university of groningen / faculty of spatial sciences

Master thesis

The influence of Natura 2000 sites on nearby property prices.

Abstract

Whereas many studies explore the relationship between different types of nature and real estate values, limited attention has been given to the specific influence of protected nature. Using the Hedonic Pricing Model, this study examines the effect of protected nature, more precisely Natura 2000 sites. The findings reveal that being farther away from a Natura 2000 site in urban areas leads to significantly lower house prices, with being 10% farther away corresponding to a 0.99% decrease in house price. Conversely, in rural areas there is no significant relationship between Natura 2000 sites and house prices. These findings indicate that proximity to Natura 2000 sites is valued differently depending on the urban-rural context. The study also compares three metropolitan areas with varying distances to Natura 2000 sites, finding that being farther away from such sites negatively impacts property prices in cities in France at different distances from Natura 2000 sites. Notably, the effect is strongest in Lille, the city located furthest away from Natura 2000 sites. The findings support existing theories on the relationship between green spaces and property values, confirming that proximity to Natura 2000 sites has a positive impact on housing prices. The study contributes to the understanding of how environmental amenities shape property values and informs policy decisions, highlighting the need for context-specific approaches when considering the conservation and management of these protected areas.

Author:	Nadi Morsink
Student number:	s4814037
Date:	25-06-2023
Study:	MSc Real Estate Studies
E-mail:	n.morsink@student.rug.nl

Contents

1. Introduction

Green spaces are a key component of urban solutions in cities. Urban solutions in cities refer to the various approaches and strategies that cities can adopt to address the challenges they face, such as environmental degradation, socioeconomic disparities, and resource scarcity (Georgescu et al., 2021). It is common knowledge that urban greenery provides a wide range of ecosystem services, and as a result, has a significant potential to improve the quality of life for urban residents (Chang et al., 2017). Therefore, understanding the influence of protected nature on housing prices is important to decision-making on policy and investment.

One of the centrepieces of EU nature and biodiversity policy with the objective of assuring the long-term survival of Europe's most valuable and threatened species and habitats is Natura 2000 legislation (European Commission, 2021). The legislation governing the determination and qualification criteria for Natura 2000 sites primarily resides in the Habitats Directive (Directive 92/43/EEC). The directive mandates that Member States of the European Union (EU) hold the responsibility of designating and proposing Natura 2000 sites within their respective territories. The selection process involves the identification of sites that are crucial for conserving specific habitats and species enlisted in the directive's Annexes. To meet the directive's criteria, Member States must designate areas as Special Areas of Conservation (SACs) to safeguard habitats or as Special Protection Areas (SPAs) to protect bird species. These sites should fulfil specific requirements, including the presence of rare, endangered, or vulnerable habitat types or species of Community interest, the need for conservation measures to restore or maintain habitats and species, and the ecological coherence and representation of these habitats and species across their natural range. Once designated, Member States must undertake effective management and implement suitable conservation measures for the Natura 2000 sites. This involves the implementation of necessary steps to uphold or restore habitats and species to a favourable conservation status. Regular assessments of the conservation status of habitats and species within Natura 2000 sites are mandated, and Member States are obliged to develop management plans or appropriate mechanisms to ensure the long-term conservation of these sites (European Commission, 2021).

Yet, preserving or reducing of these Natura 2000 sites is currently under discussion in different European countries, for example in the Netherlands (Van Mersbergen, 2022) and in the United Kingdom (Laville, 2022). Importantly, natura 2000 sites are high quality nature and can have significant ecological, environmental, and cultural values, which can positively affect the quality of life of nearby residents. Therefore, Natura 2000 sites can be seen as amenities, and it is reasonable to expect that proximity to Natura 2000 sites may influence property values (Gibbons et al., 2013). If proximity to these sites is found to have a positive effect on house prices, it could, besides the reasons for preservation mentioned in the paragraph above, also provide an economic argument for their preservation.

A study by Sijtsma et al. (2012) looked at whether exposure to 'grey' surroundings, such as highly urbanized cities, makes urban inhabitants value 'green' areas more during their vacations.

According to the findings, people who live in urban areas prefer green landscapes for their vacations more than people who reside in rural areas. This suggests that the presence of Natura 2000 sites may have a positive effect on house prices if they increase the availability of green spaces and natural amenities in the surrounding area. The value of green space may be higher for people living in highly urbanized areas compared to those living in rural areas, as they have less access to it in their daily lives and may also experience more negative effects associated with urban living. One reason is that urban residents may have less access to green space in their daily lives due to the high density of buildings and infrastructure in cities (Haq et al., 2021). As a result, green spaces can provide a much-needed opportunity for urban inhabitants to connect with nature and enjoy the benefits of greenery. Also, urban residents may experience more negative effects associated with urban living, such as air and noise pollution, heat island effects, and stress. Green spaces can help mitigate these negative effects by providing ecosystem services such as air and water filtration, temperature regulation, and noise reduction (Haq et al., 2021). To test this theory based on the Sijtsma paper, this study is carried out in three highly urban cities, as this is where the effect of proximity to Natura 2000 sites is expected to be greatest based on the paper by Sijtsma et al. (2012).

The effect of nature on real estate property value has received increasing scholarly attention, considering the impact of nature on real estate value from multiple perspectives. Previous research confirms that residential property located close to nature has a higher value than residential properties located further away from such areas (Daams et al., 2016; Daams et al., 2019; Luttik, 2000; Geoghegan, 2002; Conway et al, 2008; Gibbons et al., 2013). First, there is a paper by Daams, Sijtsma, and van der Vlist (2016) that provides valuable insights into the relationship between the presence of natural spaces and property values. This study calculates how attractive natural space affects Dutch residential property values. The key findings indicate that appealing natural space has a decreasing impact on real estate prices, from 16.0% for houses within 0.5 kilometre to 1.6% for those up to 7 kilometre distance. There also is a paper by Gibbons et al. (2013) that looks into the amenity value associated with proximity to habitats, designated areas, domestic gardens and other natural amenities in England. An interesting result from this study is that most natural amenities resulted in a premium on house prices. Proximity to preserved area's (which Natura 2000 sites are an example of) also resulted in higher prices. A paper by Melichar and Kaprová (2013) investigates the preferences of homebuyers in Prague, Czech Republic towards greenery amenities. The study uses a hedonic price model to analyse the impact of greenery on the price of residential properties in different locations, with a focus on the distance and size of the greenery. In this paper they also specifically looked into the effect of specially protected areas on house prices. They found that with every additional meter, the property price decreases with 1815 CZK (approximately € 77,-) for specially protected areas. The size of specially protected areas has a negative impact on house prices. The paper suggests that the impact of specially protected areas on property values is dependent on the distance and size of the area, which may also be applicable to Natura 2000 sites. A paper by a Koemle, Lakner and Yu (2019) aimed to find out whether farmland rents in Germany

are affected by Natura 2000 designation. The findings imply that Natura 2000 has a negative impact on the average rental price of grassland and arable land. This raises the question whether the same negative impact applies to the value of houses located near Natura 2000 sites.

There is a lot of literature on the influence of green space on housing prices. However, there are a lot less papers written on the specific topic of impact of protected nature (and more specifically, Natura 2000 sites) on house prices. The relationship between green spaces and house prices, which has been observed in previous studies, may not apply in the same manner to protected nature areas, such as those within the Natura 2000 network. Restricted development, ecological considerations prioritizing biodiversity over residential amenities, access and land use restrictions, and perceived risks and uncertainties associated with protected areas can all contribute to a different impact on property values. Therefore, the distinct characteristics and regulations surrounding protected nature areas necessitate a careful examination of their influence on property prices, distinct from the general findings related to green spaces. Policy decisions about preserving of reducing Natura 2000 sites can have a major impact on the assets of a homeowner. Additionally, the advantages of living close to Natura 2000 sites are crucial for governmental decision-making on the preservation or creation of natural areas close to residential areas as well as the planning of residential growth at specific distances from – or at the expense of – natural areas. The study of the effect of proximity to Natura 2000 sites on house prices can provide insights into the mechanisms by which environmental amenities affect property values. This can contribute to the broader literature on the relationship between the environment and property values, which is an important topic in the fields of environmental economics and urban planning.

The aim of this research is to explore the relationship between Natura 2000 sites and house prices. First, this study looks into the academic literature. Then, a quantitative data analysis will be performed based on the theory of the Hedonic Pricing Model (Rosen, 1974). The research will focus on three different types of cities: one far away from Natura 2000 sites, one with medium distance to Natura 2000 sites and one that has Natura 2000 sites inside of the city boundaries. Three cities will be chosen because of computational reasons, and to make sure that a comparison can be made between the cities with varying distances to Natura 2000 sites. After picking these three cities the locations will be linked to property transaction data from France. The estimated model is based on a dataset on house sales throughout France from January 2014 to December 2018 (Data.gouv.fr, 2021), from which we used the transactions of three different metropolitan areas.

2. Theory

The hidden value of nature in property prices becomes apparent when one realizes that a property represents not only a bundle of structural characteristics but also a set of location-specific characteristics. As such, the pricing of property reflects not only the structural characteristics (Rosen, 1974) but also the land rent surface associated with patterns of land use and other neighbourhood characteristics. How much value can be assigned to land depends on location-specific qualities (Chesire & Sheppard, 1995), including distance to high-quality or otherwise relevant preserved nature. A connection between economy and ecology can be found in the premium that properties in an appealing (or otherwise beneficial) environment have as compared to properties in a less attractive setting (Luttik, 2000), these effects can be capitalized financially. The premium being the willingness to pay for (being close to) beneficial external characteristics, such as, in the context of this study, Natura 2000 sites. This capitalization shows the welfare advantages obtained by homebuyers who reside close to natural areas.

The value of green space in a region can be reflected in house prices in a number of ways. For potential buyers or tenants, proximity to green spaces like parks, greenways or preserved nature can make a neighbourhood more appealing (Mokhtarian et al., 2008). Proximity to green space offers a number of advantages, such as enhanced physical and mental health (Bell et al., 2015), social connection (Frumkin et al., 2004), and aesthetic delight. Green areas can improve a neighbourhood's appearance and atmosphere, making it a more appealing and desirable place to live. This might increase interest in local real estate, which would raise prices. Also, green areas can improve the quality of the air and water by acting as a sound and air pollution buffer (Noway & Dwyer, 2007). These natural advantages can raise the area's general liveability and increase its appeal to potential homeowners or tenants. The impression of safety and security in a place can also be influenced by green landscapes. Green spaces that are well-kept and frequently used can foster a sense of neighbourhood and social cohesion, which can reduce crime and raise residents' perceptions of neighbourhood safety (Kuo & Sullivan, 2001).

It is widely accepted that public natural spaces provide a variety of services that add to the welfare of those who live close by (Brander & Koetse, 2011). A Natura 2000 site can be considered an amenity because it provides a range of services that contribute to human well-being. For example, it offers recreational and ecotourism opportunities as well as aesthetic and spiritual benefits. In addition to these direct benefits, protected areas also provide important indirect benefits, such as conserving biodiversity and providing ecosystem services such as air and water purification. These benefits are essential for human well-being and also contribute to the value of protected natural areas as amenities (European Environment Agency, 2022). Living close to Natura 2000 sites can provide easy access to these benefits and improve the quality of life for residents. Natural amenities, such as proximity to Natura 2000 sites, can influence housing prices because they are valued by people. A study on the effect of environmental amenities on housing prices in the Netherlands reveals that environmental factors can create a maximum price premium of 28% (Luttik, 2000). The outcome of this study gives implications

to expect that the presence of high-quality nature areas such as Natura 2000 sites can increase the value of nearby properties.

One type of green space where the price mechanism is expected to be quite similar to Nature 2000 sites is the so-called greenbelt. A greenbelt is preserved nature and a semi-public good. The purposes of a greenbelt are the preservation of land in a natural, garden-like, or agrarian state, and the shaping and limitation of urban spread (Correll et al., 1978). Even though the purpose of Natura 2000 sites is protecting nature and biodiversity, greenbelts and Natura 2000 sites have some interesting similarities which could in principle result in an equal effect on house prices. Both amenities are protected nature, designated by the government and public goods. Everything other being equal, in Boulder, Colorado, researchers found a $4.20 decrease in the price of a residential property for every foot one moves away from the greenbelt (Correll et al., 1978). And there is more literature that confirms the findings of previously named papers, namely that the further away a residential property was located from a greenbelt or park, the less its selling price, ceteris paribus (Kitchen and Hendon, 1967; Hammer et al., 1974; McMillan, 1974; Correll, et al., 1978; Peiser & Schwann, 1993). However, greenbelts are specific to cities and form a continuous ring, while Natura 2000 areas are more widespread and can be interwoven within urban regions. Both have a restrictive effect on land use, but their spatial structures differ significantly. Greenbelts act as physical boundaries, separating urban and rural areas, whereas Natura 2000 areas are distributed across various locations and encompass diverse habitats and species. Therefore, we cannot generalize the results from studies on greenbelts directly to Natura 2000 sites.

Although a greenbelt is a supply side restriction, and the current analysis does not directly focus on this aspect, it is crucial to incorporate this perspective to establish a strong foundation for the discussion. It is important to take into consideration the distinction between the amenity effect and the effects of local restrictive development policies. While the study aims to measure the amenity effect of proximity to Natura 2000 sites on housing prices, it is crucial to acknowledge the possibility that the analysis may also capture, to some extent, the impact of local restrictive development policies. These policies may restrict or regulate development in certain areas, including those near natural amenities, leading to decreased housing supply and potentially higher prices (Vikolainen et al., 2014).

This study expects to find that proximity to Natura 2000 sites has a positive effect on housing prices. This expectation is based on the theory that proximity to natural amenities, such as preserved areas, results in higher property values. Because there tends to be a greater need for green spaces in urban areas due to an absence of natural resources, the price effect of distance to Natura 2000 on property values is expected to be greater for houses in urban areas than for houses in rural areas (Sijtsma et al., 2012). This indicates that even at larger distances, the presence of Natura 2000 sites in or close to urban areas may have a significant impact on house prices. The impact these sites on property values may be less noticeable in rural regions, especially those that are farther away from Natura 2000 sites because of the amount of natural amenities that may already exist there.

3. Natura 2000 and the study area

There are over 25,000 Natura 2000 sites in Europe (European Commission, n.d.). As of 2021, France has over 3,500 Natura 2000 sites, covering approximately 20% of its terrestrial and marine territory (European Commission, 2021). This study compares three different French metropolitan areas, Lille, Rennes and Bordeaux, to investigate whether proximity to Natura 2000 sites has an effect on house prices. The three cities are chosen based on a geographically extensive assessment of the entire map of Natura 2000 sites in France. After assessment of the whole map with Natura 2000 sites, 13 cities were chosen for further elaboration; this information can be found in Appendix A. For these 13 cities, we found out how many Natura 2000 sites are located in the area and how far away, where these cities are geographically located, in which French region, and how many inhabitants they have. We looked into these aspects because it is important for the research that we pick three case studies that have similar geographical characteristics. In Appendix A, the first selection of cities are cities where Natura 2000 sites are located far away. The second group are cities that have Natura 2000 sites close to the city, but not inside the city. And finally the last group are cities where Natura 2000 sites are present inside of the city boundaries. Out of every one of these groups one city was chosen.

Lille, Rennes and Bordeaux have a clear difference in distance to, and amount of Natura 2000 areas. The three cities that are chosen are all fairly big cities, with 220,000 – 260,000 inhabitants. This is important for comparison since a certain city size also brings different amenity levels, which can have an influence on housing prices (Cheshire & Sheppard, 1995). Besides, all three cities have similar regional characteristics, even though they are not located in the same regions. This is done because for example, properties located in Paris or close to the beach will sell for a premium, which makes comparison a lot more difficult than if you pick cities with similar characteristics. Important to note is that in this research we take into consideration all transactions in the whole metropolitan area of the cities, as can be seen in the maps in Appendix B. This is done because in this research we also want to find out if the effect proximity to Natura 2000 sites on house prices is greater for highly urbanized area's (grey area's) than for rural area's (green area's) based on previous research by Sijtsma et al. (2012).

3.1 Lille

With a population of over 233,000 people, Lille ranks as the tenth-largest city in France. Lille is chosen as the case for a city with no Natura 2000 sites in its direct surroundings. Despite its metropolitan setting, the city features a number of parks and green areas. The city is home to a variety of natural settings, including as marshes, meadows, and woodlands. One of the city's most well-liked parks, Parc de la Citadelle has a zoo, a lake, and a number of sporting facilities. Other noteworthy green areas in Lille include the Bois de Boulogne, an area of woodland with a number of walking and cycling trails, and the Jardin des Géants, a botanical park with more than 400 varieties of plants. The region surrounding Lille is home to several Natura 2000 sites, including the Marais de la Deûle and the Forêt Domaniale de

Phalempin. These sites provide important habitats for a range of plant and animal species, including several rare and endangered ones.

Figure 1 clearly shows that there are no Natura 2000 sites in the direct surroundings of the city centre of Lille, the only green seen in the figure are other types of green space. Figure 1 shows a network analysis of Lille. The map shows how far you can drive in 10, 20 and 30 minutes. This is visualized because it gives an indication on how many Natura 2000 sites a citizen of Lille can reach within 30 minutes driving distance. The map shows that in Lille there are no Natura 2000 sites that can be reached within 10 or 20 minutes. Within a range of 30 minutes a person can reach nine sites, but, as the map shows, these sites are fragmented and very small.

