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Master of Science - Sustainable Architecture and Landscape Design

RESEARCHING THE INTEROPERABILITY OF NATURE-BASED SOLUTION AND PERMACULTURE DESIGN AND EVALUATING ACCORDINGLY IN ZONE 6,MILAN.

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ABSTRACT

Urbanization is a rapidly increasing global phenomenon, especially with industrialization and technological developments. Although there are many reasons for migration from rural to urban, there are many positive and negative consequences.In light of the global crises experienced in recent years and the increasing awareness of the importance of health, food, and nature, finding solutions to the problems caused by urbanization and sustainably doing this has become a necessity for nature and humanity of the relationship between societies. Therefore, it is necessary to promote sustainable urban development and address the negative effects that affect the environment and human well-being. Various effects that urban areas face, such as climate change, loss of biodiversity, air and water pollution, the danger of extinction of green areas, and social inequality, should be resolved with sustainability and the relationship between nature and humans.

For the solution of these problems, it has been tried to create alternative methods consisting of holistic ecological solutions, which have been increasing in recent years. The most striking of these are Nature-Based Solutions and Permaculture. Nature-Based Solutions are systems that are often supported by political, cultural, and economic actors who are aware of the environmental challenges facing our society and seek to develop systems that can reach and benefit large numbers of people. Permaculture, on the other hand, is compatible with the goal of spreading social and ethical values and sustainability awareness to a wider audience.

Therefore, Permaculture and Nature-Based Solutions can work together to play a crucial role in creating sustainable, resilient, and livable urban environments by addressing the challenges of urbanization and industrialization. The aim of this thesis is to investigate whether it is possible for these two disciplines to work together and to determine the benefits of working together.In addition, it is aimed to determine the general research methods and principles of Nature-Based Solutions and Permaculture and to better understand and apply them by bringing together common working methods and principles.

After determining the joint working methods of Nature-Based Solutions and Permaculture, a design strategy was created in the Zone 6 region of Milan and turned into a project in order to investigate what kind of result could be achieved in the design. In addition, considering Milan’s current economic, social, and environmental reports and the targets set in this direction, solution proposals compatible with these targets were developed.

As a result of the study, it has been seen that although Nature Based Solutions and Permaculture have individually important solutions, they become much stronger solution proposals by working with each other. The holistic solutions of Nature-Based Solutions and the ethical and philosophical dimensions of Permaculture have created a more permanent and sustainable solution by feeding each other significantly.

KEYWORDS: *Nature-Based Solutions, Permaculture, Sustainability, Urbanization*

SOMMARIO

L'urbanizzazione è un fenomeno globale in rapido aumento, in particolare con l'industrializzazione e gli sviluppi tecnologici. Sebbene ci siano molte ragioni per la migrazione dalle zone rurali a quelle urbane, ci sono molte conseguenze positive e negative. Alla luce delle crisi globali vissute negli ultimi anni e della crescente consapevolezza dell'importanza della salute, del cibo e della natura, trovare soluzioni ai problemi causato dall'urbanizzazione e farlo in modo sostenibile è diventato una necessità per la natura e l'umanità del rapporto tra le società. Pertanto, è necessario promuovere uno sviluppo urbano sostenibile e affrontare gli effetti negativi che incidono sull'ambiente e sul benessere umano. Vari effetti che le aree urbane affrontano, come il cambiamento climatico, la perdita di biodiversità, l'inquinamento dell'aria e dell'acqua, il pericolo di estinzione delle aree verdi e la disuguaglianza sociale, dovrebbero essere risolti con la sostenibilità e il rapporto tra natura e uomo.

Per la soluzione di questi problemi si è cercato di creare metodi alternativi costituiti da soluzioni ecologiche olistiche, che sono in aumento negli ultimi anni. Le più sorprendenti di queste sono le soluzioni basate sulla natura e la permacultura. Le soluzioni basate sulla natura sono sistemi spesso supportati da attori politici, culturali ed economici che sono consapevoli delle sfide ambientali che la nostra società deve affrontare e cercano di sviluppare sistemi che possano raggiungere e beneficiare un gran numero di persone. La permacultura, d'altra parte, è compatibile con l'obiettivo di diffondere i valori sociali ed etici e la consapevolezza della sostenibilità a un pubblico più ampio.

Pertanto, la permacultura e le soluzioni basate sulla natura possono lavorare insieme per svolgere un ruolo cruciale nella creazione di ambienti urbani sostenibili, resilienti e vivibili affrontando le sfide dell'urbanizzazione e dell'industrializzazione. Lo scopo di questa tesi è indagare se sia possibile che queste due discipline lavorino insieme e determinare i benefici del lavorare insieme. per meglio comprenderli e applicarli riunendo metodi e principi di lavoro comuni.

Dopo aver determinato i metodi di lavoro congiunti di Nature-Based Solutions e Permaculture, è stata creata una strategia di progettazione nella regione Zona 6 di Milano e trasformata in un progetto per indagare quale tipo di risultato potrebbe essere raggiunto nel design. Inoltre, considerando gli attuali rapporti economici, sociali e ambientali di Milano e gli obiettivi fissati in questa direzione, sono state sviluppate proposte di soluzione compatibili con questi obiettivi.

Come risultato dello studio, si è visto che sebbene le soluzioni basate sulla natura e la permacultura abbiano soluzioni individualmente importanti, diventano proposte di soluzione molto più forti lavorando insieme. Le soluzioni olistiche di Nature-Based Solutions e le dimensioni etiche e filosofiche della Permacultura hanno creato una soluzione più permanente e sostenibile alimentandosi a vicenda in modo significativo.

PAROLE CHIAVE: *Soluzioni Basate sulla Natura, Permacultura, Sostenibilità, Urbanizzazione*

ÖZET

Kentleşme özellikle sanayileşme ve teknolojik gelişmeler ile hızla artmakta olan küresel bir olgu olarak karşımışıza çıkmaktadır.Kırdan kente göçün bir çok nedeni olmakla birlikte olumlu ve olumsuzda bir çok sonucu bulunmaktadır.Son yıllarda yaşanan küresel ölçekteki krizler ve sağlık, gıda ve doğanın önemi konusunda artan farkındalık ışığında, kentleşmenin yol açtığı sorunlara çözüm bulmak ve bunu sürdürülebilir bir şekilde yapmak, toplumlar arasındaki ilişki bağlamında bir doğa ve insanlık zorunluluğu haline gelmiştir.Bundan dolayı sürdürülebilir kentsel gelişmeyi teşvik etmek çevre ve insan refahını etkileyen olumsuz etkileri ele almak gerekmektedir.İklim değişikliği,biyoçeşitlilik kaybı,hava ve su kirliliği,yeşil alanların yok olma tehlikesi,sosyal eşitsizlik gibi kentsel alanların karşı karşıya kaldığı çeşitli etkiler sürdürülebilirlik kavramı ile doğa ve insan ilişkisi ile çözümlenmelidir.

Bu sorunların çözümleri için son yıllarda gittikçe artan bütüncül ekolojik çözümlerin oluşturduğu alternatif methodlar oluşturulmaya çalışılmıştır. Bunlardan en dikkat çekenleri ise Doğaya Dayalı Çözümler ve Permakültür'dür. Doğa Temelli Çözümler genellikle toplumumuzun karşı karşıya olduğu çevresel zorlukların farkında olan ve çok sayıda insana ulaşabilecek ve fayda sağlayabilecek sistemler geliştirmeye çalışan siyasi, kültürel ve ekonomik aktörler tarafından desteklenen sistemlerdendir. Permakültür ise sosyal ve etik değerleri, sürdürülebilirlik bilincini daha geniş bir kitleye yayma hedefiyle uyumludur.

Bundan dolayı, Permakültür ve Doğa Temelli Çözümler birlikte çalışarak, kentleşme ve sanayileşmenin zorluklarını ele alarak sürdürülebilir, dirençli ve yaşanabilir kentsel çevreler yaratmada çok önemli bir rol oynayabilir.Bu tezin amacı bu iki disiplinin bir arada çalışmasının mümkün olup olmadığını araştırmak ve beraber çalışmanın getireceği faydaları belirlemektir.Ayrıca çalışmada Doğa Bazlı Çözümler ve Permakültür'ün genel araştırılması methodları ve prensipleri belirlenmesi ve ortak çalışma methodları ve prensiplerin bir araya getiririlerek daha rahat anlaşılması ve uygulanması hedeflenmiştir.

Doğa Bazlı Çözümler ve Permakültür'ün ortak çalışma methodları belirlendikten sonra tasarımda nasıl bir sonuç elde edecebileceğini araştırmak adına Milano,Zone 6 bölgesinde tasarım stratejisi oluşturularak proje haline getirildi.Ayrıca Milano'nun mevcut ekonomik ,sosyal ve cevresel raporları ile bu doğrultuda belirlenen hedefler göz önüne alınarak bu hedeflere uyumlu çözüm önerileri geliştirildi.

Çalışma sonucunda Doğa Bazlı Çözümler ve Permakültür bireysel olarak önemli çözüm yollarına sahip olsalarda bir biri ile çalışarak çok daha güçlü çözüm önerisi haline geldiği görülmüştür.Doğa Bazlı Çözümlerin bütünsel çözümleri ile Permakültürün etik ve felsefi boyutu bir birine önemli ölçüde besleyerek daha kalıcı ve sürdürülebilir bir çözüm oluşturmuştur.

ANAHTAR KELIMELER: *Doğa Temelli Çözümler, Permakültür, Sürdürülebilirlik, Kentleşme*

ΠΕΡΙΛΗΨΗ

Η αστικοποίηση είναι ένα ταχέως αυξανόμενο παγκόσμιο φαινόμενο, ειδικά με την εκβιομηχάνιση και τις τεχνολογικές εξελίξεις. Αν και υπάρχουν πολλοί λόγοι για τη μετανάστευση από την ύπαιθρο στην πόλη, υπάρχουν πολλές θετικές και αρνητικές συνέπειες. Υπό το πρίσμα των παγκόσμιων κρίσεων που βιώθηκαν τα τελευταία χρόνια και της αυξανόμενης συνειδητοποίησης της σημασίας της υγείας, της τροφής και της φύσης, η εξεύρεση λύσεων στα προβλήματα που προκαλείται από την αστικοποίηση και η βιώσιμη αυτή έχει καταστεί αναγκαιότητα για τη φύση και την ανθρωπότητα της σχέσης μεταξύ των κοινωνιών. Ως εκ τούτου, είναι απαραίτητο να προωθηθεί η βιώσιμη αστική ανάπτυξη και να αντιμετωπιστούν οι αρνητικές επιπτώσεις που επηρεάζουν το περιβάλλον και την ανθρώπινη ευημερία. Οι διάφορες επιπτώσεις που αντιμετωπίζουν οι αστικές περιοχές, όπως η κλιματική αλλαγή, η απώλεια βιοποικιλότητας, η ρύπανση του αέρα και των υδάτων, ο κίνδυνος εξαφάνισης των περιοχών πρασίνου και η κοινωνική ανισότητα, θα πρέπει να επιλυθούν με τη βιωσιμότητα και τη σχέση μεταξύ φύσης και ανθρώπου.

Για την επίλυση αυτών των προβλημάτων, έχει προσπαθήσει να δημιουργηθούν εναλλακτικές μέθοδοι που αποτελούνται από ολιστικές οικολογικές λύσεις, οι οποίες αυξάνονται τα τελευταία χρόνια. Οι πιο εντυπωσιακές από αυτές είναι οι Λύσεις με βάση τη Φύση και η Περμακουλτούρα. Οι Λύσεις που βασίζονται στη φύση είναι συστήματα που συχνά υποστηρίζονται από πολιτικούς, πολιτιστικούς και οικονομικούς παράγοντες που έχουν επίγνωση των περιβαλλοντικών προκλήσεων που αντιμετωπίζει η κοινωνία μας και επιδιώκουν να αναπτύξουν συστήματα που μπορούν να προσεγγίσουν και να ωφελήσουν μεγάλο αριθμό ανθρώπων. Η Permaculture, από την άλλη πλευρά, είναι συμβατή με τον στόχο της διάδοσης των κοινωνικών και ηθικών αξιών και της ευαισθητοποίησης για τη βιωσιμότητα σε ένα ευρύτερο κοινό.

Ως εκ τούτου, η Permaculture και οι λύσεις που βασίζονται στη φύση μπορούν να συνεργαστούν για να διαδραματίσουν κρίσιμο ρόλο στη δημιουργία βιώσιμων, ανθεκτικών και βιώσιμων αστικών περιβαλλόντων αντιμετωπίζοντας τις προκλήσεις της αστικοποίησης και της εκβιομηχάνισης. Σκοπός της παρούσας διπλωματικής εργασίας είναι να διερευνήσει εάν είναι δυνατό για αυτούς τους δύο κλάδους να συνεργαστούν και να καθορίσει τα οφέλη από τη συνεργασία. Επιπλέον, στοχεύει στον προσδιορισμό των γενικών μεθόδων έρευνας και αρχών των λύσεων που βασίζονται στη φύση και της περμακουλτούρας και για την καλύτερη κατανόηση και εφαρμογή τους με τη συγκέντρωση κοινών μεθόδων και αρχών εργασίας.

Μετά τον καθορισμό των κοινών μεθόδων εργασίας των Nature-Based Solutions και της Permaculture, δημιουργήθηκε μια στρατηγική σχεδιασμού στην περιοχή Zone 6 του Μιλάνου και μετατράπηκε σε έργο προκειμένου να διερευνηθεί τι είδους αποτέλεσμα θα μπορούσε να επιτευχθεί στο σχεδιασμό. Επιπλέον, λαμβάνοντας υπόψη τις τρέχουσες οικονομικές, κοινωνικές και περιβαλλοντικές εκθέσεις του Μιλάνου και τους στόχους που τέθηκαν προς αυτή την κατεύθυνση, αναπτύχθηκαν προτάσεις λύσεων συμβατές με αυτούς τους στόχους.

Ως αποτέλεσμα της μελέτης, διαπιστώθηκε ότι παρόλο που οι Λύσεις που βασίζονται στη φύση και η Περμακουλτούρα έχουν ξεχωριστές σημαντικές λύσεις, γίνονται πολύ ισχυρότερες προτάσεις λύσης συνεργαζόμενοι μεταξύ τους. Οι ολιστικές λύσεις των λύσεων που βασίζονται στη φύση και οι ηθικές και φιλοσοφικές διαστάσεις της Permaculture έχουν δημιουργήσει μια πιο μόνιμη και βιώσιμη λύση τροφοδοτώντας η μια την άλλη σημαντικά.

ΛΕΞΕΙΣ-ΚΛΕΙΔΙΑ: *Λύσεις βασισμένες στη φύση, Μόνιμη καλλιέργεια, Αειφορία, Αστικοποίηση*

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1. INTRODUCTION

Urbanization, a phenomenon characterized by the concentration of the human population in urban areas, has shown a rising trend in recent years due to various factors such as economic opportunities, political stability and improved transportation and communication infrastructure. This process has led to the growth of cities and the emergence of metropolises, which are now home to a large part of the world's population. However, as urban environments often exhibit poor air and water quality, insufficient green space and food insecurity, this process has also had negative consequences for the environment and the well-being of individuals, all of which can have detrimental effects on human health and overall quality of life. In addition, the high costs of basic needs such as shelter, food and water, and the stress associated with finding a job and coping with the fast-paced nature of urban life lead many to consider moving to more rural areas (Chen et al.,2018).

While migration to rural areas may be a viable option for some individuals, it is essential to note that rural areas are not immune to the pressures of modernization and urbanization and may not sustain a significant population flow. In addition, the increased demand for natural resources, infrastructure, and the environment associated with urbanization can have detrimental effects on the environment and the well-being of rural communities. Therefore, it is essential to focus on creating sustainable urban environments that can meet the needs of the growing population and address social inequality. This includes addressing the various environmental, social, and economic challenges facing urban areas, such as climate change, biodiversity loss, air and water pollution, lack of green space, and traffic congestion, and promoting equal access to resources and opportunities for all residents (Kuddus et al.,2020)

Urbanization also leads to various forms of social inequality, such as a lack of affordable housing, inadequate public services, and limited access to education, health care, and employment opportunities. In the light of the global crises and the increasing awareness of the importance of health, food, and nature, finding solutions to the problems caused by urbanization and sustainably doing this is a necessity for nature and humanity in the context of the relationship between societies. This includes promoting sustainable urban planning and design, green and blue infrastructure, public transport, and alternative energy sources. Another key point is promoting the conservation of biodiversity and natural resources and promoting the integration of urban and rural areas through sustainable land use planning and management (Sridhar & Mavrotas, 2020).

It is necessary to address the adverse effects of urbanization on the environment and human well-being by promoting sustainable urban development. This should include addressing the various environmental, social, and economic challenges facing urban areas, such as climate change, biodiversity loss, air and water pollution, lack of green space, traffic congestion, and social inequality, and promoting equal access to resources and opportunities for all residents. It is also necessary to consider the relationship between nature and humanity by promoting sustainable urban planning, green infrastructure, public transport, alternative energy sources, biodiversity, and natural resource conservation, and promoting the integration of urban and rural areas through sustainable land use planning and manage-

ment. By taking a holistic approach to urbanization and promoting sustainable practices, it is necessary to ensure that our cities are not only economically viable but also environmentally responsible and capable of providing a high quality of life for all.

In recent years, there has been a growing interest in exploring holistic ecological solutions to address the problems arising from urbanization and industrialization. While various solutions have been proposed and implemented, it is becoming increasingly clear that Nature Based Solutions (NBS) and Permaculture are among the most effective and viable options to meet these challenges. One of the key advantages of permaculture is its emphasis on promoting sustainability within society, starting at the individual level, by providing both facilitating and regulatory solutions. In addition, permaculture's social and ethical values align to spread awareness of sustainability to a wider audience. On the other hand, Nature-Based Solutions are often supported by political, cultural, and economic actors who are aware of the environmental challenges facing our society and are trying to develop systems that can reach and benefit large numbers of people. Therefore, the fact that large masses form the stakeholders of Nature-Based Solutions is proof that it is an important solution.

Working together, Permaculture and Nature-Based Solutions can play a pivotal role in creating sustainable, resilient, and livable urban environments by addressing the challenges of urbanization and industrialization. These approaches can help mitigate the adverse effects of these processes and support the development of more ecologically sound and socially equitable communities.

Permaculture emphasizes the use of natural resources and the integration of different elements to create a self-sustaining ecosystem. Permaculture can help create a more resilient and sustainable urban environment by mimicking the patterns and relationships found in nature. While Permaculture can be applied on a small scale for individuals and families, it can also reach large-scale developments with an expansionist approach. In particular, the systems developed by Permaculture solve the difficulties in accessing food, which is one of the significant problems in the coming years. Nature-based solutions involve using natural processes and ecosystems to address societal challenges such as climate change, loss of biodiversity, and urbanization. In this way, it contributes to sustainability by developing solution proposals based on the work of experts, stakeholders, and governments.

When permaculture and nature-based solutions combine, they can create a powerful synergetic effect. Permaculture helps design and plan the overall layout of a sustainable urban environment, while nature-based solutions can provide the specific tools and techniques needed to implement this design. Together, they can help create a more livable and resilient city that can better adapt to the challenges of a changing climate and growing population. Combining permaculture and nature-based solutions can provide a more comprehensive and holistic approach to sustainability, with solutions that can be applied both at the individual and social status and can enable societies to establish an essential system for adopting and implementing sustainable solutions within ethical values. In this way, individuals can make their own contributions to a sustainable future with permaculture principles that everyone can use. At the same time, social solutions can be realized with Nature-Based Solutions.

How Nature Based Solutions and Permaculture are essential for a sustainable future, and working together can create cultural, economic, and political impact and reveal methods that everyone can adopt and apply for our future. Therefore, combining these two disciplines and investigating the potential to work together will bring new breath and discipline to sustainable solution methods. In this way, by utilizing permaculture ethical values and design principles to create more durable and self-sufficient urban food systems and by incorporating the solution methods developed by Nature Based Solutions (green roofs and rain gardens Etc.), we are not only more sustainable, but also more livable urban food systems and environments can be created.

This thesis will explore the potential of permaculture and nature-based solutions to create sustainable and livable urban environments. The latest research and case studies of permaculture and nature-based solutions in urban areas will be reviewed. The potential of these approaches to address the environmental, social, and economic challenges facing urban areas today will be analyzed. The following chapter will conduct a detailed literature review on the latest research and work on permaculture and nature-based solutions in urban areas, focusing on their potential to contribute to sustainable urban development. In the literature review, the research methods used in these studies, including data collection and analysis, will be summarized, and method and classification studies developed in light of current studies will be carried out to evaluate the selected area based on these studies. Then, the methods with which Permaculture and Nature Based Solutions can work together will be determined and applied with the analyses made to the project area. The results and findings of the study will be presented in the fourth chapter. In this chapter, the contribution of Permaculture and Nature Based Solutions to sustainability will be evaluated in light of the data obtained from the application. In the last part, the data obtained from the project area and the implications of the research for sustainable urban development will be discussed and evaluated in conclusion.

2. LITERATURE REVIEW

"Philosophy is to know the existence of universal and infinite things, how they are and their causes in proportion to the power of human-being"

Risale fi'l Hudud., EbuYusuf b. İshak el-Kindî

In this chapter, a comprehensive literature review on Nature-Based Solutions and Permaculture, which is required for the thesis, has been made, and a conceptual evaluation of these two issues important for sustainability has been reviewed. Since Nature Based Solutions and Permaculture emerge as a result of various needs and problems during the study, it is necessary to investigate the origin of sustainability to determine what these problems are. While reviewing the literature, the study's objectives need to organize the answers to simple questions so that the subject can be understood better. Therefore, in the chapters, the answers to the general questions, such as what, why, and where were examing, and then detailed information, such as method and classification, was searched.

2.1. Origin Of Sustainability

Islamic philosophers advised that in order for an object to be known, its causes must be known. In this context, while investigating the origin of sustainability, first of all, it will be researched that the concept of sustainability emerged as a result of which events. Then, the causes of these events that affect the concept of sustainability will be examined, and their effects on the concept of sustainability will be examined. Afterward, the historical development of the concept of sustainability will be examined, and sustainable architecture will be mentioned. As a concluding review, the Bosco Verticale Milano building will be critically examined as an example of sustainable architecture.

2.1.1. Historical Timeline Affecting Current Sustainability

When the events that affect the concept of sustainability are examined, the effects of global crises and global warming stand out. In particular, the effects of global warming appear as a problem that needs to be solved in order to create a sustainable future. Afterward, when we started to investigate the cause of the global warming problem, as a conclusion that urbanization and industrialization are essential factors. (Figure 1).

In this context, starting from the industrial revolution can be determined as the beginning of the historical timeline of the problem while doing research. Due to the fact that light and heavy industries are generally established in urban settlements, the development of job opportunities and the emergence of migration from rural areas due to the need for workers are among the most important events affecting urbanization. Therefore, the increase in population and increased CO_2 emissions due to industrialization are the main causes of global warming.

Apart from global warming, other global crises in our world also directly or indirectly affect our lives, therefore, political, economic, health, etc. that affect sustainability (First and Second World War, 1973 oil crisis, 2008 Financial Crisis, Ebola, H1N1, Covid-19) Since there are unpredictable crises for a sustainable future in the global crises in these areas and they directly affect sustainability, for that reason these crises should be examined.

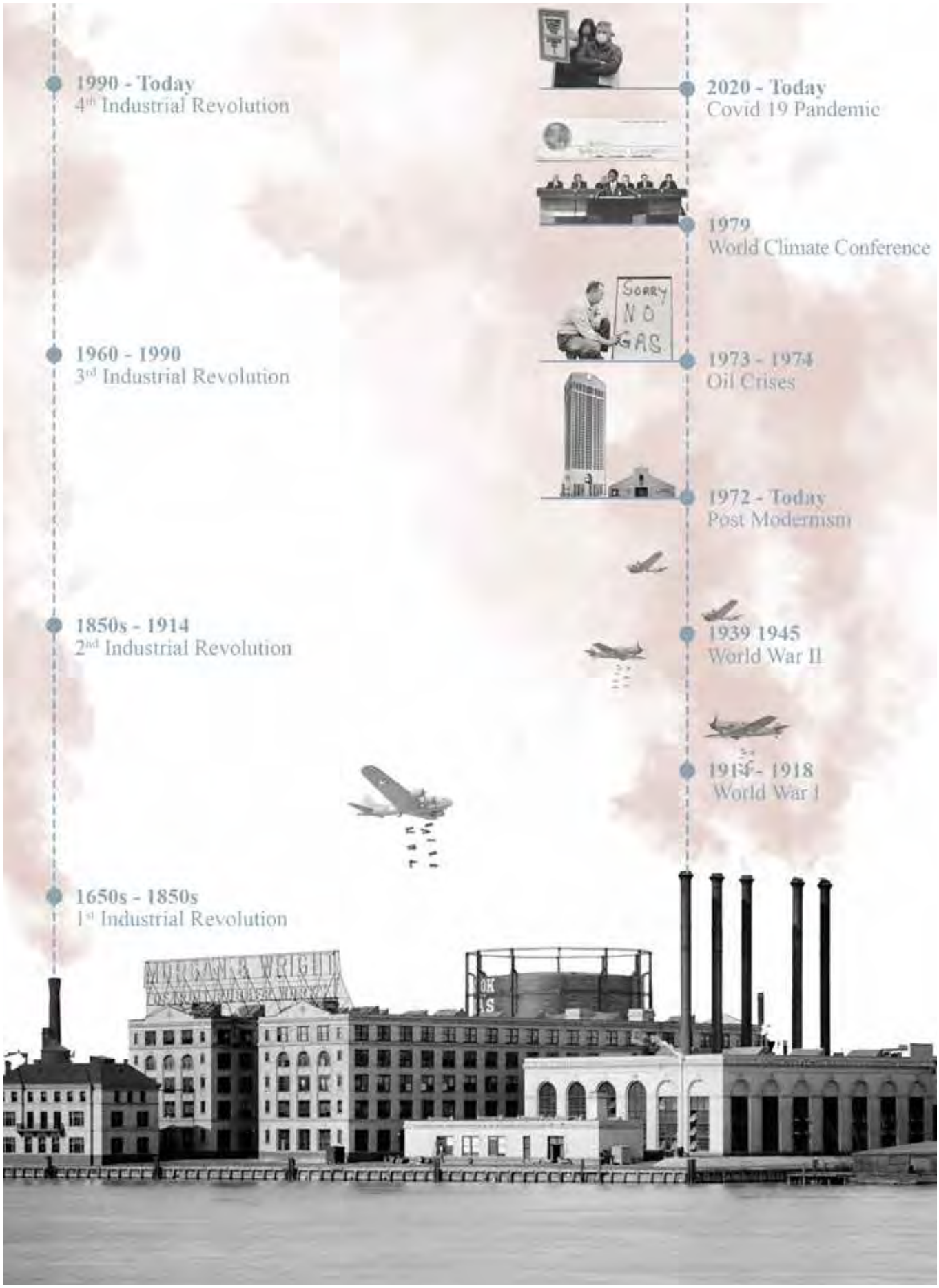


Fig 1. Historical Timeline Affecting Current Sustainability.

2.1.2. Industrial Revolutions

One of the most significant developments in the last 300 years has been the industrial revolution, which still affects our modern world. The industrial revolution affects our habits, economy, policies, living standards, and environment. This influence is spreading rapidly on a global scale with its involvement in technological developments. Today, we can consider industrial revolutions as four waves.

It is accepted that the beginning of the first industrial revolution dates back to the 1650s until the 1850s. The First Industrial Revolution has realized with the invention of steam machines in England in 1712 and the use of machines produced using the power of water and steam (Hobsbawm, 2008, p.53). Rapid production was realized with steam machines instead of hand power, especially iron-steel and textile production increased. In addition, with the invention of the steam train, railway networks increased, and trade accelerated (Pereira & Romero, 2017).

One of the crucial effects of the First Industrial Revolution is the changes in the social structure. In this period, the rapid increase in production and consumption, the increase in migration from the countryside to the city with industrialization, and therefore the emergence of problems such as housing, health, unemployment, infrastructure, and the formation of new settlements (suburban) by expanding cities began to emerge. Again in this period, the working class emerged as a new social class emerged by industrialization and the capitalist order, and after the problems that emerged in this process, various revolts and seeking rights as a result of the problematic situations experienced by the workers appear as a new way of showing a social behavior.

The second industrial revolution took place between 1850 and 1914. In this period, the influence of Germany and the United States is observed. New inventions such as the electric motor and the internal combustion engine had significant effects in the second industrial era. In addition, the invention of the telephone and the telegraph, which is one of the communication resources, are also essential inventions that occurred in this period. Steam engines have started to be replaced by petroleum energy, so advances have been made in technology and efficiency. Another critical factor is that the works aimed at increasing the efficiency of the factories started to be carried out in this period. With the Fordist production, which aims to use unskilled workers efficiently, developed by Henry Ford, and the Taylorism system developed by Frederick Winslow Taylor, which is the first stage of this approach, systems based on ensuring the entire control of factory production have been developed (Ansal, 1996).

When we examine the social effects in this period, it is seen that there are many problems such as overcrowding and pollution, especially with the increase in population in cities, the addition of subway and bus systems as alternative solutions to transportation with rapid growth, the construction of high-rise buildings to solve the problem of dense population and many problems such as the creation of city planning policies and related solutions have been developed. With the introduction of technology, the quality of life and communication methods have improved. The importance of the working-middle class has increased, and various unions and social aid works have been carried out to defend the rights of this class (Peter, 2020).

The third industrial Revolution started with the technological developments and digitalization

of information in the years 1960-1990. With the industry's use of automated production systems, the need for manpower in production has decreased to a minimum, and electronic technological systems have been integrated into the production process. The third industrial revolution took place in the years when we first encountered the concept of sustainability. When the effects of technological developments and industry are examined in this context, studies such as environmentally sensitive industrialization, research on the environmental effects of industry on the city, and separation and renewal of industrial wastes began to be carried out in this period (Peter, 2020).

Socially, technology began to take an important place in our lives in the third industrial period; the widespread use of technologies such as telephone, television, computer, car, and plane in daily life, the growth of cities as a result of these developments, the introduction of concepts such as intelligent transportation systems into our lives are the developments that changed the social structure in this period.

On the other hand, the fourth industrial revolution is used for the process that has continued since 1990. The most crucial development in this period is the increase in the importance of the internet and software, the software as the most important production and marketing tool of large industrial companies, and the conversion and marketing of artificial intelligence and intelligent robot systems into products with this software. When the fourth industrial revolution is examined socially, it is a period in which we use technology in every field of our lives and use the internet as the primary source of communication and information.

When we examine the industrial revolutions in general, each has created positive and negative effects in its own time and conditions. Especially after the second industrial revolution, the technological developments and the increase in the effects of the industry on nature show us that the environmental impact has increased with the second industrial revolution, and the nature-human relationship has started to weaken. Although it draws attention as a significant development in human history, it is one of the negative results of the second industrial revolution: ecological damages increased difficulty and started to affect the world.

2.1.3. Urbanization

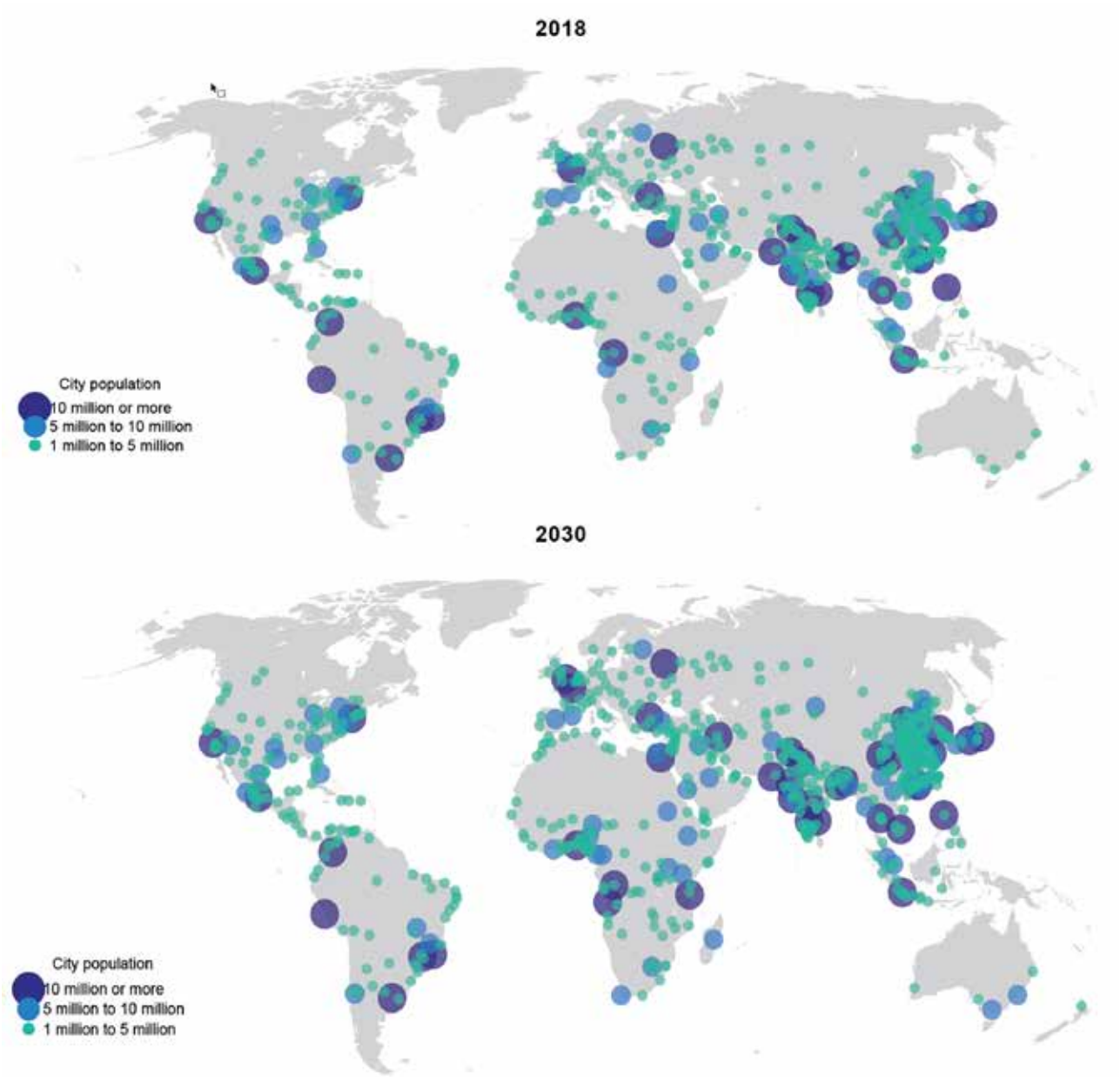
In this section, firstly, urban theories, social theorists, and empirical theorists' approaches to urban theories will be examined. Some utopian approaches developed for cities will be examined, and solutions produced in the face of problems will be discussed with the perspective of the city will be compared. After that, the classification of settlements and the relationship between the current situation and sustainability will be examined by making a distinction between urban and rural.

2.1.3.1. Urban Theories and approaches

Before the second world war, only London and New York had a population of 8 million. However, after the war, this number increased to 22 megalopolises due to the rapid increase in migration from rural to urban, especially with the development of industrialization (Parker,2003). While this number reached 33 in 2018, it is expected to reach 43 Megapolis cities in 2030 (UNDESA, 2018) (Figure 2).

Figure 2

World Urbanization Prospects The 2018 Revision ,Cities with 1 million inhabitants or more, 2018 and 2030.



Notes. *World Urbanization Prospects: The 2018 Revision*

In this period of rapid urbanization, many urban theories have emerged historically. Famous sociologists have studied urban theory as a sub-title of social theory. Max Weber sees the city as a continuation of the Middle Ages and the Renaissance as an important step in the transition from ancient society to feudalism and from feudalism to capitalism and defines cities as settlements where trade is made, and laws are made to protect and develop this trade. Georg Simmel, on the other hand, sees cities like Weber as a historical development. However, Simmel observes the city's human context as a center of freedom. Another observation of Simmel is that the common interest of the people in the city is money. According to Simmel, the ability of the city to work in an orderly and harmonious way is an

effort made by people to protect their common interests. Henri Lefebvre, who has a Marxist view, is the use value of the city; he defines the physical environment, people, and raw materials and exchange value as the value of commodities produced for sale by the capitalist mode of production. According to Lefebvre, the city is the meeting point of use and exchange value. Also, according to Lefebvre, the city should be developed and changed, so he studied the importance of city planning and advocated the design and discussion of utopian ideas (Parker,2003).

Social theorists such as Weber, Simmel, and Lefebvre worked to determine the city's essence and reduce it to a level that everyone could understand. On the other hand, empirical or practical urban studies try to make sense of this chaotic and unstable world, classify it, identify its problems, and find the source of the problems. For instance, researcher Jane Adams worked on social issues in the city and practical measures that could be applied to alleviate poverty. With the Hull House project, she realized the problems in the city, such as migration, education, and economy, and conducted studies where women could receive education in these areas. Empirical approaches are not to define the city or to understand how it works, but to work on the problems in its current structure and the causes of the problems, creating solution proposals (Parker,2003).

The idea of creating the perfect city is a concept that has been researched from the past to the present and opened to discussion with various suggestions from time to time. Nowadays, he appeared with the "The Line" project supported by Saudi Arabia's Crown Prince Mohammed bin Salman. When we examine the projects that have been realized as utopian cities or ideal cities, we can see the 'Garden City Movement' by Ebenezer Howard trying to create a rural-urban synthesis, Le Corbusier's 'Radiant City' project, and Frank Lloyd Wright's 'Broadacre City' project. The general purpose of these projects is to offer solutions that can minimize the problems that arise due to the development and growth of cities. However, these projects, which are not made with sustainable concerns, have been partially or entirely unsuccessful in practice from the past to the present (Parker,2003).

2.1.3.2. Examining the City from Social Perspective

The cities that city planners designed as ideal cities were generally designed through social housing projects created to meet the needs of the increasing population with industrialization. However, social housing had both positive and negative aspects. High-density buildings and residential areas in the neighborhoods were not enough to resolve social, ethnic, and economic differences and even caused social and security problems by creating internal conflicts and stratification in mass housing. Another reason for this was that the economic and social differences in the city polarized the society, especially the new immigrants who had to live with communities of the same ethnic, religious and economic class, which resulted in ghettoization in the cities. Ghetto areas, on the other hand, have been subjected to interventions to change and renew their current state due to political and economic reasons.

This system is caused by the problems generated by the capitalist order in general and the industrial and technological developments in the last 200 years affecting the whole world. Meanwhile, Karl Marx and Engels began to examine what they called the capitalist system of exploitation. While Karl Marx tried to understand capitalism's mode of

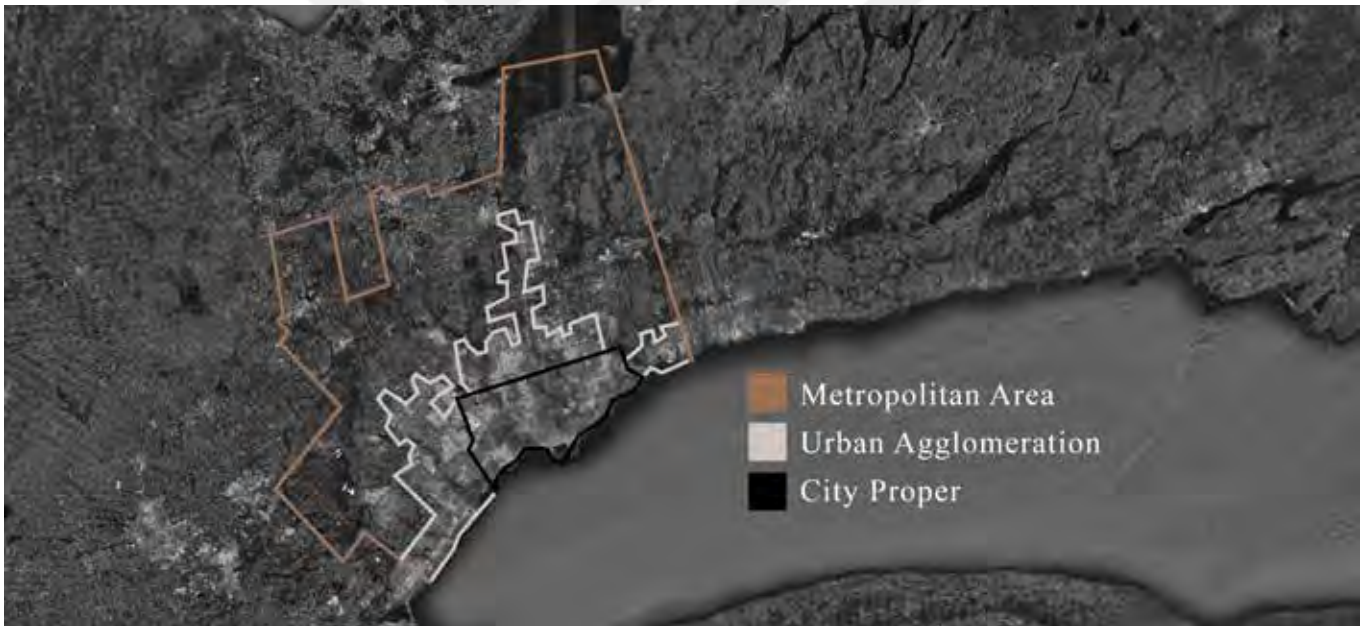
production and its general mechanism, Engel looked more at its sociological dimension. According to Marx, there are two distinctions in the capitalist order, the bourgeois and the proletariat, and their common point is money. In other words, money and labor are exploited. In the capitalist city, commodities are not just things that can be bought but also public spaces. The city could be defined as a tool capable of producing different commodities. According to Marx, the urban capitalist is not a cause of the social process but the spaces in which social change lives. Therefore, the city is significantly affected by the change experienced (Parker,2003).

2.1.3.3. The relationship between urbanization and sustainability

Although there is no clear and standard definition for cities, it is accepted by everyone as areas managed by central governments where a large number of people live and work. Looking at the expansion systems of cities, we can classify them as City Proper, an urban agglomeration, and a metropolitan area. This classification is associated with the city's economic and social interconnectedness and interlinked commerce degrees. (Figure 3).

Figure 3

World Urbanization Prospects The 2018 Revision ,Toronto City Borders



Notes. *World Urbanization Prospects: The 2018 Revision*

Sustainable solutions include that are prioritized according to this classification. In this classification, it can be seen clearly how and whom the problems affect. The concept of city and sustainability draws attention as an area that has been studied for the last 60 years. Cities' growth, industrialization, and urbanization have affected their sustainability. Sustainability is a concept that should be considered more than ecologically. Sustainability in economic, political, environmental, and social areas is an important concept for the city. It is necessary to determine the unemployment problem of a growing city reasonably and predictably and to work on it. Likewise, the destruction caused by cities as they grow should be foreseen, and a sustainable city should be created by creating solutions for this.

2.1.4. Global Warming

As in the past, climate changes continue today, and also natural and anthropogenic effects impact climate change. The vertical and horizontal movements of the earth's forms are due to natural causes; for instance, the dust clouds formed as a result of the eruption of the Pinatubo volcano in 1991 caused the average temperature of the world to decrease by 1°C due to the effect of the sun's rays on our world, or the effects of the current systems and wind directions as a result of continental shifts one of the reasons (Houghton, 2009).

Global warming is defined as the increase in temperature values by factors such as the amount of sunlight received by the world, how much it can reflect this light, how much the temperature can hold in the atmosphere, and the evaporation and condensation of water vapor, naturally or with human influence (Houghton, 2009).

The greenhouse effect is the reflection of short wavelength rays from the sun to the atmosphere as long wavelength heat rays after they hit the earth and their return to the earth by being reflected by the greenhouse gases in the atmosphere. The water in the atmosphere is vital in the greenhouse effect. While 85% of the total greenhouse effect is caused by water vapor and 12% by water molecules, 7% is caused by anthropogenic gases (CO_2, CFCs, Methane, Nitrogen Oxide, and Ozone).

The most crucial gas in global warming is CO2. Under normal conditions, CO2 is found at a rate of 0.038% in the atmosphere, but CO2 causes 50-60% of the anthropogenic greenhouse effect. In recent years, the increase in CO2 in the atmosphere has been about 0.5% every year. The current concentration of CO2 is about 350ppm. It is estimated that this amount can reach 450ppm by 2050 as a result of this increase, which is more than 1.5 times more than the rate before the Industrial Revolution. The biggest reasons for this increase are considered to be the use of fossil fuels and deforestation. Initiate negative and positive feedback mechanisms against the greenhouse effect of our world. Negative feedback is self-regulating against warming and causes global cooling, while positive feedback is self-enhancing and causes global warming. Positive and negative feedback occurs simultaneously as the world's reactions (Aksay et al., 2005) (Table 1).

Table 1

Contribution Rates and Emission Sources of Anthropogenic Originated Gases

Trace Gases (in %)	*Contribution Rate*	*Emission Sources*
CO2	%50	Burning fossil fuels such as coal, oil, and natural gas. Destruction of tropical forests.
CFC	%22	Aerosols in spray cans. Refrigerants in refrigerators. Cleaning agents used in electronics air conditioning systems.
CH4	%14	Hard and Soft foam production. Rice fields. Stomachs of cows
Ozon	%7	Burning of biomass Garbage collection areas Leaks in natural gas pipelines Coal mines
N20	%4	Traffic Combustion events in thermal power plants Using artificial fertilizers in agriculture

Notes. *Due to increased NOx emissions in the troposphere.*

It is known that global warming causes changes in climate types and rises in sea levels. In terms of biology, rapid climate changes pose a threat. It is expected that the expected temperature increase of 1–3.5 °C in 100 years will not adapt to this, and many living species will remain in danger of extinction. It means the danger of extinction in a quarter of plant and animal species and one in eight bird species. Projects designed in terms of sustainability should offer suggestions to reduce global warming and protect and improve plant and animal habitats by foreseeing its consequences in this context (Aksay et al., 2005)

2.1.5. Global Crises

Examining the critical events affecting our world plays a vital role in our planning for the future. When the crises on a global scale are examined in the last 150 years, they can be examined under two headings: environmental/nature crises and social crises. The most important recent crisis with environmental impact was examined under a heading as climate changes due to global warming and its effects. In this section, global crises and their effects in political, economic and health areas will be examined and the relationship between the effects of these crises and sustainability will be explained.

2.1.5.1. Global crises with social impact

Crises with social effects are crises that occur in politics, the economy, and health. Throughout the history of humanity, the effects of political decisions have had significant consequences for countries. In the last 150 years, the most important political crises that have affected the world have undoubtedly been the 1st and 2nd World Wars.

The First World War was recorded as a war with global effects between many states between 1914 and 1918. The search for raw materials and

colonies, which increased with industrialization, is shown as one of the main reasons for the war. In addition, developing industry and technology, new weapon technologies, and changing the balance of power between the states have put countries in a power race. Socially, the nationalist movement brought about by the French revolution pushed the multinational states (Tsarist Russia, Ottoman Empire, Austro-Hungarian Empire) to division. As a result of the war, there has been a crisis on a global scale due to reasons such as famine, epidemics, etc., after the war resulted in much destruction and death.

The Second World War occurred between 1939-1945 due to the economic depression and crises experienced by the countries that lost after the First World War. The Second World War was a war in which countries were much more developed in terms of industrialization and technology, so destruction and death were much more. Especially in the last years of the Second World War, the nuclear weapons used by the United States against Japan resulted in great destruction (Çimen, 2007).

The environmental impact of the war was also devastating. After the First World War, according to the figures announced by the French Forest Service, 350,000 hectares of forest area were cut and used for war. In America, 220 million feet of timber; 3,051,137 standard gauge railway sleepers; 1,926,693 various wood products, and 534,000 cord firewood - and this was only in the last two years of the war, in which the United States was late. To better understand the areas destroyed by war, it will suffice to know that the United States produces 65 million feet of timber annually (Heiderscheidt, 2018).

In the field of health, today's example is Covid-19, also global epidemics such as HIV/AIDS, Swine Flu, and Ebola have affected the whole world with their deadly effects in past. These crises in the field of health have affected societies politically and economically. The economy's slowdown, even coming to a standstill throughout, has consequences that will show its effect for many years. This type of epidemic that damage social relations in society has caused us to be culturally affected (Mold, 2020)

The economic, political, and health crises that started over a country and affected the whole world, such as the 1st and 2nd World Wars, the Great Depression, the 2008 Financial Crisis, Covid-19, and the epidemics, had social effects. The high inflation experienced, especially after the economic crises, has directly affected the living standards by reducing the purchasing power of the people. He had to struggle to find solutions to people's changing living standards and preserve their old life standards. For example, migrating people to cities with new business areas in order to gain better living conditions has emerged as a threat that can affect even the demographic structure of cities. In the health dimension, situations such as health problems caused by malnutrition, maternal and infant deaths, and unavailable health services due to the lack of purchasing power for developing technologies in important health sectors have been created. As a result of the reduction of investments in social areas by the states causes a pause or a regression in areas such as cultural development, education, and art (United Nations Dept. of Economic and Social Affairs, 2011).

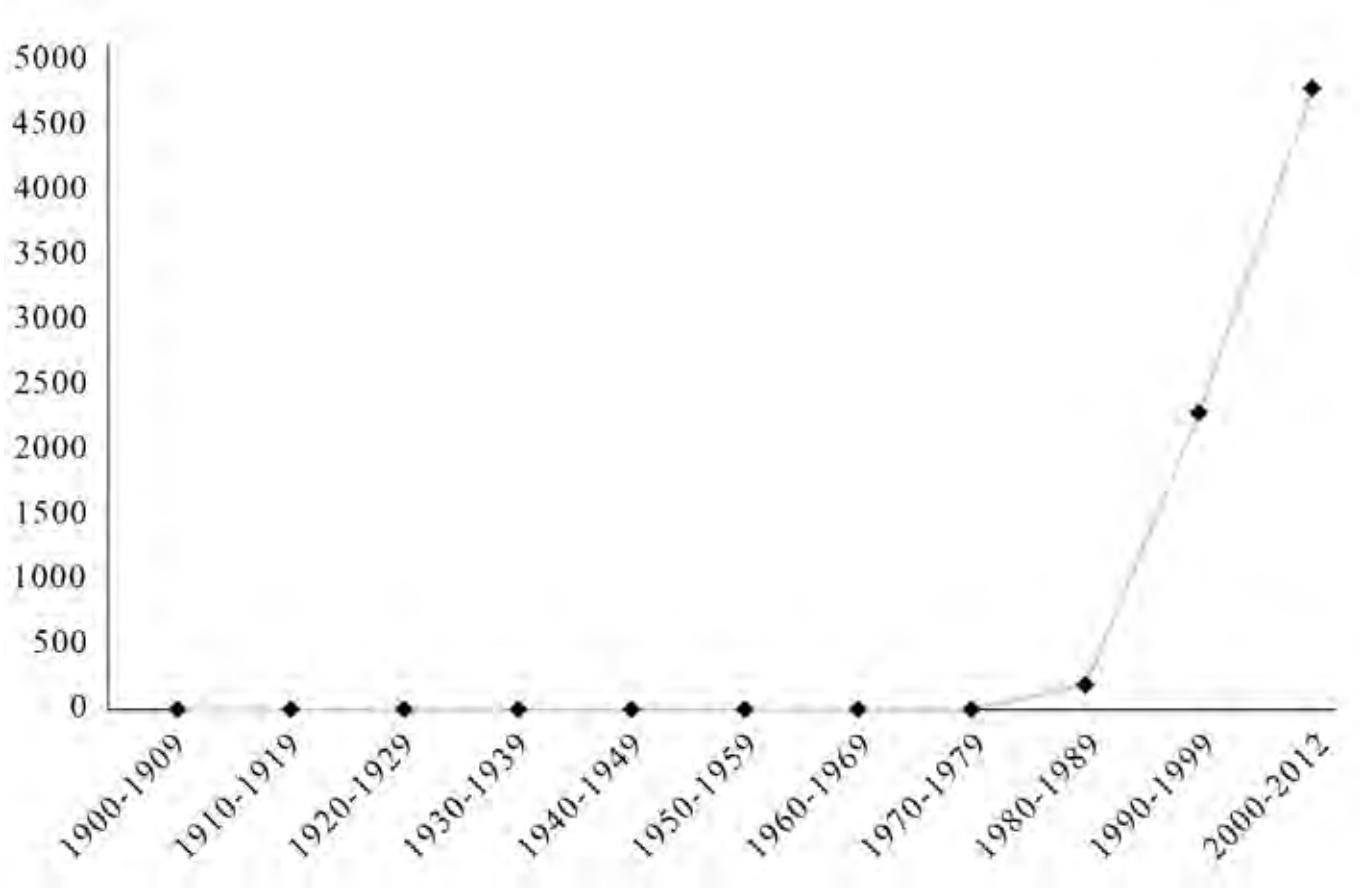
2.1.6. What is Sustainability?

Although the concept of sustainability came into our lives by using it in the Brundtland Report

by the 1987 World Commission on Environment and Development (WCED), it was used as a concept idea in German sources as "Nachhaltigkeit" in 1713 for forests that were not harvested. In addition, although sustainability is not used as a word, studies have been made for this. For example, we can cite the work of Thomas Malthus in 1798, which deals with the fact that the existing agricultural areas are insufficient to feed the population while the causes of mass hunger are being investigated. The non-renewable resource studies of economist Harold Hotelling in 1931 are examples of this field. Today, it has become an essential concept with its rapidly increasing popularity. Another method we can refer to look at the interest in the concept of sustainability can be book titles that use the word "sustainability" directly. (Kuhlman, 2010) (Table 2).

Table 2

Books with the word "sustainable" or "sustainability" in the title, 1900–2012.

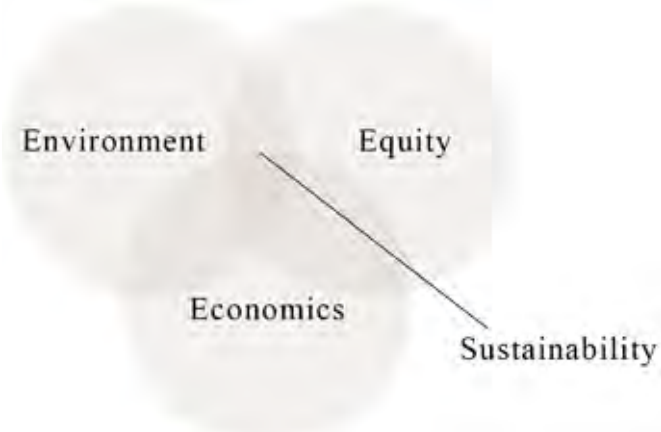


Notes. *Adopted from Sustainable: A History (Caradonna, 2014)*

In recent years, studies on sustainability have been handled from an ecological perspective. When we look at these studies in general, the concept of sustainability has emerged as a model that combines the concepts of environmental, economic, and social justice. In addition to these three concepts, it can be added considering the importance of education (Figure 4).

FIGURE 4

The three Es of sustainability represented in a diagram. A "sustainable" society requires a balance between and equal concern for the environment, social equality, and the economy.



Notes. *Adopted from What is Sustainability? (T. Kuhlman, J. Farrington.,2010)*

From a more innovative perspective, sustainability is defined not as an intersection point but as a subset of each other. In this system, where society and economy are subsets within the universal environmental cluster, everything is defined as interconnected systems (Caradonna, 2014) (Figure 5).

FIGURE 5

This diagram places the environment at the foundation of the model.

Notes. *Adopted from Sustainability:A History (Caradonna,2014)*

In order to protect biodiversity in environmental sustainability, it consists of environmental protection systems such as protecting water, saving energy, using zero waste and recycling systems, etc. In economic sustainability, it is the ability of organizations to work permanently with acceptable profit rates in the long term while managing their resources. On the other hand, social sustainability is defined as the policies of societies or certain social groups to live together and strengthen their harmony. The common purpose of these three main titles is not to harm their relations with each other. For example, an institution working with the aim of economic sustainability while considering environmental sustainability in its recycling methods or packaging waste policies can also support social sustainability with responsible consumption awareness activities (Caradonna, 2014)

The definition of sustainability in 1987: Brundtland Report defines the methods we use to meet our current needs as being able to meet the needs of future generations without compromising their ability to meet their needs. According to this definition, short and long-term sustainability studies emphasize the importance of protecting future generations and the continuity of today's needs.

The concept of sustainability is related to architecture, like many other disciplines. The concept of sustainability is present in almost every field of architecture, such as city planning, building solutions, and landscape applications. Sustainable architecture is a type of design that focuses on creating buildings and structures that are environmentally friendly and resource-efficient throughout a building's life cycle. This includes the initial design, construction, operation, maintenance, renovation, and demolition of a building. Sustainable archite-

cture seeks to minimize the adverse effects of buildings on the environment and human health while at the same time improving the well-being and comfort of building occupants. Since the 1960s, scientific studies have been carried out on the concept of architecture and the environment, and architectural solutions have been designed with ecological designs and nature. The Club of Rome explored the problems faced by human society in 1968. By conducting joint research with the Massachusetts Institute of Technology, he published in his report in 1972 that the contribution of limited natural resources to the economy is limited and that sustainability is not possible with existing solutions. In addition, studies have also been carried out on systems that will indicate the architectural dimension in the sustainability rating. The first sustainable building rating system (BREEAM) was established in England in 1990. The United States makes this rating with the LEED system. Today, many developed or developing countries use these systems to apply the parameters of sustainable architecture to building systems. Details of these systems are generally rated as location and transportation, site, energy and atmosphere, materials and substances, availability of water, Internal environment of building quality, innovation, and establish priorities (Iyengar, 2015.).

There are many approaches to sustainable architecture, including using renewable materials, energy-efficient design, and the inclusion of green spaces and natural light. Some standard features of sustainable architecture include passive solar design, which uses solar energy to heat and cool a building, and the use of green roofs, which can help regulate a building's temperature and reduce the runoff of rainwater.

An essential aspect of sustainable architecture is the use of renewable materials. These materials, such as bamboo, straw, and recycled plastic, can be used to replace traditional building materials such as concrete and steel. Using renewable materials can help reduce the environmental impact of buildings as they require less energy to produce and generally have a lower carbon footprint. Another critical aspect of sustainable architecture is the use of energy-efficient design. This may include the use of improved insulation, energy-efficient windows, and efficient heating and cooling systems. These design strategies can help reduce the amount of energy needed to maintain a comfortable indoor environment that can save energy costs and reduce greenhouse gas emissions.

Sustainable architecture has environmental benefits as well as social and economic benefits. For instance, sustainable buildings can provide healthier indoor environments for inhabitants, which can increase their well-being and productivity. Additionally, sustainable architecture can support local economies by creating jobs in the construction and building industries and promoting the use of locally sourced materials.

Sustainability and the resulting sustainable architecture are applied in a small part of the global construction industry due to the increasing needs and public awareness due to economic concerns. Also, another opinion is that designs made using the sustainable concept should be replaced by regenerative architectural solutions, which can be self-renewing and serve their purposes. Notices the use of systems that can be completely destroyed in nature afterward as a more progressive and holistic approach. This leads us to the opinion that sustainable architecture should work with new solutions by working with different fields and that available

and constantly applicable solution proposals should be created with the use of holistic systems.

2.1.7. Case Study of Sustainable Architecture: Bosco Verticale Milano

Bosco Verticale, an important study of Sustainable Architecture practices, completed its construction in Milan in 2014. It was designed as two buildings on an area of approximately 30,000 m2, and the 112 and 80 meters high buildings were built with the idea of creating a vertical forest. Its primary purpose is for humans and other creatures to live in a typical habitat. In this context, it contains 780 trees and 15,000 perennials and ground plants, and 5,000 shrubs. With the idea of vertical forest, it tries to reduce CO2 emission and regulate humidity with green mesh. By design, the effects of each season can be seen thanks to the seasonal cycles of the plants. In addition, this structure, which can be a nest in the animal habitat, is home to 1600 birds and butterflies. It has been an extremely successful project in creating its own flora and fauna. (Figure 6)

FIGURE 6

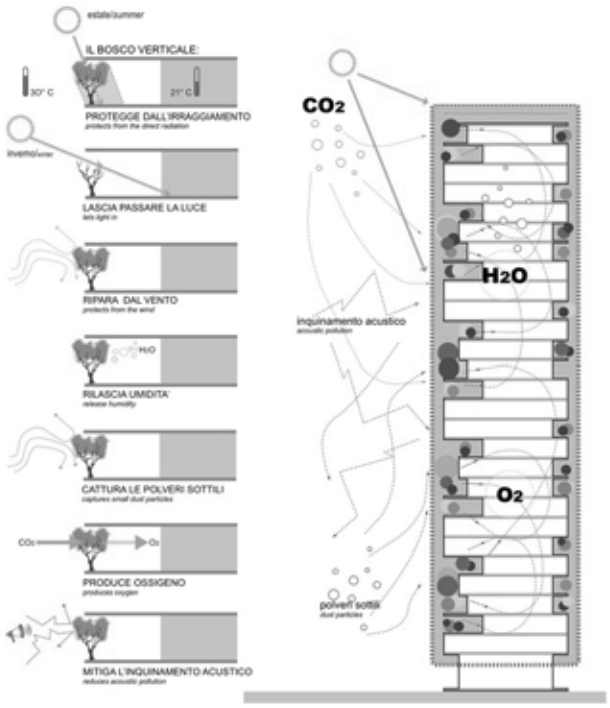
Image of the Bosco Verticale Milano

Notes. *Stefano Boeri Architetti Studio.*

It has a structure that reduces the use of land in cities where perpendicular architecture is used architecturally. It creates micro-climates with the idea of vertical forests and helps to filter the air pollution that occurs as a result of urban pollution (Figure 7).

FIGURE 7

Bosco Verticale, Diagrammatic representation of systems produced for CO2 and Sunlight.



Notes. *Stefano Boeri Architetti Studio.*

For instance, we can see the contribution of this project to sustainability, but we need to consider whether sustainability is actually what it should be. Covering balconies with ornamental plants or making green roof designs is not a sufficient solution exclusively. All the technological products we consume beyond our needs are harmful, and also there are some green solutions. Because of the water consumed, maintenance costs and plants cut off from their habitats negatively affect our ecosystem. For example, in Milan, where the average rainfall

is 91 millimeters, it is clear that we cannot supply water from rainwater, and its sustainability is not possible in a building with 800 trees, 15,000 perennial and/or ground cover plants, and 5,000 shrubs. Therefore, in sustainable designs, although these studies are exemplary and can be considered the best of the worst, we need to provide this with more efficient studies. Although complex project design has an important place in architecture, it needs to be more straightforward and more applicable in order to disseminate such designs.

