POLITECNICO DI TORINO

Master's Degree in "Ingegneria Edile"

Master's Degree Thesis

Evaluation of risks with a special focus on climate change related risks in real estate development

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Abstract

Climate change is growing up and up resulting in increasingly unpredictable natural disasters. Because of this, the real estate sector is changing to safeguard people's safety as well as existing buildings and assets. This change is leading developers to take care of natural and man-made disaster risks in their feasibility evaluations and investments. In general, depending on the country risk assessment and management are considered more or less important as an investment approach for developers. Having an overall idea of all the risks impacting real estate is the best starting point as an approach towards "new" risks. Studying how the real estate market is composed is a critical point to talk about his risk correlation. From research conducted by "DiPasquale & Wheaton, 1994" and "S. Rossi, 2016" as starting point, a schematisation explains how this market is divided into six sectors: construction sector, private market, public sector, space market, asset market and financial market. Consequently, all the risks were connected to the real estate schematisation giving to developers a clear idea about which risks affect which sub-category. Furthermore, to understand which stage of the building's construction the risk may arise, all of these risks are linked to a plan of work created from an analysis of three different plans of work by ACE, RIBA, and UNI 10723:1998, to which the property development process is linked. After the explanation of the risks affecting the feasibility of real estate development projects, this dissertation aims to schematize the process that a real estate developer needs to follow to include the natural and man-made disaster risks in his investments. Being a huge topic, after a broad examination, the focus narrowed to an Italian perspective, analysing the natural and man-made disaster risks affecting the country, as well as the responses of developers to them. As a result, the findings and observations of this study have defined a lack of risk assessment and management from an Italian perspective, particularly in terms of climate change and natural and man-made disaster risks. An in-depth examination of the topics covered in this elaborate could alter the way Italian developers think and work, resulting in higher profitability in real estate development due to better risk estimation and mitigation, giving the developer a better perspective in terms of economics, quality results, the safety of those who will build or use the building, and environmental stewardship.

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Introduction

"As orchestrators of the entire process, developers take the greatest risk in property development but typically reap the greatest rewards"

Vicky Bramley-White

As mentioned by Vicky Bramley-White developers are increasingly exposing themselves to risk as if it was a challenge leading to a reward matched by risk. Nowadays, the biggest challenge that is covering all sectors is climate change and the disasters caused by climate change. This argument cannot be excluded in the real estate sector; so, developers are increasingly sensitive to climate change and the risks caused by it.

The elaboration of this thesis started through an "Erasmus+ - Final Project" conducted from 02/2022 to 07/2022.

The topic of the project was to study the real estate sector schematasing it, because it was considered of paramount importance to understand the 'shape' of the entire sector, and to study the risks impcating the real estate with a special focus to the environmental and man-made risks.

After this time, accordingly by the Italian supervisor it was decided to go deeper to find out an approach to study and take into account as the climate change phenomenon impacts the real estate sector and in particular the steps that a developer has to follow to understand if the investment is profitable or not.

This thesis is structured into three chapters and for each of them, there is a summary at the end of the chapter.

To conduct this research no particular software was used except latex for the written, and diagrams.net for the diagrams.

Turning now to the content of each chapter in the first one the real estate market is set out, its schematisation, and it is studied the European real estate housing market situation and the real estate situation in Italy.

The second chapter discusses risk management from a theoretical point of view, explaining the process of project risk management. Thereby introducing the several risks impacting the real estate sector and how these risks are connected to the real estate schematization made in the first chapter. The same several risks (subdivided into buying and selling and renting properties) are linked to the outline of the property development process, made through the plan of work.

Finally, in the last chapter there is a focus on environmental and man-made risks in real estate with a schematisation of a real estate development process in a standard way, and then applying this approach to each specific risk. For the sea level rise risk a more practical approach is conducted.

Chapter 1

Real Estate

1.1 Real Estate Sector

Every good, service, and resource purchased or sold in the economy has a market. But what is a market? In general, it is a "place" where buyers and sellers engage in the purchase, sale, or rental of goods, services, and resources. The real estate market is a really broad topic: one of the definitions says that it is the place where supply[1] and demand[2] for property, as well as property rights, collide; and when this happens the equilibrium price[3] is generated (figure 1.1).

To get an overall picture, the real estate market has been schematized with a point of departure from some research carried out by "**DiPasquale & Wheaton, 1994**"[2] and "**S. Rossi, 2016**"[3] arriving, after different considerations, to the final diagram, shown in the figure 1.3.

[1]Supply means the number of assets that the manufacturer is willing to produce, and sell, at a specific price. This is determined by the asset's price and the manufacturer's production cost[1]

[2]Demand means the quantity of an asset that a person is willing to appropriate. This is determined by the asset's price in question, the person's income, and the price of other assets, whether competitive or complementary to the asset in question[1]

[3]The equilibrium price is the amount of money that buyers are willing to give up to obtain the asset and sellers are willing to accept in exchange for a unit of a given asset[1]

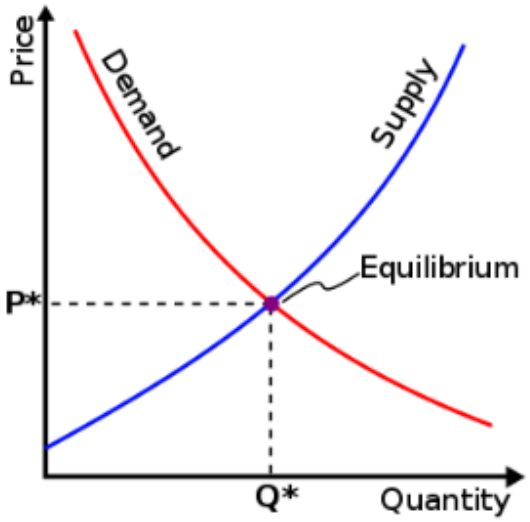


Figure 1.1: Demand, Supply and Equilibrium point.

Source: Wikipedia, SilverStar, 2006.

1.1.1 Starting Point

Accordingly to the authors cited above the real estate market is divided into three categories: **asset market**, **space market** and **construction sector**.

1. Space market. The needs of tenants, households, and firms and the type and quality of building available determine the demand and the rent for real estate space in the property market. So, the aim is to conclude rental contracts consistent with the need for housing or long-term planning of one's business. The demand for space depends on exogenous factors such as firm production levels, income levels and the cost of occupying that space relative to the cost of consuming other commodities. The cost of occupying space, rent, is the annual outlay necessary to obtain the use of the real estate. Rent is not determined in the asset market but in the space market; the goal is to determine a rent level at which the demand for space equals the supply of space.

2. Asset market. It covers the buying, selling, or exchanging between investors of buildings. Demand and supply, affected by the capital market, are determined by owners and/or investors respectively looking for properties where living in and/or to buy/sell. Being a durable capital good, the production and price of real estate are determined in the asset market. The price depends on the quantity of demand and availability; the supply comes from the construction sector and depends on the construction price.

Furthermore, the asset market should, in the long term, equate market prices with replacement costs that include the cost of land. However, due to the lags and delays inherent in the construction process, the two may differ dramatically in a short period. For example, if demand for space ownership suddenly increases, prices will rise as well due to a fixed supply of assets.

3. Construction sector. The developer's goal in this sector is to buy building land and turn it into something that will raise market supply by providing spaces to rent or sell making a profit. So, the construction sector influences the supply of new real estate space and assets which depends on the price of assets relative to the cost of construction.

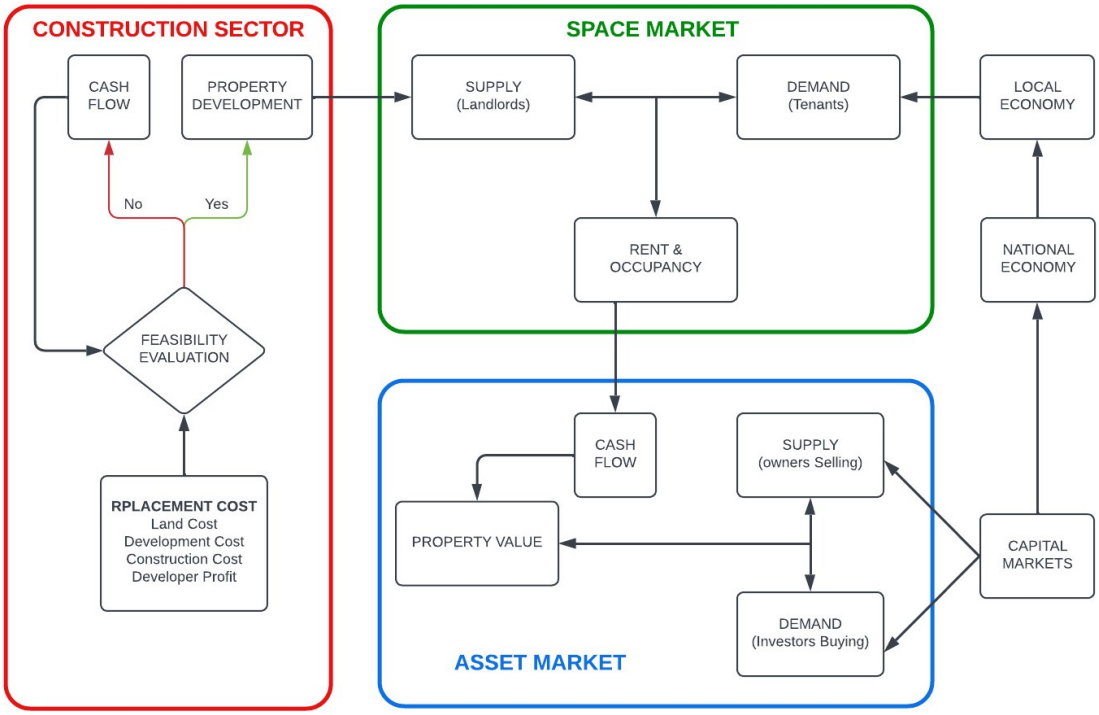


Figure 1.2: Space market, asset market and construction sector

Source: own elaboration, 2023. Based on 'DiPasquale & Wheaton, 1994'[2] and 'S. Rossi, 2016'[3]