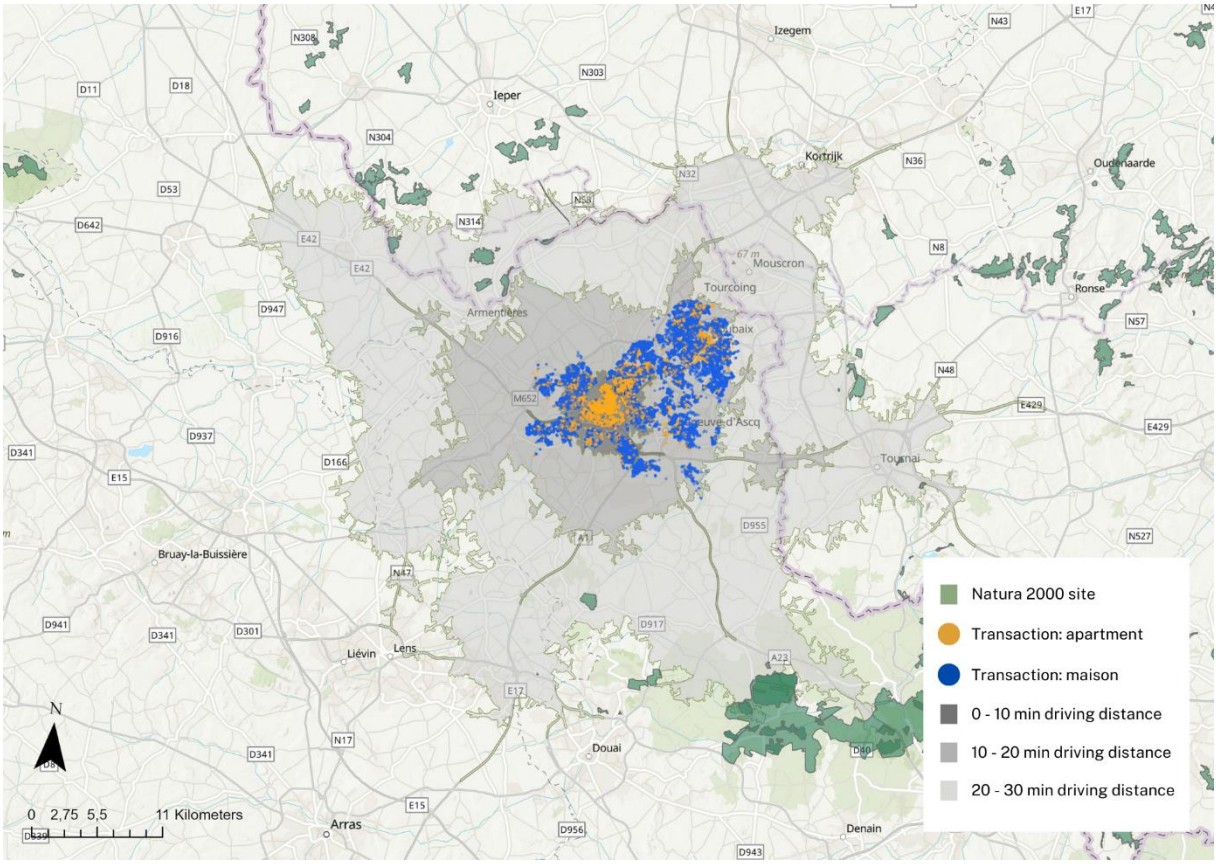

Figure 1. Network analysis of Lille (Own edit, 2023).

3.2 Rennes

Rennes is chosen as the case for a city with a medium amount of Natura 2000 sites in its surrounding area. With a population of over 220,000, Rennes ranks as the eleventh-largest city in France. The city has a number of parks and green areas that provide a variety of leisure possibilities for its citizens despite its urban setting. Parc du Thabor has a botanical garden. The Parc des Gayeulles, a sizable park with a number of walking and biking paths, and the Jardin du Mail, an old garden with a number of statues and fountains, are two more noteworthy green areas in Rennes. The Marais de Saint-Jacques and the Vallée du Canut are two of the Natura 2000 locations that are close to Rennes. These protected areas provide

as homes for a variety of plant and animal species, including numerous rare and endangered ones, and are essential for maintaining and improving biodiversity in the area. Several bird species, notably the Eurasian bittern and the purple heron, depend on the Marais de Saint-Jacques, a wetland region in the city's southwest, as an essential habitat. The endangered and protected larger mouse-eared bat, on the other hand, has a significant habitat in the forested valley known as the Vallée du Canut.

Figure 2 shows that there are no Natura 2000 sites within the city boundaries of Rennes, however, there are some sites close to the city. The map shows how far you can drive in 10, 20 and 30 minutes. There are no Natura 2000 sites that you can reach within 10 minutes of the centre of the city, but within 20 minutes a person can reach two different sites and within half an hour they can reach four different (fairly bigger) Natura 2000 sites.

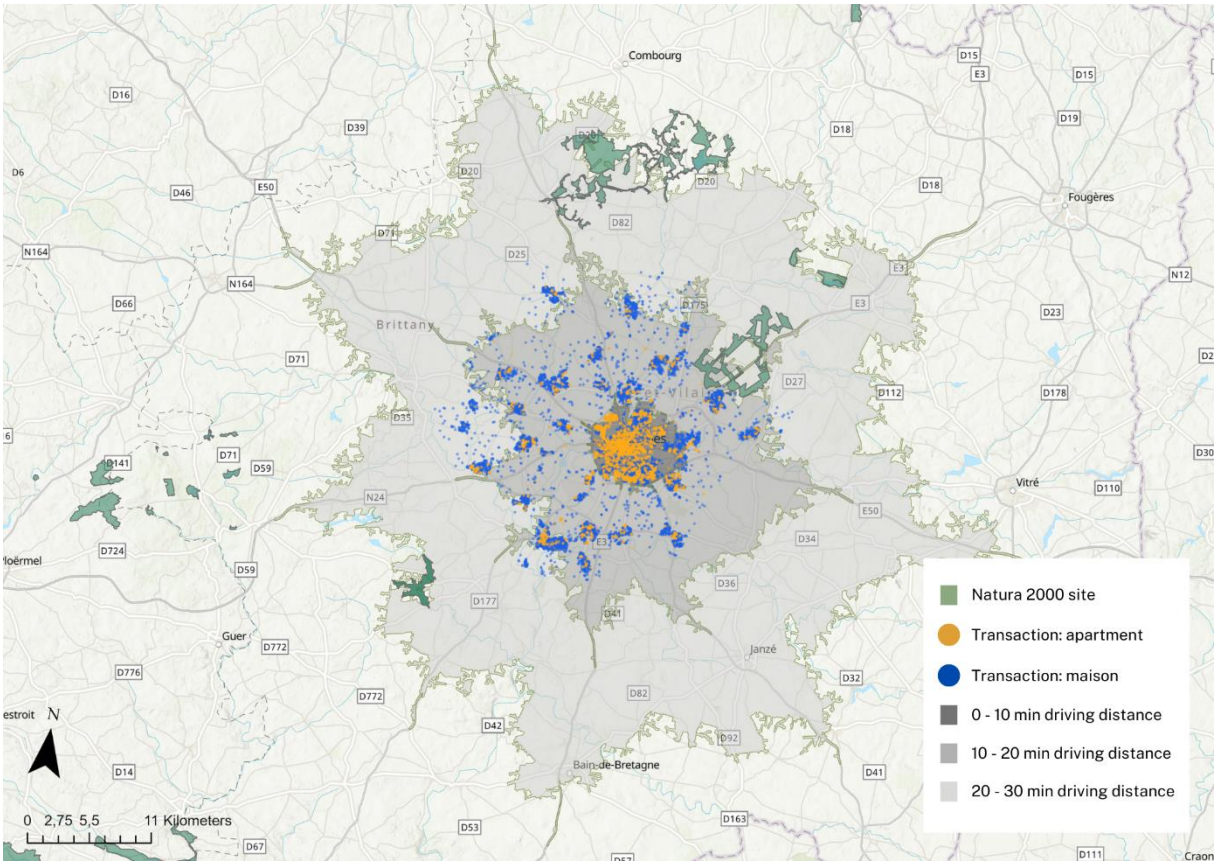

Figure 2. Network analysis of Rennes (Own edit, 2023).

3.3 Bordeaux

Bordeaux, a city in the southwest of France with over 260,000 residents, is renowned for its beautiful architecture. The city does, however, also have a remarkable green framework that plays a crucial role in its character. There are a number of parks, gardens, and woodlands throughout the city. Bordeaux is chosen as the case for a city that has Natura 2000 sites inside the city. The Marais de Bruges and the Estuaire de la Gironde are two of the Natura 2000 areas in Bordeaux. These protected areas are essential for maintaining and expanding the biodiversity in the area since they serve as vital homes for a variety

of rare and endangered plant and animal species. A wetland region outside of the city called the Marais de Bruges serves as a crucial home for a number of bird species, including the common tern and the black-winged stilt. On the other side, the Estuaire de la Gironde is a sizable estuary that is crucial for various fish species, notably the European sturgeon, as a feeding and breeding area.

Figure 3 shows that there are Natura 2000 sites within the city boundaries Bordeaux. The map shows how far you can drive in 10, 20 and 30 minutes. In Bordeaux there is one Natura 2000 site that is reachable within 10 minutes of the centre of the city. Within 20 minutes a person can reach six different sites and within half an hour they can even reach 12 Natura 2000 sites. Bordeaux is an example of a city that has great accessibility to Natura 2000 sites and it is also a city where the offer of accessible protected green spaces is very diverse, from wetlands to estuaries.

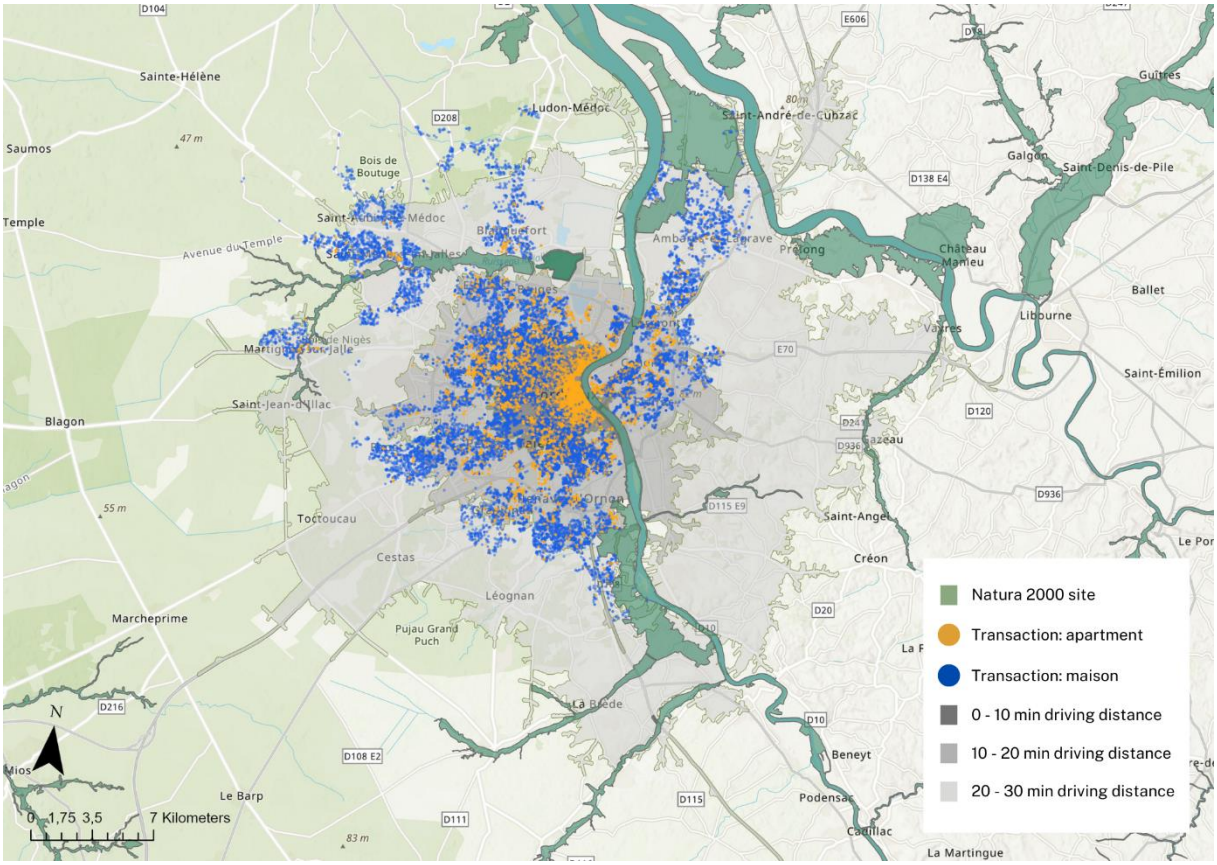

Figure 3. Network analysis of Bordeaux (Own edit, 2023).

4. Methodology and data

4.1 Methodology

This research aims to find the relationship between proximity to Natura 2000 sites and house prices. To study this relationship a hedonic multivariable regression is used. The model aims to show the impact of the independent variable, proximity to Natura 2000 sites, on the dependent variable, transaction price. The Hedonic Pricing Model is used to investigate the potential externality effect of proximity to Natura 2000 sites on the prices of nearby property values. The Hedonic Pricing Model infers the implicit worth of a properties underlying characteristics (structural, locational/accessibility, neighbourhood, and environmental) using housing market transactions. The theoretical foundation for this technique is provided by Rosen (1974), who demonstrates how the utilitarian benefit of marginal changes in one attribute in a bundle of a composite commodity like housing may be valued by quantifying the change in expenditure incurred in equilibrium. Several housing characteristics can be considered to be given, at least in the short term, as it is almost impossible to change their level in accordance with market demand. The demand side therefore primarily determines the equilibrium market price of housing, which represents the customers' subjective evaluations. It is also anticipated that market participants are rational and well-informed about the range of housing property qualities in order to achieve equilibrium. According to these assumptions, the housing costs at the residential location is a function of its structural, neighbourhood, and environmental factors (Freeman, 2003). The following form may then be used to describe the model:

$$Ph = fh(S, N, E)$$

Where *Ph* is the property's price, which is determined by the explanatory characteristics of housing. The traditional hedonic factors are: Structural variables (*S*): e.g. number of rooms, size of living area, parcel size, etc. Neighbourhood variables (*N*): e.g. proximity to city centre, transportation, crime, etc. Environmental variables (*E*): e.g. proximity to urban open areas, air quality, distance to nature etc. From a regression of housing transaction sales prices on the characteristics of the house sold applied hedonic analysis recovers the marginal valuations or ‘implicit prices’ of the separate housing characteristics. According to hedonic pricing theory, a property located close to a Natura 2000 site will sell at a higher price compared to a property located further from a Natura 2000 site, ceteris paribus.

Since the distribution of the transaction prices tends to be skewed, the natural logarithm of the transaction price is typically used, by doing that, the distribution becomes closer to being normally distributed. The natural logarithm of the dependent variable helps with the linearity between the dependent and independent variables (West, 2021). The key independent variable is distance to Natura 2000 sites, for this variable we will also use the natural logarithm. And other variables that will go through a log transformation are: surface of the property and number of rooms.

For measuring the effect of this variable on the dependent variable we use a single coefficient for distance instead of working with distance category dummies. Working with a single coefficient for distance can show if there is a positive or negative relationship, and the magnitude of the relationship. There are several papers on the effect of green space on housing prices in the academic field that use the same approach (Gibbons et al. 2013; Melichar & Kaprova, 2013; Melichar et al., 2009). Working with distance category dummies, like other studies on the effect of green space on house prices use (Daams et al., 2019; Daams et al., 2016), is empirically of limited use in this research since we work with case studies of cities with a lot, medium and few distance to Natura 2000 sites. Since cities are used as case studies with varying distances to the areas, a single coefficient will be more straightforward to compare between the cities.

In this research we control for unobserved heterogeneity on for example neighbourhood characteristics, local infrastructure and socioeconomic factors across locations by including location dummies. This is done to reduce omitted variable bias by cancelling out similarities in the prices which can be ascribed to location (Daams et al., 2016). This variable also takes care of the effect of more localized green space other than Natura 2000 sites that may influence transaction prices. Variables for other types of green space are not included in this research because the model may not be able to appropriately separate their respective contributions to housing values, due to their spatial correlation. This approach is based on the paper by Daams et al. (2019), where they explained that including the other types of green space could result in more multicollinearity (Pendleton & Shonkwiler, 2001). The analysis includes the proximity to Natura 2000 sites variable for transactions combined at the 5-digit postal code level. The assumption is that within a postal code level, amenities are similar, and differences in price can be attributed to property-specific characteristics and other specific known variables of interest, such as distance to the closest Natura 2000 site. Following Bourassa, et al. (2007) in the final model dummies related to zip codes rather than directly related to specific departments are included as control variables. The same holds true for the time-related fixed effects, as price patterns may differ because of economic fluctuations. So, the time effect can be considered by introducing time dummy variables on a yearly basis that are coupled to data obtained at various points in time.

The following statistical model is estimated for the base model (1):

$$lnP_{ijt} = \propto + \beta_1 lnDistanceN2000_{ij} + \beta_2 lnSurface_{ij} + \beta_3 lnRooms_{ij} + D_4 Propertytype_{ij} + D_5 City + \gamma_t + \mu_j + \varepsilon_{ijt} \quad (1)$$

where in the base model (1) lnP is the log of the transaction price of property i that is located in zip code area j at transaction year t; $\propto$ represents the constant; $lnDistanceN2000$ is the parameter of interest, this is the log of distance to the closest Natura 2000 site in kilometers; $lnSurface$ is representing the surface of the relevant property in log square meters; $lnRooms$ indicates how many rooms the sold property has in log form; $Propertytype$ is a dummy variable that states whether the transaction is an single family house (0) or an apartment (1); $City$ is a dummy variable for the different

metropolitan areas; γ indicates the different time periods in years *t* and is controlling for time fixed effect (2014 up to and including 2018); μ is a zip code dummy controlling for spatial fixed effects *j*; ε is the error term in this equation. This denotes the standard errors, that are spatially clustered at the city and zip code level and timely clustered at yearly-level, to account for spatial and time autocorrelation in house prices.

4.2 Data

Information on transaction prices come from the French government. The dataset includes information on more than 13 million residential properties that were sold in France between January 2014 and December 2018. The General Directorate of Public Finance (Direction générale des finances publiques, DGFiP) publishes and generates this data. This information comes from cadastral records and notarial deeds (Data.gouv.fr, 2021). How this amount relates to the actual number of residential homes sold during this time period is not stated by the supplier. The dataset has complete coverage for the whole country and was created with the goal of increasing transparency in the land and real estate market (Data.gouv.fr, 2021). Besides prices and dates, the dataset also contains details on living area, the number of rooms, and property type. These variables are functioning as control variables in the model, this allows for a better isolation of the price effect of Natura 2000 sites. The dataset also contains information about addresses, including home addresses, house numbers, zip codes, city codes, city names, and department codes. Also, the dataset can be geocoded at the property level because it contains geographic coordinates. This is very useful for this research since we can calculate distance of each transacted property to the closest Natura 2000 site with this information. To make the interpretation of the results easier, the variables are renamed to English.