2.1.8. Conclusion

During the life cycle, people experienced many problems and wanted to produce solutions according to the conditions of the period. These solutions have produced different effects and results throughout history. These results, which directly affect every part of the society living in the society, have also occurred with the general request of the society. Of course, the process of influencing society is directly effective with the socioeconomic impact of individuals. It would not be suitable to use the effects of a ruler who made a war decision in the 17th century for people who were dealing with farming in the village but had to leave everything behind and fight because of this war decision. However, in today's societies, primarily social and technological awareness occurs with the effect of every segment of society in current problems. Especially in recent years, technology has brought us so close to each other that it is necessary to be aware of regional or global problems and to give people the responsibility of working together to solve them. In this context, many events and reasons affecting the concept of sustainability, its origin, and its application have occurred in the last 150 years. The effects of the industrial revolution have been one of the causes of global warming and climate change with the locomotive effect, and research has been carried out to solve the emerging problems. The human being, who must do the necessary work to cause and solve these problems, has discovered the concept of sustainability. Realizing how vital sustainability is actually reminded us that we need to understand nature again and cooperate with nature. In addition, it is evident that other significant global crises affect us at the social, economic, political, or environmental levels. Therefore, we need to gain the ability to foresee the problems that may arise or solve them as soon as possible by adding these dimensions to the work we do in cooperation with nature. In this context, for sustainability, we need to establish a general sustainable development system that everyone can implement and solve the political, economic, and social dimensions in cooperation with nature.

2.2. NATURE-BASED SOLUTIONS

In this section, a literature review has been done that will enable us to have general information about Nature-Based Solutions as a result of examining the current literature. Basic questions about what, why, where, and how nature-based solutions will be answered, and examples of these studies will be given at the end of the section. After all, in conclusion, the importance of Nature-Based Solutions in this thesis will be emphasized, and the positive and negative aspects will be discussed with a critical approach.

2.2.1. What are Nature-Based Solutions

Throughout human history, nature has been the main teacher. Humans, who have the habit of living in harmony with nature, have survived with the ability to imitate and adapt. Using this ability, he established social relations and hunted, built, and developed shelters. Humanity, who solves the problems they experience with the ability to imitate nature, has started to lose this ability over time after they have settled down. Especially in the last 200 years, technological and scientific developments have accelerated this process, resulting in a struggle against nature and our distance from nature. As the main teacher of nature, the first solution to our problems is the resource we will apply to make this development sustainable. That is why we must find solutions to our problems by working with nature, not against nature.

2.2.1.1. Definition of Nature-Based Solution

Natural base solution is an important method to solve our current problems or needs by collaborating with nature. Nature-Based Solution defines solutions to create and sustainably manage ecosystems by mimicking nature's functioning, regeneration, self-repair, sprawl, and development and bringing it back to life with the aim of increasing biodiversity, coping with social challenges, economic benefit, and human well-being as productive actions (Maes & Jacobs, 2015).

Nature-based solutions can be positioned as the umbrella of many sustainable solutions (Dumitru & Wendling, 2021). In addition, the ecosystem approach supports collaboration with concepts such as ecosystem services, ecosystem-based adaptation/mitigation, and green and blue infrastructure (Baduceau et al., 2015). It can also work with many disciplines, stakeholders, investors, and governments to obtain data for the appropriate method and solution. While this enables Nature Based Solutions to reach wide areas, it enables different sectors to unite around common denominators and, therefore, to be adopted and supported by large segments in terms of sustainability and applicability (Cohen et al.,2016).

In order for an application to be a Nature-Based Solution project, it must meet certain conditions. Existing parks or structures are not considered Nature-based solutions. However, if functional changes or interventions can be made in these areas/structures, they can be accepted as Nature-based solutions. Nature-based solutions are to develop the project area with its own methods, to organize it in a way that will provide multiple benefits, and to ensure that the project is used and inspired by nature to address a social problem. However, in the process of being inspired by nature, Nature Based Solutions exclude methods that aim to artificially mimic nature, such as genetically modified organisms or biomimicry (Almassy et al., 2018).

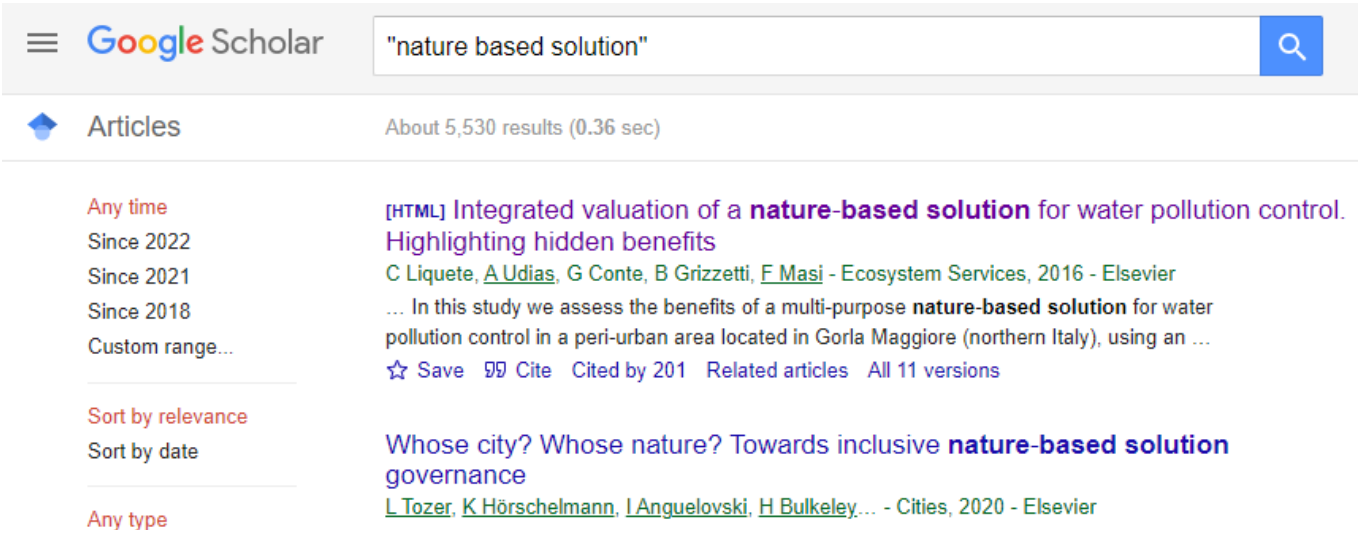
2.2.1.2. Origin of Nature-Based Solution

Investigating geography, they are in, understanding the workings of nature, and living their lives accordingly has been compulsory learning tool for many local people. Planting and harvesting time of crops, determining beneficial or harmful plants, determining the paths for the shortest distance, knowing which trees to cut for winter wood and which should not be cut, knowing flora and fauna of the area where it is found, and using endemic species in different areas (health, economy, Etc.), many teachings, such as the protection of animals and plants that affect ecosystems, or the removal of invasive species, have been reflected in our lives as experiences passed down from generation to generation.

It was only in the 1970s that these methods entered the modern scientific literature as environmental and ecosystem services. In the 1990s, various studies were conducted to understand the human-nature relationship, and the term Nature-Based Solution was first used by the International Union for Conservation of Nature (IUCN) in 2002. In 2005, Nature-Based Solutions were included in the Millennium Ecosystem Assessment (MA) report, which includes scientific-based solutions for the protection, restoration, and sustainable management of ecosystems and where evaluations are made by experts. Later, it was included in the World Bank Report in 2008, in the position paper of IUCN UNFCCC in 2009, and in the report jointly commissioned by the IUCN-World Commission on Protected Areas, The Nature Conservancy, UNDP, Wildlife Conservation Society, The World Bank, and WWF in 2010. (IUCN Nature-based Solutions to address global societal challenges). Since 2013, it has been added to the EU research and Innovation Policy Agenda in the fields of nature, society, and economy as a large-scale scientific research area. Its general framework has been determined (Somarakis, 2019). Nature-Based Solution has been the subject of approximately 5500 academic studies today and continues to be popular as a sustainable solution method today. (Figure 8) (Google Scholar.,2022, (e.g. Ruangpan et al., 2020, see also Fletcher et al., 2015).

FIGURE 8

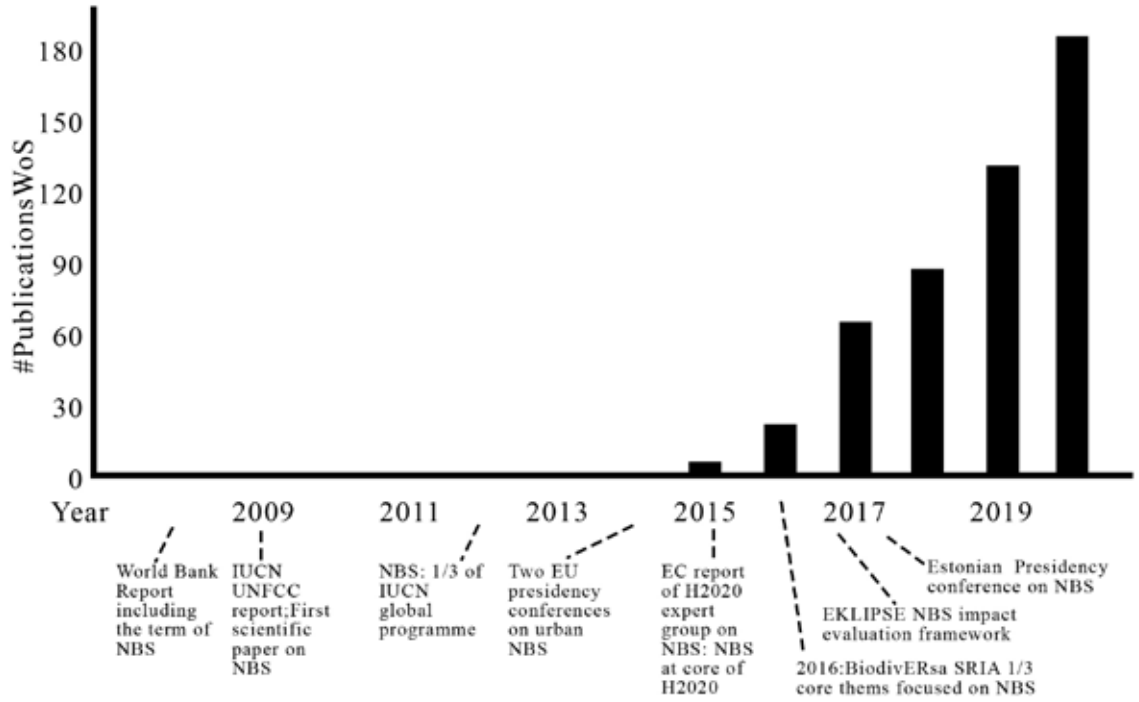
Searching Data, Google Scholar 2022.



Notes. *Google Scholar*

FIGURE 9

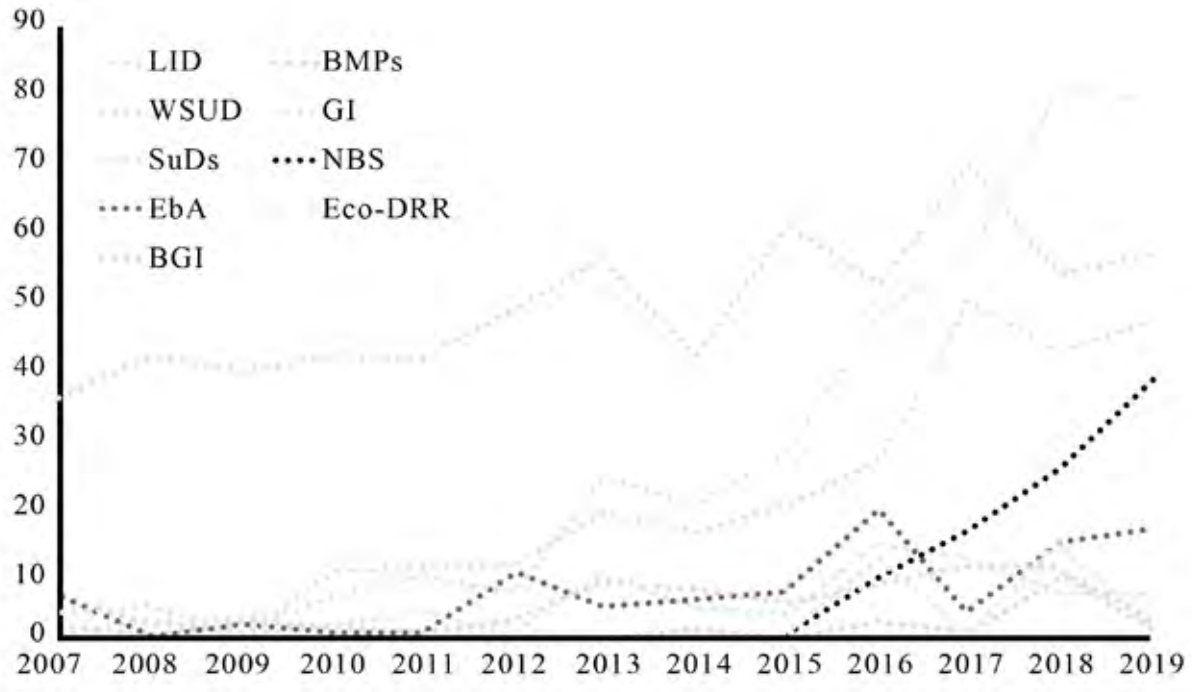
Nbs publications and policy development timeline



Notes. *Biodiverse ,undated*

FIGURE 10

Trends in publication numbers: NBS and comparable approaches



Notes: *LID - low impact development;WSUD – water sensitive urban design; SUDS – sustainable drainage systems; EbA – ecosystem based adaptation; BGI – Blue Green infrastructure; BMPs – best management practices; GI – Green Infrastructure; NBS – Nature Based Solutions; Eco-DRR – eco disaster risk reduction.*

2.2.2. Why do We Need Nature-Based Solutions

Today, 55% of the world's population lives in urban settlements, while 45% lives in rural areas. In 2050, this rate will increase to 68% for cities and decrease to 32% for rural areas, and people will begin to live in more urban areas. Considering the world population estimate for 2050, approximately 2.5 billion people will begin to live in more urban areas (UNDESA, 2019). On the European continent, on the other hand, while 73% of the population lives in cities, it is expected to increase to 82% by 2050 (Haines & Weber, 2010). Considering these figures, urbanization, and migration will affect the settlements in terms of economic, social, health, political and natural resources and will bring about demographic changes over the next 25 years.

From a sociological and economic perspective, cities' attractiveness and obvious benefits stand out. The main reasons why cities are the most preferable settlements in today's living conditions are; job opportunities, social life, accessibility, health services, technological development, education, Etc. The reasons draw attention; of course, there are adverse effects that cities add to human life, but these are generally reflected as psychological effects (stress, loneliness, individuality, anxiety, Etc.). In rural areas, it is observed that the effects are generally the opposite.

Nature-based solutions can work with stakeholders and citizens in the field of economy, especially in cities, by laying the groundwork for interdisciplinary and different sectors to interact with each other. In this way, it can develop business and finance models by benefiting from both public and private financing and providing benefits in the economic and social fields. The solutions developed beforehand can ensure that events that cause devastating and significant material damage, such as climate and natural disasters, can be overcome with much less damage. It can be a pioneering approach in reducing the political pressure on governments created by issues such as youth unemployment and inequality, especially in cities experiencing economic recession. For example, the renewal and re-functioning of abandoned areas where nature-based solutions are mainly applied and the improvement of old industrial areas or recreation facilities can contribute economically by transforming them into areas that can increase the general welfare of citizens economically (Bauduceau et al., 2015).

Another point of view is the effects of nature, the city, and human relations. Rapid urbanization, rapid deterioration of natural capital and ecosystem, climate changes, more destructive natural disasters in cities, decrease in city air quality with industrialization, need for clean water, the inadequacy of agricultural areas the reasons are among the nature-related problems observed in the city (IPCC, 2018; IPBES, 2019). Likewise, rural areas are the opposite of cities, where these problems are partially or not experienced.

Nature-Based Solutions proposes a robust system that can be used to tackle these challenges. It primarily works to reduce the effects of climate change, adapt and reduce disaster risk, thereby contributing to biodiversity and ecosystem services. In addition, scientific, political, and economic studies in recent years have been due to the awareness of the importance of nature. Therefore, sustainable development is essential to protecting biodiversity, reducing the effects of climate change, developing natural solutions against natural disasters, and developing gray and blue infrastructure. In addition, a positive psychological effect can be achieved by

increasing the natural areas from the negative effects of the city on human psychology. Social ties can be strengthened, especially with the greening of neighborhood areas or green corridors created in streets or avenues. For this reason, social-cultural benefits can be achieved by making use of nature-based solutions in places such as parks, squares, schools, hospitals, and public areas.

As a result, most of the problems that people experience today have occurred after the damage to the relationship of human nature with nature, and this effect is observed more intensely, especially in cities. In rural areas, the relationship with nature increases welfare with Nature-Based Solutions, helping people reach a decent standard of living in the areas where they live instead of going to other places.When the effect of humanity on nature and the effect of nature on humanity is examined socially, economically, and psychologically, it is an inevitable fact that we need to live together with nature. Therefore, it is an effective investment tool that will enable us to minimize the damages that may occur in the current and future economic, social, and health areas by solving the damages we inflict on nature with nature-based solutions.

2.2.3. Where can Nature-Based Solutions be used

When the literature review of the application areas of Nature-Based solutions is made, we come across many different approaches. Therefore, these approaches should be organized and combined into a single systematic approach to present them more systematically and reach more practical information while applying them.

Nature-based solutions are divided into Spatial Scale (Macro, Meso, Micro), Temporal Scale (Short: 5 Years, Medium: 10 Years, Long Term: +10 Years). Spatial scale according to each scale unit (Macro, Meso, Micro) It will be analyzed by dividing into 3 as Urban, Rural, and Landscape. The temporal scale will be analyzed by dividing into 2 as social and ecological. In this way, it is ensured that the working areas of the Nature-based solutions are fully examined. Selected 10 challenges from the expert report on NBS supported by DG Research and Innovation (European Commission, 2016) and a recent review of NBS frameworks (Kabisch et al., 2016):

1.Climate mitigation and adaptation;
2.Water management;
3.Coastal resilience;
4.Green space management (including enhancing/ conserving urban biodiversity);
5.Air/ambient quality;
6.Urban regeneration;
7.Participatory planning and governance;
8.Social justice and social cohesion;
9.Public health and well-being;
10.Potential for new economic opportunities and green jobs.

In addition to these ten challenges, there are six interventions determined by the European Commission for Nature-based solutions implementation;

1. Building-scale interventions
2.Interventions in the public space
3.Interventions in water bodies and drainage systems
4.Interventions in transport linear infrastructures
5.Interventions in natural areas and management of the rural land
6.Coasline/Cost interventions

2.2.3.1. Spatial Scale

We can classify nature-based solutions as spatial scale: Macro, Meso, and Micro scale. For macro-scale urban areas, we can give examples such as cities, villages, and surrounding hamlets, agricultural areas in rural areas, and wildlife forests as Landscape areas. Neighborhoods, streets, and avenues in urban areas on a mesoscale, hamlets in rural areas, agricultural areas, and parks in landscape areas can be examples. Finally, at the micro-scale, We can give examples of the building and their surroundings in urban areas, the house and their surroundings in rural areas, and gardens in landscape areas. (Table 3).

Table 3

Representative examination areas of Nature Based Solutions by Spatial Scale

	Urban	*Rural*	*Landscape*
Macro	City Region	The village is surrounded by hamlets and agricultural fields.	Forest
Meso	Neighborhood Street	Hamlet	Park Recreation
Micro	Building	House	Courtyard Vertical Garden

Notes. *Own work*

Table 4

Table prepared according to the DG Research and Innovation(European Commission) report by adding ten challenges and six interventions

	Makro			Mezo			Mikro		
Settlements	*U*	*R*	*L*	*U*	*R*	*L*	*U*	*R*	*L*
1. Climate mitigation and adaptation;	●	●	●	●			●		
2. Water management;	●	●	●	●	●	●	●	●	
3. Coastal resilience;	●			●			●		
4. Green space management	●	●	●	●	●	●	●	●	●
5. Air/ambient quality;	●			●			●		
6. Urban regeneration;	●			●			●		
7. Participatory planning and governance;	●			●			●		
8. Social justice and social cohesion;	●	●		●	●		●	●	
9. Public health and well-being;	●	●		●	●				
10. Potential for new economic opportunities and green jobs.	●	●		●	●		●	●	
1. Building-scale interventions	●	●		●	●		●	●	
2. Interventions in the public space	●	●		●	●		●	●	
3. Interventions in water bodies and drainage systems	●	●	●	●	●	●	●	●	●
4. Interventions in transport linear infrastructures	●	●		●	●				
5. Interventions in natural areas and management of the rural land	●	●	●	●	●	●	●	●	●
6.Coasline/Cost interventions	●			●			●		

Notes.*Own work*

2.2.3.2. Temporal Scale

On the temporal scale, Nature-Based Solutions need certain times according to the project's content. Considering the maturation and spread of green areas, it is observed that the project is concluded with the effect of the time factor. For example, while the effects of systems for the use of gray water can be observed in the short term, while the results of the studies to increase the air quality can be observed in the medium term, the effects of social strategies emerge in the long term. Therefore, Nature-Based Solutions should be planned as short-term (5 years), medium-term (10 years), and long-term (+10 years). Of course, the prolongation of this process should be considered as the maturation process of the maximum data; otherwise, the effect can be observed immediately after the Nature-Based Solutions applications, but this is the time required for it to reach the desired level. In addition, this time planning gives us the opportunity to determine our

priority / urgent needs so that the needs in the applications and the solutions produced for this can help us to create solutions by including the time factor. For example, when making a green roof plan, it is necessary to use gray water to meet the water requirement for the area, so our primary goal should be to set up systems to harvest water and then start the green roof project so when our green roof planning is finished, we can have a water harvest made with rain or gray water.

2.2.4. Methodology And Classification of Nature-Based Solutions

Specifying a general approach or classification for Nature-Based Solutions is challenging because each field is evaluated with its own conditions and needs and also projects are produced by creating solutions. However, when the literature is searched, it is known that there are some common approaches used by everyone. Hence, the methods used when determining the working areas of Nature-Based Solutions can be used for methodological approach and classification of solutions. In this section, we will first define a general methodological approach by determining which steps Nature Based Solutions should follow when applying to a project. Then, in the section, we will determine the general methodological approach and classification by including the ten challenges and six interventions determined by the European Commission for Nature-Based Solutions.

2.2.4.1 Methodological Approach of Nature-Based Solutions

It is necessary to deal with nature-based solutions in 3 stages: planning, implementation, and delivery. The planning phase consists of 7 steps. It starts with defining the objective of the study first. The second step is to determine the scale of the project (macro, meso, micro) and determine the analysis level accordingly. The third step is to collect the available information and categorize it according to the needs. The fourth step is to examine the urban typology and character in order to understand the project area. In the fifth step, the necessary analyzes are made to determine the natural features of the project area. The sixth step is to analyze the current and potential status of Nature-based solutions. In the seventh and last step, the development and evaluation of the field should be made by choosing Nature-based solutions. The planning phase should be completed due to the evaluation of these seven steps, and the Implementation phase should be started. The construction of the Nature-Based solutions determined during the implementation phase should be evaluated in the field. The delivery stage is the stage that includes the determination of strategies such as operating, maintaining, monitoring, and following; at this stage, the necessary training is given for the sustainable continuation of the projects prepared by the municipality, private company, or individual initiative.

2.2.4.1.1. Planning Phase

The planning phase consists of seven steps;
1-Defining Objectives: There are many solutions that provide different and various benefits in the application of Nature Based Solutions, so the main target should be determined, and the purpose of the study should be defined accordingly.
2-Selecting the analysis level: As we have mentioned before, Nature-Based Solutions can work at macro, meso, and micro scales with 5-10 year plans. Therefore, in this step, it is necessary to determine a project at what scale and for how long.
3-Information and data processing: Considerable European cities have their own data systems. It is necessary to examine whether this information is

the information or data required for Nature Based Solutions, so that time will be saved and other needed information and data will be determined.

4-Typology and Characterisation: Each settlement has its own characteristic feature, so it is necessary to analyze the typology and character of the settlements so that it can be determined which Nature Based Solution can be applied more efficiently. In addition, we need to understand the settlement in a more general method by making this step in economic and social analysis.

5-Diagnosis of the natural capital: The most important step is understanding nature and developing solutions accordingly. In this step, it is necessary to determine how nature works and what soil, vegetation, water presence, land shape, and climate type it has.

6-Analysis of the Nature-Based Solutions' available and potential: After completing these five steps, we need to analyze which Nature-Based Solution is available or if there are areas with potential. In this step, even if the project area is at a micro-scale, a general examination of the settlement should be made by including analyzes at macro and meso scales, potential areas should be determined, and it is necessary to provide advantages for future studies, and to foresee the problems that may occur.

7-Selecting and assessing the measures: In the last step, appropriate ones should be selected from the ten challenges and six interventions determined by the European Commission for Nature-Based Solutions.

2.2.4.1.2. Execution Phase

The seven steps, which were completed during the execution phase, should be studied in detail during the implementation phase and tested in the field. The compatibility of the design and analysis with the field studies should be checked, and the systems that need detailed design should be rearranged. Another important point of this stage is that evaluations should be made with analyzes such as cost-benefit so that how the current economic situation is affected and its sustainability should be checked. It has an important place at this stage in making an evaluation for the contractor company that will carry out the application. After these steps, the project can be started, and the design can be constructed.

2.2.4.1.3. Delivery Phase

In the project implementation phase, training is the most critical step for the sustainability of the project after delivery. It is necessary to continuously monitor Nature Based Solutions and to ensure that the system is maintained with new solutions after various malfunctions, so it should be ensured that the project will be able to cope with the problems that will occur in the future with the training to be given.

2.2.4.2. Classification of Nature-Based Solutions

In the methodological approach of Nature Based Solutions, we mentioned that suitable solution methods should be selected in the seventh step of the planning phase. In addition, it was stated in the previous sections that Nature-Based Solutions would use ten challenges and six interventions determined by the European Commission when classifying them. In this section, these articles will be examined in detail.

2.2.4.2.1. Challenges of Nature-Based Solutions

Nature-Based Solutions is expected to struggle with ten identified challenges. These are;

1-Climate Mitigation and Adaptation: Today, in the cities of developed countries, the quality of life is decreasing due to climate change, air pollution,

urban heat islands, floods, disasters, Etc., faced with such situations. Another effect of these events is that they directly affect biodiversity (Grimm et al., 2008). The effect of global warming on carbon emissions is city-based. Therefore, it is necessary to resist climate change by taking measures for carbon reduction and greenhouse gas control (UNFCCC, 2016).

Climate resilience is associated with two concepts: 'adaptation,' that is, responding to and adapting to stress, and 'mitigation,' that is, reduction through measures taken as a result of an event. Therefore, the methods that can be applied can be realized as adapting to fight against climate resistance or mitigating the problems. In addition, the methods applied in other substances contribute directly or indirectly to the fight against climate change (Table 5).

Table 5

Potential actions for global climate mitigation and expected impacts

Potential actions	Expected impacts
• Increasing the area of (or avoiding the loss of) green space, particularly wetlands and tree cover, for both direct and indirect carbon storage.	• Carbon sequestration in vegetation and soil (Davies et al., 2011; Pataki et al., 2006). • Reducing the temperature at meso or microscales, thus decreasing the energy demand for cooling, especially in warmer climates, and reducing associated carbon emissions (Akbari, 2002). • Increased flood regulation (meso or microscale impact) (Pregnolato et al., 2016).
• Maximizing the net sequestration of carbon through species selection and management practices i.e. improving mitigation as well as choosing species that are adapted to future conditions.	• Climate change mitigation and carbon storage by vegetation, including carbon stored in soil (Davies et al., 2011; Pataki et al., 2006). • Improved air quality (mesoscale impact) (Baró et al., 2014).

Notes. *EKLIPSE (2017).*

Table 6

Potential climate adaptation actions at the meso and microscale and expected impacts

Potential actions	Expected impacts
• Increasing the area of (or avoiding the loss of) vegetation and particularly tree cover. • Increasing green walls and roofs to cool down the city through outdoor energy management using shading and the latent heat of evapotranspiration of plants and soils.	• Maximize cooling effect by evapotranspiration and shading, thus reducing local temperatures and ameliorating heat island effects and heat stress (Alexandri and Jones, 2008; Fioretti et al., 2010; Kazmierczak, 2012). • Securing long-term carbon storage in vegetation and soil and avoid carbon emissions from land-use changes (global impact). • Increased energy savings at building and street level through the insulating effect of plants (Alexandri and Jones, 2008; Zinzi and Agnoli, 2011). • Reducing wind speed and thus wind chill in cold climates.

Notes. *EKLIPSE (2017).*

2-Water Management: Population growth and industrialization in cities affect the rate of clean water per capita. Therefore, it is important to control and manage the quality and quantity of water resources. Water resources and use in cities should be managed by various classifications. Today, with water harvesting, rainwater and wastewater should be collected, and studies should be carried out for their reuse. Rainwater can be collected through water harvesting projects that can be applied, especially in cities that receive heavy rainfall. Used wastewater, which defines as gray water, can be treated and reused, or it should be reused by storing it for areas such as gardens, agricultural areas, and plant irrigation.

Table 7

Potential water management actions and expected impacts

	Reduce Run-Off	Flood peak reductions/Increase in time to peak	Reduce load from run-off into sewerage systems	Reduce risk of flooding from flash-floods.	Reduce costs related to loads into sewerage systems	Reduce risk of flooding from rivers.	Increase infiltration/water storage	Enhance water retention capacity in the area	Reduce risk of damages from drought	Increase evapotranspiration	Reduce risk from urban heat island effect	Improve human health	Increase human well being	Improve water quality/reduce pollutants	Increase biodiversity	Increase carbon storage capacity
*Type of actions**	*P*	*P*	*P*	*I*	*I*	*I*	*P*	*S*	*I*	*P*	*I*	*S*	*S*	*S*	*S*	*S*
• Renaturing urban waterbodies (opening channels, de-culverting, increase vegetation, greening waterfronts).		●				●	●			●	●	●	●	●	●	●
• Use of vegetation in urban areas (e.g. street trees, grassland, green roofs and facades, infiltration gardens and urban forests).			●	●	●		●	●	●	●	●	●	●	●	●	●
• Creation of artificial waterbodies for short term temporal water storage.	●	●	●	●	●			●	●				●			
• Creation of new vegetated surface waterbodies (ponds, drains, lakes, bio-retention cells).	●	●	●	●	●		●	●	●	●	●	●	●	●	●	●
• Creation of new subsurface waterbodies for water storage.	●	●	●	●	●		●	●	●							
• Create areas for temporary flooding along rivers (floodplains) by moving flood protection infrastructures.	●					●				●			●	●	●	●
• Restore/create/increase wetlands in river basins.	●					●	●	●	●	●				●	●	●

***Notes**. The letters represent the categories of indicators as defined in the DPSIR Framework (see Gabrielsen and Bosch, 2003) P – Pressure indicators, I – Impact indicators, S – State indicators*

3-Coastal Resilience: Water resources are the areas where residential areas are most concentrated. One-third of the world's population lives in coastal areas. While coastal areas make an essential contribution to biodiversity ecologically, they also have economic and social benefits (Barbier, 2013). On the other hand, Nature-Based Solutions should offer measures to sustainably maintain and protect these advantages of coastal areas. It should also consider economic and social values while offering solutions, especially on water erosion and coastal resilience (Narayan et al., 2016).

Table 8

Potential coastal resilience actions and expected impacts

Potential actions	*Expected impacts*
• Use NBS against coastal storms and sea level rises (Yepsen et a., 2016) and protect the population from these risks in combination with engineered structures (Stark et al., 2016).	•Increased population and infrastructures protected by a cost-effective creation of NBS (Cohen-Shacham et al., 2016) and increased resilience of cities.
• Promote various NBS in coastal areas that can maintain or restore valuable coastal ecosystems and coastal biodiversity (Barbier, 2013).	• Better protection and restoration of coastal ecosystems including valuable species and habitats (Gedan et al., 2011).
• Integrate development and conservation objectives using a better quantification of ecosystem services (Piwowarczyk et al., 2013).	• Sustainable development of coastal regions and reduced conflicts over resources or landuse (Narayan et al., 2016).

Notes. *EKLIPSE (2017).*

4-Green Space Management: Green and blue areas refer to areas in cities based on natural and semi-natural elements such as parks, gardens, forests, rivers, and wetlands. These areas provide a range of benefits to the community, including ecological, economic, and societal benefits. They can help improve the sustainability and resilience of urban areas by providing ecosystem services such as water filtration, carbon sequestration, and wildlife habitat.

Green and blue spaces are important to urban planners as they can help create a sustainable urban structure and contribute to a community's cultural and social fabric. It provides recreation, social interaction, and education and supports healthy living. They are also valuable for urban biodiversity, providing resources and habitat for species and improving functional and structural connectivity at the urban level. It is important for cities to strategically plan and manage green and blue spaces through the use of green space management plans that take into account local conditions and practices and take into account the needs and access of local people. These plans may be based on national and European strategies and frameworks as well as local governance plans. On the other hand, Nature-Based Solutions work to protect these areas and provide social and economic benefits (Andersson et al., 2014).

Table 9

Potential air quality actions and expected impacts

Potential actions	*Expected impacts*
• Inventories, hierarchizing and representation of green and blue spaces (e.g. Mapping and Spatial Planning) (Buijs et al., 2016; Davies et al., 2015; Hansen et al., 2015; Martos et al., 2016).	• Clear accounts of existing, restored, modified and new NBS (Buijs et al., 2016; Buizer et al., 2015; Elands et al., 2015).
• Set clear and measurable quality and quantity requirements for existing and new NBS (Mazza et al., 2011; Pinho et al., 2016).	• Increase of quality and quantity of green and blue existing, restored and new NBS (Gómez-Baggethun and Barton, 2013).
• Make use of innovative, interdisciplinary planning methods for green space co-design and coimplementation, including development of innovative social models for long-term positive management (e.g. Citizen Engagement for Health) (Derkzen et al., 2015; Fernandez et al., 2015).	• Increased stakeholder awareness and knowledge about NBS and ecosystem services, as well as citizen participation in the management of NBS (Filibeck et al., 2016; Hansen et al., 2015; Mell et al., 2013).
• Create, enlarge, fit out, connect and improve green and blue infrastructure by implementing NBS projects (Kazmierczak and Carter, 2014; Landscape Institute, 2009; Madureira et al., 2011).	• Improve the connectivity and functionality of green and blue infrastructures (Brown et al., 2015; Niemelä, 2014).
• Conserve, improve and maintain existing NBS areas in respect to biodiversity (Elands et al., 2015; Elmqvist et al., 2015).	• Increase achievement of biodiversity targets (Elands et al., 2015; Elmqvist et al., 2015).

Notes. *EKLIPSE (2017).*

5-Air/Ambient Quality: Air quality is a significant concern in urban areas, as poor air quality can have severe consequences for human health. Air quality issues are often linked to climate change mitigation policies, because many actions that improve air quality, such as reducing fossil fuel combustion, also reduce greenhouse gas emissions..

Green infrastructure, which includes natural and semi-natural elements such as vegetation, can improve air quality by removing pollutants through dry deposition and lowering air temperature, which slows the formation of secondary pollutants such as ozone. While green infrastructure does not contribute significantly to overall pollutant and greenhouse gas emissions at the city level, it can be considered a good investment due to its many side benefits and long-term contribution to facility value (Baró et al., 2015).

6-Urban Regeneration: Urban transformation refers to the revitalizing and rejuvenating process of urban areas experiencing decline or lack of investment. This can include a range of activities, including economic development, physical remediation, social and community building, and environmental remediation. The aim of urban renewal is to improve the overall quality of life in the area and make it more attractive and functional for residents, businesses, and visitors.

One of the critical aspects of urban transformation is the need to consider the interconnections between different aspects of urban development, such as design and aesthetics, urban structure, and environmental sustainability. For instance, the inclusion of green spaces and other features that pro

mote environmental health and sustainability can help create more livable and attractive communities. Additionally, improving a district's design and aesthetic appeal can foster a sense of pride and community among residents, reducing crime and promoting social cohesion.

Overall, urban regeneration is a complex and multifaceted process that requires careful planning and consideration of the needs and wants of the community. Cities that take a holistic approach that considers the economic, social, and environmental dimensions of urban development can work to create vibrant and sustainable communities that are attractive and liveable for all. (Hansen et al., 2016).

7-Participatory planning and Governance: In the context of urban planning, NBS may include incorporating green spaces and other natural elements into the built environment to provide a range of ecosystem services such as air purification, flood control, and habitat for wildlife.

Table 10

Potential urban regeneration actions and expected impacts.

Potential actions	*Expected impacts*
• Enforce micro-scale and cross-scale interactions, consider urban hinterland and "distant landscapes" sensu Andersson et al. (2014). • Increase ecological connectivity across NBS sites. • Enhance biodiversity and community engagement (e.g. creating community gardens or pocket parks). • Design rain gardens or facade greening systems.	• Greater ecological connectivity across urban regeneration sites, and across scales. • Increased extent of greenery on urban facades.
• Support energy efficiency in building design and layout, building form, infiltration and ventilation, insulation, heating and lighting (Hemphill et al., 2004).	• More energy efficient building design and long-term use. • Reduction in the amount of building material going to landfill.
• Encourage re-use of building materials in new construction and promote efficient use of resources, materials, and construction techniques that maximise the effective life-cycle of the building (Hemphill et al., 2004).	• Reduced use of energy in the production of building materials and the construction of new buildings.
• Convert brownfield to green areas in urban regeneration projects (Mathey et al., 2015). • Design for: o richness in urban environments, such as the promotion of street life, natural surveillance, visual richness, public art, and street furniture (Biddulph, 2011); o diversity in use, such as mix of people, mix of uses, appropriate densities and visual diversity (Biddulph, 2011); o ease of movement, including through movement, priority given to public transport, priority given to innovative parking, meeting needs of people with sensory impairments (Biddulph, 2011).	• Local citizens have a say in the design and management of homes and office buildings, contributing to social justice outcomes. • Increased amount of green open space for residents. • Increased cultural richness and diversity in urban areas, as well as improved ease of movement.
• Provide the urban brand with a narrative and a value aimed at changing the perception of potential users or visitors, whether they are citizens, international tourists or investors.	• Changing images of the urban environment, attracting new residents, visitors, tourists and investors.

Notes. *EKLIPSE (2017).*

Effective planning and governance of Nature-Based Solutions require the integration of different types of knowledge and expertise, including the perspectives and needs of citizens and other stakeholders. It is also important to consider the interests and perceptions of different groups in order to develop Nature-Based Solutions that are acceptable and supported by the community. Further, the integration of ecosystem thinking into urban planning can help ensure Nature-Based Solutions are designed and implemented in ways that promote the long-term sustainability of natural systems and their capacity to benefit people and the environment. Overall, the integration of Nature-Based Solutions into urban planning can help create more livable, healthy, and sustainable communities for all (Hansen et al., 2016).

Table 11

Potential urban regeneration actions and expected impacts

Potential actions	*Expected impacts*
• Design knowledge co-production processes to bring openness, transparency in governance processes, and legitimacy of knowledge from citizens/civil society, practitioners and policy stakeholders (Crowe et al., 2016; Frantzeskaki and Kabisch, 2016; Specht et al., 2016). • Create different institutional spaces for cross-sectoral dialogue and interactions of different stakeholders for strengthening/fostering adaptive co-management and knowledge sharing about urban ecosystems (Crowe et al., 2016; Dennis and James, 2016; Fors et al., 2015; Frantzeskaki and Tilie, 2014; Ugolini et al., 2015). • Enable cross-sectoral partnerships for NBS design, implementation and maintenance (Crowe et al., 2016; Krasny et al., 2014; Specht et al., 2016; Ugolini et al., 2015).	• Legitimate different forms and systems of knowledge in participatory planning processes, empowering citizens/civil society, practitioners and policy stakeholder involvement in NBS projects. • Social learning about the location and importance of different types of sociocultural values for NBS, enabling NBS to be designed in line with community aspirations and expectations. • Policy learning leading to more efficient design, delivery, and monitoring of NBS. • Inter-departmental collaboration leading to NBS designs for multi-functionality. • Improved co-ordination of NBS strategies within and across levels of governance.
• Support processes that enrich or regenerate ecological memory for restoring urban ecosystems with NBS (Colding and Barthel, 2013).	• Improved understanding of different perceptions of urban nature. Integration of these understandings into urban design is likely to lead to higher levels of ownership of NBS by local communities.
• Promote and work towards creative designs of NBS in cities that are adaptive over time (Collier et al., 2013; Vandergert et al., 2015).	• NBS that are flexible to changing environmental, social or economic conditions.
Support community-based projects on greening and restoring urban green spaces that also ensure accessibility to these spaces and stewardship (Dennis and James, 2016; Krasny et al., 2014).	• Increased accessibility to green open space, supporting social justice outcomes.

Notes. *EKLIPSE (2017).*

8-Social Justice and Social Cohesion: Social justice refers to the fair and equitable distribution of resources, opportunities, and privileges within a society. It is concerned with ensuring that all members of a society have the opportunity to participate fully and contribute to the well-being of their community. In the context of green infrastructure planning, social justice considerations are important to ensure that

the benefits of green spaces and other nature-based solutions are equally distributed and accessible to all members of society, regardless of their social or economic status.

Environmental justice is a related concept that focuses on ensuring that the adverse effects of environmental degradation and resource depletion are not disproportionately borne by disadvantaged or marginalized groups. This may include addressing issues such as the unequal distribution of environmental hazards and the lack of access to clean and healthy living environments in some communities.

Promoting social cohesion in urban areas is also an essential aspect of social justice. Social cohesion refers to the bonds and connections that exist within a society and the degree to which individuals feel a sense of belonging and mutual responsibility towards each other. It can be influenced by structural factors such as the economic, political, and social structures of society and by cognitive factors such as shared values and beliefs. Promoting social cohesion may include fostering supportive processes, intercultural understanding, and dialogue that enable people from different backgrounds to feel comfortable and involved in their living environment (De Vries et al., 2013; Leikkilä et al., 2013).

Table 12

Potential social justice and social cohesion actions and expected impacts.

Potential actions	Expected impacts
• Distribute various types of NBS across urban areas to ensure a range of ecosystem services and experiential qualities of place are available to people from different socio-economic backgrounds (Raymond et al., 2016b).	• A greater diversity and number of people having the opportunity to experience and enjoy the natural environment through investments in NBS in multiple areas (Natural England, 2014).
• Support experiential learning and capacity building programs on NBS in ways that meet the varying requirements, rights and duties of local residents (Krasny et al., 2013).	• An increase in communities' sense of ownership of local natural places (Natural England, 2014). • More people having opportunities for learning about nature and gaining new skills; building trust, tolerance and respect between groups.
• Actively engage excluded social groups in the design, delivery and monitoring of NBS, as well as in the rules to support the governance of NBS.	• NBS designed, delivered and monitored in ways that reflect the needs and interests of typically excluded social groups.
• Build the capacity of typically excluded groups to participate in NBS decision-making processes. Capacity building can include efforts directed to improving basic literacy and numeracy, physical security, employment, information and recognition as a citizen (Rutt and Gulsrud, 2016).	• Typically excluded groups having the capacity to actively engage in NBS decision-making processes, thereby supporting social cohesion among diverse socio-economic groups.

Notes. *EKLIPSE (2017).*

9-Public Health and Well-Being: Nature-based solutions can have a range of positive effects on the health and well-being of city dwellers. Urban green spaces such as parks, gardens, and trees provide a range of ecosystem services that can benefit human health and well-being. For instance, urban green spaces can help regulate the urban heat island effect, which can cause extreme weather events such as heat waves that can lead to premature death and disease (Barton & Grant, 2006). Urban green spaces can also help reduce exposure to environmental pollution by mitigating the urban heat island effect and reducing air and noise pollution (Madureira et al., 2015).

In addition to these physical health benefits, Nature-Based Solutions can also have positive psychological and physiological effects. Urban green spaces can provide opportunities for relaxation and stress relief and increase opportunities for physical activity, which can provide a range of positive health benefits, including reducing the risk of cardiovascular disease, improving pregnancy outcomes, and reducing obesity and diabetes. Urban green spaces can also provide opportunities for exploratory behavior in children and improve immune system functioning. While Nature Based Remedies can have many positive health and well-being benefits, it is also important to consider potential negative effects such as allergic reactions or vector-borne diseases. These potential adverse effects can be minimized by the appropriate design, maintenance, and management of urban green spaces and the selection of appropriate species. Cities can work to create more livable, healthy, and sustainable communities for all by carefully assessing the potential health and well-being impacts of Nature-Based Solutions (Lõhmus and Balbus, 2015).

Table 13

Potential public health and well-being actions and expected impacts

Potential actions	Expected impacts
• Distribute various types of urban green spaces as NBS across urban areas.	• Provision of health benefits and ecosystem services, which are available to people from different age groups and socio-economic backgrounds.
• Provide adequate urban planning and design mechanisms to ensure sufficient green space provision for positive health effects.	• A greater diversity and number of people having the opportunity to benefit from the positive health effects from urban green spaces.
• Design of urban green spaces, such as parks and playgrounds, should take in account the needs of children and the elderly while taking measures to minimize the risk of injuries.	• Improvement of opportunities for exploration by children and improvement of immune system already in children.
• Provide proper urban green space design, maintenance and recommendations to minimize trade-offs (allergenic pollen, transmission of vector-borne diseases).	• Decrease of detrimental effects of urban green spaces.

Notes. *EKLIPSE (2017).*

10-Potential for new economic opportunities and Green Jobs: Nature-based solutions can provide a range of benefits beyond those directly related to their primary environmental goals. These co-benefits can include increased real estate values, positive health impacts, improved water management, and recreational services. Nature-based solutions can be cost-effective and provide significant benefits to households and governments by addressing a variety of environmental problems in urban areas. (OECD, 2013).

In addition to these direct benefits, Nature Based Solutions can also create economic opportunities for "green businesses" and "green collar jobs," defined as jobs in the clean energy and environmental sectors. These jobs can range from low-skilled, entry-level positions to higher-skilled, higher-paying jobs and can be a significant source

of employment and economic development in urban areas. By promoting Nature-Based Solutions and the development of green businesses and green-collar jobs, cities can work to create more sustainable and economically vibrant communities (Apollo Alliance, 2008; Falxa-Raymond et al., 2013).

Table 14

Potential actions for supporting economic opportunities and green jobs and their expected impacts

Potential actions	Expected impacts
• Encourage methods to transfer the benefits of common goods provided by NBS to the initiators of NBS, e.g. through tax reductions or subsidies (Meulen et al., 2013).	• Increased willingness to invest as more of the cobenefits accrue to the initiator. • Increased competitive advantage for cities applying NBS measures (OECD, 2008). • Net additional jobs in the green sector fuelled by new green investments.
• Support vocational training programs to enhance skills in the design and delivery of NBS measures (Falxa-Raymond et al., 2013).	• Increased knowledge on NBS and the appropriate implementation of the NBS measures. • Individual earnings uplift arising from skills enhancement in the design and implementation of NBS.
• Increase knowledge and awareness on NBS in the urban environment for stakeholders and policy makers.	• Increase in implementation of NBS and associated employment as initiators become more familiar with NBS solutions. • Policy makers will develop an active approach towards NBS application within the public domain and infrastructure. • Policy makers will develop an active approach towards NBS application and possible provision of (co)financing arrangements for private properties. • Increased knowledge base, as more implementation of NBS will increase their application under diverse circumstances.
• Develop online NBS impact calculation tools.	• Increased awareness of NBS solutions and their effectiveness and (co)benefits. • Increased knowledge base on values of NBS impacts.
• Restore or plant green spaces or other NBS.	• Creation of green jobs relating to construction and maintenance of NBS (Saraev, 2012). • Benefits for work productivity including reduced absenteeism (Saraev, 2012). • Increased commercial (Gensler, 2011) and domestic property prices (Eftec, 2013; Forestry Commission, 2005; Luttick, 2000). • Attraction of businesses (Eftec, 2013). • Increased social interaction (see Challenge 8).

Notes. *EKLIPSE (2017).*

2.2.4.2.2. Interventions of Nature-Based Solutions

When classifying the application areas of Nature Based Solutions, where and how interventions can be made is an important step. For this, the six interventions determined by the European Commission will be a reference source for us. In this section, we will examine the six interventions in detail and categorize them as climate, environmental, social, and economical.

1-Building-Scale interventions: Buildings have various usage design opportunities due to their structures. Apart from the floors designed as living spaces, Nature Based Solutions approaches buildings with a more general perspective. Areas such as roofs, facades, and courtyards can be determined as the areas where Nature-Based Solutions can be applied.

Table 15

Building Scale Interventions

Green Roofs: Designing and Fitting out the Roofs Of Buildings			
Green Roof	In-Height Orchards	Fresh Rooftops	Rainwater Harvesting
Green Facades		*Naturing Community-Use Spaces*	
Green Facades and Vertical Gardens	Actions in Community Courtyards	Regreening Spaces Between Buildings	

Notes. *IUCN (2020).*

A green roof is a roof that is partially or entirely covered with vegetation. Green roofs can be used in residential, commercial, and industrial buildings. Green roofs can help insulate a building by reducing energy costs in winter and summer. By absorbing rainwater, it can reduce the load on the local stormwater infrastructure. Vegetation on a green roof can absorb pollutants and improve air quality. It can provide a habitat for birds, insects, and other wildlife. Also, green roofs can add visual appeal to a building and create a pleasant environment for people to enjoy. Two main types of green roofs are intense green roofs and extensive green roofs. Intense green roofs are typically thicker and can support a wide variety of plants, while extensive green roofs are more delicate and typically support only short, drought-tolerant plants.

In-height orchards, also known as vertical orchards or vertical farming, are a type of agricultural practice that involves growing fruit trees or other plants in a vertical configuration, often using artificial lighting and hydroponics. This method of growing plants can be used in urban areas where space is limited, or in environments where soil quality is poor or unavailable.In-height orchards have several potential benefits, including. Such as,Increased efficiency: Vertical farming can produce a large amount of produce in a relatively small space, making it an efficient use of land. Pesticide reduction: Vertical farming systems can be designed to minimize the need for pesticides since plants are grown in a controlled environment.Year-round production: Vertical farming systems can be designed to allow for year-round production, even in areas with har-

sh weather conditions. Water conservation: Vertical farming systems can use less water than traditional farming methods since water can be recycled and reused within the system. However, there are also challenges associated with in-height orchards, including the initial cost of setting up the system, the ongoing cost of artificial lighting and other inputs, and the potential for pests and diseases to spread more efficiently within a controlled environment.

Rainwater harvesting is the collection and storage of rainwater for later use. Rainwater can be collected from roofs, paved areas, or other surfaces and stored in various containers, including cisterns, barrels, or underground tanks. There are several benefits to rainwater harvesting, including. Rainwater harvesting can help conserve water resources, particularly in areas with limited availability. Using rainwater for irrigation or other non-potable purposes can save money on water bills. Rainwater harvesting can help reduce the demand for treated drinking water, saving energy and reducing pollution from treatment processes. Rainwater is typically pure and free of chemicals and minerals, making it ideal for use in irrigation or other non-potable applications. To effectively harvest rainwater, it is important to properly design and maintain the rainwater collection system. This may include installing gutter systems to collect rainwater from roofs, installing filters to remove debris and contaminants, and properly storing the collected water to prevent contamination.

A green facade, also known as a vertical garden or living wall, is partially or entirely covered with vegetation. Green facades can be found inside or outside buildings and can be used to add visual appeal, improve air quality and provide other environmental benefits. Green facades can help insulate a building, reducing energy costs in winter and summer. Vegetation on green facades can absorb pollutants and improve air quality. It can also provide a habitat for birds, insects, and other wildlife. Another critical point is that green facades can help reduce noise pollution by absorbing sound waves. There are a number of factors to consider when designing and maintaining a green facade, including the type of plants used, irrigation and fertilization requirements, and the structural support needed to hold plants in place. It is important that the green facade is designed correctly and maintained to ensure its long-term success.

Re-greening the spaces between courtyards or buildings shows comparable benefits. In particular, it can improve air quality, provide the opportunity for rainwater harvesting, and accordingly absorb rainwater, thereby reducing the burden on urban infrastructure. Another important point is that green spaces have positive effects on mental health. Economically, it contributes positively to property value.

2-Interventions in the public space: The areas where the effects of Nature-Based Solutions can politely be observed are public spaces, and the solutions made here provide social and economic benefits to the settlement. Even though the works accomplished in public areas are works prepared with the initiative of the municipalities, they are the areas that need to be protected with the awareness of the society so that the practices can be protected in a sustainable way with the cooperation of the municipality society.

Table 16

Interventions in the public space

Urban Street			
Street Furniture	Pervious Pavement	Comfortable Urban Places	Urban Micro-Climates
Urban Nature			
Allotment Gardens	Urban Parks and Urban Forests	Renaturing Abandoned Areas and Opportunity Plots	

Notes.*IUCN (2020).*

Every area and object in residential areas can be used for Nature-Based Solutions. We can think of this from the creation of systems such as the selection of street furniture from sustainable materials or the operation of street lighting with solar energy from the application of permeable pavements. In addition, considering the city's density, it is necessary to work on how to use the abandoned areas. Every area is valuable, and we need to evaluate it as potential areas that need to be developed for Nature-Based Solutions.

Nature-Based Solutions, creating community gardens in cities is an essential solution in social and economic terms. Allotment gardens, also known as community gardens or allotments, are small plots of land allocated to individuals or groups for the purpose of growing fruit, vegetables, and other crops. Allotment gardens are often found in urban areas and can provide a space for people to grow their own produce, participate in horticultural activities, and make community connections. Dedicated gardens can provide a source of locally grown fresh produce for individuals and families. Gardening can be a physically active activity that can improve health and well-being. Allotment gardens provide people with the opportunity to connect with their neighbors and form community connections. In addition, dedicated gardens can provide a space for people to learn about horticulture and environmental sustainability. To effectively manage an allotment garden, it is important to consider factors such as soil quality, irrigation, pests and diseases, and the needs of the plants being grown. It may also be necessary to establish rules and guidelines for the use of the assigned garden and to involve local people in the planning and management of the garden.Urban forest refers to trees, forests, and other vegetation in urban areas, including street trees, parklands, and green spaces. The most important benefit of urban forests is that trees and other vegetation can absorb pollutants and improve air quality in urban areas. It can be used as an important measure for flood disasters. Urban forests should allow for wildlife, and biodiversity should be increased with the habitat to be formed here.

3-Interventions in water bodies and drainage systems: In the context of water bodies and drainage systems, Nature Based Solutions can include the use of natural features such as wetlands, vegetation, and topography to manage water resources, reduce the risk of flooding and improve water quality. Nature Based Solutions can be an effective and cost-ef-

fective way to manage water resources and reduce the risk of flooding. It also has the added benefit of improving air quality, providing habitat for wildlife, and increasing the aesthetic value of an area..

Table 17

Interventions in Water Bodies and Drainage Systems

Natural			
Sustainable Urban Drainage Systems	Restoration of Ponds and Lakes	Renaturing Rivers and Streams	Controlled Flood Plains

Notes.*IUCN (2020).*

Sustainable urban drainage systems (SUDS) are designed to sustainably manage stormwater runoff in urban areas. SUDS aim to mimic the natural water cycle by allowing rainwater to seep into the ground rather than run off from hard surfaces and into drainage systems. This can help reduce runoff volume, improve water quality, and reduce the risk of flooding. With permeable pavement, it forms a drainage system by filtering rainwater and ensuring its passage to the soil. Also, ditches are shallow, vegetated channels used to convey and filter stormwater runoff. They can be used to manage the flow from roads, parking lots, and other hard surfaces. Floodplains are lands adjacent to rivers, streams, and other bodies of water that are prone to flooding. Protecting and managing floodplains can help reduce the risk of flooding and improve water quality by allowing floodwaters to spread and infiltrate the soil. Floodplains can be used to restore ponds and lakes by providing a natural buffer against flood waters and improving water quality through the filtering action of the soil. While SUDS can be an effective way to manage stormwater runoff in urban areas, it also provides additional benefits such as improving air quality, providing wildlife habitat, and increasing an area's aesthetic value.

In the context of pond and lake restoration, Nature-Based Solutions may involve using natural features such as vegetation, wetlands, and topography to improve water quality, reduce flood risk and provide habitat for wildlife. Wetlands are lands that are saturated with water for at least part of the year. They can be natural or built and can provide a range of benefits, such as reducing the risk of flooding, improving water quality, and providing habitat for wildlife. Wetlands can be used to restore ponds and lakes by providing a natural filter for pollutants and excess nutrients and increasing the diversity of aquatic plants and animals. Planting trees, shrubs, and grass on the edges of ponds and lakes can help stabilize shorelines, reduce erosion, and improve water quality by filtering out pollutants and excess nutrients. Vegetation can also provide a habitat for wildlife and increase the aesthetic value of the area.
4-Linear Transport infrastructures: Nature Based Solutions uses transportation systems to work in integration with green and blue infrastructure systems and to provide connections to green corridors. It is an important issue that it is not separated from each other in order to protect and develop the natural habitat; that is, it has not been interrupted. That's why linear transportation systems are essential for the connections of Nature-Based Solutions.

Table 18

Interventions in Transport Linear Infrastructures

Urban		
Greening Streets	Permeable Pavement	Greening High Capacity Transport Linear Infrastructures

Notes.*IUCN (2020).*

Green Street systems, are methods that have their own biodiversity and contribute to integration with other Nature-Based Solutions. Planting trees, shrubs, and grass along linear transport infrastructure can help stabilize the ground, reduce erosion, and improve air quality by absorbing pollutants. Vegetation can also provide a habitat for wildlife. Also, wildlife crossings are structures that allow animals to safely pass over or under linear transport infrastructure such as roads and railways. They can help reduce the impact of transportation infrastructure on wildlife by preventing animal-vehicle collisions and allowing animals to move freely in their habitats.

5-Interventions in natural areas and management of the rural land: Although Nature-Based Solutions are human-oriented systems that work with nature, they can be used in the protection and restoration of nature. It also offers solutions, especially in rural areas or where the human-nature relationship should be limited.

Table 19

Interventions in Natural Areas and Management of the Rural Land

Natural			
Natural Protected Areas	Wetlands	Periurban Parks	Rural Land Management

Notes.*IUCN (2020).*

The management, protection, and restoration of rural land and nature conservation areas are among the application areas of Nature-Based Solutions. With sustainable land use, land management can be done to meet the needs of people while protecting natural resources and ecosystems. This may include practices such as agroforestry, permaculture, and conservation agriculture that minimize the impact on the environment and promote the long-term health of the land.

The periurban park is around the city is an open space located on the outskirts of urban areas. They can provide city dwellers with a range of benefits such as recreation, relaxation, and contact with nature. Parks around the city can also help conserve natural resources and biodiversity, improve air quality, and reduce the urban heat island effect.

6-Coastline/Cost interventions: Coastal areas are vulnerable to a range of environmental, social and economic challenges, including sea level rise, co-

astal erosion, and the effects of human activities such as development and pollution. Nature Based Solutions has intervention techniques within coastal areas.

Table 20

Coastline / Coast Interventions

Natural			
Dune Restoration	Beach Regeneration	Salt Marsh and Coastal Wetland Regeneration	Creation of Oyster Reefs

Notes.*IUCN (2020).*

Dune restoration is the process of rehabilitating dunes that have been damaged or degraded. Dunes are important coastal features that provide a range of benefits, including protecting the coastline from storms and erosion, providing habitat for wildlife, and supporting the natural beauty of the area.

There are various approaches that can be used to restore dunes, including: Planting vegetation such as grasses, shrubs, and trees can help to stabilize the dunes and reduce erosion. Native plants are typically used in dune restoration projects because they are adapted to local conditions and are more likely to thrive. Adding sand to a dune can help to rebuild its height and width, which can be lost due to erosion or other factors. Sand can be added manually or through the use of heavy machinery. Fencing can be used to exclude animals such as rabbits and sheep from dunes, which can prevent them from damaging the vegetation and undermining the dune structure. Educating the public about the importance of dunes and the need to protect them can help to reduce the impact of human activities on dunes, such as trampling, littering, and off-road driving. Moreover, Beach regeneration is another method for protecting the coastline area. Such as fencing, educating the public, beach regeneration, and planting vegetation, as well as beach nourishment involves adding sand to a beach to rebuild its width and height, which can be lost due to erosion or other factors. Dune restoration and beach regeneration can help to protect the coastline, improve the quality of natural resources, and support the long-term health and well-being of local communities. It is important to carefully plan and execute dune restoration and beach regereneration projects to ensure that they are effective and have minimal impact on the environment.

Salt marshes and coastal wetlands are important coastal ecosystems that provide several benefits, including protecting coastlines from storms and erosion, improving water quality, and providing habitat for various species. These ecosystems can be damaged or disrupted by a number of factors, including sea level rise, coastal erosion, and the effects of human activities such as development and pollution. Several approaches can be used to revitalize salt marshes and coastal wetlands. Wetland restoration involves actively rehabilitating damaged or degraded wetlands. This may include techniques such as reforestation, replanting, and the creation of artificial wetlands to restore the natural ecosystem and its functions. Habitat enhancement involves improving the habitat quality of an area to support the growth and reproduction of native species. This may include measures such as planting vegetation, adding nest boxes or platforms, and reducing the impact

of human activities. Sustainable land use includes managing land to meet people’s needs while conserving natural resources and ecosystems. This may include practices such as agroforestry, permaculture, and conservation agriculture that minimize the impact on the environment and promote the long-term health of the land. Engaging local communities in the management of salt marshes and coastal wetlands ensures that interventions that are culturally and socially acceptable and sustainable in the long term might help.

Oyster reefs are formed when oysters attach themselves to a hard surface, such as a rock or a piece of artificial material, and begin to grow. Over time, these oysters will grow and multiply, forming a dense, interlocking structure known as an oyster reef. There are several ways to create oyster reefs, depending on the location and the resources available. One common method is to create a structure that can be placed in the water, such as a reef ball or a concrete block, and then introduce young oysters, or spat, onto the surface. These oysters will then attach themselves to the structure and begin to grow, eventually forming a full-fledged reef. Another method involves the use of natural materials, such as shells or old tires, which can be placed in the water and then seeded with oyster spat. This method can be more environmentally friendly, as it utilizes materials that are already present in the ecosystem. Creating oyster reefs can have many benefits, including improving water quality, providing habitat for a variety of marine species, and stabilizing shorelines. Oyster reefs are also an important food source for many animals, including humans. However, it is important to carefully consider the location and method of creation, as well as the potential impacts on the ecosystem, before embarking on a reef-building project.

Table 21

Eart of the Nature-Based Solutions are characterised in the following tables, according to the aforementioned criteria.The table shows how each Nature-Based Solutions contributes to reducing the effects of the climate threats dentified in Site Area.