1.1.2 Final schematisation

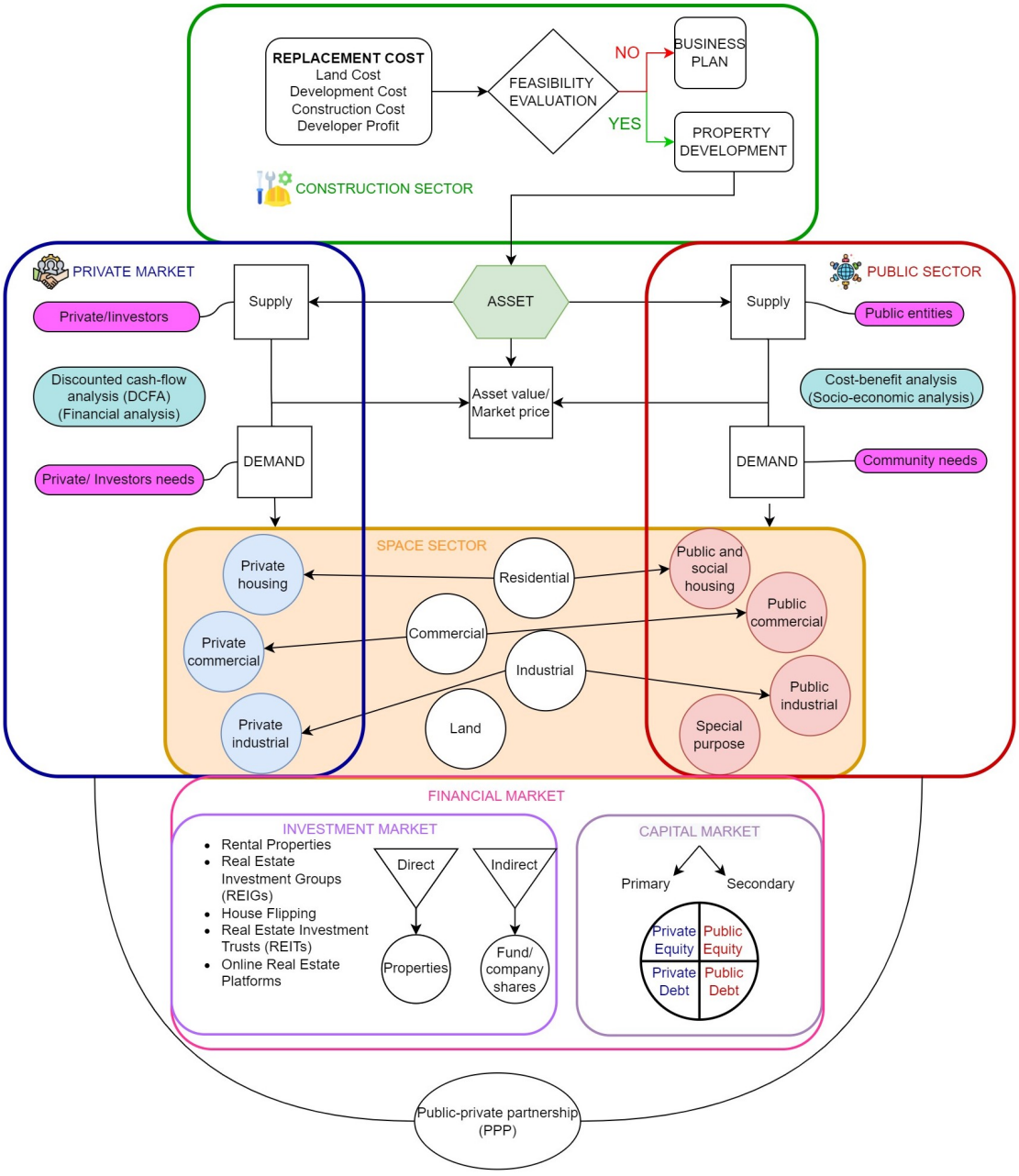


Figure 1.3: Markets schematisation

Source: own elaboration, 2023.

As stated in the "starting point", the asset and space markets are two different groups, but it is not clear which link belongs to the first one with the renting market and which link belongs to the second one with the buying and selling market. Renting and purchasing markets do not need a separation, i.e. space, or asset, can be rented, bought or sold. The question arises: "what do the space and the asset represent?". The space market is represented by residential, commercial, industrial, land and special purpose properties (look the section 1.2) and to have space to buy, sell or rent is one of the goals to satisfy the needs of individuals, people, families, community, owners, landlords, tenants, investors. So this allows defining the presence of a private and public market.

The asset market reflects the goal of the investors operating in the private market, but also in the public market through the private-public partnership. The following schematisation is composed of six groups: **construction sector**, **private market**, **public sector**, **space market**, **asset market** and **financial market**.

Construction sector

The construction sector is the gear in all process which produce assets that raises the supply of the private market and public sector. In this sector, developers are the main figures who assess the replacement cost (given by the land cost, development cost, construction cost and developer profit) and through the feasibility evaluation, they will be able to understand if the investment may be profitable to undertake or not. Developers often buy a plot of land, plan the marketing of the property, develop the program to design and build, obtain the necessary public approval and financing, construct the structures, and rent out, manage, and eventually sell them.

As suggested by the Eurostat there are several ways to measure the size of the construction sector: through the gross value added (GVA) and by analysing the number of enterprises (local units), the number of people employed and the growth of employment among the regions.[4]

- Gross value added (GVA): the balancing item in the production account of the national accounts is called gross value added (GVA), which is defined as the value of output (at basic prices) minus the value of intermediate consumption (at purchaser prices). The amount of GVA produced by the construction industry as a share of the total GVA is used to estimate the size of the sector.

  Referring to the figure 1.4 it is possible to figure out how the trend of this share from 2010 to 2021 in Europe was between 5 and 6%. It peaked at 5.8% in 2010, then decreased to 5.1% from 2014 to 2017 before rising once more to reach 5.5% in 2020 and 2021. Among the 14 Member States, in which the share of GVA fell, the biggest decrease was in Greece, Bulgaria, Spain and Slovakia.

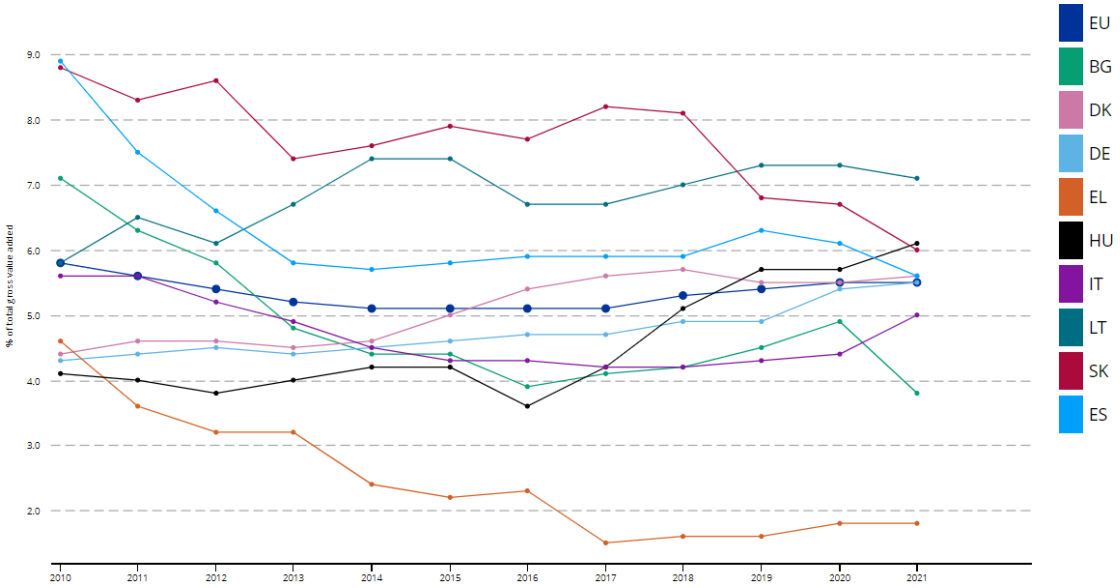


Figure 1.4: GVA of Europe, Bulgaria, Denmark, Germany, Greece, Hungary, Ireland, Italy, Latvia, Spain. 2021

Source: Eurostat, 2022

The highest growth is shown by Denmark, Germany, Hungary, Lithuania and Finland among the Member States with an increasing share of the construction sector. In Italy, there is a trend slightly descending from 5.6% (2010) to 4.4% (2020) growing to 5.0% until 2021.

- Analysis of the number of enterprises (local units): the number of people employed and the growth of employment among the regions; these data are given by "NUTS 2 Regions (Nomenclature of Territorial Units for Statistics".

  Analysing the year 2020, the largest number of enterprises in the construction sector is given by Île de France with 176000 enterprises; Lombardia - Italy with 95000 (2019 data); Provence-Alpes-Côte d'Azur - France with 89000 and Rhône-Alpes - France with 85000.

  Concerning the number of people employed in the construction sector, for the same year, have been employed 605000 people in Île de France; 256000 in Lombardia - Italy (2019 data); 203000 in Cataluña and 205000 in Comunidad de Madrid - Spain.

Finally, the growth rate of employment in the construction sector, in 2020, has an increase of 19.5% in Prov.Luxembourg - Belgium; 15.2% Ipeiros - Greece; 12.1% Budapest - Hungary; 11.1% Mecklenburg-Vorpommern - Germany; 10.4% Utrecht - Netherlands and 10.0% Sud-Vest Oltenia - Romania.

Asset market

The asset market defines the supply that can come from the construction sector, by new constructions or renovation, or can be represented by existing buildings. The supply can either belong to the private market or the public sector. In addiction, the supply especially of new construction, does not vary quickly because the construction industry has a long lead time (just think of the construction time).

Private market

The private market is the place where everyone can take part, i.e. investors, households, firms, landlords, and tenants. As mentioned before, the supply depends on the assets generated by the construction sector. In this field, the assets include all the properties and buildings constructed, or recovered, for the needs of private users. This, the private needs, reflect the demand and so the reason to have space. In other words, the supply might be represented by investors placing properties into the market for sale or rent to households, tenants or firms who represent the demand. Vice-versa, households, tenants or firms can constitute the supply selling or ceasing to rent the property to the investor who will represent the demand by buying and/or just recovering the property to reintroduce it to the market.

In the private market is used the **discounted cash flow** (**DCF**) which is a valuation method used to estimate the value of an investment based on its expected future cash flows. DCF analysis determines the present value of predicted future cash flows using a discount rate. The notion of the present value of money may be used by investors to analyse if the future cash flows of an investment or project are equal to or higher than the initial investment.[5] This is a financial and monetary analysis, which means that it is carried out from the point of view of the party responsible for implementing and managing the project.

Public sector

This is the sector where investors take part in public procurements held by public entities. Public sector management can be seen as a complex of challenges, where the aim is to adopt the best possible solution via planning and checking, using scientific proof, engineering complex solutions, and using the best practices and codes of conduct. An investment in the public market stems from the need for community-facing spaces that may be dictated either by urban regeneration or by the need to create new spaces. Usually, in this market, the aim is to utilise existing buildings/spaces by restoring and/or rebuilding them.

The supply, influenced by the asset created from the construction sector, is fed by public entities to cover the needs of the community and represent the demand.

