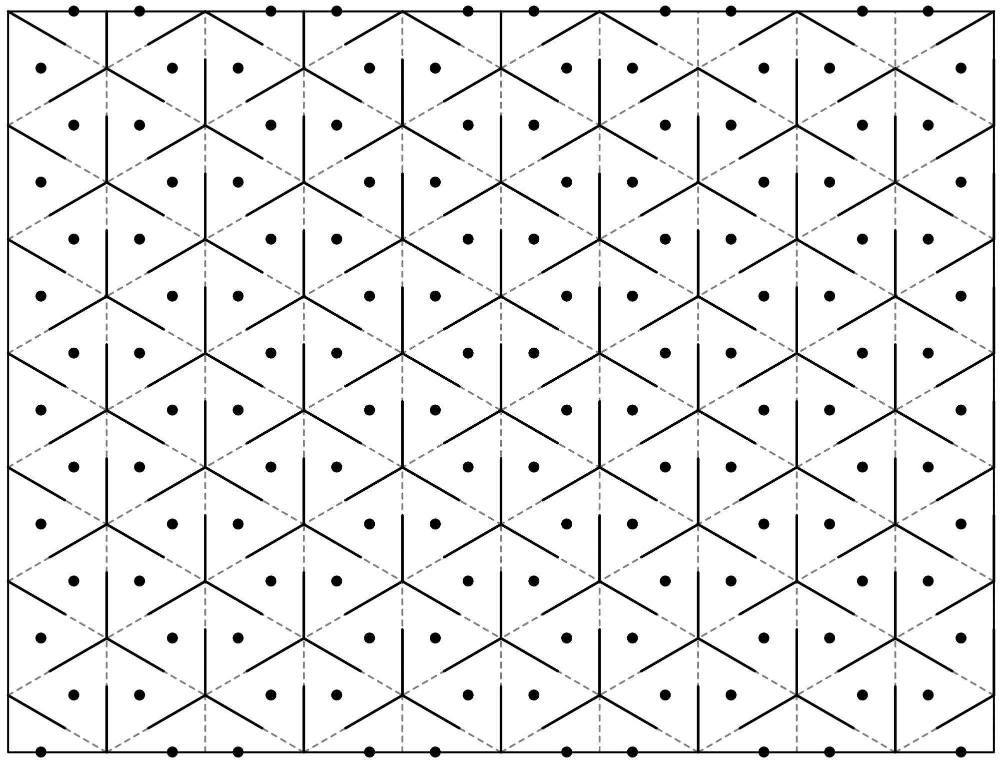
From a structural perspective, the most effective integration occurs with a triangular arrangement due to the way each element responds to variations in adjacent elements. By transforming the elemental intersections within the hexagonal division from single triple intersections to triple double intersections, the structure would significantly enhance its structural resilience and stability.

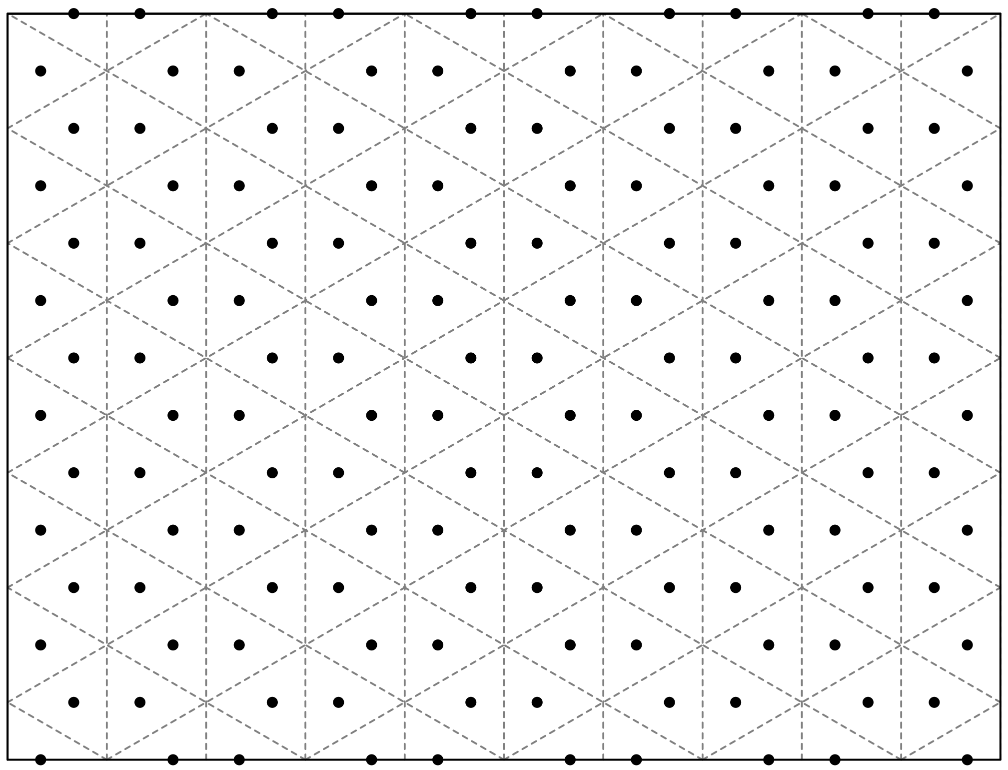
The concept involves the creation of a modular system of cells that can be replicated to form an artificial landscape within an urban context. This landscape is designed to be easily assembled and disassembled, allowing for its adaptability and replication across various sites.