Climate Threats	CT1	CT2	CT3	CT4	CT5	CT6	CT7
Buildings							
Green Roofs	1	1			3	2	
Green Facades,Vertical Gardens	2				3	2	
Naturing community-use spaces	2				3	1	3
Public Space							
Street Furniture	3					2	
Permeable Pavement	1	2	2		3	3	
Comfortable urban places	1	3			3	1	
Urban micro-climates						1	
Allotment gardens	1	2			2	1	3
Urban parks and urban forests	1	2	3		2	1	3
Renaturing abandoned areas	1	2	3		2	1	3
Water Bodies and Drainage Systems							
Sustainable urban drainage systems	1	1	1		2		
Restoration of ponds and lakes	1	2	3		1	2	
Renaturing rivers and streams	1	1	3		1	2	
Controlled flood plains	1	1	1				
Transportation Linear Infrastructures							
Greening streets	2	3			3	1	
Green linear infrastructures	2	3			3	1	
Natural areas and Management of Rural							
Natural protected areas	1	1		1	2	2	1
Wetlands	1	1			2	2	
Periurban parks	1	2			2	2	3
Rural land management	1	2			1	2	1
Coast							
NBS against the advancing coastline		2	1	1			

Notes: *The intensity of this contribution is shown on a scale of ; 3:Medium, 2:High, 1:Very High. CT1:Flooding due to extreme precipitations(pluvial flooding), CT2:Flooding due to rivers exceeding their capacity(fluvial flooding), CT3:Sea level rise, CT4:Waves,extreme swell, CT5:Drought, CT6:Temperature increase, CT7:Fires.*

Table 22

Environmental Co-benefits of the Nature-Based Solutions

Environmental Co-Benefits	EN1	EN2	EN3	EN4	EN5	EN6	EN7
Buildings							
Green Roofs	●					●	●
Green Facades,Vertical Gardens	●			●	●	●	
Naturing community-use spaces	●			●	●	●	●
Public Space							
Street Furniture				●	●	●	
Permeable Pavement	●	●			●		
Comfortable urban places	●			●	●	●	
Urban micro-climates	●						
Allotment gardens	●		●			●	●
Urban parks and urban forests	●	●		●	●	●	●
Renaturing abandoned areas	●	●	●	●	●	●	
Water Bodies and Drainage Systems							
Sustainable urban drainage systems	●	●	●				
Restoration of ponds and lakes	●	●	●			●	
Renaturing rivers and streams	●	●	●			●	
Controlled flood plains	●		●				
Transportation Linear Infrastructures							
Greening streets	●	●		●	●	●	●
Green linear infrastructures	●	●	●	●	●	●	
Natural areas,Management of Rural							
Natural protected areas	●	●	●	●	●	●	●
Wetlands	●	●	●			●	
Periurban parks	●	●	●	●	●	●	●
Rural land management	●	●	●			●	●
Coast Interventions							
NBS against the advancing coastline	●	●	●			●	

Notes: *EN1:Regulation of the water cycle, EN2:Improvement of the water quality, EN3:Improvement of the soil quality,stability and erosion, EN4:Improvement of the air quality, EN5:Improvement of the noise quality and comfort, EN6:Biodiversity, EN7:Carbon storage.*

Table 23

Social Co-benefits of the Nature-Based Solutions

Social Co-Benefits	SO1	SO2	SO3
Buildings			
Green Roofs	●	●	
Green Facades,Vertical Gardens		●	
Naturing community-use spaces	●	●	
Public Space			
Street Furniture			●
Permeable Pavement			
Comfortable urban places	●		●
Urban micro-climates	●	●	●
Allotment gardens	●	●	●
Urban parks and urban forests	●	●	●
Renaturing abandoned areas	●	●	●
Water Bodies and Drainage Systems			
Sustainable urban drainage systems	●		●
Restoration of ponds and lakes		●	●
Renaturing rivers and streams	●	●	●
Controlled flood plains		●	●
Transportation Linear Infrastructures			
Greening streets	●	●	●
Green linear infrastructures			
Natural areas,Management of Rural			
Natural protected areas	●	●	●
Wetlands		●	●
Periurban parks	●	●	●
Rural land management		●	●
Coast Interventions			
NBS against the advancing coastline		●	●

Notes: *SO1:Health and Quality Life, SO2:Recreation and Environmental Education Enhancing the Space for Social Gathering, SO3:Regeneration of Degraded Areas and Potential for Reducing Criminality and Improving the Connectivity of Urban Spaces.*

Table 24

Economic Co-benefits of the Nature-Based Solutions

Social Co-Benefits	EC1	EC2	EC3
Buildings			
Green Roofs	●		●
Green Facades,Vertical Gardens	●	●	●
Naturing community-use spaces			●
Public Space			
Street Furniture			●
Permeable Pavement	●		●
Comfortable urban places			●
Urban micro-climates			●
Allotment gardens		●	●
Urban parks and urban forests			●
Renaturing abandoned areas		●	●
Water Bodies and Drainage Systems			
Sustainable urban drainage systems	●		
Restoration of ponds and lakes			●
Renaturing rivers and streams			
Controlled flood plains			●
Transportation Linear Infrastructures			
Greening streets			●
Green linear infrastructures			●
Natural areas, Management of Rural			
Natural protected areas		●	●
Wetlands			●
Periurban parks		●	●
Rural land management		●	●
Coast Interventions			
NBS against the advancing coastline		●	●

Notes: *EC1:Reducing Energy Consumption, EC2:Improvement of Local Employment, EC3:Increasing the Value of Land and Property.*

2.2.5. Case Studies: Regeneration of urban green belts: Luttergrünzug, Bielefeld

Urban green belts are important for multiple reasons; They provide recreational opportunities such as walking, jogging, and picnicking, and they also help protect the natural environment by providing habitat for plants and wildlife. Green belts also help improve air quality and provide ecological connectivity, which is essential to the overall health of the ecosystem. Renewing urban green belts is important because it helps these areas continue to function effectively and deliver the intended benefits. This may include improving infrastructure such as walking and jogging paths and adding amenities such as playgrounds and ponds. It may also include efforts to protect and restore the natural environment, such as planting trees and other vegetation and creating wildlife habitats. Luttergrünzug in Bielefeld is an ideal example of a renewed urban green belt. It is located in the city and connects the eastern city center with the Heepen district. It is used by approximately 36,000 people for recreational purposes and provides significant ecological benefits. The local government decided to renovate Luttergrünzug to improve its rainwater retention and flood protection capacity, which will become increasingly important in the future due to the increasing rate of heavy rainfall events. (DTP, 2017).

Figure 11

Regeneration of urban green belts: Luttergrünzug, Bielefeld

Notes. *Urban Nature Atlas (2021).*

Table 25

Project Aim and Benefits of the Luttergrünzug, Bielefeld

Mitigation Benefits	*Urban Challenges Addressed*
• Cooling and Insulation • CO2 sequestration • Renewable energy production • Use pf low-carbon materials •Promotion of sustainable behaviors	• Air pollution • Heat island effect • Water scarcity • Rainwater drainage/runoff • Flood resilience • Ecological and social connectivity • Urban Upgrading • High energy use
Duration	*Financing Sources*
• Planning: September 2016 – ongoing; The first four measures are to be completed in 2020/21, and further measures from 2024 onwards (Uthmann,2018)	• EU level: European Water Framework Directive (EU WRRL) • National level: Public funding for urban development and Zukunft Stadtgrün Komminvest (Green Urban Futures Fund) • City level: INSEK urban development programme for the northern Inner city, waste- water fees from the City of Bielefeld; private funds (Uthmann,2018)
Component NBS	*Costs*
• Retention areas with specialized vegetation, dam ponds, individual trees	• Construction cost of the adopted variant is 5.8 million EUR; the planning cost is 1.2 million EUR.

Notes:*Urban Nature Atlas (2021).*

The renovation of Luttergrünzug in Bielefeld was initiated due to the aging of the green belt and the shortcomings it suffered, including alluvial ponds, conflicts between pedestrians and cyclists, and overgrown areas. The project also took into account the inputs of Bielefeld citizens who attended two workshops to provide feedback on the redesign and redevelopment of the area, as well as the requirements of the European Water Framework Directive on ecological connectivity and flood protection. DTP, the planning office responsible for the project, developed a framework concept for the redesign and redevelopment of Luttergrünzug, which was later adopted by the Bielefeld Committee for Environment and Climate Protection, except for the deepening of the area. As part of the new design, one of the reservoirs will be abandoned, and another will be upgraded and expanded to function as the new Luttersee. The framework concept also proposes to better integrate Luttergrünzug with its surroundings, improving road areas and entrances, quality of trails and open spaces, and ensuring safety, as well as enhancing the experience of water, leisure, sports, and other recreational opportunities. Further development of green spaces in the core area. The renovation of Luttergrünzug, in general, aims to improve the functionality and ecological value of the green belt for the benefit of the citizens of Bielefeld (Bielefeld, 2019).

Table 26

Urban Challenge Solution

Urban Challenges	Solutions
Air Pollution	The Luttergrünzug has a climatic compensatory function that contributes to the filtration of air (DTP,2017).
Heat Island effect	The Luttergrünzug, due to it is shape and geographical orientation, functions as an air duct and ventilation corridor for cold air; this reduces heat stress in summer periods (DTP,2017).
Water scarcity	The newly created Luttersee will increase the water surface of the Luttergrünzug (Bielefeld, 2019).
Rainwater drainage/runoff	The former dam pond 2, as well as the areas along the Lutter will be turned into biotope and species protection areas, which will improve its retention capacity; vegetation will include reeds and typical water accompanying woody plants (DTP,2017).
Flood resilience	The biotope and species protection areas will strengthen the flooding resilience of the Luttergrunzug.
Ecological and Social Connectivity	The Luttergrünzug will increasingly connect different green spaces to each other (e.g. the recreational focal points Sparrenberg in the west and Heeperholz in the east) (DTP,2017)
Urban upgrading	Different parts of the city will be better connected through, e.g. the separation of pathways and bikeways; the Luttersee will have a concentrated arrangement of restaurants with public toilets, a playground, a sunbathing area, and the Lutterterrace; the latter has already been built (DTP,2017).

Notes:*Urban Nature Atlas (2021).*

The framework concept for the renovation of Luttergrünzug divides the green belt into two main sections, the east and west sections, and divides these sections into smaller sections from A to D (Figure 12 and 13). Section C, or "LutterPark," will contain the new Luttersee, and adjacent allotment gardens will include a large green space if Section D or "LutterLandschaft." There will be various recreational opportunities in the eastern and western parts, including playgrounds and fitness areas. A cross-section of the deepening area of Luttergrünzug (Figure 14) provides more detailed information on what the regenerated areas will look like in the future, including the dimensions of the water surfaces and the type of vegetation to be used. It is important to have a clear plan for the renovation of Luttergrünzug to ensure that it meets the needs and goals of the community and continues to provide valuable ecological and recreational benefits to the citizens of Bielefeld.

Figure 12

The Western Part of the Luttergrünzug as envisioned in the framework concept.

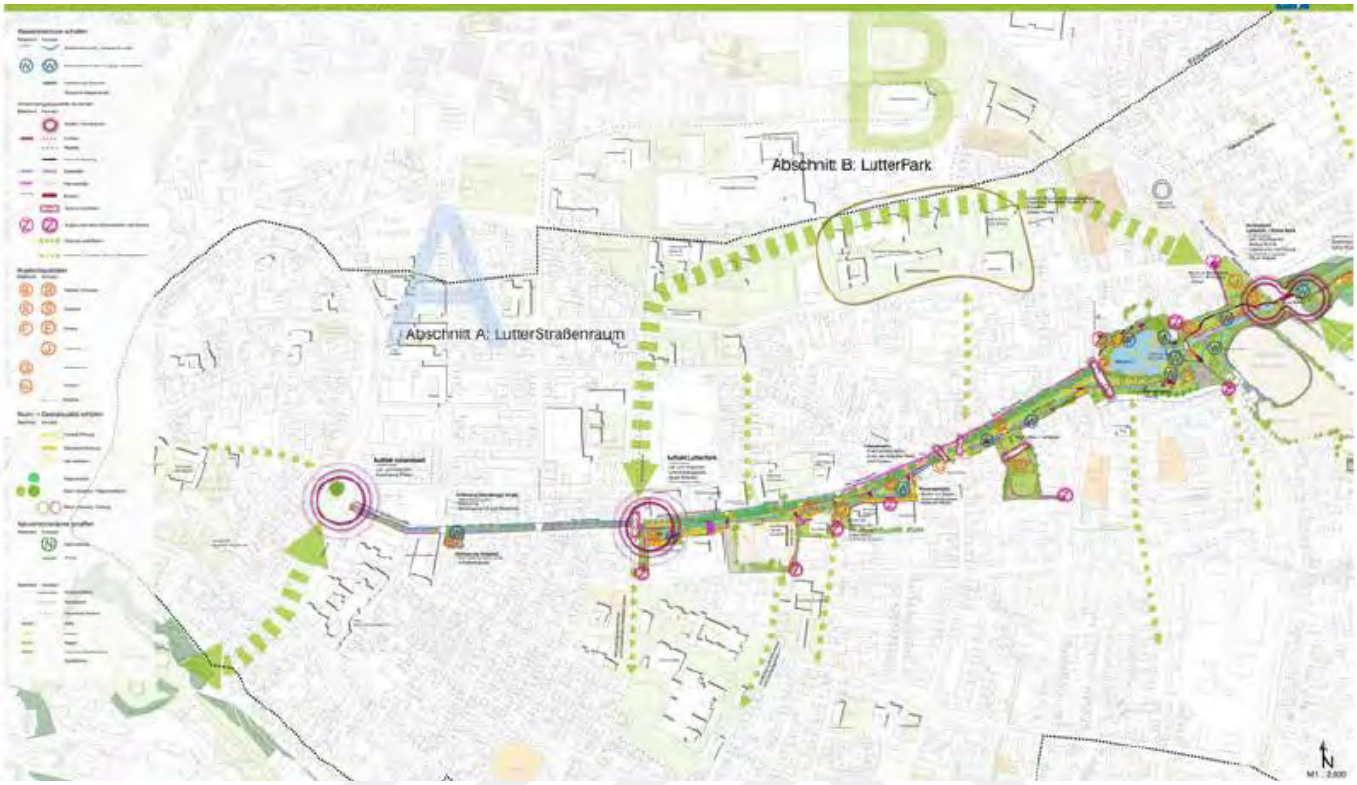
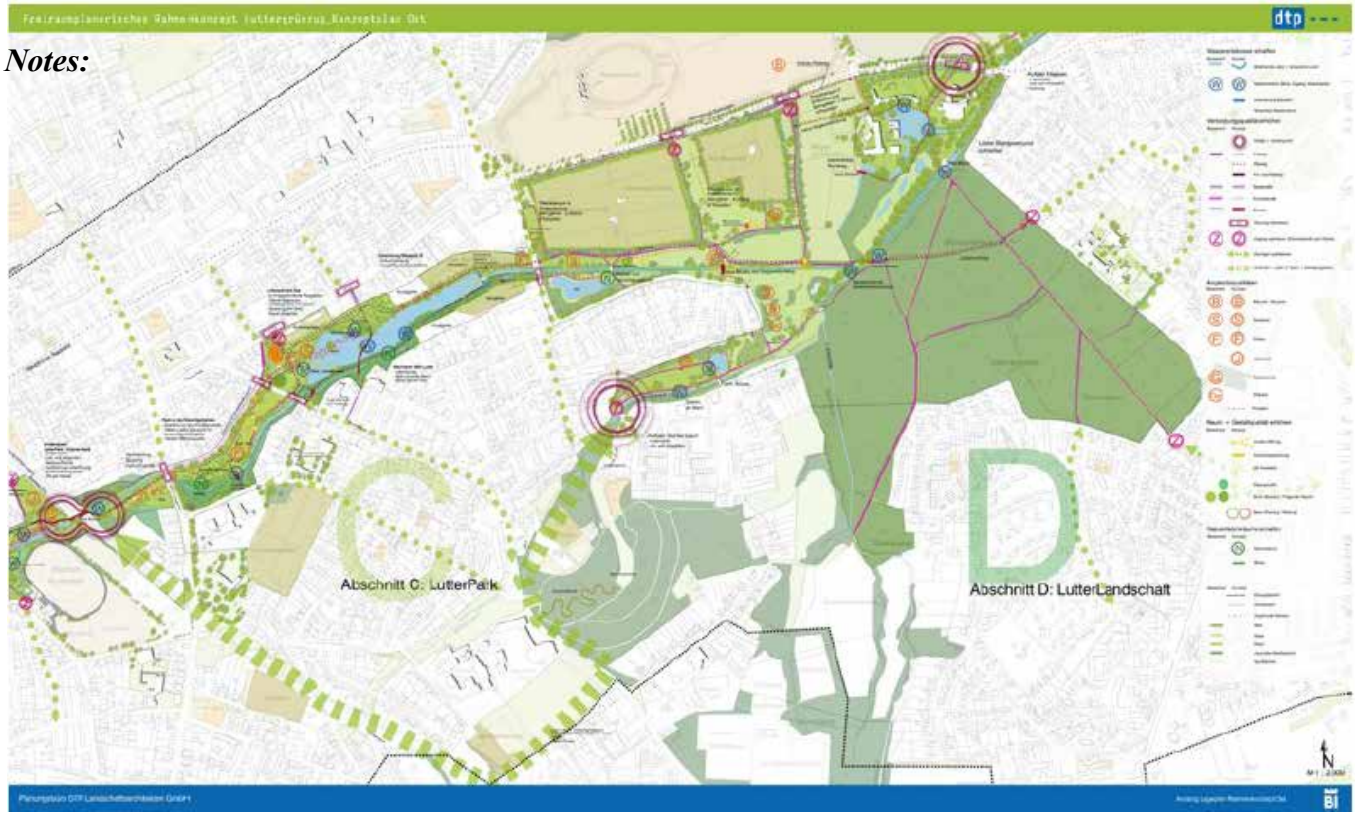


Figure 13

The Eastern part of the Luttergrünzug as envisioned in the framework concept.

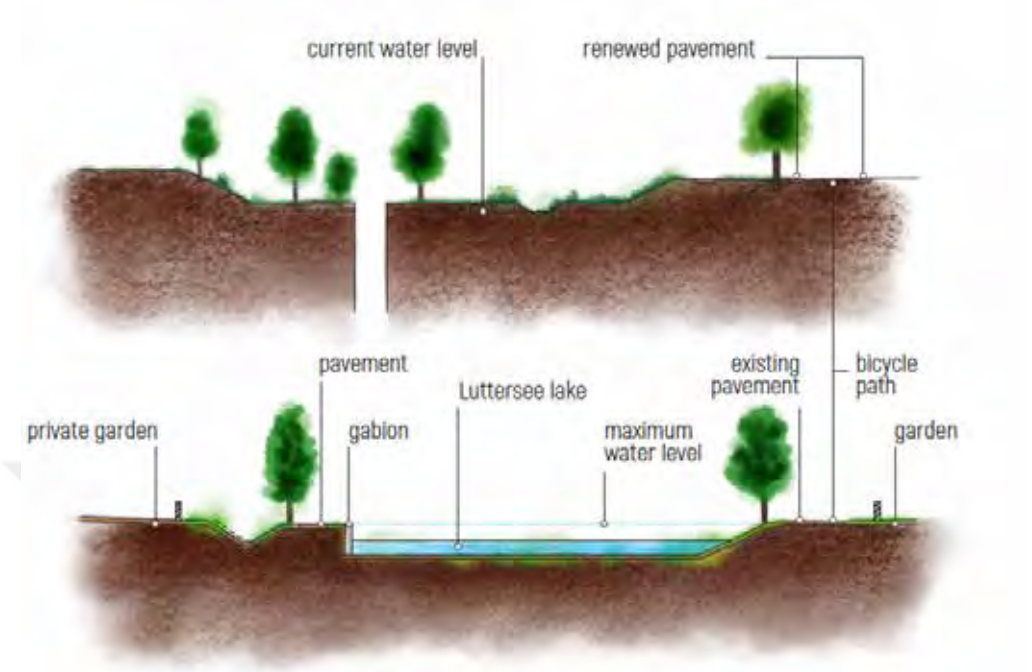


Notes:

Notes. *Urban Nature Atlas (2021).*

Figure 14

Cross-section of the deepening area of the regenerated Luttergrünzug(above).Park of between Lerchenstabe and Nachtigallstabe(below) (based on Planungsbüro DTB Landschaftsarchitekten GmbH



Notes.*Urban Nature Atlas (2021).*

2.2.6. Conclusion

Nature Based Solutions emerge as an essential field of examination among ecological solutions. The scope of the implementation area, the coexistence of a multidisciplinary field, and especially the fact that governance is the main executive in the studies have facilitated its relevance compared to other methods. In addition, some aspects of Nature-Based Solutions are neglected and need to be developed. Although the support and management of the works by municipalities and governments provide advantages in the field of application, the public needs to enter this process and internalize the projects, so the methods and classifications should be carried out by transferring them to the public at a level that the public can understand. One of the neglecting and most important aspects of Nature Based Solutions that need to be developed is the effect of the human factor before the implementation, the decrease after the implementation, and methods that improve the public's sense of belonging to the project should be developed. It is required to improve the benefits of the implementation area, especially by counting food production and social activities. For this reason, consideration should be taken to make it understandable to everyone by organizing the methodology and classification chapter in a straightforward and understandable literature review. Another critical point is that most of the studies are conducted in urban areas and focus on solving the problems there. Although urban areas are where nature is most hazardous in the existing situation, rural areas should not be ignored. It should be regulated in the form of increased food efficiency, especially in rural areas, and providing economic gain in rural areas. Nature-Based Solutions can have an essential role in rural development, as the economic gains of the people in the implementation of these methods in rural areas can increase development and reduce migration.

2.3. PERMACULTURE

In this section, we will comprehensively explain the what, why, and where questions in the general literature review by examining the existing studies on Permaculture. After this section, we will examine the ethical value perception of Permaculture, taking into account the socio-cultural impact of Permaculture. Afterward, the application methods and principles of Permaculture will be examined. In the last part, a sample project review will be done in order to better understand the information given in the literature review. In the last part, according to the information conveyed in the current literature review, Permaculture will be examined with a critical perspective, explaining its relationship with my thesis by giving conclusions about the positive areas or areas that need improvement.

2.3.1. What is Permaculture

Food supply and production are one of the most important needs of humanity. Permaculture essentially encompasses systems created to live in abundance and meet our own needs by establishing food production systems. In doing so, permaculture also strives not to make someone else's life miserable. When we look at the existing systems, it is seen how much destruction is done for production, and permaculture can increase it to a very high-efficiency level with much less energy and effort. To summarize, meeting the needs by blessing nature is the basis of permaculture (Bell, 2005).

The definition of permaculture was developed with the work of Bill Mollison in the mid-1970s, and its popularity increased with the book "Permaculture 1" published in 1978 by Bill Mollison and his student David Holmgren. The origin of permaculture is the creation of the self-sufficient plant and animal systems that take care of human benefit. Permaculture was formed by combining the word permanent agriculture. It is a method of creating a sustainable, permanent food source and planning it in a culturally suitable way for everyone. It is necessary to meet our own needs with practical knowledge, to include them in our daily life, and to have the accountability to fulfill our responsibility by accepting that there is a problem while doing this and being aware of many methods to solve this problem (Mollison, 1988).

Permaculture can also be interpreted as nature awareness. We can define it as observing nature, respecting the habitats of every living thing, and realizing that they work together. While doing this, the main point is to know what our needs are and how we should reduce our unnecessary uses. For instance, it is necessary to realize how much of the technological and scientific developments in the last 150 years have emerged in line with our needs, determine the essential parts for sustainability, and reduce the others. Of course, this discourse does not mean that it is against technology and scientific developments, but it argues that it should be used for our real needs (Bell, 2005).

Permaculture also creates systems by designing human settlements, thus creating a holistic ecological system, working on food production, structures, technologies, energy, natural resources, landscape, animal systems, plant systems, and social and economic structures, and creating solutions (Mollison, 1988).

2.3.2. Why do we need Permaculture

One of the main priorities of permaculture is food production in cooperation with nature. The food crisis in recent years has proven once again how important food is. In the first months of the

pandemic, we wanted to learn about many topics, from bread making to what we can produce at home. These months, which we consider as a temporary period, are actually very close to settling into our lives permanently. According to British scientist and Professor of Population Biology John Beddington, by 2030, those living will see a world that needs 50% more energy, 50% more food, and 30% more water. That's why we need food production in cooperation with nature, and we should do it wherever it can be produced. It is necessary for each individual to find this in these studies. Moreover, these production stages do not require us to learn basic learning methods. Much food production knowledge is passed on from generation to generation through experience and is generally known. Perhaps the most important thing to note here is the production model that provides at least three benefits and to produce with nature, not against nature.

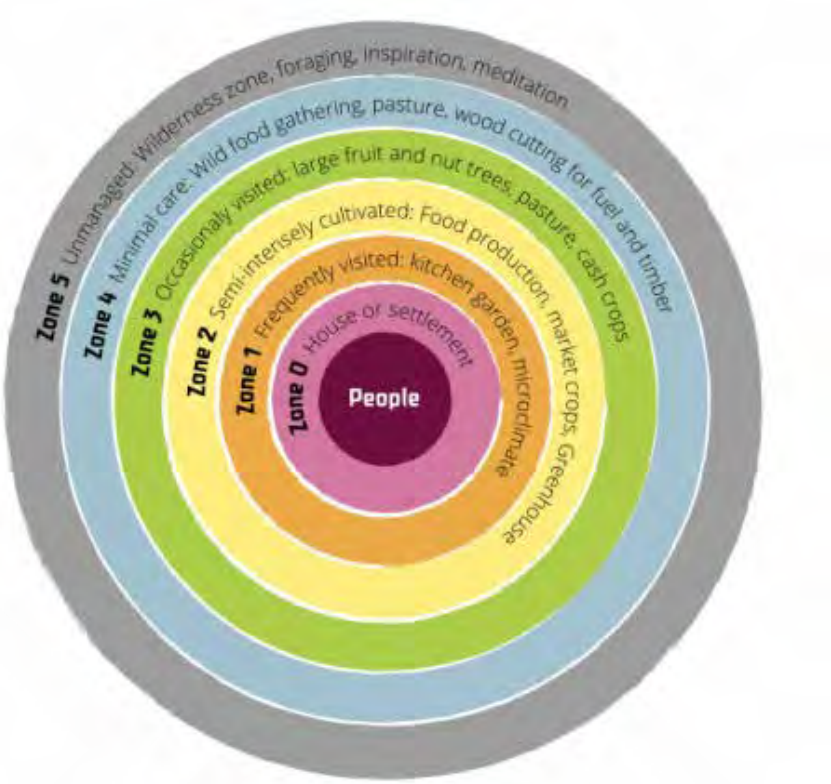
The problems that the world has experienced in the last 150 years have been mentioned in the previous sections. The issue that we need to pay attention to here will be the solutions we have to find as a result of these behaviors and how they can be done. The fact that many ecological solution proposals or green awareness concepts that have been implemented or tried to be implemented in recent years have remained only between the state or within some activist meetings does not mean that we do not need individual efforts for these problems. The environment and consumption of natural resources, which have increased in recent years, is everyone's responsibility. This consumption has serious consequences, such as climate change, destruction of natural habitats, and loss of diversity. Permaculture helps reduce this consumption and contributes to the conservation of natural resources. Also, permaculture makes people's lives more sustainable. This could mean people have the same or better quality of life with less energy and resource consumption. Permaculture also helps communities and individuals gain more self-confidence, which in turn makes people's lives better (Holmgren, 2020).

2.3.3. Where can permaculture be used

When the working areas of permaculture are examined, we see that it progresses in a similar way to other ecological working systems. Permaculture has the opportunity to work at all scales, from the smallest micro-scale to the global scale. However, an important feature that distinguishes permaculture from other systems is that the scale has to start from the micro. In this way, the designer starts his work by himself and expands over time according to the needs of the design field. In other words, permaculture recommends that we start with ourselves first, so our house, street, and neighborhood appear as important areas for us. In addition, nature is used as the greatest regulator in the philosophy of permaculture, so wildlife areas are stated as important and untouchable areas. For example, while it is possible to grow plants to be grown in pots in front of the window in the city center in accordance with permaculture, it is possible for the designer to expand the area according to his needs over time. The important thing in this system is that the integrated needs work in harmony with the existing system and work in continuous cooperation with each other. Permaculture has developed a system with working principles within itself, and zones are used according to this system. Our designs are determined thanks to these zones determined by our frequency of use (Holzer, 2011).

Figure 15

Permaculture Zone System



Notes: *These zones are; 0. Defined as the person itself and its home, 1. Frequently used areas such as our kitchen and garden, as the foods we frequently consume during the day are designed in this region, time loss for transportation is avoided. We encounter a vegetable that we need to collect for dinner from this region, 3. Seasonal fruit fields are here, we can think of them as an area that we use once a week or less, 4. Products such as trees and shrubs that we collect to meet our energy needs, which we use very rarely, are here, 5. Wildlife The field we call and should not be entered.*

2.3.4. What are the ethical values of Permaculture

Permaculture is a design philosophy and set of principles for creating sustainable human settlements and farming systems. It is based on observing and imitating natural ecosystems and aims to create self-sustaining, diverse, and productive environments that minimize waste and maximize resource use. Therefore, Permaculture wants to evaluate its establishment of ethical values and the observance of moral boundaries within its general philosophy (Mollison, 1988).

Permaculture consists of three main ethical values that it has determined. One of the most important ethical values is to care for the world. This value recognizes the interdependence of all living things and the need to protect and restore the natural environment. Permaculture practitioners aim to use resources in a sustainable and regenerative way and to minimize negative impacts on the world. This value recognizes the importance of diversity in ecosystems and communities and seeks to create systems that support and foster a wide variety of species and ecosystems. Permaculture practitioners strive to create diverse and flexible systems that can

adapt to changing conditions. In this way, he advises not only to make designs in line with his own needs but also to work on repairing, renewing, and transferring his environment to the future sustainably (Mollison, 1988).

Another ethical value of permaculture is to care about people. Permaculture seeks to create communities and systems that are egalitarian, diverse, and supportive of the well-being of all people. This includes meeting people's basic needs, such as food, shelter, and clean water, as well as promoting social and economic justice. Permaculture believes that, first of all, the social structure should be protected, developed, and developed together. Permaculture practitioners take responsibility for their actions and their impact on the environment and communities. This includes paying attention to the consequences of their choices and taking steps to minimize negative effects. As nature has diversity within itself, human beings have diversity among themselves, so she believes that these features should be used together for common purposes and mutual ethical values in order for everyone to benefit from each other to the maximum (Mollison, 1988).

The value of fair sharing, or "setting limits on population and consumption," is also an essential aspect of permaculture. This value encourages the idea of sharing resources and abundance rather than hoarding or over-consumption. Permaculture practitioners aim to live within their means and distribute resources fairly. permaculture encourages cooperation and collaboration rather than competition to create sustainable and resilient systems. This value recognizes that we are all interdependent and that working together is often more effective and productive than working alone. In fact, we know that many systems need fair sharing in order to protect and develop them and to develop a sense of belonging. Maintaining general order by promoting fair sharing in permaculture advises people to shift their needs from the individual to the social (Mollison, 1988).

In general, the ethical values of permaculture are based on the belief that we can create sustainable and equitable human settlements and agricultural systems that are in harmony with the natural world. By following these values, permaculture practitioners seek ways to create healthier, more resilient, and more equitable communities and ecosystems.

Figure 16

Permaculture Ethical Values

Notes:*Mollison (1988).*

2.3.5. What are the principles of Permaculture

Although the design principles of permaculture differ according to the projects, 12 design principles that we can accept as universal were determined by David Holmgren. Each principle appeals to specific purposes in itself, as well as supports each other holistically, and makes the design suitable for permaculture (Holmgren, 2002).

Figure 17

12 design principles of permaculture

Notes: *Holmgren (2002)*

The permaculture principle of "Observe and Interact" encourages individuals to take a closer look at their surroundings and actively engage with the environment in order to better understand it. This principle emphasizes the importance of learning from the natural world, as well as being an active participant in it. By observing the natural systems around us, we can learn how they function, how they're interconnected, and how they're affected by various factors such as weather, soil conditions, and the presence of different plant and animal species. This knowledge can then be used to inform our decisions and actions, such as where to plant certain crops, how to manage the land, and how to work with the natural systems to create a more sustainable and resilient environment. It also means being aware of the observations of others, and making sure to listen to the people who are working to live with the same environment. Engaging with the people who has been working in the area for long time, and learning from their experience also part of this principle. In practical terms, "observing and interacting" might involve taking regular walks through your property to see what's happening, keeping a journal to document changes over time, or experimenting with different gardening techniques to see which ones work best in your specific location. In permaculture design, the principle of observe and interact is a key step in the design process, it is used as a guide to understand the natural systems and the human factors around you, before making any decisions on the design and implementation of permaculture projects (Holmgren, 2002).

The permaculture principle of "Catch and Store Energy" refers to the idea of capturing and conserving resources that can be used to support life. This principle is closely connected to the con-

cept of creating a sustainable and resilient environment, as it emphasizes the importance of finding ways to harvest and use resources efficiently. In permaculture, this principle is often applied in the form of capturing and storing water, creating soil fertility, and preserving food. For example, one way to catch and store water is to design systems that slow down and spread out runoff, such as by creating swales and other earthworks that help to retain water on the property.

Another way is to collect rainwater and store it in cisterns or other water catchment systems for later use. Another way to apply this principle is to create soil fertility by using compost, mulch, and other organic matter to improve the soil's ability to hold water and nutrients. This can be done by adding organic matter from the surrounding area, or by using composting methods to break down organic materials. Preserving food also is part of this principle by preserving food in ways that allows to save them for future use. such as canning, pickling, drying, and fermenting can extend the life of food and make it available for consumption throughout the year. It's also important to remember that permaculture is not only about catching and storing energy, but also about reducing the overall energy needs and creating systems that are able to function independently, so that they can continue to produce food, water and other resources, even during times of stress or scarcity. In addition to that, this principle also includes capturing the energy from the sun, wind, and other sources, in order to create renewable energy systems. Such as installing solar panels, wind turbines, or small hydroelectric systems to generate electricity, or designing passive solar buildings that capture and store the sun's heat (Holmgren, 2002).

The permaculture principle of "Obtain a Yield" refers to the idea of designing systems that are able to produce valuable resources, such as food, medicine, fuel, and materials. This principle is important for creating a sustainable and resilient environment, as it ensures that there is a constant source of resources available for human use. In permaculture, this principle is often applied by creating diverse and multi-functional systems that are able to provide a range of different resources. For example, a permaculture farm or garden might include a variety of different crop species, such as vegetables, fruits, nuts, and herbs, as well as animals, such as chickens and bees, all of which can provide food, medicine, and other resources. It's also important to remember that obtaining a yield doesn't just mean producing food, it also includes other forms of yield such as social, cultural, ecological and financial yields. For example, a garden or farm can also provide other benefits such as improved mental and physical health, opportunities for community building and education, biodiversity conservation and financial returns. Permaculture design follows the principle that everything that's included in the design should have multiple functions and yields. Every element in a permaculture design should be carefully chosen to ensure that it can provide multiple benefits and yields, rather than just focusing on a single purpose or output. In addition to that, the principle of obtain a yield also encourages to focus on producing yields that are sustainable over time, and that regenerate the natural systems rather than depleting them. This principle, is also closely connected to the other permaculture principles, such as "Catch and Store Energy" and "Use and Value Renewable Resources and Services", which support the creation of systems that are able to produce resources in a sustainable and resilient way (Holmgren, 2002).

The permaculture principle of "Apply Self-regulation and Accept Feedback" encourages individuals to take a proactive and self-aware approach to managing their impact on the environment, and to be open to feedback and learning from their experiences. This principle emphasizes the importance of being aware of the effects of our actions and making adjustments as needed in order to create a sustainable and resilient environment. In permaculture, this principle is often applied by creating systems that are able to regulate themselves, such as by using natural processes to control pests and diseases, or by designing systems that are able to adapt and change as conditions change. For example, in permaculture gardening, using companion planting and crop rotation can help to control pests and diseases, while also improving soil fertility and crop yields. Similarly, creating a permaculture landscape design that mimics natural ecosystems can also help to create a self-regulating system that is able to adapt to changing conditions. Another important aspect of this principle is the ability to accept feedback and learn from experiences, and make adjustments as needed. The principle encourages individuals to be open to new information, willing to change their actions or strategies when feedback or observations indicates a need for it. Permaculture also encourages to have a close monitoring and observation of the systems and being open to new information and changes as they happen. Permaculture design process includes monitoring, evaluation and adjustment of the system over time, so that it can adapt to changes and challenges in the environment. It's also important to note that the principle of self-regulation and feedback is closely connected to the other permaculture principles, such as "Observe and Interact" and "Use and Value Renewable Resources and Services", as it relies on having a deep understanding of the natural systems and the ability to adapt and change as needed (Holmgren, 2002).

The permaculture principle of "Use and Value Renewable Resources and Services" encourages individuals to find ways to use resources that are replenished naturally, and to value the services that these resources provide. This principle is important for creating a sustainable and resilient environment, as it emphasizes the importance of using resources in a way that does not deplete them or cause harm to the environment. In permaculture, this principle is often applied by finding ways to use resources that are abundant, renewable, and locally available, such as solar energy, wind energy, water, and plant-based materials. For example, a permaculture property might include systems for capturing and storing rainwater, creating compost to improve soil fertility, or using solar energy to heat water or generate electricity. In addition to that, this principle also encourages valuing the services that these resources provide, such as clean air and water, pollination, pest control, and soil formation. It means that, in permaculture design, it is important to consider the role and function of each element in the system and how it contributes to the overall well-being of the ecosystem and the people. It also means promoting and supporting biodiversity, to ensure that the ecosystem services are not depending on a few specific species. This also includes using biological pest control methods, such as using predators to control pests, rather than chemical pesticides. The principle of using and valuing renewable resources and services is closely connected to other permaculture principles, such as "Catch and Store Energy" and "Obtain a Yield", as it relies on creating systems that are able to produce resources in a sustainable and resilient way. It also connected to the principle of "Apply self-regulation and accept feedback", as it encourages individuals to be aware of

the effects of their actions and make adjustments as needed to use resources in a sustainable way (Holmgren, 2002).

The permaculture principle of "Produce No Waste" encourages individuals to find ways to use all available resources, and to minimize waste and pollution. This principle is important for creating a sustainable and resilient environment, as it emphasizes the importance of using resources efficiently and reducing the negative impact of human activities on the environment. In permaculture, this principle is often applied by finding ways to recycle and reuse materials, such as composting food and yard waste, reusing greywater for irrigation, or creating systems for recycling paper, glass, and other materials. It also includes reducing the overall consumption and reducing the need for resources. By reducing consumption of energy, food and other resources, it helps in reducing waste at the source. In permaculture design, this principle is also applied by finding ways to use the by-products of one system as inputs for another, so that nothing goes to waste. For example, using compost to improve soil fertility, using chickens to control pests and till the soil, or using greywater to water plants. It's also important to remember that the principle of "Produce No Waste" is closely connected to other permaculture principles, such as "Catch and Store Energy" and "Use and Value Renewable Resources and Services", as it relies on finding ways to use resources efficiently and create closed-loop systems where waste is minimized. It also relates to "Apply self-regulation and accept feedback", as it encourages individuals to be aware of the effects of their actions and make adjustments as needed to reduce waste and pollution (Holmgren, 2002).

The permaculture principle of "Design from Patterns to Details" encourages individuals to start with a broad understanding of the relationships between different elements of a system, and then work their way down to the specifics. This principle is important for creating a sustainable and resilient environment, as it emphasizes the importance of understanding the big picture and the connections between different parts of a system. In permaculture, this principle is often applied by starting with an understanding of the patterns of the natural systems, such as the patterns of the sun, wind, and water, and the patterns of the land, such as the slope, aspect, and soil type. Once these broad patterns are understood, it is possible to start designing specific elements, such as gardens, orchards, and buildings, that work with these patterns. It also means, looking at the systems from different scales, from the landscape level, to the zone level, to the sector level, and then to the specific element level. By understanding the big picture and the connections between different parts of a system, it's possible to create designs that are more resilient and sustainable. Permaculture design process also follows this principle by using a holistic approach to design, considering the interconnection and relationship of each element in the system. This principle also encourages to use a "systems thinking" approach in design, which considers all parts of the system together, rather than just looking at one specific element or problem. It is also related to the permaculture principle of "Observe and interact", as it relies on having a deep understanding of the natural systems and the ability to identify the patterns that are present. In addition, it's also connected to other permaculture principles, such as "Catch and Store Energy" and "Use and Value Renewable Resources and Services", as it relies on understanding the patterns of resources and the connections between different parts of a system to design sustainable systems (Holmgren, 2002).

The permaculture principle of "Integrate Rather than Segregate" encourages individuals to design systems that are able to function as a whole, with each element connected to and supporting the others. This principle is important for creating a sustainable and resilient environment, as it emphasizes the importance of creating systems that are able to work together and support one another. In permaculture, this principle is often applied by designing systems that are able to use the outputs of one element as inputs for another, creating a closed-loop system where waste is minimized. For example, in a permaculture garden, plants that fix nitrogen in the soil might be grown alongside plants that require nitrogen, such as vegetables, so that the two systems can work together to create a more sustainable and resilient system. It also means, designing systems that are able to integrate the different elements to function together in the same space, such as having a vegetable garden and an animal system together, where the animals can help in fertilizing and tilling the soil, and the vegetables can provide food and shade for the animals. In addition, this principle also encourages to design systems that are able to integrate different functions into the same element, such as a multi-purpose building that is able to function as a residence, office, and workshop all in one, or a tree that is able to provide food, medicine, fuel, and shade all at the same time. This principle is also connected to the permaculture principle of "Design from patterns to details", as it relies on understanding the connections between different parts of a system, to create designs that are more resilient and sustainable. It also relates to other permaculture principles, such as "Catch and Store Energy" and "Obtain a Yield", as it encourages designing systems that are able to produce resources in a sustainable and efficient way, by connecting different parts of the systems together (Holmgren, 2002).

The permaculture principle of "Use Small and Slow Solutions" encourages individuals to start with small, simple solutions and gradually build complexity over time. This principle is important for creating a sustainable and resilient environment, as it emphasizes the importance of taking a gradual, step-by-step approach to designing and implementing systems. In permaculture, this principle is often applied by starting with small, easy-to-implement solutions, such as planting a small vegetable garden or building a simple rainwater catchment system, and then gradually building on these solutions over time. For example, a small vegetable garden can be expanded to include fruit trees and berry bushes, and eventually become a diverse food-producing system. This principle also encourages to test and observe the solutions before scaling them up, it means making sure that the solutions are working well before expanding them, so that issues can be identified and addressed early on. In addition, this principle also encourages to consider the long-term and the overall effect of the solutions, rather than focusing on quick fixes or short-term solutions. It also encourages to use incremental changes to reduce the risk and uncertainty, and to improve the adaptability of the solutions to changing circumstances. This principle is closely related to the permaculture principle of "Apply self-regulation and accept feedback", as it relies on being aware of the effects of our actions and making adjustments as needed. It also relates to other permaculture principles, such as "Catch and Store Energy" and "Obtain a Yield", as it encourages designing systems that are able to produce resources in a sustainable and efficient way, by taking a gradual and incremental approach (Holmgren, 2002).

The permaculture principle of "Use and Value Diversity" encourages individuals to design

systems that are able to support a wide range of different species and functions, and to recognize the value of this diversity. This principle is important for creating a sustainable and resilient environment, as it emphasizes the importance of creating systems that are able to adapt and change as conditions change. In permaculture, this principle is often applied by designing systems that are able to support a wide range of different plant and animal species, as well as different functions, such as food production, soil improvement, pest control, and habitat creation. For example, a permaculture garden might include a wide range of different crop species, as well as animals, such as chickens, bees, and butterflies, all of which can provide food, medicine, and other resources. It also includes promoting and supporting biodiversity, to ensure that the ecosystem services are not depending on a few specific species, and that the system is able to adapt and change as conditions change. In addition, this principle also encourages to recognize the value of diversity in terms of culture and society, by valuing the different perspectives and ways of life. It means creating space for different cultures, languages and ways of life, and respect and learn from them. This principle is closely related to the permaculture principle of "Integrate Rather than Segregate", as it relies on creating systems that are able to work together and support one another by having a diverse range of elements. It also relates to other permaculture principles, such as "Catch and Store Energy" and "Obtain a Yield", as it encourages designing systems that are able to produce resources in a sustainable and efficient way, by having a diverse range of species and functions (Holmgren, 2002).

The permaculture principle of "Use Edges and Value the Marginal" encourages individuals to design systems that make use of the unique and productive areas found at the boundaries and edges of different habitats, such as the intersection of a meadow and a forest, or the edge of a pond and a field. This principle is important for creating a sustainable and resilient environment, as it emphasizes the importance of recognizing and making use of areas that are often overlooked or undervalued. In permaculture, this principle is often applied by designing systems that make use of the unique microclimates, soils, and other resources found at the edges and boundaries of different habitats. For example, the edge of a pond might be a productive area for growing aquatic plants, while the transition zone between a meadow and a forest might be a good place to grow shade-loving crops. It also means recognizing the value of areas or elements that are often considered "waste" or "unproductive" such as wetlands, rocky outcrops, or even urban areas, and finding ways to use and value them in the design. In addition, this principle also encourages to design systems that make use of the unique ecological and social connections found at the edges and boundaries, such as the diverse ecosystem interactions, and the ability to connect different communities and cultures. This principle is closely related to the permaculture principle of "Use and value diversity", as it relies on recognizing the value of diverse and often overlooked elements, and finding ways to use and integrate them in the design. It also relates to other permaculture principles, such as "Catch and Store Energy" and "Obtain a Yield", as it encourages designing systems that are able to produce resources in a sustainable and efficient way, by making use of unique and diverse habitats and resources (Holmgren, 2002).

The permaculture principle of "Creatively Use and Respond to Change" encourages individuals to design systems that are able to adapt and

change in response to changing conditions. This principle is important for creating a sustainable and resilient environment, as it emphasizes the importance of creating systems that are able to adapt and change as conditions change. In permaculture, this principle is often applied by designing systems that are able to adapt and change in response to changes in weather, climate, pests, diseases, and other conditions. For example, a permaculture garden might include a variety of different crop species that can be grown in rotation, so that the garden is able to adapt to changing conditions. It also means being aware and prepared for the potential changes that can happen and finding ways to be proactive rather than reactive in responding to change. It also encourages being open to new opportunities and creative solutions that come with change, instead of viewing change as a problem or a threat. In addition, this principle also encourages to design systems that are able to change and evolve over time, so that they are able to adapt and change as conditions change. It also means designing systems that are able to change and adapt at different scales, from small-scale changes such as replacing one crop with another, to larger-scale changes such as re-designing an entire system. This principle is closely related to the permaculture principle of "Use Small and Slow Solutions", as it relies on taking a gradual, step-by-step approach to designing and implementing systems that are able to adapt and change as conditions change. It also relates to other permaculture principles, such as "Catch and Store Energy" and "Obtain a Yield", as it encourages designing systems that are able to produce resources in a sustainable and efficient way, by being adaptable and responsive to change (Holmgren, 2002).

With these principles determined by permaculture, we understand what we should pay attention to in design and how to start. These principles are the principles that emerged in the light of the ethical values in the previous section. It gives hints of respect and sharing for nature and human. The use of these ethical values and principles while applying permaculture design is one of the important effects for the harmony of the design with permaculture.

2.3.6. Case Studies: Berg-En-Dal Permaculture Farm

In the Western Cape province of South Africa, Berg en Dal Farm is located in the semi-arid Little Karoo region at the intersection of four different bioregions, including the Succulent Karoo, Renosterveld, Acacia Riverine Steppe, and Albany. With annual precipitation levels of less than 300 mm and temperatures ranging from 40°C in summer to -4°C in winter, the farm offers a unique and challenging environment for sustainable living (Kruger, 2015).

The farm also hosts the Klein Karoo Sustainable Drylands Permaculture Project (KKSDP), which was established in 1999 by a group of individuals to create a lifestyle that conforms to permaculture principles and philosophies. The 405-hectare project area is intended to be a living model for permaculture, with training and workshops organized to support the demonstration. It was learned that the land, which was previously used for livestock and purchased with no access to water, is in a severely deteriorated state. KKSDP works on the principle of cooperation with members with different shares. Housing area boundaries are defined according to small sub-basins, allowing flexibility in accordance with permaculture ethics and principles. Additionally, members must follow certain rules, such as the use of biodegradable cleaning and cosmetics and contributions of time or money for farm maintenance and infrastructure (Kruger, 2015).

A study by Kruger (2015) highlighted a specific residential area on the farm that serves as a model for sustainable permaculture design in terms of energy efficiency and building construction. Local materials were used whenever possible, such as poplar wood processed at a nearby sawmill, boulders found in abundance on the property, and mudbricks made from the earth. Fine-textured soil was used for plastering, eco-friendly linen-based paint was used on the exterior, and limited concrete was used in the basement and joint material (Kruger, 2015).

The building design incorporates a passive thermal system, referred to by homeowners as a "desert climate strategy." The building is oriented east-west, with its long façade facing north to maximize sun exposure in winter. Deciduous trees were planted to the east, while evergreens to the west provided shade in the summer and let in sunlight in the winter. The roof of the north-facing veranda is angled to provide shade in summer and sunlight in winter. The fact that the house is located in a valley also allows for cooling with natural breezes. Homeowners report that the house is 8-10°C cooler outside in the summer months and 10-15°C cooler in the narrow, windowless mud-brick cellar added to the southwest façade. Hot water for the bathroom and kitchen is provided by a solar water heater, which also provides shade for the east façade. Energy consumption is kept to a minimum with electrical power from solar panels, and deep cycle batteries and a modified sine wave regulator are used to ensure self-sufficiency (Kruger, 2015).

2.3.7. Conclusion

The most important feature of permaculture is that it promises a sustainable life by considering our basic needs, such as nutrition, energy, communication, production, and consumption. We can adapt very quickly to this system, which is built directly on our needs and where we can get quick results, because we live with a utilitarian approach as a human feeling, and it needs to be beneficial for us to accept integration with a sustainable life, so the system should be beneficial to us in our basic needs; otherwise, sustainability is utopian and only for some activists. It will remain a struggle, and it will be difficult for everyone to adopt it. Another advantage of permaculture is that the methods it has determined are directly related to our past knowledge and experience, so it is a system that can be adapted quickly. Even though we are a generation that grew up with city life, some of our family elders still live in rural areas, and our relationship with the countryside has decreased compared to the old times, but it can still be preserved with family ties, but it should be noted that this relationship is rapidly decreasing and maybe in its last stages. With the transfer of permaculture teaching to generations, a direct contribution can be made to the nature-human relationship by strengthening the urban-rural relationship. Of course, like every system, permaculture is not perfect, especially since it has difficulties integrating technology into the system, which makes it difficult to spread permaculture in general. However, technology has the potential to play an important role in the development of permaculture. In my thesis, I want to establish a system that can reach more popularity by integrating permaculture and technology and our technological habits into permaculture. In addition, another deficiency of permaculture is that permaculture designs appear unaesthetic and in chaos when viewed from the outside. Therefore, I believe that by adding the training I have received in landscape design to the system, I can regain the perception of beauty and simplicity in design.

Figure 18

View of the project area from the valley adjacent to the land

Notes: *Anonymous, 2018*

Figure 19

Mandala Garden

Notes. *LauRa Maier, 2014*

Figure 20

Homestead at Berg-en-Dal

Notes. *LauRa Maier, 2014*

3. DISCUSSION AND METHODS

In this chapter, the Methodology that will enable Nature Based Solutions and Permaculture to work together will be determined in the light of current studies. Starting with the general discussion of Nature-Based Studies and Permaculture, the advantages, and disadvantages of these two disciplines will be presented. Afterward, a site selection will be made for the selection of the sample project area required for the determination of the Methodology, and historical, social, political, and environmental investigations will be made about this area. Then, the general Methodology will be determined by determining the appropriate ones from the Nature-Based Solutions and Permaculture principles for the Methodology to be applied to the field.

3.1. General Discussion of Nature-Based Solution and Permaculture

Nature-Based Solutions can be used as the top title of Permaculture in terms of its scope. Merely Nature-Based Solutions, Permaculture aims to protect nature and produce solutions in cooperation with nature, but Permaculture is more interested in regulating the philosophical dimension and ethical values. Therefore, it includes neighborhood relations based on producing inter-communal relations and sharing surplus products and has the characteristics of regulating the social structure. Also, Nature Based Solutions generally offer a workspace from city scale to building scale, while Permaculture generally works from building scale to city scale. This makes the two working methods complementary and a control mechanism. On the other hand, Nature-based solutions can be implemented as a government policy, which increases the support power of Nature-Based Solutions and emphasizes the strength of their applicability. Therefore, the fact that society and the state have the opportunity to work together for a sustainable future with these two solutions working together adds an important value to us for sustainability. It can cover the whole city with its nature-based solutions policies with administrative support such as Permaculture created with individual initiatives.

In general, sustainability-related problems are directly related to urbanization problems, and the application of Nature Based Solutions and Permaculture to cities is an important solution to minimize these problems. For instance, when looking at the European building typology, we see that the building courtyards are very suitable for use as permaculture areas, soilless agriculture can be made with the fertilizer and gray water obtained from the roofs of the buildings, and the energy needs can be met with permaculture solutions. However, on the other hand, its implementation in rural areas will provide great advantages in rural areas. For instance, in rural areas, monoculture agricultural areas can be partially integrated into permaculture areas, and we can turn rural areas into attraction centers with Nature Based Solutions, thus reversing the migration from rural to urban areas. In addition, it can provide economic development in economically distressed rural areas with the gains to be obtained from the joint work of Nature-Based Solutions and permaculture. Where there are no major problems and sustainability is more feasible, ecological destruction will be less, and sustainability will be easier. However, in order to solve the effects of the problem directly, examining the cities and solving the problems may also affect the rural areas, so it would be beneficial to prioritize the urban areas. Therefore, it is necessary to solve the problems that the city is exposed to by choosing the study area in the urban area.

3.2. Site Selection Zone 6, Milano, Italy

Italy is a country located in Southern Europe, known for its rich cultural and historical heritage. The country is the birthplace of the Roman Empire and the Renaissance, and is home to numerous World Heritage sites, including the historic centers of Rome, Florence, and Venice (UNESCO, 2021). Italy is also known for its art, architecture, fashion, and cuisine. The country is diverse in terms of landscapes and natural environments, including mountains, beaches, and islands. Italy is also an important player in the global economy, with a strong manufacturing sector and a growing service industry. It is the eighth-largest economy in the world, and the fourth-largest in the European Union (World Bank, 2020).

Figure 21

Italy border and geological structure map

Notes.*ArcGIS*

Table 26

Italy Demographics and Geographic Information Table

Total Italian population: 60,483,973	Lombardy: 9,642,406
Total Italian women: 31,056,366 (51.3%)	Milan Metropolitan Area: 4,320,088
Total Italian men: 29,427,607 (48.7%)	Milan Center Population: 1,337,155

Populations of Cities

Rank	*Name*	*Region*	*Population*	*Rank*	*Name*	*Region*	*Population*
01	Roma	Lazio	2.872.021	06	Cenova	Liguria	592.507
02	Milano	Lombardiya	1.337.155	07	Bologna	E.Romagna	386.181
03	Napoli	Campania	978.399	08	Floransa	Toskana	381.037
04	Torino	Piyemonte	896.773	09	Bari	Apulia	327.361
05	Palermo	Sicilya	678.492	10	Katanya	Sicilya	315.601

Notes. *OECD report, 2018*

The Lombardy region, one of the 20 administratively divided regions of Italy, is located in Northern Italy. It is the region with the highest population and the fourth largest area in Italy, and it is also the second most dense region in terms of the number of people per km2 when the population and area are taken into account (ISTAT, 2014). Lombardy is located in the center of the Alpine Range and the Po Valley and therefore has strategic importance (Regione Lombardia,2020).

. The fact that more than 25% of the Lombardy Region, which is 23,860 km2 in size, is determined as protected areas shows that it is in an advantageous position in terms of nature and environmental quality. The region is home to 24 regional parks, 70 state, and regional nature reserves, as well as Europe's largest park, Stelvio National Park. In addition, these areas, which have rich biodiversity, have characterized the plant and animal habitats thanks to the "Natura 2000 Network". These areas, which have been preserved from the past to the present, show the importance that Italy and especially the Lombardy region attach to nature and biodiversity (Regione Lombardia,2020).

Also, to preserve this natural and ecological landscape heritage, the Lombardy Regional Landscape Plan (Piano Paesaggistico Regionale or PPR) is provided with a regulation outlining the guidelines and regulations for the conservation and preservation of the landscape and cultural heritage of the Lombardy region in Italy. The plan is developed by the regional government and aims to ensure that any new development or change in the landscape is compatible with the cultural and natural heritage of the area. It also aims to prevent the degradation of the natural and cultural resources of the region and to promote sustainable development. The PPR is regularly updated and reviewed to ensure it complies with current laws, policies, and best practices for landscape protection and conservation.