In this study, data on housing transaction locations and data on environmental quality metrics (Natura 2000 sites) must be linked. The use of GIS improves accuracy in the consideration of proximity to Natura 2000 sites. The data on the variable of interest, proximity to Natura 2000 sites, is gathered using GIS-mapping. The map with Natura 2000 sites is retrieved from the database of the European Environment Agency (European Environment Agency, 2023). This agency has a map with all Natura 2000 sites in Europe. The European database of Natura 2000 sites consists of a compilation of the data submitted by the Member States of the European Union. This European database is generally updated once a year to take into account any updating of national databases by Member States. The Natura 2000 sites used in this study are all designated between 1995 and 2012 (Legifrance, 2019). For linking transaction data of the French properties to location ArcGIS Pro is used. Geographic Information Systems (GIS) is commonly used for spatial data analysing or editing.

4.3 Descriptive statistics

The dataset contains a total of 142,487 observations after cleaning the data. For a description of the data cleaning process, see Appendix C. The division between the cities is shown in Table 1 and is as follows: there are 46,929 observations for Lille, 28,529 for Rennes and 67,029 for Bordeaux. Table 2 shows the summary statistics of the measured distances to nearest Natura 2000 sites, information on the sites and property specific characteristics.

The average distance to a Natura 2000 site is 7.056 kilometers for the whole dataset. Important to note is that the average distance to a site in Lille (chosen as the case for a city far from Natura 2000 sites) is 12.316 kilometer. The average distance for transactions in Rennes (case for medium distance to Natura 2000 sites) is 9.09 kilometer. And the average distance for transactions in Bordeaux (city close to Natura 2000 sites) to a site is 2.507 kilometer. The closest a property is located to a Natura 2000 site in this dataset is 3 meters, and the transaction furthest from a site is located 16 kilometres away. In the whole dataset, most of the site types are site type B, SCIs and SACs (Sites of Community Importance and Special Areas of Conservation - sites designated under the Habitats Directive). The average size of a Natura 2000 site in the dataset is 27,569,280 hectare. Note that Bordeaux has the highest average size of a site, namely, 48,247,907 hectare.

The transaction prices in the whole dataset range between 15,000 and 4.9 million euros. € 15,000 is the minimum value since transactions below this price where handled as outliers (Morgan, 2007). The mean selling price in the dataset is € 228,121 and the median is € 178,500. The median price for houses on the French market was € 269,000 in 2022. The asking price for 80% of properties fell between € 136,319 and € 575,000 (Real Advisor, 2023). If we look at the surface of the houses in the dataset, the mean is 74.58 m² and the median is 68 m². The average number of main rooms in the dataset is 3.29 and the median is 3 main rooms. Most of the property types in the dataset are apartments, almost 62%, and the other 38% are single family houses, this control variable will be a dummy in the analysis. It stands out that Bordeaux has a higher average house price than Lille and Rennes, more than € 50,000 more per house. Lille and Rennes almost have the same average price per transaction. All three cities have approximately the same surface and number of rooms per house. For visualization and more information on the descriptive statistics see Appendix D.

Table 1. – Observations per metropolitan area.

City	Frequency	Percent
Lille	46,929	32.94
Rennes	28,529	20.02
Bordeaux	67,029	47.04
Total	142,487	100

Table 2. – Descriptive statistics.

City	Variable	Min	Mean	Max	St. Dev.
Lille	House price	15,000	206,813	4,980,870	333,703
	Distance closest N2000	6.445	12.316	15.824	1.41
	Surface m²	15	76.49	888	41.70
	Number of rooms	1	3.46	28	1.62
	Apartment (1=yes)	0	0.53	1	0.49
	Single family house (1=yes)	0	0.47	1	0.49
	Site type A (1=yes)	0	0.09	1	0.29
	Site type B (1=yes)	0	0	0	0
	Site type C (1=yes)	0	0.91	1	0.29
	Size closest N2000 site	1,220,399	3,698,517	4,042,681	801,448
Rennes	House price	15,000	195,583	1,029,900	161,519
	Distance closest N2000	0.019	9.090	16.071	2.912
	Surface m²	15	73.47	460	37.11
	Number of rooms	1	3.36	26	1.54
	Apartment (1=yes)	0	0.72	1	0.44
	Single family house (1=yes)	0	0.28	1	0.44
	Site type A (1=yes)	0	0	0	0
	Site type B (1=yes)	1	1	1	1
	Site type C (1=yes)	0	0	0	0
	Size closest N2000 site	4,272,472	15,789,130	27,590,981	4,912,911
Bordeaux	House price	15,000	256,888	1,845,750	302,367
	Distance closest N2000	0.003	2.507	8.848	1.901
	Surface m²	15	73.22	656	39.55
	Number of rooms	1	3.16	30	1.42
	Apartment (1=yes)	0	0.65	1	0.48
	Single family house (1=yes)	0	0.35	1	0.48
	Site type A (1=yes)	0	0.03	1	0.16
	Site type B (1=yes)	0	0.97	1	0.16
	Site type C (1=yes)	0	0	0	0
	Size closest N2000 site	2,621,808	48,247,907	66,982,109	26,283,309
Total	House price	15,000	228,121	4,980,870	292,675
	Distance closest N2000	0.003	7.056	16.071	4.871
	Surface m²	15	74.34	888	39,834
	Number of rooms	1	3.29	30	1.52
	Apartment (1=yes)	0	0.62	1	0.48
	Single family house (1=yes)	0	0.38	1	0.48
	Site type A (1=yes)	0	0.04	1	0.20
	Site type B (1=yes)	0	0.66	1	0.47
	Site type C (1=yes)	0	0.30	1	0.45
	Size closest N2000 site	1,220,399	27,569,280	66,982,109	27,982,125

5. Results

Table 3 reports the results for the base model (1) which uses distance to the closest Natura 2000 site, property characteristics, year fixed effects and location fixed effects at postal code 5-level to control for location characteristics. The result of the regression indicates a joint significance for the main specification. The base model has a R-Squared of 0.516, which means the model explains 51.65% of the variance. Part of the results for the independent variables are in line with expectations. For instance, larger houses are associated with higher property values and single family houses are the most highly valued type of housing structure. However, an increase in rooms doesn't increase the value of a property, since the regression shows a negative relationship between transaction price and number of rooms. There is also no significant effect in difference in transaction prices between the three cities. As seen in the results for model (1), the distance to closest Natura 2000 sites coefficient is significant at the 1% level. For the base model we can state: if the property is located 10% farther away, the price of a house decreases with 0.41%, ceteris paribus. This suggests that the further away a property is located from a Natura 2000 site, the lower the transaction price.

After running the regression for the base model we will be adding more variables to investigate if this improves the results. Information on the type of Natura 2000 site and the size of the Natura 2000 site will be added. Here, site type is a variable that describes the type of Natura 2000 site that is closest to the transaction of interest. The different types are site type A: SPAs (Special Protection Areas - sites designated under the Birds Directive); site type B: SCIs and SACs (Sites of Community Importance and Special Areas of Conservation - sites designated under the Habitats Directive); and site type C: where SPAs and SCIs/SACs boundaries are identical (sites designated under both directives). In this model size of the Natura 2000 site is the surface area of the site closest to the transaction of interest in square kilometres. In this model a 1% increase in distance to a Natura 2000 site would decrease the transaction price by 4.25%, ceteris paribus. We see that in the extended model (2) the size of the Natura 2000 site does not have a significant relationship with the transaction price on any of the significance levels. However, the type of Natura 2000 site does have a significant relationship with the price. In the regression table site types A and B are compared against site type C, type C Natura 20000 areas are areas that are both type A and type B. So in other words, more diverse Natura 2000 sites. Type A sites and type B sites both show a negative coefficient. What we can see in the results is that if a Natura 2000 site is only a type A or a type B site (so less diverse), proximity to this site has a lower impact on the price than if it would be a combination of both. This gives us reason to believe that diversity of Natura 2000 areas around a city also affects house prices.

Then, in model (3) the distance to the closest Natura 2000 site will be interacted with the size of the closest Natura 2000 site to see if the effect of distance and size together better explains variation in housing prices. Model (3) is specified based on the findings by Melichar and Kaprová (2012) that the interaction between the distance to the protected site and the size of the site also has an impact on house

prices. The interaction effect of distance and size in model (3) indicates that the effect of distance on the transaction price depends on the size of the Natura 2000 site. More specifically, the coefficient of the interaction term suggests that for a one percent increase in both distance and size, the transaction price increases by 0.000000000764% more than what would be expected if these effects were simply additive. The effect is significant at the 99% level. It is important to note that when the interaction term is added, the separate coefficient for distance becomes less significant, and the coefficient for size becomes significant. This suggests that the effect of each variable on the transaction price is conditional on the value of the other variable. This is in line with the findings of the paper by Melichar and Kaprová (2012). However, the effect of the interaction between distance and size is so small (way smaller than in the paper by Melichar and Kaprová) that we choose model (2) as the preferred model to continue our analysis with.

Table 3. – Regression results model 1-3.

Variable	(1) Base	(2) Extended	(3) Interaction
Distance to N2000	-.041***	-.042***	-.009**
	[.002]	[.002]	[.004]
Size of N2000 site		.000	.000***
		[.000]	[.000]
Distance * Size			.000***
			[-.000]
Site type A		-.018*	-.022**
		[.010]	[.010]
Site type B		-.076***	-.099***
		[.016]	[.016]
Surface	.822***	.822***	.821***
	[.004]	[.004]	[.004]
Number of rooms	-.107***	-.107***	-.106***
	[.004]	[.004]	[.004]
Apartment	-.122***	-.123***	-.123***
	[.002]	[.002]	[.002]
Rennes	-.263	-.187	-.142
	[.157]	[.158]	[.158]
Bordeaux	.003	.074	.117
	[.139]	[.140]	[.140]
Intercept	9.031***	9.034***	8.953***
	[.140]	[.140]	[.140]
Year effects	YES	YES	YES
Location effects	YES	YES	YES
Observations	142,487	142,487	142,487
R-Squared	0.522	0.522	0.522
Degrees of Freedom	1995.47	1922.15	1900.48

Dependent variable is the natural logarithm of transaction price. For distance to the closest Natura 2000 site the natural logarithm of kilometres is used. Size of the Natura 2000 site is measured in km². For site type category site type C is left out as reference category. The surface is the natural logarithm of the surface in m². Number of rooms is also taken in log form. Apartment is a dummy variable for the property type, where 0 = single family house and 1 = apartment. For metropolitan area Lille is left out as the reference category. * = $p < 0.1$, ** = $p < 0.05$ and *** = $p < 0.01$.

In Table 4, the comparison between model (4) and model (5) aimed to investigate whether the price effect of distance to Natura 2000 on property values differs between houses in urban areas and houses in rural areas. This comparison was motivated by the study conducted by Sijtsma et al. (2012), which gave reason to believe that the value of green space may be higher for people living in highly urbanized areas compared to those living in rural areas. Model (4) only includes transactions from the inner cities of the three cities, 'grey areas', while model (5) only contains the transactions outside the inner city area, 'green areas'. We want to find out whether transactions in the highly urbanized areas show a stronger effect of proximity to Natura 2000 sites on transaction prices then the transactions in rural areas. In urban areas, the results indicate that if a property is located 10% farther from the closest Natura 2000 site this leads to a substantial decrease in house prices, specifically a 0.99% decrease. This negative relationship implies that urban houses located farther away from Natura 2000 sites tend to have lower property values. This finding is noteworthy because it contradicts the findings observed in rural areas, namely that there is no significant relationship between transaction prices and proximity to Natura 2000 sites. This suggest that there is no premium for living close to Natura 2000 sites when a property is located outside the city centre of a metropolitan area.

These findings indicate that proximity to Natura 2000 sites is valued differently depending on the urban-rural context. These results align with the expectations based on the prior study by Sijtsma et al. (2012), further supporting the notion that the price effect of proximity to Natura 2000 sites differs between urban and rural settings. The contrasting findings in urban and rural areas shed light on the complex dynamics between Natura 2000 sites and property values. The negative relationship in urban areas suggests that proximity to Natura 2000 sites may be viewed positively by inhabitants, possibly due to the aesthetic benefits (Mokhtarian et al., 2008), enhanced physical and mental health (Bell et al., 2015), social connection (Frumkin et al., 2014), improved environmental quality (Noway & Dwyer, 2007) and social cohesion/safety aspects (Kuo & Sullivan, 2001) associated with natural environments. In contrast, the findings for rural areas implies that residents or potential buyers in rural settings may perceive Natura 2000 sites as less desirable, potentially due to factors such as restricted land use (Malpezzi, 1996), limited development opportunities (Vikolainen et al., 2014), or perceived environmental drawbacks. The finding that rural residents do not value Natura 2000 sites positively can also be due to the fact that Natura 2000 designation has a negative impact on the average rental price of grassland and arable land (Koemle et al., 2019), which is reason for farmers to perceive it as a burden rather than a benefit. Based on the findings we could argue that in urban areas an amenity effect can be measured, while in rural areas the findings go more towards a measure of land use regulations.

Table 4. – Regression results for urban and rural comparison.

Variable	(4) Urban	(5) Rural
Distance to N2000	-.099***	.001
	[.003]	[.003]
Size of N2000 site	.000***	-.000
	[.000]	[.000]
Site type A	-.153***	.290***
	[.012]	[.017]
Site type B	-.457***	.277***
	[.033]	[.022]
Rennes	.183	-.013
	[.204]	[.088]
Bordeaux	.240	.195***
	[.152]	[.021]
Intercept	9.277***	8.368***
	[.152]	[.033]
Property characteristics	YES	YES
Year effects	YES	YES
Location effects	YES	YES
Observations	64,273	78,214
R-Squared	0.528	0.523
Degrees of Freedom	2881.66	1280.16

Finally, in Table 5 this study compares three different cities, one with high distance from Natura 2000 sites (6), one with a medium distance to Natura 2000 sites (7) and one with Natura sites inside its city borders (8), to see if proximity to Natura 2000 sites has an effect on the price of a house. The preferred model is also used as a basis for models (6), (7) and (8). First we will state outcomes of the key independent variable, so we can interpret what it means afterwards. For Lille (6) the results suggests that if the distance to a Natura 2000 site goes up by 10%, the price of a house decreases with 3.54%, ceteris paribus. For Rennes (7) we can see that if the distance to a Natura 2000 site goes up by 10%, the price of a house decreases with 0.47%, ceteris paribus. And for Bordeaux (8) the table shows that if the distance to a Natura 2000 site goes up by 10%, the price of a house decreases with 0.49%, ceteris paribus. All three models show that there is a significant negative relationship between housing prices and distance to the closest Natura 2000 site. We can conclude that the results are in line with the expectations that increasing distance from Natura 2000 sites has a negative effect on residential property prices. Model (7), Rennes, represents the best fit, since it has the highest adjusted R-Squared of 0.593, meaning that the independent variables account for 59.33% of the variance of the dependent variable, the residential property prices. Model (6), Lille has the lowest R-Squared.

Interesting to note is that the effect of distance to Natura 2000 sites on house prices is strongest in the city that is, on average, located the furthest away from Natura 2000 sites, Lille. The finding that the effect of distance to Natura 2000 sites on house prices is strongest in Lille, despite being located the

furthest away from Natura 2000 sites and having fewer, smaller, and less diverse Natura 2000 sites, may seem counterintuitive. However, there are several factors that could contribute to this result. First, it can be because of the scarcity effect. The scarcity of Natura 2000 sites in Lille could make them more valuable and desirable to residents. A resource's value often rises when it is in limited supply (Sehnert et al., 2014). In this instance, Lille's restricted supply of Natura 2000 sites may increase people' appreciation of these protected regions, strengthening the link between distance and house prices. Another possibility is that it's due to accessibility to nature: Lille, being further away from Natura 2000 sites, has limited access to natural areas and green spaces compared to the other cities. This is shown in the network analysis in Chapter 3. As a result, the presence of even a few Natura 2000 sites in Lille could have a more significant impact on the perceived desirability and value of properties (Bockarjova et al., 2020). The lack of other natural amenities in the city could amplify the effect of Natura 2000 sites on house prices (Sijtsma et al., 2012). There may be additional variables impacting property values in addition to proximity to Natura 2000 sites, while the size and diversity of Natura 2000 sites are essential considerations. Property values can also be influenced by elements including neighbourhood characteristics, amenities, infrastructure, socioeconomic circumstances, and market dynamics (Rosen, 1974). The association between the distance to Natura 2000 areas and Lille house prices may be influenced by these other variables, producing a stronger observed impact. It is also striking that the effect in Bordeaux is not different from the effect in Rennes, while the Natura 2000 site in the city centre of Bordeaux is a beautiful river. The lack of a stronger effect on house prices in Bordeaux, despite the presence of a visually appealing Natura 2000 site, indicates that additional factors are likely influencing the housing market dynamics in these cities.

Table 5. – Regression results for comparison between cities.

Variable	(6) Lille - high	(7) Rennes - medium	(8) Bordeaux - low
Distance to N2000	-.354***	-.047***	-.049***
	[.032]	[.014]	[.002]
Size of N2000 site	.000***	.000**	-.000
	[.000]	[.000]	[.000]
Site type A	1.081***		.069***
	[.109]		[.012]
Site type B			
Intercept	8.281***	8.713***	9.394***
	[.236]	[.083]	[.025]
Property characteristics	YES	YES	YES
Year effects	YES	YES	YES
Location effects	YES	YES	YES
Observations	46,929	28,529	67,029
R-Squared	0.454	0.593	0.533
Degrees of Freedom	1184.78	1341.10	2318.58

6. Discussion

In general, since all three cities showed that increasing distance to Natura 2000 sites decrease house prices, we can state that the findings of this research are in line with the theory that proximity to green space results in higher house prices (Daams et al., 2016; Daams et al., 2019; Luttik, 2000; Geoghegan, 2002; Conway et al, 2008; Gibbons et al., 2013). The lack of a statistically significant relationship between transaction prices and proximity to Natura 2000 sites in rural areas implies that the findings observed in urban areas cannot be directly generalized to rural contexts. In urban areas, the negative relationship between distance to Natura 2000 sites and house prices indicates that urban houses located farther away from these sites tend to have lower property values. This finding suggests that proximity to Natura 2000 sites is valued positively by urban inhabitants in contradiction of how Natura 2000 sites are perceived by rural inhabitants. Considering these findings, the importance of preserving Natura 2000 sites may be viewed differently depending on the urban-rural context. These results emphasize the complex dynamics between Natura 2000 sites and property values, highlighting the need for context-specific approaches when considering the conservation and management of these protected areas.