In the public sector, the investment is evaluated through socio-economic analysis, unlike the private market where is used economic-financial analysis. The methods to conduct the socio-economic analysis are: **cost-benefit analysis** and **multi-criteria analysis**.

The **cost-benefit analysis** is an economic and monetary analysis, which means that the evaluation is carried out from the community point of view and based on the discounted cash flow technique. In this method, the most important phase is the analysis and quantification of costs and benefits, which can both be direct[4], indirect[5] and intangibles[6].

The **multi-criteria analysis** is a tool for the simplification and resolution of complex decision-making processes. This type of analysis is used because:

- the analysis is made explicit, transparent and readable (using the different parameters to formulate the final judgement);
- it satisfies the need to pursue one or more (often conflicting) objectives, under conditions of scarce resources (environmental, economic, etc.);
- it makes explicit order of priority among several alternatives, noting several significant criteria;
- intangible and/or incommensurable effects are also considered (usually neglected in other evaluation techniques). These effects are those that are difficult to translate into monetary values or evaluations;
- the number of subjects involved in a choice process is larger;

[4]Costs and benefits under the responsibility of the party carrying out and operating the work.

[5]Costs and benefits under the responsibility of parties other than the one carrying out and operating the work.

[6]Costs and benefits not assessable, at least directly, in monetary form.

- decision-makers are supported through the application of choice criteria in the expression of preferences;

- they can be applied in different scientific fields.

As result, is obtained the most satisfactory scenario (plan, project, alternative) for achieving the objective. Thus, compared to the cost-benefit analysis, there has been a shift from an optimal assessment to the identification of the most satisfactory solution through different criteria, not necessarily monetary.

Finally, there are several techniques to apply multi-criteria analysis: weighted summation, Electre, analytic hierarchy process (AHP), analytic network process (ANP), and others.[6]

Space market

It is defined by tenants, households, businesses that need to rent, buy or sell a property from the private market. On the other hand, the public sector is defined by the satisfaction of the community needs. So, the space market embraces either the public and private sector but in different typologies and purposes.

The residential properties are divided into private housing and public and social housing. What the latter has more than the former is to cover, as more as possible, the demand of families or people who have insufficient income.

The commercial and industrial properties are divided into private and public depending on who will use that space.

The land properties are for both and, lastly, the special purpose properties are referred only to the public sector.

In addition, the space market deals with physical capital, instead the investment market deals with financial capital (money). In the real estate market, financial capital is used to purchase or rent physical capital assets.

The supply and demand are in common belong investment and space market e.g. a landlord can have the necessity to sell or rent a property, as supply, and in the other hand an investor could answer determining the demand; or vice-versa an investor could sell or rent a property (supply) with the answer of a household (demand). In any case the supply is defined by the existing assets or the new assets introduced to the market by the construction sector.

Financial market

Financial markets encompass any location or mechanism that allows buyers and sellers to trade financial instruments such as bonds, shares, various foreign currencies, and derivatives. This market promotes the interaction of individuals in need of capital and those with capital to invest. In addition, it enables players to transfer risk (usually through derivatives) and stimulate trade, in addition to raising cash.[7] The financial markets include the investment and capital markets explained in the following.

Investment market

Diversification of portfolios through real estate asset allocation is becoming an increasingly common and convenient practice for investors. Not by coincidence, real estate is gaining a reputation cementing its position as the "fourth asset class" after stocks, bonds, and cash. Learning more about this booming asset class, it is critical for investors to grasp the key distinctions between direct and indirect (REIT) real estate investing, which have substantial implications for risk, returns, and diversification.[8]

The term "direct property investment" refers to the purchase, ownership, rental, management, and/or sale of real estate for profit and return. This might entail purchasing a property with the intention of generating money through renting in the short term and profit on sale in the long term, or it can involve purchasing a property for less than market value, making renovations, and selling for a profit shortly after. Regardless matter how the profit is made, direct investment is capital rich and cash flow dependant. In certain situations, it also relies on obtaining bank lending and mortgages, ideally at advantageously low interest rates, to guarantee that the interest spent on the lending does not eat up too much of the profit from the development or rental return.[9]

Conversely, with the indirect property investment the investor does not purchase real estate directly, but shares in a fund or in a company, which in turn hold real estate assets. In this case, the investor plays a passive role and is confined to supplying funds to the project or company/fund, whilst the developer (builder) is responsible for all parts of the real estate project (site acquisition, project analysis, coordination of the team and the construction phase up to resale or rental).[10]

Indirect property investing is frequently perceived to be less risky than direct property investing, and especially less risky than early-stage company investments. However, it is critical to recognise that there is still some risk involved. There is no assurance that the funds will be repaid or that a profit will be realised, as there is with any investment opportunity.

In addition, being a durable capital good, the production and price of real estate are determined in the investment market.

Furthermore, the investment market should, in the long term, equate market prices with replacement costs that include the cost of land. However, due of the lags and delays inherent in the construction process, the two may differ dramatically in a short period of time. For example, if demand for space ownership suddenly increases, prices will rise as well due to a fixed supply of assets.

In conclusion, the investment market falls under the private market and the public market through public procurements and public-private partnership. Direct real estate investment lets collide the investment market (more generically the private market) in the private equity of the capital market. Instead, with indirect real estate investment, the investment market collides in the capital market.

The investment market includes five categories: rental properties, real estate investment groups (REIGs), house flipping, real estate investment trusts (REITs) and real estate crowdfunding.

- Rental properties.

  Individuals with do-it-yourself (DIY) renovation abilities and the patience to supervise renters can benefit greatly from owning rental properties. This technique, however, necessitates significant expenditure to cover initial maintenance expenses and offset unoccupied months.

  There are two different categories of rental properties: *residential* and *commercial rental properties*.

  The first category of properties are defined as dwellings acquired by an investor and occupied by tenants under a lease or another sort of rental agreement. Residential rental properties can provide monthly cash flow, long-term appreciation, leverage using borrowed money, and tax benefits on the income generated by the investment. Owning a residential rental property might provide tax benefits that other, more indirect real estate investments, such as a real estate investment trust (REIT), do not.

  In the other hand, there are some drawbacks to residential rental property. The most important distinction is that residential rental property is not a very liquid investment. Cash flow and appreciation are excellent, but if a property stops supplying one or both due to mismanagement or market conditions, it can be difficult to cut losses and go.The first step to sell a failing rental property is to locate a buyer who sees value in the investment that the investor no longer perceive or just does not exist. There are also significant difficulties that come with being a landlord, though hiring a property management company may assist, and that expense eats into the investment's profit margin. Finally, there is the risk posed by tax law changes. The tax status of residential rental property might alter, removing part of the investment's allure.

Regarding to the commercial real properties often refers to buildings that house businesses, although it can also refer to land utilised for profit and huge residential rental properties. The designation of a property as a commercial property has implications for how it is financed, how it is taxed, and how the laws are applied to it. The performance of these properties, including sales prices, new building rates, and occupancy rates, is frequently used as a proxy for economic activity in a specific region or economy. Even if, in commercial properties the initial investment expenditures for the building, as well as the costs connected with tenant customisation, are higher than in residential real estate, overall profits can be higher and several frequent difficulties associated with residential tenants are absent when dealing with a firm and clear agreements. From this explanation can be deduced that commercial property is a sound investment.

Commercial property investors can also use the triple net lease, in which the firm leasing the premises bears expenses such as real estate taxes, building insurance, and maintenance. Residential real estate investors do not have access to this benefit.[11]

- Real Estate Investment Groups (REIGs)

  A real estate investment group (REIG) is any organisation with several partners whose primary emphasis and business is real estate. REIGs may decide to acquire, refurbish, sell, and/or finance real estate properties solely for the sake of profit. REIGs frequently purchase properties, which they then resell in part or in whole to investors while retaining responsibility for their administration and maintenance.[12]

- House flipping

  House flipping is only for those who have extensive knowledge in real estate valuation, marketing, and renovation, because this type of investment necessitates cash as well as the capacity to do or supervise repairs as needed. Unlike the rental property investors, the real estate flippers frequently aim to financially sell the undervalued properties they acquire in under six months. Flippers who are unable to quickly offload a property may be in difficulty since they often do not retain enough uncommitted cash on hand to pay the mortgage on a property over long term and this might lead to further, escalating losses. Another type of flipper earns money by purchasing moderate properties and increasing value by renovating them. This is a longer-term investment, as investors can only afford one or two properties at a time.

- Real Estate Investment Trusts (REITs)

  According to Stan Ross, former managing partner of Ernst & Young's Real Estate Group, REITs are defined as: "real operating companies that lease, renovate, manage, tear down, rebuild, and develop from scratch." REITs are referred only about some kind of commercial real property, such as: office buildings, shopping malls, hotels, and apartment buildings. Furthermore, REITs provide the consistent and predictable cash flow generated by owning and leasing real estate, but with the liquidity of a common stock. Moreover, REITs typically have ready access to capital and can thus buy and construct additional buildings as part of their ongoing real estate business. Alongside this, REITs can increase the stability of investment portfolios. REITs offer substantial dividend yields that have historically outperformed the yields of most publicly listed stocks, making them an attractive investment for an individual retirement account (IRA) or other tax-deferred portfolio.

  There are two categories of REITS: *equity* and *mortgage* REITs.

  An equity REIT is a publicly listed company that acquires, manages, renovates, maintains, and occasionally sells real estate properties as its primary business. Many of them can also build additional properties when the economic conditions are good. It is tax advantaged in that, not taxed on its income and is required by law to pay out at least 90% of its net income as dividends to its shareholders.

  A mortgage REIT originates and manages loans and other financial products backed by real estate assets. This category has larger dividend yields and can produce exceptional investment returns, but equity REITs have traditionally provided stronger long-term total returns, more consistent market price performance, reduced risk, and more liquidity. Furthermore, equity REITs allow the investor to select the type of property as well as the geographic location of the assets.[13]

- Real estate crowdfunding

  This is a platform for those who want to invest with others in larger commercial or residential ventures. The investment is made through online real estate platforms. So, crowdfunding is a technique of obtaining funds for businesses as well as an easier approach for investors to access to such initiatives. Crowdfunding works on the premise that many individuals are prepared to invest a modest amount obtaining, likely, enormous quantities of money quickly; so the investors have the ability to become shareholders in a company or in a real estate property. From the companies side, crowdfunding gives the possibility to access to capital that they might would not be able to raise.

Crowdfunding, besides giving the opportunity to get in without a large amount of money to the investor, could reach an enormous potential for investment gains if the company eventually goes public, meaning they issue new stock via an initial public offering (IPO). One of the most significant risks of crowdfunding is that investors are putting money into a relatively unknown firm. In other words, the firm has little financial history. As a result, there is a chance that investors will lose their whole investment.[14]

Capital market

In real estate, capital market is a financial market which is used to provide long-term debts[7] and/or investment opportunities. In other words, they are markets for buying and selling debt and equity instruments. The capital market includes primary market and secondary market.