LOMBARDIA REGIONAL PLAN

Table A - Geographic Areas and Typological Units of Landscape

LEGEND

- Geographic Areas
- Highways
- Main Roads
- Hydrographic Infrastructures
- Provincial Borders
- Regional Borders
- Urbanized Areas
- Lakes

TYPOLOGICAL LANDSCAPE UNITS

Alpine Belt

- Landscapes of Valleys and Slopes
- Landscapes of Relief Energies

Prealpine Belt

- Landscapes of Insubric Lakes
- Mountain and Ridge Landscapes
- Landscapes of the Pre-alpine Valleys

Hilly Area

- Amphitheatres and Morainic Hills
- Foothills and the Banina Hill

High Plain Range

- Excavated River Valleys
- Diluvial Shelves and the Dry High Plain

Low Plain Range

- Riverside Landscapes
- Forage Crop Landscapes
- Landscape of the Cereal Plain
- Landscape of the Rice-growing Plain

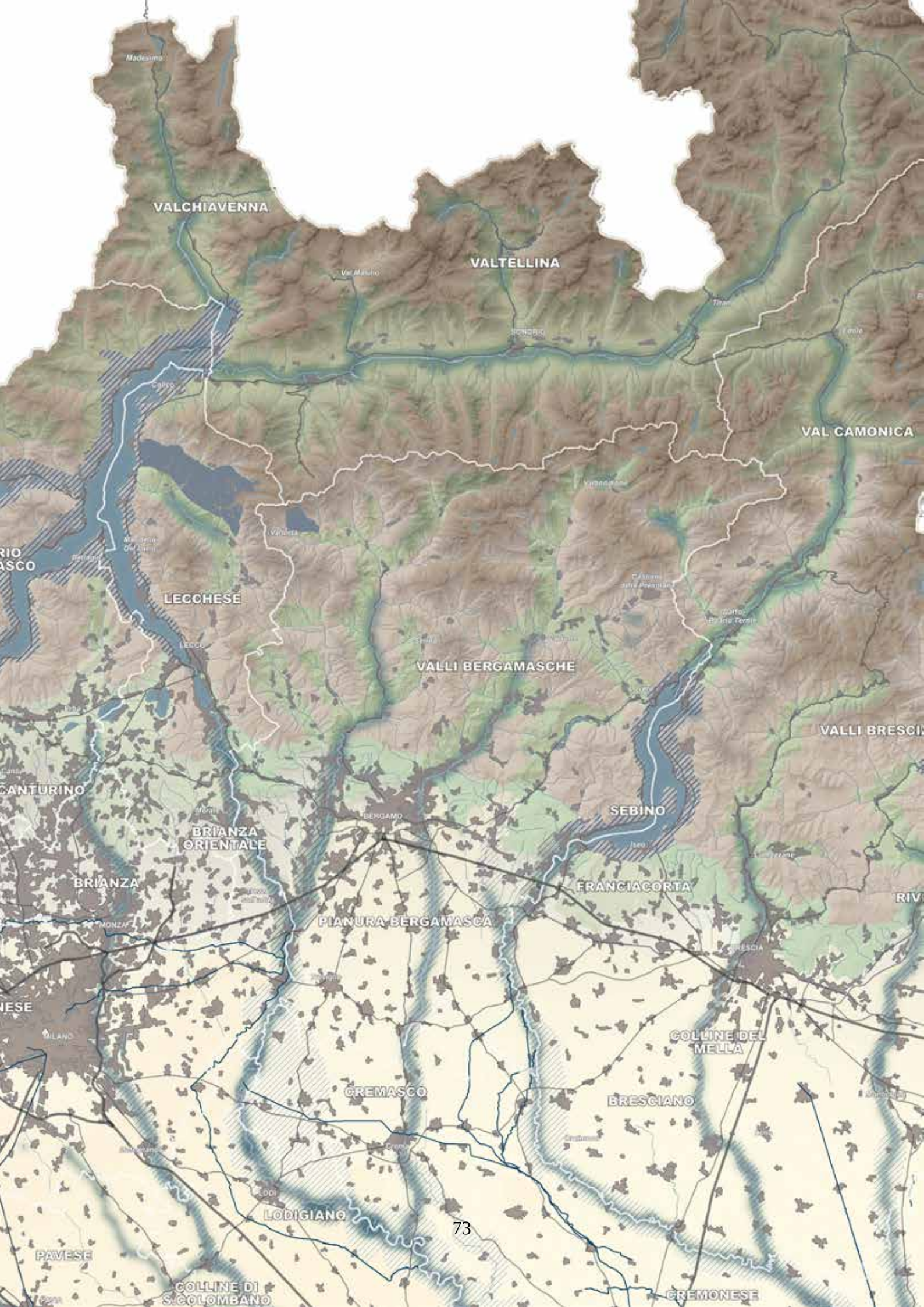
Oltrepo Pavese

- Landscape of the Apennine Foothills
- Landscape of the Apennine Mountains
- Landscape of the Apennine Valleys

N

0 5 10 20 30 40

Figure 22


VALCHIAVENNA
VALTELLINA
VAL CAMONICA
LECCHESE
VALLI BERGAMASCHE
SEBINO
BRIANZA ORIENTALE
BRIANZA
FRANCIACORTA
PIANURA BERGAMASCA
COLLINE DEL MELLA
CREMASCO
BRESCIANO
LODIGIANO
PAVESE
COLLINE DI S.COLOMBANO
CREMONESE

LOMBARDIA REGIONAL PLAN

Table B - Identification Elements and Paths of Landscape Interest

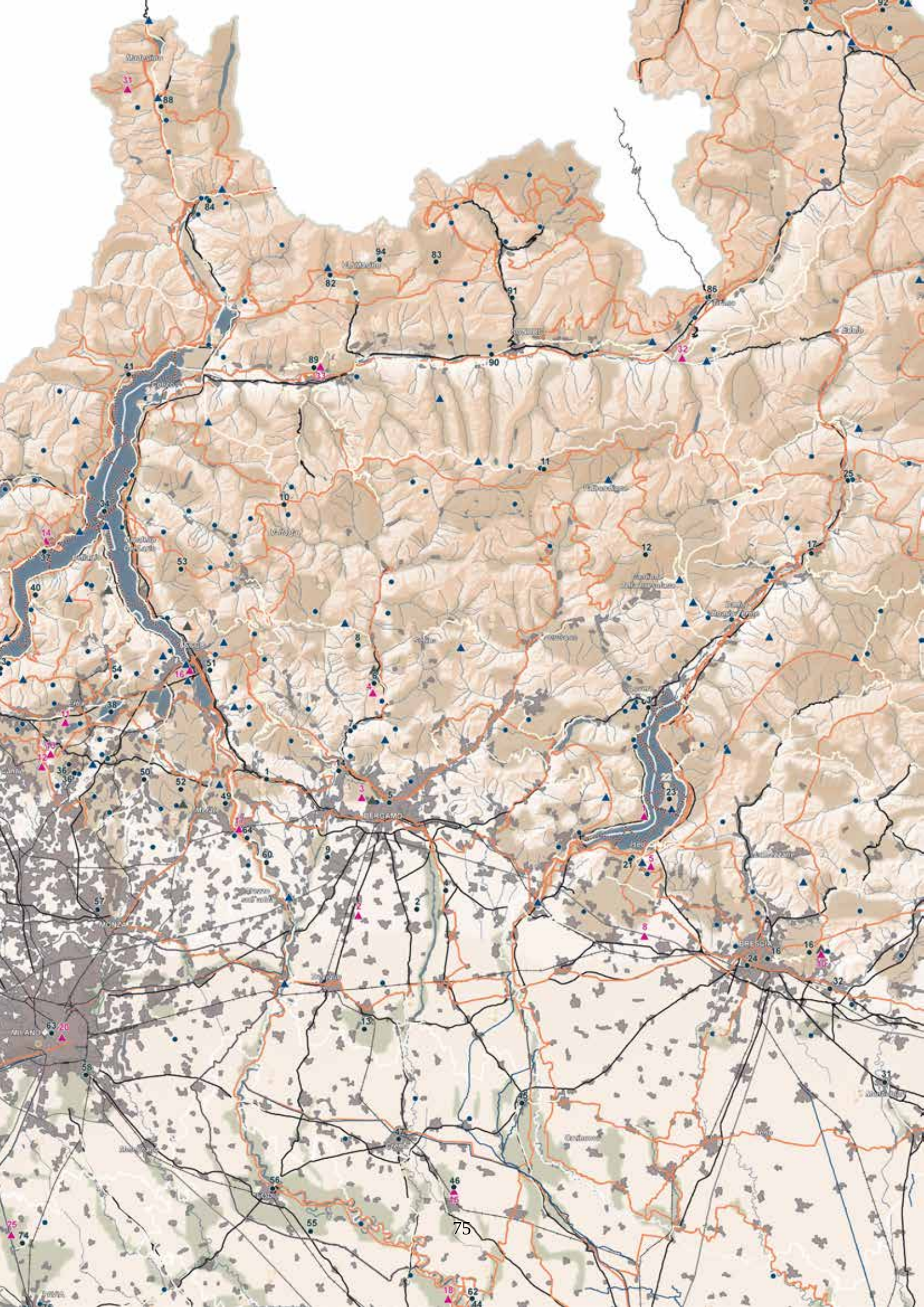
LEGEND

- Provincial Borders
- Regional Borders
- Regional Identity
- Traditional Agricultural Landscapes
- Geosites of Regional Importance
- UNESCO Natural Heritage Areas
- Panoramic Roads
- Navigation Lines
- Landscape Guide Trails
- Belvedere (Viewpoint)
- Sensitive Visuals
- Observation Points of the Landscape
- Reference Road
- Inland Watersheds
- Railways
- Urbanized Areas
- Surface Hydrography
- Artifical Hydrographic Infrastructures

AREAS OF REGINAL RELEVANCE

- Mountain
- Oltrepo
- Plain

Figure 23


BERGAMO
BRESCIA
MILANO

LOMBARDIA REGIONAL PLAN

Table C - Institutions for the Protection of Nature

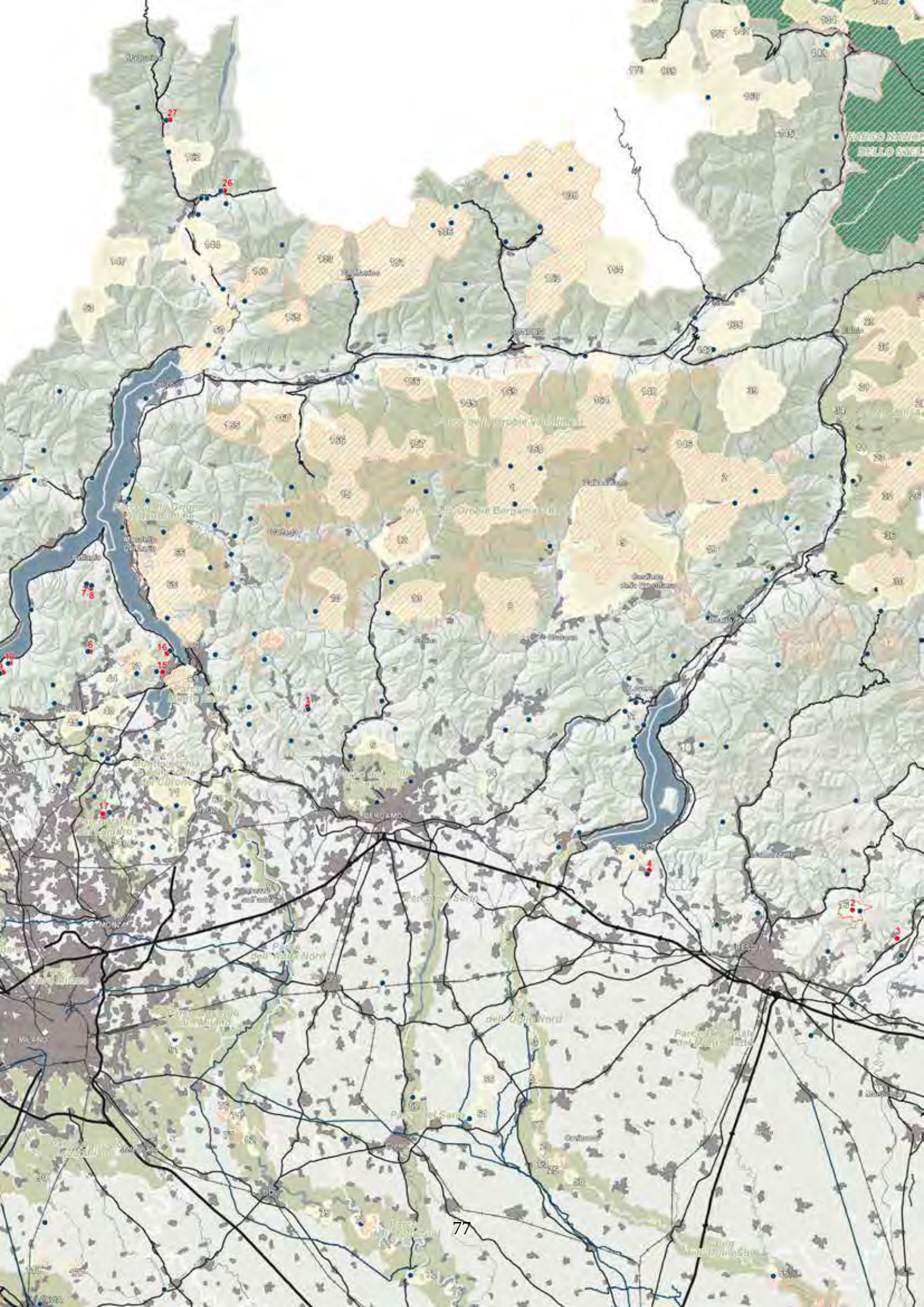
LEGEND

- Provincial Borders
- Regional Borders
- Inland Watersheds
- Artificial Hydrographic Infrastructures
- Surface Hydrography
- Railways
- State Roads
- Highways
- Urbanized Areas
- Stelvio National Park
- Natural Monuments
- Natural Reserves
- Geosites of Regional Importance
- SIC - Sites of Community Importance
- SPA - Special Protection Areas

REGINAL PARKS

- Regional Parks established with PTCP
- Regional Parks established without PTCP

Figure 24



LOMBARDIA REGIONAL PLAN

Table D - Reference Framework of the Regional Landscape Discipline

LEGEND

- Provincial Borders
- Regional Borders
- Inland Watersheds
- Surface Hydrography
- Railways
- Highways
- State Roads
- Urbanized Areas
- Stelvio National Park
- Regional Parks Established
- Areas of High Naturalness
- Specific Historical Environmental Value
- Protection of the Lakes of Mantua
- Insubric Lakes
- Landscape Protection of the River Po
- Landscape Protection of Po Valley System
- Naviglio Grande and Naviglio of Pavia
- Naviglio Martesana
- Canals of Regional Landscape Importance
- Geographical, Geomorphological Interest
- Geological-stratigraphic,Geo-mining,Petrographic and Volcanological Interes
- Paleontological and Mineralogical Interest
- Oltrepo Pavese - Area of Protection
- UNESCO Natural Heritage
- Areas of Protection Criticality

N

0 5 10 20 30 40

Figure 25


Parco delle Orobie Valtellinesi
Parco delle Orobie Bergamasche
Parco della Grigna Settentrionale
Parco del Monte Barro
Parco di Montevecchia e della Valle del Curone
Parco Valle del Lambro
Parco dei Colli di Bergamo
Parco del Serio
Parco dell'Adda Nord
Parco Nord Milano
Parco Agricolo Sud Milano
Parco dell'Oglio Nord
Parco Regionale del Monte Netto
Parco del Serio
Parco Agricolo Sud Milano
Parco dell'Adda Sud
Parco dell'Oglio Sud

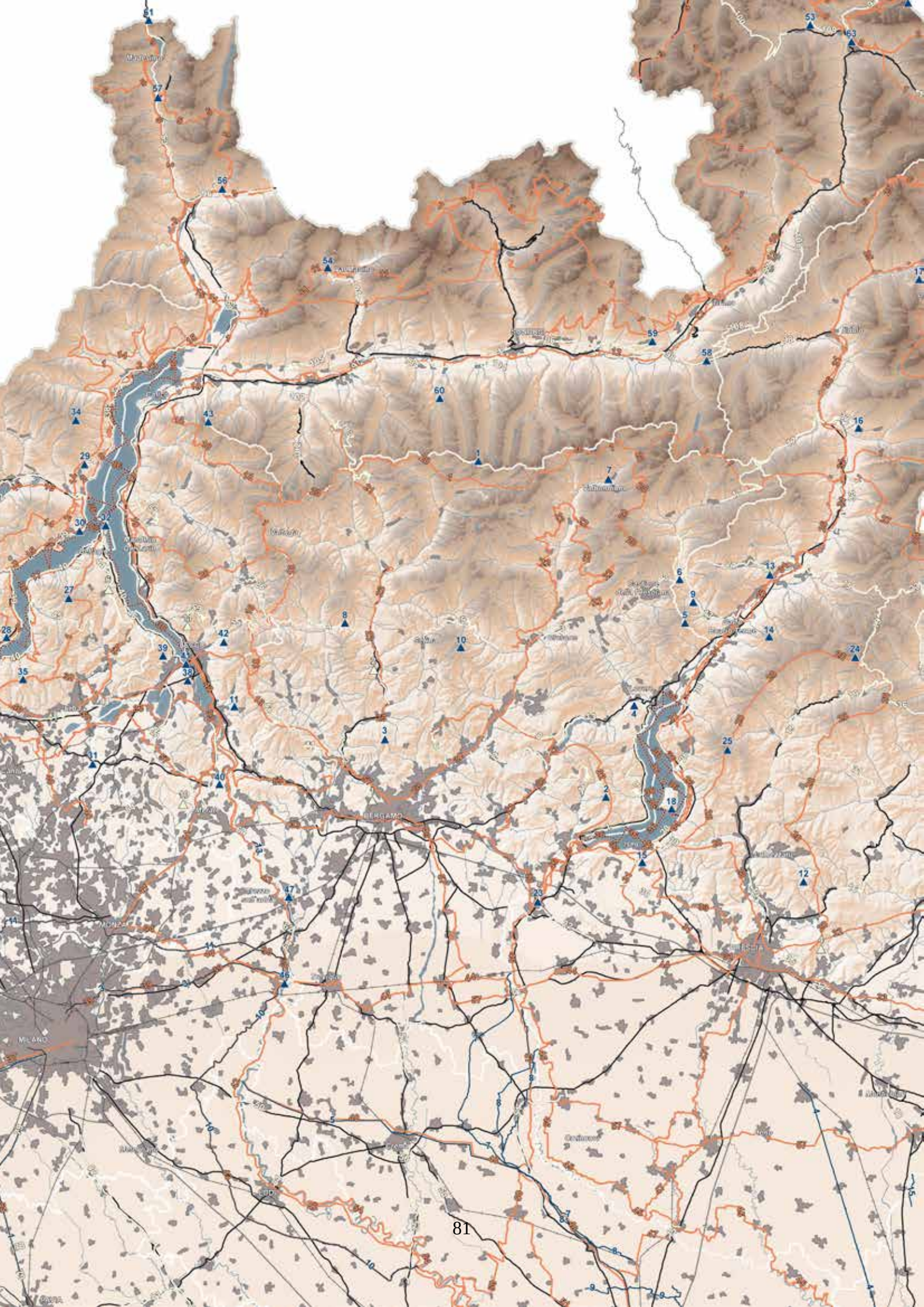
LOMBARDIA REGIONAL PLAN

Table E - Road Network of Landscape Importance

LEGEND

- Provincial Borders
- Regional Borders
- Panoramic Roads
- Navigation Lines
- Landscape Guide Trails
- Belvedere
- Sensitive Visuals
- Reference Road Layout
- Inland Watersheds
- Railways
- Urbanized Areas
- Surface Hydrography
- Artificial Hydrographic Infrastructures

Figure 26


BERGAMO
MILANO

LOMBARDIA REGIONAL PLAN

Table F - Landscape Redevelopment Ambits and Areas of Regional Attention

LEGEND

- Major Lakes and Rivers
- Surface Hydrography
- Urbanized Areas
- Railway Network
- Road Network

LANDSCAPE DETERIORATION BY HYDROGEOLOGICAL

- Areas Subject to Landslides

LANDSCAPE DETERIORATION BY URBANIZATION

- Lombardia Metropolitan System
- Conurbations
- Airports
- Highways Network
- Power Lines
- Main Shopping Centers
- Cinema Multiplexes
- Industrial Logistics Areas
- Skiable Areas
- Extractive Areas
- Waste Disposal and Recovery Plants

LANDSCAPE DETERIORATION BY TRANSFPRMATIONS

- Intensive Livestock Farming

LANDSCAPE DETERIORATION BY UNDER-USE

- Abandoned Quarries
- Disused Agricultural Areas

- Heavily Polluted Streams
- Contaminated Sites of National Interest

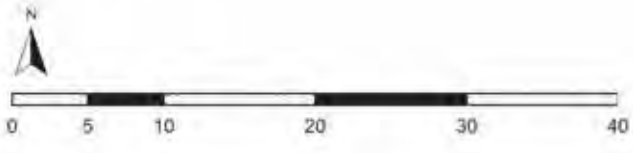
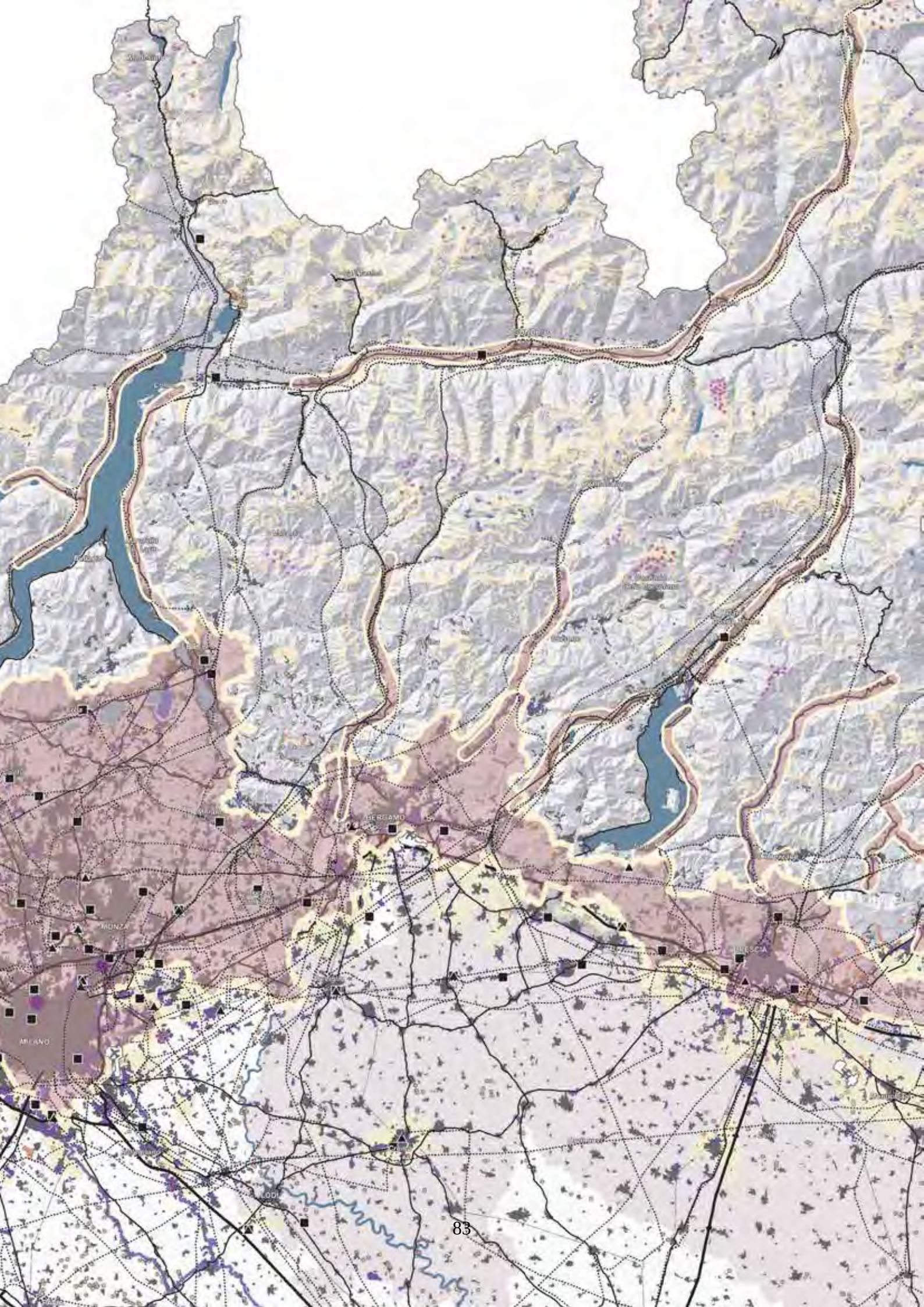
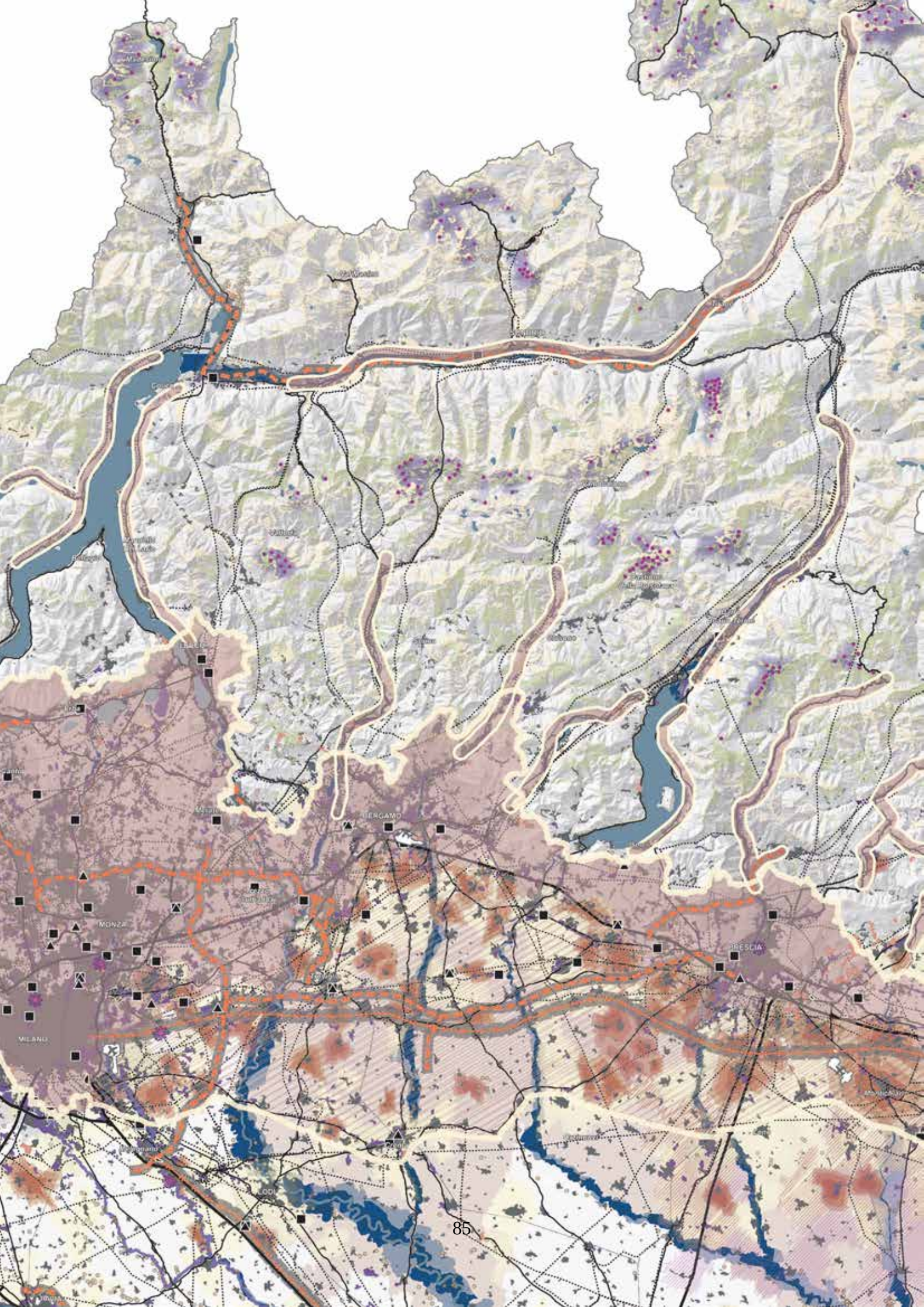


Figure 27


BERGAMO
BRESCIA
MONZA
MILANO
LODI


LOMBARDIA REGIONAL PLAN
Table G - Containment of Degradation Processes and Landscape Qualification Ambits
LEGEND
Landscape Deterioration cause by Hydrogelogical Institutions and Disaster and Catastrophic Events
Areas subject to Landslides
River Bands of Outflow from the Flood
River Flood Belt for Catastrophic Flooding
Landscape Deterioration cause by Urbanization Processes
Lombardia Metropolitan System
Scope of Possible 'expansion ' of LMS
Linear Conurbations
Neo-urbanization
Power Lines
High-Speed Railways
Planned Major Road
Main Shopping Center
Cinema Multiplexes
Industrial Logistics Areas
Industrial Districts
Skiable Areas
Exactive Areas in Activity
Waste Disposal and Recovery Plants
Landscape Deterioration cause by Under-use,Abandonment and Disposal
Intensive Livestock Farming
Abandoned Quarries
Pastures at Risk of Abandonment
Subjected to Abandonment Phenomena
Agricultural Abandoned Phenomena
Landscape Deterioration cause by Critical Environmental
Higher Air Pollution
Heavily Polluted Streams
Contaminated Sites of National Interest
N
0
5
10
20
30
40

Figure 28


BERGAMO
BRESCIA
MONZA
MILANO
LODI

Milan, as the capital of Lombardy, is one of the most important cities in Italy and Europe. The city has a rich historical and cultural heritage, a strong economy, and a dynamic political and social environment (Comune di Milano, 2020). Furthermore, Milan is an important center for design and innovation, making it an ideal location for an urban project that combines nature-based solutions and permaculture design with urban settlement.

Historically, Milan has been an important center of trade and commerce for centuries, with the city's strategic location at the crossroads of major trade routes helping to establish it as a major economic power in the region (Cipolla, 1965). The city has a rich cultural heritage, including numerous art and architectural treasures, such as the famous Cathedral of Milan and the Sforza Castle (Comune di Milano, 2020). These historical landmarks and the city's rich cultural history make it an attractive location for an urban project that combines nature-based solutions and permaculture design with urban settlement, as it can help to preserve and enhance the city's unique cultural heritage while promoting sustainable development.In terms of economy, Milan is home to many international companies and is considered the business capital of Italy (Camera di Commercio di Milano, 2021). It is also a major center for fashion and design, with many of the world's leading fashion houses and design companies headquartered in the city (Camera Nazionale della Moda Italiana, 2020). Additionally, Milan is a leading center for innovation and technology, with a growing number of startups and technology companies choosing to base themselves in the city (Politecnico di Milano, 2021). These strong economic foundations make Milan an ideal location for an urban project that promotes sustainable development and economic growth, as it can help to attract investment and support the local economy..

Politically, Milan has a strong and active local government committed to promoting sustainable development and protecting the environment (Comune di Milano, 2020). Ongoing work is being done to promote green spaces and improve air quality in the city. The local government's commitment to sustainability can support and promote the project by providing the necessary resources and support to ensure its success. Within this, Piano Territoriale di Coordinamento Provinciale (PTCP) has developed a regional land use plan that coordinates the development of a particular province in Italy. This plan is prepared by the Provincial government and approved by the Regional government, laying out guidelines and policies for the use and development of land within the province, including zoning regulations, infrastructure plans, and conservation work. PTCP aims to promote sustainable development and balance the needs of different stakeholders, such as residents, businesses, and the environment. It also includes several key components as follows while serving as a tool to coordinate the actions of government and private actors at different levels involved in land use and development;

- *Zoning regulations:* These regulate the areas that divide the province into different areas, such as residential, commercial, industrial, or agricultural, according to their intended use.

- *Infrastructure plans:* develops plans that determine the location and development of transport networks, utilities, and public services.

- *Conservation and environmental protection:* It defines areas of ecological importance and sets guidelines for their conservation and management.

● *Economic development:* identifying opportunities and constraints for economic growth and developing policies to support it.

● *Social development:* identifying opportunities and constraints on social development and setting policies to support it.

PTCP is an essential tool for coordinating the actions of different actors involved in land use and development. It ensures the sustainable and equitable use of provincial lands and the balancing of the needs of different stakeholders. It is also an important document for the private sector to understand when they will invest in a particular area.

In addition, the Piano Territoriale di Coordinamento Provinciale (PTCP) and the United Nations' Sustainable Development Goals (SDGs) aim to promote sustainable development and improve the well-being of people and the environment. However, while the PTCP is a regional land use plan specific to a province in Italy, the SDGs are a global framework adopted by all United Nations member states. The SDGs are a set of 17 goals and 169 goals aimed at ending poverty, protecting the planet, and ensuring that all people live in peace and prosperity by 2030. They cover a wide range of topics, including economic growth, social inclusion, environmental protection, and good governance. The PTCP, on the other hand, is a legally binding document that outlines the strategic objectives and policies for the use and development of land in a given province, lays out guidelines and policies regarding the use of land within the province, infrastructure plans and conservation efforts and development, including zoning regulations. It is also an important document for the private sector to understand when they plan to invest in a particular area. While the SDGs are not legally binding, they provide a framework for governments, businesses, and other stakeholders to work together to achieve sustainable development. PTCP can align with the SDGs by including policies and objectives that support the achievement of the SDGs. For instance, PTCP may include policies to promote renewable energy, conserve biodiversity or support sustainable transportation to comply with the SDGs. In summary, although PTCP and SDGs have different legal statuses and scopes, both aim to promote sustainable development and improve the well-being of people and the environment, and it is possible for PTCP to align with the SDGs.

MILANO PROVINCIAL TERRITORIAL COORDINATION PLAN (PTCP)

Table 0 - Strategic Plan

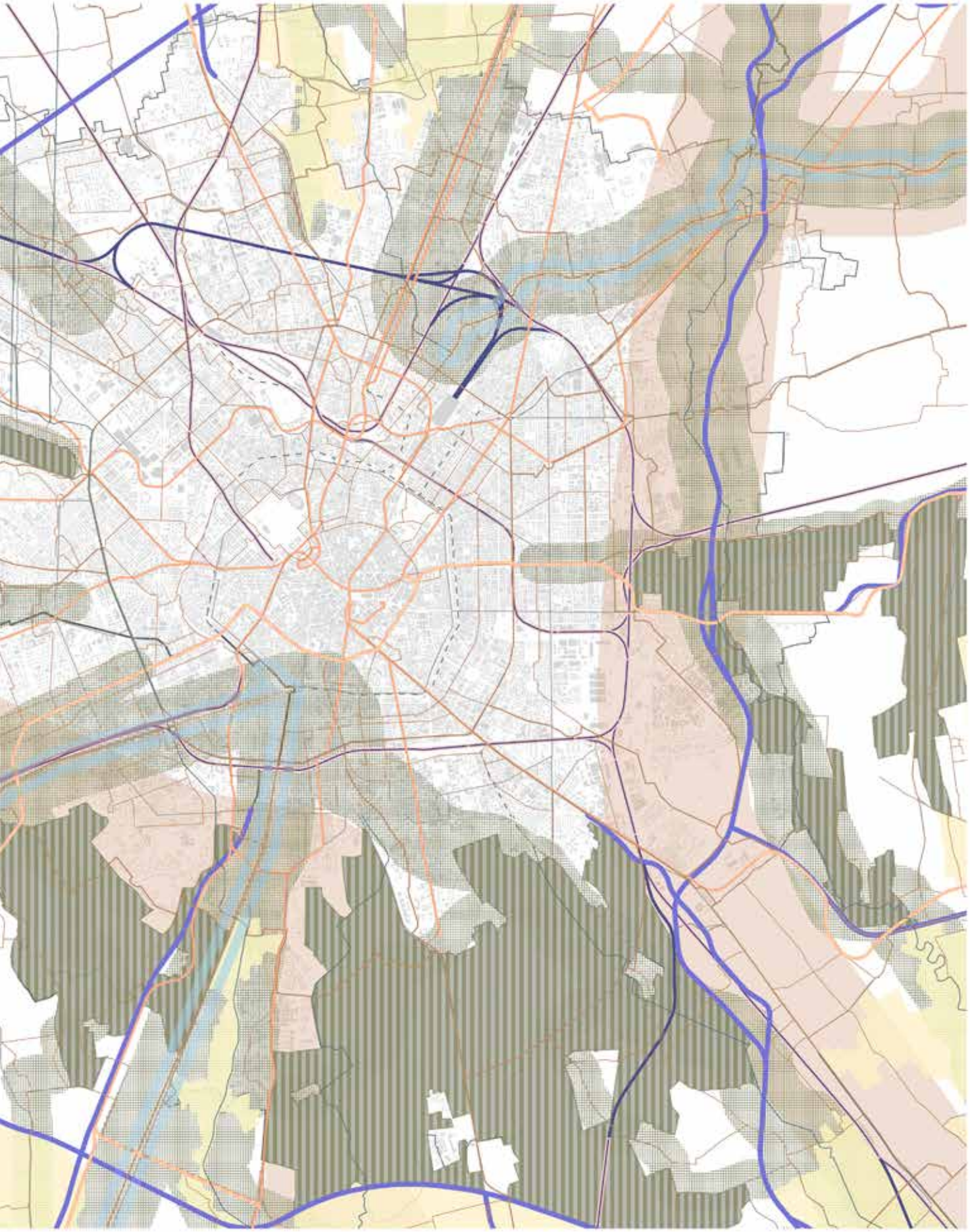
This table is a section of the plan that sets out the strategic guidelines and objectives for the overall planning process. It defines the key principles, objectives, and criteria that will guide the development of the plan, and outlines the overall vision for the Province of Milan.

LEGEND

Centers of Interchange

- Riverbed
- Existing Highway Infrastructure
- Existing Underground - Metro System
- Tramways
- Railways
- Cycling Network
- Existing Road Infrastructure
- Parks with Soil and Water Wealth
- Regional Parks
- Botanic Poly Attractors
- Green Network
- Great Territorial Dorsali
- Naviglio System - Buffer 200 m.

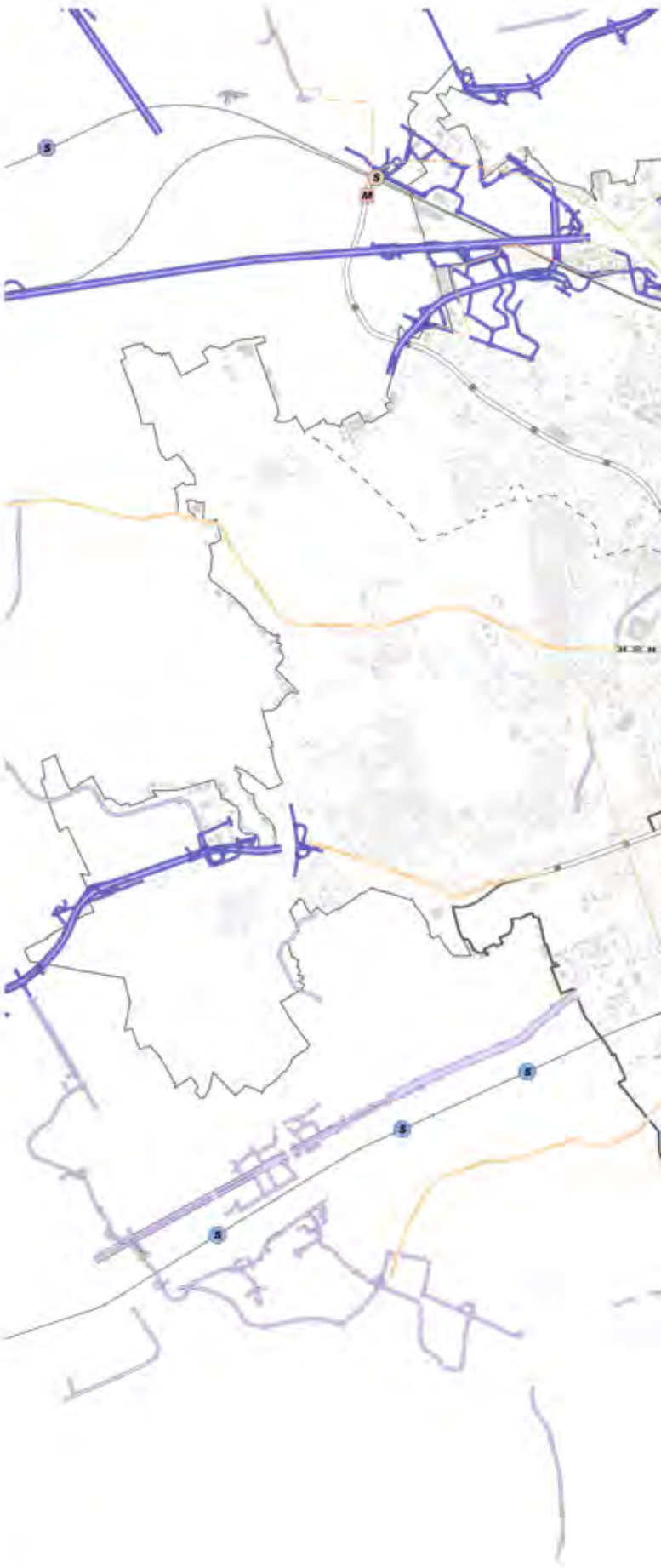
Figure 29



MILANO PROVINCIAL TERRITORIAL COORDINATION PLAN (PTCP)

Table 1 - Infrastructure system

This plan include transportation, energy, water supply, waste management, and telecommunications. For each system, the table provides information on the existing infrastructure, planned infrastructure, and future development goals.



LEGEND

Centers of Interchange

- Supra-Local Significance
- Local Significance
- S — Suburban Railway Service
- R — Regional Railway Service
- M — Metro Stop
- M — Metro Project Stop

Railway Stations of Project

- Decommission
- New / Redevelopment

Metro-Trams of Project

- Metro
- Trams

Public Transport Network

- Works under study
- Scheduled works
- Planned works

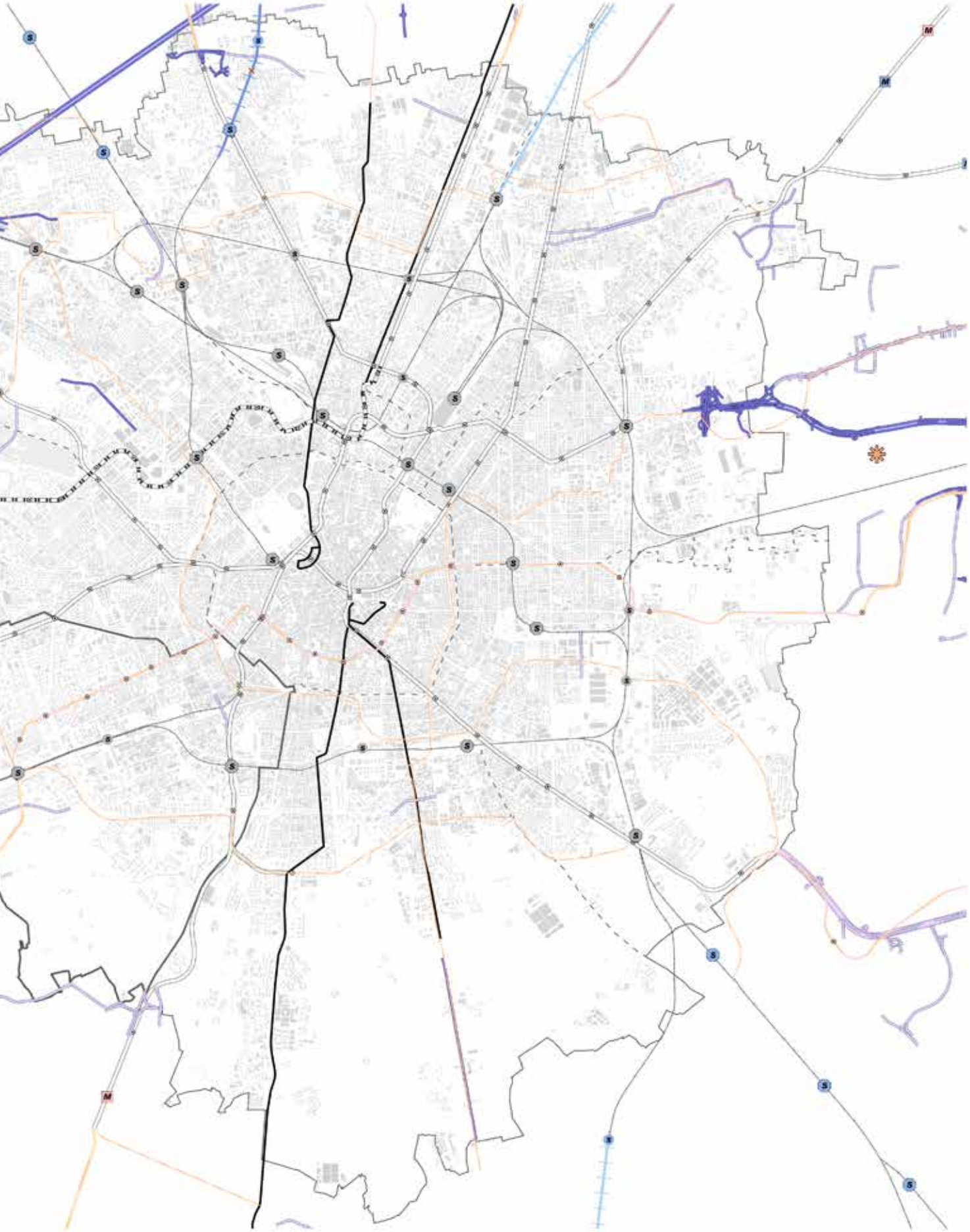
Road Network

- Separate Carriageways
- Simple Carriageway
- Roundabout

N

0 2 4

Figure 30



MILANO PROVINCIAL TERRITORIAL COORDINATION PLAN (PTCP)

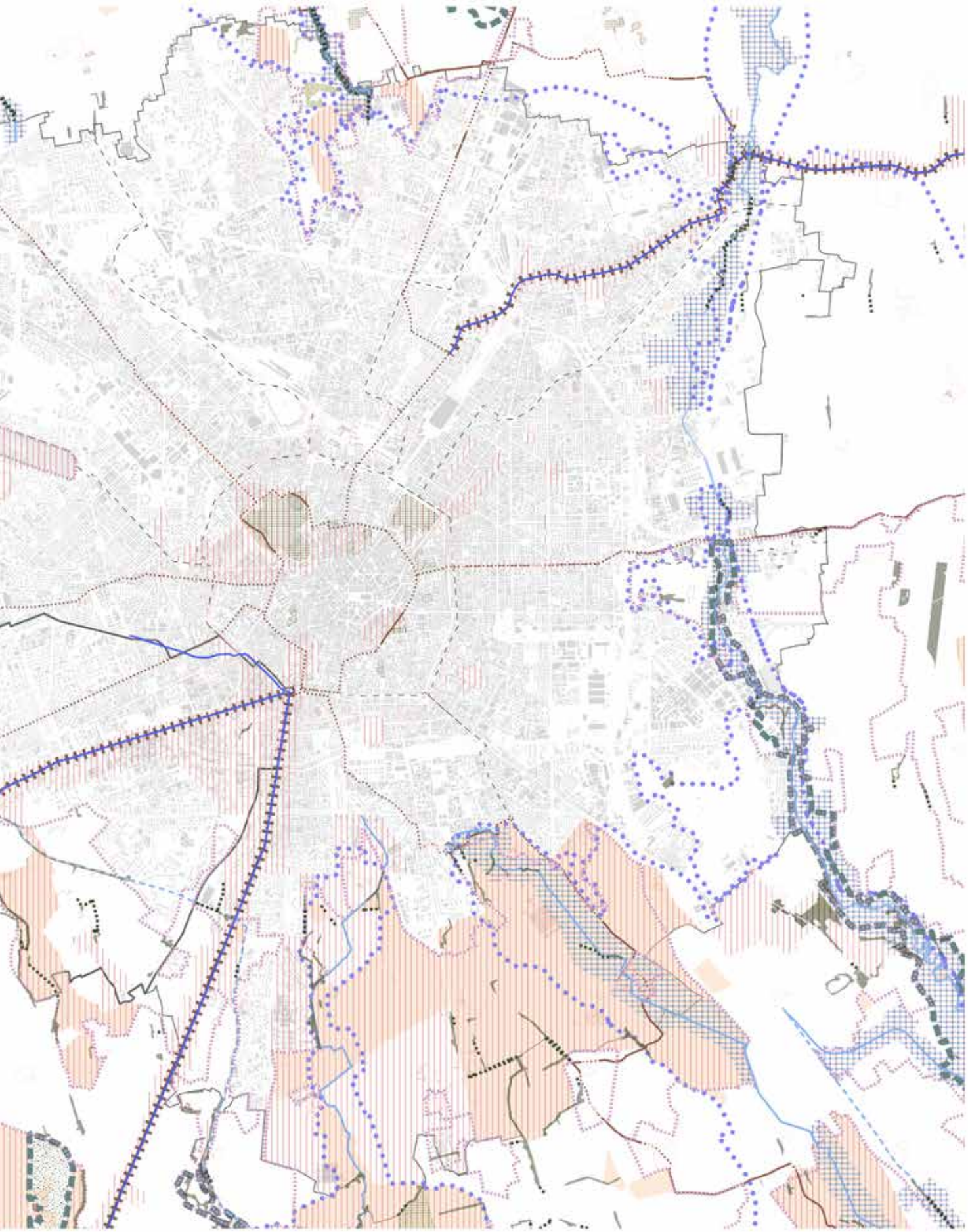
Table 2-Systems and Elements of Landscape Relevance

The objective of Table 2 is to provide a comprehensive inventory of the landscape elements that contribute to the identity and character of the Province of Milan, as well as to establish guidelines for their protection and enhancement.

LEGEND

- Typological Units of Landscape
- Forest Areas
- Linear Forest Areas
- Canal
- Naviglio
- Regional Park
- Nuclei of Ancient Formation
- Natural Parks established or Propoesd
- Historical-Landscape Routes
- Historic Gardens and Parks
- Bands of Landscape-River Importance
- Naturalistic Importance Areas
- Landscape Importance Areas
- Agricultural Areas of Landscape Importance

Figure 31



MILANO PROVINCIAL TERRITORIAL COORDINATION PLAN (PTCP)

Table 3 - Degradation of Landscape Elements

The table includes a variety of landscape elements, such as degraded natural and rural landscapes, polluted urban and suburban areas, degraded infrastructure and transportation networks, and cultural heritage sites at risk of decay.

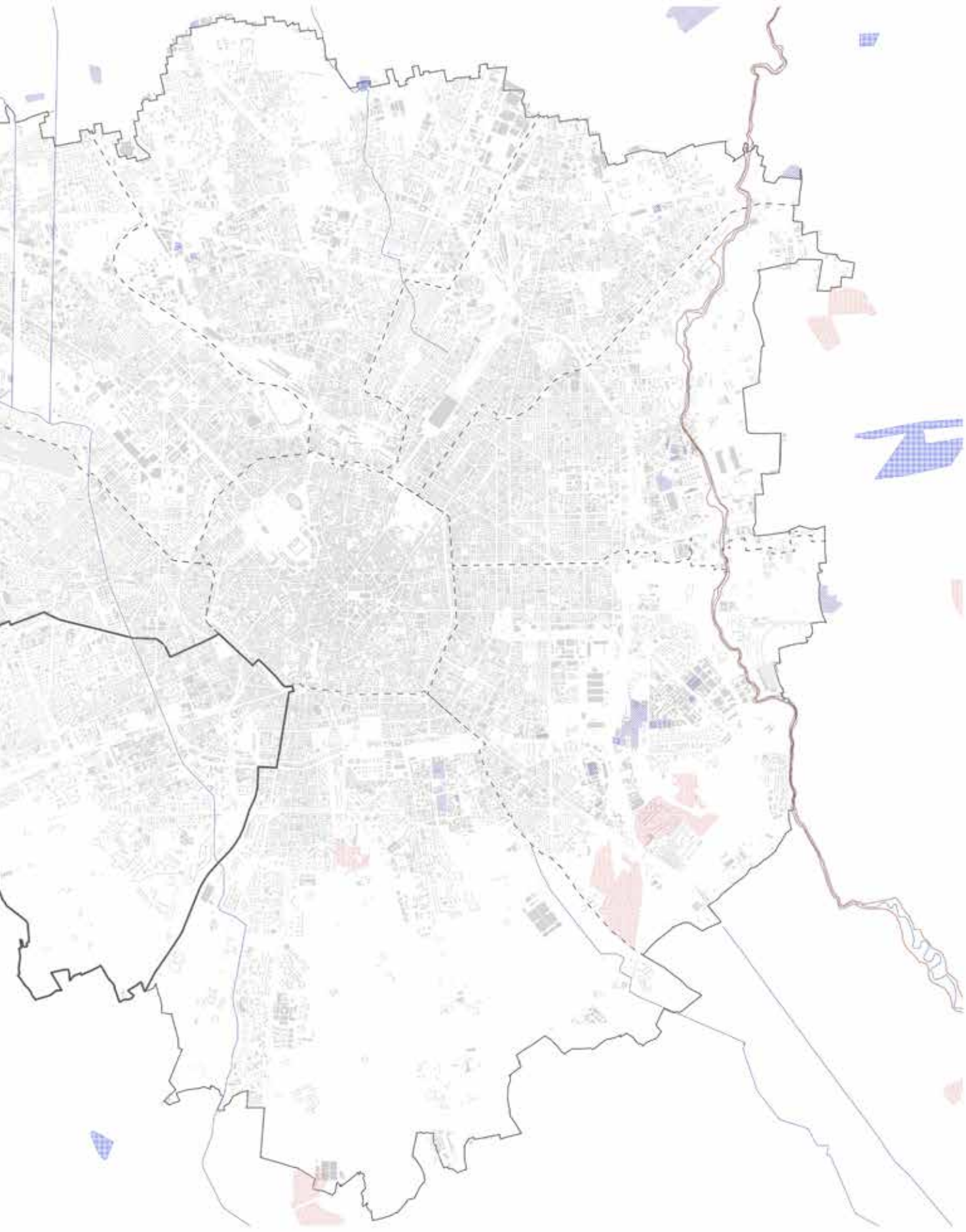
LEGEND

- Contaminaed Sites of National Interest
- Heavily Polluted Streams
- Flood Areas
- Hydrogeological Constraint
- Abandoned Areas
- Industrial Areas
- Intensive Crop Areas (Greenhouses)
- Horticultural Crop Areas

N

0 2 4

Figure 32



MILANO PROVINCIAL TERRITORIAL COORDINATION PLAN (PTCP)

Table 4 - Ecological Network

The table identifies potential threats and risks to the Ecological Network, such as habitat fragmentation, invasive species, or climate change, and proposes strategies for its protection and enhancement.

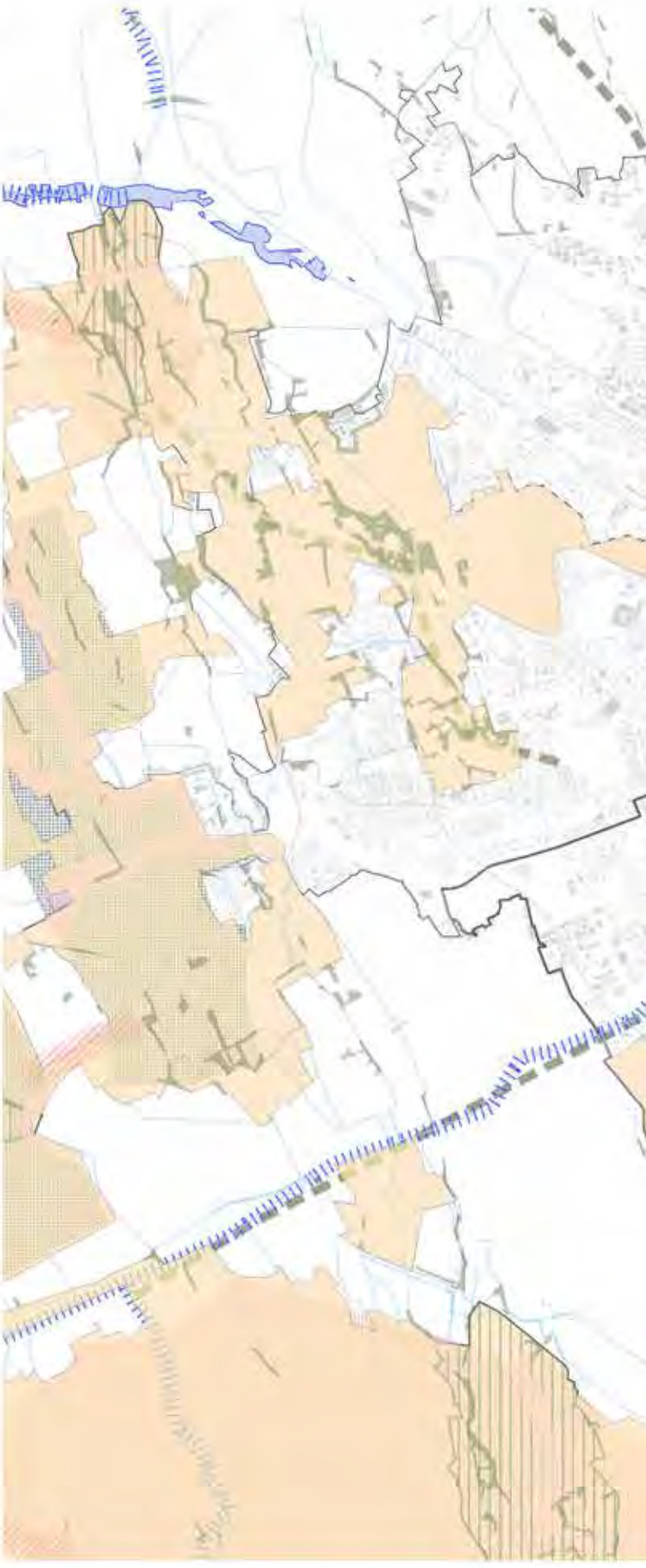
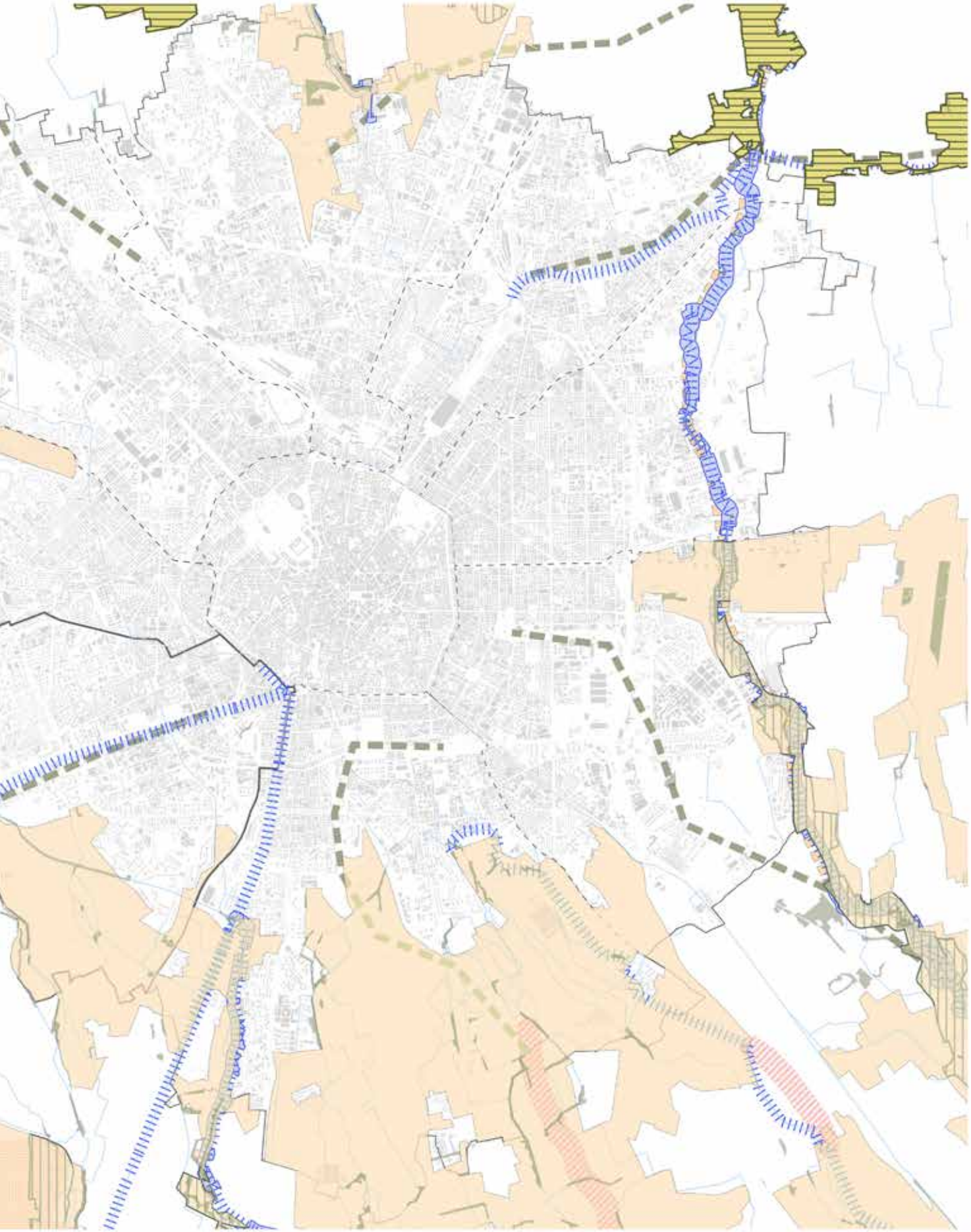


Figure 33



MILANO PROVINCIAL TERRITORIAL COORDINATION PLAN (PTCP)

Table 5 - Reconnaissance of Protected Areas

This table that require protection due to their environmental, cultural, historical or social value. This includes natural areas, such as parks, nature reserves, and protected habitats, as well as cultural and historic sites, such as archaeological sites, buildings, and landscapes of particular cultural value.

LEGEND

- Scope of Navigli PTR
- Natural Parks Established
- Natural Parks Proposed
- Special Protection Zones
- Rivers and Streams

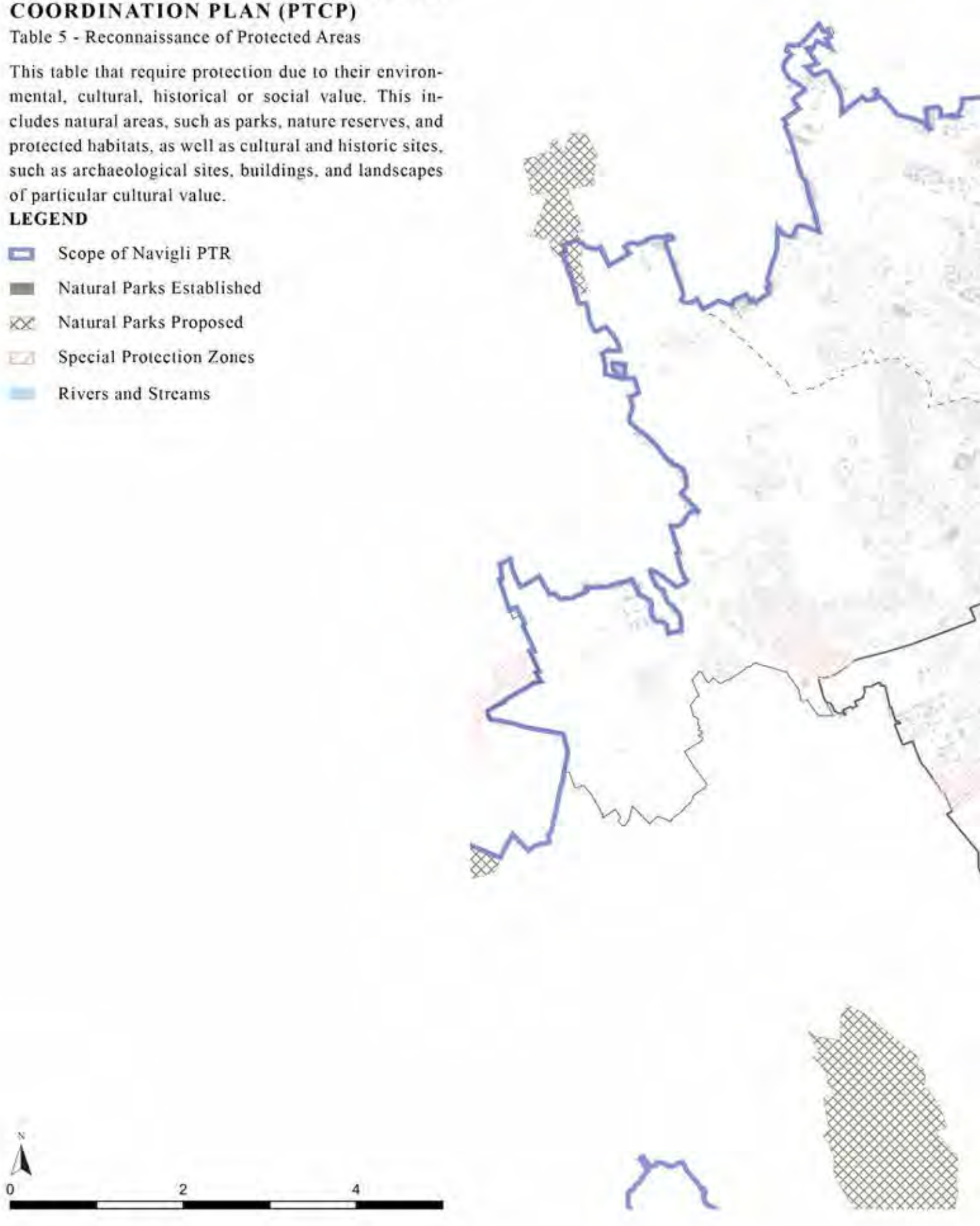
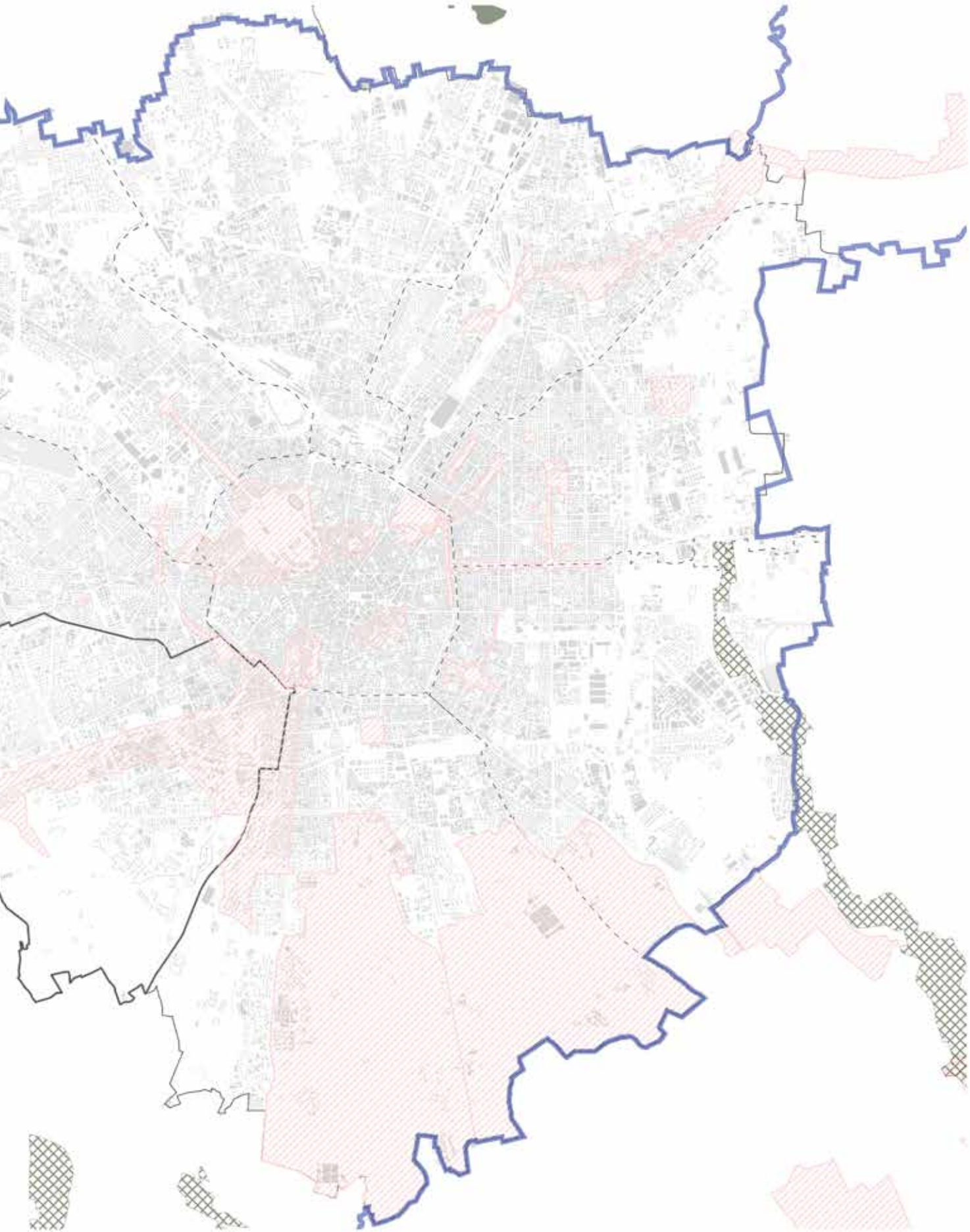


Figure 34

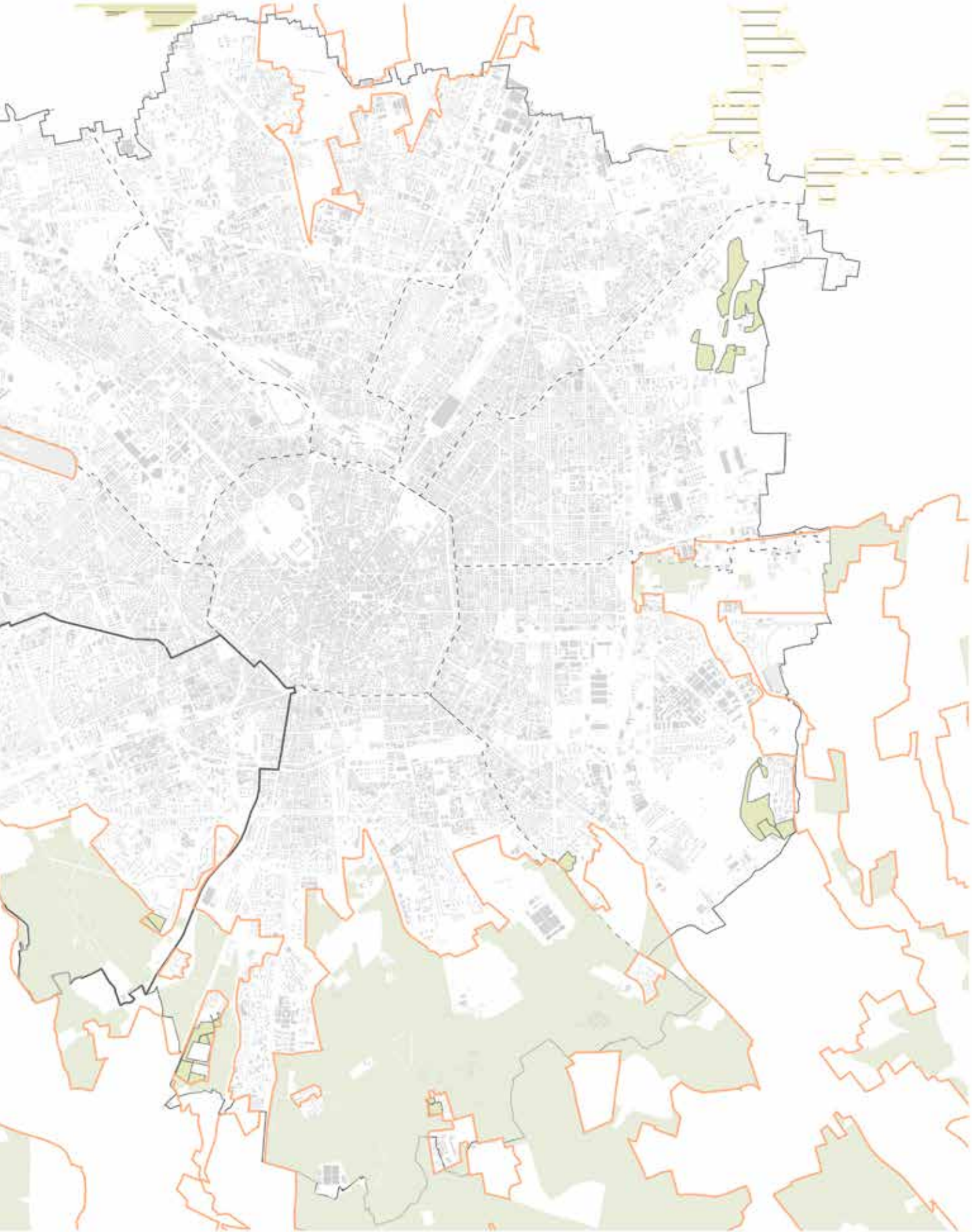


MILANO PROVINCIAL TERRITORIAL COORDINATION PLAN (PTCP)

Table 6 - Agricultural Areas of Strategic Importance

The objective of Table 6 is to provide a comprehensive inventory of the agricultural areas of strategic interest within the Province of Milan, as well as to establish guidelines for their protection and management.