Findings of this paper would provide arguments against reducing Natura 2000 sites in urban settings. Even though Natura 2000 sites can have negative implications due to land use restrictions (Malpezzi, 1996; Vikolainen et al., 2014), results of this study show that property owners do value these areas as amenities. The valuation of these amenities are shown by the fact that properties in urban areas sell for a premium when located closer to a Natura 2000 site, in contradiction to rural areas. Especially the difference in the effect of distance to Natura 2000 sites on house prices between urban and rural areas have important implications for policymakers and urban planners who are interested in protecting natural areas while minimizing negative impacts on property values. This result suggest that policies aimed at protecting natural areas may have different impacts on property values in urban and rural areas, and that policymakers and urban planners should take these differences into account when designing policies and interventions. The results of this study give reason for policymakers to pay attention to the conservation of protected nature close to or in the city. For urban residents, these areas are important. In urban areas, where there is a clear negative relationship between distance to Natura 2000 sites and house prices, preserving these sites may be crucial to maintaining the aesthetic, environmental, and social benefits they offer. However, in rural areas, where proximity to Natura 2000 sites does not significantly impact property values, the preservation of these sites may not be perceived as highly important by residents or potential buyers.

Discussion revolves around the complex interrelationships among Natura 2000 sites, housing prices, and their policy implications. In several European countries, including the Netherlands and the UK, concerns arise regarding preserving or reducing Natura 2000 sites. The Netherlands, being a small country with a significant number of such sites (Ministry of Economic Affairs, 2022), faces the challenge of balancing nitrogen emission reduction requirements for farmers near these sites (De Pue &

Buysse, 2020) while addressing the severe housing shortage (Boelhouwer, 2020). The proximity of housing developments to Natura 2000 sites presents difficulties in obtaining building permits (Vikolainen et al., 2014) due to potential nitrogen emissions. Thus, a dilemma emerges where the resolution of one issue exacerbates the other. Experts propose that reducing the number of Natura 2000 sites in the Netherlands could be a step towards addressing both the housing and nitrogen crises (Van Mersbergen, 2022). This indicates the need for policymakers to carefully consider the trade-offs between environmental protection and housing needs when formulating regulations and determining the extent of protected areas. Similarly, in the UK, there is a political debate surrounding the importance of Natura 2000 sites compared to the obstacles they pose. British newspaper the Guardian published an article confessing that the UK environment secretary wants to scrap an important part of European environmental law that protects special species. The nature green paper published by the secretary's department argues that wiping the slate clean and ditching habitats regulation case law and rules would help to simplify the planning process, which is now too complicated (Lavelle, 2022).

The investigation of price developments in the UK following the removal of specific Natura 2000 areas would be of significant interest for future research. While this study has already provided valuable insights into the relationship between Natura 2000 sites and property prices, examining the current situation in the UK can be viewed as a unique opportunity for a 'pure experiment' that could yield more reliable results than the existing study. Pure experiments are often considered to offer greater validity due to their rigorous and controlled research designs (Krauss, 2021). By comparing the findings of the current study with the potential impacts of removing Natura 2000 areas in the UK, a broader perspective can be obtained regarding the effects of preserving Natura 2000 sites on property value dynamics in different countries and contexts. This comparative analysis would help to confirm or refute the consistency of the findings from the existing study and identify broader trends and patterns in the relationship between Natura 2000 sites and real estate values. The UK's current status as a 'pure experiment', involving policy changes directly affecting Natura 2000 sites, presents a unique opportunity to investigate the causal effects of such modifications. It could facilitate a deeper understanding of the actual impact of reducing Natura 2000 areas on the housing market and help determine the generalizability of the findings from the existing study beyond the specific French context.

Another topic for discussion is the finding that the effect of proximity to Natura 2000 sites on house prices is strongest in the city located farthest away from those sites (Lille). The study aims to examine the effect of distance from Natura 2000 sites on house prices (referred to as the 'distance effect'). However, the 'availability effect' of Natura 2000 sites is also important, considering factors beyond distance alone. Availability refers to the accessibility and benefits associated with having multiple Natura 2000 sites nearby, which can enhance the attractiveness and value of properties. Additionally, the presence of multiple Natura 2000 sites in the surrounding area indicates higher environmental quality and biodiversity, contributing to higher property values. The study included a network analysis in Chapter 3, which revealed that Bordeaux had the best accessibility to Natura 2000

sites and the highest number of sites in its surroundings (12 sites within a 30-minute drive). However, it was found that the effect of Natura 2000 sites on house prices was not strongest in Bordeaux (8), but rather in Lille (6), which is the city furthest away from the sites. This suggests that the observed results are not solely attributable to the distance effect. This can also be connected to the theory formulated based on the Sijtsma et al. (2012) paper, because there are not a lot of Natura 2000 sites in the surrounding area (so Lille is less 'green' than Bordeaux), which makes the urban inhabitants value the existing green space more. To gain a comprehensive understanding of the relationship between environmental amenities and property values, researchers and policymakers should consider both the availability of Natura 2000 sites and the number of sites in the vicinity. This broader perspective enables a nuanced analysis of the collective impact of nearby sites and their accessibility, providing valuable insights for land-use planning, conservation strategies, and decision-making related to sustainable development in areas surrounding Natura 2000 sites. For future research, it is recommended to give more prominence to the accessibility effect in studying the impact of Natura 2000 sites on house prices. Furthermore, conducting a detailed network analysis for each transaction individually, rather than using a city-centred approach, would provide more detailed information for analysis and interpretation.

With an average distance in Lille of 12 kilometres to the closest site, this finding raises questions about the reach of the effect of nature on property values. To understand this phenomenon, we can draw insights from the research conducted by Daams, Sijtsma, and van der Vlist (2016) on the effect of natural space on property prices and the role of perceived attractiveness. According to the Daams et al. (2016) study, the effect of attractive natural space on property prices diminishes with increasing distance. Their findings indicate that the impact falls from 16.0% for properties within 0.5 kilometres of natural spaces to 1.6% for properties up to 7 kilometres away. These results suggest that the effect of nature on property values attenuates as distance increases. In light of these findings, the observation that the effect of proximity to Natura 2000 sites on house prices is strongest in a city located very far away from those sites, with an average distance of 12 kilometres and the closest transaction to a site being 6.5 kilometres away, seems counterintuitive. One possible explanation is that other factors beyond physical proximity contribute to the perceived attractiveness and desirability of nature in this particular city. It is important to recognize that the effect of nature on property prices can be influenced by various factors, including the quality and characteristics of the natural spaces, regional preferences, and the availability of alternative natural areas nearby. The presence of attractive natural spaces within or close to the city, even if not specifically designated as Natura 2000 sites, may still positively influence property values. These alternative natural spaces could offer similar amenities, such as recreational opportunities, scenic landscapes, or environmental benefits, thereby enhancing the desirability and attractiveness of the area. Furthermore, the perception of nature's impact on property values can be shaped by cultural and socioeconomic factors (Keeler et al., 2019). Local preferences, community values, and regional traditions may play a role in shaping individuals' perceptions and preferences regarding natural amenities. It is possible that the specific dynamics and preferences within this city contribute to a

heightened appreciation and valuation of nature, even at relatively greater distances from Natura 2000 sites. Overall, while the general trend in the Daams et al. (2016) study suggests a diminishing effect of natural space on property prices with increasing distance, the observed finding in this study indicates that the influence of proximity to Natura 2000 sites on house prices can be stronger in a city located far away from those sites. This suggests the presence of other factors, such as alternative natural spaces and regional preferences, that contribute to the perceived attractiveness of nature and its impact on property values in this specific urban context.

Further research could explore the specific characteristics and attributes of the natural spaces within and surrounding the metropolitan areas, in relation to the socioeconomic and cultural factors that shape residents' perceptions and valuation of nature. An additional avenue of inquiry that would enhance the current study is the examination of the perceived attractiveness of the areas included in the analysis and its potential influence on the observed price effects. Specifically, it would be valuable to supplement this research with the approach employed in the study conducted by Daams et al. (2016). One limitation of this research now is that you don't know whether the nearest Natura 2000 site is a beautifully diverse nature reserve or just a plain piece of farmland protected because rare birds happen to breed there. This distinction could have a considerable impact on the observed effects, as suggested by the findings of the aforementioned study. Therefore, incorporating an assessment of the aesthetic and ecological qualities of the Natura 2000 sites into the analysis would provide an additional dimension to the interesting findings already provided by this research. Namely, that proximity to Natura 2000 sites has a positive effect on house prices.

7. Conclusion

Previous research has examined the relationship between nature and real estate values from various angles (Daams et al., 2016; Gibbons et al., 2013; Melichar and Kaprová, 2013; Koemle et al., 2019). The literature review suggested that natural amenities, such as protected green spaces, can positively impact house prices. However, there is limited academic literature specifically investigating the impact of Natura 2000 sites on house prices. This study aimed to address this gap by exploring the effect of proximity to Natura 2000 sites on housing prices. This research used a quantitative data analysis based on the Hedonic Pricing Model to answer the main research question regarding the effect of Natura 2000 sites on house prices. This research is relevant as decisions regarding the preservation or removal of Natura 2000 sites are currently under discussion in Europe. Understanding how Natura 2000 sites affect house prices can inform policy decisions. This study contributed to the broader understanding of how environmental amenities shape property values, relevant to research fields such as environmental economics and urban planning.

The preferred model (2) revealed that if the property is located 10% farther away, the price of a house decreases with 0.41%, holding other factors constant. So, for example, if a property is located 2.2 kilometres away from Natura 2000 site instead of 2 kilometres, a property can have a transaction price of € 497.950 instead of € 500.000,-. Additionally, the diversity of Natura 2000 areas around a city was found to affect house prices. The results showed that in urban areas, increasing distance to the nearest Natura 2000 site by 10% was associated with a significant 0.99% decrease in house prices. These findings align with the expectations based on the prior study by Sijtsma et al. (2012) and highlight the differing price effects of proximity to Natura 2000 sites in urban and rural contexts. These research findings provide evidence against the removal of Natura 2000 sites in urban settings, as property owners demonstrate a preference for these areas as amenities. Conversely, in rural areas, where proximity to Natura 2000 sites does not significantly impact property values, the preservation of these sites may not be perceived as highly important by residents or potential buyers. The differential impacts on property values in urban and rural areas suggest the need for tailored policies that account for the specific contextual characteristics. The observation that the effect of proximity to Natura 2000 sites on house prices is strongest in Lille raises questions about the reach of the effect of nature on property values. While previous research suggests a diminishing effect of natural space on property prices with increasing distance (Daams et al., 2016), the current study indicates that other factors beyond physical proximity contribute to the perceived attractiveness and desirability of nature in this particular context. The presence of alternative natural spaces within or close to the city, the specific characteristics of these spaces, and regional preferences may play a significant role in shaping individuals' perceptions and valuation of nature. The cultural and socioeconomic factors inherent to the city may contribute to a heightened appreciation and valuation of nature (Keeler et al., 2019), even at relatively greater distances from Natura 2000 sites.

The findings of this research have implications for urban planning, policymaking, and real estate investment. It highlights the need for context-specific approaches when considering the conservation and management of protected areas, as the perceived value of nature can vary depending on the urban-rural context and the availability of alternative natural spaces. Policymakers and urban planners should take these differences into account when designing policies and interventions aimed at preserving natural areas while minimizing negative impacts on property values. Overall, this study contributes to the understanding of the relationship between protected natura and property values, shedding light on the complexity of this association and emphasizing the importance of considering multiple factors beyond physical proximity in assessing the impact of nature on property prices.

References

Bell, S., Phoenix, C., Lovell, R., & Wheeler, B. W. (2015). Seeking everyday wellbeing: The coast as a therapeutic landscape. *Social Science & Medicine*, 142, 56-67.

Bockarjova, M., Botzen, W. J. W., van Schie, M. H. and Koetse, M. J., (2020). Property price effects of green interventions in cities: A meta-analysis and implications for gentrification. *Environmental Science & Policy*, 112, pp.293-304.

Boelhouwer, P. (2020) "The Housing Market in the Netherlands As a Driver for Social Inequalities: Proposals for Reform," *International Journal of Housing Policy*, 20(3), pp. 447–456.

Bourassa, S., Cantoni, E. and Martin, H. (2007) Spatial dependence, housing submarkets, and house price prediction. *Journal of Real Estate Finance and economics*, 35(2), pp. 143-160.

Brander, L. M., and Koetse, M. J. (2011) "The Value of Urban Open Space: Meta-analyses of Contingent Valuation and Hedonic Pricing Results." *Journal of Environmental Management*, 92(10): 2763-73

CBS (2023) *Stijging Nederlandse huizenprijzen in top vijf Europese Unie*. [online] Centraal Bureau voor de Statistiek. Available at: https://www.cbs.nl/nl-nl/nieuws/2022/41/stijging-nederlandse-huizenprijzen-in-top-vijf-europese-unie#:~:tekst=In%20het%20tweede%20kwartaal%20van%202022%20was%20de%20transactieprijs%20van (Accessed 17 Feb. 2023).

Chang, J., Qu, Z., Xu, R., et al. (2017) 'Assessing the ecosystem services provided by urban green spaces along urban center-edge gradients', *Scientific Reports*, 7(1), 11226.

Cheshire, P. C., Sheppard, S. (1995) On the price of land and the value of amenities. *Economica*, 62:247–267

Conway, D., Li, C. Q., Wolch, J., Kahle, C., and Jerrett, M. (2010) "A Spatial Autocorrelation Approach for Examining the Effects of Urban Greenspace on Residential Property Values." *Journal of Real Estate Finance and Economics*, 41 (2): 150-6.

Correll, M. R., Lillydahl, J. H. and Singell, L. D. (1978) "The Effects of Greenbelts on Residential Property Values: Some Findings on the Political Economy of Open Space," *Land Economics*, 54(2), pp. 207–217.

Daams, M. N., Sijtsma, F. J. and van der Vlist, A. J. (2016) "The Effect of Natural Space on Nearby Property Prices: Accounting for Perceived Attractiveness," *Land Economics*, 92(3), pp. 389–410.

Daams, M. N., Sijtsma, F. J. and Veneri, P. (2019) "Mixed Monetary and Non-Monetary Valuation of Attractive Urban Green Space: A Case Study Using Amsterdam House Prices," *Ecological Economics*, 166.

Data.gouv.fr, 2021. *Geolocated DVF geolocated real estate valuation requests.* [Online] Available at: https://www.data.gouv.fr/fr/datasets/demandes-de-valeurs-foncieres-geolocalisees/ (Accessed 2 January 2023).

De Pue, D. and Buysse, J. (2020) "Safeguarding Natura 2000 Habitats from Nitrogen Deposition by Tackling Ammonia Emissions from Livestock Facilities," *Environmental Science and Policy*, 111, pp. 74–82.

European Commission (2021) *Natura 2000 in France.* Available at: https://ec.europa.eu/info/publications/natura-2000-france_en (Accessed: February 7, 2023).

European Commission (no date) *Natura 2000*, *Natura 2000 - Environment*. European Commision. Available at: https://ec.europa.eu/environment/nature/natura2000/index_en.htm (Accessed: November 30, 2022).

European Environment Agency (2022) '*Guidelines on climate change and Natura 2000'*, EU Publications. Available at: https://op.europa.eu/en/publication-detail/-/publication/59c03f44-f672-4f61-bbf7-5422479cf6bb (Accessed: 11 May 2023).

European Environment Agency (2023) *Natura 2000 data - the European network of protected sites.* Available at: https://www.eea.europa.eu/data-and-maps/data/natura-14 (Accessed: February 27, 2023).

Freeman, A. M., III. (2003) *Measurement of environmental and resource values: Theory and methods.* Washington, DC: Resources for the Future

Frumkin, H., Frank, L. D., & Jackson, R. J. (2004) *Urban sprawl and public health: Designing, planning, and building for healthy communities*. Island Press.

Geoghegan, J. (2002) The value of open spaces in residential land use. *Land Use Policy*, 19(1):91–98.

Gibbons, S., Mourato, S. and Resende, G. M. (2014) "The Amenity Value of English Nature: A Hedonic Price Approach," *Environmental and Resource Economics*, 57(2), pp. 175–196.

Hammer, T.R., Coughlin, R.E., Horn IV, E.T. (1974) The effect of a large urban park on real estate values. *American Institute of Planners Journal*, 40(4), 274–277.

Keeler, B. L. et al. (2019) "Social-Ecological and Technological Factors Moderate the Value of Urban Nature," *Nature Sustainability*, 2(1), pp. 29–38.

Kitchen, J.W., Hendon, W.S. (1967) Land values adjacent to an urban neighborhood park. *Land Economics*, 43 (3), 357–361.

Koemle, D., Lakner, S. and Yu, X. (2019) "The Impact of Natura 2000 Designation on Agricultural Land Rents in Germany," *Land Use Policy*, 87.

Krauss, A. (2021) "Assessing the Overall Validity of Randomised Controlled Trials," *International Studies in the Philosophy of Science*, 34(3), pp. 159–182.

Kuminoff, N., Parmeter, C. and Pope, J. (2010) Which hedonic models can we trust to recover the marginal willingness to pay for environmental amenities? *Journal of Environmental Economics and Management*, 60(3), pp. 145-160.

Kuo, F. E., and Sullivan, W. C. (2001) Environment and crime in the inner city: Does vegetation reduce crime? *Environment and Behavior*, 33(3), 343-367.

Laville, S. (2022) *UK government to scrap European law protecting special habitats*, *The Guardian*. Guardian News and Media. Available at: https://www.theguardian.com/environment/2022/jun/30/uk-government-scrap-european-law-protecting-special-habitats (Accessed: November 30, 2022).

Lee, C. M. and Linneman, P. (1998) "Dynamics of the Greenbelt Amenity Effect on the Land Market—the Case of Seoul's Greenbelt," *Real Estate Economics*, 26(1), pp. 107–129.

Legifrance (2019). Accueil | Légifrance, le service public de la diffusion du droit. [online] Gouv.fr. Available at: https://www.legifrance.gouv.fr/ (Accessed: July 5, 2023).

Luttik, J. (2000) The value of trees, water and open space as reflected by house prices in the Netherlands. *Landscape and Urban Planning*, 48(3-4), 161-167.