New stock and bond issues are sold to investors in the primary market. Governments for bonds, (municipal, local, or national) and business enterprises for bonds and equity, are the key entities looking to raise long-term funding on this market.

Existing securities are sold and acquired in the secondary market by investors or traders, usually on an exchange, over-the-counter, or elsewhere.[15]

The real estate capital market normally exposes investors to lower levels of risk than investments in unsecured capital markets. Capital market investing helps small investors with limited capital to participate in real estate investment and generates liquidity for investors. Meanwhile, the capital market assists real estate developers in raising funds for their projects.

A traditional approach to real estate capital markets assumes a basic debt and equity design with four quadrants of capital: private debt, private equity, public debt and public equity.

- Private equity real estate investing entails the acquisition, financing, and direct ownership and holding of title to a single property or portfolio of properties, as well as the indirect ownership and holding of a securitized or other divided or undivided interest in a single property or portfolio of properties via some type of pooled fund investment vehicle or arrangement. Individually managed (or independent) accounts, commingled funds, real estate holding companies, real estate holding corporations, actively managed real estate operating companies, and other similar structures are common.

[7]Debts that take more than one year to pay off are considered long-term.

Private accredited and non-accredited individual and institutional investors, as well as privately held and publicly traded real estate development, investment, and operating companies, are among those that participate in private equity real estate.[16]

- Regarding public equity come into play REITs already argued in the investment market.

Real estate debt should be considered by institutional investors as a means of diversifying their portfolios by investing in real assets that have the potential to deliver long-term cash flow predictability, good credit quality, and a yield premium above typical fixed-income alternatives.

- Private real estate debt has a broader credit and sector range than public real estate debt and may be a more pure-play choice. Long-term investors can access evergreen possibilities that are diverse by market, sector, size, and seniority. Private real estate debt can also give a yield premium over commercial mortgage-backed securities (CMBS)[8], especially during origination, which may compensate for the higher illiquidity.

- In comparison to private debt, public real estate debt is traded in the market, giving liquidity and transparency. These real estate bonds may provide investors with exposure to big and diversified portfolios. CMBS are a type of securitized public investment vehicle. Traditional CMBS provide credit investors with the chance to diversify across a pool of real estate assets, potentially mitigating both geographical and property sub-sector risk.[17]

Public-private partnership (PPP)

It provides a long-term, sustainable strategy for upgrading social infrastructure, raising the value of public assets, and better utilising taxpayer funds.[19]

Specifically, PPPs are collaborations between the public and private sectors in the design, planning, construction, financing, management, operation, and exploitation of public services that were previously only provided under the control of the state. Thus, public-private partnerships offer the state an option for conventional self-realization.

[8]Commercial mortgage-backed securities (CMBS) are fixed-income investment instruments secured by commercial mortgages rather than residential mortgages. Real estate investors and commercial lenders alike can benefit from CMBS liquidity.[18]

So, the PPP is the connection between the public and private market: it comes from the public authorities (supply) to satisfy the community needs (demand) through collaboration with the private investors.[20]

The public entity shares or transfers ownership, financing responsibility, or operation of a public facility or asset with a private enterprise. The private corporation commits to a combination of constructing, financing, or operating responsibilities in connection to the public facility or asset, therefore removing or lowering the public sector's role. In exchange, the private partner receives fees or other earnings that would otherwise be directed to the public treasury. In principle, the private sector benefits from a return on capital improvement and/or asset operation, while the public sector benefits from the avoidance of upfront capital and/or operational expenses, as well as efficiencies in construction and service delivery. The PPP accord is governed through a formal partnership agreement that specifies how the costs, risks, and profits of the transaction are distributed, what each party must guarantee, and what remedies can be applied in the case of nonperformance or default.[21]

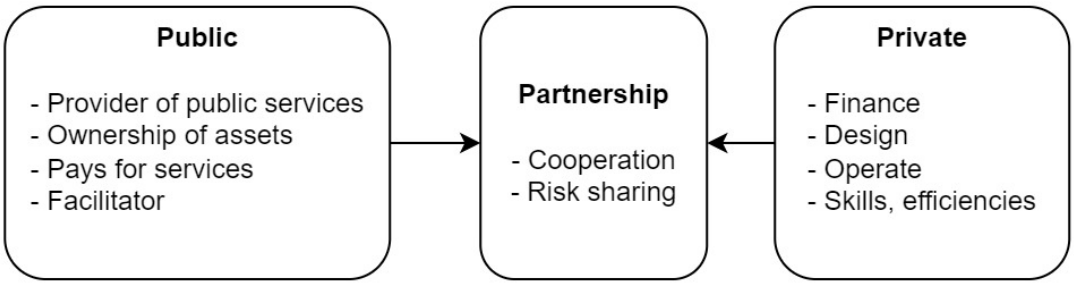


Figure 1.5: Public-Private Partnership

Source: own elaboration, 2023. Based on 'World Bank Group City Resilience Program. «Public Private Partnership. Investment in infrastructure.»[21]'

Why and when choose a PPP over a traditional procurement?

The Public Sector Comparator (PSC) is the technical construct developed to test whether public-private partnerships provide superior Value for Money (VFM) to traditional procurements. Specifically, the public sector comparator is the hypothetical cost adjusted with a risk component in case work is financed and managed by a public administration.

PSC = basic PSC + transferable risk + risk retained.

The basic PSC is the discounted sum of all costs. The value for money highlights the margin of convenience compared to traditional procurement, this is more visible in the figure 1.6. [22]

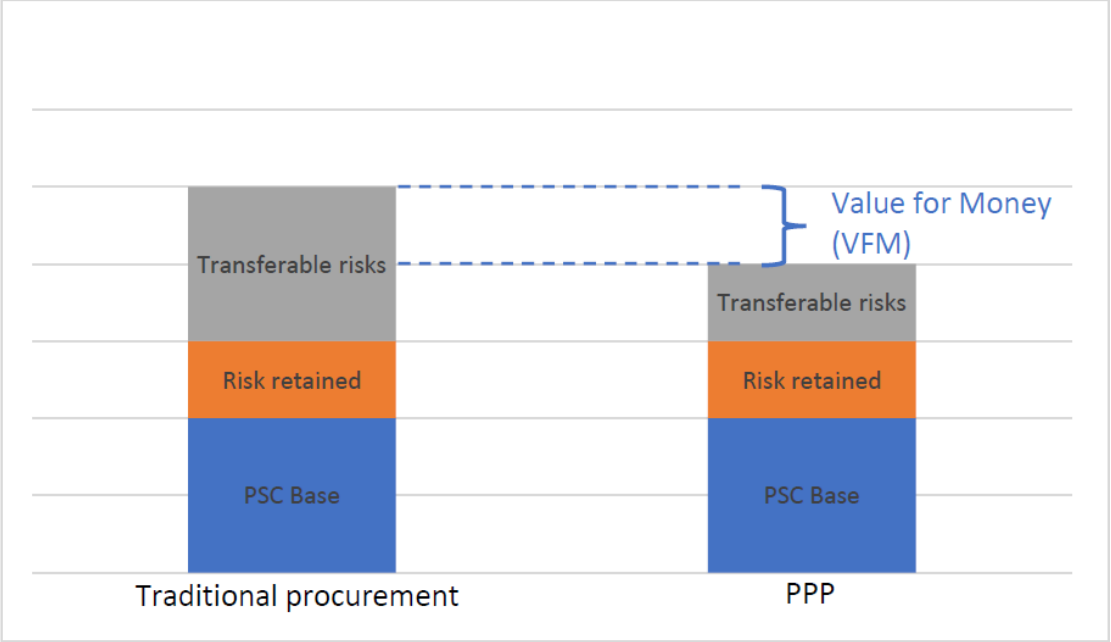


Figure 1.6: Value for Money

Source: own elaboration, 2023.

1.2 Types of properties in the Real Estate

Since property types have been mentioned more than once, they will be listed and defined below, there are five main types of real estate [23]:

1. **Residential real estate** : Any property used for residential purposes from one or more related or unrelated people living together as a social group . Examples include single-family homes, condos, cooperatives, duplexes, townhouses, and multifamily residences with fewer than five individual units.

2. **Commercial real estate**: Any property used exclusively for business purposes, such as apartment complexes, gas stations, grocery stores, offices, parking facilities, hotels, restaurants, shopping centers, stores, banks, cinemas and theaters.

3. **Industrial real estate**: Any property used for manufacturing, production, distribution, storage, and research and development. Examples include factories, power plants, warehouses, landfill, mine or quarry, salvage and storage yard.

4. **Land**: the solid surface on the Earth as distinguished from water. The term "raw land" refers to soil in its natural state, devoid of all man-made constructions. Off-site infrastructure improves a site in some or all ways. One or more man-made buildings or associated structures may be present on a site and contribute nominally to market value. In this category are includes undeveloped property, vacant land, caves and agricultural land (farms, orchards, ranches, and timberland).

5. **Special purpose**: Property used by the public, such as hospital, cemeteries, places of worship, government buildings, libraries, parks and schools.

1.3 Cycles of Real Estate

The market equilibrium point is determined by the collision of demand and supply, as discussed in previously. However, the real estate market, like any other market, undergoes fluctuations in demand and supply. These fluctuations are such that when prices and trading volumes are plotted on a graph the shape of a hexagon called "honeycomb cycle" is obtained, defined by ANCE (Associazione Nazionale costruttori edili).[9] [3] The relationship between average prices and the number of transitions highlights supply and demand behaviour. First of all, it is important to define the primary and secondary transaction.[24]

The first one represent the demand or supply from whom is not also, respectively, a supplier or demander.[10]. Instead, the secondary transaction is represented by the supplier who is also a demander and vice-versa.[11] The difference between them is that in the primary transactions demand and supply are independent of each other, but in the secondary a change of demand cause a change of supply. These variations can occur in the volume of transactions without affecting prices. So the volume of transactions will be more volatile than prices.