Figure 35



MILANO PROVINCIAL TERRITORIAL COORDINATION PLAN (PTCP)

Table 7 - Soil Protection

A comprehensive inventory of the soils within the territory, as well as the potential threats and risks to their quality and fertility. Identifies various types of soils, and describes the various land uses that may impact soil quality

LEGEND

- River Bodies
- Stream Bodies
- Flood Risk Areas
- Quarry Areas
- Flood Plain Areas
- Aquifers with Very High Vulnerability
- Ground Water Areas / Prevalent Regeneration
- Ground Water Areas / Villoresi Canal
- Ground Water Areas / Influence Villoresi Canal
- Main Recharge Areas of the Aquifer

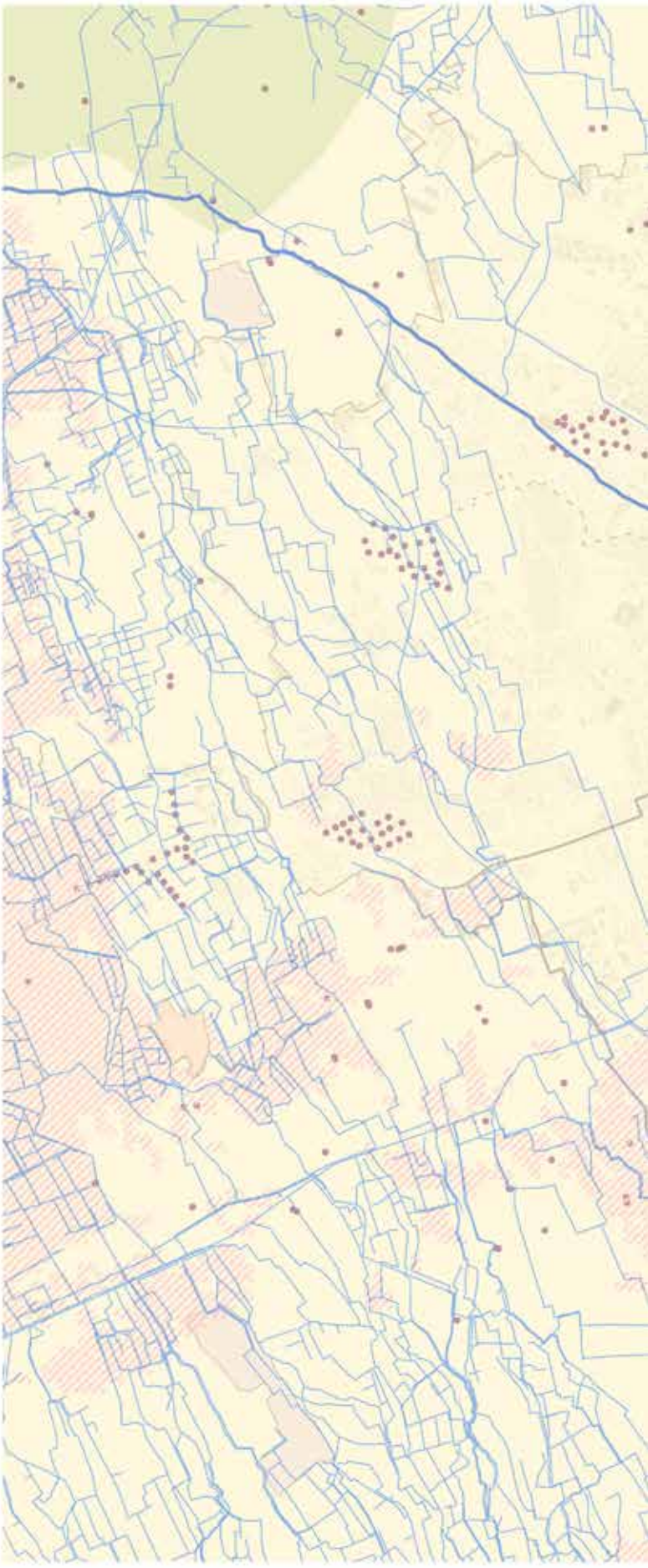
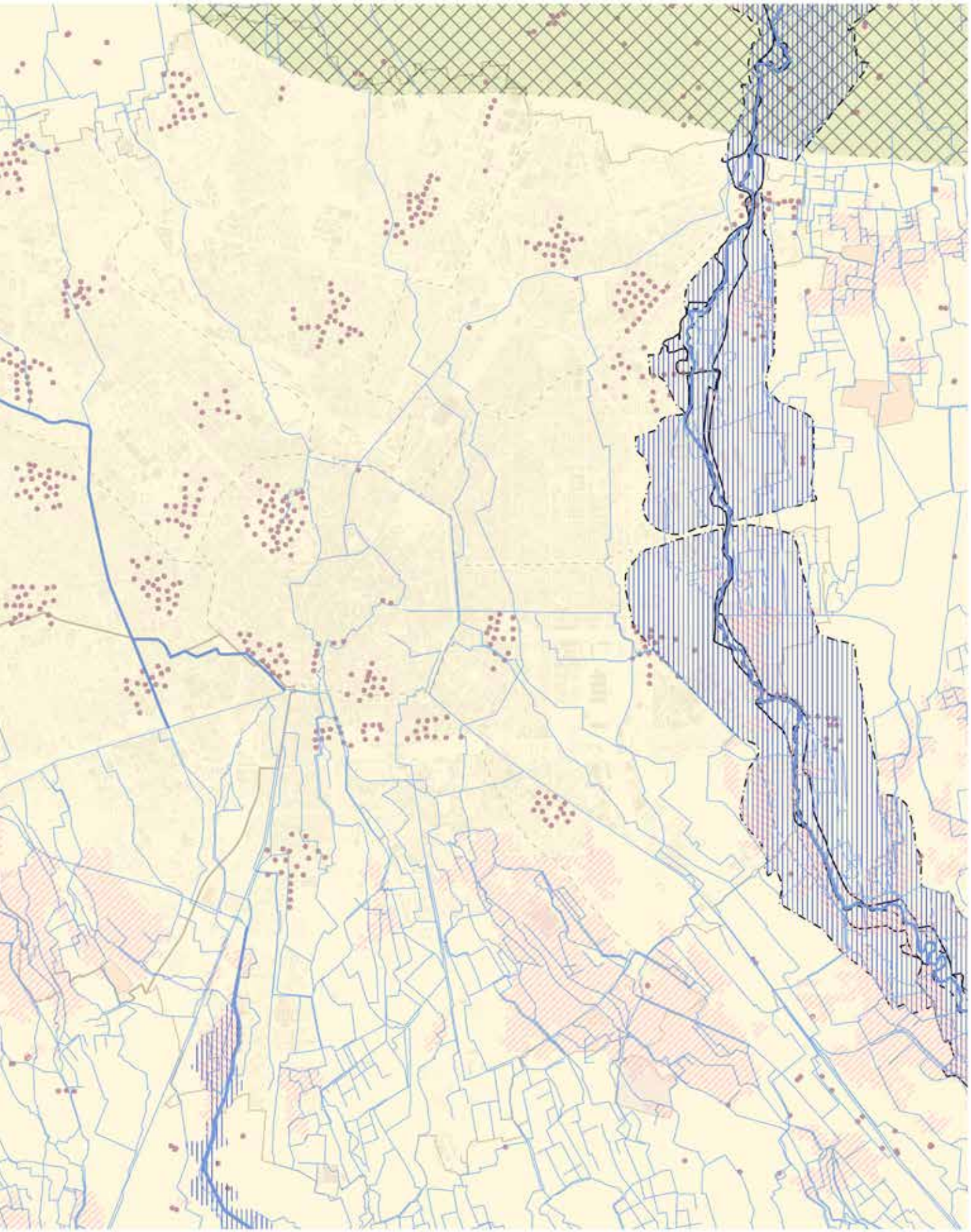


Figure 36



There is also a land use plan that guides the development of a particular municipality or group of municipalities in Piano di Governo del Territorio (PGT), Italy. In this way, guidelines and policies are drawn up for the use and development of land within the municipality, prepared by the local government, and approved by the regional government.

PGT aims to promote sustainable development and balance the needs of different stakeholders, such as residents, businesses, and the environment. It also serves as a tool to coordinate the actions of government and private actors at different levels involved in land use and development.

Milan's 2030 plan has been developed in integration with this plan. Milan 2030 is a master plan for the development of the city of Milan, adopted by the city council in 2019. It outlines the city's vision for sustainable development and urban renewal over the next decade and covers a wide range of topics, including urban planning, transport, energy, and environmental protection.

The Milan 2030 plan is designed to create a more livable and sustainable city by focusing on improving public spaces, promoting sustainable transportation, and reducing environmental impact. One of the main objectives of the plan is to create new and innovative public spaces and improve the quality of existing ones through the creation of new parks and green spaces, the redevelopment of abandoned spaces, and the creation of new squares and public spaces. PGT and the Milan 2030 master plan are aligned with the SDGs, including policies and objectives that support the achievement of the SDGs and work together to achieve the sustainable development of a given municipality.

In terms of the environment, Milan is located in an area with a rich natural heritage, which includes numerous parks and protected areas (Regione Lombardia, 2021). The city is also working to promote sustainable transport and reduce its carbon footprint, maintaining a number of initiatives to promote bicycles and electric vehicles (Comune di Milano, 2020). These environmental initiatives, combined with the city's proximity to natural areas, make Milan the ideal location for an urban project involving nature-based solutions and permaculture design. These solutions can help support biodiversity, improve air and water quality, and reduce the urban heat island effect in the city (United Nations, 2017).

The Barona, Lorenteggio district is the sixth of Milan's nine districts and is located in the southwestern part of Milan. It generally consists of residential areas and commercial areas. According to the census made in 2015, approximately 149,334 people live. Zone 6 neighborhood 18.28 km^2 and contains 8,169 people per km^2.

Zone 6 includes the districts of Porta Genova, Giambellino, Lorenteggio, and Barona, and the Naviglio Grande passes through this zone. Another important aspect of the region is that a part of the southern agricultural park (Parco Agricolo Sud Milano) is located in this area. Also, Parco di Trenno and many parks are in this area.

Zone 6 is a suitable area for Nature-Based Solutions and Permaculture, thanks to its location and environmental factors. The agricultural park in the southeast of the region and the influence of the Naviglio Grande on the region provide a suitable area for the work to be done here. Permaculture and

Nature-Based Solutions that can be applied, especially in the South Agricultural Park, are an important starting point for spreading over the whole area. In addition, when we examine the building typology, we see that this density decreases towards the southwest, where it concentrates as it approaches the center of Milan, which gives us the opportunity to work in various conditions. High-density constrained Nature Based Solutions and Permaculture design have the potential to be an important indicator for how areas that can be applied can be correlated with low-density areas.

As a result, Milan, and especially the Zone 6 region, is an ideal location for an urban project that combines nature-based solutions and permaculture design with the urban settlement. The country’s rich cultural and historical heritage, diverse natural landscapes, and strong economy make it an attractive location for sustainable development projects. Likewise, Milan’s rich historical and cultural heritage, strong economy, dynamic political and social environment, and strong sustainability commitment to preserve the natural heritage and improve air quality make it an ideal location for such a project. With this thesis, a more sustainable future can be achieved for the city. The project area (Milan Zone 6 area) provides suitable environmental advantages for the integration of Nature-Based Solutions and Permaculture, which makes this area an important starting point as a study area. (Comune di Milano, 2020; Regione Lombardia, 2021; United Nations, 2017).

MILANO 2030 - TERRITORIAL GOVERNMENT PLAN (PGT)

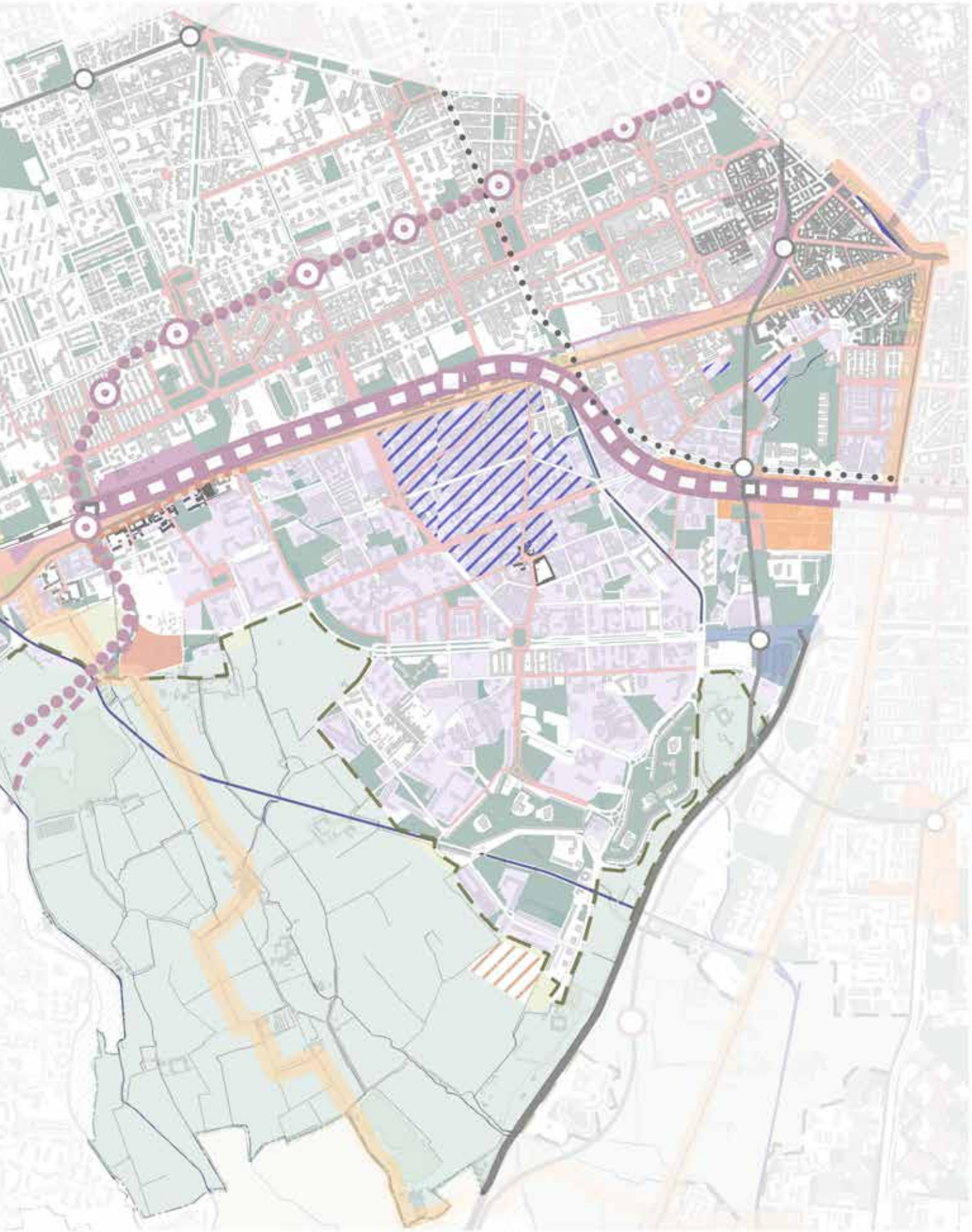
Table D01 - Plan Project

This specific table within the PGT that focuses on the design of the city's public spaces. It includes guidelines and specifications for the design of streets, sidewalks, parks, and other public spaces, with the aim of creating more livable and attractive urban environments.

LEGEND

- MM Stations in Programming
- Railway Circle Line in Operation
- Areas of Environmental Regeneration
- Regional Parks: Parco Agricolo Sud
- Existing Urban Green
- Areas of Urban Renewal
- Areas Intended for Agricultural Activity
- Interchange Nodes: FAMAGOSTA
- Areas for Large Urban Functions: RONCHETTO
- S. Cristoforo - Equipped Park
- Cycle networks: Regional Cycle Networks
- Metropolitan Network Under Construction
- Metropolitan Network in Planning

Figure 37



MILANO 2030 - TERRITORIAL GOVERNMENT PLAN (PGT)

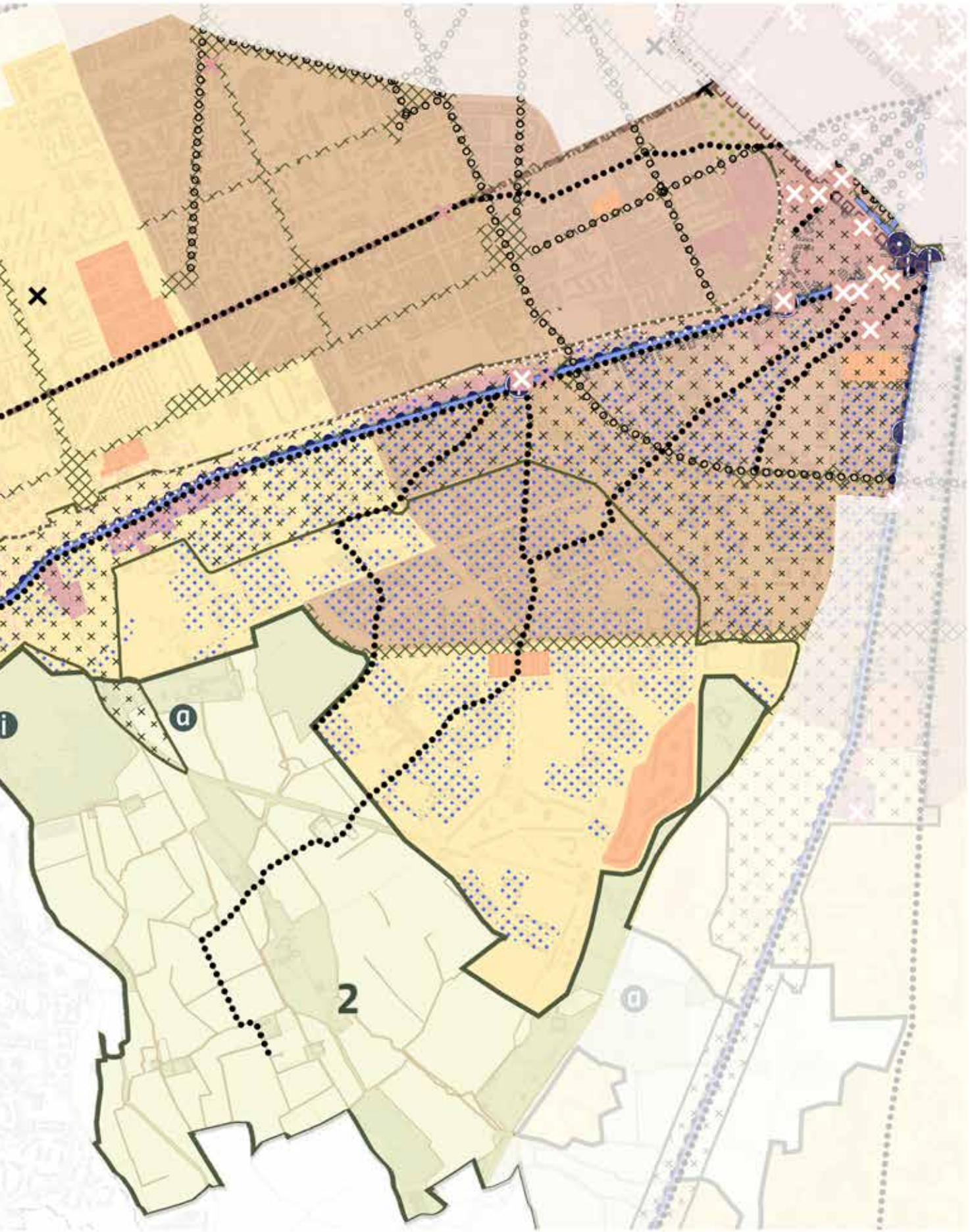
Table D02 - Map of the Landscape

Information about the various types of land use in Milan. It also highlights areas of particular importance for their natural or cultural value, such as historical landmarks, archaeological sites, and areas of ecological significance.

LEGEND

- Buildings Historical and Cultural Significance
- Areas of Recent Regulatory Plans
- Central Nucleus of Ancient Formation
- Regional Parks: Parco Agricolo Sud
- Neighborhoods of Settlement Value
- Historic Canals and Areas of Landscape
- Areas of Urban Renewal
- Area of Prevalence of the Urban Landscape
- Historical Routes

Figure 38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MILANO 2030 - TERRITORIAL GOVERNMENT PLAN (PGT)

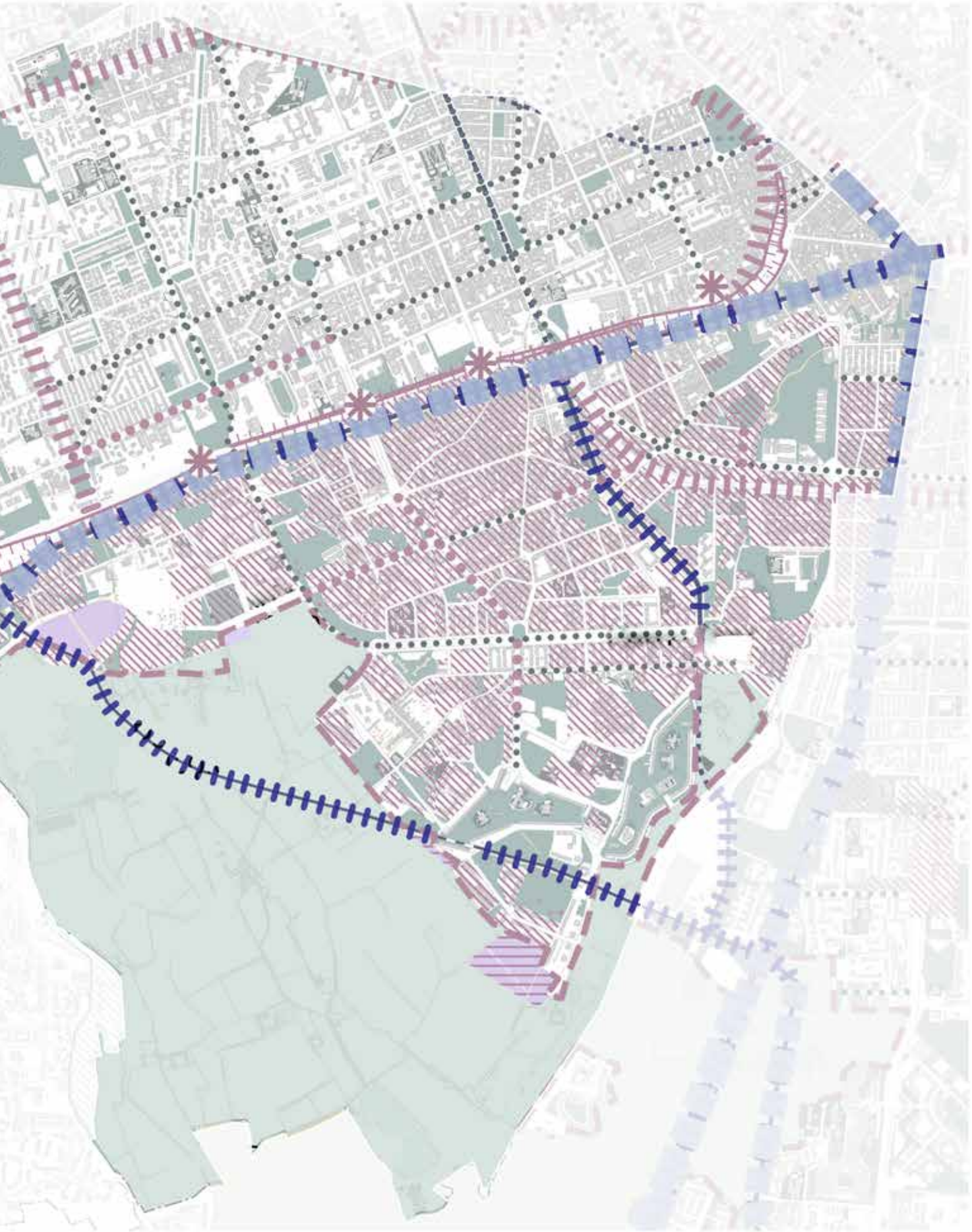
Table D03 Municipal Ecological Network Scheme

The Municipal Ecological Network is a system of green spaces and natural habitats that are interconnected and functionally linked, providing ecological and environmental services to the city.

LEGEND

- Areas of Environmental Regeneration
- Green Infrastructure
- Linear Green Connections
- Regional Parks: Parco Agricolo Sud
- Existing Urban Green
- Agricultural Areas
- Blue Infrastructure

Figure 39



MILANO 2030 - TERRITORIAL GOVERNMENT PLAN (PGT)

Table - G09 Local Seismic Hazard Map

The table provides guidelines and policies for building design and construction, as well as for land use planning, in order to reduce the vulnerability of buildings and infrastructure to seismic hazards.

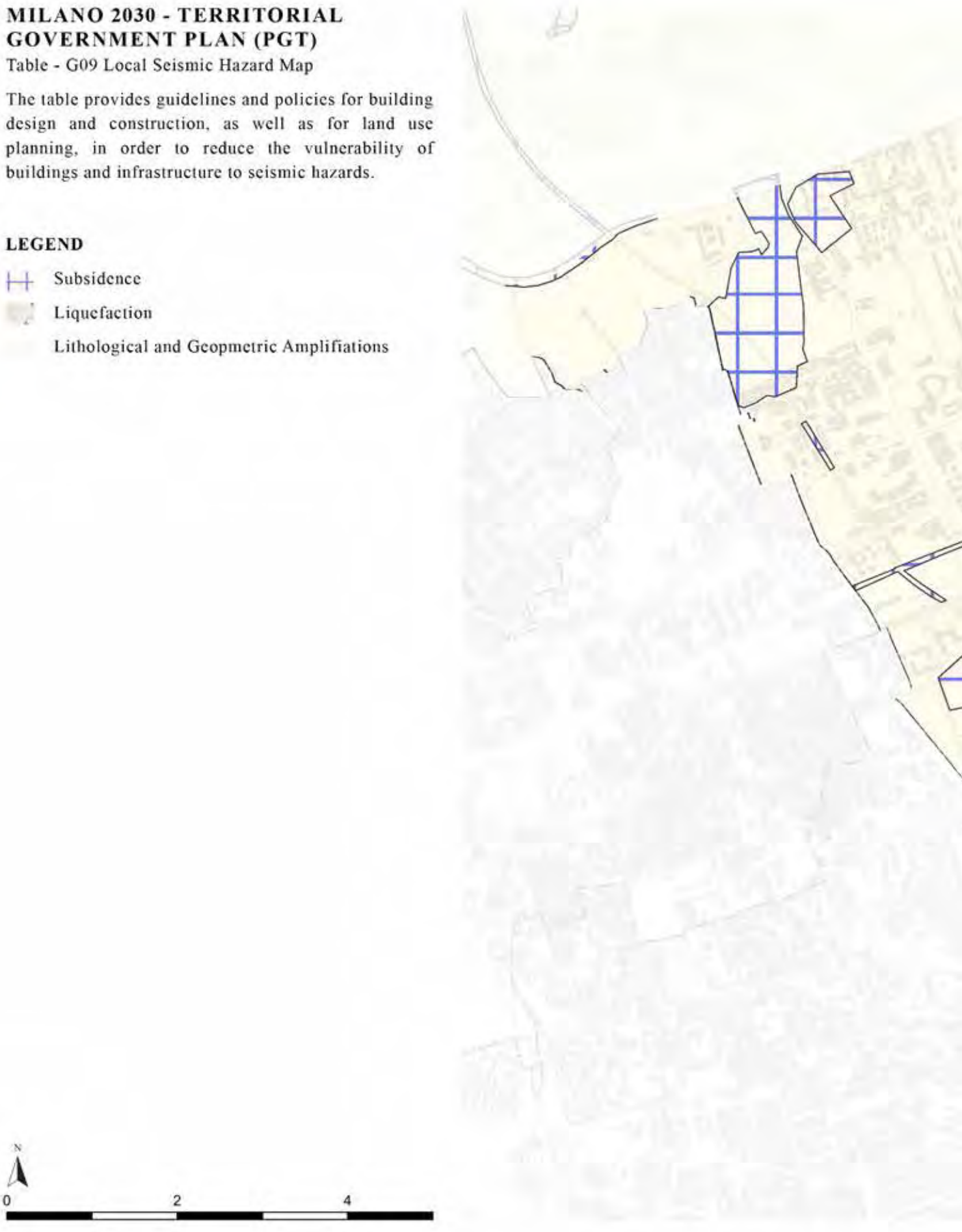
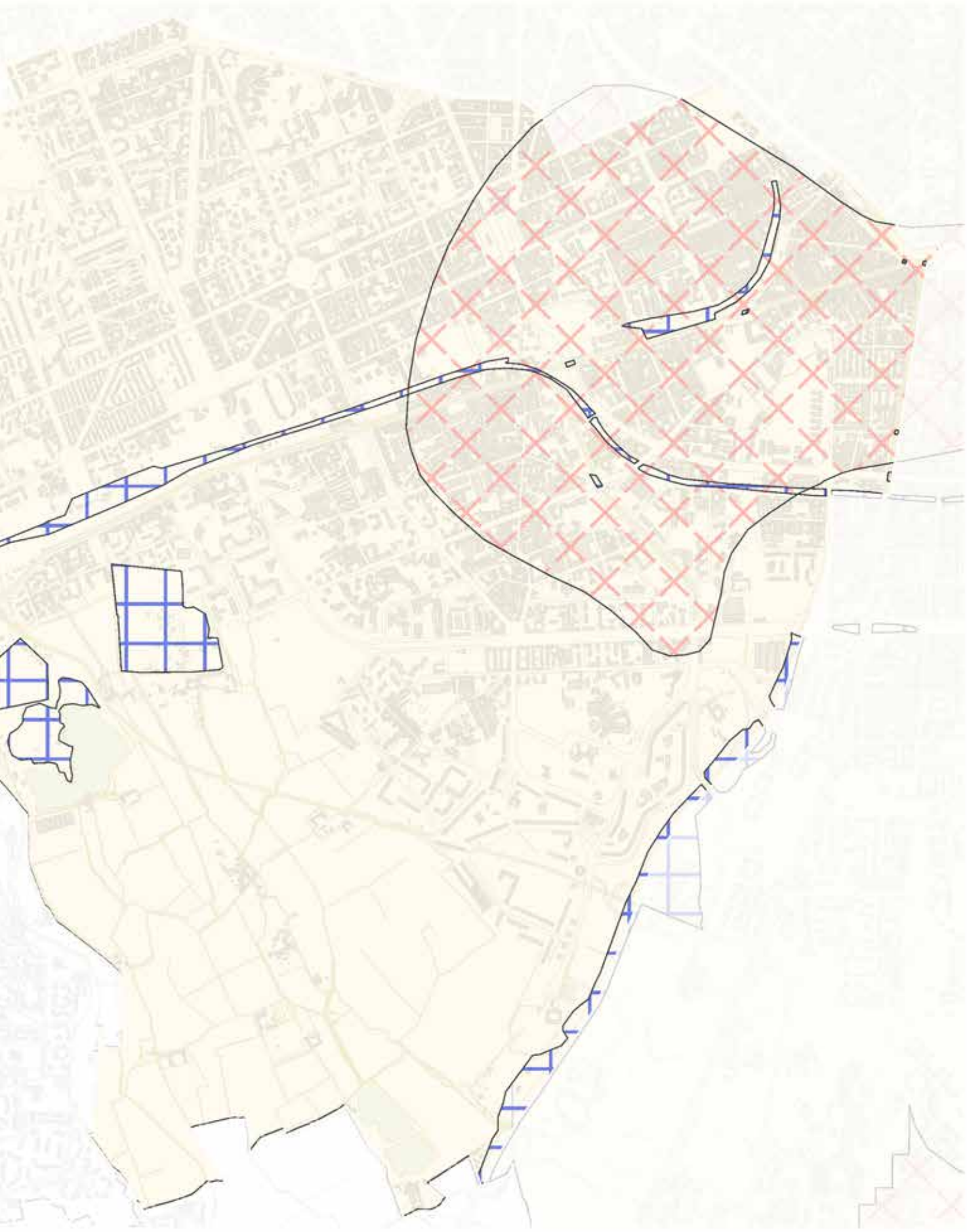


Figure 40



MILANO 2030 - TERRITORIAL GOVERNMENT PLAN (PGT)

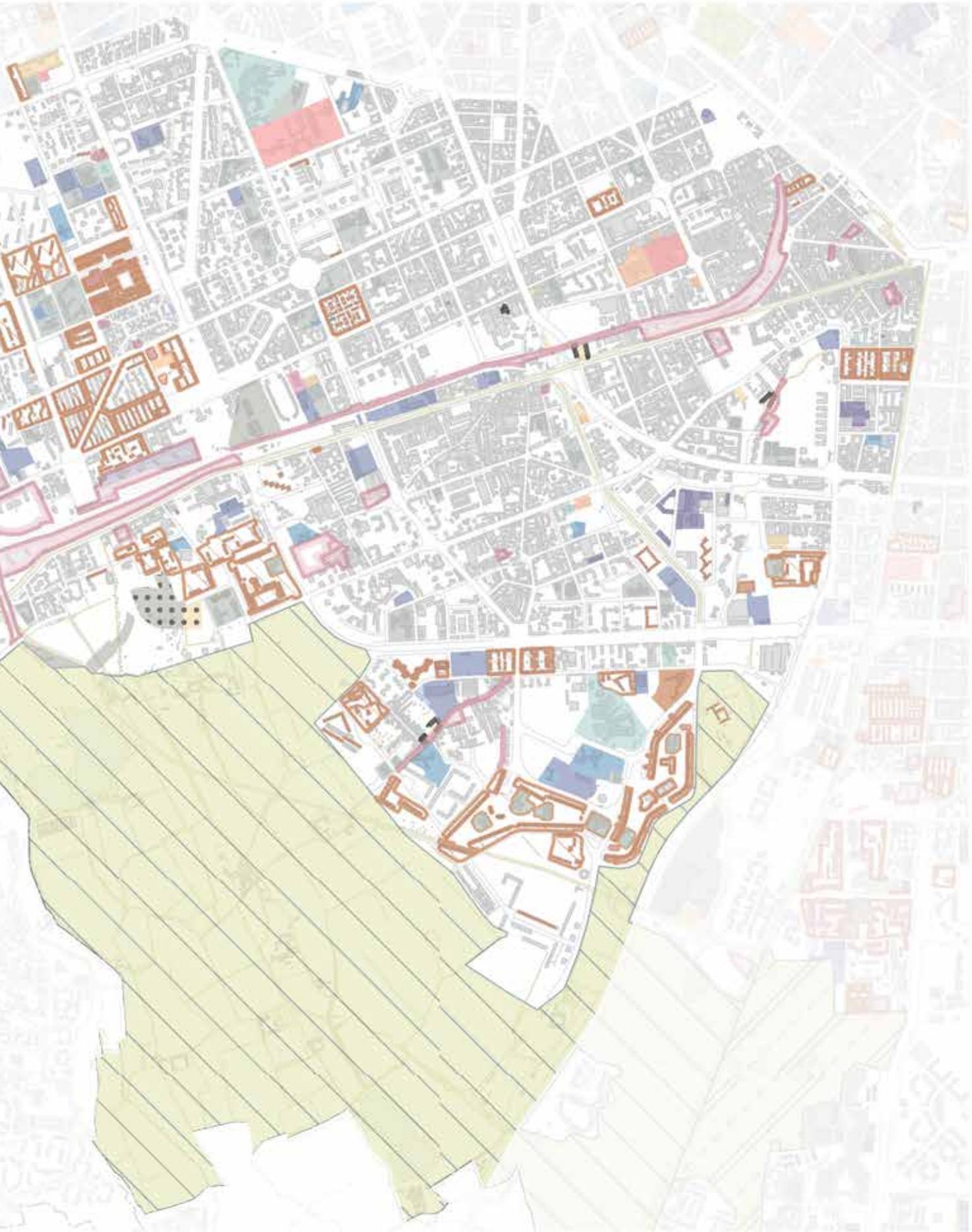
Table S01 Public services and general interest

The purpose of Table S01 is to ensure that these essential services are accessible to all residents of the city, regardless of their socio-economic status or location within the city.

LEGEND

- Administrative
- Commerce
- Culture
- Justice
- Instruction
- Health
- Sport
- Tourism
- University and Research
- Technological and Environmental
- Mobility and Public Transport
- Security and Civil Protection
- Residential
- Social Services

Figure 41



3.3. SCALE

In the literature review of Nature Based Solutions, we made the classification according to macro, meso, and micro scales. In the thesis study, we will classify using the same methodology so that the detailed examination necessary for the sustainable development of the region will be provided. By examining the whole area on a macro scale, the 2030 development plan created from the Milan PGT and PTCP studies will be created and integrated into the sustainable development work. In the meso scale, the principles determined for Nature-Based Solutions and Permaculture will be integrated together, focusing especially on the relations with the southern agricultural area and its surroundings. Finally, a sample residential building on the micro-scale will be determined, and a detailed analysis of the application of Nature Based Solutions and Permaculture will be made.

Double control will be provided with the understanding of macro-to-micro scale in Nature Based Solutions and micro-to-macro scale in permaculture. At the same time, the project is being developed, and thus, the working style of the methods developed for sustainable development will be determined correctly and applicable.

3.4. METHODOLOGY

In this section, the general methodologies of Nature-Based Solutions and Permaculture design will be combined, and a methodological approach will be created so that it can be applied to the area to be determined for the thesis.

When the classification of Nature Based Solutions is examined, it has been mentioned in the literature section that this classification is generally made over six interventions and ten challenges. In addition, scale and time are very important parameters in Nature Based Solutions. Therefore, short, medium and long-term project studies with macro, meso, and micro scales are required.

Permaculture designs, on the other hand, are projects that can start with individual inspiration, and they develop their work on the micro-scale and can spread to the macro scale over time while using the Zone System while doing. In addition, permaculture stands out as a set of ethical values, and while doing this, taking care of the World and humans and creating a fair and principled sharing system are the most important goals 12 design principles have been determined in order to implement this.

In this thesis, it is necessary to create a methodological approach to combine the two disciplines in order to systematically integrate the methodologies of Nature-Based Solutions and Permaculture to increase their benefits and to help them improve their social and ethical values. By creating systematic tables for short, medium, and long-term solutions on the macro scale, short, medium, and long-term solutions on the meso scale, and finally, short, medium, and long-term solutions on the micro-scale, in the light of scale and time parameters, which are among the most important parameters for Nature-Based Solutions. The general methodological approach will be explained. Nature Based Solutions and Permaculture intersect in many areas. By combining permaculture principles with Nature-Based Solutions, they can create a unity of common principles and approach solutions in design with a new perspective (Table 27).

Table 27

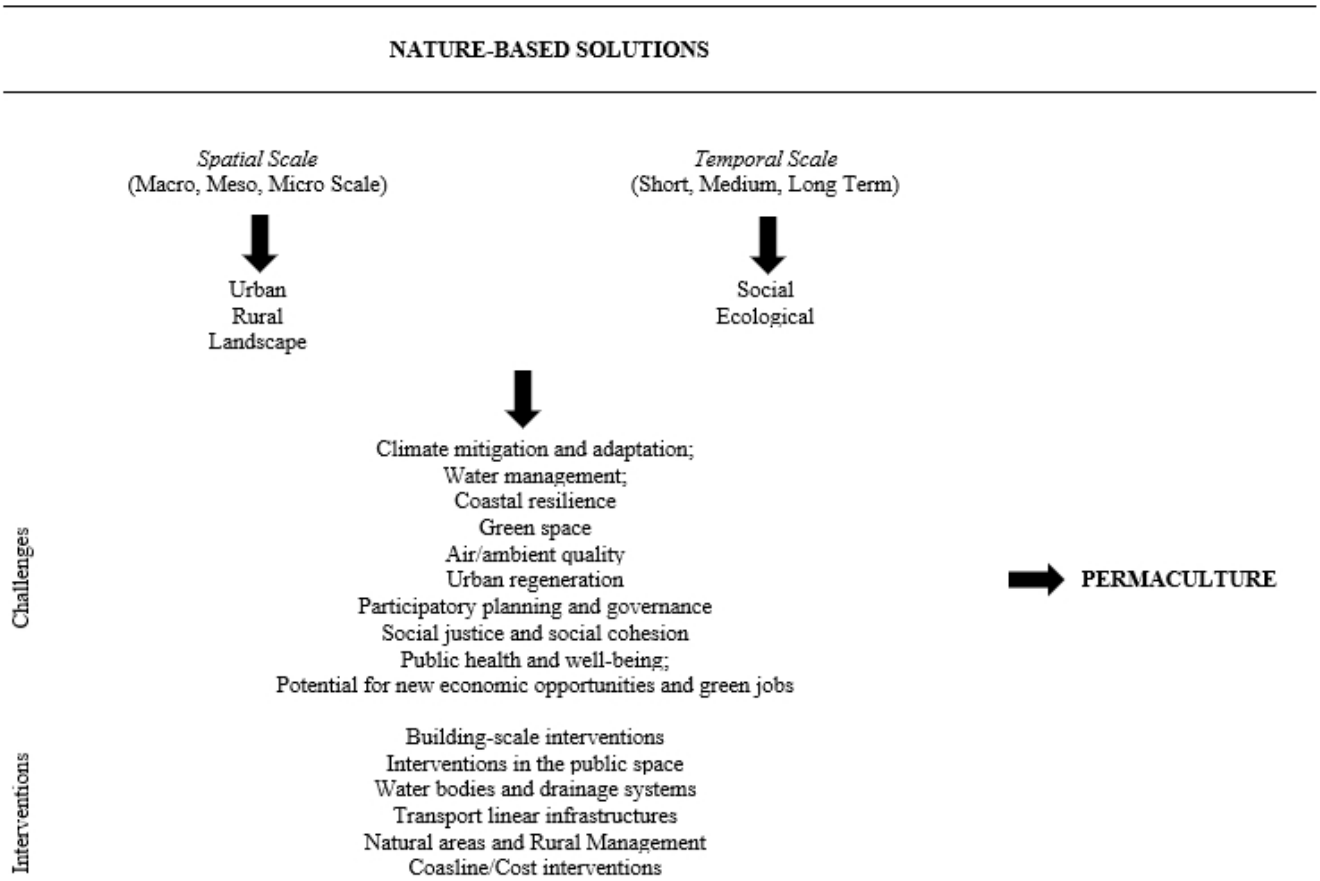
Intersection areas in line with the common goals of Nature Based Solutions and Permaculture Principles

Permaculture Principles	Observe and Interact	Catch and Store Energy	Obtain a Yield	Apply self-regulation	Use Value Renewable Resources, Services	Produce No Waste	Design from Patterns to Details	Integrate rather than Segregate	Use Small and Slow Solutions	Use Value Diversity	Use Edges and Value the Marginal	Creatively Use and Respond to Change
Nature Based Solutions												
Climate Mitigation and Adaptation	●	●		●		●	●	●	●	●	●	●
Water Management			●	●	●	●	●	●	●	●	●	●
Coastal Resilience			●	●	●	●	●	●	●	●	●	●
Green Space Management	●	●	●	●	●	●	●	●	●	●	●	●
Air/Ambient Quality		●	●	●		●		●	●	●	●	●
Urban Regeneration	●		●	●	●		●	●			●	●
Participatory Planning and Governance				●		●		●			●	●
Social Justice and Social Cohesion				●				●	●		●	●
Public Health and Well-Being				●		●		●	●		●	●
Potential for New Economic opportunities		●	●	●	●	●		●			●	●
Building-Scale Interventions			●	●	●	●	●	●	●	●	●	●
Public Space Interventions			●	●	●	●	●	●	●	●	●	●
Water Bodies and Drainage Systems Interventions			●	●	●	●	●	●	●	●	●	●
Transport Linear Infrastructures Interventions			●	●	●	●	●	●	●	●	●	●
Natural Areas and Management of Rural Land Int.	●	●	●	●	●	●	●	●	●	●	●	●
Coasline Interventions			●	●	●	●	●	●	●	●	●	●

Notes.*Own Work*

Table 28

General Methodology



Notes.*Own Work*

Table 29

Genel Methodology Analysis List.

	Step 1. *Analysis*	*Step 2.* *Conceptual Approach*	*Step 3.* *Design*
Macro Scale	Systemic Analysis Heat Map Blue Infrastructure Green Infrastructure NBS Interventions NDVI analysis	Synthesis Map	Master Plan 1.1000 Section 1.1000 3D
Mezo Scale	CO2 Emission Map Landuse 2030 Milan Plan, PGT, SDG Functional areas	Synthesis Map Diagram	Master Plan 1.200 Section 1.200 3D
Micro Scale	Figure Ground Building Typology Vegetation Climate Topography Tangible, Intangible Heritage Synchronic Map Diachronic Map	Synthesis Map Diagram Collage	Master Plan 1.50 Section 1.50 Elevation 1.50 3D

Notes. *Own Work*

The general methodological approach of the thesis will start with the analyzes to be made at macro, meso, and micro scales. In this way, the project will be able to directly examine the natural, environmental, political, and social aspects of the area and determine the appropriate principles for Nature-Based Solutions and Permaculture. Later, the analyzes will be combined and synthesized, and design approaches will be determined. In the last stage, the project will be explained with design and architectural methods.

4.DESIGN PROCESS

4.1. Information About Design Process

Milan has the potential to be an important field of study in terms of its cultural, economic, historical and environmental impact for Nature Based Solutions and Permaculture design. As it can be understood from Policy Documents, it is desired to protect and develop the cultural and historical texture of Milan by working on politically environmentally friendly solutions. Therefore, it is important to carry out and research the ecological projects to be made in Milan in this context. Design proposals that strengthen and develop the relationship between Nature and Human, which is one of the important aims of the project, are important for preserving the texture of Milan. With this thesis, can the ecological sustainability principle, which is of great importance for Milan, be developed by investigating the relationship between Nature-Based Solutions and Permaculture? It is desired to contribute to the sustainable development of the city by researching this in harmony with the existing policies, Nature-Based Solution and Permaculture.

As stated in the Design Process methodology, one should start with the current analysis of Milan. In this way, it is possible to reach the right result and make a design suggestion. Although this thesis wants to present a design proposal, the analysis is of great importance in this context, as its main purpose is to investigate the contribution of the cooperation of Nature Based Solutions and Permaculture to sustainable development.

The design strategy to be created after the analysis can work in cooperation with existing policies such as PPR, PTCP, PGT and supports these policies. The design strategy created after the current analysis and the subsequent design proposal should be considered as the case study of the study and should be considered as a road map. In this way, it is aimed to give an idea about how the application can be made on the sample area by determining the joint working principles of Nature-Based Solutions and Permaculture.

4.2. Analysis

The main analysis part of the thesis proceeded with an approach from the general to the specific. Therefore, by synthesizing the PPR analysis of the Lombardy Region, the region was looked at from a general point of view, and then the analyzes required for the Nature Based Solutions and Permaculture design were made by going down to the city scale of Milan. In the next step, the Milan Zone 6 region was analyzed and the potential areas, challenges and overall strategy for Nature-Based Solutions and Permaculture design were established. Then, Nature-Based Solutions and Permaculture principles were applied on the neighborhoods and streets selected from the region.

LOMBARDIA REGIONAL PLAN

PPR - Synthesis Map

LEGEND

- Provincial Borders
- Regional Borders
- Internal catchment areas
- Surface hydrography
- Railways
- State Roads
- Highway
- Urbanized areas
- Stelvio National Park
- Regional Parks
- Areas of high naturalness
- Area of specific historical environmental value
- Protection and redevelopment of the Mantua lakes
- Insubric lakes
- Scope of specific landscape protection of the river
- Scope of landscape protection of the river valley system
- Landscapes of the valleys and slopes
- Landscape of Relief Enerjies
- Landscapes of insubric Lakes
- Landscape of the mountains and ridges
- Landscape of the pre-alpine valleys
- Landscape of the amphitheaters and morainic hills
- Landscape of the foothills and the Banina hill
- Landscapes of the excavated river valleys
- Landscapes of the diluvial shelves and the dry high plain
- Landscapes of the river belts
- Landscape of forage crops
- Landscape of the cereal plain
- Landscape of the rice plain

N

0 5 10 20 30 40

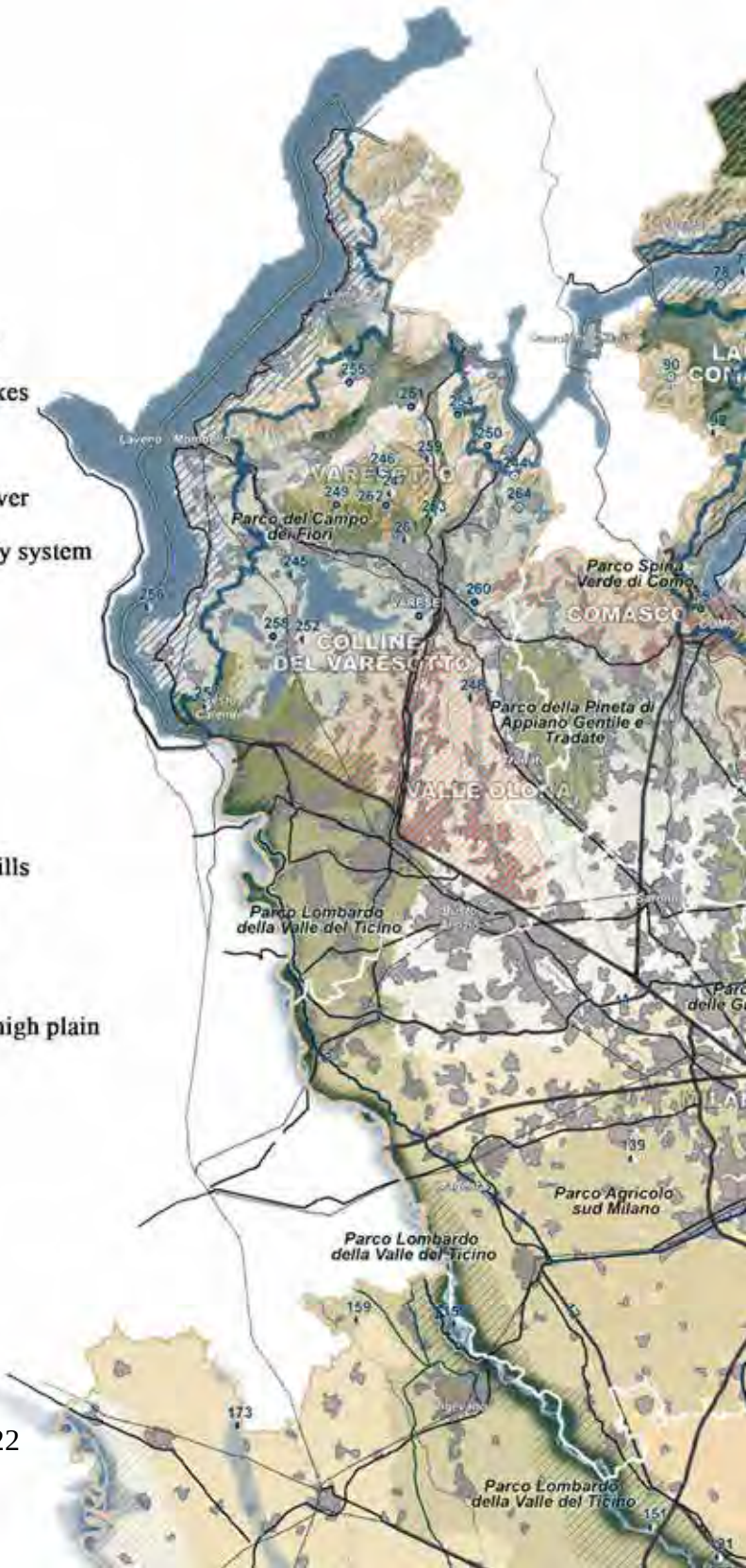


Figure 42


VALCHIAVENNA
VALTELLINA
SONDRIO
Parco delle Orobie Valtellinesi
VAL CAMONICA
Parco delle Orobie Bergamasche
Parco della Grigna Settentrionale
LECCHESE
VALLI BERGAMASCHE
Parco del Monte Barro
Parco di Montevecchia e della Valle del Curone
Parco dei Colli di Bergamo
Parco Valle del Lambro
BRIANZA
FRANCIACORTA
Parco del Serio
PIANURA BERGAMASCA
Parco dell'Adda Nord
Parco Nord Milano
Parco Agricolo sud Milano
Parco dell'Oglio Nord
Parco Regionale del Monte Netto
CREMASCO
BRESCIANO
Parco del Serio
Parco Agricolo sud Milano
LODIGIANO
Parco dell'Adda Sud
Parco dell'Oglio Sud
PAVESE

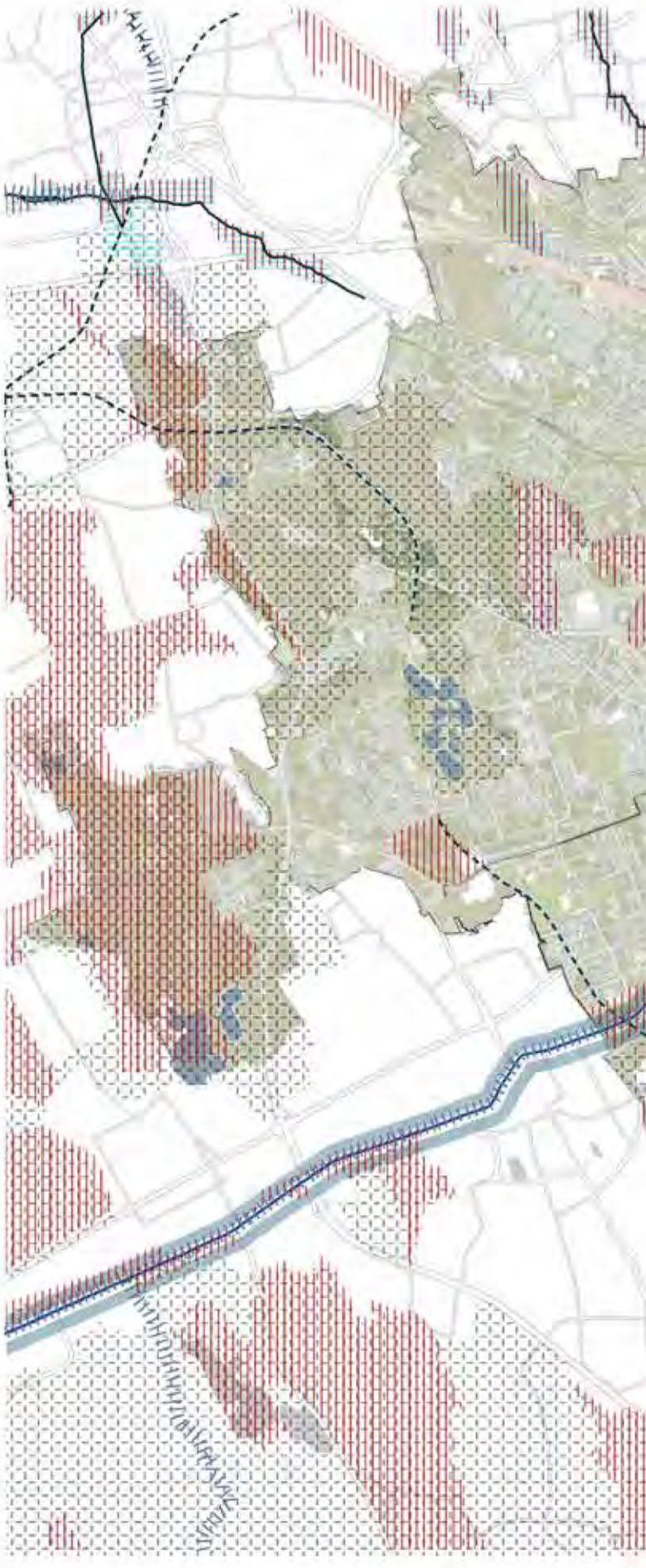
MILANO
SYNTHESIS MAP

In this map, Milan's general analyzes are combined, such as green-blue infrastructure, ecological analysis and areas that need protection are synthesized.In this way, the risks and advantages in the general view of Milan are shown.

LEGEND

Centers of Interchange

- Forest
- Vegatation Areas
- Uncultivated Pasture
- Agricultural Areas
- Courtyard Vegatation Areas
- South Milan Agricultural Park
- Temporarily Devoid of Vegetation Areas
- Pond
- Stream
- Naviglio Grande River
- Lambro River
- Underground Stream
- Re-opening Naviglio
- Bands of Landscape-River Importance
- Main River Ecological Corridors
- Regional Ecological Network
- Areas of Landscape Importance
- Naviglio System - Buffer 200 m.