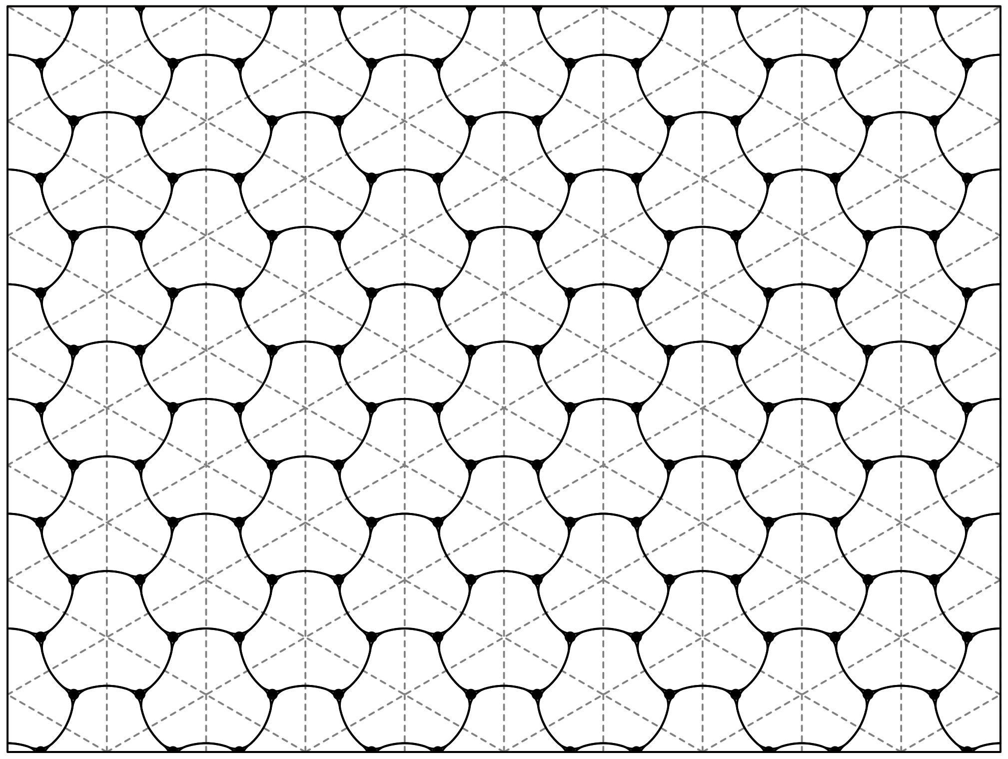


System

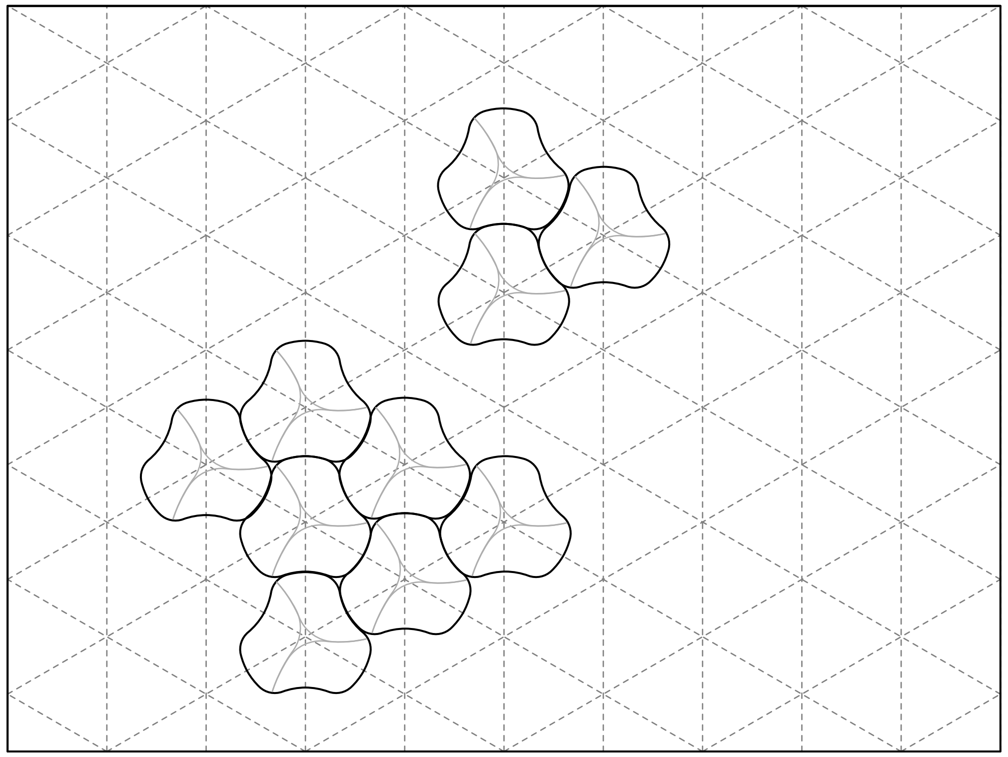


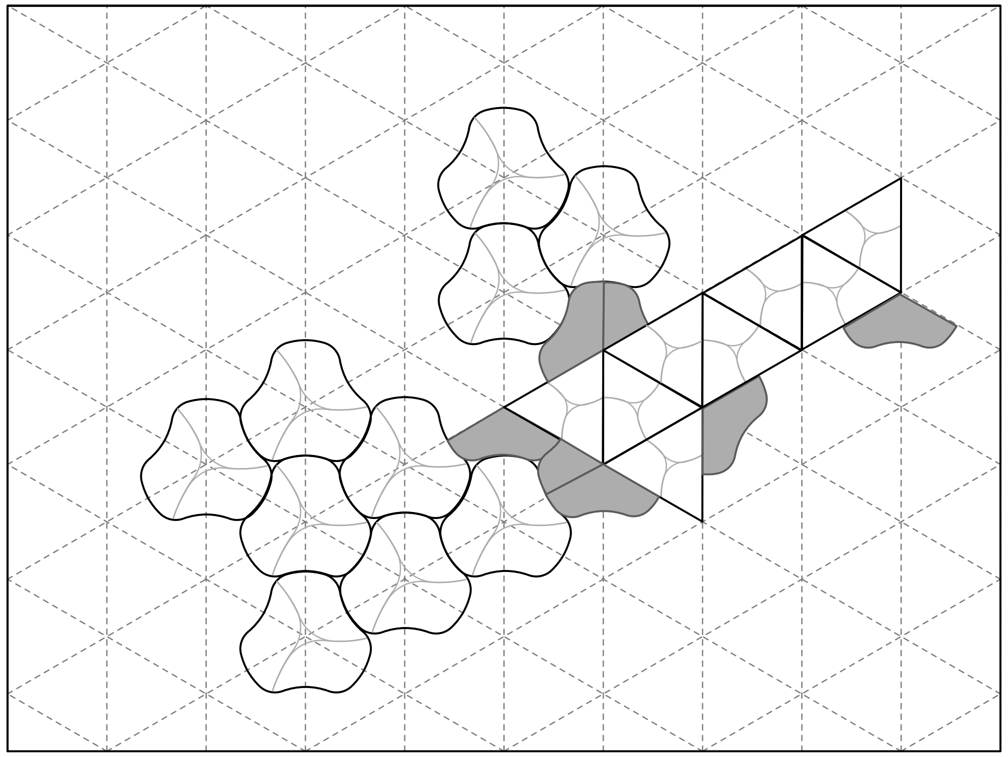






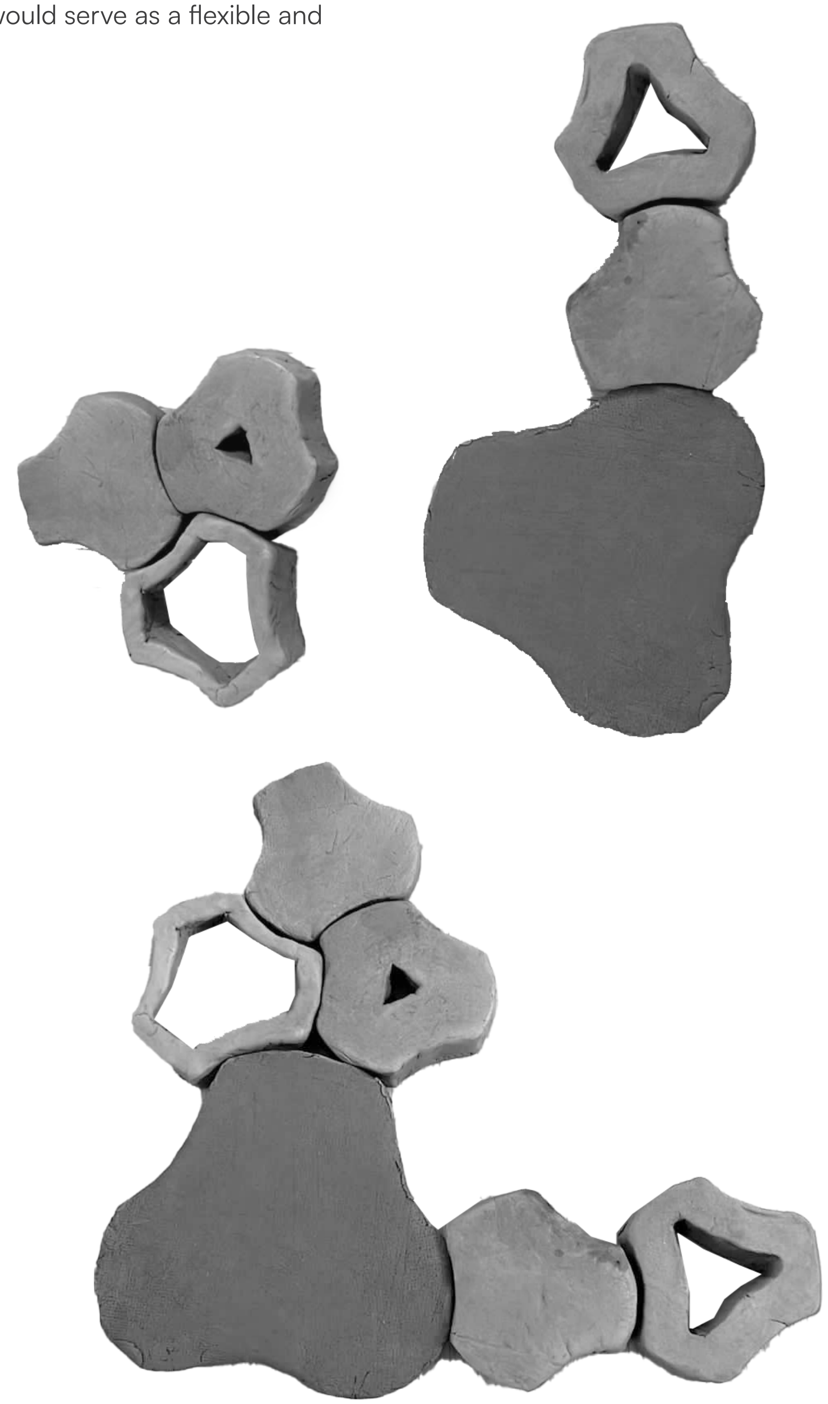
Modules





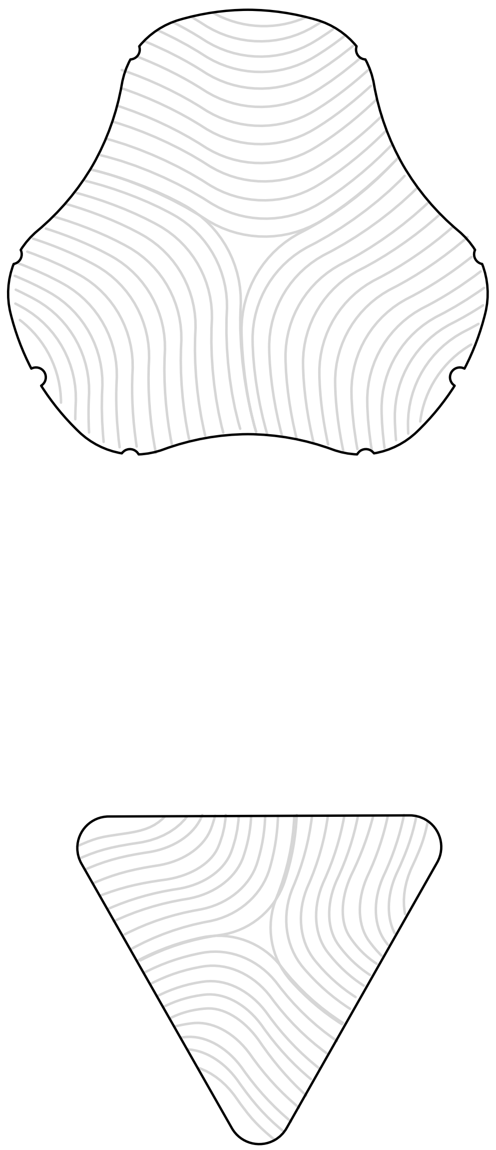
Modules past experimentation

In the initial stage, the focus was on bringing together smaller components of hexagonal units