[9] other paths are possible giving graphs with different shapes

[10] such suppliers are developers of new property and people who are moving out of the market. Instead, such demander are developers or first-time occupiers

[11] They are owners moving homes or selling one to buy another

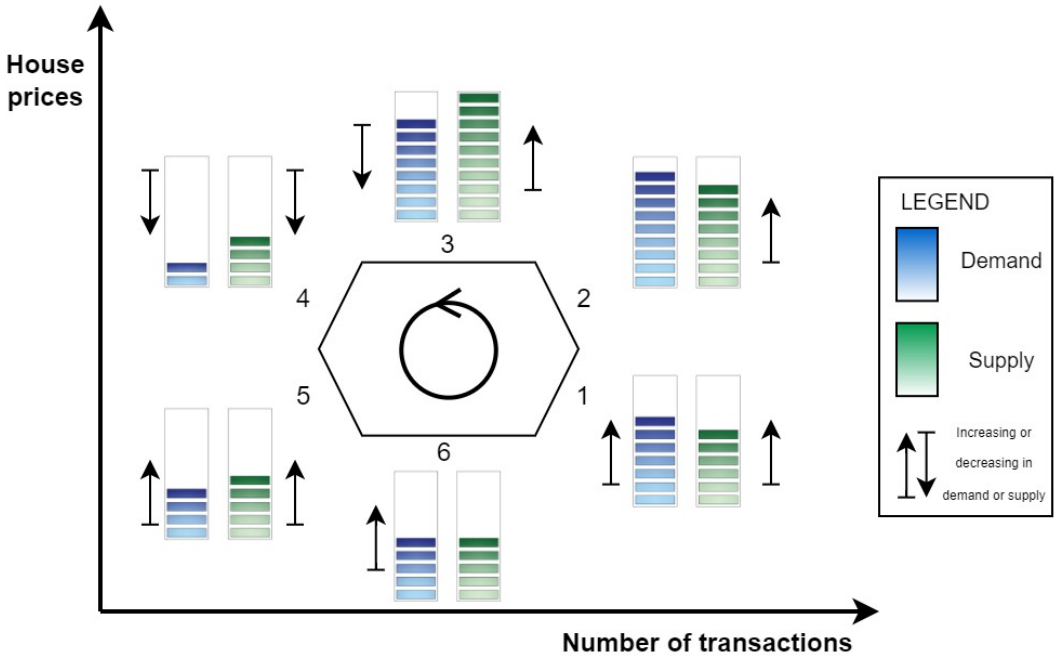


Figure 1.7: Honeycomb Cycle

Source: own elaboration, 2023. Based on 'Paolo Piselli, Elisabetta Marzano and Roberta Rubinacci, 2022'[25].

Looking at the figure 1.7, where each segment of the honeycomb represents a phase of the cycle, the following can be deduced [25]:

- Phase 1: transactions and prices rise as a result of an excess of demand being met by an increase in supply, resulting in a rise in prices. The prices rise and the high profits attract new investors and encourage old ones to invest, and new construction is being undertaken to try to capture unmet demand. Clearly, this is a good time to invest by an expansion of business and credit cycles, triggering positive expectations for housing market performance.
- Phase 2: Prices continue to rise but transactions slow down because total demand has risen more than total supply. However, the business and credit cycles are typically still expanding.
- Phase 3: Transactions continue to slow down and prices are constant because the supply exceeds the demand which stops increasing or starts to fall. This is the market phase riskier since the demand is not able to absorb the excess quantity of properties entered into the market. The consequence is lead a halt in new construction projects.

- Phase 4: Prices and transactions are falling. The demand is decreasing, especially if there is a prevision of prices falling and a further drop is expected. The supply falls by an equal amount. This process is slow and the market is very inactive.

- Phase 5: prices continue to decrease but transactions begin to grow again. Construction started again because the supply expects the economy to start increasing again. This better perspective could let increase even the demand. The prices continue to decrease because the supply is increasing more than demand.

- Phase 6: the prices stop decreasing and being to be constant and the transactions start again to increase. In this phase, there is the expectation that the business cycle and other exogenous macro variables are expanding, contributing to increased demand and the supply can keep up with the demand. The end of this phase leads to a rise in prices and a new cycle.

The real estate market's flaws contribute to the perpetuation of these cyclical situations. The lack of information and the long technical times required for new construction are the determining factors, even though fiscal interventions and changes in interest rates at the start or end of a recessionary period can influence the direction of a cycle or the extent of its peaks. Because of the greater rigidity of supply in the real estate market, demand is the first to react, while supply is unresponsive and in perpetual pursuit, and their equilibrium is never established. The demand level, rather than the production cost level, has the largest effect on the price level in the real estate market. In other words, the end user, or real estate customer, is the one who drives the market by his or her decisions, moves, and financial resources.

1.4 European Real Estate Housing Market

This section talks mostly about investments regarding the study of supply, demand and space. So, the questions are: what is the situation in European Union? What is the trend regarding the owning and renting of properties? How does the European population live in terms of size and quality?

1.4.1 Owning or renting?

Data are given from the 'Eurostat' explicit that the situation in 2021 amounted to having the 70% of the population living in their own home, so the 30% left living in rented housing.[26] In general, to owning in all Member States is most common, unlike Germany where either owning or renting is represented by the half population. Austria and Denmark have respectively 54% and 59% homeownership shares, which is still among the lowest. The countries with the largest percentages of homeowners are Romania with 95%, followed by Hungary with 92% and Croatia with 91%. Italy has 74% of the population owning and 26% of the population renting.

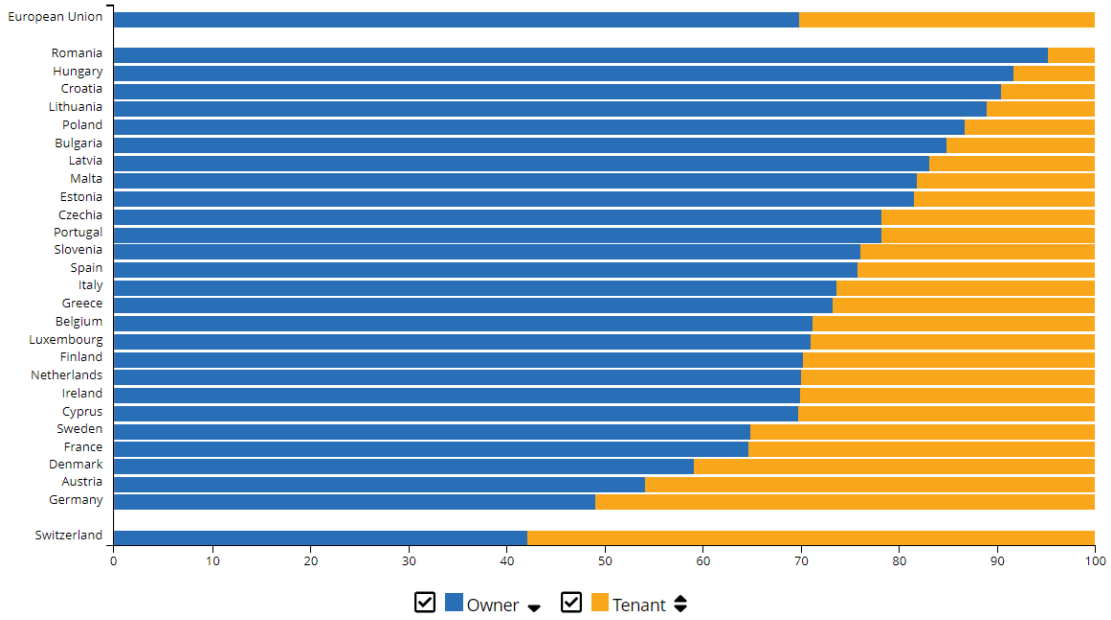


Figure 1.8: Owner and tenant in the European Union, 2021 [%]

Source: Eurostat, 2022

1.4.2 House or flat?

Depending on whether people live in a city or the countryside, living in a home or a flat varies throughout the Member States. Continuing to analyse the situation of 2021, in the EU the population living in a house amount to 53%, the 46% live in a flat and the last 1% is divided among vans, houseboats and other types of accommodations (figure 1.9).[26]

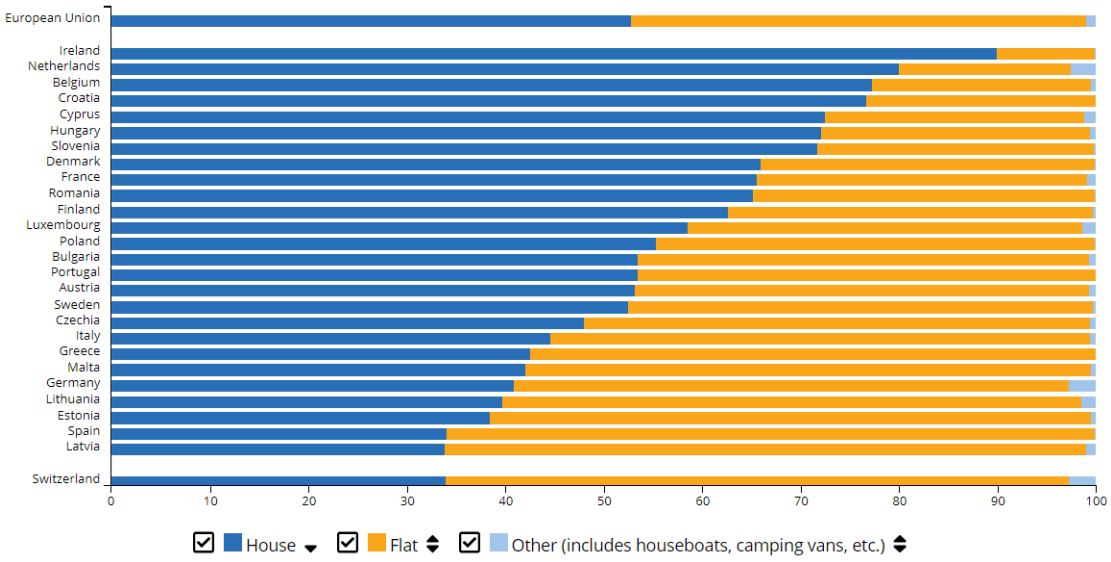


Figure 1.9: Type of housing, 2021 [%]

Source: Eurostat, 2022

Looking at the figure 1.10 is possible to deduce that in the EU the population which lives in a house, in cities, amounts to 28% (71% live in a flat). Ireland is on the top, with 82% of the population living in a house (18% live in a flat). Germany and Italy are at the same level with 22% of people living in their own homes (76% and 78% respectively live in a flat). At the bottom, there is Latvia with 11% of people living in a house (86% live in a flat).