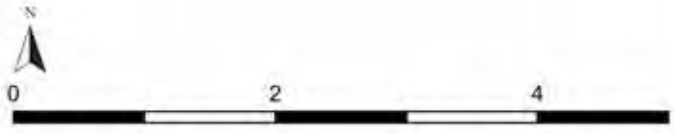
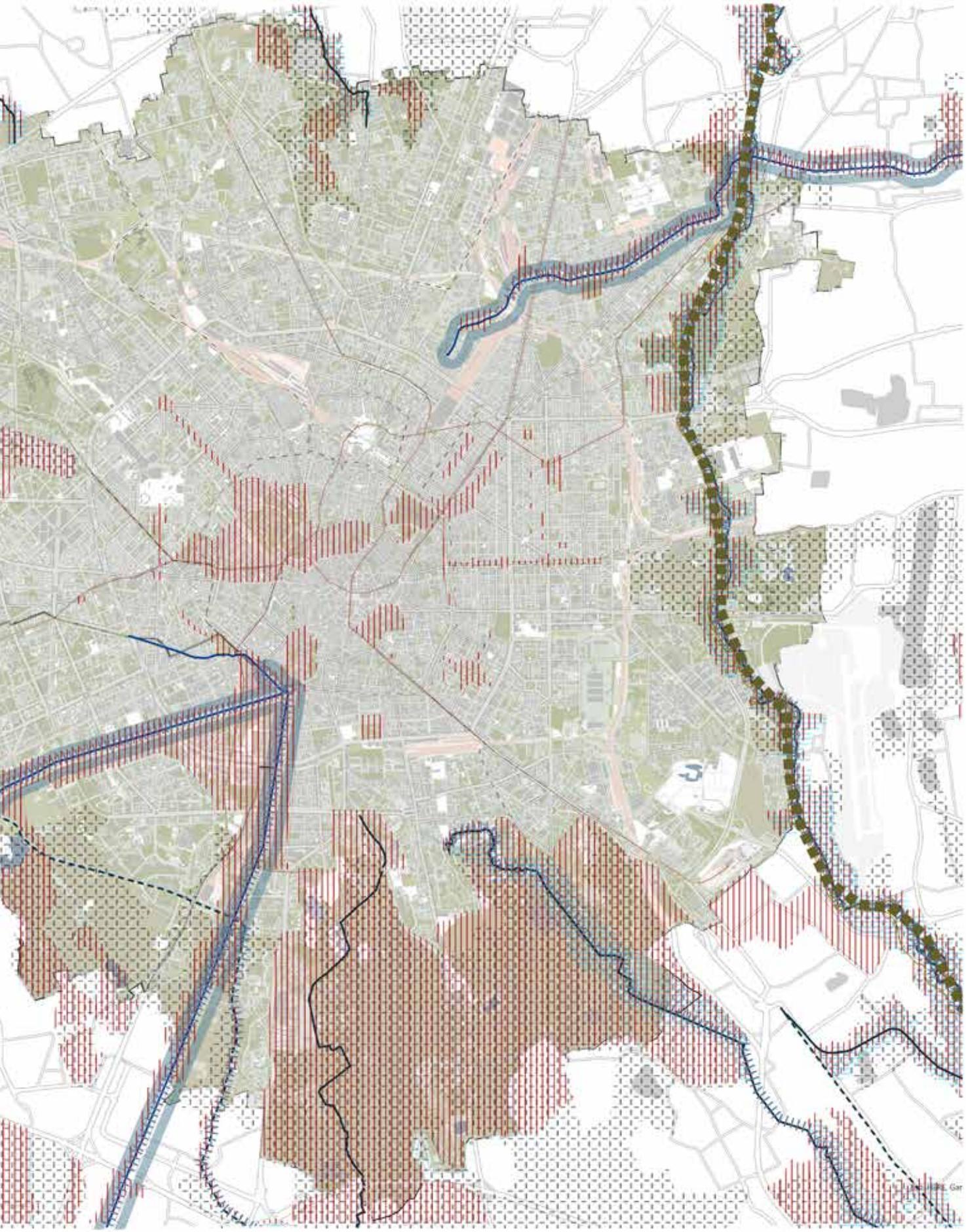


Figure 43



MILANO
BLUE INFRASTRUCTURE

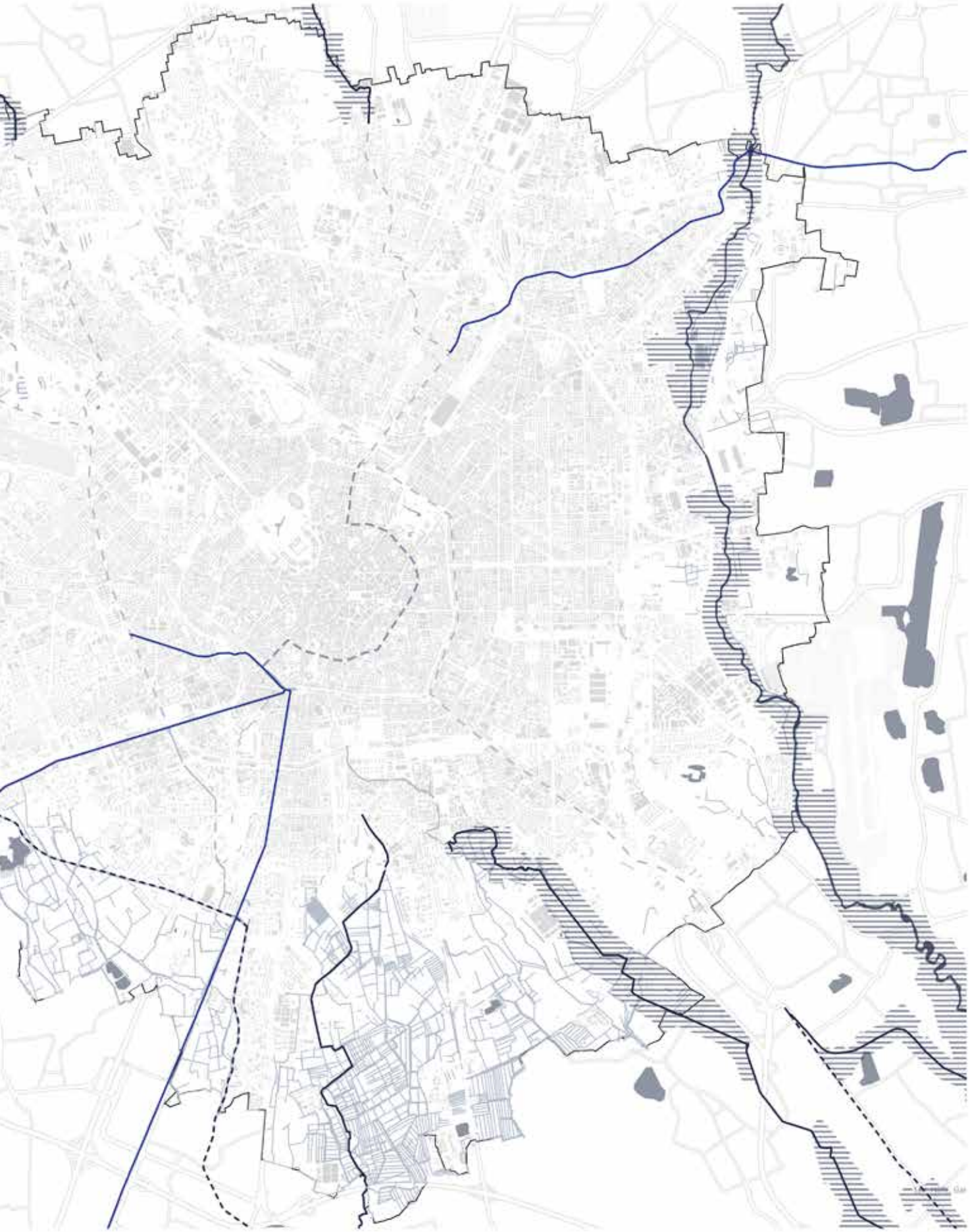
The canal and its associated waterways, including the Naviglio Pavese and the Naviglio Martesana, are important elements of Milan's blue infrastructure. In addition, there are many irrigation channels, especially around the southern agricultural park.

LEGEND

Centers of Interchange

- Pond
- Stream
- Naviglio Grande River
- Lambro River
- Underground Stream
- Re-opening Naviglio
- Bands of Landscape-River Importance

Figure 44



MILANO
GREEN INFRASTRUCTURE

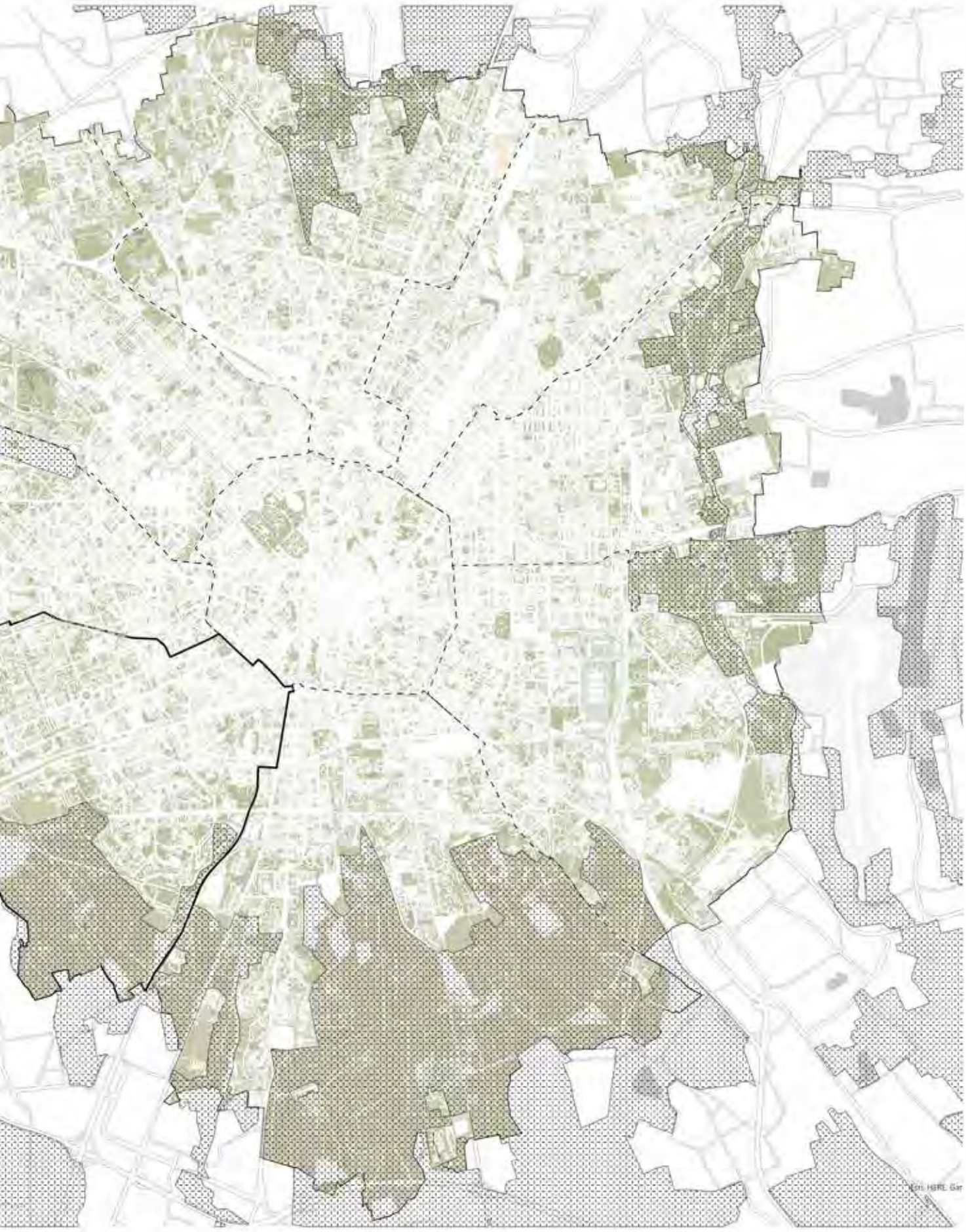
Green infrastructure refers to the interconnected network of natural and semi-natural spaces that provide a range of ecosystem services. These services include improving air and water quality, mitigating the urban heat island effect. and supporting biodiversity.

LEGEND

Centers of Interchange

- Forest
- Vegatation Areas
- Uncultivated Pasture
- Agricultural Areas
- Courtyard Vegatation Areas
- South Milan Agricultural Park
- Temporarily Devoid of Vegetation Areas

Figure 45



MILANO
FOOTPRINT ANALYSIS

This map classifies areas according to the amount of carbon footprints affect. The largest sources of emissions were transportation, which accounted for 50% of the total, followed by energy consumption in buildings (27%) and waste management (16%).

LEGEND

Carbon Footprint

- Low
- Medium
- High

Figure 46

MILANO
NITROGEN DIOXIDE (NO2) EFFECT

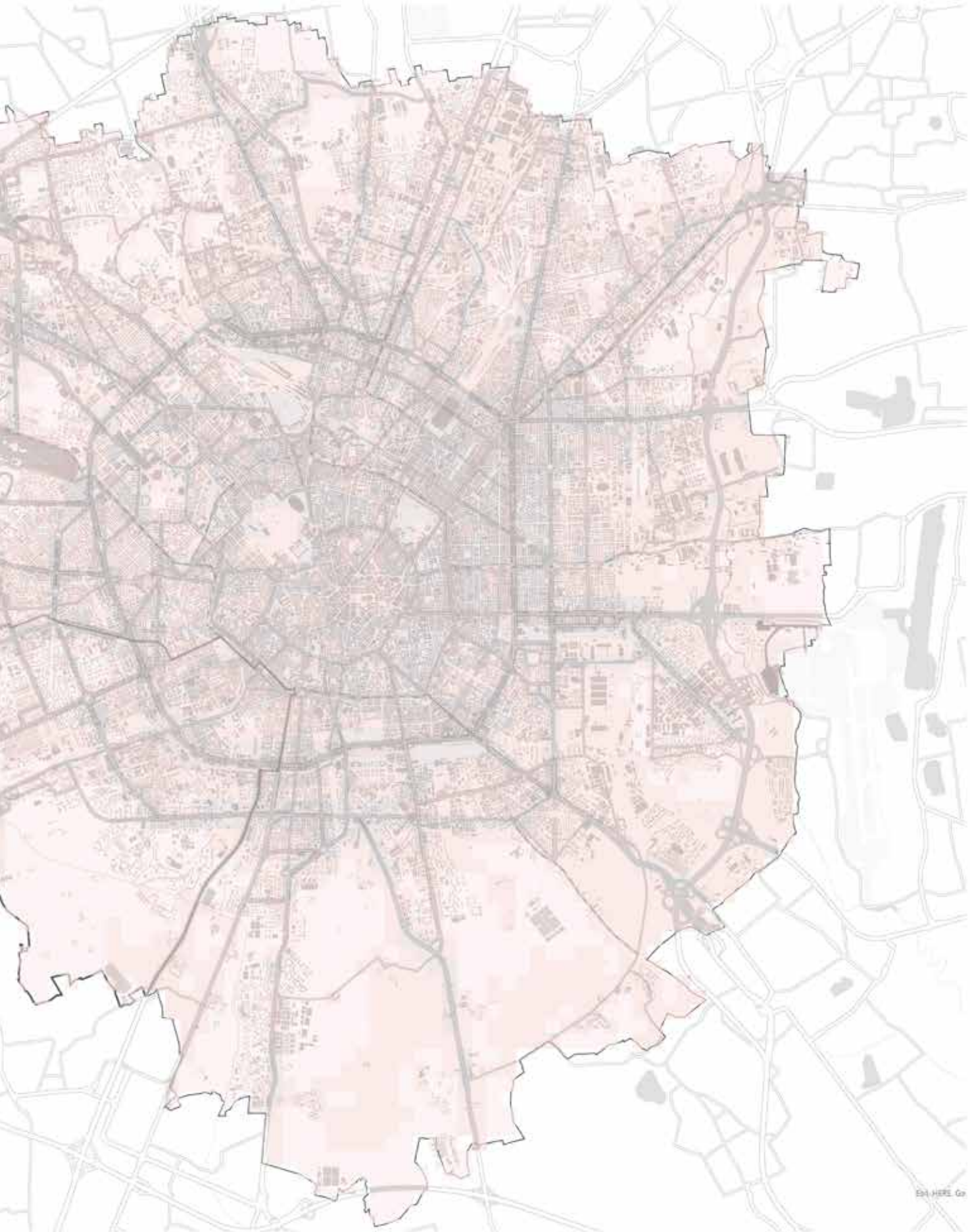
This map shows the amount of nitrogen dioxide for measuring and evaluating Milan's air quality.The estimate describes the impact deriving from the exposure of the population of Milan to concentrations of NO2 higher than the annual average of 20µg/m3.

LEGEND

m3 NO2	% increase general mortality
40 - 45	2.80%
45 - 50	5.50%
50 - 55	8.30%
55 - 60	11,0%
60 - 65	13.8%

m3 NO2	% increase in bronchitis symptom frequency in children (5-14 years)
40 - 45	10.5%
45 - 50	21.0%
50 - 55	31.5%
55 - 60	42.5%
60 - 65	52.5%

Figure 47



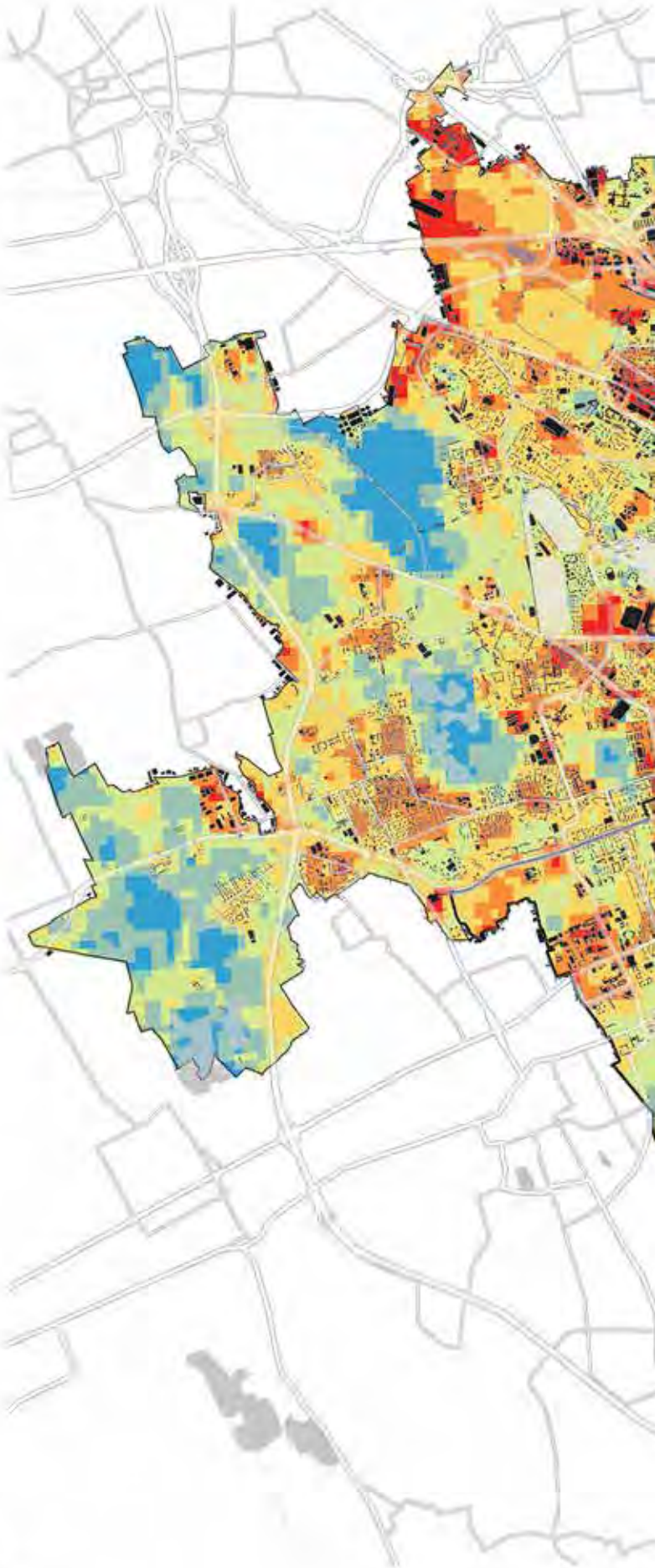
MILANO
LAND SURFACE TEMPERATURES

Identification of Major Summer Hotspots over Milan using Landsat-8 Thermal Satellite data: Fine resolution satellite thermal data used as a basis for mapping the spatial distribution of urban surface temperatures and identifying urban hotspots in summertime

LEGEND

Temperatures

- 27.9 - 30.0
- 30.0 - 32.2
- 32.2 - 34.4
- 34.4 - 36.6
- 36.6 - 38.8
- 38.8 - 41.0



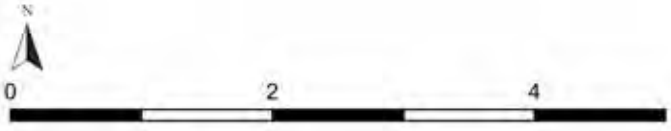
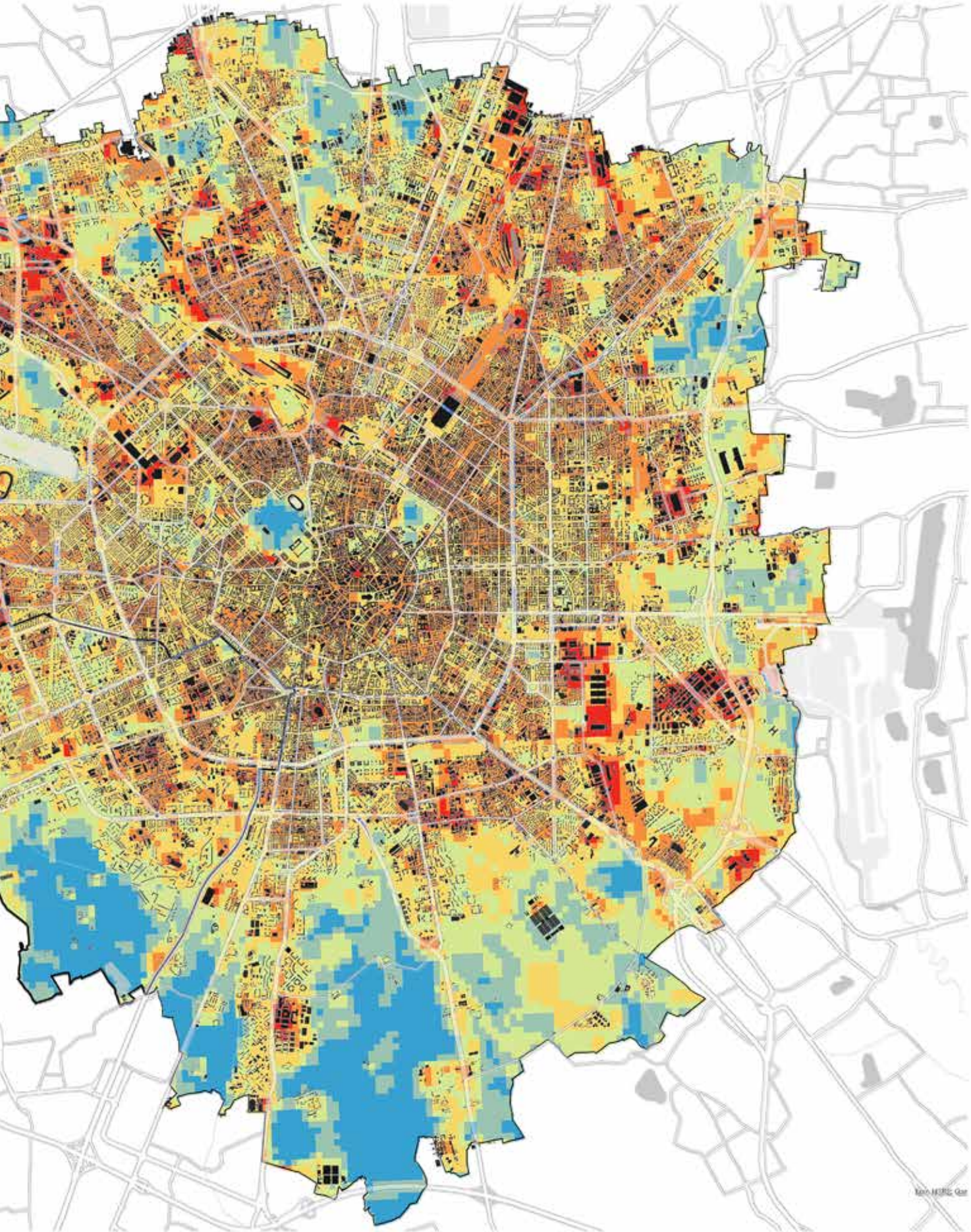


Figure 48



MILANO
NDVI ANALYSIS

Normalized difference vegetation index (NDVI) is a simple graphical indicator that is often used to analyze RS measurements and assess whether the target being observed contains green health vegetation or not.

LEGEND

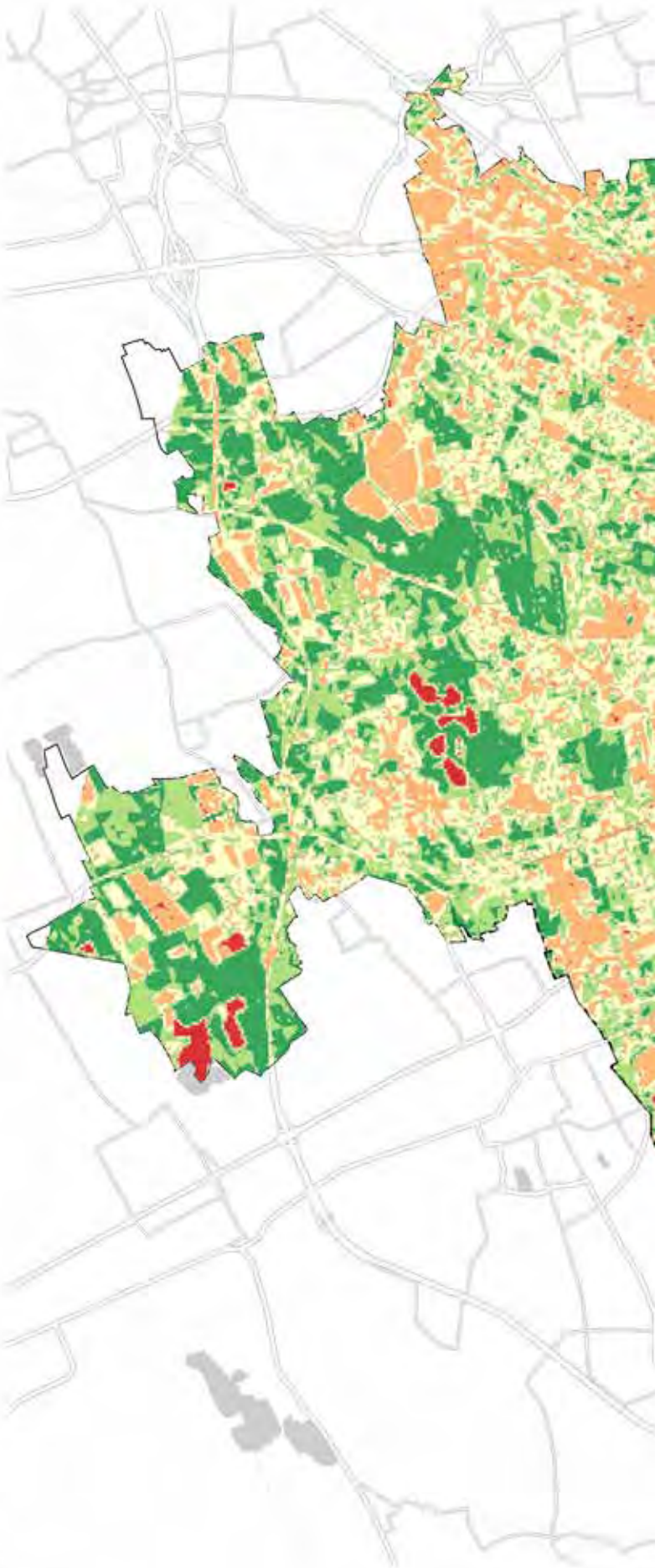
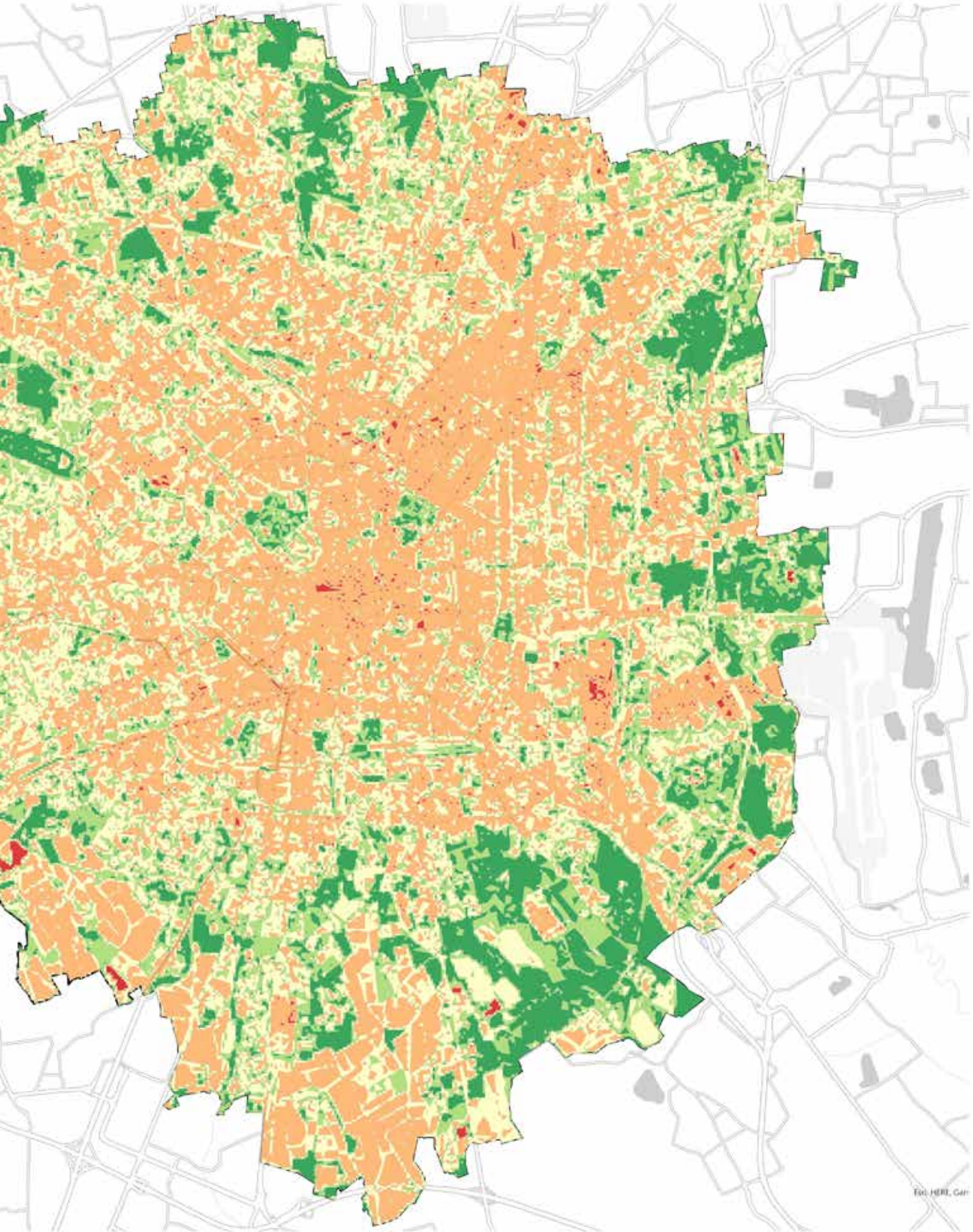


Figure 49



MILANO
FIGURE GROUND ANALYSIS

To understand the form of the development, built versus unbuilt, street patterns and block typologies around the site.Buildings are filled in black and the voids (open lands) in white.Provide guidelines for contextual and spatial analysis and block organisation.

LEGEND

Centers of Interchange

- Solid
- Void
- Transportation
- District Borders
- City Border

Figure 50


Esri, HERE, Gar

MILANO
BUILDINGS DENSITY

This map shows the distribution of Milan on areas with hard and soft structures. Milan center and its surroundings attract attention especially as dense building areas.

LEGEND

Building Density

- High
- Low
- Very Low
- Lowest

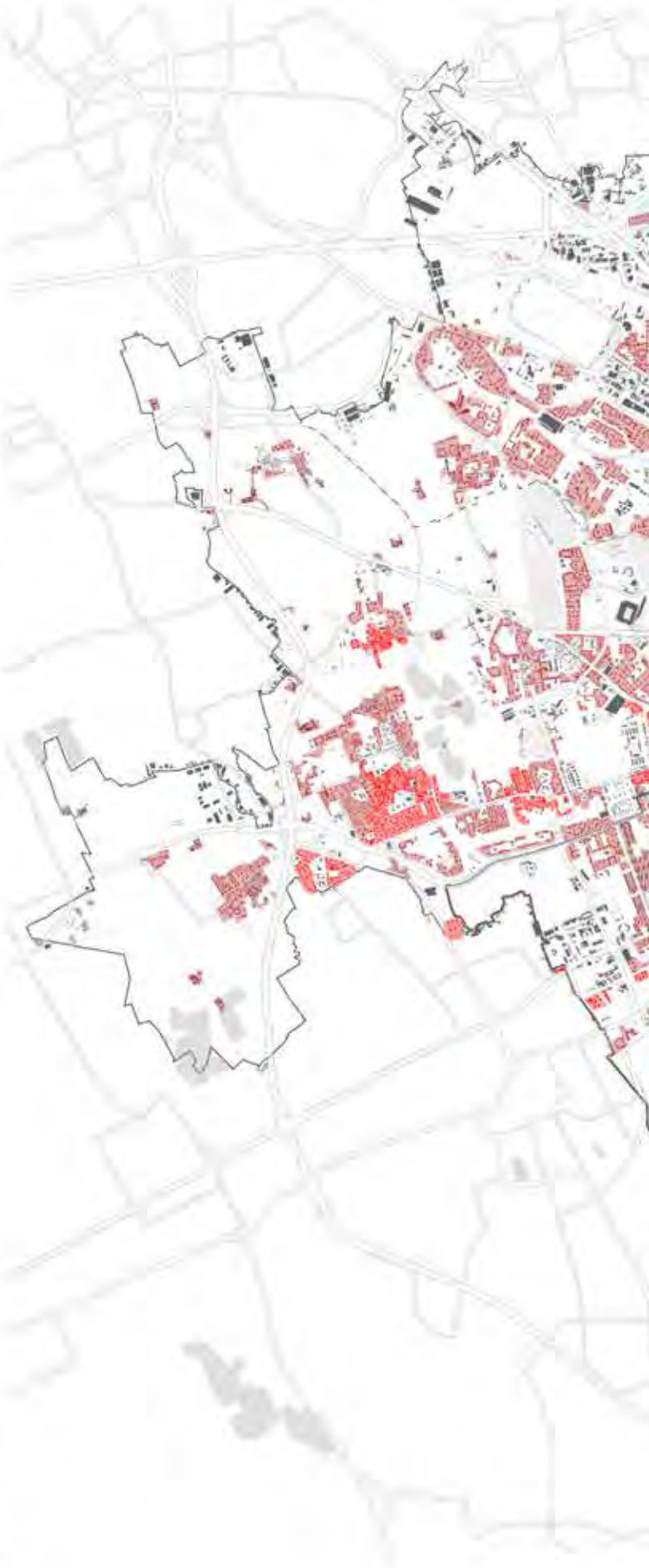
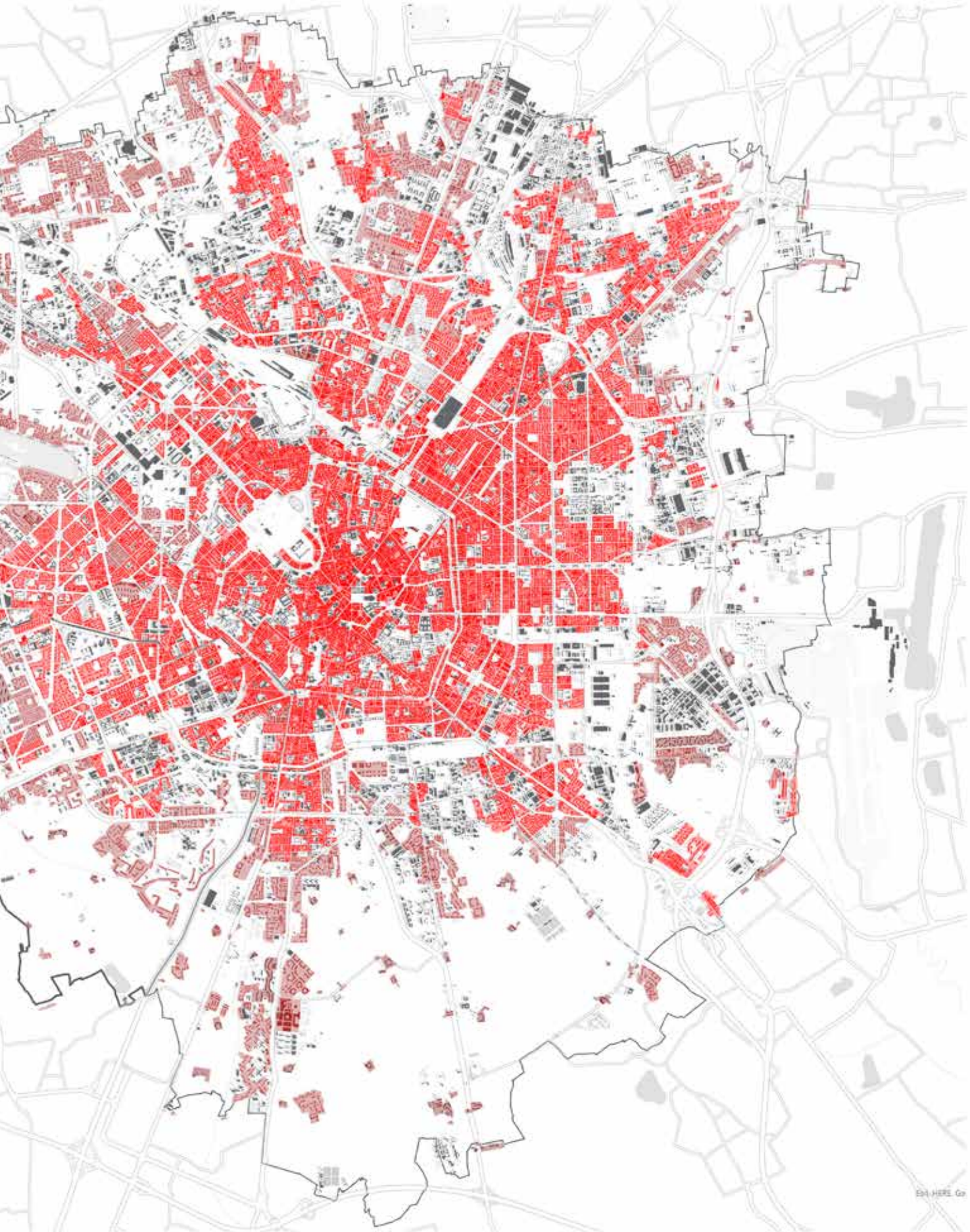


Figure 51



MILANO
POPULATION DENSITY

This map shows the distribution of the Milan population over the areas. The surrounding area of Milan center attracts attention especially as dense living areas.

LEGEND

Population Density

- Highest
- Very High
- High
- Low
- Very Low
- Lowest

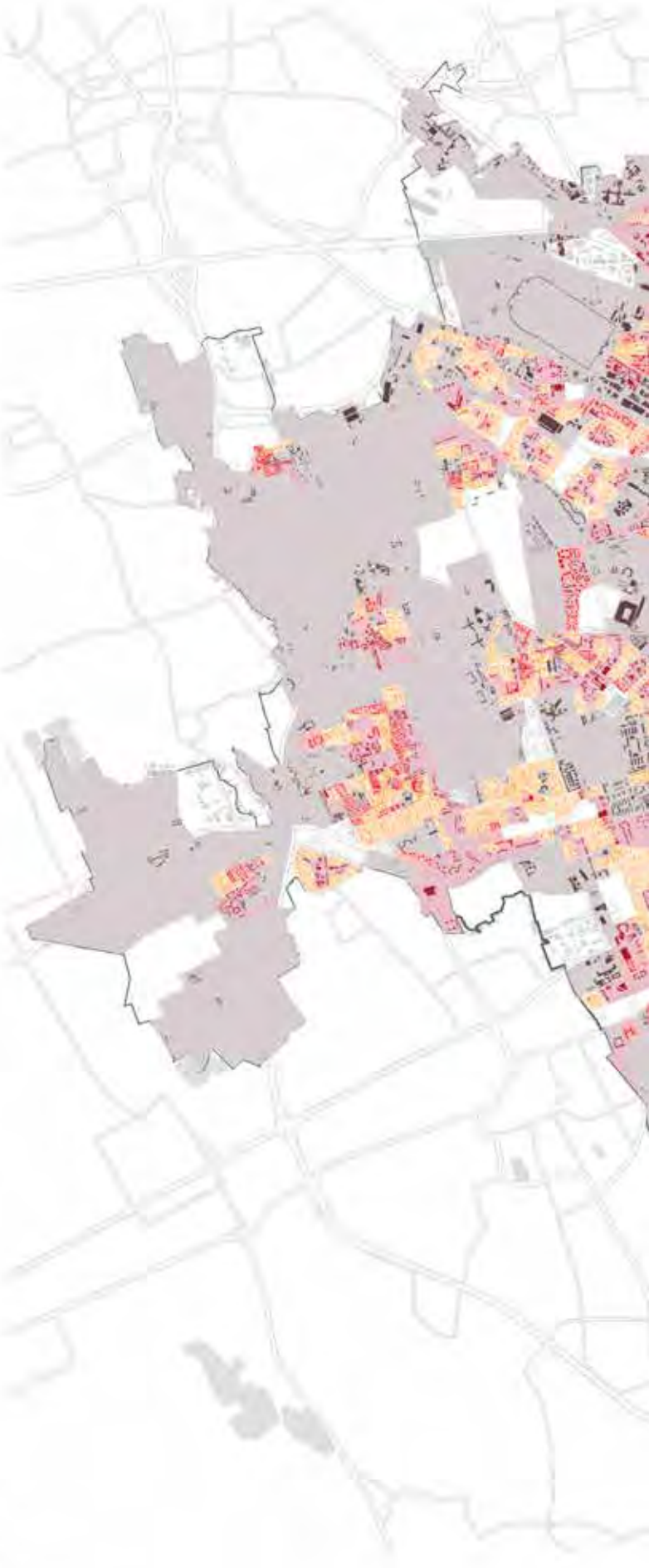
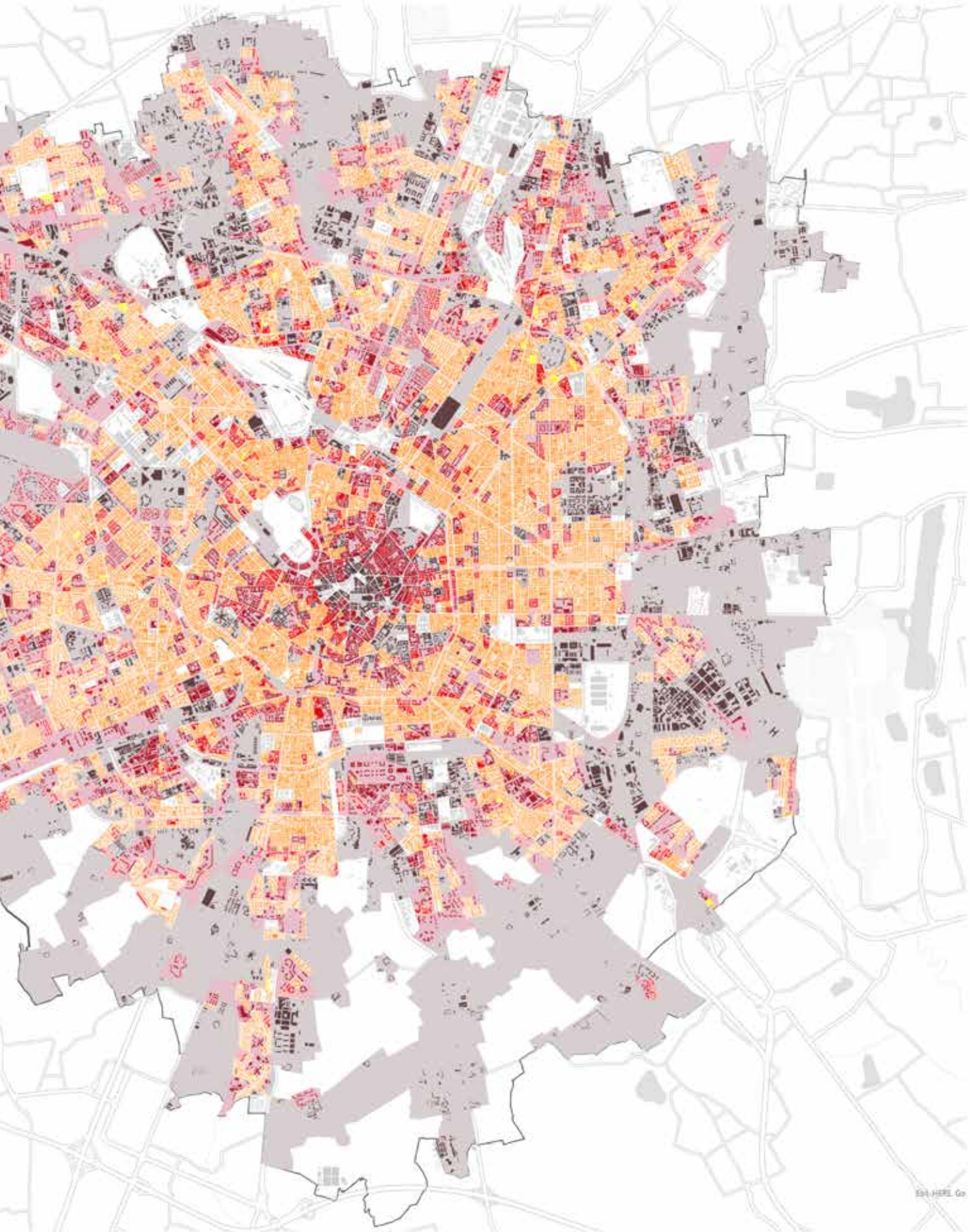


Figure 52



MILANO
TOPOGRAPHY AND RELIEF MAP

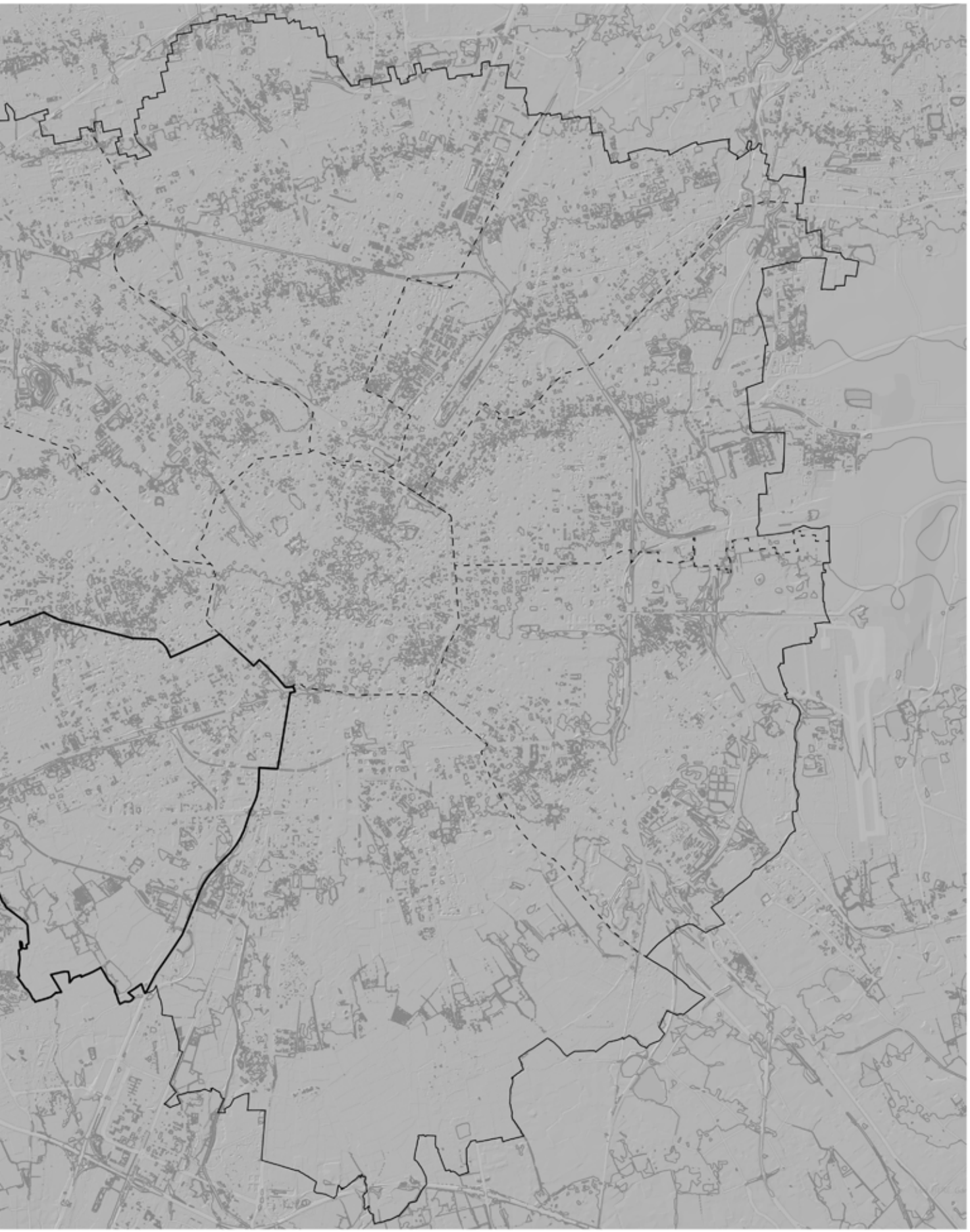
This map consists of isohips lines created at 5 m intervals and a raised-relief map in order to show the Geographical landforms of Milan.

LEGEND

Raised-Relief

5m intervals

Figure 53



MILANO
SOIL ANALYSIS

There are two different lands in the south-west Milan region. These are Suoli Motta franco sabbiosi (MTT1) (Typic Endoaquepts coarse loamy, mixed, superactive, mesic), and Suoli Figino franchi (FIN1) (Aquic Hapludalfs coarse silty, mixed, active, mesic), located in the medium hydromorphic plains.

LEGEND

MTT1 - Suoli Motta Franco Sabbiosi

The sandy loam Motta soils are located in the main depressions and at the heads of the springs, areas which share drainage difficulties due to the presence of a semi-permanent aquifer close to the surface. The slope is none to low (0.1%). They were formed on non-calcareous sandy-silty sediments. They have a homogeneous distribution in the cartographic unit and are mainly used for arable land.

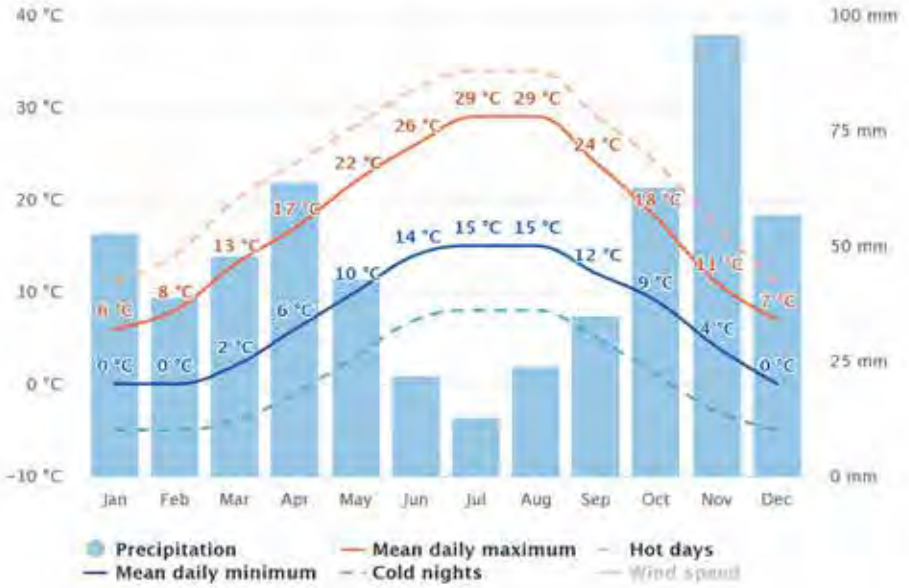
FIN1 - Suoli Figino Franchi

The Figino franc soils are located on the sub-level surfaces interposed between the main flow lines and the more stable areas, with poor or slow drainage. The slope is none to low (0.1%). They were formed on fluvio-glacial gravel deposits with a silty sandy or clayey sandy matrix. They have a homogeneous distribution in the cartographic unit and are mainly used for alternating arable land, with poplar groves.

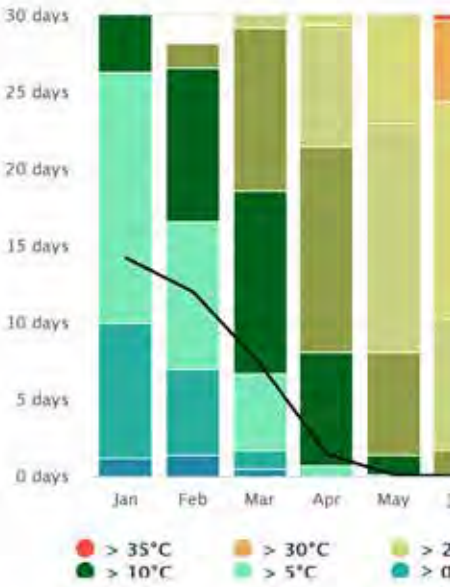
Figure 54

MILANO CLIMATE ANALYSIS

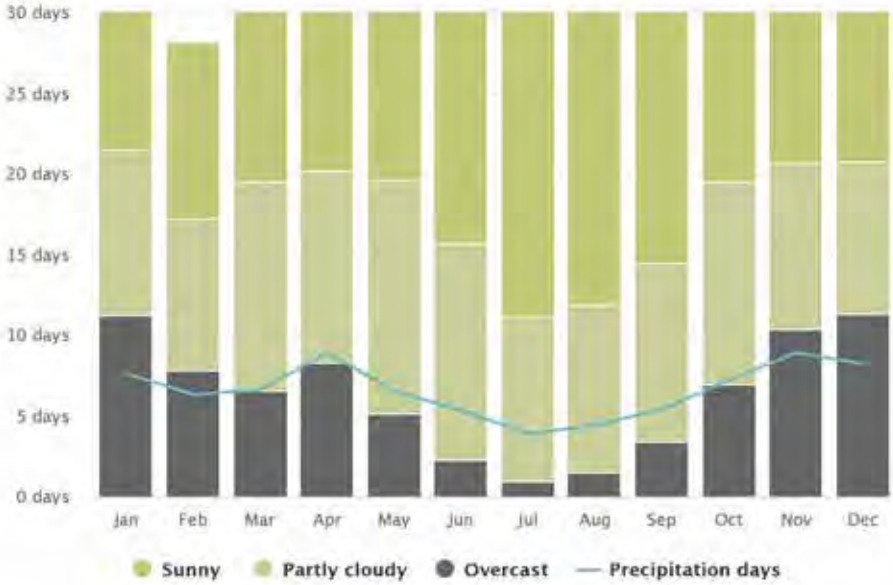
Average Temperatures and Precipitation



Maximum Temperatures



Cloudy, Sunny, and Precipitation Days



Precipitation Amounts

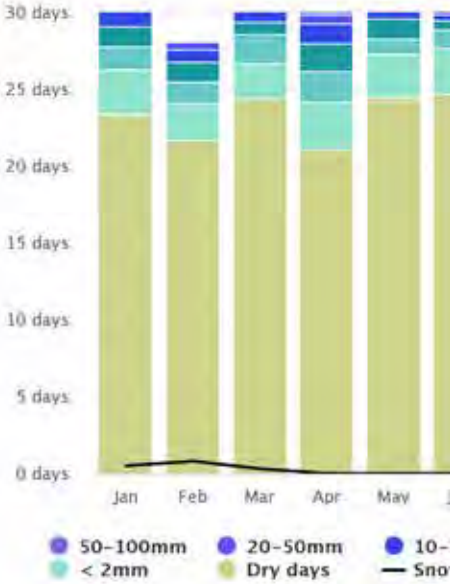
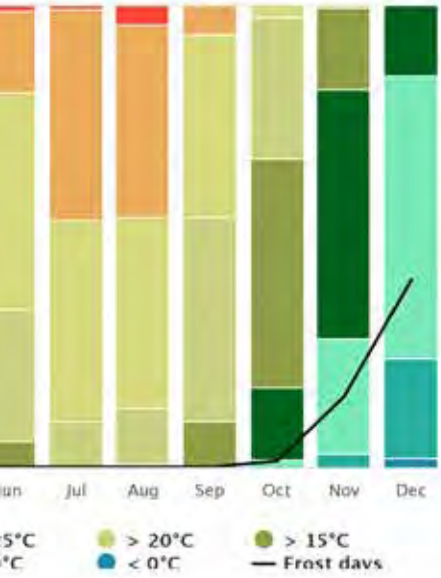
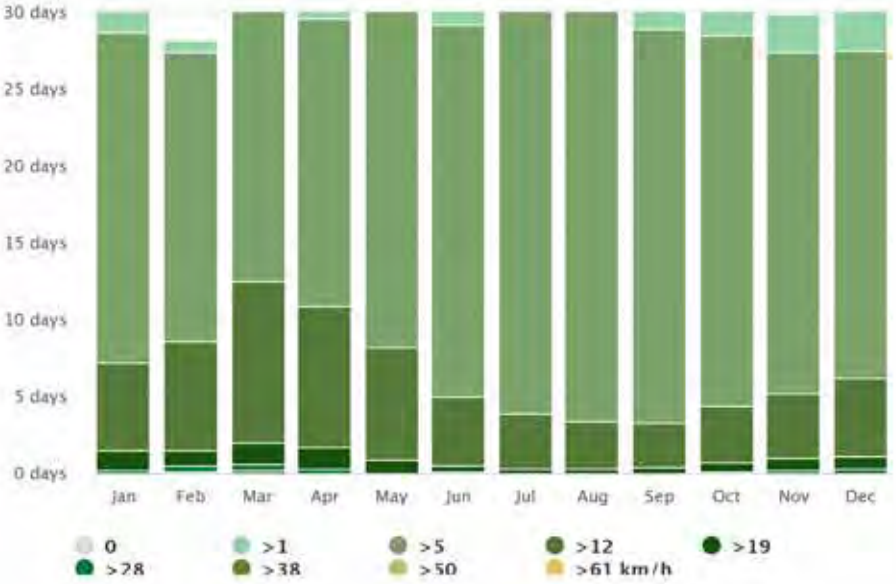
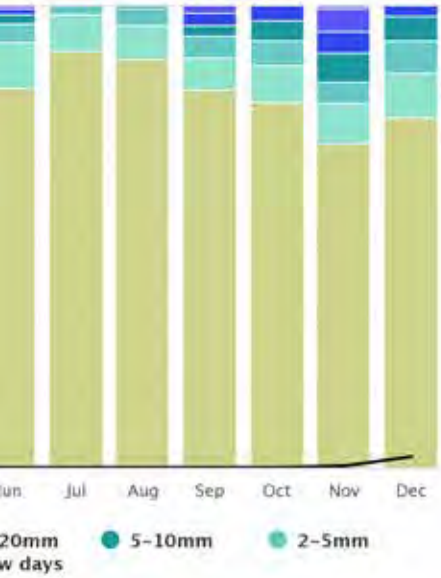


Figure 55

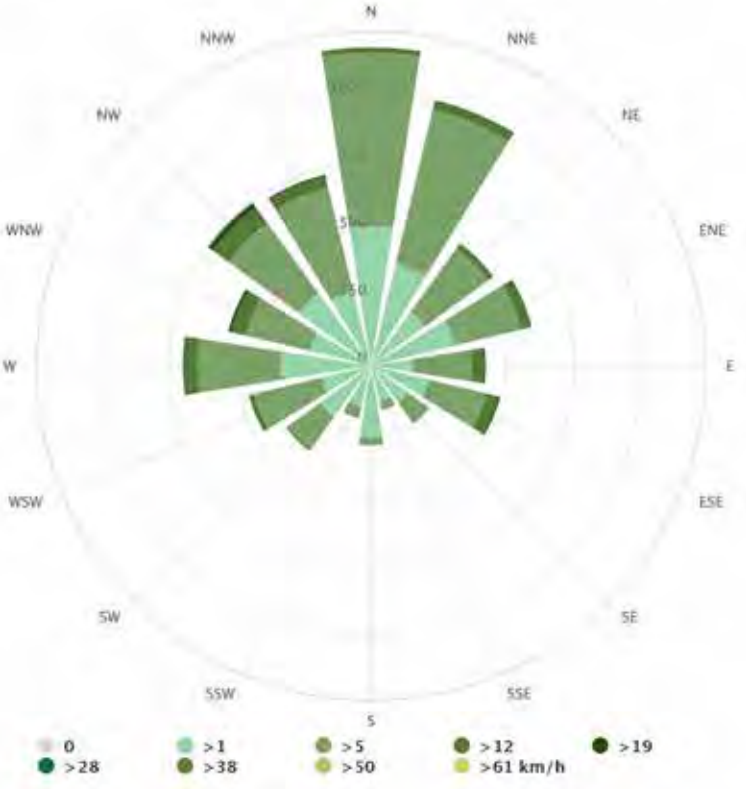


Wind Speed





Wind Rose



4.3. Zone 6, Design Process

Milan is one of the most densely populated cities in Italy and faces significant environmental challenges, including air pollution, soil degradation, and water scarcity. In response to these challenges, the city has developed a number of nature-based solutions, including the creation of green spaces and the promotion of sustainable agriculture.Zone 6 is a neighborhood area located on the outskirts of Milan, Italy. It is an important area for nature-based solutions and permaculture because it is primarily used for agricultural purposes, with a focus on sustainable practices.

Zone 6 is an important area for these efforts because it is a large, open space that can be used for agricultural purposes. The area is home to a number of farms and agricultural cooperatives that practice permaculture, a system of agriculture that promotes the sustainable use of land by working with natural ecosystems rather than against them.Permaculture involves a number of practices, including crop rotation, companion planting, and the use of natural pest control methods. These practices help to improve soil health and reduce the need for chemical inputs, which can have negative impacts on both the environment and human health.

In addition to its importance for permaculture and sustainable agriculture, Zone 6 is also an important area for biodiversity. The area is home to a number of plant and animal species that are not found in other parts of Milan. This biodiversity is important for maintaining ecosystem health and for providing ecosystem services, such as pollination and water purification.

Zone 6 is an important area for nature-based solutions and permaculture in Milan. Its focus on sustainable agriculture and biodiversity conservation is helping to address some of the city's most pressing environmental challenges.

Therefore, it was investigated how compatible it is for Nature-Based Solutions and Permaculture by analyzing the Zone 6 region in the Design process. Afterwards, the potential areas analysis created by combining the analyzes and the areas of the studies to be carried out in the Zone 6 region were determined. By analyzing the difficulties for Nature-Based Solution and Permaculture, it was ensured that the project area was understood and suitable solutions could be produced. The fight for these difficulties was determined with the general strategy. Areas selected from Zone 6 and areas with different characteristics were evaluated for Nature-Based Solutions and Permaculture. At the last stage of the project, green, blue, gray solutions methods were developed and solution suggestions were given in order to strengthen the relationship between the fields and Permaculture.

MILANO 2030 - TERRITORIAL GOVERNMENT PLAN (PGT)

Synthesis Map

This synthesis map, created by combining the tables prepared according to Milan 2030 and PGT planning, includes environmental regeneration areas, green and blue infrastructure and landuse analysis.

LEGEND

- Park and Recreation Areas
- Blue Infrastructure
- Liquefaction
- Regional Parks: Parco Agricolo Sud
- Environmental Regeneration Areas
- Commercial
- Residential
- Industrial

Figure 56

MILANO ZONE 6, SYSTEMATIC ANALYSIS

Potential Map

Each of the existing analyzes was re-evaluated for NBS and Permaculture; The areas where NBS and Permaculture can be applied are colored black if the potential is high, and white if it is low. Thus, the most suitable area for the project has been determined.