to form multiple assemblies with varying densities. By delved into exploring the individual elements, their aggregations, and the possibilities for creating diverse intervals between them. To aid exploration, by constructed a physical model at a 1:20 scale. Throughout this process, I dedicated the efforts to refining proportions and joints, aiming to develop a stable system that would serve as a flexible and modular platform.

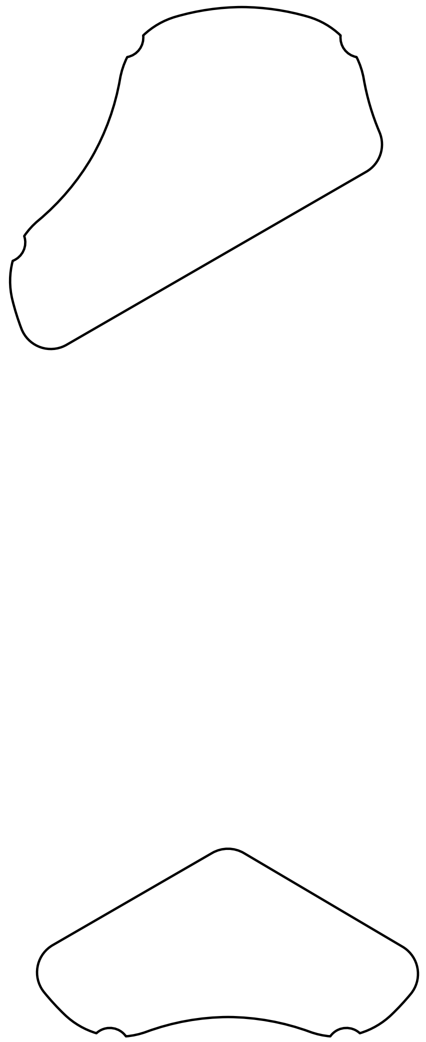


Base modules

Two main base modules that allow to generate in a simple way different configurations



Two conector base modules that allow to connect in a simple way the two main modules



Variation modules

Full void (void for water, vegetation)