Malpezzi, S. (1996) "Housing Prices, Externalities, and Regulation in U.S. Metropolitan Areas," *Journal of Housing Research*, 7(2), pp. 209–241.

McMillan, M. (1974) Open space preservation in developing areas: an alternative policy. *Land Economics*, 50 (4), 410–417.

Melichar, J., Vojáček, O., Rieger, P. and Jedlička, K., 2009. Measuring the value of urban forest using the Hedonic price approach. *Regional Studies*, 2, pp.13-20.

Melichar, J. and Kaprová Kateřina (2013) "Revealing Preferences of Prague's Homebuyers Toward Greenery Amenities: The Empirical Evidence of Distance-Size Effect," *Landscape and Urban Planning*, 109(1), pp. 56–66.

Ministry of Economic Affairs (2022) *Natura 2000, Natuur en biodiversiteit | Rijksoverheid.nl*. Ministerie van Algemene Zaken. Available at: https://www.rijksoverheid.nl/onderwerpen/natuur-en-biodiversiteit/natura-2000 (Accessed: November 30, 2022).

Mokhtarian, P. L., Cao, X., and Handy, S. L. (2008). Do changes in neighborhood characteristics lead to changes in travel behavior? A structural equations modeling approach. *Transportation*, 35(5), 535-556.

Morgan, A. (2007) 'The Impact of Hurricane Ivan on Expected Flood Losses, Perceived Flood Risk, and Property Values', *Journal of Housing Research*, 16(1), pp. 47–60.

Nowak, D. J., & Dwyer, J. F. (2007). Understanding the benefits and costs of urban forest ecosystems. In S. T. A. Pickett, M. L. Cadenasso, & J. M. Grove (Eds.), Urban ecosystems: Ecological principles for the built environment (pp. 81-114). Springer.

Palmquist, R. B. (2005). Property value models. In: *Handbook of Environmental Economics*, Vol. 2. ed. Karl Göran-Mähler and Jeffrey R. Vincent, 763–819. North Holland: Amsterdam.

Peiser, R.B., Schwann, G.M. (1993) The private value of public open space within subdivisions. *Journal of Architectural and Planning Research*, 10 (2), 91–104.

Real Advisor. (2023) *France: House Prices 2023 · EUR / m2* | RealAdvisor. Available at: https://realadvisor.fr/en/property-prices (Accessed: March 8, 2023).

Rosen, S. (1974) Hedonic prices and implicit markets: product differentiation in pure competition. *Journal of Political Economy*, 82(1), 34-55.

Sijtsma, F. J. et al. (2012) "Does 'grey' Urban Living Lead to More 'green' Holiday Nights? A Netherlands Case Study," *Landscape and Urban Planning*, 105(3), pp. 250–257.

Sehnert, S., Franks, B., Yap, A. J. and Higgins, E. T., (2014). Scarcity, engagement, and value. *Motivation and Emotion*, 38(6), pp. 823-831.

Van Mersbergen, C. (2022) *Deskundigen: Vervang Deel Beschermde Natuur door andere natuur om Boeren Te Helpen*. Het Parool. Available at: https://www.parool.nl/nederland/deskundigen-vervang-deel-beschermde-natuur-door-andere-natuur-om-boeren-te-helpen~bba98b25/?referrer=https%3A%2F%2Fwww.google.com%2F (Accessed: November 30, 2022).

Vikolainen, V., Bressers, H. and Lulofs, K. (2014) "A Shift Toward Building with Nature in the Dredging and Port Development Industries: Managerial Implications for Projects in or near Natura 2000 Areas," *Environmental Management*, 54(1), pp. 3–13.

West, R.M. (2021) "Best practice in statistics: The use of log transformation." *Annals of Clinical Biochemistry*. 2022;59(3):162-165.

Appendices

Appendix A – Geographically extensive assessment Natura 2000 sites in France

Appendix B – Maps with transactions

Appendix C – Data cleaning process

Appendix D – Descriptive statistics

Appendix A – Geographically extensive assessment Natura 2000 sites in France

Cities far from Natura 2000 sites

City	*Location*	*Region*	*Inhabitants*
Limoges	South West	Haute-Vienne	130,876
Lille	North	Hauts-de-France	234,475

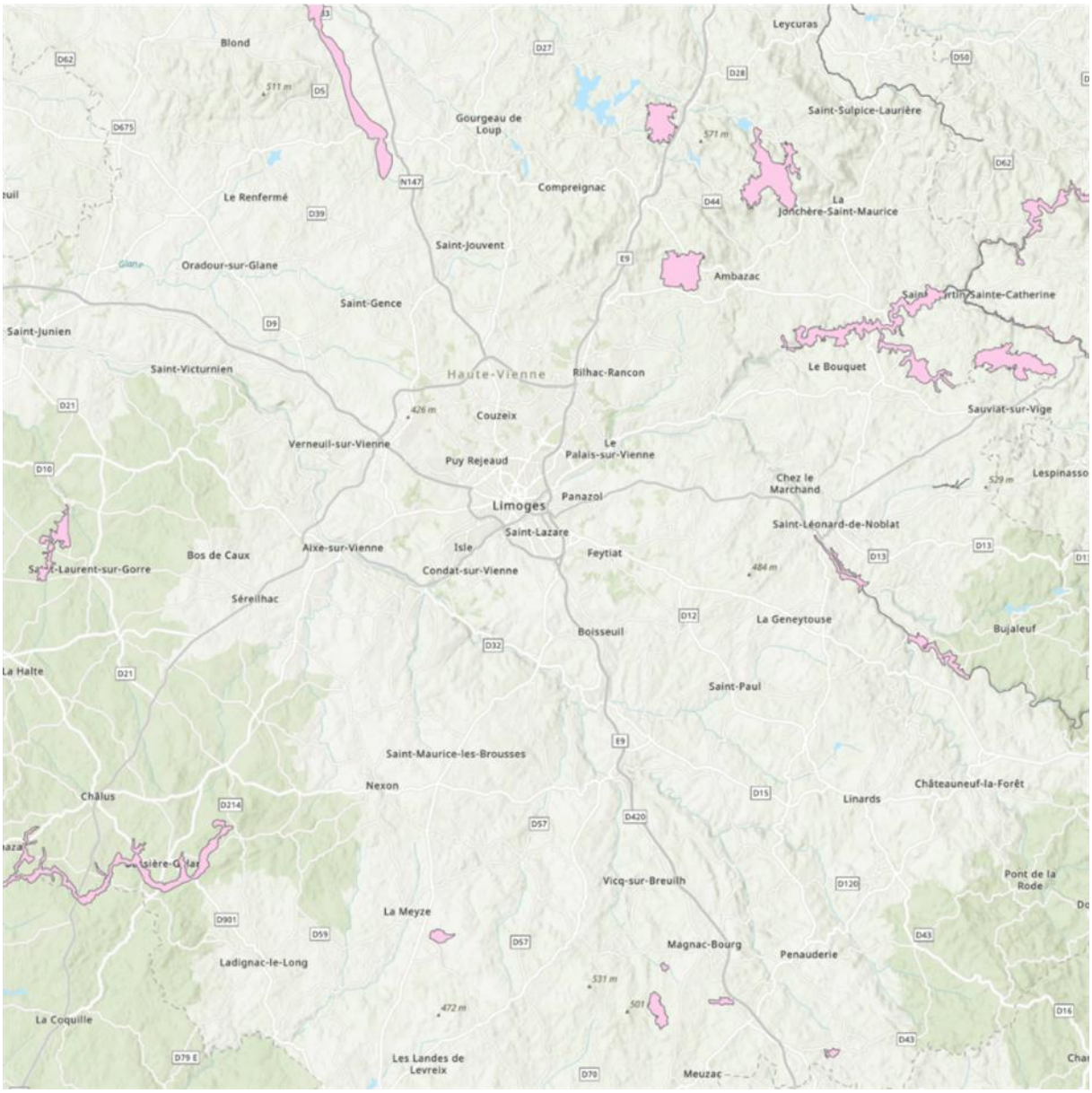

Figure A.1. Natura 2000 sites surrounding Limoges.

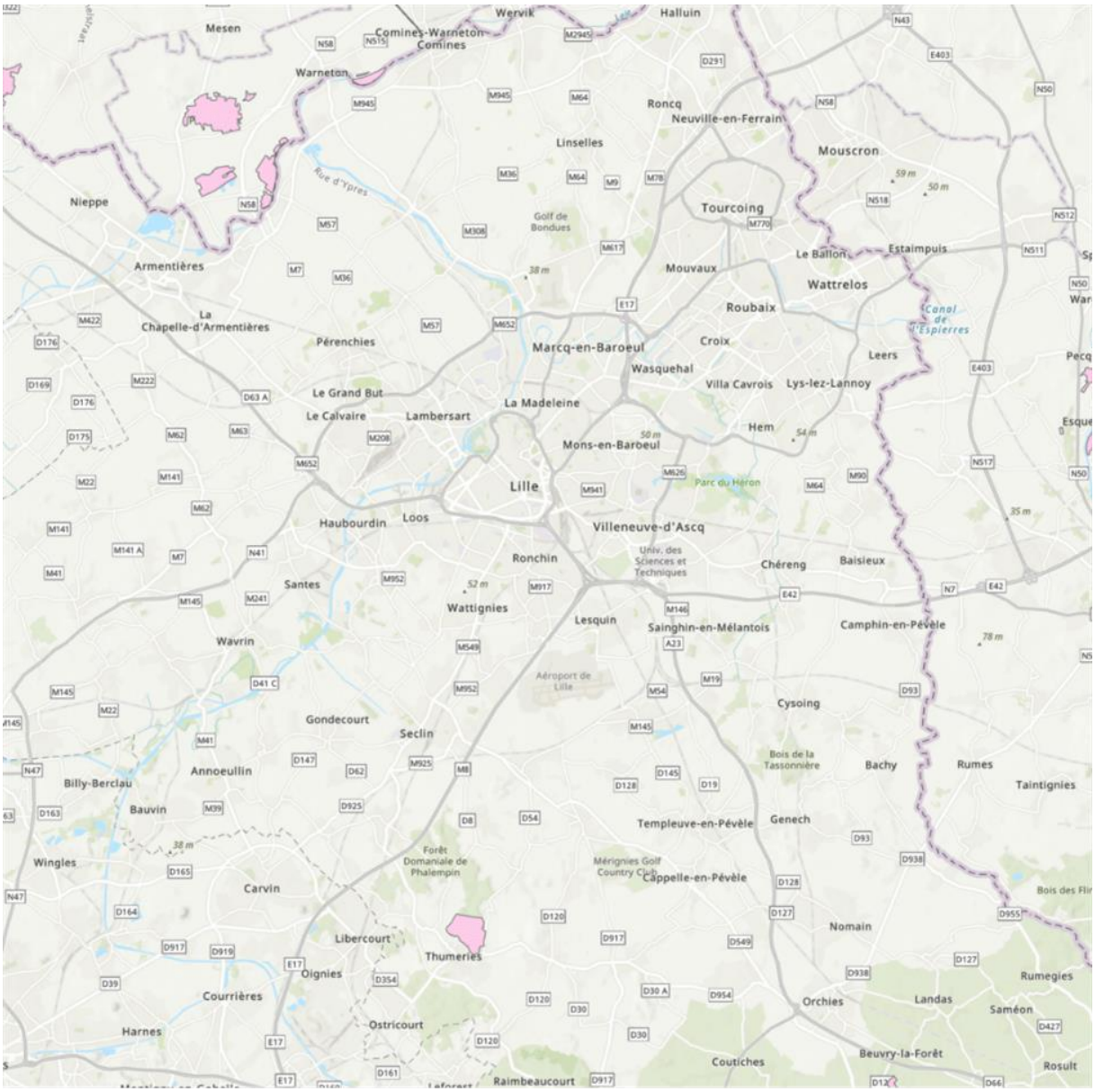

Figure A.2. Natura 2000 sites surrounding Lille.

Cities with a medium distance to Natura 2000 sites

City	*Location*	*Region*	*Inhabitants*
Rennes	North West	Brittany	220,488
Le Mans	North West	Pays de la Loire	143,847
Clermont-Ferrand	Central	Auvergne-Rhône-Alpes	147,865
Reims	North East	Grand Est	181,194
Saint-Etienne	Central	Auvergne-Rhône-Alpes	173,821
Dijon	East	Bourgogne-Franche-Comté	158,002

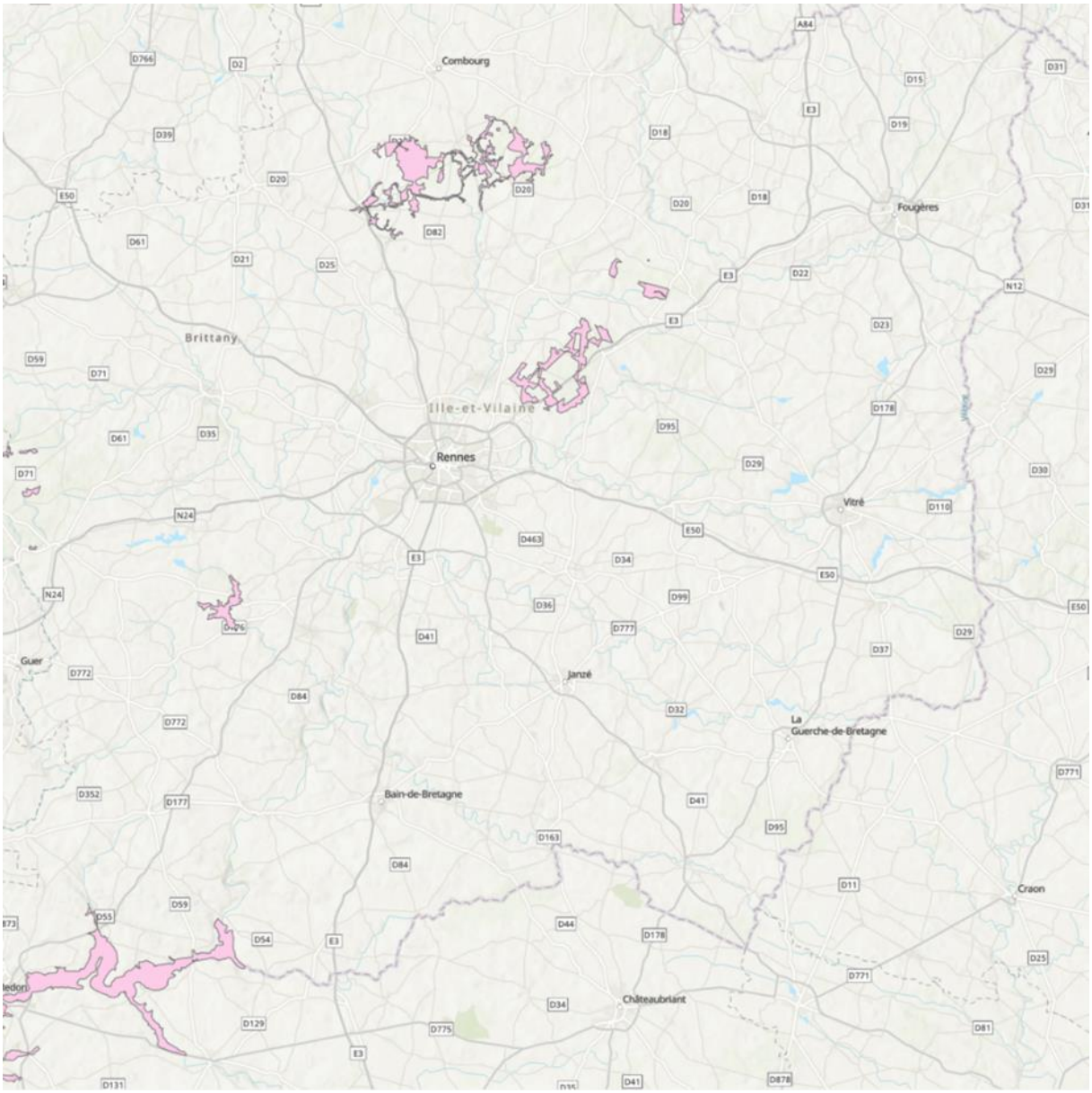

Figure A.3. Natura 2000 sites surrounding Rennes.

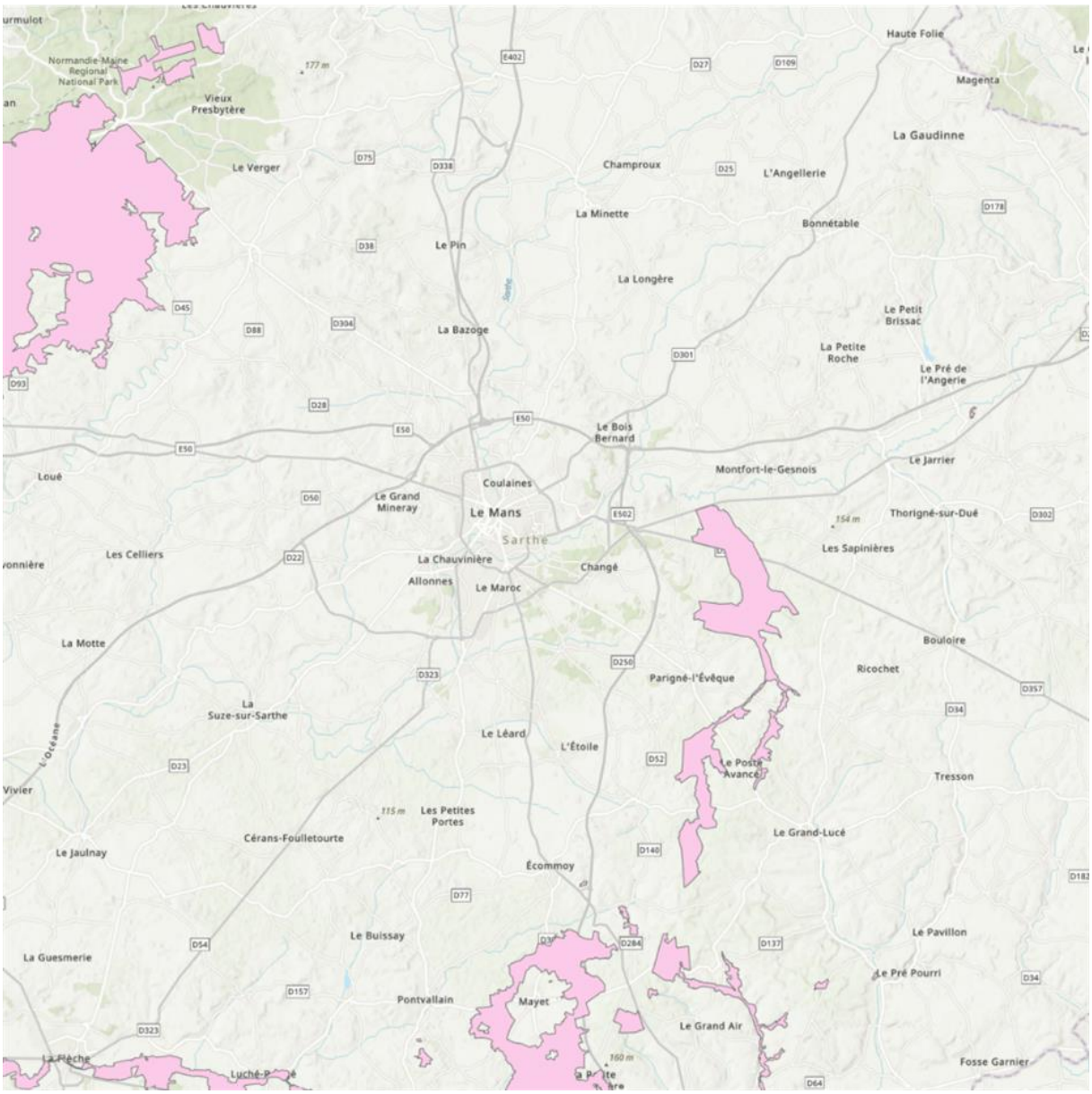

Figure A.4. Natura 2000 sites surrounding Le Mans.