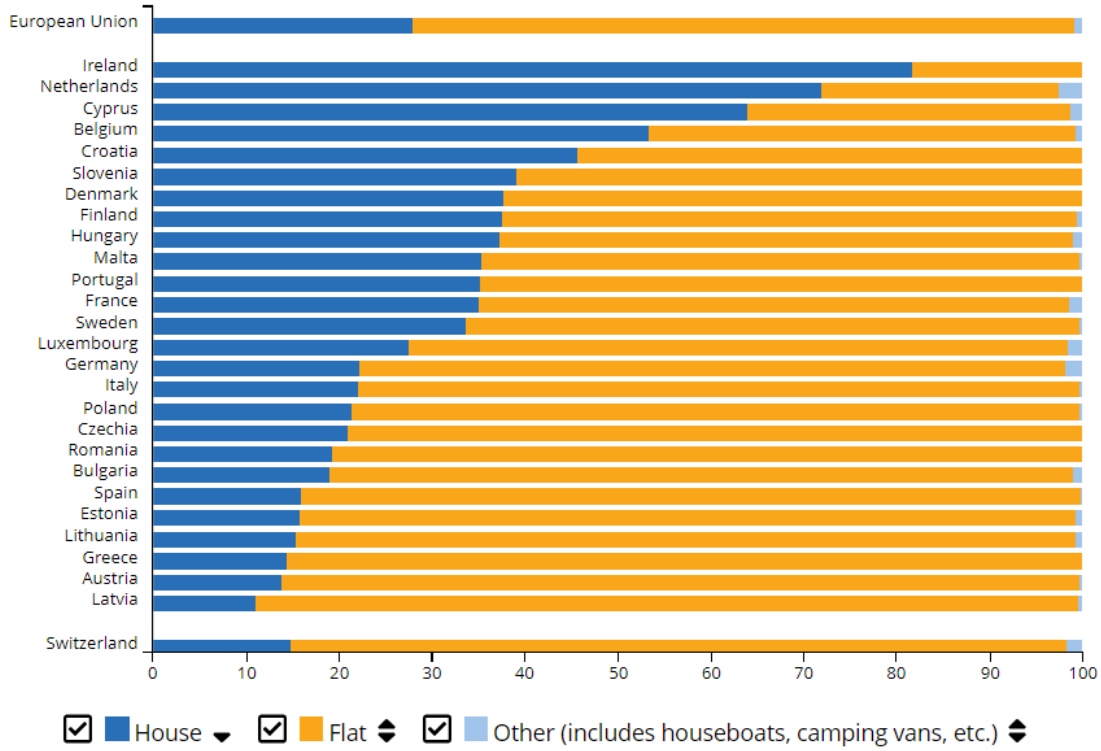


Figure 1.10: Type of housing in cities, 2021 [%]

Source: Eurostat, 2022

Looking at the figure 1.11 is possible to deduce that in the EU the population which lives in a house, in town and suburbs, amounts to 58% (41% live in a flat). Ireland is on the top, with 91% of the population living in a house (9% live in a flat). Italy and Germany are close with respectively the 52% and 48% of people living in a house (48% and 52% respectively live in a flat). At the bottom, there is Greece with 33% of people living in a house (72% live in a flat).

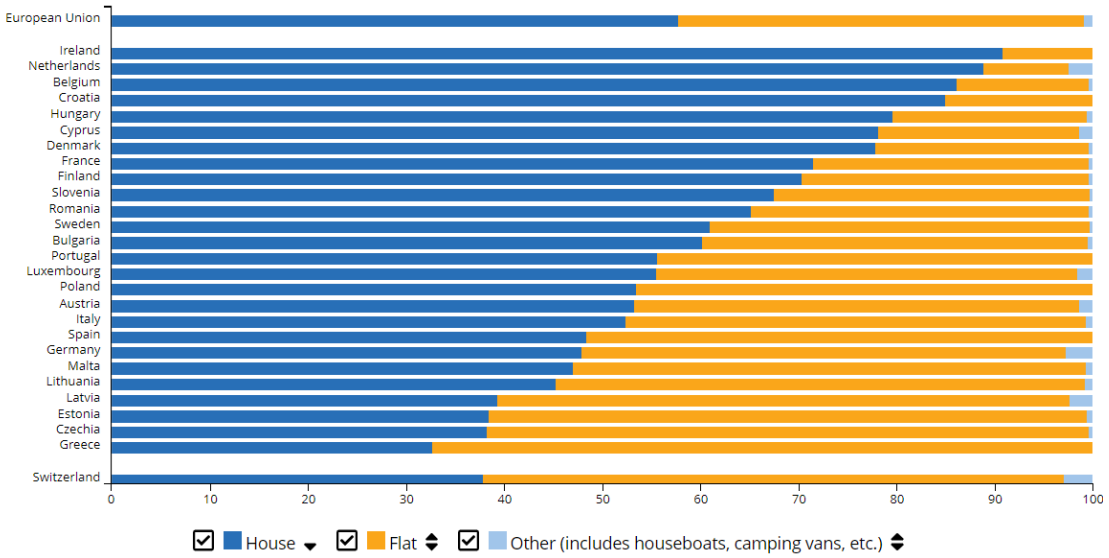


Figure 1.11: Type of housing in town and suburbs, 2021 [%]

Source: Eurostat, 2022

Looking at the figure 1.12 is possible to deduce that in the EU the population which lives in a house, in rural areas, amounts to 83% (15% live in a flat). Hungary is on the top, with 99%, of the population living in a house. Italy and Germany are close with respectively the 70% and 62% of people living in a house (29% and 33% respectively live in a flat). At the bottom, there is Latvia with 59% of people living in a house (41% live in a flat).

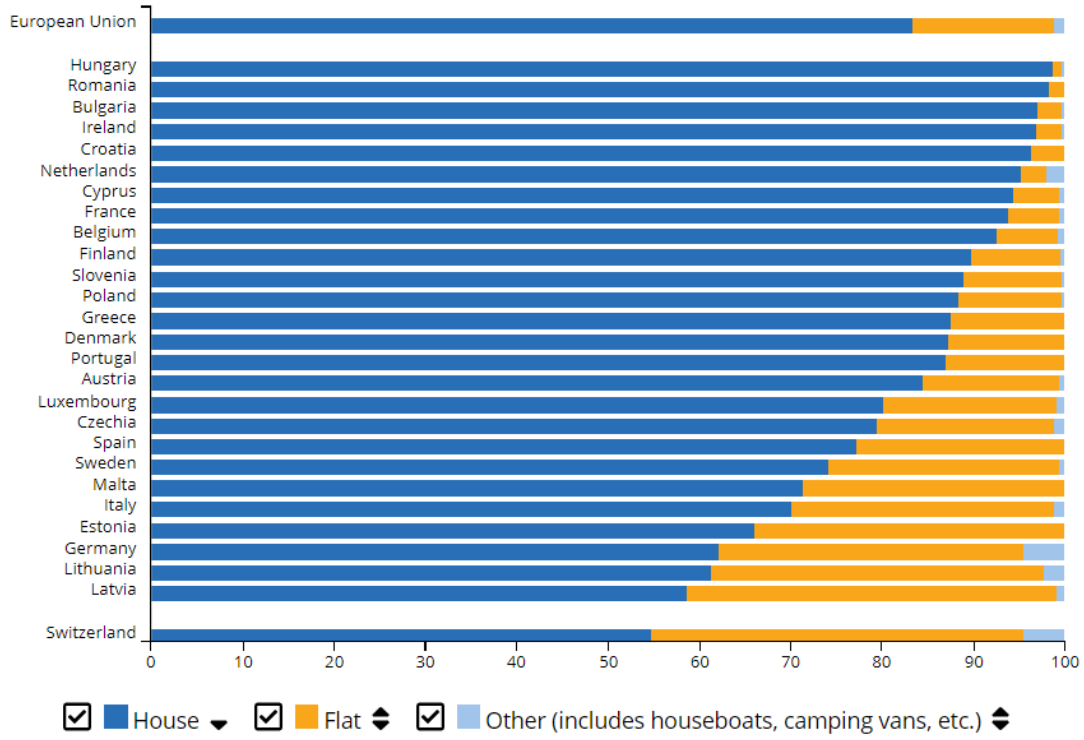


Figure 1.12: Type of housing in rural areas, 2021 [%]

Source: Eurostat, 2022

In conclusion, is possible to notice how the higher amount of the population living in a house is in rural areas, followed by towns and suburbs and, in the end, by cities. One reason to motivate this trend may be the higher price of houses in cities respectively of towns, suburbs and rural areas.

1.4.3 Prices to purchase or rent houses

As said above the market price of properties influences demand in terms of quantity, quality, type and location of property obtainable. For this is important to keep track of the prices trend.

In particular, looking at the trend of the **houses prices** between 2010 and 2021 (with an increase of 37%) it is registered that since 2013, there has been a consistent rising trend, with notably significant rises between 2015 and 2021.[27]

The increase includes 23 Member States of the EU with the peak of +139% registered in Estonia, followed by Hungary with +122%, Luxembourg with +115%, Latvia with +101% and Austria with +100%. Instead Italy, Cyprus, and Spain registered decreases respectively of -13%, -8% and -2%.

Talking, instead, of **rents**, in EU between 2010 and 2021 is registered an increase of 16%. Even for this one, the largest increase is represented in Estonia with +154%, followed by Lithuania with +110% and Ireland with +68%. Decreases are observed in Greece with -25% and Cyprus with -3%.

Another important element to take into account is the **inflation**, because inflation is defined as the sustained increase in the general average level of prices of goods and services over a given period of time, which leads to a decrease in the purchasing power of money. Between 2010 and 2021, in EU is registered a total increase of 17%. The highest is registered by Hungary with +33%, Romania with +31%, Estonia with +30%, Lithuania with +25% and the lowest by Greece with +2%, Cyprus with +7% and Ireland with +8%.[28]

In conclusion, the expense of housing can be a hardship with rising home prices and rentals. The percentage of the population living in a household where total housing expenses exceed 40% of available income may be determined by looking at the **housing cost overburden rate**. The proportion of people living in such a household in the EU's cities in 2021 was 10.4%, compared to 6.2% in rural areas. With the exception of Bulgaria, Romania, Croatia, and Lithuania, cities across every Member State had a higher housing cost overburden than rural areas.

In Greece, Denmark and Netherlands (with, respectively, 32, 22 and 15%) there was registered the highest housing cost overburden rate in cities, instead in rural areas they were Greece, Bulgaria and Romania (with, respectively, 22, 13 and 11%). In Italian cities and rural areas the percentage amount respectively at 9 and 6%.

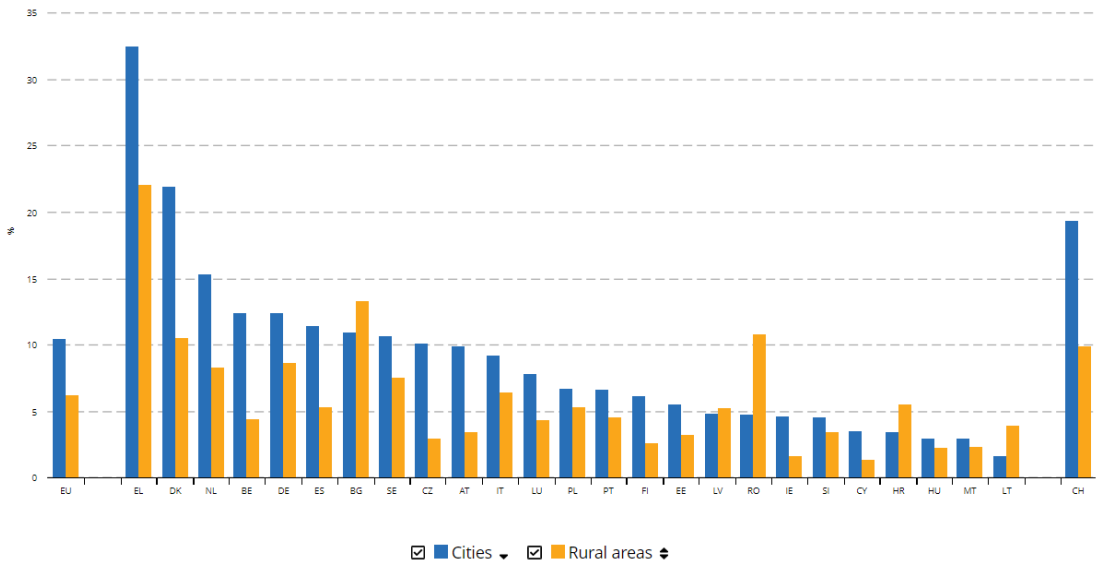


Figure 1.13: Housing cost overburden: cities or rural area, 2021 [%]

Source: Eurostat, 2022

1.4.4 Space sector insight

Analysing the space sector it is important to talk about the **size of housing** and **housing quality**.