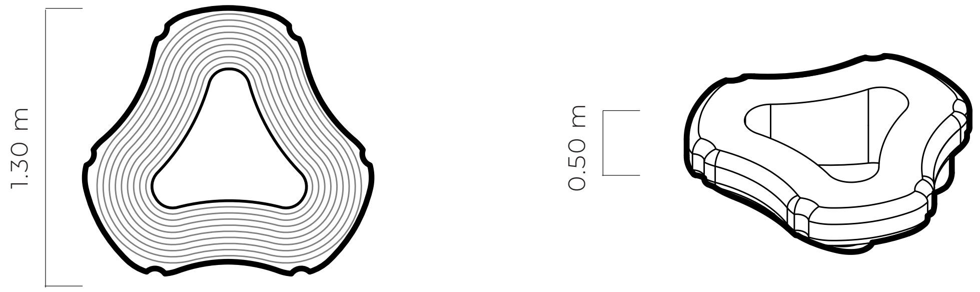
Semi void

Small void

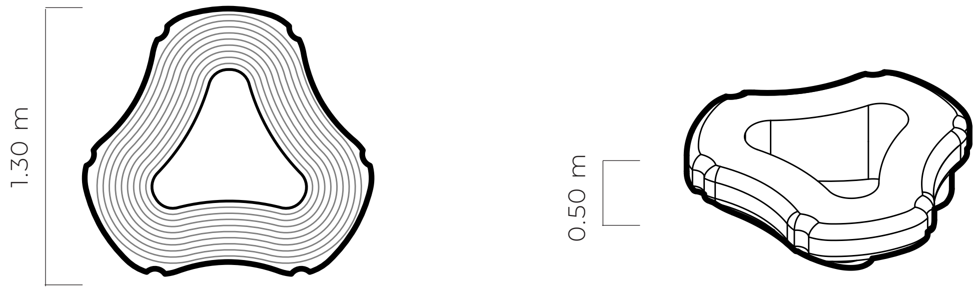
Porosity void

Bed of the river modules

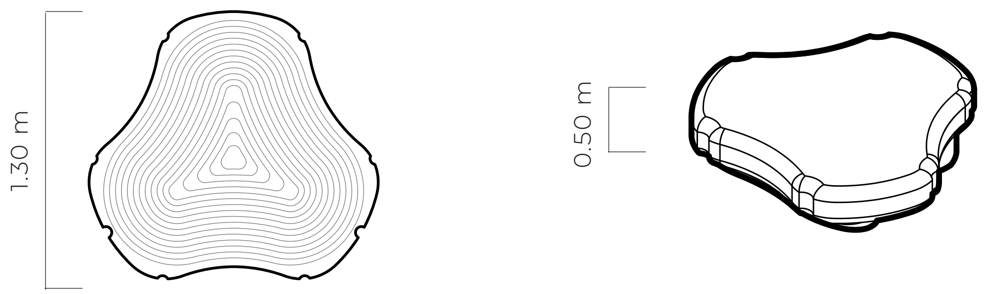
Semi void vegetation



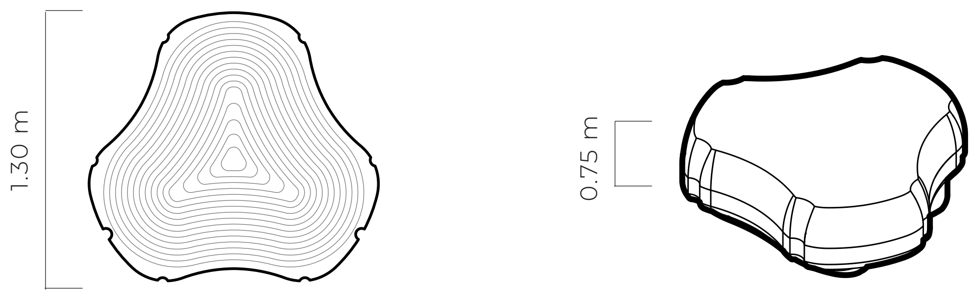
Semi void water



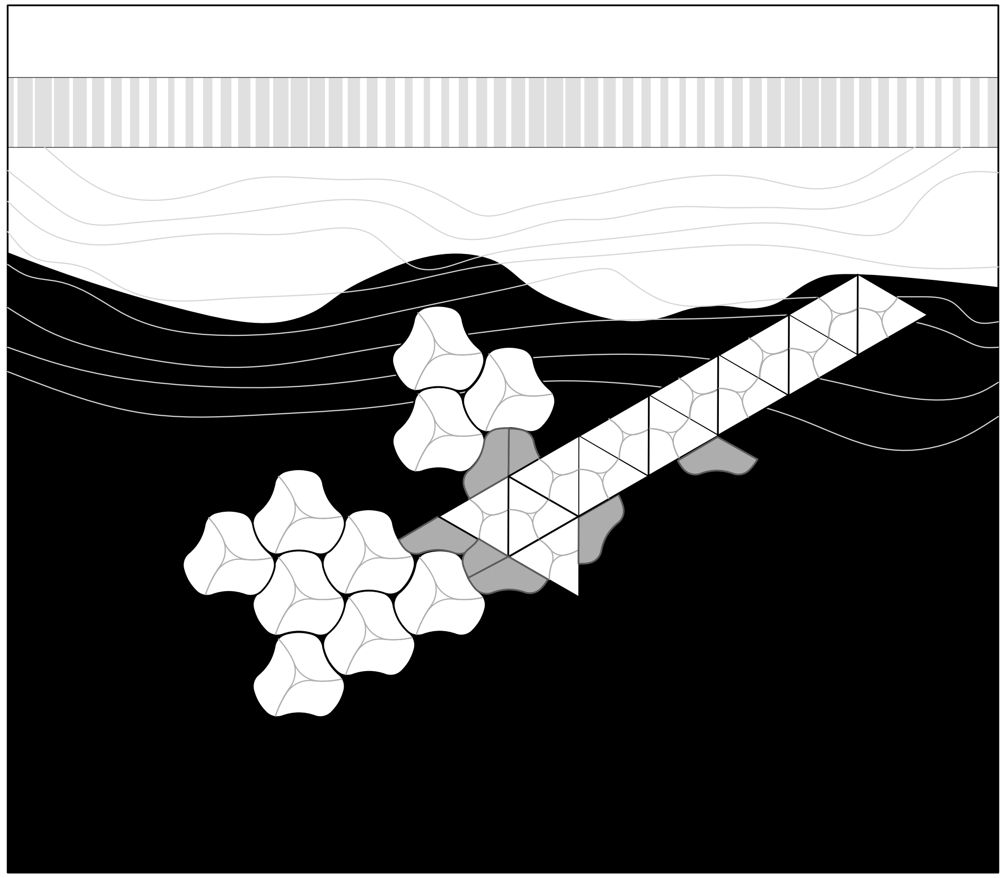
Full plataform

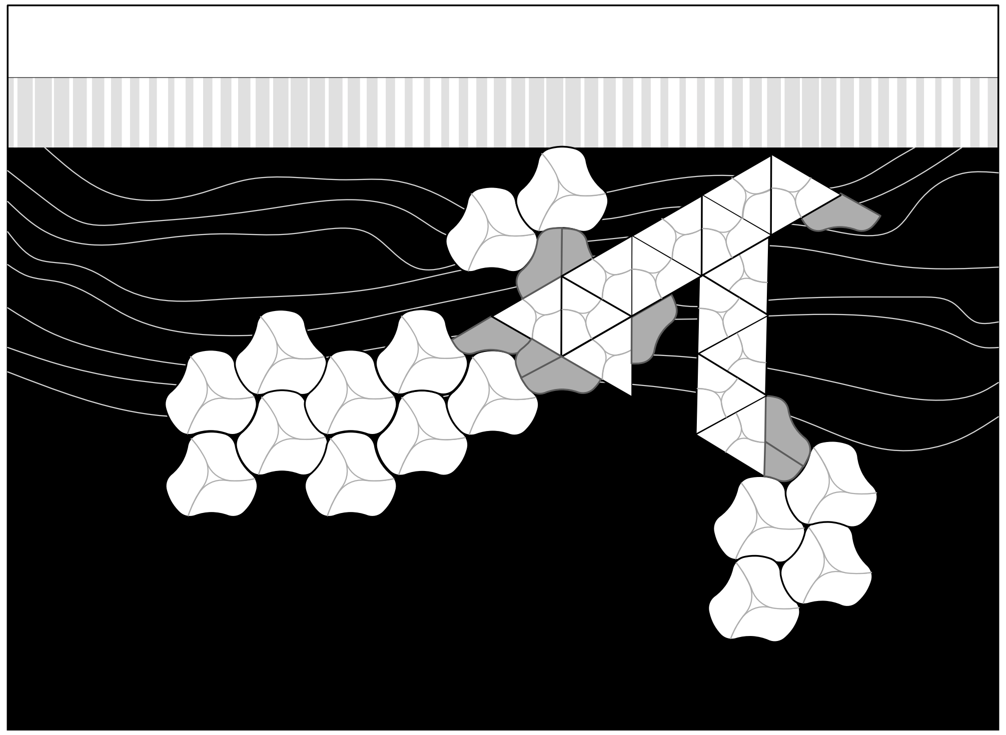


Seat plataform

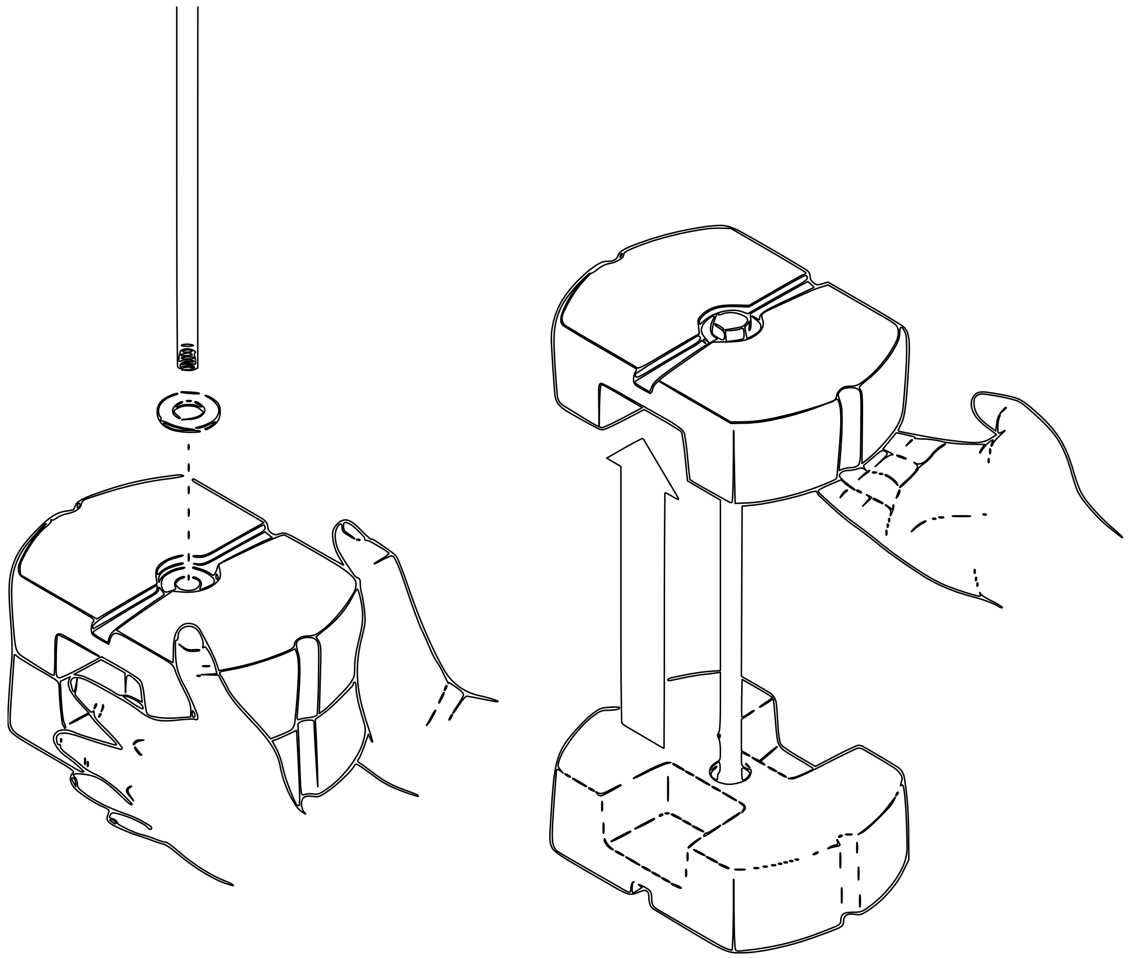


Variation module plan



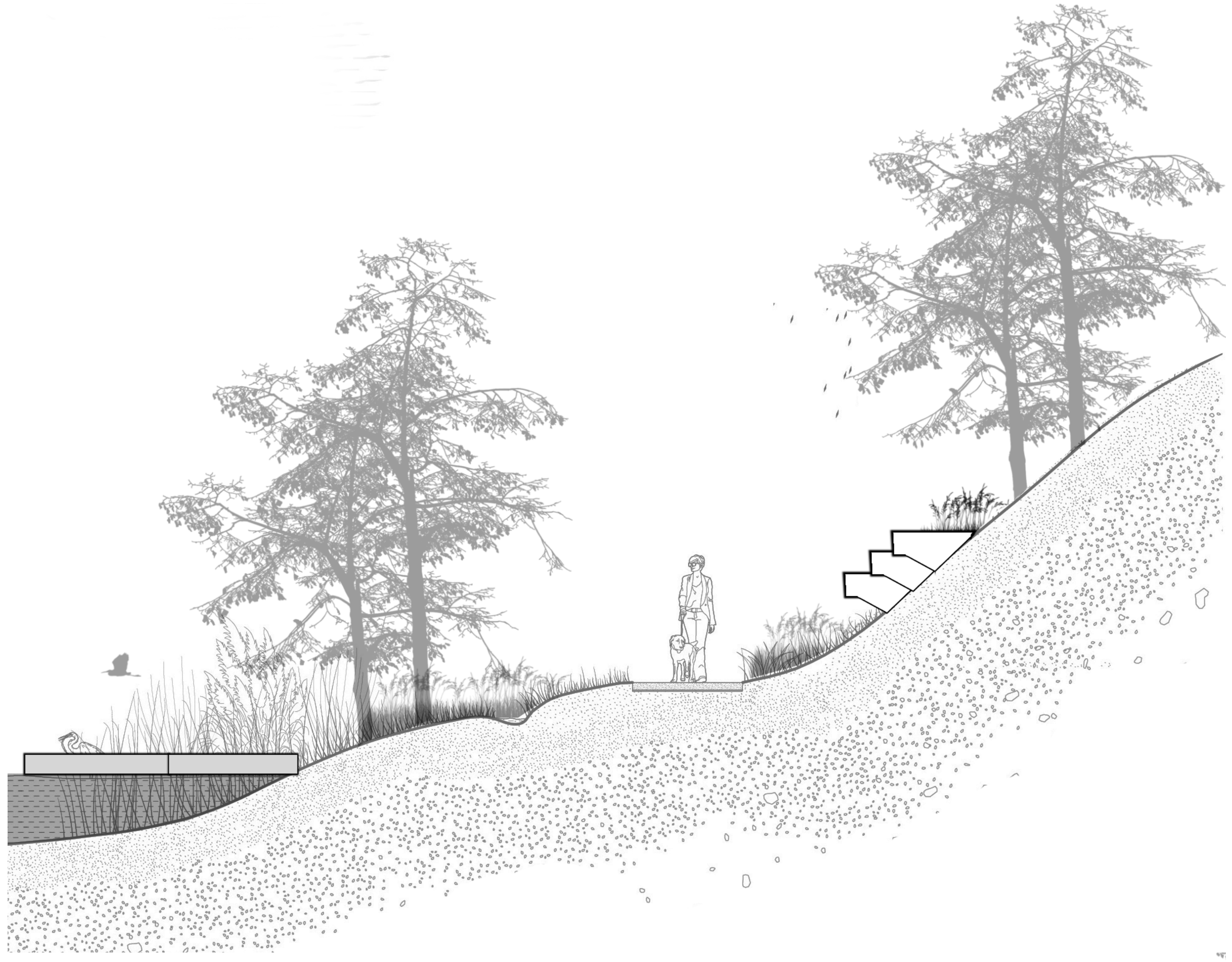


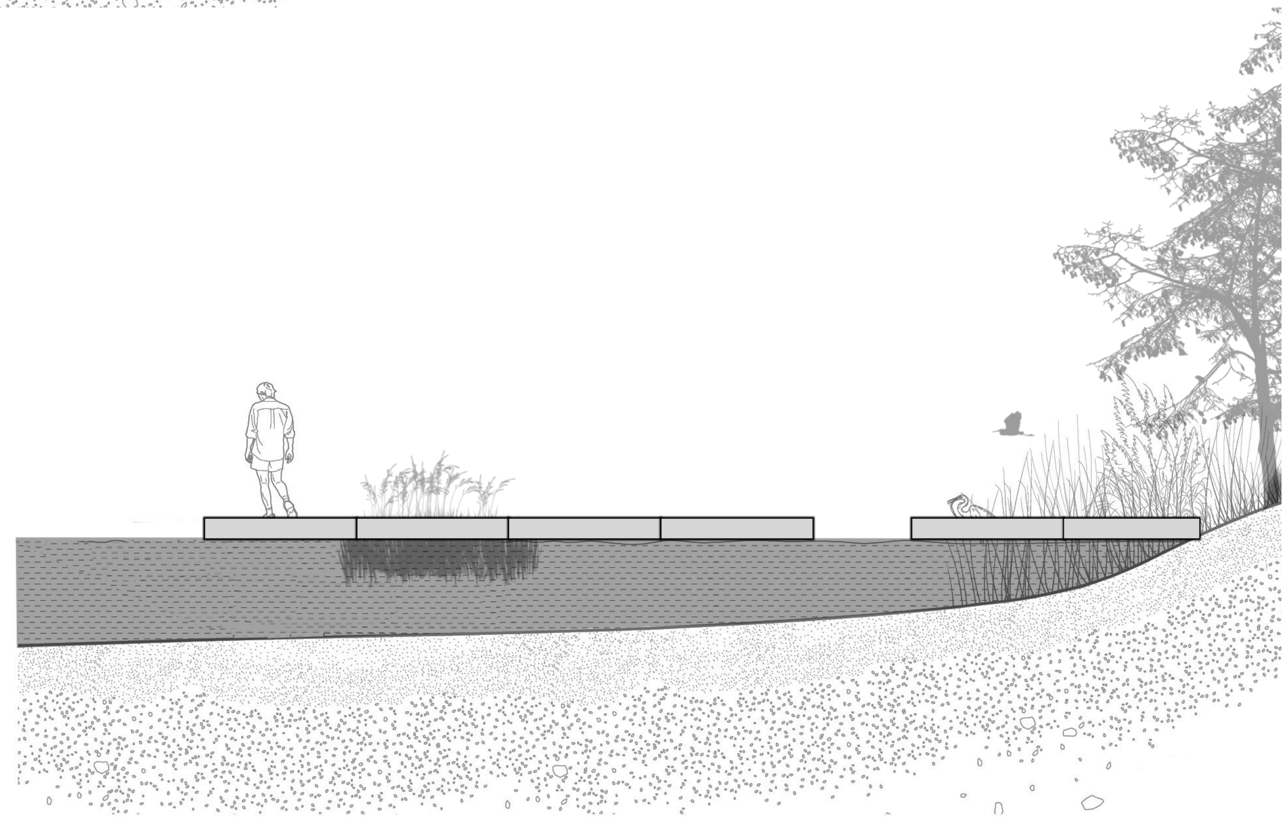
Join



Bolted connections involve the use of bolts, nuts, and washers to join the pontoon units together. Holes are typically pre-drilled in the units to allow for the insertion of bolts. The bolts are tightened to create a strong connection, holding the units firmly in place. It provides a strong and stable joint between pontoon