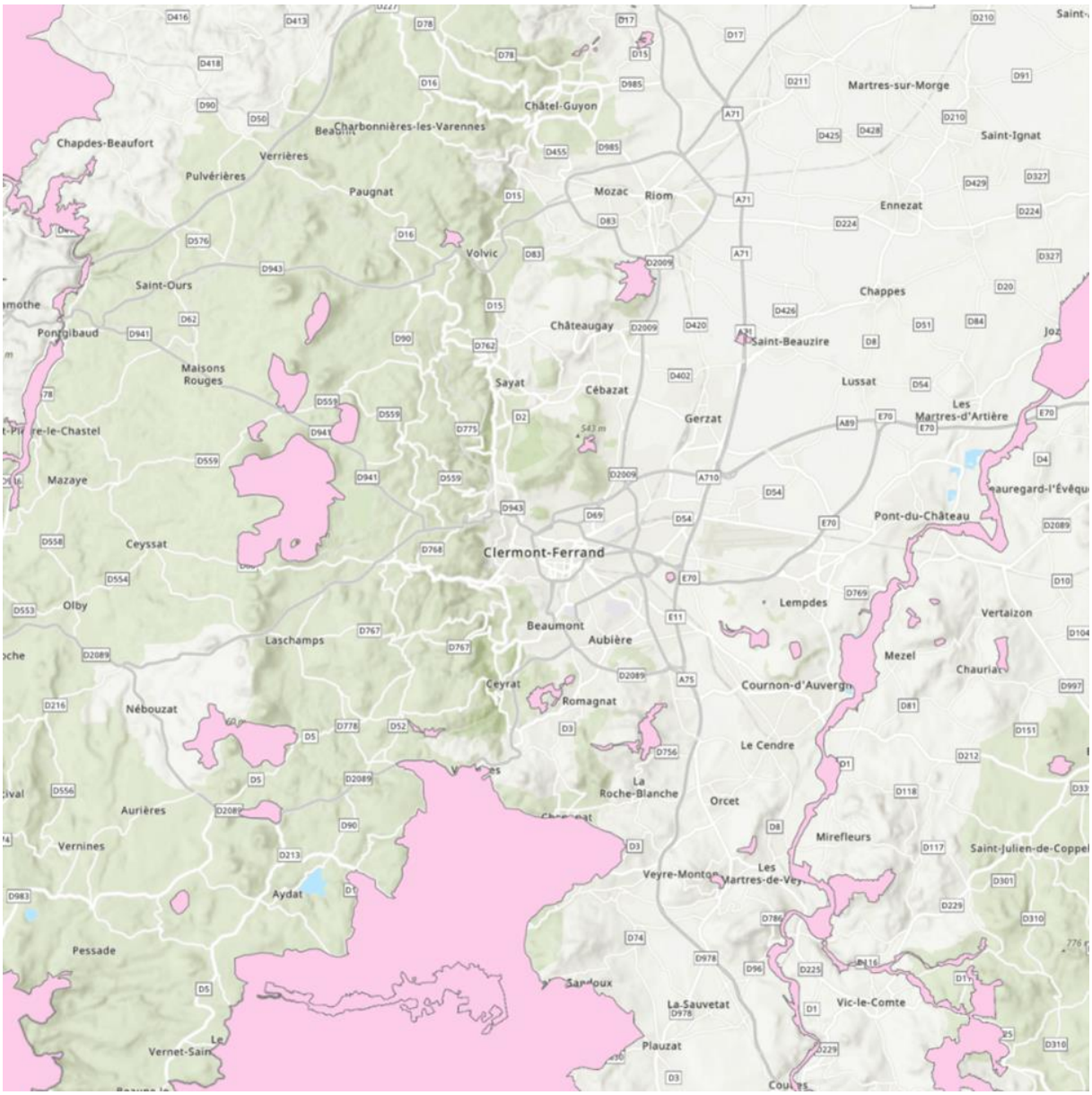

Figure A.5. Natura 2000 sites surrounding Clermont-Ferrand.

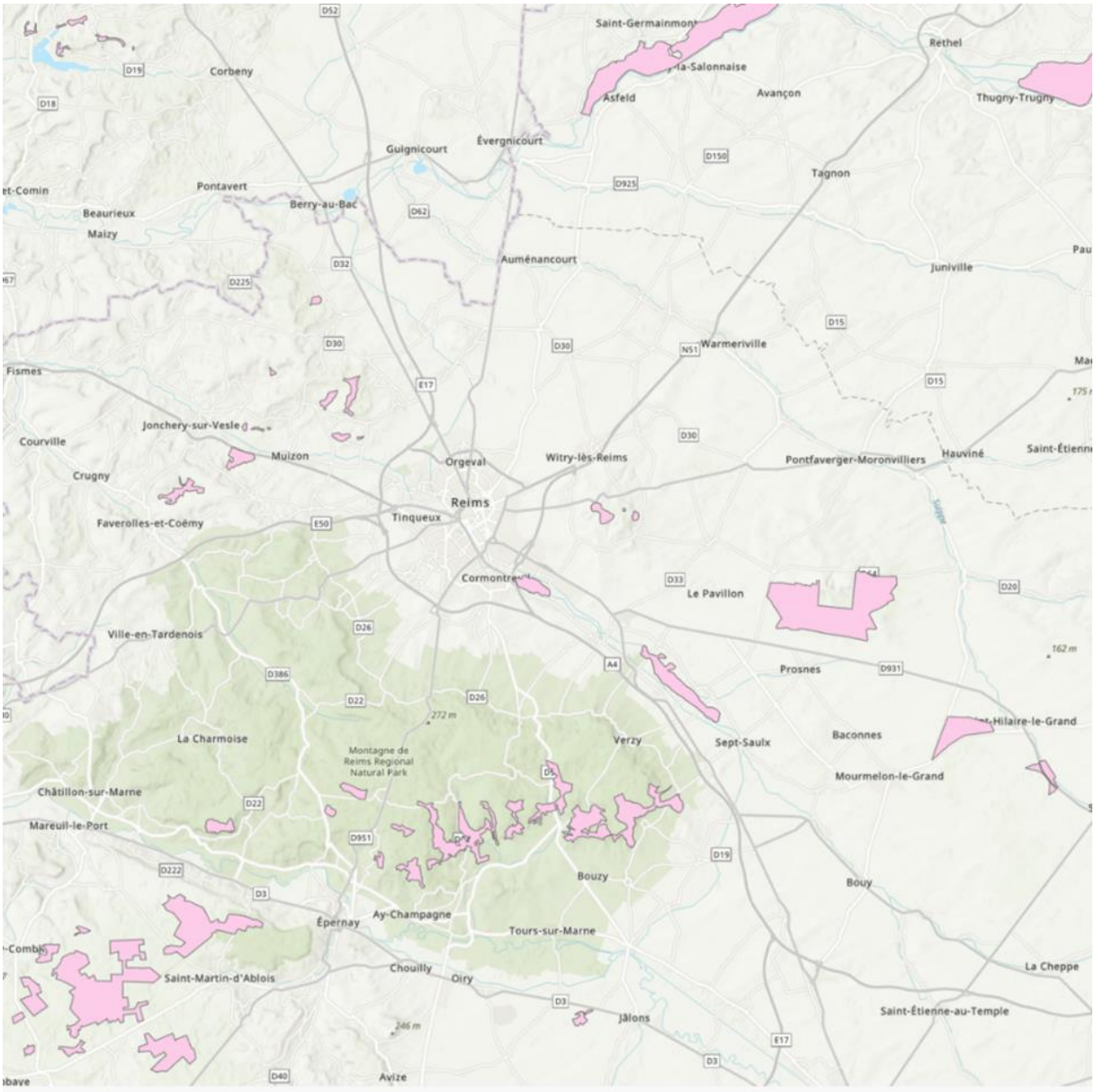

Figure A.6. Natura 2000 sites surrounding Reims.

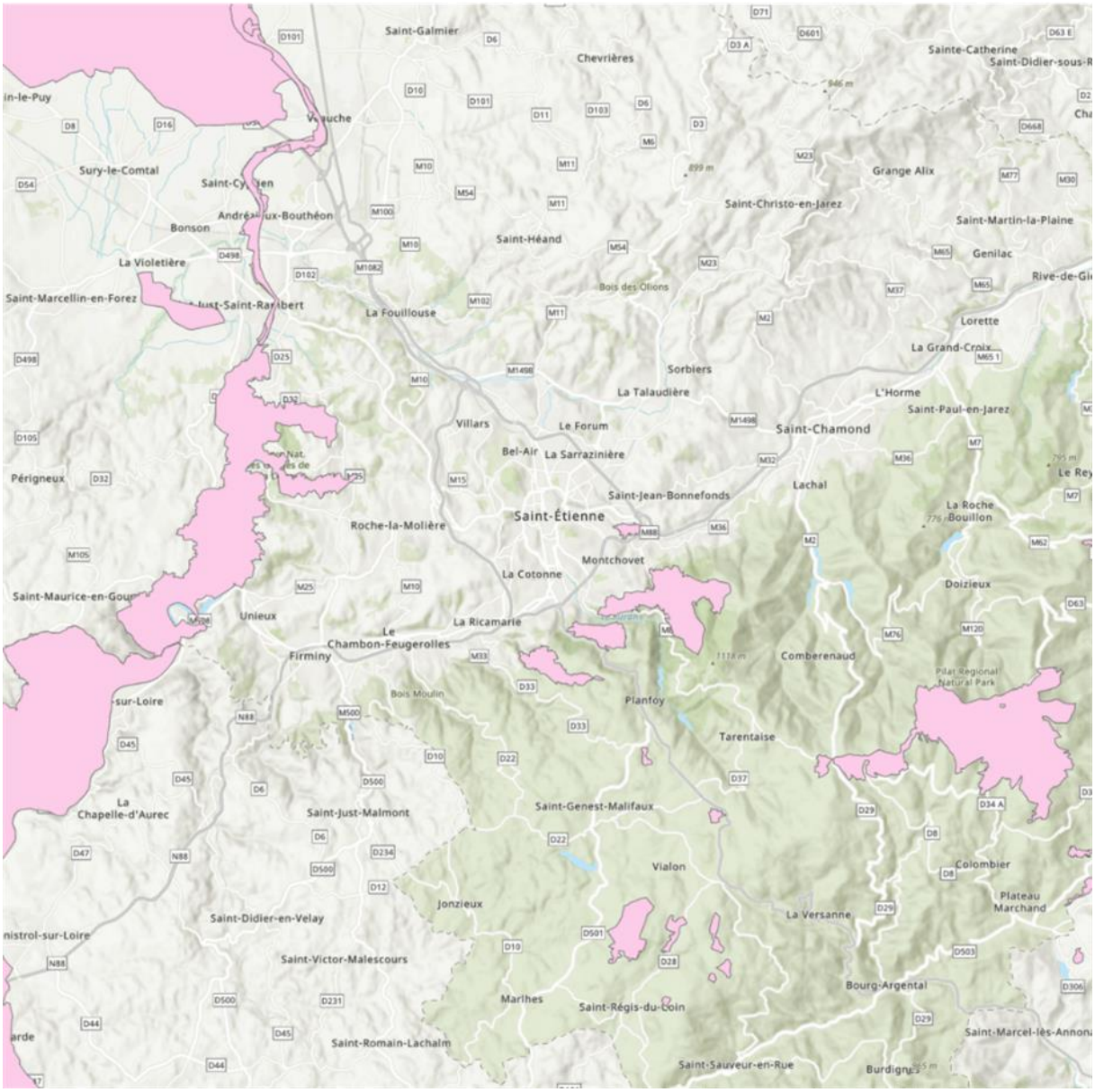

Figure A.7. Natura 2000 sites surrounding Saint-Étienne.

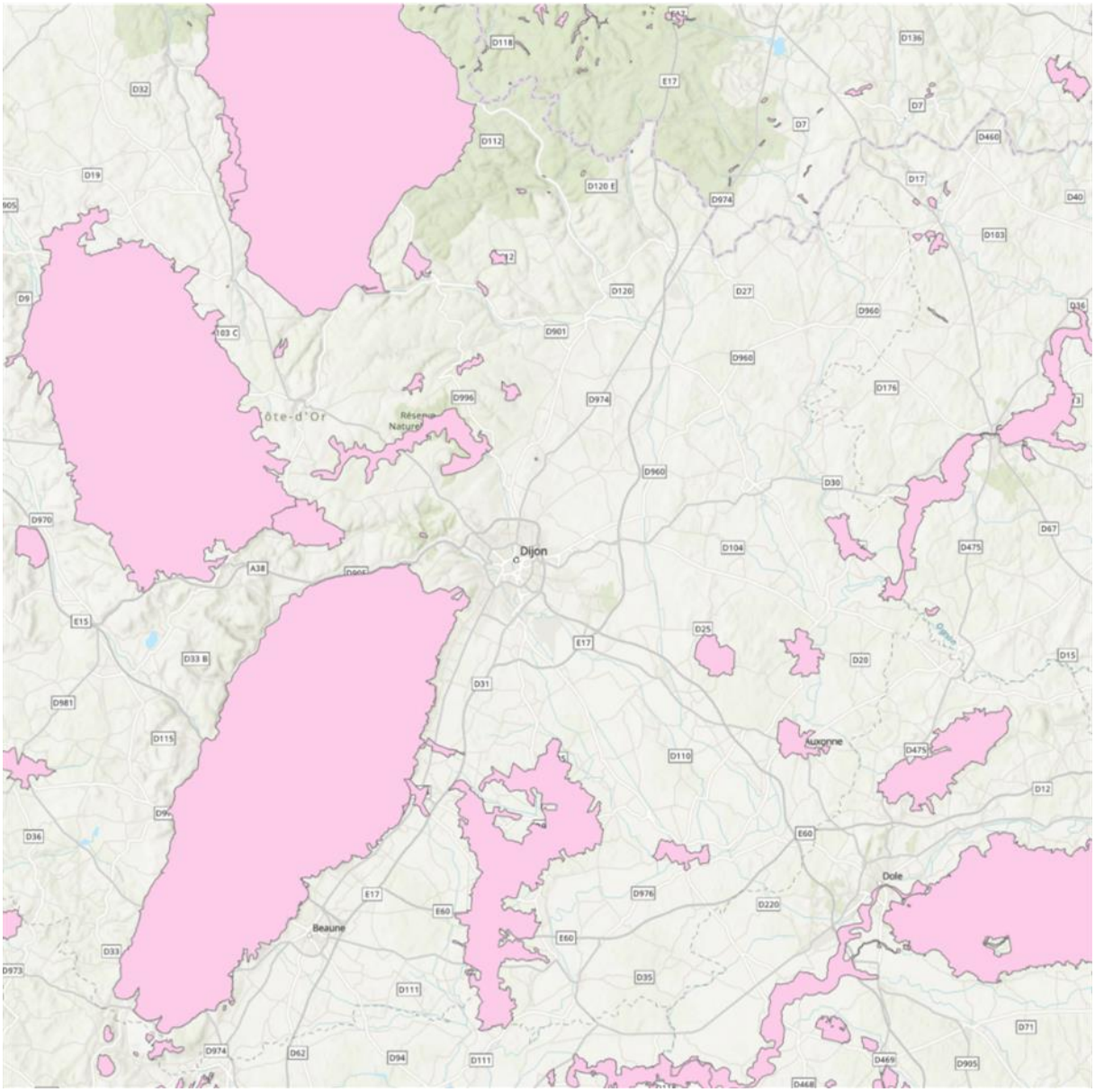

Figure A.8. Natura 2000 sites surrounding Dijon.