- Size of housing: the average *number of rooms per person* in the EU in 2020 was 1.6, which may be used to estimate the size of housing. Malta has the most rooms per person among the Member States (2.3), followed by Belgium, Ireland and Netherlands (all 2.1 rooms). The nations of Romania and Poland (both 1.1 rooms), Croatia, Latvia and Slovakia were at the other end of the spectrum (all with 1.2 rooms on average per person). Italy has 1.4 rooms per person.[29]

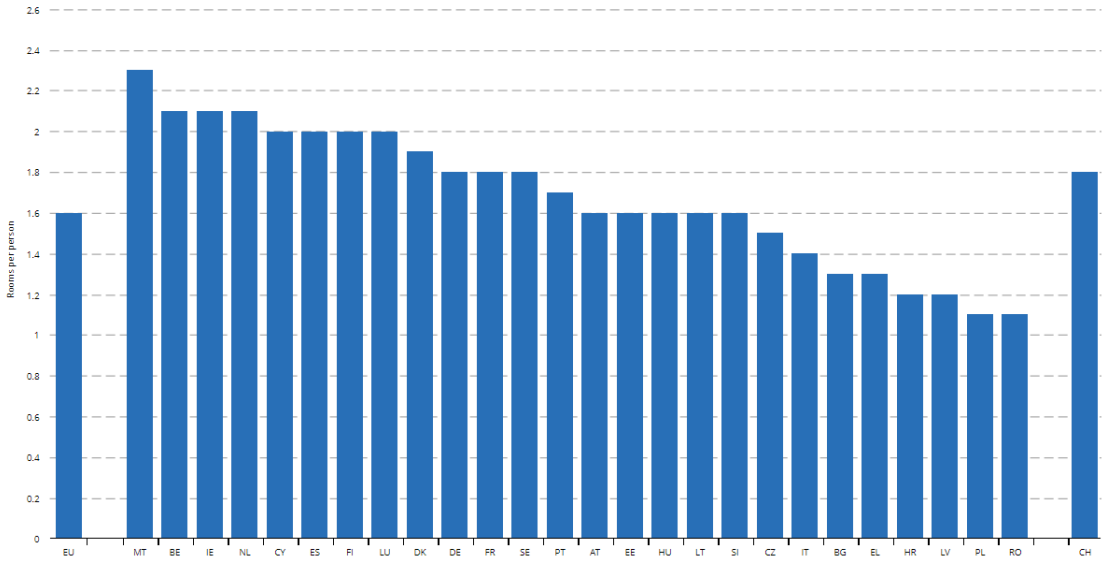


Figure 1.14: Average number of rooms per person, 2021

Source: Eurostat, 2022

The *number of people living per household* is a related indicator. In the EU in 2021, there were 2.3 people on average living in each household. There were 2 people in Germany, Denmark and Sweden and 1.9 people in Finland; 2.9 people in Slovakia; 2.8 people in Poland; 2.7 people in Croatia; and 2.3 people in Italy.

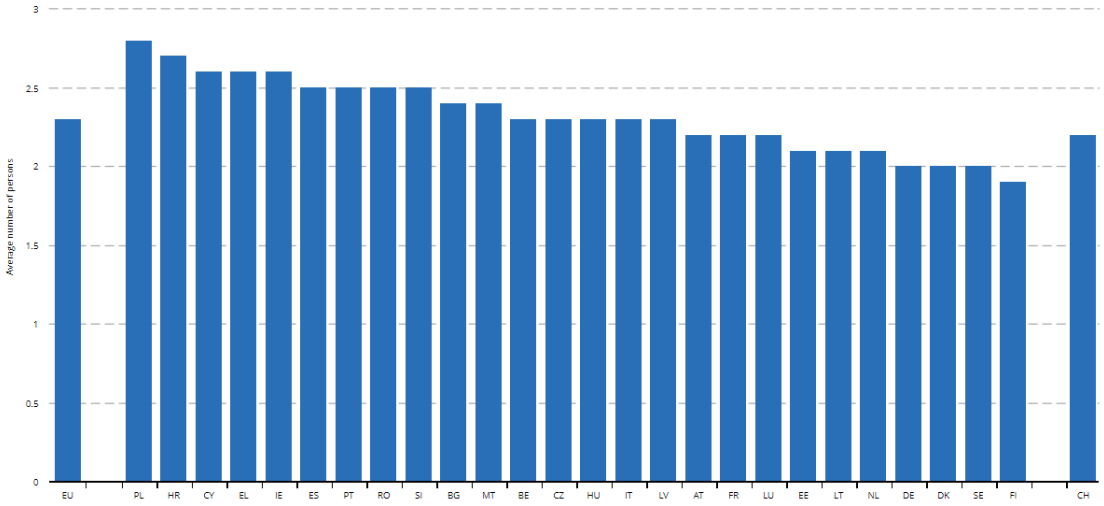


Figure 1.15: Average household size, 2021

Source: Eurostat, 2022

- Housing quality: there are several ways to measure the quality of housing.[30]

  One is whether or not people reside in *overcrowded housing*. The percentage of people residing in such a house in the EU fell from 19.1% in 2010 to 17.1% in 2021. The countries with the highest overcrowding rates in 2021 were Latvia (41.3%), Romania (41.0%) and Bulgaria (37.9%), while Cyprus (2.3%) and Malta had the lowest rates (2.9%). Germany and Italy had, respectively, 10.6 and 28.0%.

  Another way to measure the quality of housing is, unlike overcrowded homes, *under-occupied homes*. This indicates that it is too big for the needs of the household that lives there. Older people or couples who continue to live in their house after their children have grown up and moved out are the traditional cause of under-occupation. In the EU in 2021, 33.6% of people resided in homes with under occupants. The largest percentages of under-occupied homes were found in Malta (71.8%), Cyprus (70.9%), and Ireland (69.1%), while the lowest percentages were found in Romania (7.2%), Latvia (10.1%), and Greece (11.8%). The amount of Germany and Italy is, respectively, 34.2 and 15.4%.

In conclusion, different ways of housing quality measure than the previous two are given from the *ability to keep the house warm*, the *leaking roof* and the *lack of toilet and shower*.

- In the figure 1.16 is explicit that 6.9% of people did not be able to keep their house comfortably warm in 2021 in the EU. The highest is observed in Bulgaria with 23.7% and the minimum in Slovenia, Sweden and Austria all with 1.7%. Germany and Italy registered, respectively, the amount of 3.3% and 8.1%.

- In the EU in 2020, 14.8 % of people reported having a leaky roof (figure 1.17. The countries with the largest shares were Cyprus (39.1%), Portugal (25.2%) and Slovenia (20.8%). 19.6% is the share of Italy and 12% of Germany.

- In the EU in 2020, 1.5 per cent of people did not have access to a toilet, shower or bath (figure 1.18. Romania had the highest prevalence of this (21.2% of the population), followed by Bulgaria, Latvia (both 7.0%), and Lithuania (6.4%). In Italy, the amount corresponds to 0.5%. For Malta, Luxembourg, Netherlands and Sweden the values are zero.