units. When properly tightened, bolts create a secure bond that can withstand various forces and loads, ensuring the stability and integrity of the modular pontoon system.Bolted connections allow for adjustability and flexibility in the assembly of modular docks or pontoon units. They offer the convenience of disassembling and reassembling the structure as needed, making it easier to modify or reconfigure the layout of the floating platform.

Collage reference visualization





References

Bibliograpy

Crutzen, P. and Stoermer, E. (2000) The anthropocene, Global Change Newsletter, International Geosphere-Biosphere Program Newsletter, no. 41: 17—18.

Armstrong, P. (2002) The Postcolonial Animal, Society and Animals, 10(4): 413—20.

Dilnot, C. (2005) Ethics? Design?, The Archeworks Papers, 1(2): 1—168.

Hribal, J. (2007) Animals, agency, and class: writing the history of animals from below, Human Ecology Review, 14(1): 101—12.

River.Space.Design: Planning Strategies, Methods and Projects for Urban Rivers

Den Doncker, Sébastien. (2016). River Design. 10.13140/RG.2.2.23268.17287.

Denisa Halajova et al 2019 IOP Conf. Ser.: Mater. Sci. Eng. 471 092090

Garkhel, Kunal. (2020). Floating Architecture as a new paradigm of architecture. 10.13140/RG.2.2.30993.76649.

ACIOLY JR C., FRANSEN J., MAKOKHA E., GILIG PAYOT J., Skinner Rein- hard, Teerlik H., Zwanenburg M., Knocking on the Mayor's Door. Participatory Urban Management in Seven Cities. Delft: Eburon, 2006.

UN Habitat, Cooperative Housing: a bibliography (Latin America). Ed. UN Habitat, Nairobi, 1989.

REVEDIN J., CONTAL MH., Sustainable Design III, Alternatives, 2014.

PRESSMAN A., Designing Relationships: The Art of Collaboration in Architecture, 1st Ed., Routledge, 2014. RAINBOW P., The Foucault Reader. New York: Parthenon Books, Ed.1984

HILL J., Occupying Architecture: Between the Architect and the User, Routledge, London, 1998.

HOFMANN S., Architecture is Partecipation: Die Baapiloten: Methods and Projects, JOVIS, 2015.

HILL J., Occupying Architecture: Between the Architect and the User, Routledge, London, 1998.
HOFMANN S., Architecture is Partecipation: Die Baapiloten: Methods and Projects, JOVIS, 2015.

Morton, T. D. (2013). Hyperobjects: Philosophy and Ecology after the End of the World. https://ci.nii.ac.jp/ncid/BB13730346

Mancini, C., & Lehtonen, J. (2018). The Emerging Nature of Participation in Multispecies Interaction Design. https://doi.org/10.1145/3196709.3196785

GRANATH JAN Å., Architecture - Participation of users in design activities, September 2011.

Thank you

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