Cities close to Natura 2000 sites

City	*Location*	*Region*	*Inhabitants*
Nantes	North West	Pays de la Loire	318,808
Angers	West	Pays de la Loire	155,850
Amiens	North	Hauts-de-France	134,706
Toulouse	South	Occitania	493,465
Bordeaux	South West	Nouvelle-Aquitaine	260,958

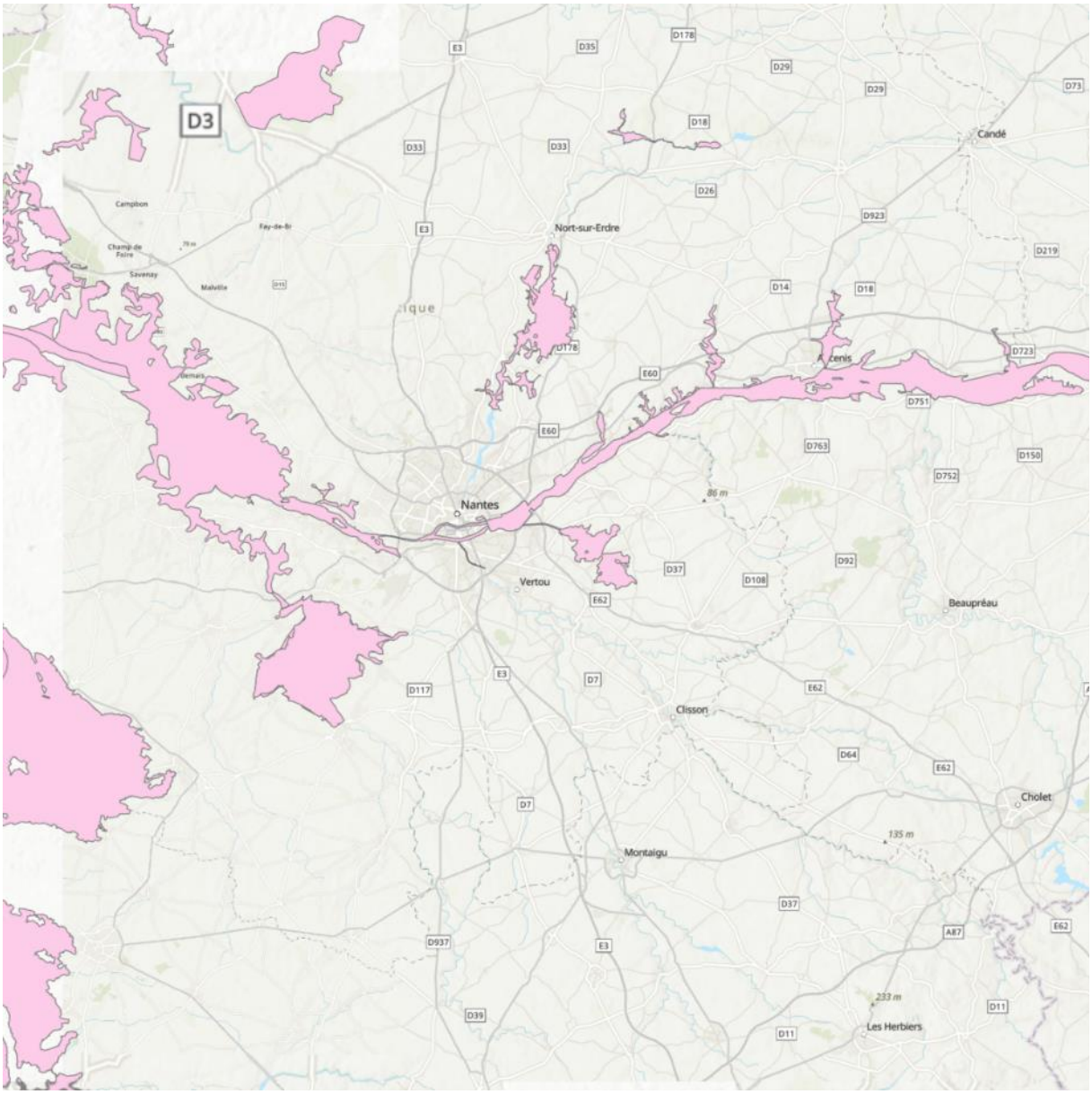

Figure A.9. Natura 2000 sites surrounding Nantes.

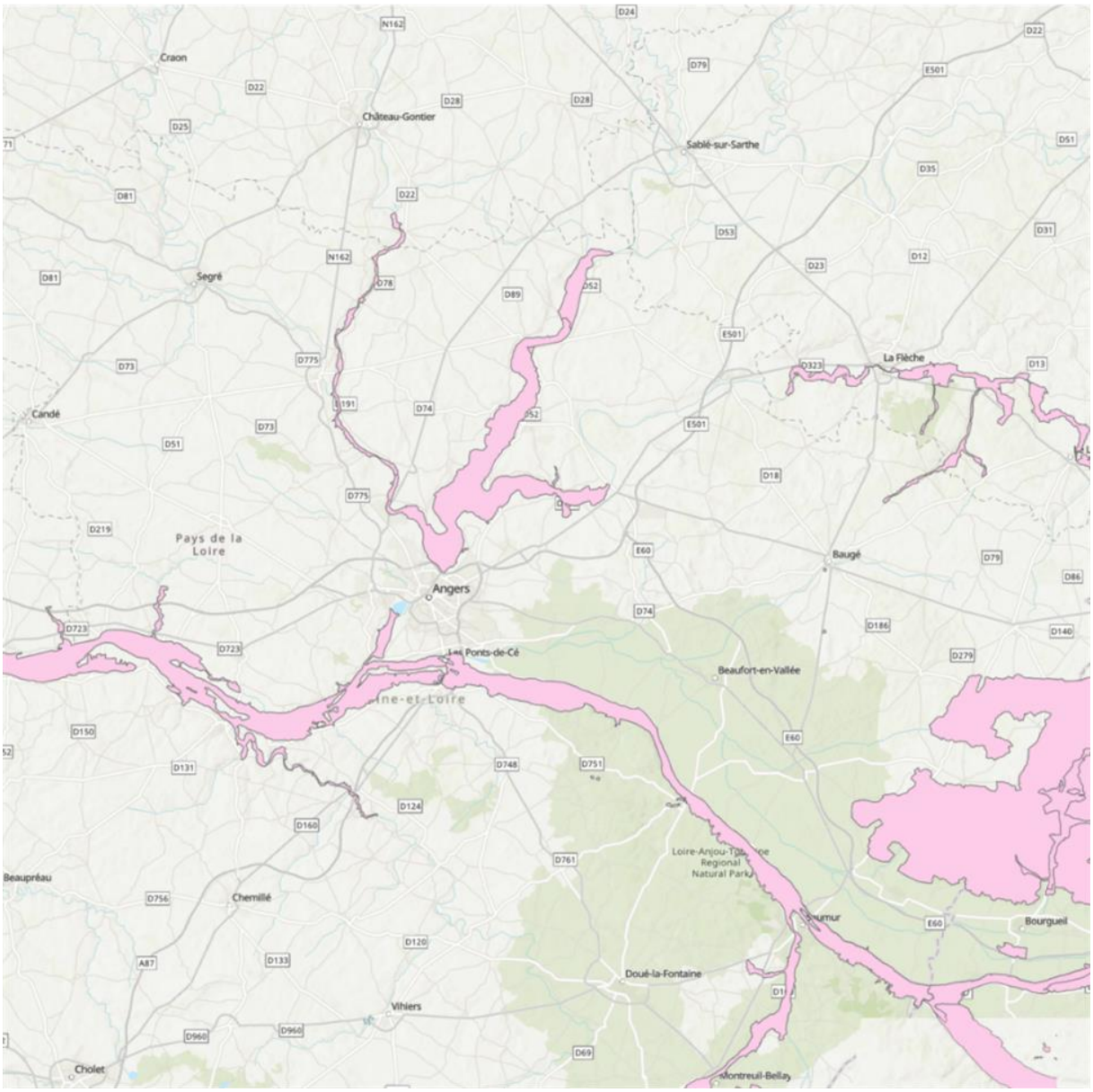

Figure A.10. Natura 2000 sites surrounding Angers.

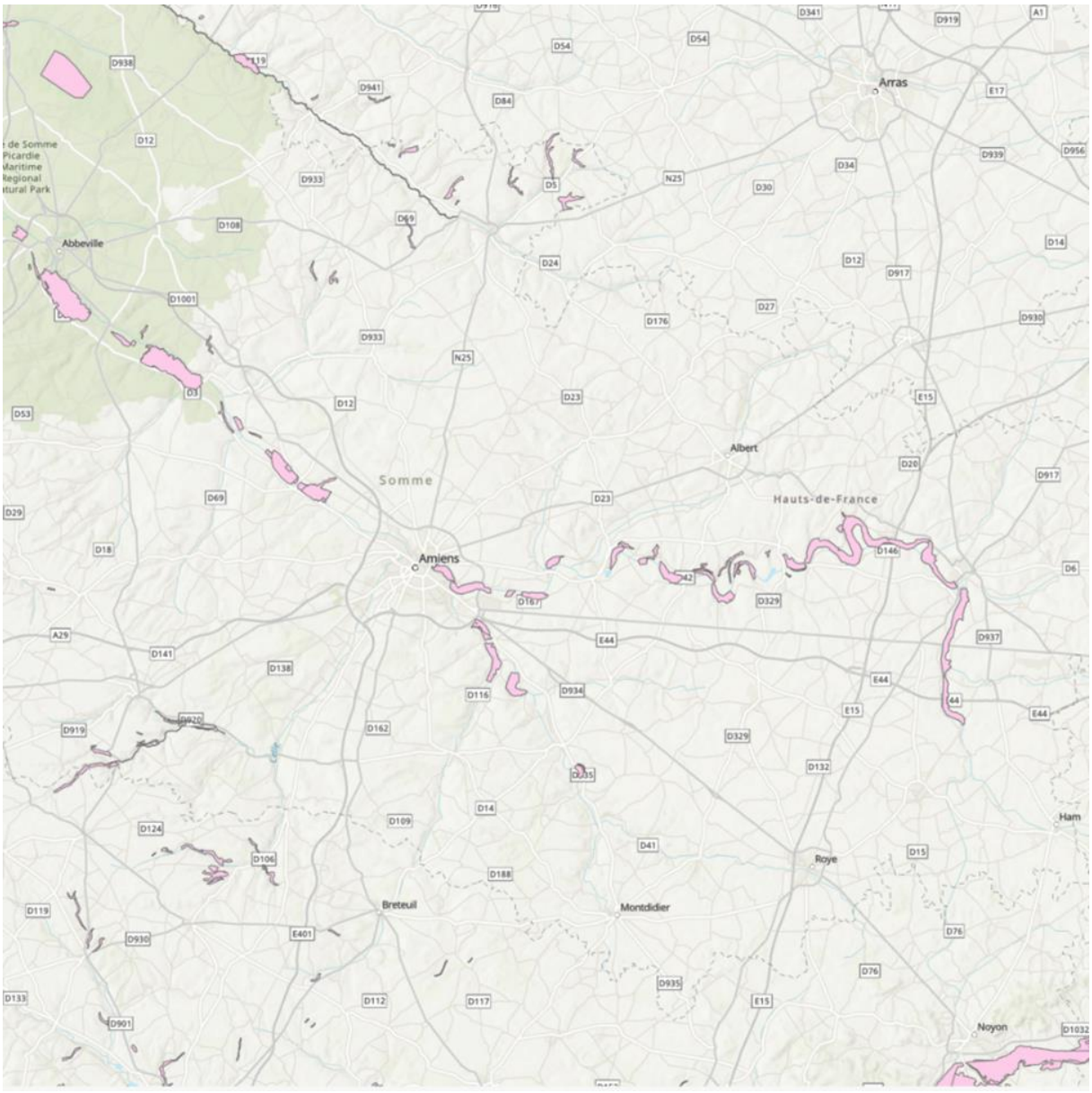

Figure A.11. Natura 2000 sites surrounding Amiens.

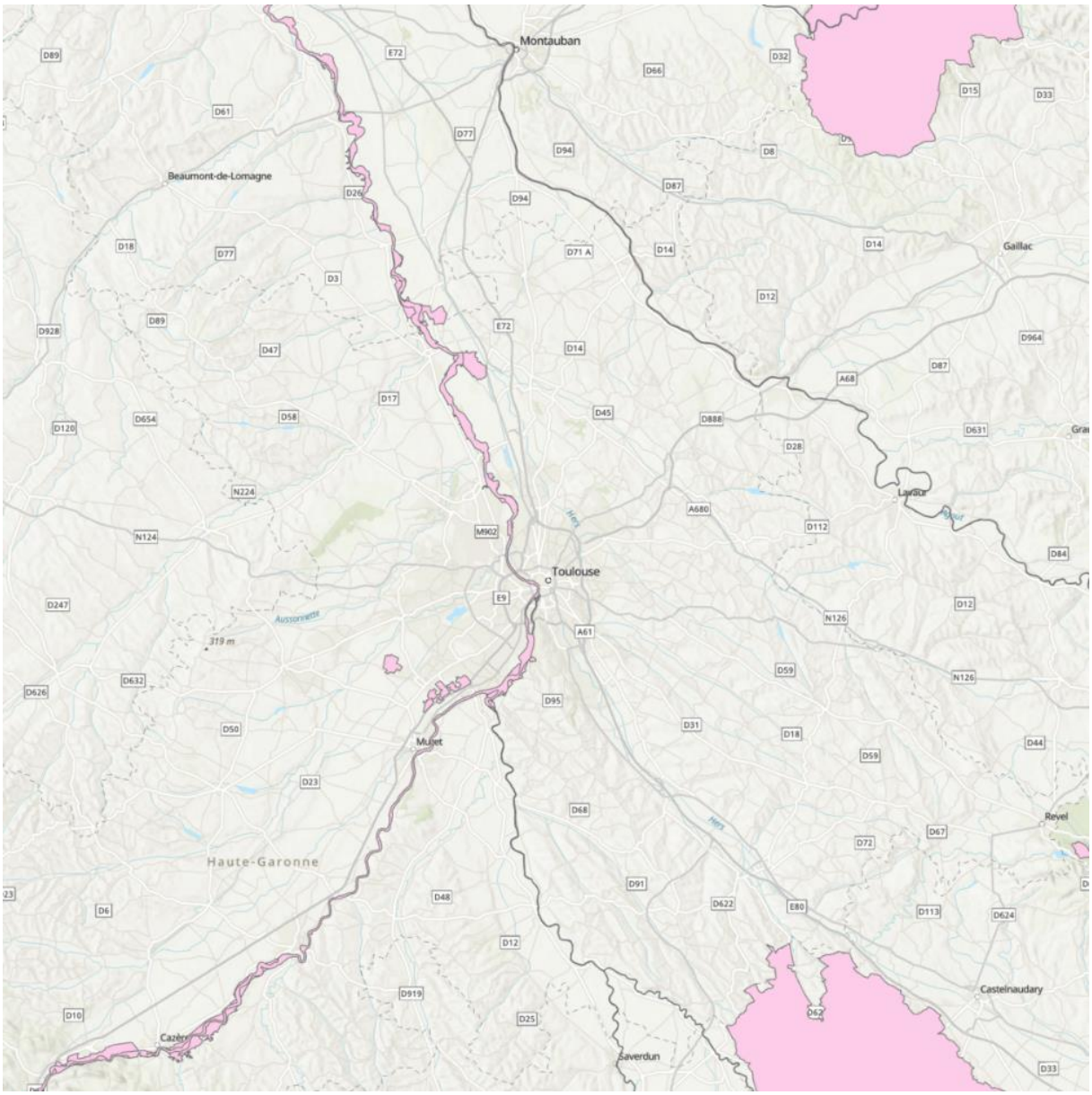

Figure A.12. Natura 2000 sites surrounding Toulouse.

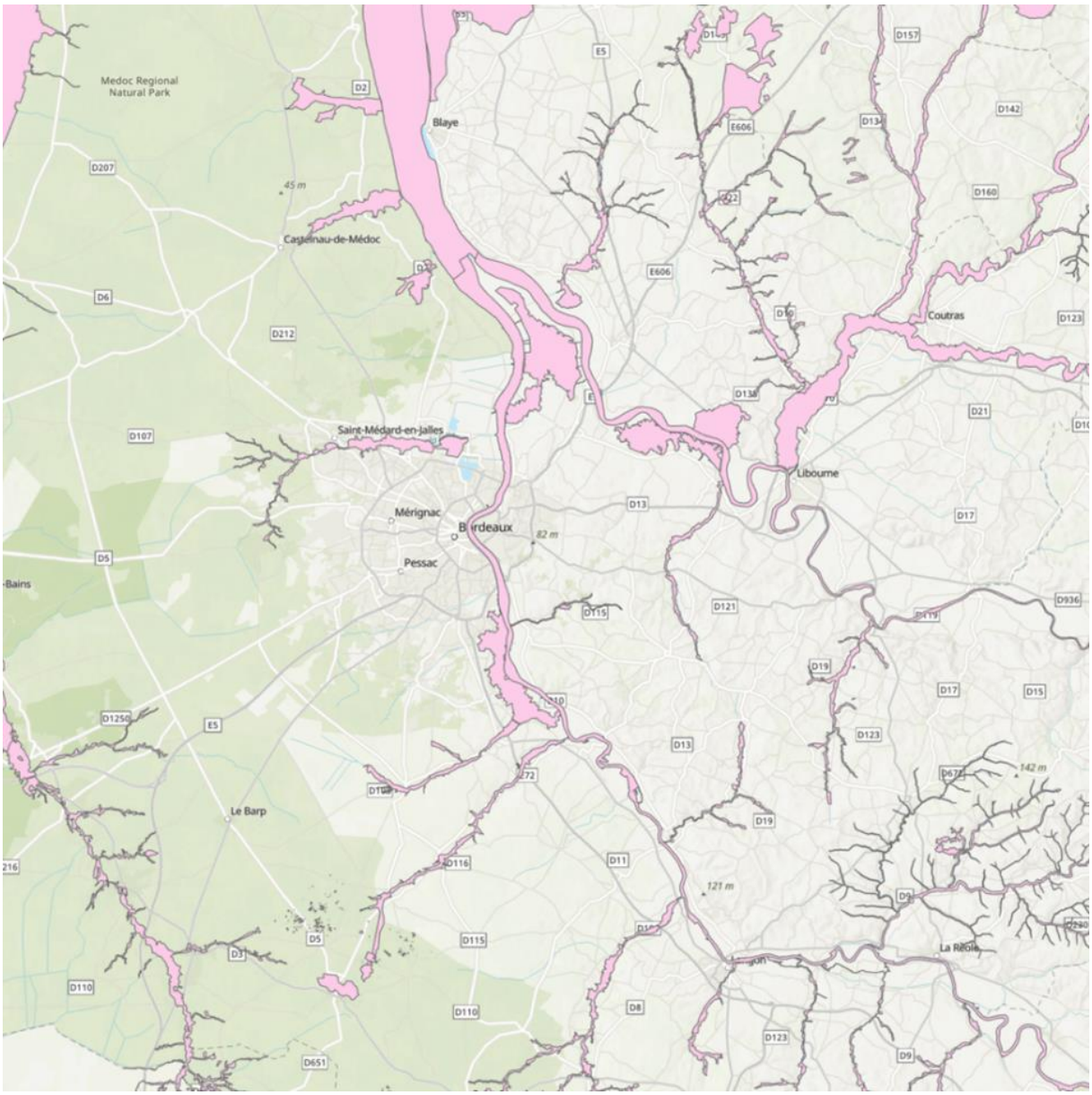

Figure A.13. Natura 2000 sites surrounding Bordeaux.