LEGEND

Potential of NBS and Permaculture

Low

High

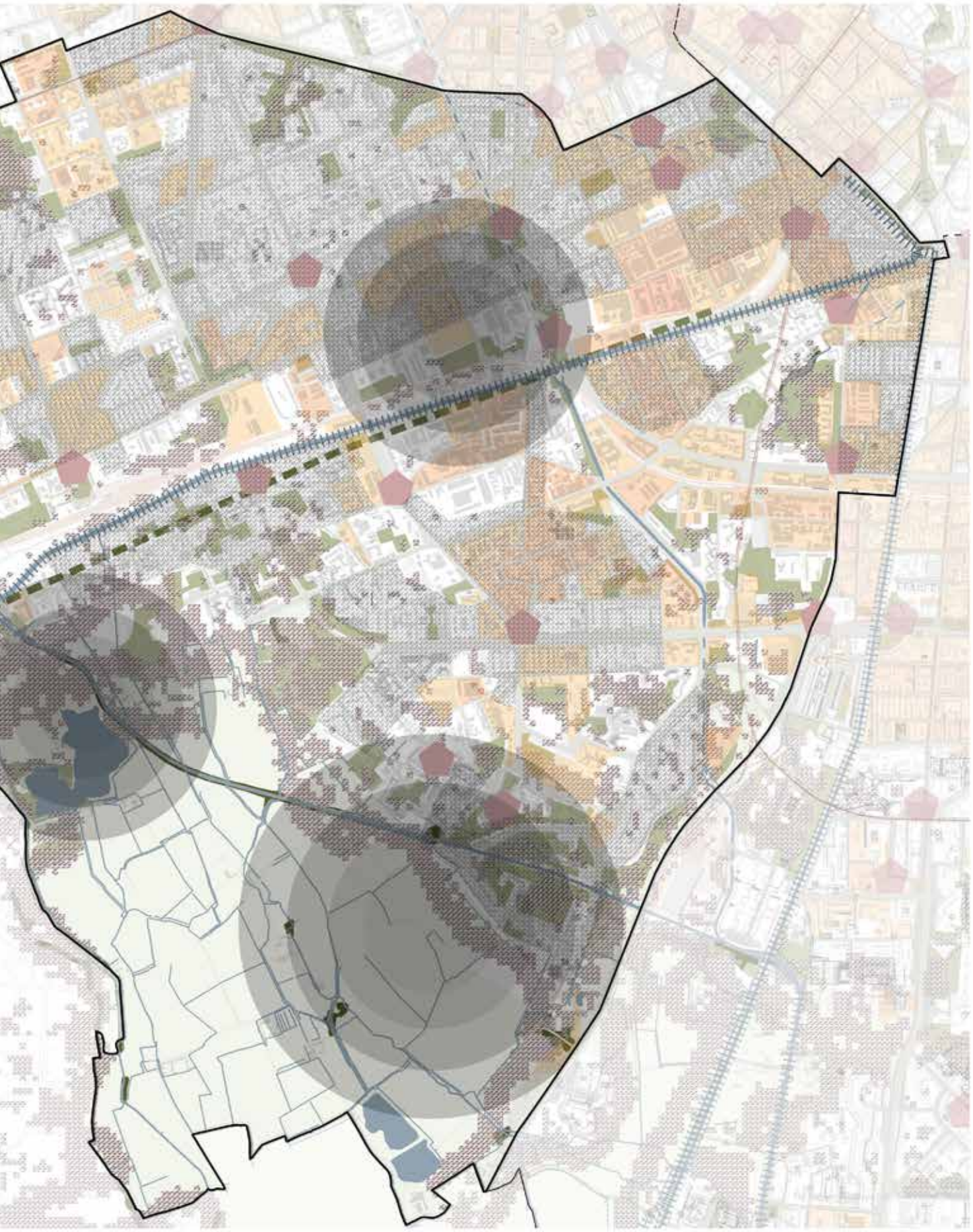
Figure 57

MILANO - ZONE 6, SYSTEMATIC ANALYSIS

Challenge Map

In this analysis, areas are classified according to the methodology required for the Nature-Based Solution and Permaculture Design approaches.

Figure 58



MILANO - ZONE 6, SYSTEMATIC ANALYSIS

Main Design Strategy

General Design Strategy is based on the ecological corridor established between South Agricultural Park and Parco dei Fontanili. It is about protecting agricultural heritage and contributing and developing this culture of the people living in this area.

LEGEND

- 1 Core Area 1 - Parco dei Fontanili
- 2 Core Area 2 - South Agricultural Park
- Primary Green Corridor
- Primary Blue Corridor
- Secondary Green Corridor
- Secondary Blue Corridor
- Primary Green Connection
- Secondary Green Connection
- Primary Blue Connection
- Secondary Blue Connection
- Green Interventions Areas

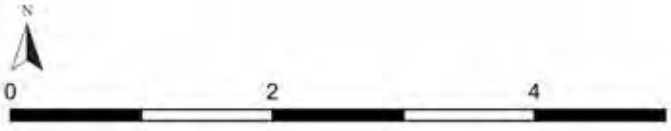


Figure 59


2

MILANO - ZONE 6, SYSTEMATIC ANALYSIS

NBS and Permaculture Methodological Approach

NATURE-BASED SOLUTION

Challenges

- 1. Climate mitigation and adaptation;
- 2. Water management;
- 3. Coastal resilience;
- 4. Green space management
- 5. Air/ambient quality;
- 6. Urban regeneration;
- 7. Participatory planning and governance;
- 8. Social justice and social cohesion;
- 9. Public health and well-being;
- 10. Potential for new economic opportunities

Interventions

- 1. Building-scale
- 2. Public space
- 3. Water bodies and drainage systems
- 4. Ttransport linear infrastructures
- 5. Natural areas and management of the rural
- 6.Coasline/Cost interventions

PERMACULTURE

Ethical Values

- 1. Earth Care
- 2. People Care
- 3. Fair Share

Principles

- 1. Observe and interact
- 2. Catch and store energy
- 3. Obtain a yield
- 4. Apply self regulation and accept feedback
- 5. Produce no waste
- 6. Use renewable resources and services
- 7. Design from pattern to detail
- 8. Integrate rather than segregate
- 9. Use small and slow solutions
- 10. Use and value diversity
- 11. Use edges and value the marginal
- 12. Creatively use and respond to change

Figure 60


1
2
3

Figure 61

Figure 62

MILANO - ZONE 6, INTERVENTIONS

Building - Scale Interventions

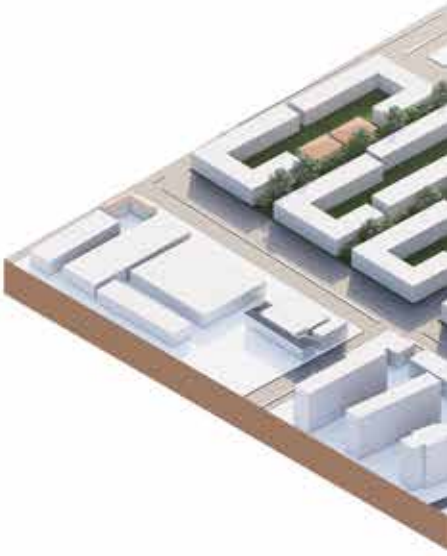
Nature Based Solutions and Permaculture are developing solutions for Building-Scale Interventions. While working at the building scale, permaculture tries to evaluate various areas and integrate them into its own system. It advises the practitioner to evaluate even the most minor areas. Therefore, it uses a scale that progresses from vegetables grown in pots to balcony and garden designs.

Nature Based Solutions solutions reach more comprehensive areas. It offers solutions such as Green Roof, Green Facades, and Community Courtyards. Milan Zone 6 has urban regeneration areas in the Policy Documents. Therefore, ecological studies in these areas are supported as a government policy.

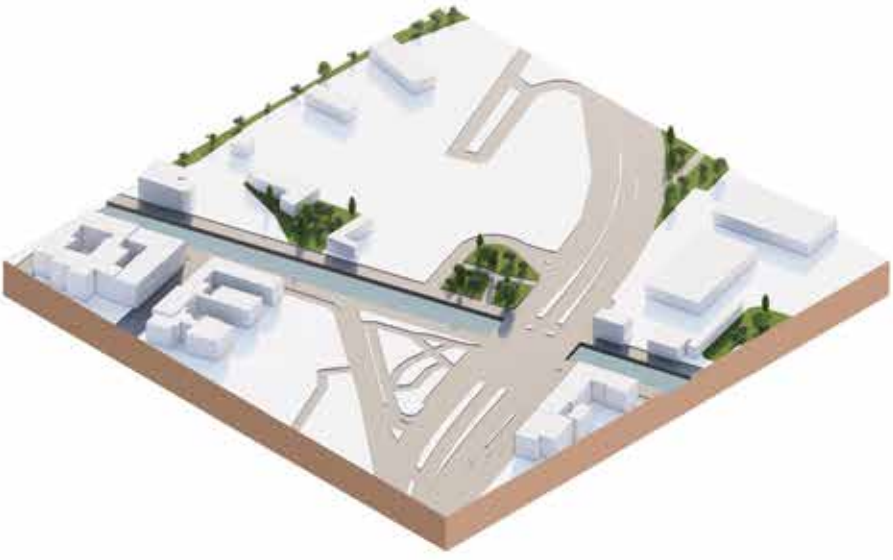
Figure 63

NATURE - BASED SOLUTIONS
BUILDING SCALE INTERVENTIONS

GREEN ROOF
Via Italo Svevo



ACTION IN COMMUNITY G
Via Glosue Borsi



RE-GREENING SPACES BETWEEN BUILDINGS
Viale Cassala

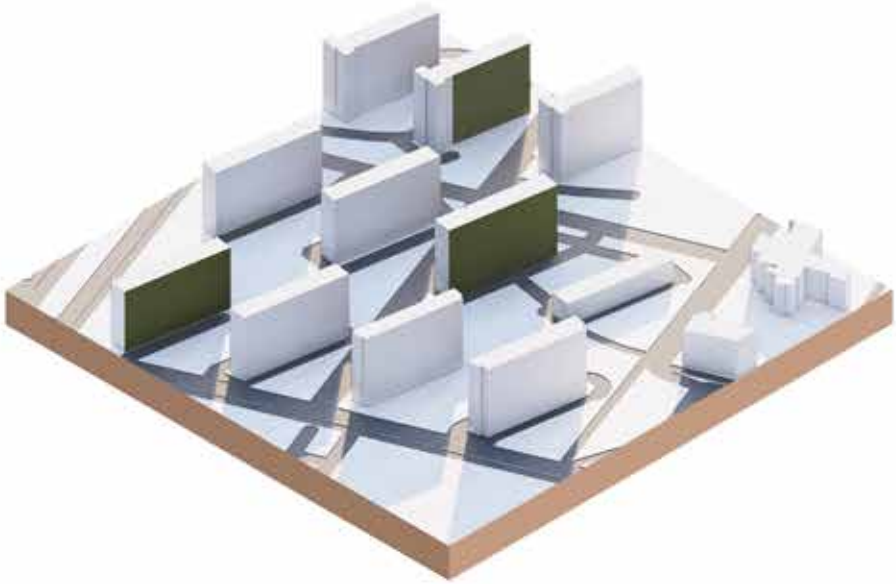
RAINWATER HARVESTING
Viale Liguria

Figure 64

COURTYARD

IN - HEIGHT ORCHARD
Viale Faenza

G



GREEN FACADES AND VERTICAL GARDEN
Via Angelo Inganni

Figure 65


Green Facades and Vertical Gardens
A
A
Actions in Community Courtyards
Re - Greening Spaces Between Buildings

Figure 66

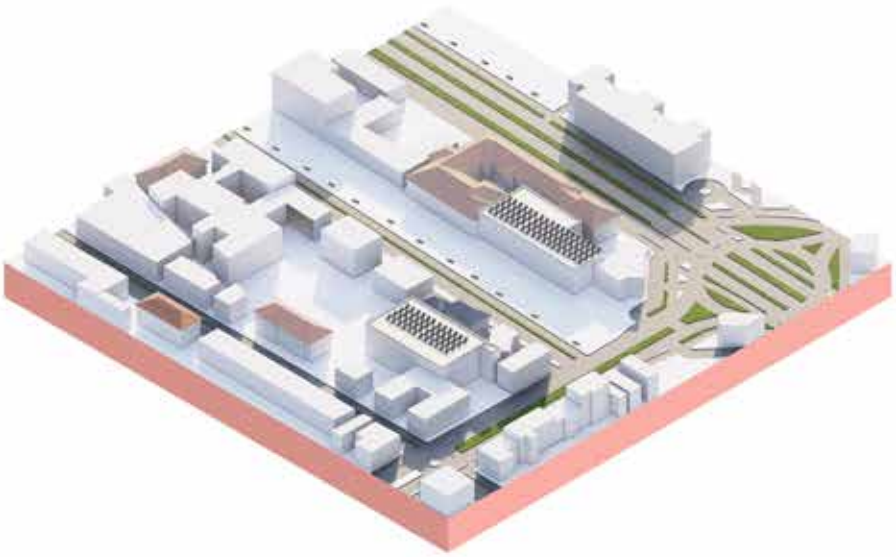
MILANO - ZONE 6, INTERVENTIONS

Public Space Interventions

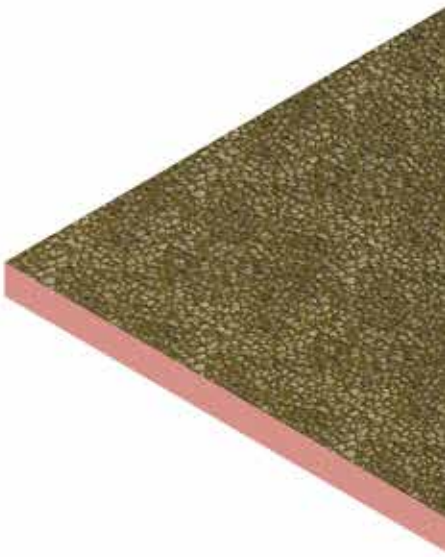
Nature-Based Solutions can be implemented in urban areas, such as public spaces, to improve air and water quality, reduce the urban heat island effect, provide green spaces for recreation and relaxation, and enhance biodiversity. Permaculture public space interventions apply these principles to transform public spaces into productive and biodiverse areas that provide food, shelter, and ecosystem services for the local community. The area has historically suffered from poor air quality and limited green spaces, but these interventions aim to improve the environmental and social conditions of the region.

Figure 67

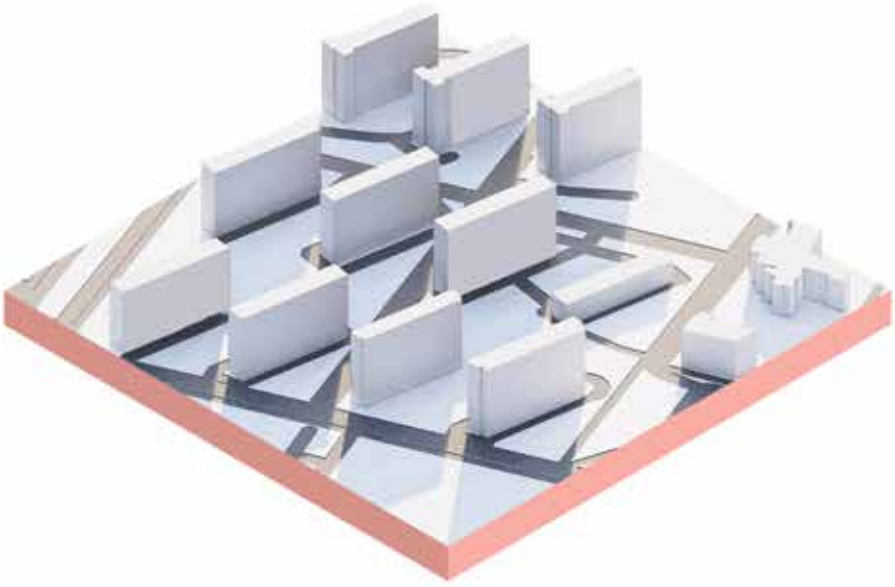
NATURE - BASED SOLUTIONS
PUBLIC SPACE INTERVENTIONS



STREET FURNITURE
Viale Liguria



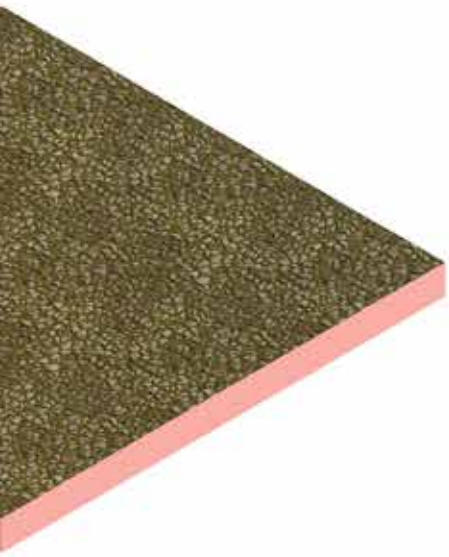
PERVIOUS PAVEMENT



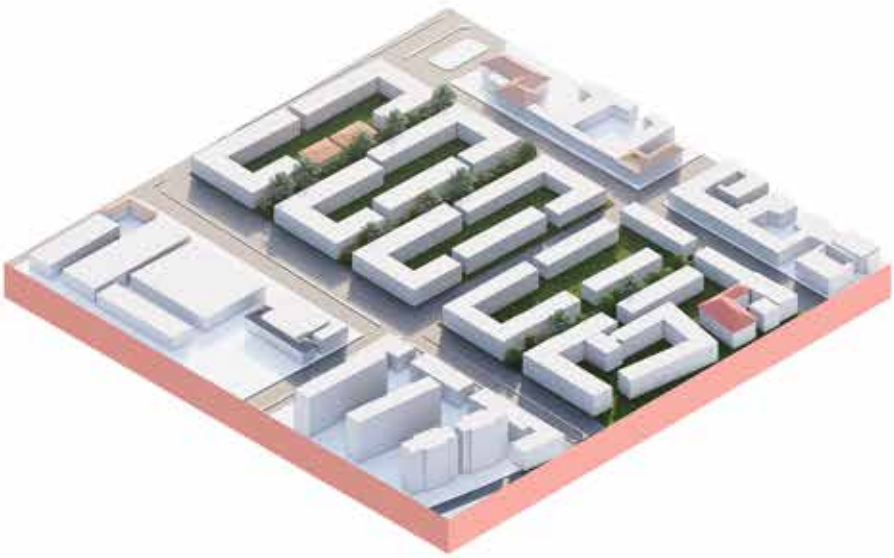
COMFORTABLE URBAN PLACE
Via Angelo Inganni

URBAN MICRO CLIMATES
Via Italo Svevo

Figure 68



URBAN PARKS AND URBAN FORESTS
Via Cesare Chiodi



ALLOTMENT GARDENS
Via Giosue Borsi

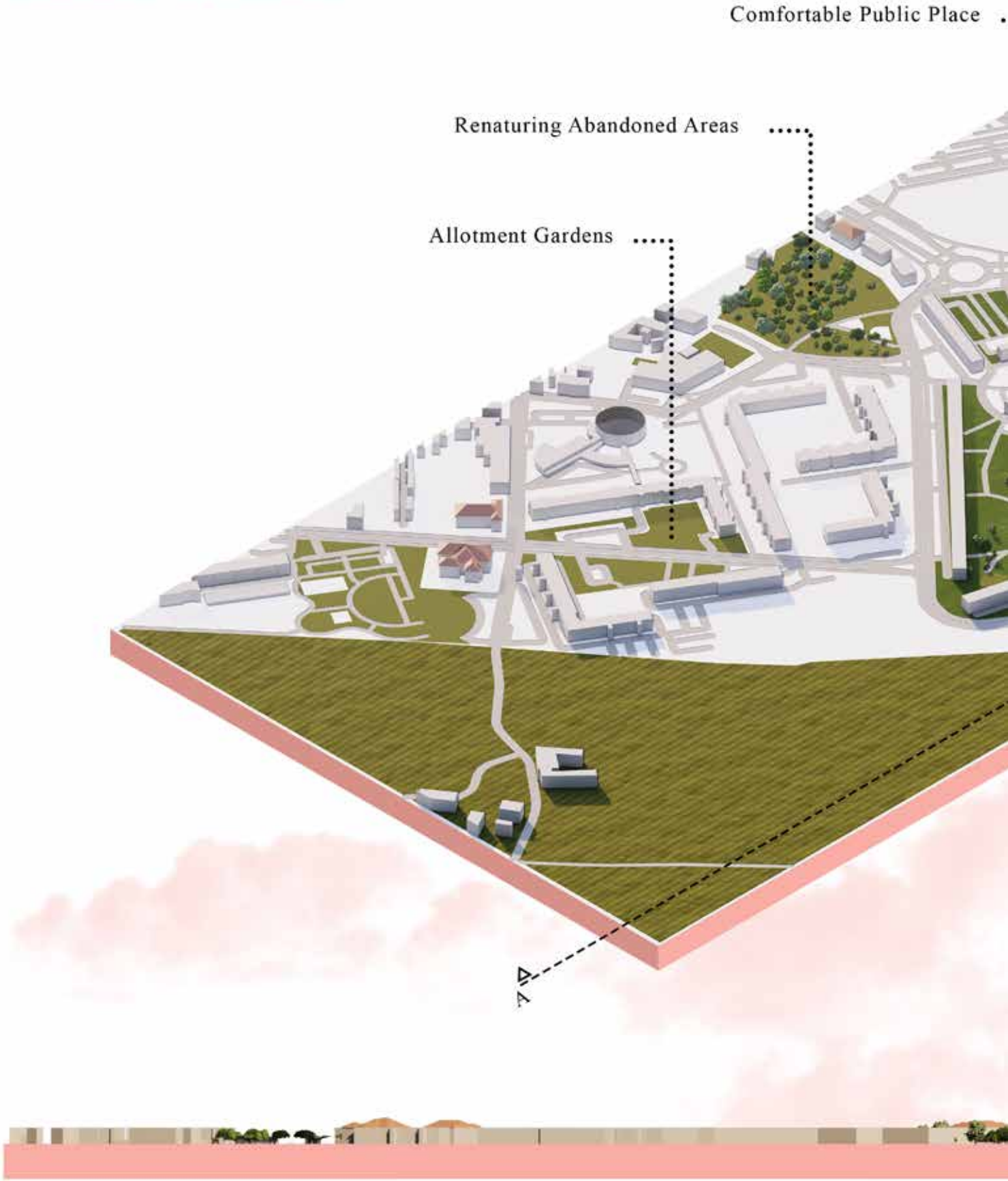

Comfortable Public Place
Renaturing Abandoned Areas
Allotment Gardens
A
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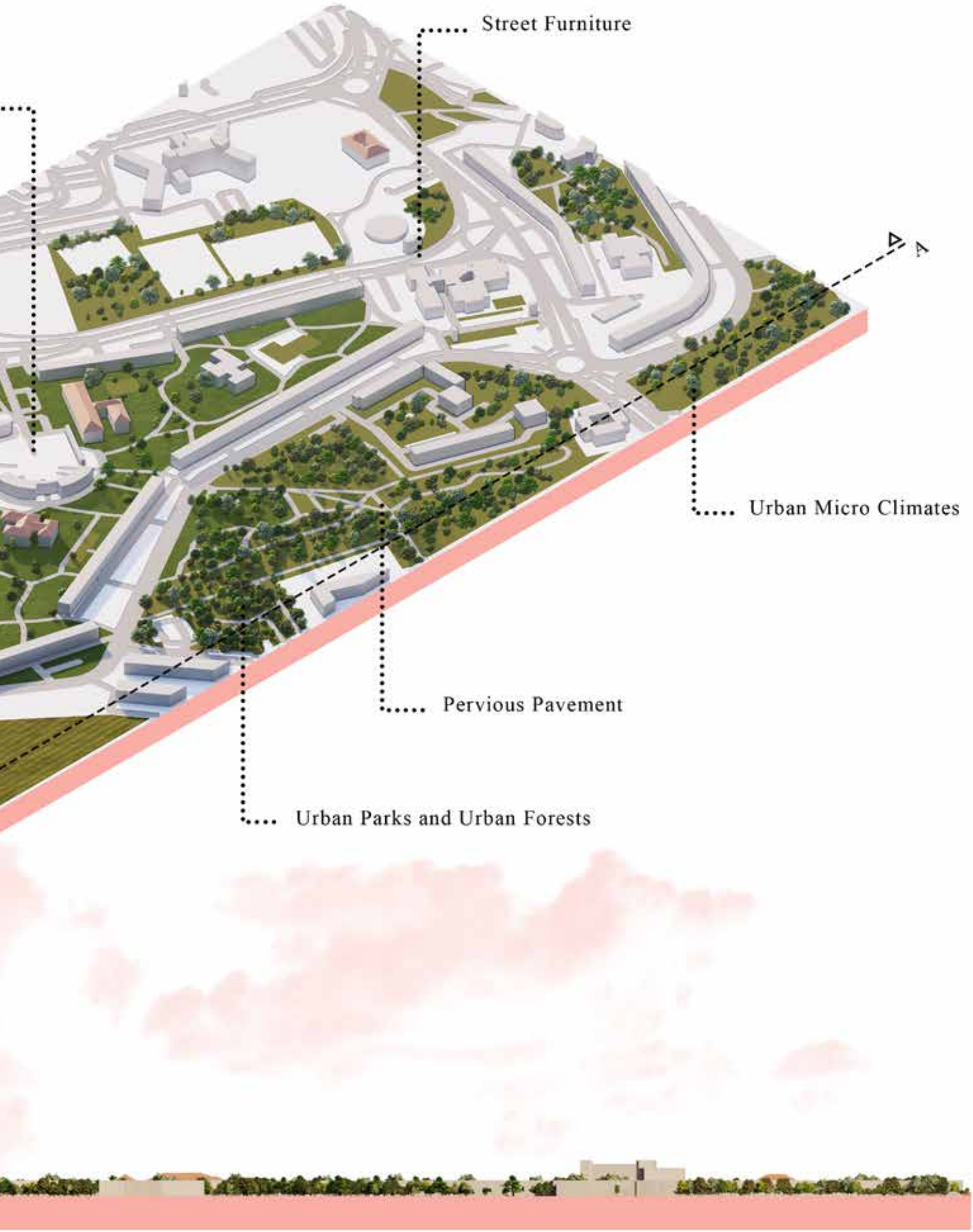
Figure 69


Street Furniture
A
A
Urban Micro Climates
Pervious Pavement
Urban Parks and Urban Forests

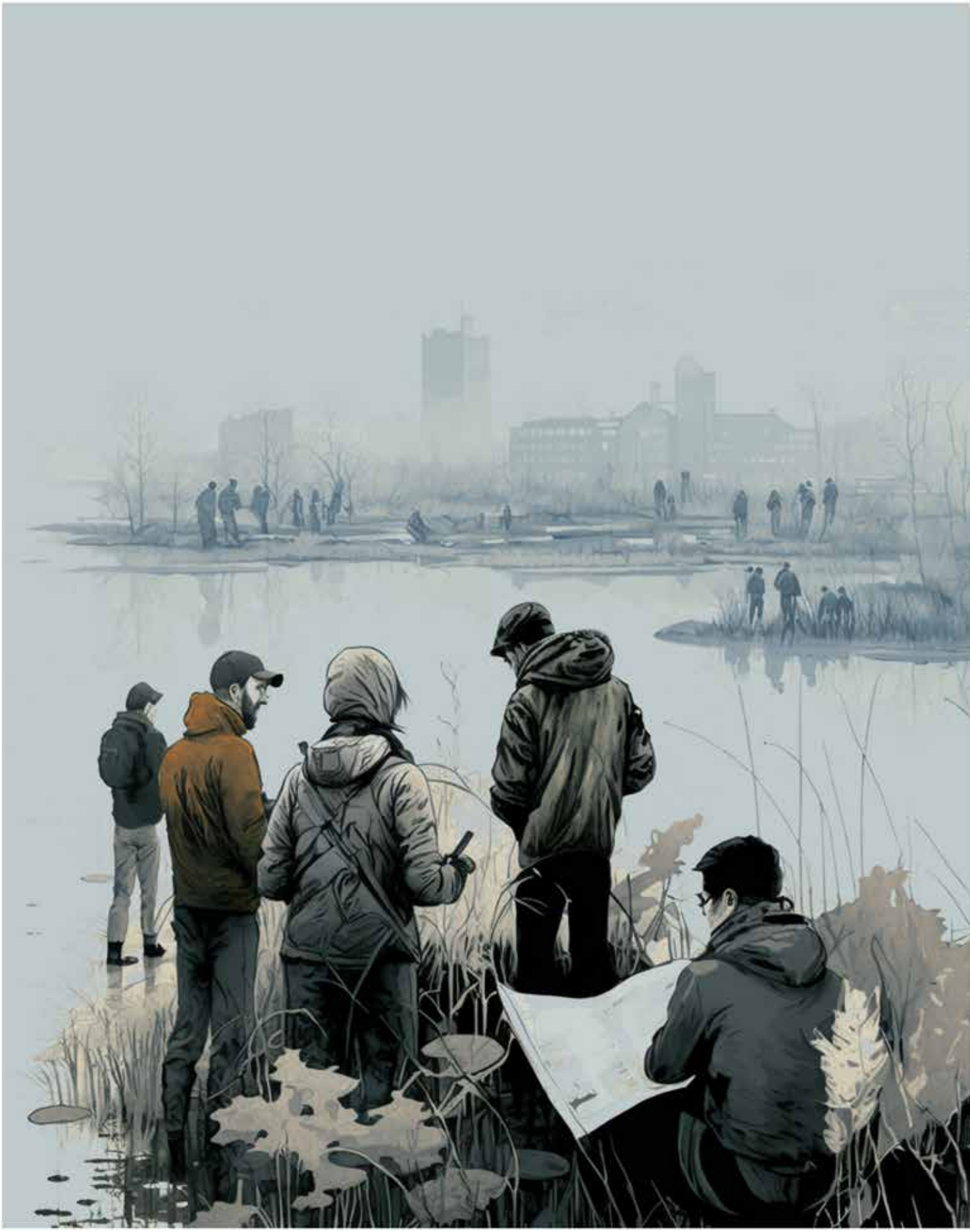


Figure 70

MILANO - ZONE 6, INTERVENTIONS

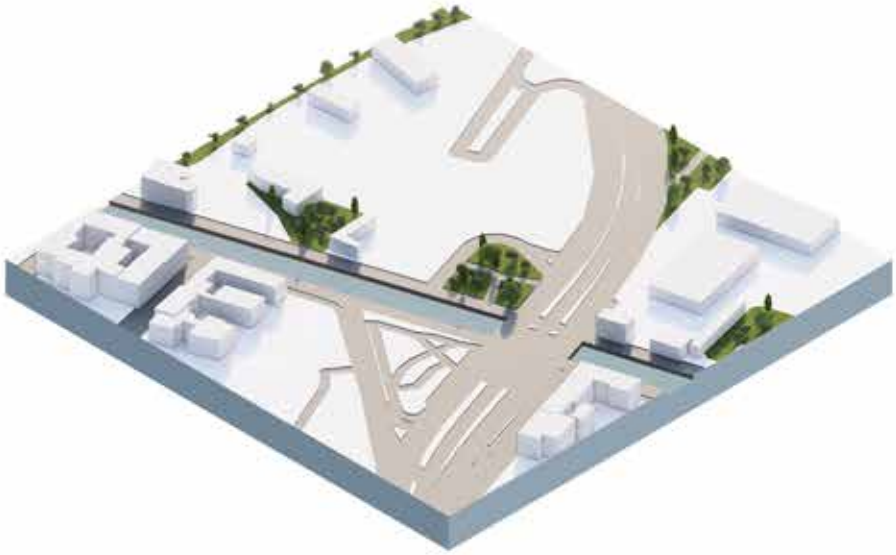
Water Bodies and Drainage Systems Interventions

Nature-Based Solutions and permaculture principles can be applied to water management in urban areas, such as Milano Zone 6, to address water scarcity, reduce flooding and erosion, and enhance water quality.Milan Zone 6 area has one of the main resources of Naviglio. The presence of the South Agricultural Park in this area and meeting the water needs of these agricultural areas is an important priority.

Overall, these NBS and permaculture water management interventions in Milano Zone 6 demonstrate the potential for nature-based solutions to address water-related challenges in urban areas. By implementing these interventions, Milano Zone 6 has become more resilient to flooding and erosion, while also improving water quality and enhancing the aesthetic value of public spaces.

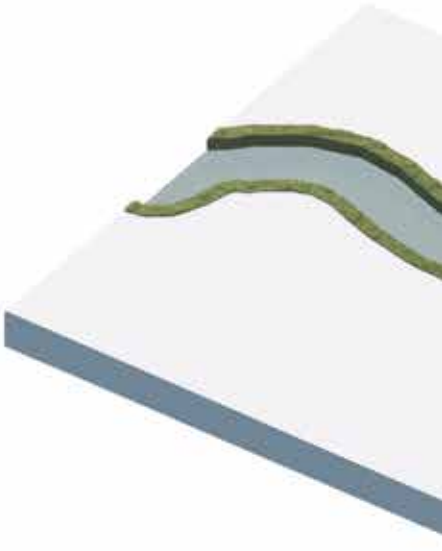
Figure 71

NATURE - BASED SOLUTIONS
WATER BODIES AND DRAINAGE SYSTEMS INTERVENTIONS



SUSTAINABLE URBAN DRAINAGE SYSTEMS
Viale Cassala

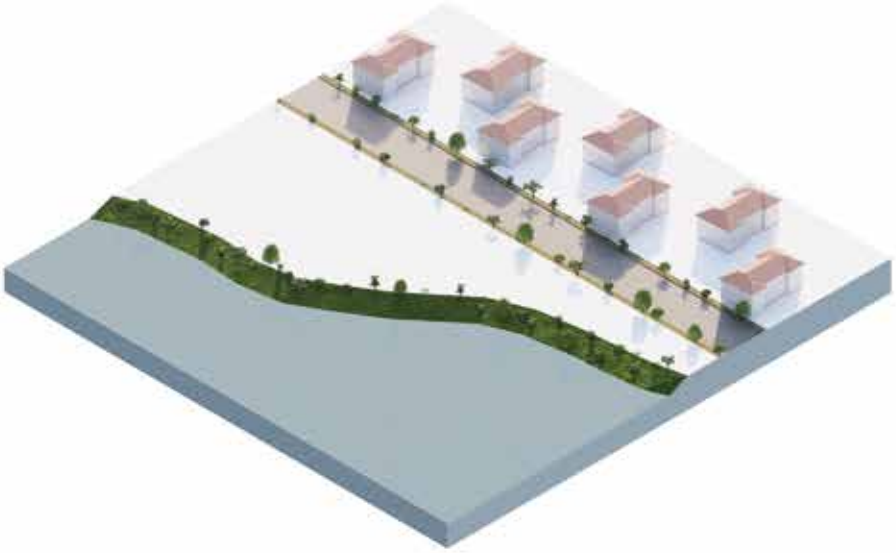
RESTORATION OF PONDS
Via Grancino



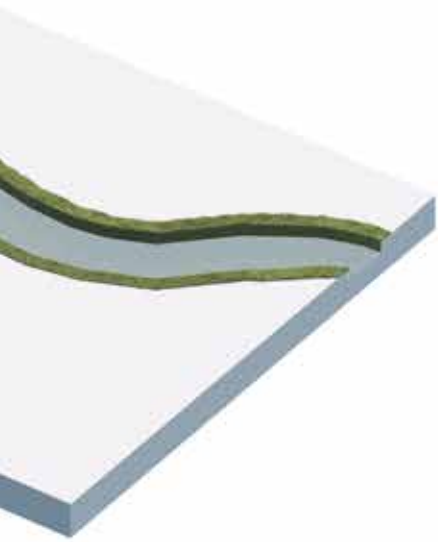
RENATURING RIVERS AN
Via Italo Svevo

Figure 72

AND LAKES



CONTROLLED FLOOD PLAINS
Vicolo Laghetto



D STREAMS

Figure 73

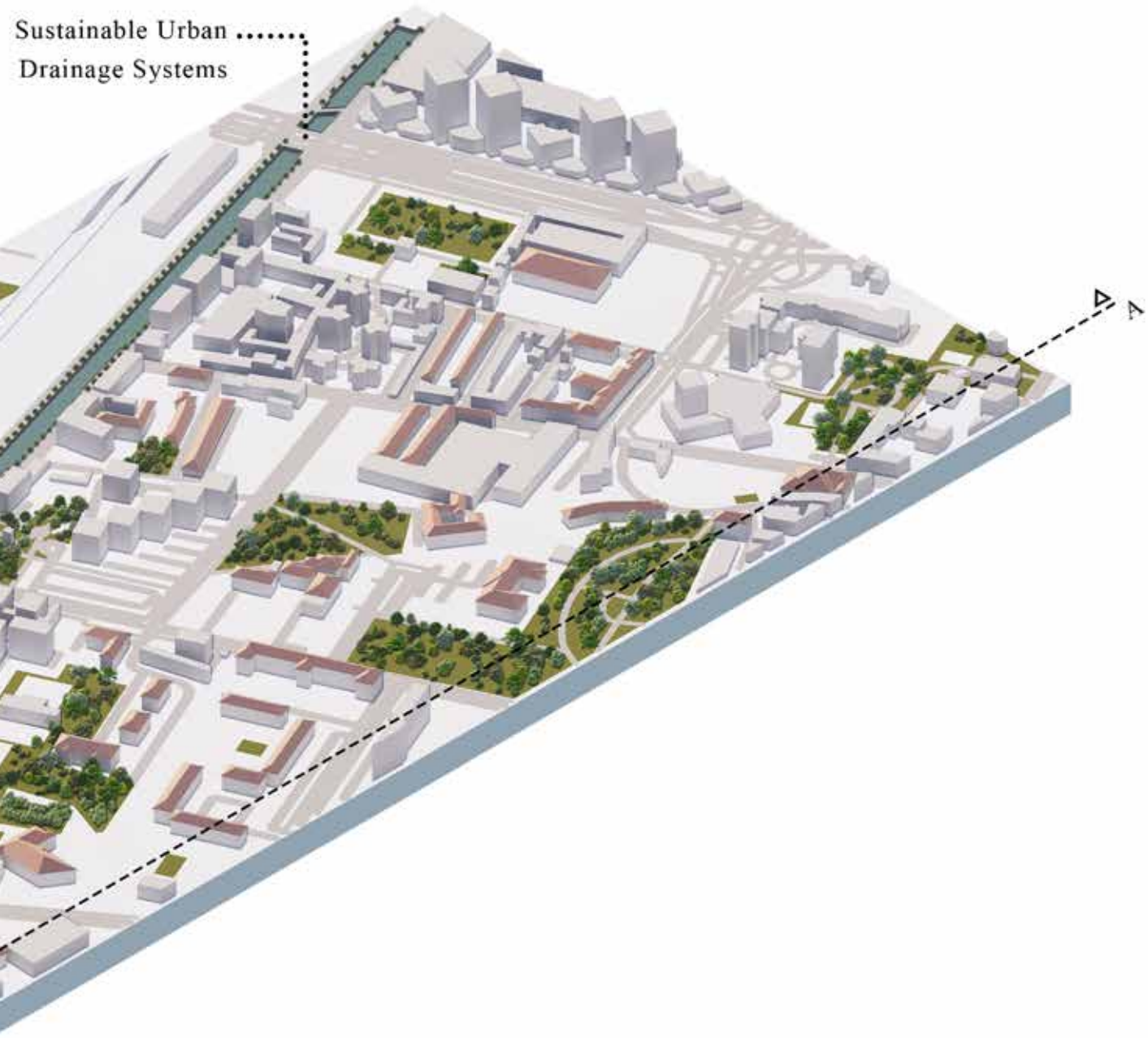

Sustainable Urban
Drainage Systems
A
A

Figure 74

MILANO - ZONE 6, INTERVENTIONS

Transport Linear Infrastructures Interventions

Nature-Based Solutions and permaculture principles have been implemented in Milano Zone 6 to address challenges related to linear transport infrastructure. Especially since Permaculture focuses on food production-based systems, transportation areas can also be used for food production. Especially considering the agricultural heritage of the region, orchards to be applied on roads and streets have the potential to be an important intervention for the local citizen.

Consequently, these NBS and permaculture interventions in linear transport infrastructure in Milano Zone 6 demonstrate the potential for green infrastructure to enhance the functionality and sustainability of transport infrastructure, while also improving the quality of life for residents and promoting environmental stewardship. By implementing these interventions, Milano Zone 6 has become more resilient to climate change, while also promoting active transportation and enhancing the aesthetic value of public spaces.

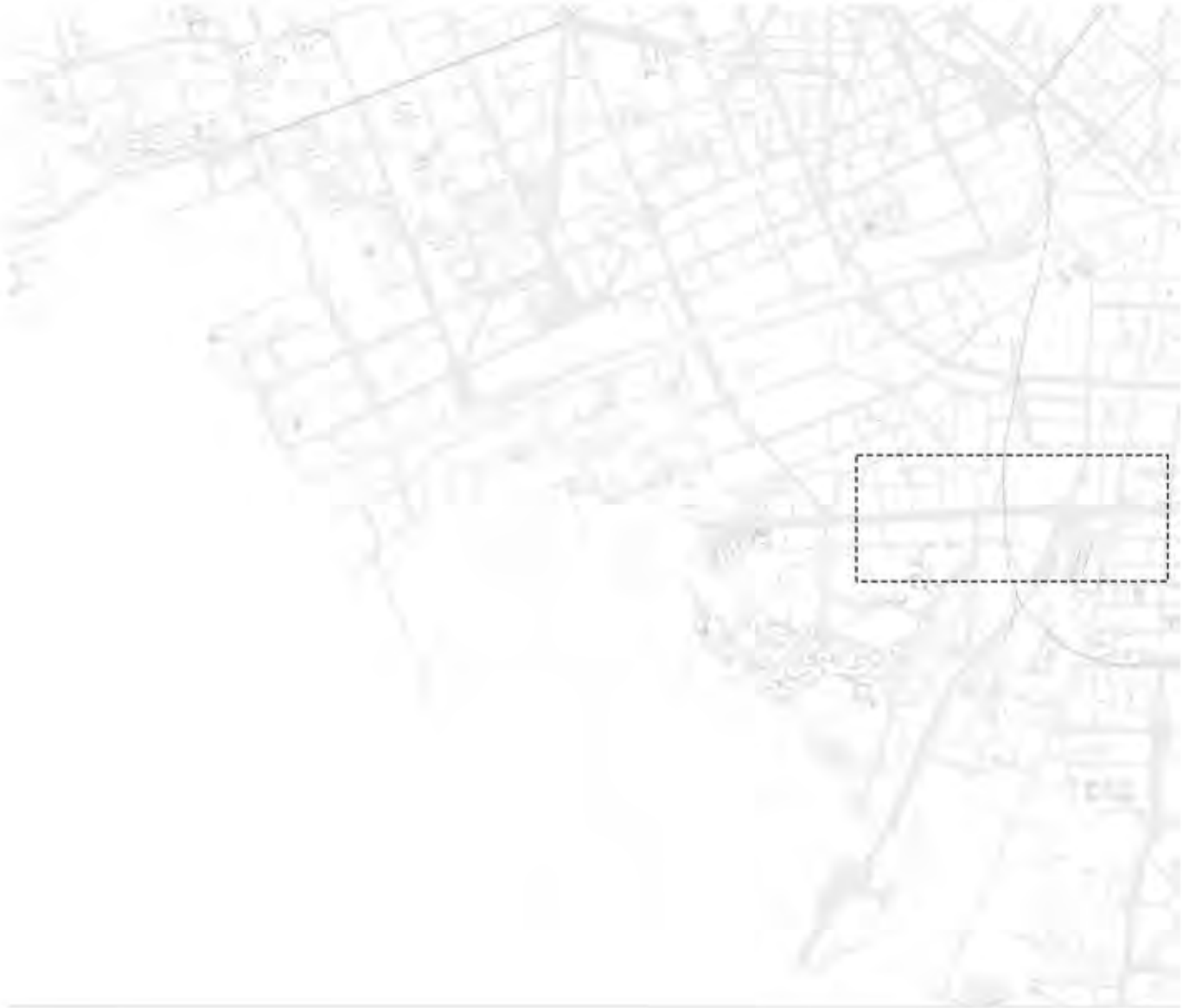
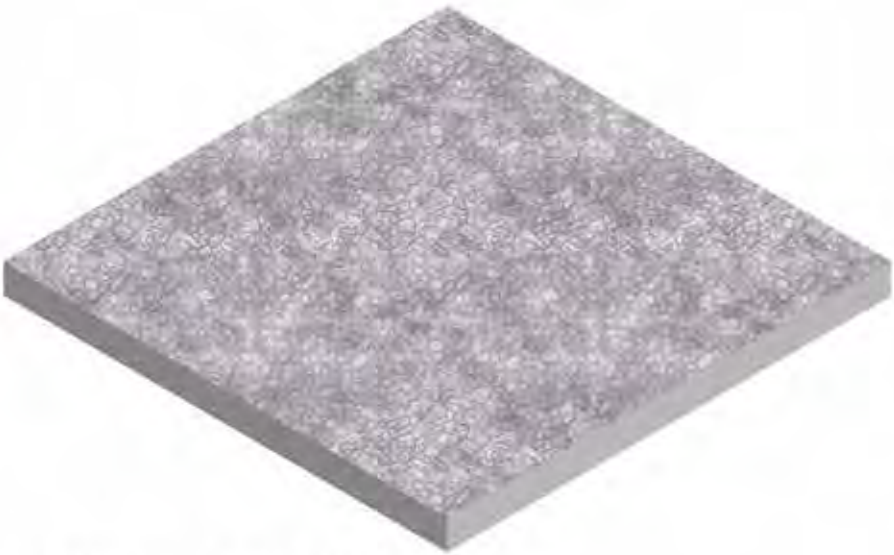


Figure 75

NATURE - BASED SOLUTIONS
TRANSPORT LINEAR INFRASTRUCTURES INTERVENTIONS



PERMEABLE PAVEMENT

GREENING HIGH CAPACI
Vicolo Laghetto

Figure 76

TY TRANSPORT LINEAR

GREENING STREETS
Viale Liguria

NATURE - BASED SOLUTIONS
TRANSPORT LINEAR INFRASTRUCTURES INTERVENTIONS
VIALE FAMAGOSTA

Figure 77


reet
Greening High Capacity Transport Linear
A
A

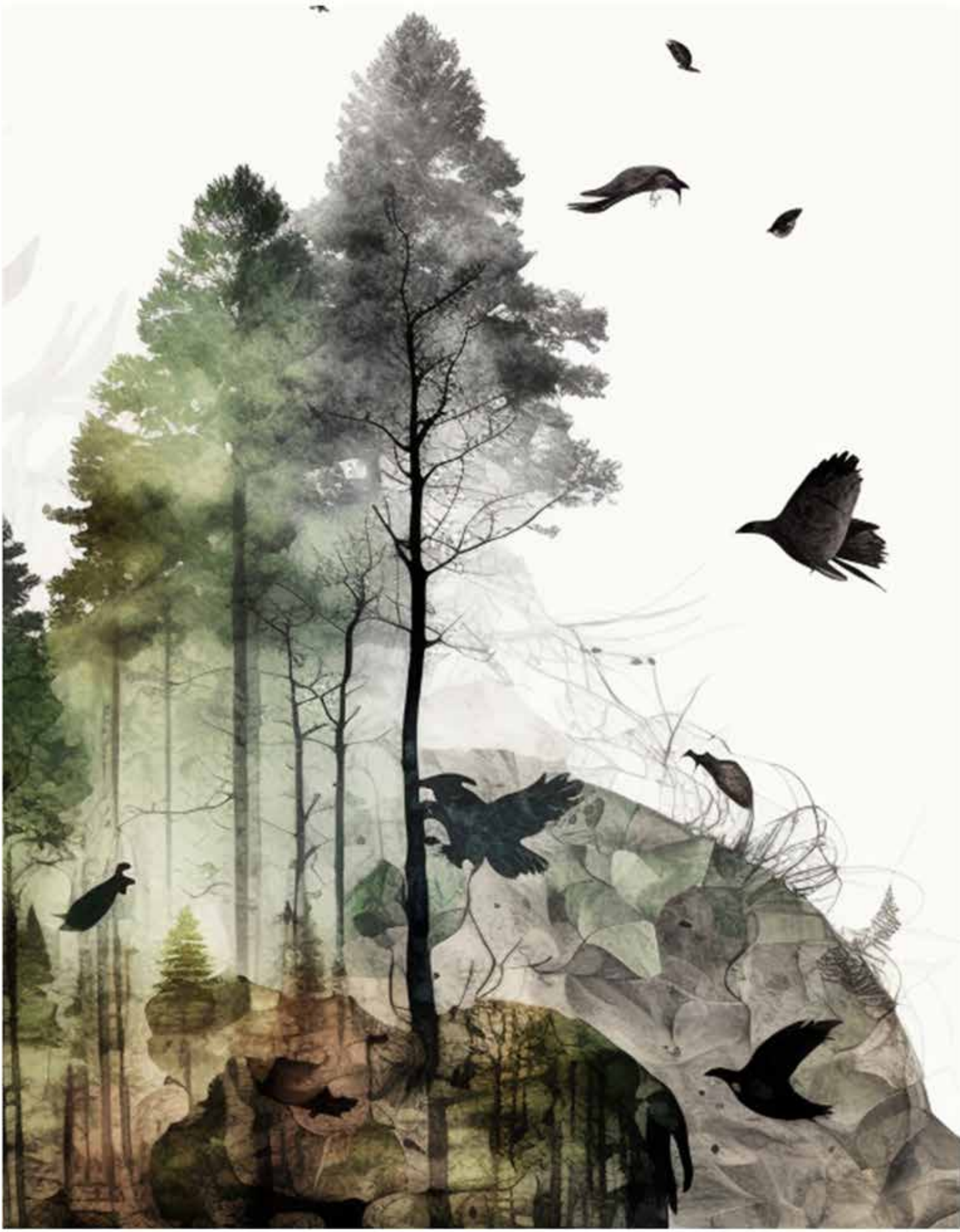


Figure 78

MILANO - ZONE 6, INTERVENTIONS

Natural Areas and Management of the Rural Land Interventions

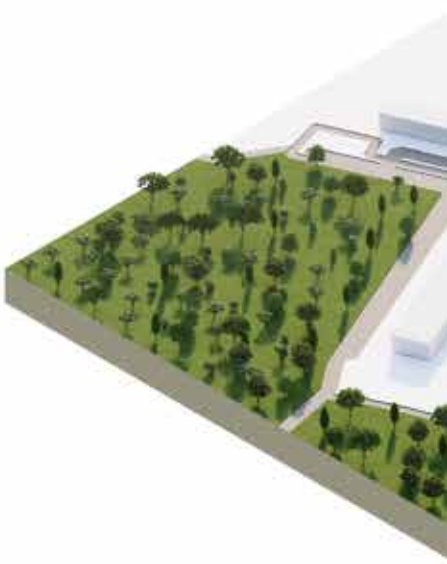
Nature-Based Solutions (NBS) and permaculture principles have been implemented in Milano Zone 6 to enhance the management of natural areas and rural land. Especially Parco Agricolo Sud Milano: The Parco Agricolo Sud Milano project aims to promote sustainable agriculture and enhance the biodiversity of the rural landscape in the southern part of the city. The park includes farmland, woodlands, and wetlands, and provides opportunities for recreation and education.

As a result, these NBS and permaculture interventions in natural areas and rural land in Milano Zone 6 demonstrate the potential for sustainable agriculture and land management practices to enhance the biodiversity of the landscape and promote social, economic, and ecological benefits. By implementing these interventions, Milano Zone 6 has become more resilient to climate change, while also improving the quality of life for residents and promoting environmental stewardship.

Figure 79

NATURE - BASED SOLUTIONS
NATURAL AREAS AND MANAGEMENT OF THE RURAL LAND INTERVENTIONS

WETLANDS
Via Buccinasco



PERI - URBAN PARKS
Via Cesare Chiodi

NATURAL PROTECTED AR
Vicolo Laghetto

Figure 80

RURAL LAND MANAGEMENT

Via Primo Mazzolari

EAS

Figure 81


ls
Natural Protected Areas
Rural Land Management
A
A
Periurban Parks

PERMACULTURE GREY AND BLACK SOLUTIONS

Permaculture is a design system that aims to create sustainable and self-sufficient human environments by mimicking natural ecosystems. Greywater and blackwater solutions are an important aspect of permaculture design as they allow for the efficient and safe disposal of waste while also conserving water.

Greywater refers to wastewater from sinks, showers, and washing machines. Permaculture design incorporates greywater systems that capture, filter, and reuse this water for irrigation purposes. One common system is the "mulch basin" where greywater is directed to a planting basin filled with mulch and plants. The plants absorb nutrients from the greywater, filtering it naturally and providing an additional source of food or medicine.

Blackwater refers to wastewater from toilets and kitchen sinks. Unlike greywater, blackwater contains fecal matter and requires more extensive treatment before it can be reused. Permaculture solutions for blackwater often involve composting toilets, which use natural processes to break down human waste into a safe and nutrient-rich soil amendment. Other options include constructed wetlands, which use a combination of plants and bacteria to filter and treat the water. In summary, permaculture provides sustainable solutions for greywater and blackwater management, allowing for the safe disposal of waste and the conservation of water resources.

Mulch basin system involves redirecting greywater from sinks, showers, and washing machines to a mulch basin filled with organic matter and plants. The plants absorb the nutrients from the greywater, and the mulch filters the water naturally, creating a self-sustaining irrigation system.

Composting toilets use natural processes to break down human waste into a safe and nutrient-rich soil amendment. The toilets typically have two compartments, one for urine and one for solid waste. The solid waste is mixed with sawdust or other organic matter to help with the composting process, which takes several months to complete.

Greywater filtration system method involves using a series of filters, such as sand and gravel, to remove contaminants from greywater. The filtered water can then be reused for irrigation or other non-potable purposes.

Bioreactor system: A bioreactor system is a type of blackwater treatment system that uses microorganisms to break down the waste. The system typically involves a series of chambers where different types of bacteria are used to break down the waste, resulting in clean water that can be reused for irrigation or other non-potable purposes.These are just a few examples of the methods that can be used for permaculture grey and black water solutions. The specific method used will depend on factors such as the type and amount of waste, the available space, and the desired outcome.

FIGURE 82

Composting Toilets system

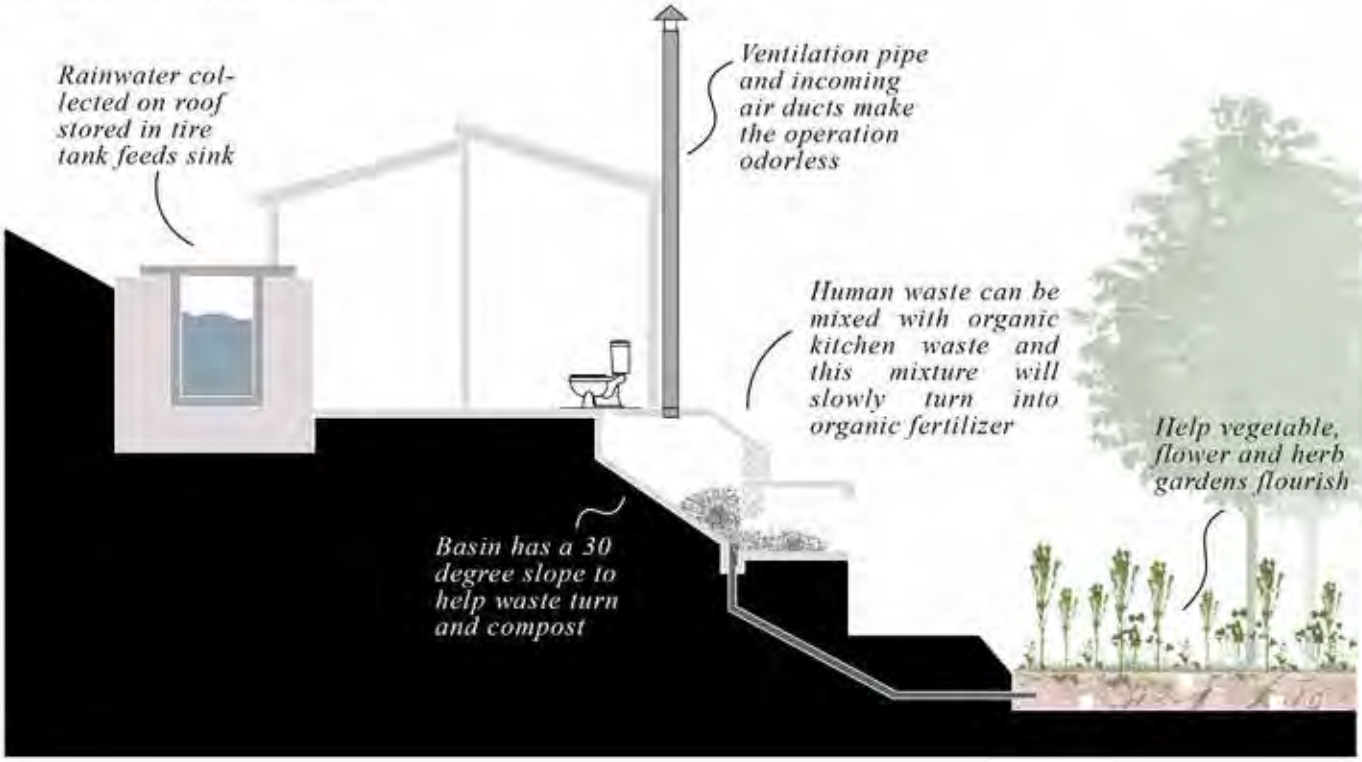
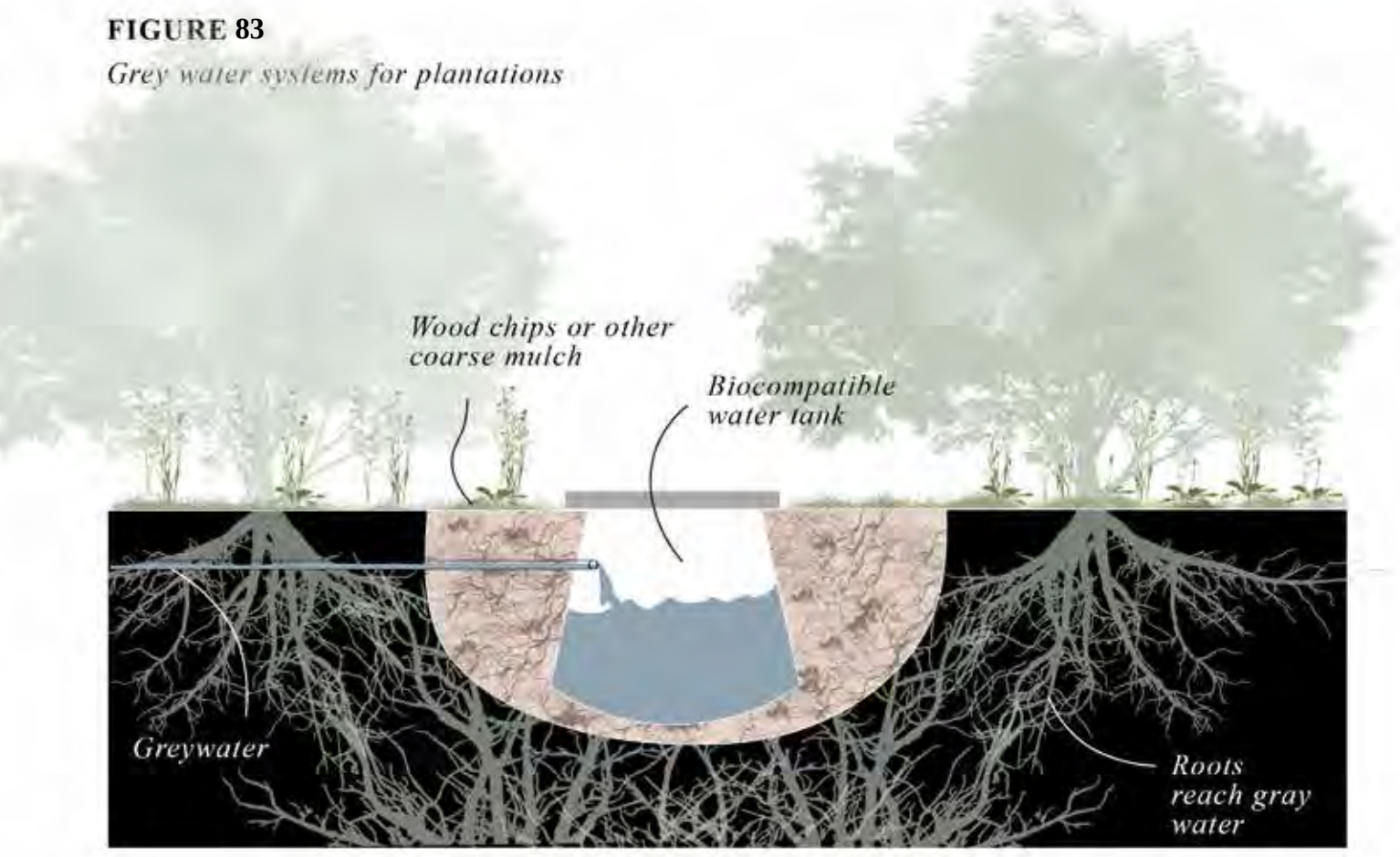


FIGURE 83

Grey water systems for plantations



PERMACULTURE GREY AND BLACK SOLUTION

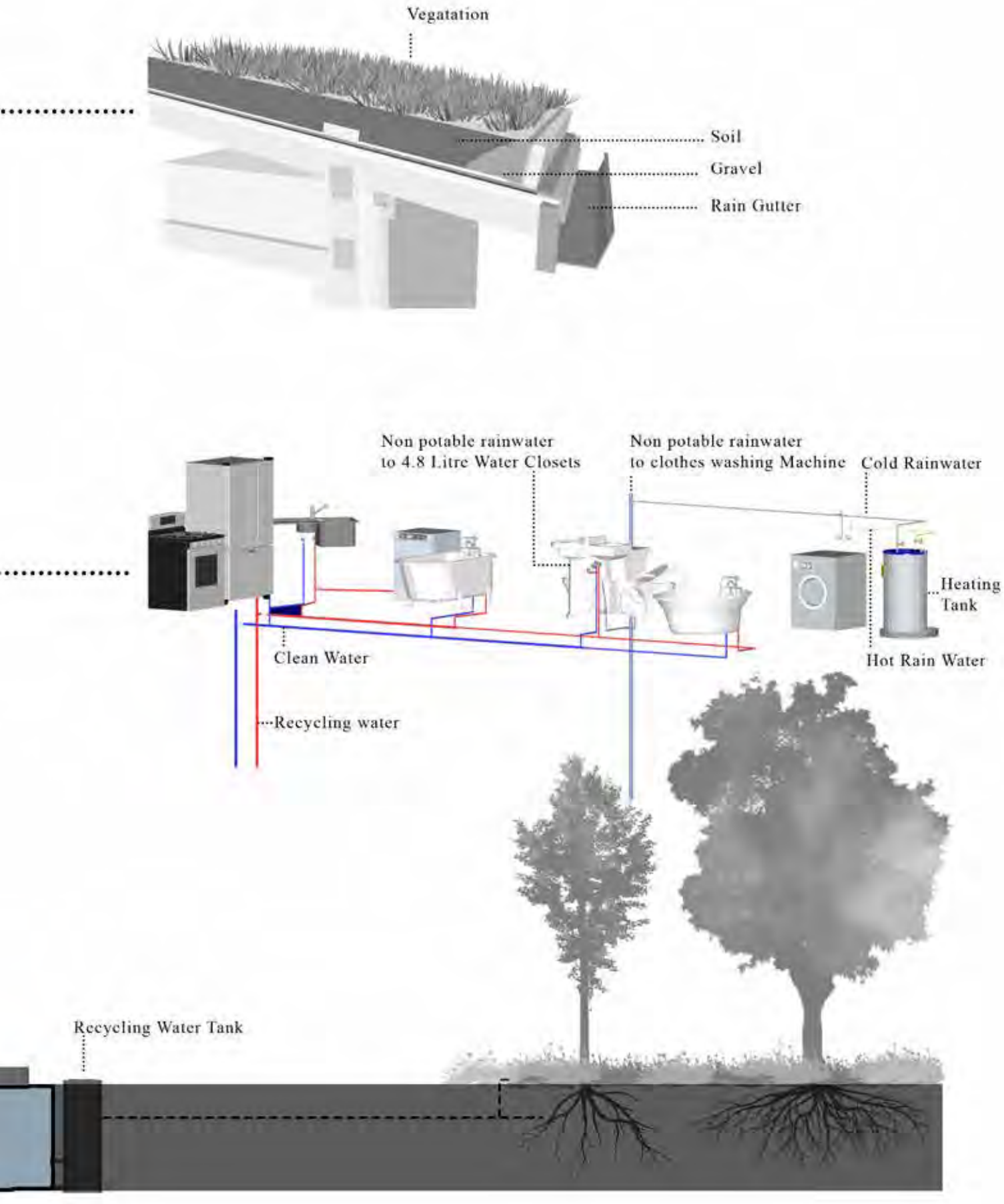

Vegatation
Soil
Gravel
Rain Gutter
Non potable rainwater
to 4.8 Litre Water Closets
Non potable rainwater
to clothes washing Machine
Cold Rainwater
Heating
Tank
Clean Water
Hot Rain Water
Recycling water
Recycling Water Tank

Figure 84

PERMACULTURE BLUE SOLUTIONS

Permaculture Blue solutions are methods used to address issues related to water management, conservation, and quality. The term "blue" in permaculture refers to water, including both surface and groundwater resources.