Appendix B – Maps with transactions

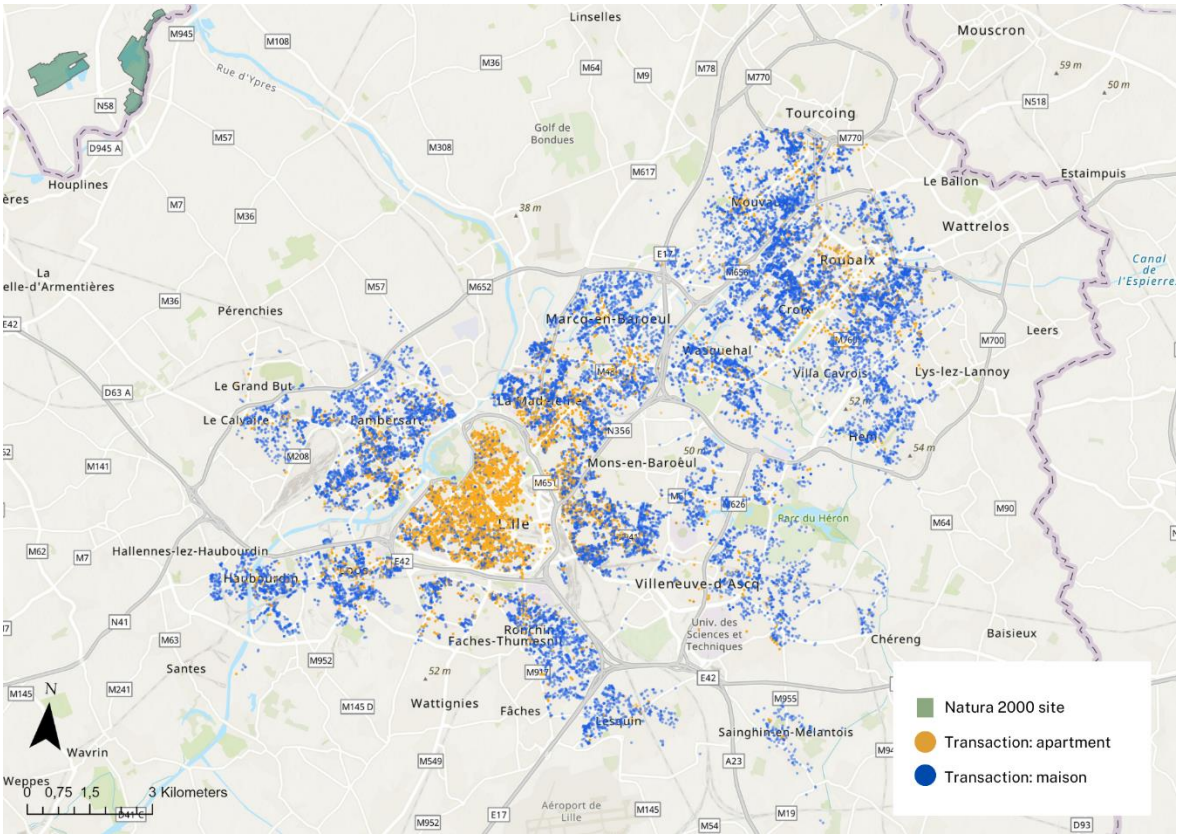

Figure B.1. Transactions in Lille metropolitan area.

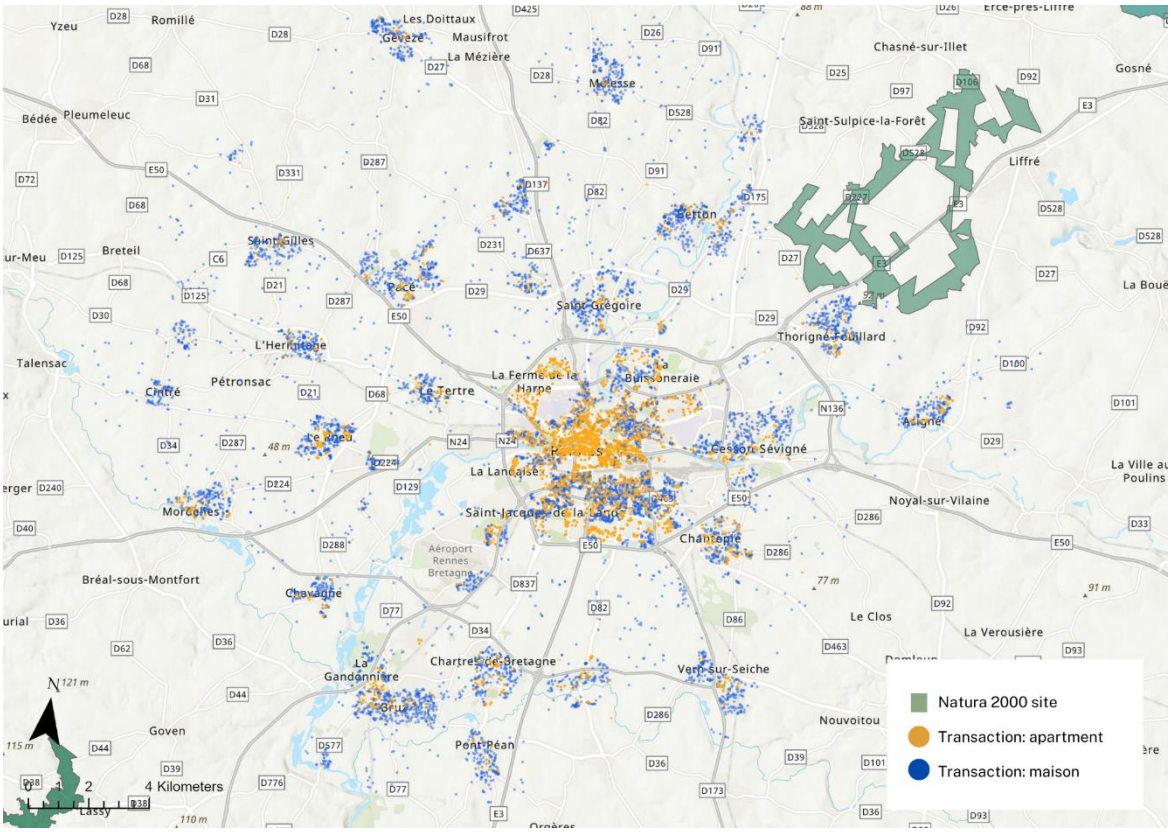

Figure B.2. Transactions in Rennes metropolitan area.

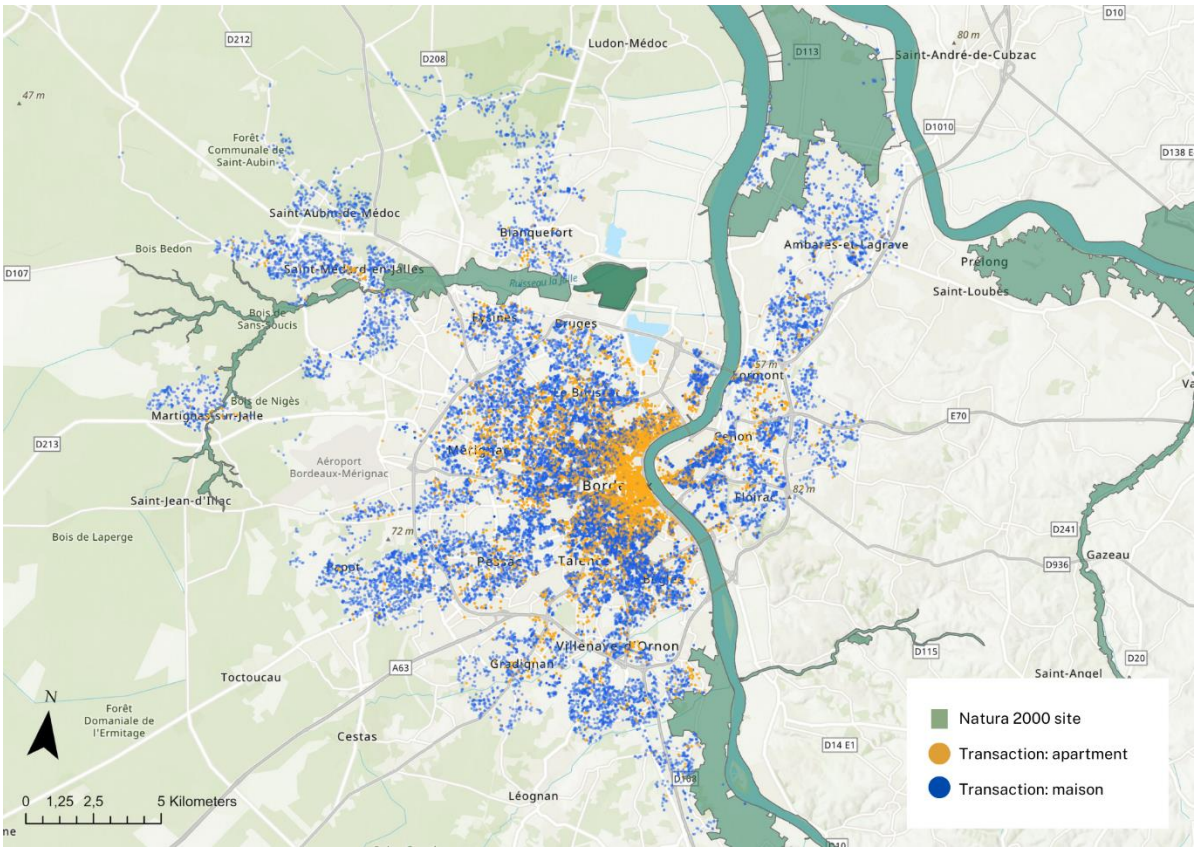

Figure B.3. Transactions in Bordeaux metropolitan area.

Appendix C – Data cleaning process

First all transactions that are not located in the metropolitan areas of interest (Lille, Rennes and Bordeaux) are removed. Following Morgan (2007), transaction prices below or above a threshold may represent outliers, hence any transactions below a price of 15,000 euros have been excluded, since these are not realistic. In this study we are only interested in residential properties, so all observations that are not residential under the variable 'type_local' are dropped. Also, the properties that are a 'dependance' are dropped, because this type of property is not even 1% of all observations, and then it makes more sense to only compare only between 'apartment' and 'maison'. With regards to the handling of missing data, the observations that have no information on the variables 'houseprice' 'distinkm', 'type', 'surface', 'numberofrooms', 'sitesize' and 'sitetype' are dropped. The choice to drop these variables if they have no relevant information was made because these variables are important to know later on in the research when comparisons between different types of properties and Natura 2000 sites are made. There are also quite a lot of double observations, not all observations for 'id_mutation' are unique. All duplicates will be dropped. This leaves us with a dataset with 142,487 unique observations. The GIS layer with Natura 2000 sites from European Environment Agency (2023) originally covers whole Europe. For the GIS map used for this study the vast majority of this layer was omitted, and only the data for the country of France was visualized on the map.

Appendix D – Descriptive statistics

Table D.1. – Observations per site type.

Site type	Frequency	Percent	Cumulative
A	6,129	4.28	4.28
B	94,041	65.74	70.02
C	42,880	29.98	100
Total	143,050	100	

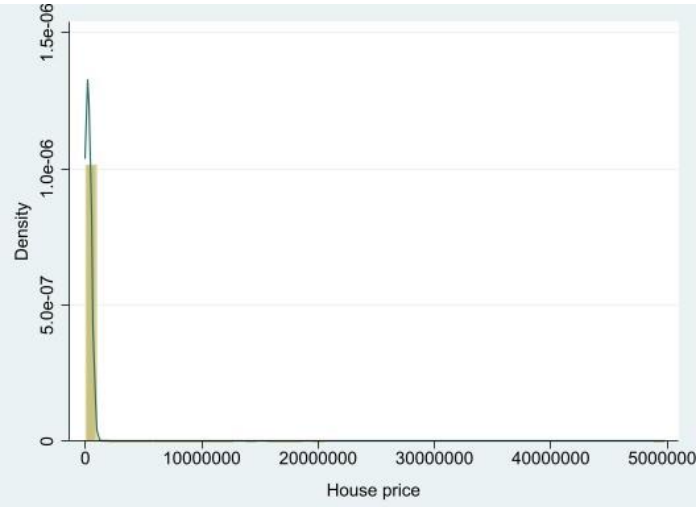

Figure D.2. Histogram house price.

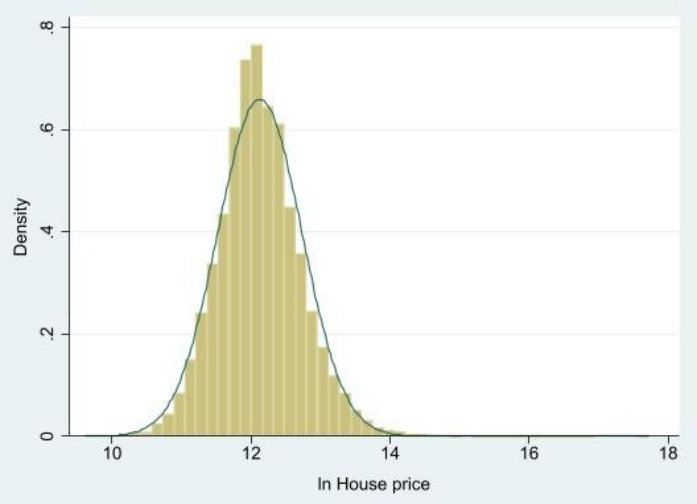

Figure D.3. Histogram ln House price.

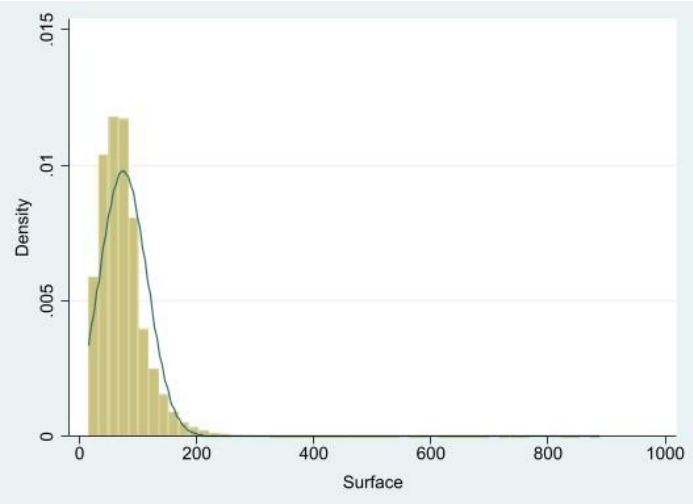

Figure D.4. Histogram surface.

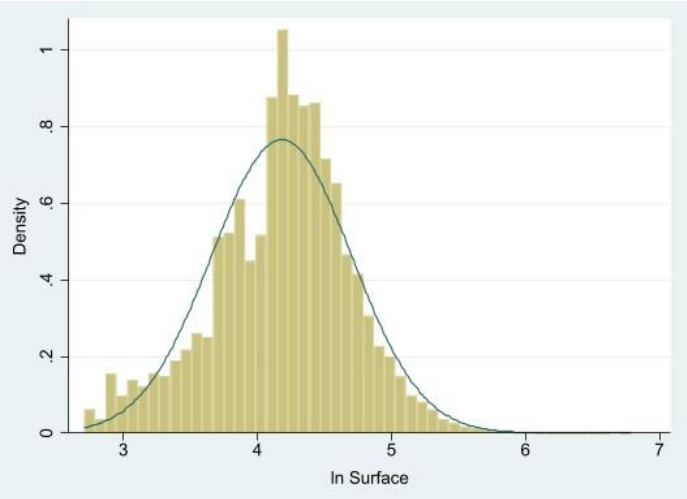

Figure D.5. Histogram ln Surface.

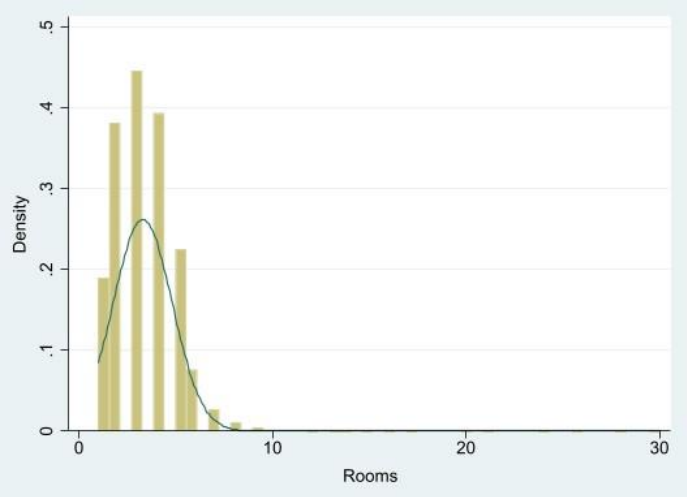

Figure D.6. Histogram number of rooms.

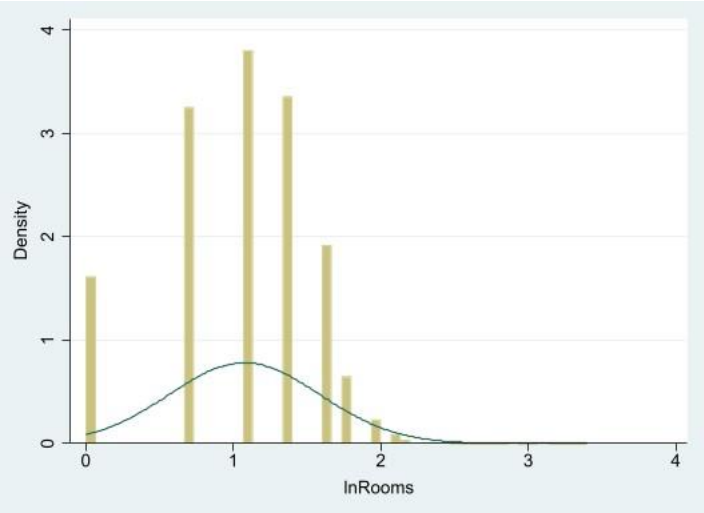

Figure D.7. Histogram ln Number of rooms.