Permaculture Blue Solutions aim to work with natural water systems rather than against them, using techniques such as rainwater harvesting, water conservation, and erosion control to create sustainable water management systems. For that reason, Permaculture use some common method for blue solutions.

One of the most important aim is Rainwater harvesting: This involves collecting and storing rainwater for later use. Systems can range from simple rain barrels to more complex cisterns or tanks. The collected water can then be used for irrigation, washing, or even drinking if properly treated.

It is an important method that can shape the surface shapes according to permaculture designs and increase the efficiency we will get from the working areas.Therefore, swales are an important design element. Swales are shallow ditches or depressions that are designed to capture and slow down water runoff. They can be used to prevent erosion, recharge groundwater, and provide water for plants.

Greywater systems: As mentioned earlier, greywater systems can be used to reuse wastewater from sinks, showers, and washing machines for irrigation purposes.

Permeable paving materials, such as gravel or porous concrete, allow rainwater to seep into the ground rather than run off into storm drains. This can help recharge groundwater and prevent erosion.

Another importan method is riparian restoration. Riparian areas are the transitional zones between land and water ecosystems, and they are important for water quality and habitat. Permaculture design often involves restoring or enhancing riparian areas by planting native species, controlling invasive species, and preventing erosion.

Also Keyline design is a land management technique that involves using contours and slope to guide the movement of water across a landscape. By strategically placing features such as ditches or berms, keyline design can help distribute water more evenly and improve soil fertility. Overall, Permaculture Blue solutions aim to create sustainable and resilient water management systems that work in harmony with the natural environment.

FIGURE 85

Pond typology according to usage functions

Hydrology

-Soil allows seepage
-Uncompacted
-Unstable embankment

Irregation

-Emptied during growing season
-Compacted or lined

Fire Fighting

-Stay full during dry season
-High volume non-electric release
-High landscape position

Habitat

-Varied depths and edges
-Seasonal fluctuations

Recreation

-Stays full throughout summer
-Fradual slopes

Aquaculture

-Controlled inflow and outflow
-Designed for harvest

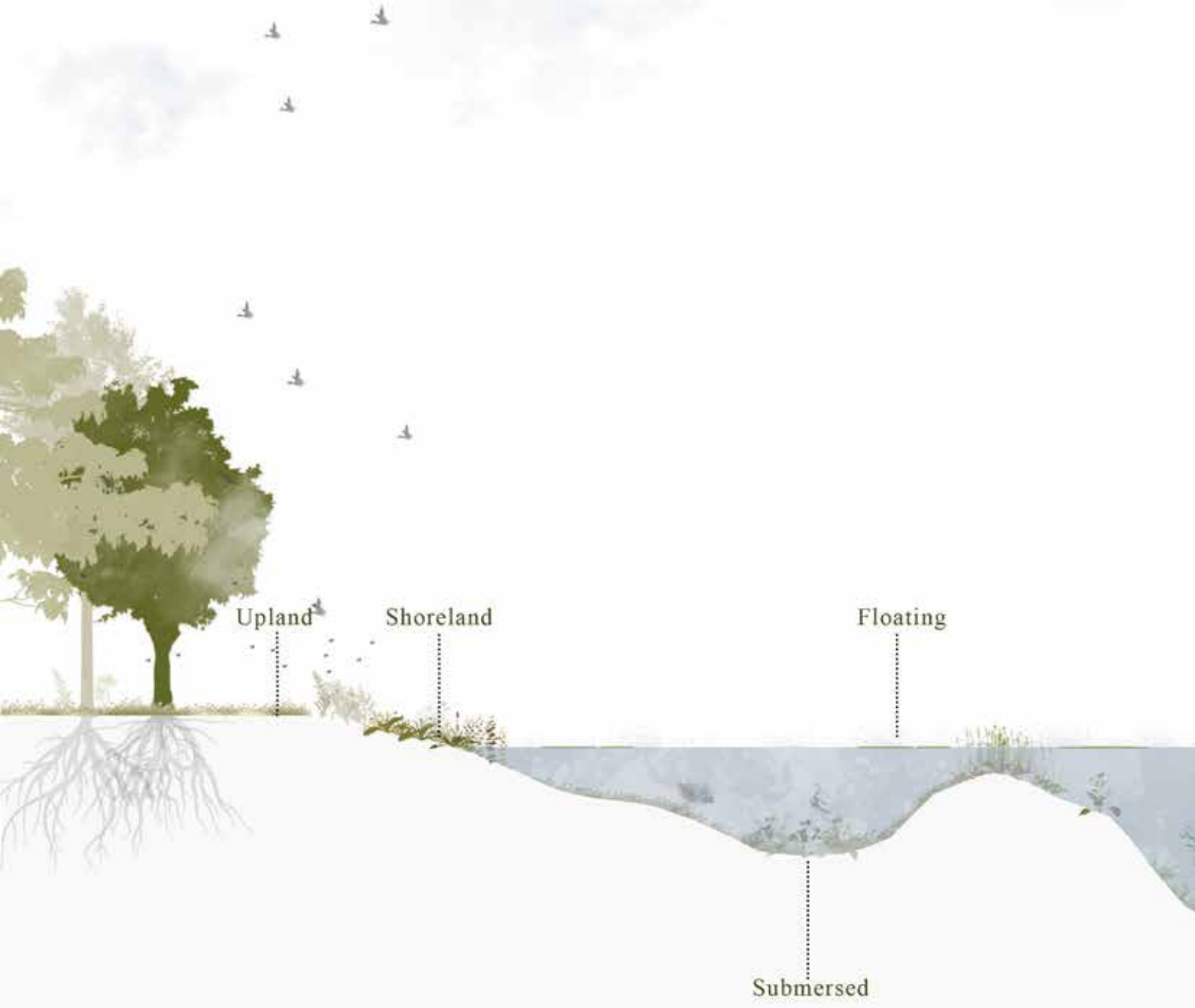
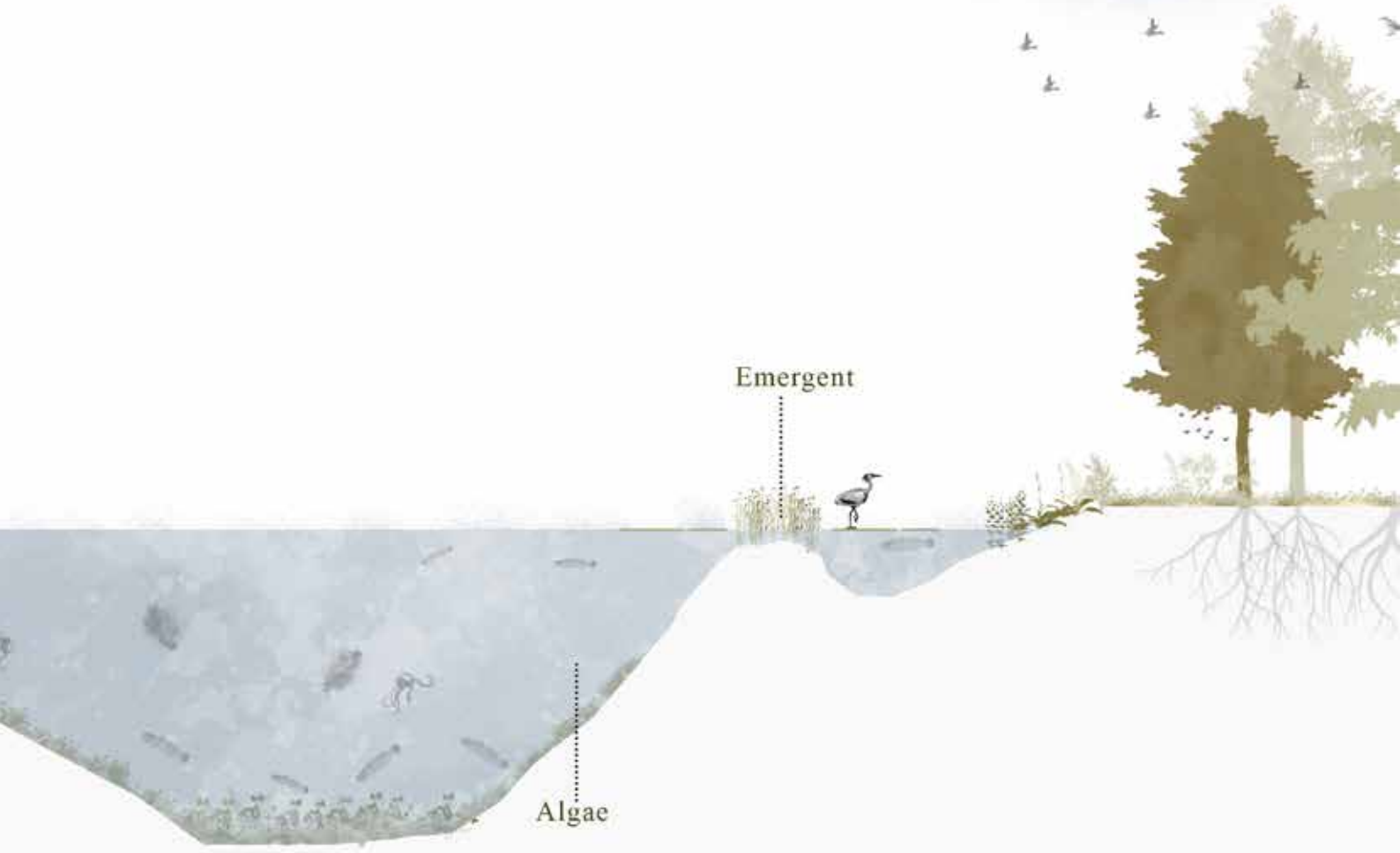


Figure 86


Emergent
Algae

PERMACULTURE GREEN SOLUTIONS

Permaculture Green solutions are methods used to address issues related to land management, soil fertility, and plant health. The term "green" in permaculture refers to the living systems on the land, including plants, animals, and microbes.

Permaculture Green solutions aim to mimic natural ecosystems by creating diverse, interconnected, and regenerative systems that produce food, fiber, and other resources while improving soil fertility and biodiversity.Some common Permaculture Green solutions include:

Agroforestry: Agroforestry is a land management system that involves integrating trees, crops, and livestock in a mutually beneficial way. Trees provide shade, shelter, and nutrients for crops and animals, while crops and animals provide a source of income and help maintain the health of the soil. Polyculture:

Polyculture is a farming technique that involves growing multiple crops together in the same field. This approach can help reduce the risk of crop failure and pest outbreaks, as well as improve soil fertility by creating a diverse range of root structures and nutrient demands. Composting: Composting is a method of turning organic waste into nutrient-rich soil amendment. Permaculture design often incorporates composting as a way to recycle food and garden waste and improve soil health.

Cover crops: Cover crops are crops that are grown specifically to improve soil health, such as by adding organic matter, fixing nitrogen, or preventing erosion. Permaculture design often involves using cover crops in rotation with cash crops to maintain soil fertility and prevent soil degradation.

Natural pest management: Permaculture design often emphasizes natural pest management techniques, such as companion planting, crop rotation, and using natural predators to control pests. This approach helps reduce the use of synthetic pesticides, which can harm the environment and human health.

Biointensive gardening: Biointensive gardening is a method of growing food that involves maximizing yields while minimizing inputs. This approach emphasizes building healthy soil, planting densely, and using natural pest control methods to create a sustainable and productive garden.

Overall, Permaculture Green solutions aim to create regenerative and self-sustaining systems that produce food, fiber, and other resources while improving the health of the soil and the surrounding ecosystem.

FIGURE 87

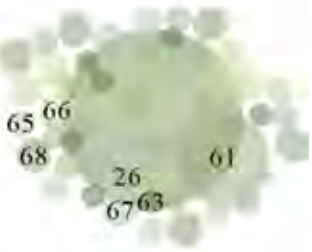
Permaculture Design Garden Solutions

Semi Dwarf Apple Orchard

52 Honey Crisp
40 Alpine Strawberry
61 Wild Indigo
23 Comfrey

Cherry Permaculture Guild

60 Northstar Cherry
61 White Wild Indigo
26 Purple Prairie Clover
63 Chives
64 Daffodil
65 French Sorrel
68 Veronica
66 Meadom Blazingstar
67 Creeping Thyme

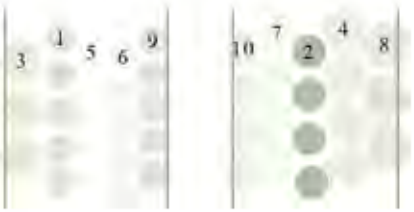


Hedge Wall Guild

1 Eastern Hemlock
2 Arbor Vitae
3 Forsythia
4 Basket Willow
5 Pea Shrub
6 Seaberry
7 Apple Rose
8 Wild Senna
9 Beach Plum
10 Cup Plant
11 Magnolia Vine
12 Dutchmans Pipe
13 Daylily
14 Mints
15 Lingonberry

Hoophouse Greens (Hardy) Perennial Guild

1 Arugula
2 Beet
3 Napa Cabbage
4 Chives
5 Dano Lettuce
6 Pac-Choi
7 Radish
8 Sweet Vetch
9 Tatsoi
10 Turnip



Paw Paw Patch Guild

1 Sugar Maple
2 Paw Paw
3 Spicebush
4 Ciwujia
5 Currants
6 SWilde Senna
7 Groundnut
8 Snakeroot
9 Solomon's Seal
10 Wild Ginger

Elderberry Walnut

1 Black Walnut
2 Plum
3 Elderberry
4 Black Currant
5 Black Raspberry
6 Grape
7 Chives
8 Daffodil
9 Summer Squash

Salsa Garden Guild

1 Tomato
2 Basil
3 Borage
4 Collard
5 Sea Kale
6 Peppers
7 Nasturtium
8 Onions
9 Cilantro
10 Comfrey
11 Asparagus

Fruit and Nut Guild

1 Groundnut
2 Fennel
3 Spearmint
4 Gingko
5 Wild Ginger
6 Comfrey
7 Violet
8 Hard Almond
9 Pear
10 Raspberry
11 Fig

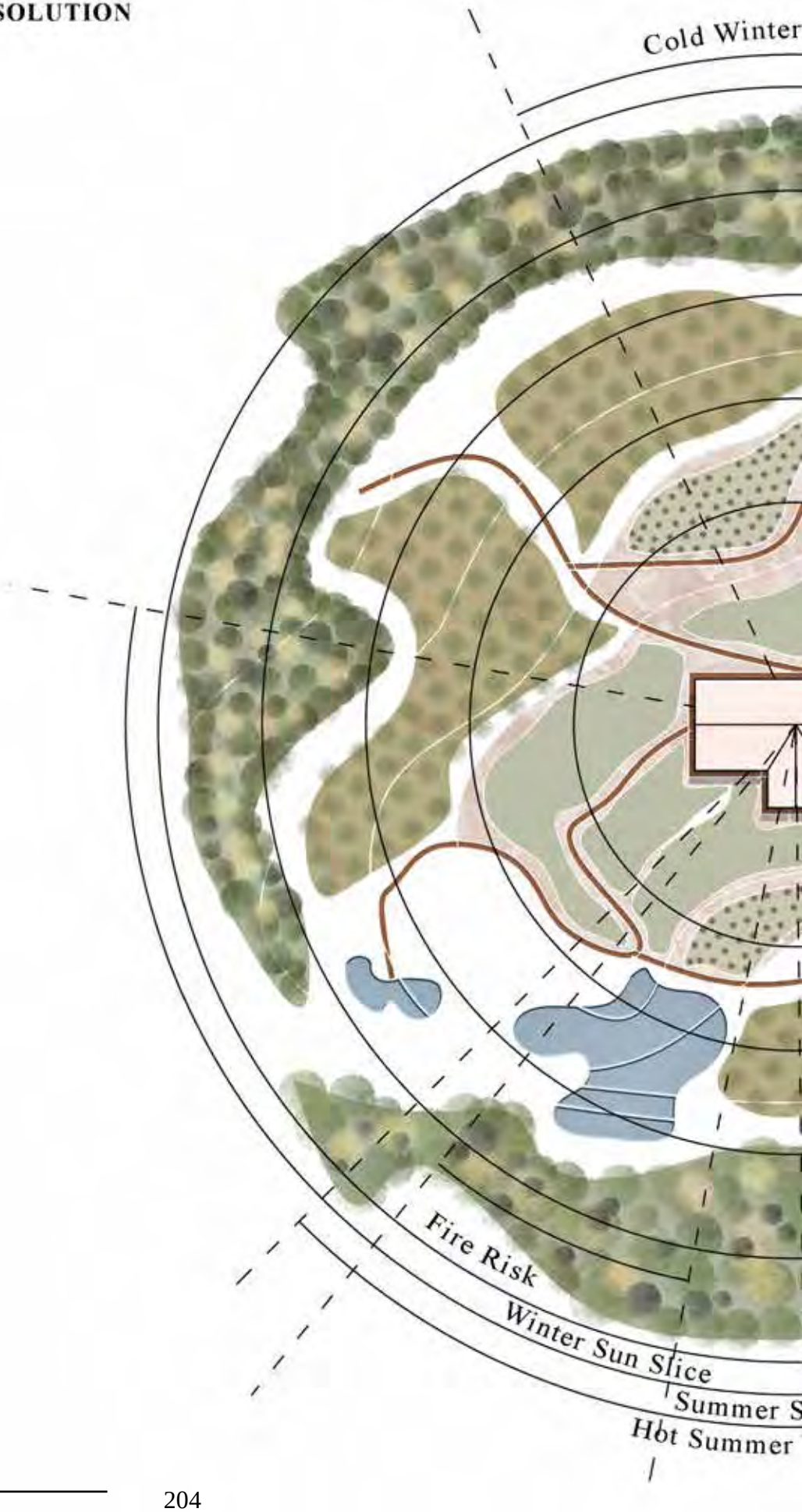
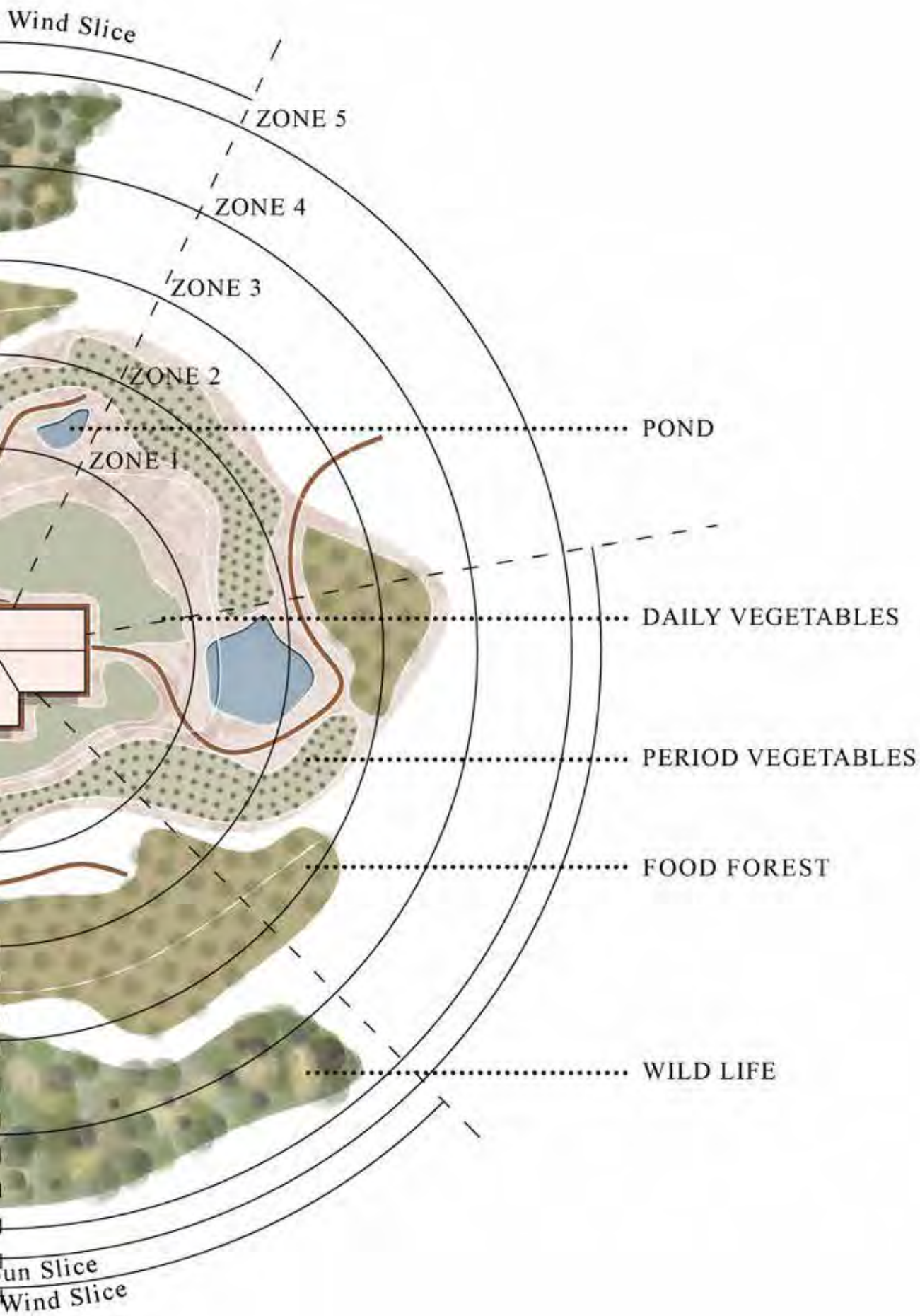


Figure 88


Wind Slice
ZONE 5
ZONE 4
ZONE 3
ZONE 2
ZONE 1
POND
DAILY VEGETABLES
PERIOD VEGETABLES
FOOD FOREST
WILD LIFE
un Slice
Wind Slice

MILANO FLORA ANALYSIS

Tree Species

Species	: Acer Platanoides
Common Name	: Norway Maple
Type	: Shade tree
Height	: 12m-15m
Wide	: 12m-15m
Grow Rate	: 0.6m-0.9m per year
Sun	: Full sun to part shade
Soil	: Deep,moist,acidic
Functions	: May become invasive

Species	: Acer Saccharinum
Common Name	: Silver Maple
Type	: Shade tree
Height	: 15m-30m
Wide	: 12m-15m
Grow Rate	: 0.6m per year
Sun	: Full sun to part shade
Soil	: Deep,moist,acidic
Functions	: Habitat for various species

Species	: Quercus Rubra
Common Name	: Red Oak
Type	: Canopy
Height	: 18m-22m
Wide	: 13m
Grow Rate	: 0.6m per year
Sun	: Full sun
Soil	: Acidic, loamy, moist,clay
Functions	: Edible Use

Species	: Quercus Robur
Common Name	: Famia
Type	: Ornamental
Height	: 12m-18m
Wide	: 12m-18m
Grow Rate	: 0.2m per year
Sun	: Full sun
Soil	: Loamy, moist, well-drained
Functions	: Toxic to people and animals

Figure 89



Species	: Robinia Pseudoacacia
Common Name	: Robinia
Type	: Canopy - Ornamental
Height	: 9m-15m
Wide	: 9m-15m
Grow Rate	: 0.6m per year
Sun	: Full sun to part shade
Soil	: Acidic, loamy, moist, sandy
Functions	: Medicinal Uses, Edible Uses



Species	: Carpinus Betulus
Common Name	: Hornbeam
Type	: Canopy
Height	: 12m-18m
Wide	: 10m-12m
Grow Rate	: 0.2m per year
Sun	: Full sun to part shade
Soil	: Acidic, loamy, moist, wet
Functions	: Attracts wildlife



Species	: Prunus Cerasifera
Common Name	: Red Leaf Myrobalan
Type	: Flowering - ornamental tree
Height	: 7m
Wide	: 7m
Grow Rate	: 0.3m-0.6m per year
Sun	: Full sun
Soil	: Acidic, loamy, moist, clay
Functions	: Support variable ecosystems



Species	: Liquidambar Styraciflu
Common Name	: Storace Americano
Type	: Canopy
Height	: 18m-22m
Wide	: 12m-15m
Grow Rate	: 0.3m-0.6m per year
Sun	: Full sun
Soil	: Acidic, loamy, moist, sandy
Functions	: Edible Use

MILANO FLORA ANALYSIS

Tree Species

Species	: Juglans Nigra
Common Name	: Shoot Nero d'America
Type	: Canopy - Ornamental
Height	: 15m-22m
Wide	: 15m-22m
Grow Rate	: 0.3m-0.6m per year
Sun	: Full sun
Soil	: Acidic, alkaline, loamy,wet
Functions	: Edible Use

Species	: Liriodendron Tulipifera
Common Name	: Tulip Tree
Type	: Shade tree
Height	: 5m-8m
Wide	: 4m-8m
Grow Rate	: 0.6m per year
Sun	: Full sun
Soil	: Moist, well drained, clay
Functions	: Edible Use

Species	: Tilia Spp
Common Name	: Tiglio
Type	: Shade - Flowering
Height	: 15m-24m
Wide	: 9m-15m
Grow Rate	: 0.3m-0.6m per year
Sun	: Full sun and partial shade
Soil	: Acidic, alkaline, moist,clay
Functions	: Habitat for various species

Species	: Acer Pseudoplatanus
Common Name	: Red Leaf Myrobalan
Type	: Shade tree
Height	: 12m-18m
Wide	: 12m -15m
Grow Rate	: 0.6m per year
Sun	: Full sun to light shade
Soil	: Well-drained, acidic
Functions	: Well with urban conditions

Figure 89



Species	: Ulmus Minor
Common Name	: Common Elm
Type	: Canopy
Height	: 30m
Wide	: 15m
Grow Rate	: 1 m per year
Sun	: Full sun to part shade
Soil	: Acid, neutral, basic alkaline
Functions	: Attracts wildlife



Species	: Acer Saccharum
Common Name	: Sugar Maple
Type	: Shade tree
Height	: 18m-22m
Wide	: 12m - 15m
Grow Rate	: 0.3m-0.6m per year
Sun	: Full sun to part shade
Soil	: Well-drained, acidic,alkaline
Functions	: Edible Use



Species	: Acer Platanoides
Common Name	: Norway Maple
Type	: Shade tree
Height	: 12m-15m
Wide	: 12m-15m
Grow Rate	: 0.6m-0.9m per year
Sun	: Full sun to part shade
Soil	: Deep, moist, acidic
Functions	: May become invasive



Species	: Acer Saccharinum
Common Name	: Silver Maple
Type	: Shade tree
Height	: 15m-30m
Wide	: 12m- 15m
Grow Rate	: 0.6m per year
Sun	: Full sun and partial shade
Soil	: Deep, moist, acidic
Functions	: Habitat for various species

MILANO FLORA ANALYSIS

Tree Species

Species	: Acer Saccharum
Common Name	: Sugar Maple
Type	: Shade tree
Height	: 18m-22m
Wide	: 12m-15m
Grow Rate	: 0.3m-0.6m per year
Sun	: Full sun to part shade
Soil	: Well-drained, acidic
Functions	: Edible Use

Species	: Quercus Palustris
Common Name	: Querce di Palude
Type	: Canopy
Height	: 18m-22m
Wide	: 7m-12m
Grow Rate	: 0.6m per year
Sun	: Full sun
Soil	: Acidic, loamy, moist,wet
Functions	: Edible Use

Species	: Benila Nigra
Common Name	: River Birch
Type	: Shade tree
Height	: 12m-24m
Wide	: 12m-18m
Grow Rate	: 0.3m-0.6m per year
Sun	: Full sun and partial shade
Soil	: Acidic, loamy, moist
Functions	: Edible Use

Species	: Cedrus Libani
Common Name	: Cedars of Lebanon
Type	: Ornamental
Height	: 40m
Wide	: 10m
Grow Rate	: 0.3m per year
Sun	: Full sun
Soil	: Loam, sandy, clay
Functions	: Medicinal Uses

Figure 89



Species	: Quercus Rubra
Common Name	: Quercus Rosse
Type	: Canopy
Height	: 18m-22m
Wide	: 13m
Grow Rate	: 0.6m per year
Sun	: Full sun
Soil	: Acidic, loamy, moist, wet
Functions	: Edible Use



Species	: Sophora Japonica
Common Name	: Sophora
Type	: Canopy
Height	: 15m-22m
Wide	: 9m-12m
Grow Rate	: 1m per year
Sun	: Full sun to part shade
Soil	: Loam, clay, acidic, alkaline
Functions	: Urban street tree planting



Species	: Cedrus Deodara
Common Name	: Cedri dell'Himalaya
Type	: Evergreen
Height	: 12m-2lm
Wide	: 6m-12m
Grow Rate	: 0.3m-0.6m per year
Sun	: Full sun
Soil	: Acidic, loamy, moist, clay
Functions	: Habitat for various species



Species	: Platanus x Acerifolia
Common Name	: Platani
Type	: Canopy- Ornamental
Height	: 22m-30m
Wide	: 18m-22m
Grow Rate	: 0.3m-0.6m per year
Sun	: Full sun to part shade
Soil	: Acidic, loamy, moist, clay
Functions	: Edible Use

MILANO FLORA ANALYSIS

Tree Species



Species	: Morus Alba
Common Name	: Mulberries
Type	: Shrub
Height	: 9m-2lm
Wide	: 9m - 15m
Grow Rate	: 1m per year
Sun	: Full sun
Soil	: Moist, well-drained
Functions	: Edible Use



Species	: Rhus Typhina
Common Name	: American Sumacs
Type	: Shrub
Height	: 4m-7m
Wide	: 6m-9m
Grow Rate	: 0.3m-0.6m per year
Sun	: Full sun to part shade
Soil	: clay, sand, loam, acidic
Functions	: Attracts Birds



Species	: Liriodendron Tulipifera
Common Name	: Tulip Tree
Type	: Shade tree
Height	: 5m-8m
Wide	: 4m-8m
Grow Rate	: 0.6m per year
Sun	: Full sun
Soil	: Moist, well drained, clay
Functions	: Edible Use



Species	: Prunus Serrulata
Common Name	: Japanese Flowering Cherry
Type	: Ornamental
Height	: 2lm-30m
Wide	: 12m
Grow Rate	: 0.6m per year
Sun	: Full sun
Soil	: Well drained soil
Functions	: Requires maintenance

Figure 89

Species	: Tilia Spp
Common Name	: Tiglio
Type	: Shade - Flowering
Height	: 15m-24m
Wide	: 9m - 15m
Grow Rate	: 0.3m-0.6m per year
Sun	: Full sun to part shade
Soil	: Acidic, loamy, moist, clay
Functions	: Habitat for various species

Species	: Acer Pseudoplatanus
Common Name	: Sycamore Maple
Type	: Shade tree
Height	: 12m-18m
Wide	: 12m-15m
Grow Rate	: 0.6m per year
Sun	: Full sun to light shade
Soil	: Well-drained, acidic
Functions	: Well with urban conditions

Species	: Taxodium Distichum
Common Name	: Cipresso Calvo
Type	: Canopy
Height	: 30m-40m
Wide	: 10m
Grow Rate	: 0.3m-0.6m per year
Sun	: Full sun
Soil	: Moist, well-drained,clay
Functions	: Support variable ecosystems

Species	: Juglans Nigra
Common Name	: Shoot Nero d'America
Type	: Canopy - Ornamental
Height	: 15m-22m
Wide	: 15m-22m
Grow Rate	: 0.3m-0.6m per year
Sun	: Full sun
Soil	: Acidic, alkaline, loamy
Functions	: Edible Use

MILANO FLORA ANALYSIS

Tree Species



Species	: Ulmus Laevis
Common Name	: Elms
Type	: Canopy - Ornamental
Height	: 30m or more
Wide	: 12m
Grow Rate	: 1 m per year
Sun	: Full sun
Soil	: Nutrient-poor soil
Functions	: Withstand bouts of wetness



Species	: Populus Nigra
Common Name	: Poplar Cypress
Type	: Canopy - Ornamental
Height	: 12m -15m
Wide	: 9m
Grow Rate	: 0.6m per year
Sun	: Full sun
Soil	: Acidic, alkaline and wet soils
Functions	: Habitat for various species



Species	: Aesculus Hippocastanum
Common Name	: Ippocastano
Type	: Canopy - Ornamental
Height	: 15m-22m
Wide	: 12m-21m
Grow Rate	: l.2m-l.7m per year
Sun	: Full sun and partial shade
Soil	: Acidic, loamy, moist,clay
Functions	: Edible Use



Species	: Ulmus Pumila
Common Name	: Siberian Elm
Type	: Canopy - Ornamental
Height	: 15m-21m
Wide	: 12m
Grow Rate	: 1m per year
Sun	: Full sun
Soil	: Nutrient-poor soil
Functions	: Carbon Farming

Figure 89



Species	: Fagus Sylvatica
Common Name	: Beech
Type	: Canopy - Ornamental
Height	: 15m- 18m
Wide	: 10m-13m
Grow Rate	: 0.3m-0.6m per year
Sun	: Full sun
Soil	: 0.3m-0.6m per year
Functions	: Edible Use



Species	: Ginkgo Biloba
Common Name	: Ginkgo
Type	: Canopy - Ornamental
Height	: 8m-15m
Wide	: 7m-10m
Grow Rate	: 0.3m-0.6m per year
Sun	: Full sun to part shade
Soil	: Moist, well-drained, wet
Functions	: Tolerates heat, air pollution



Species	: Liquidambar Styraciflua
Common Name	: Starace Americana
Type	: Canopy
Height	: 18m-22m
Wide	: 12m -15m
Grow Rate	: 0.3m-0.6m per year
Sun	: Full sun
Soil	: Acidic, loamy, moist, clay
Functions	: Edible Use



Species	: Celtis Australis
Common Name	: Bagolaro
Type	: Canopy
Height	: 25m and more
Wide	: 12m-15m
Grow Rate	: 0.3m-0.6m per year
Sun	: Full sun
Soil	: Light well-drained and loamy
Functions	: Edible Use

MILANO FLORA ANALYSIS

Agricultural Species (Cereals,Crops,Vegetables,Fruit

Species	: Triticum Aestivus
Common Name	: Wheat
Type	: Graminaceous
Height	: 40-80 cm
Wide	: 5cm
Category	: Cereal
Sun	: Full sun
Sowing	: October-November
Harvesting	: June

Species	: Zea Mays
Common Name	: Corn
Type	: Poaceae
Height	: +2m
Wide	: 20cm
Category	: Cereal
Sun	: Full sun
Sowing	: March-April
Harvesting	: September

Species	: Beta Vulgaris
Common Name	: Beet
Type	: Chenopodiaceae
Height	: 1-2m
Wide	: 10cm
Category	: Industrial Crop
Sun	: Underground
Sowing	: March
Harvesting	: June-July

Species	: Glycine Max
Common Name	: Soy
Type	: Phaseoleae
Height	: 30cm
Wide	: 10cm
Category	: Industrial Crop
Sun	: Full sun
Sowing	: April-May
Harvesting	: September-October

Figure 90

Species	: Hordeum vulgaris
Common Name	: Barley
Type	: Poaceae
Height	: 60-120cm
Wide	: 5cm
Category	: Cereal
Sun	: Full sun
Sowing	: Autumn or Spring
Harvesting	: June

Species	: Avena Sativa
Common Name	: Oats
Type	: Poaceae
Height	: 50-120cm
Wide	: 5cm
Category	: Cereal
Sun	: Full sun
Sowing	: March-April
Harvesting	: August-September

Species	: Brassica Napus
Common Name	: Rapeseed
Type	: Brassicaceae
Height	: 150cm
Wide	: 10cm
Category	: Industrial Crop
Sun	: Full sun
Sowing	: August
Harvesting	: June

Species	: Helianthus Annuus
Common Name	: Sunflower
Type	: Helianthinae
Height	: 3m
Wide	: 20cm
Category	: Industrial Crop
Sun	: Full sun
Sowing	: April-May
Harvesting	: August-September

MILANO FLORA ANALYSIS

Agricultural Species (Cereals,Crops,Vegetables,Fruit

Species	: Solanum Lycopersicum
Common Name	: Tomato
Type	: Solanineae
Height	: 50cm
Wide	: 30cm
Category	: Vegetable
Sun	: Full sun
Sowing	: February-March
Harvesting	: July-August

Species	: Phaseolus Vulgaris
Common Name	: Bean
Type	: Faboideae
Height	: 40cm
Wide	: 20cm
Category	: Vegetable
Sun	: Partial Shading
Sowing	: Marh to July
Harvesting	: 180 days after sowing

Species	: Cucurbita Maxima
Common Name	: Pumpkin
Type	: Cucurbitaceae
Height	: 30cm
Wide	: 40cm
Category	: Vegetable
Sun	: Partial shading
Sowing	: April-May
Harvesting	: September-October

Species	: Cucumis Melo
Common Name	: Melon
Type	: Cucurbitaceae
Height	: 50cm
Wide	: 40cm
Category	: Vegatable
Sun	: Partial Shading
Sowing	: April-May
Harvesting	: June-July

Figure 90

Species	: Allium cepa
Common Name	: Onion
Type	: Allioideae
Height	: 30cm
Wide	: 10cm
Category	: Vegetable
Sun	: Underground
Sowing	: February-March
Harvesting	: 90-120 days after sowing

Species	: Allium Sativum
Common Name	: Garlic
Type	: Allioideae
Height	: 20cm
Wide	: 5cm
Category	: Vegetable
Sun	: Underground
Sowing	: February-March
Harvesting	: August-September

Species	: Pisum Sativum
Common Name	: Pea
Type	: Fabaceae
Height	: 40cm
Wide	: 20cm
Category	: Vegetable
Sun	: Full sun
Sowing	: Octoboer or February
Harvesting	: 90-100 days after sowing

Species	: Asoaragus Officinalis
Common Name	: Asparagus
Type	: Liliaceae
Height	: 15cm
Wide	: 2cm
Category	: Vegateble
Sun	: Full sun
Sowing	: March-April
Harvesting	: June

MILANO FLORA ANALYSIS

Agricultural Species (Cereals,Crops,Vegetables,Fruit

Species	: Vitis Vinifera
Common Name	: Vine
Type	: Vitaceae
Height	: 100-150cm
Wide	: 120cm
Category	: Fruit
Sun	: Full sun
Sowing	: From October to May
Harvesting	: From July to October

Species	: Prunus Persica
Common Name	: Peach
Type	: Rosaceae
Height	: 4-8m
Wide	: 6-8m
Category	: Fruit
Sun	: Full sun
Sowing	: Autumn or Spring
Harvesting	: June-July

Species	: Pirus Communis
Common Name	: Pear
Type	: Rosaceae
Height	: 14-18m
Wide	: 10m
Category	: Fruit
Sun	: Full sun
Sowing	: March
Harvesting	: September-October

Species	: Prunus Avium
Common Name	: Cherry
Type	: Rosaceae
Height	: 15m
Wide	: 10m
Category	: Friut
Sun	: Full sun
Sowing	: March
Harvesting	: June-July

Figure 90



Species	: Prunus Armeniaca
Common Name	: Apricot
Type	: Rosaceae
Height	: 4-8m
Wide	: 6-8m
Category	: Fruit
Sun	: Full sun
Sowing	: Autumn or Spring
Harvesting	: June-July



Species	: Malus Domestica
Common Name	: Apple
Type	: Rosaceae
Height	: 10m
Wide	: 6-8m
Category	: Fruit
Sun	: Full sun
Sowing	: March-April
Harvesting	: From July to November



Species	: Prunus Domestica
Common Name	: Plum
Type	: Rosaceae
Height	: 3-8m
Wide	: 6-8m
Category	: Fruit
Sun	: Full sun
Sowing	: Agust
Harvesting	: From June to September



Species	: Olea Europaea
Common Name	: Olive
Type	: Oleaceae
Height	: 12-18m
Wide	: 6-12m
Category	: Industrial Crop
Sun	: Full sun
Sowing	: April-May
Harvesting	: November-December

MILANO FAUNA ANALYSIS

Bird and Animal Species

The hooded crow (Corvus cornix) is an animal endowed with marked intelligence, highly social and gregarious, capable of adapting to the city without difficulty and of finding food in any place. Among the first causes of the numerical increase of the specimens present in the city, observed in recent years, we must consider its ability to use various sources of food and the poor management of waste by citizens, including the uncontrolled abandonment of residues of foods. The basic strategy to contain their number is therefore not to leave food scraps in open-air places, including uncovered "trash bins".

The pigeon needs no introduction, it is known by all citizens of Milan and lives in many other European cities; it's a species originally domesticated, then rewilded following release of bred specimens. Rock pigeons (Columba livia) nest in nature in the cavities of rock walls and the attics of our cities they are a great substitute for that, providing points.

Two species of parrots have been present in Milan for some years: the Indian-collared Parakeet (Psittacula krameri manillensis), native to Asia and, in smaller numbers, the Monk Parakeet (Myopsitta monachus), native to South America. These animals derive from a few individuals, intentionally released. Less frequently we can observe parrots of the genera Amazona and Ara.

For decades, exotic aquatic turtles - or more correctly alien pond turtles - have been sold as the ideal first pet for children and adults. Those found for sale are only the very young individuals, which are therefore small, attractive, apparently delicate, inexpensive. They are thought to be easily manageable in small containers. Nothing more wrong. Few clarify at the time of purchase - or of the gift - that those turtles are newborns of American or Asian species that can multiply their size tenfold in just three to four years, reaching a length of about 30 cm and which can reach up to 35 cm.

Figure 91

In spring, in Milan, three species of swifts (common swift) (Apus apus), pale swift (Apus pallidus), greater swift (Tachymarptis melba) nest, which arrive every year from Africa where they spend the winter. Swifts are perhaps the birds best adapted to flight: they are able to fly for at least ten months, sometimes even for years, without ever stopping; they feed, drink and mate in flight. They have legs that are poorly suited for locomotion, but perfect for clinging to rock walls and city buildings.

The starlings (Sturnus vulgaris) from mid-summer (July) begin to form large groups, which progressively enlarge in the autumn months (October-November) and, in the late autumn afternoons, transform into collective roosting, when they gather on tall trees squares and avenues to spend the night. Why do these birds do this? To defend themselves from predators, to stay warmer, because they tend to move in groups towards feeding places. Furthermore, by attending dormitories, young people learn adaptive behaviors from adults.

Nutria (Myocastor coypus) is a rodent native to Central and South America. It was introduced in Italy in the early twenties of the last century for the production of "castorino" furs. Following the fur market crisis, the companies irresponsibly released the coypu in the wild to avoid slaughter costs. Thanks to their ability to adapt, nutria have colonized the environments most suited to them, the banks of rivers and swampy areas. The coypu has been very present in the area around Milan for years and, through canals and irrigation ditches, it sometimes enters the city.

The gray squirrel (Sciurus carolinensis) is native to North America and was introduced in Italy as a pet, then released accidentally or voluntarily to "enrich" urban parks with fauna. It has spread widely in northern Italy and for some years it has also been present in some parks and gardens in Milan. The gray squirrel, an allochthonous species, has a strong capacity to expand its territory and threatens the survival of the red squirrel (Sciurus vulgaris), the native species that lives in Italian and European woods.

ZONE 6 ,MILANO
MASTER PLAN (SHORT TERM)

In the Zone 6 region, short-term Nature-Based solution and permaculture applications should be designed as a period of understanding and learning for the people living in the region.

In the first 5 years, the agricultural culture in the region should be applied with simple methods. With the direct contribution of the public to this process, learning methods can be realized.

By starting the development studies of the green areas already existing in the region with the principles of Nature Based Solutions and Permaculture, people are provided to work directly in these areas.

Figure 92

ZONE 6 ,MILANO
MASTER PLAN (MEDIUM TERM)

In the Medium Term, risk areas should be identified and forestation studies should be carried out in accordance with Nature-Based Solution and Permaculture firsts, especially in regions with high carbon and nitrogen emissions, and preventing this risk should be determined as a priority target.

While the efforts to create a common culture with the gains of the local people in the first 5 years continue, the cultivation areas should be expanded and an important source of income and food should be obtained. The income to be obtained through conscious consumption and the sale of surplus products will increase the economic gains in the region.

Figure 92

ZONE 6 ,MILANO
MASTER PLAN (LONG TERM)

The most important long-term approach is for the people to have a decision-making process according to their own needs. It is the people of the region who have the ability to make a joint decision about the South Agricultural Park, which is extremely important for Milan in this period, and to work according to this decision.

In this map, the appearance of the southern agricultural park, which will emerge in the light of possible developments, has been tried to be reflected. However, the cultural, economic and social structure of the people who are an important factor in his thesis will be an important source and designer of this process.

Figure 92

Figure 93

Master’s Thesis / Design Process
Building Scale

Figure 93

Figure 93

Master’s Thesis / Design Process
Water Bodies and Drainage Systems

Figure 93

Figure 93

Master's Thesis / Design Process
Natural Areas and Management of Rural Land

5. CONCLUSION

Nature Based Solutions can be considered a broad umbrella term for Permaculture in its scope. Both Nature Based Solutions and Permaculture aim to protect nature and find solutions compatible with nature. Permaculture focuses more on regulating the philosophical and ethical dimensions of sustainability, and it leads in a significant way when it considers sustainable solutions. While doing this, it does this by considering the neighborhood relations based on production and surplus sharing between societies as well as regulating the social structure. Nature-Based Solutions, on the other hand, is an important method with its general perspective and solutions to problems. While addressing this, the fact that stakeholders are doing government policies and people from many disciplines with a participatory approach increases its importance today.

It is clearly understood with this thesis that the co-operation of these two approaches creates a general sustainable development socially, economically and politically for sustainable solutions. In addition, the nature-based solutions that can be applied from city scale to building scale as a working scale, and the tendency of Permaculture to work from building scale to city scale ensures that these two approaches form a complementary and mutually reinforcing and controlling system.

As a result of the thesis, it has been seen that Nature-Based Solution and Permaculture design can work in harmony with each other and have the ability to close each other's deficiencies. During the study, it was observed that much more efficiency was obtained with the working method created by Nature Based Solutions and Permaculture. It has been understood that solution proposals that can work in harmony with existing environmental reports can be developed. Thanks to the methodological approach prepared with this thesis, it will be able to make important contributions to future studies as it determines the methods necessary for Nature-Based Solutions and Permaculture to work together.

6. REFERENCES

1. INTRODUCTION

Chen, L., Ren, C., Zhang, B., Wang, Z., & Liu, M. (2018). Quantifying urban land sprawl and its driving forces in Northeast China from 1990 to 2015. Sustainability, 10(1), 188.

Kuddus, M. A., Tynan, E., & McBryde, E. (2020). Urbanization: a problem for the rich and the poor?. Public health reviews, 41, 1-4.

Sridhar, K. S., & Mavrotas, G. (2021). Challenges of urbanization in the global south: Introduction and overview. In Urbanization in the Global South (pp. 1-17). Routledge India.

2. LITERATURE REVIEW

Cline, W. R. (1992). The economics of global warming. Institute for International Economics, Washington, DC, 399.

Allitt, P. N. (2014). The Industrial Revolution. Course Guidebook. Smithsonian Institution, United States of America.

Stearns, P. N. (2020). The industrial revolution in world history. Routledge.

Dincer, I., Colpan, C. O., & Kadioglu, F. (Eds.). (2013). Causes, impacts and solutions to global warming. Springer Science & Business Media.

Smerdon, J. (2018). Climate change: the science of global warming and our energy future. Columbia University Press.

Houghton, J. (2009). Global warming: the complete briefing. Cambridge university press.

Aksay, C. S., Ketenoğlu, O., & Latif, K. U. R. T. (2005). Küresel Isınma ve İklim Değişikliği. Selçuk Üniversitesi Fen Fakültesi Fen Dergisi, 1(25), 29-42.

Coleman, D. C. (1956). Industrial growth and industrial revolutions. Economica, 23(89), 1-22.
Bentley, J. H. (2013). Environmental crises in world history. Procedia-Social and Behavioral Sciences, 77, 108-115.

Didem, K. O. C. A. (2020). Sanayi devrimlerinin tarihsel arka planı ve işgücü becerileri üzerindeki yansımaları. OPUS International Journal of Society Researches, 16(31), 4531-4558.

Srinivas, V. (2018). Major financial crisis: From Great Depression to Great Recession.

Heiderscheidt, D. (2018). The impact of world war one on the forests and soils of europe. Ursidae: The Undergraduate Research Journal at the University of Northern Colorado, 7(3), 3.

El-Gamal, M. A., & Jaffe, A. M. (2009). Oil, dollars, debt, and crises: The global curse of black gold. Cambridge University Press.

Caradonna, J. L. (Ed.). (2017). Routledge handbook of the history of sustainability (p. 37). Abingdon, UK: Taylor & Francis.

Baweja, V. (2014). Sustainability and the architectural history survey. Enquiry, 11, 40-51.

Grober, U. (2007). Deep roots-a conceptual history of'sustainable development'(Nachhaltigkeit).

Caradonna, J. L. (2014). Sustainability: A history. Oxford University Press.

Kuhlman, T., & Farrington, J. (2010). What is sustainability?. Sustainability, 2(11), 3436-3448.

Iyengar, K. (2015). Sustainable architectural design: An overview. Routledge.

Djalali, A., & Vollaard, P. (2008). The complex history of sustainability: an index of trends, authors, projects and fiction. After Zero, 18(1).

UNDESA, P. (2018). World urbanization prospects: the 2018 revision. Retrieved August, 26, 2018.

Iwaszuk, E., Rudik, G., Duin, L., Mederake, L., Davis, M., Naumann, S., & Wagner-Lotkowska, I. (2019). Addressing climate change in cities: catalogue of urban nature-based solutions. Sendzimir Fundation.

MacKinnon, K., Sobrevila, C., & Hickey, V. (2008). Biodiversity, climate change, and adaptation: nature-based solutions from the World Bank portfolio (No. 46726, pp. 1-112). The World Bank.

Somarakis, G., Stagakis, S., Chrysoulakis, N., Mesimäki, M., & Lehvävirta, S. (2019). ThinkNature nature-based solutions handbook.

Almassy, D., Pinter, L., Rocha, S., Naumann, S., Davis, M., Abhold, K., Bulkeley, H. (2018) Urban Nature Atlas: A Database of Nature-Based Solutions Across 100 European Cities

Kabisch, N., Korn, H., Stadler, J., & Bonn, A. (2017). Nature-based solutions to climate change adaptation in urban areas: Linkages between science, policy and practice. Springer Nature.

Barton, M. (2016). Nature-based solutions in urban contexts: A case study of Malmö, Sweden. IIIEE Masters Thesis.

Gutiérrez, L., García, G., & García, I. (2017). Nature-based solutions for local climate adaptation in the Basque Country. Ihobe, Environmental Management Agency Ministry of the Environment, Territorial Planning and Housing - Basque Government.

Hawxwell, T., Mok, S., Mačiulytė, E., Sautter, J., & Dobrokhotova, E. (2019). Municipal governance for nature-based solutions. Fraunhofer IAO: Stuttgart, Germany.

Cohen-Shacham, E., Walters, G., Janzen, C., & Maginnis, S. (2016). Nature-based solutions to address global societal challenges. IUCN: Gland, Switzerland, 97, 2016-2036.

IUCN. (2020). Global Standard for Nature-Based Solutions. A User-Friendly Framework for the Verification, Design and Scaling up of NbS.

Raymond, C. M., Breil, M., Nita, M. R., Kabisch, N., de Bel, M., Enzi, V., ... & Berry, P. (2017). An impact evaluation framework to support planning and evaluation of nature-based solutions projects. Report prepared by the EKLIPSE Expert Working Group on Nature-Based Solutions to Promote Climate Resilience in Urban Areas. Centre for Ecology and Hydrology.

Auduceau, N., Berry, P., Cecchi, C., Elmqvist, T., Fernandez, M., Hartig, T., Krull, W., Mayerhofer, E., N, S., Noring, L., Raskin-Delisle, K., Roozen, E., Sutherland, W., & Tack, J. (2015). Towards an EU Research and Innovation Policy Agenda for Nature-based Solutions & Re-naturing Cities: Final Report of the Horizon 2020 Expert Group on 'Nature-based Solutions and Re-naturing Cities'. Publications Office of the European Union.

Freitas, T., Wiedman, G., & Enfedaque, J. (Eds.). (2019). The EU-Brazil Sector Dialogue on Nature-Based Solutions: Contribution to a Brazilian Roadmap on Nature-Based Solutions for Resilient Cities. Publications Office of the European Union.

Wild, T., Freitas, T., & Vandewoestijne, S. (2020). Nature-based solutions: State of the art in EU-funded projects. Publications Office of the European Union.

Cardinali, M., Dumitru, A., Vandewostijne, S., & Wendling, L. (2021). Evaluating the Impact of Nature-Based Solutions: A Summary for Policy Makers.

Naumann, S., & Davis, M. (2020). Biodiversity and Nature-Based Solutions: Analysis of EU Funded Projects. Independent Expert Report.

Mahmoud, I. H., Morello, E., Vona, C., Benciolini, M., Sejdullahu, I., Trentin, M., & Pascual, K. H. (2021). Setting the social monitoring framework for nature-based solutions impact: Methodological approach and pre-greening measurements in the case study from clever cities milan. Sustainability, 13(17), 9672.

Morello, E., & Pareglio, S. (2018). Catalogue of Nature-Based Solutions for Urban Regeneration. Politecnico Di Milano University.

United Nations. (2011). The global social crisis: Report on the world social situation 2011.

Blankenburg, S., & Palma, J. G. (2009). Introduction: the global financial crisis. Cambridge Journal of Economics, 33(4), 531-538.

Pereira, A. C., & Romero, F. (2017). A review of the meanings and the implications of the Industry 4.0 concept. Procedia Manufacturing, 13, 1206-1214.

Ansal, H. (1996). Esnek üretimde işçiler ve sendikalar (post-fordizm'de üretim esnekleşirken işçiye neler oluyor?). Birleşik Metal-İş Sendikası.

Stearns, P. N. (2020). The industrial revolution in world history. Routledge.

Parker, S. (2003). Urban theory and the urban experience: Encountering the city. Routledge.
UNDESA, P. (2018). World urbanization prospects: the 2018 revision. Retrieved August, 26, 2018.

Houghton, J. (2009). Global warming: the complete briefing. Cambridge university press.

Aksay, C. S., Ketenoğlu, O., & Latif, K. U. R. T. (2005). Küresel Isınma ve İklim Değişikliği. Selçuk Üniversitesi Fen Fakültesi Fen Dergisi, 1(25), 29-42.

Çimen, A., & Göğebakan, G. A. (2007). Tarihi değiştiren savaşlar. Timaş Yayınları.

Heiderscheidt, D. (2018). The impact of world war one on the forests and soils of europe. Ursidae: The Undergraduate Research Journal at the University of Northern Colorado, 7(3), 3.

Mold, A. (2020). Covıd And Socıety The Hıstory Of Publıc Health Crıses Governance And Trust. Centre for History in Public Health, London School of Hygiene and Tropical Medicine.

United Nations. Dept. of Economic and Social Affairs. (2011). The global social crisis: Report on the world social situation 2011. United Nations Publications.

Kuhlman, T., & Farrington, J. (2010). What is sustainability?. Sustainability, 2(11), 3436-3448.

Caradonna, J. L. (2014). Sustainability: A history. Oxford University Press.

Iyengar, K. (2015). Sustainable architectural design: An overview. Routledge.

Maes, J., & Jacobs, S. (2017). Nature-based solutions for Europe’s sustainable development. Conservation letters, 10(1), 121-124.

Dumitru, A., & Wendling, L. (2021). Evaluating the impact of nature-based solutions: A handbook for practitioners. European Commission EC.

Bauduceau, N., Berry, P., Cecchi, C., Elmqvist, T., Fernandez, M., Hartig, T., ... & Tack, J. (2015). Towards an EU research and innovation policy agenda for nature-based solutions & re-naturing cities: Final report of the horizon 2020 expert group on’nature-based solutions and re-naturing cities’.

Cohen-Shacham, E., Walters, G., Janzen, C., & Maginnis, S. (2016). Nature-based solutions to address global societal challenges. IUCN: Gland, Switzerland, 97, 2016-2036.
Almassy, D., Pinter, L., Rocha, S., Naumann, S., Davis, M., Abhold, K., & Bulkeley, H. (2018). Urban Nature Atlas: A database of nature-based solutions across 100 European cities. Report of H2020 Project Naturvation.

Somarakis, G., Stagakis, S., Chrysoulakis, N., Mesimäki, M., & Lehvävirta, S. (2019). ThinkNature nature-based solutions handbook.

Haines-Young, R., & Weber, J. L. (2010). European Environment Agency. Land Accounts for Europe 1990–2000-Towards Integrated Land and Ecosystem Accounting.

United Nations, Department of Economic and Social Affairs, Population Division (2019). World Urbanization Prospects: The 2018 Revision (ST/ESA/SER.A/420). New York: United Nations.

Mollison, B. (1988). Permaculture: a designer’s manual. Permaculture: a designer’s manual.

McKenzie, L., & Schneider, P. (2011). A facilitator’s Handbook for Permaculture. Solutions for Sustainable Lifestyles. Produced with Support from Developed by IDEP Foundation with PERMATIL and GreenHand.

Crawford, M. (2015). Trees for gardens, orchards, and permaculture (No. 635.977 C899t). Permanent Publications,.
Block, M., & Bokalders, V. (2010). The whole building handbook: how to design healthy, efficient and sustainable buildings. Routledge.

Falk, B. (2013). The resilient farm and homestead: An innovative permaculture and whole systems design approach. Chelsea Green Publishing Company.

Bane, P. (2012). The permaculture handbook: garden farming for town and country. New Society Publishers.

Mitchell, A. (2012). The Edible Balcony: Growing Fresh Produce in Small Spaces. Rodale Books.

Mars, R. (2005). The basics of permaculture design. Chelsea Green Publishing.

Hawken, P., & Rand, E. (2014). Sustainable revolution: permaculture in ecovillages, urban farms, and communities worldwide. North Atlantic Books.

Holmgren, D. (2002). Permaculture: Principles & pathways beyond sustainability. Holmgren Design Services.

Nugent, J., & Boniface, J. (2005). Permaculture plants.

Kemp, J. (2012). Permaculture in pots: how to grow food in small urban spaces (No. 631.58 K32p). Permanent Publications,.

Smitham, V., & Bosco IV, G. (2012). Permaculture Design: A Step by Step Guide.

Lockyer, J., & Veteto, J. R. (Eds.). (2013). Environmental anthropology engaging ecotopia: bioregionalism, permaculture, and ecovillages (Vol. 17). Berghahn Books.

Jacke, D., & Toensmeier, E. (2005). Edible forest gardens, volume II: ecological design and practice for temperate-climate permaculture (Vol. 2). Chelsea Green Publishing.

Orion, T. (2015). Beyond the war on invasive species: A permaculture approach to ecosystem restoration. Chelsea Green Publishing.

Hemenway, T. (2009). Gaia’s garden: a guide to home-scale permaculture. Chelsea Green Publishing.

Holmgren, D. (2020). Essence of permaculture. Seymour, VIC, Australia: Melliodora Publishing.

Holzer, S. (2011). Sepp Holzer’s permaculture: a practical guide to small-scale, integrative farming and gardening. Chelsea Green Publishing.

Bell, G. (2005). The Permaculture Way: Practical steps to create a self-sustaining world. Chelsea Green Publishing.

Holmgren, D. (2002). Permaculture: Principles & pathways beyond sustainability. Holmgren Design Services.

3. DISCUSSION AND METHODS

Camera di Commercio di Milano. (2021). Milan and Lombardy: Economic data and statistics. Retrieved from https://www.milanocamcom.it/en/milan-and-lombardy/economic-data-and-statistics

Camera Nazionale della Moda Italiana. (2020). Italian fashion statistics. Retrieved from https://www.cameramoda.it/en/italian-fashion-system/statistics/

Cipolla, C. M. (1965). Milan: The industrial city. In Cities and society (pp. 175-202). London: Methuen.

Comune di Milano. (2020). Milan: A sustainable city. Retrieved from https://www.comune.milano.it/wps/portal/ist/en/the-city/sustainability

Politecnico di Milano. (2021). Research and innovation. Retrieved from https://www.polimi.it/en/research-innovation/

Regione Lombardia. (2021). Natural heritage. Retrieved from http://www.regione.lombardia.it/wps/portal/istituzionale/HP/servizi-per-cittadini/turismo-e-tempo-libero/patrimonio-naturale

UNESCO. (2021). World Heritage List. Retrieved from https://whc.unesco.org/en/list/