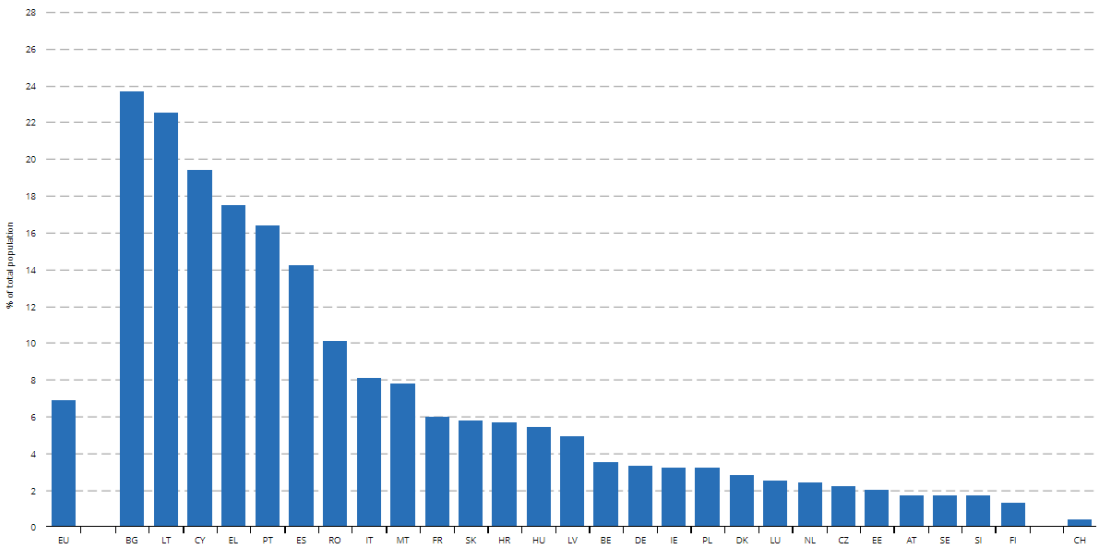


Figure 1.16: People unable to keep the house warm, 2021

Source: Eurostat, 2022

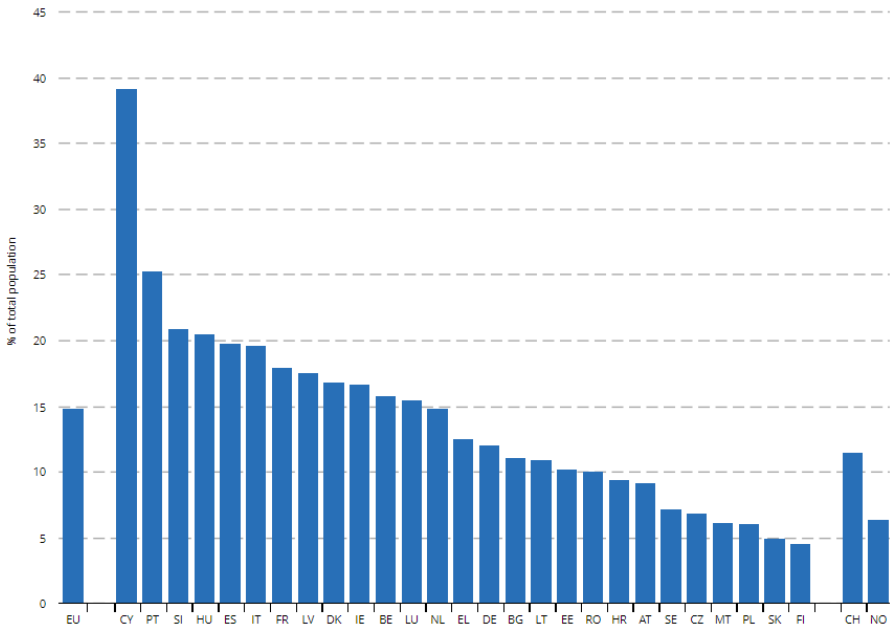


Figure 1.17: People living in a house with leaking roof, 2020

Source: Eurostat, 2021

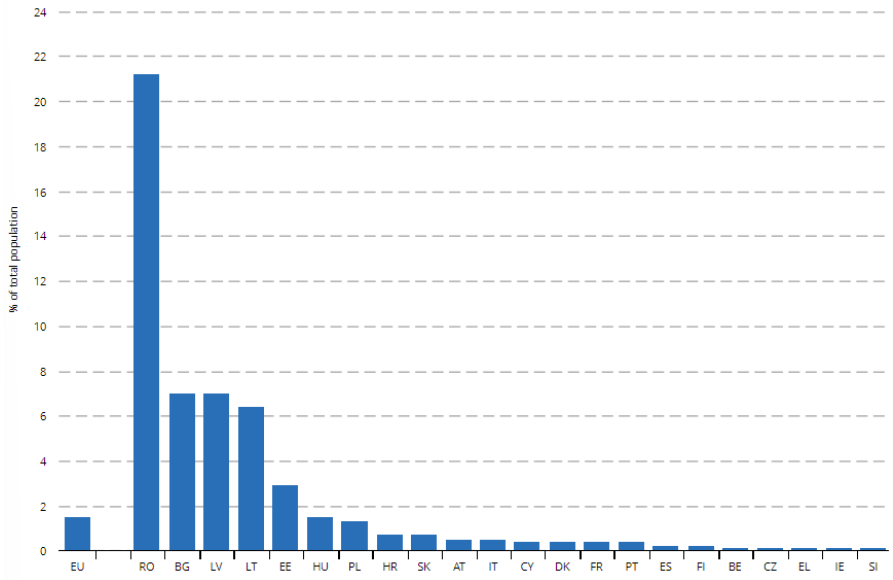


Figure 1.18: People living in a house without toilet, shower or bath, 2020

Source: Eurostat, 2021

1.5 Real Estate Investment in Italy

The cyclical development of the housing market is primarily controlled by variations in the amount of demand, which is the major variable in explaining changes in the quantities exchanged. Changes in the level of demand, in turn, are influenced by the supply prices of houses, the stock of accumulated savings, the cost of financing, and current and expected incomes. Looking at the cycle in the figure 1.19 in terms of the number of properties bought and sold, the NTN index number (Number of Normalized Transactions) with a base (equal to 100) in 1995 reaches a peak in 2006 (index equal to 169), then plummets in 2013 to 78, significantly below the series' beginning level. The number of residences acquired and sold has been recovering since 2014, reaching 150 in 2021 but with a drop from 121 in 2019 to 112 in 2020. Thus, the purchasing and selling market has three cycles from 1995 to 2021: phase I, from 1996 to 2006, shows an expanding tendency. After the peak in 2006 a falling down, until 2013, characterise the phase II. Finally, from 2013 to 2021, phase III is an increasing trend; yet, it is still not totally defining this cycle since reliable trend market forecasting is difficult. The drop of buying and selling in 2020 (-7,7% compared to 2019) is due to the crisis induced by the effects of the COVID-19 pandemic and the necessary counteracting actions. Instead, in 2021 the growth is back to almost 750 thousand buying and selling houses, i.e. a 34% increase over 2020.[31]

1.5.1 Volumes in terms of buying and selling

Analysing volumes trend in terms of buying and selling in the various Italian territorial areas and capital and non-capital municipalities, it is registered a similar increase of buying and selling volumes for the various Italian territorial areas overcoming the 30% compared to 2020 and 20% compared to 2019. For the capital municipalities, in 2021, there is a +28,7% compared to 2020 and +14,3% compared to 2019 for the whole country. For the non-capital municipalities, in 2021, the growth amounted of over 36%, with a peak of over 38% in the centre and almost 29% in the south and islands than in 2020. The purchasing and selling tendency effects the IMI ("intensità del mercato immobiliare," i.e. the intensity of the housing market), which indicates the proportion of stock bought and sold. On a nationwide scale, this metric is 2.17% in 2021, up from 1.63% in 2020 and 1.76% in 2019[12]. This shows that market intensity will be stronger in 2021 compared to both 2020 (+0.55) and 2019 (+0.41). The IMI is strengthening, notably in the country's north, with IMI readings above 2.6%.

[12]i.e. 2.17 homes bought and sold for every 100 registered in the land register

Although development in capital cities has been more gradual, the latter nevertheless have a stronger market dynamism, both nationally and in detail of territorial territories.

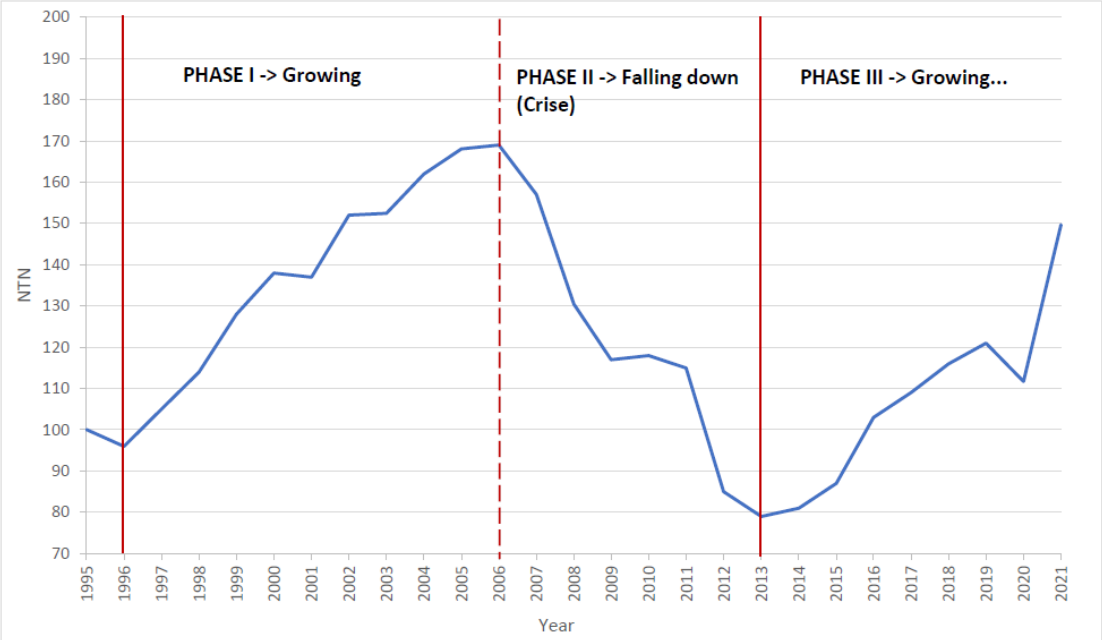


Figure 1.19: Buying and selling trend in Italy (from 1995 to 2021)

Source: own elaboration, 2023. Based on 'OMI - Rapporto Immobiliare, 2022.'[31]

1.6 Summary of the chapter

In this first chapter, the aim is to give a clear explanation of the real estate market and process and a picture of the European and Italian real estate situations.

From a general point of view, after defining the "place" of the market, the real estate market was studied, described, and schematised (into sub-markets and sectors). This was possible by having as a starting point some research conducted by "DiPasquale & Wheaton, 1994" and "S. Rossi, 2016", where the schematisation includes the construction sector, space market, and asset market, and considering the capital market. Subsequently, this schematisation was redefined as misunderstandings and unclear connections between the various groups were found, one of the tasks of this research in this chapter. Therefore, the asset market and the space sector were redefined. Furthermore, there was also an enrichment of sub-markets and sectors by distinguishing between the private market and the public sector, adding the financial market, containing the investment market and the capital market, and considering public-private partnership.

To complete the theoretical definition of real estate, cycles were analysed using a model defined by ANCE (National Association of Building Contractors): the hexagonal or honeycomb model. This shows how supply and demand change under the influence of house prices and the number of transitions. The name of the model is given by the hexagonal shape of the graph.

Finally, to understand the current situation in the real estate sector, research has been conducted at the European level, mainly through Eurostat and Istat.

In particular, the following analyses were carried out from a European perspective:

- percentage of the population living in their own houses and rented houses;
- the percentage of the population living in a house or a flat, distinguishing between cities, towns and suburbs, and rural areas;
- prices to purchase or rent houses;
- space sector insight: the size of housing, the number of people living per household, and housing quality, including, for the latter, overcrowded housing, under-occupied homes, the ability to keep the house warm, leaking roof, and lack of toilet and shower.

Instead, from an Italian perspective, the NTN index (Number of Normalized Transactions) is treated and graphed from 1995 to 2021. During this period, three cycles are figured out: phase I, from 1996 to 2006, shows an expanding tendency; phase II, from 2006 to 2013, shows a falling down; and phase III, from 2013 to 2021, shows an increasing trend. To conclude the Italian perspective, an analysis of volume trends in terms of buying and selling is carried out.

Chapter 2

Risk Management & Risks in Real Estate. Allocation to the Real Estate scheme, the plan of work and the outline

2.1 Risk Management

Risk is defined as an unpredictable occurrence or circumstance that, if it occurs, has a positive or negative impact on a project's purpose; hence, construction projects are heavily influenced by risk since they are planned and managed based on uncertain forecasts. These uncertainties develop as a result of unpredictability and ambiguity in performance measurements such as cost, time, and quality.[32]

Few researchers have looked at risk management from the perspective of a particular project phase, such as conceptual and feasibility, design, and construction, rather than the entire project life cycle.[33]. It is necessary to identify both internal and external project risks. Comprehensive risk identification and assessment methods mitigate the negative consequences of risk while boosting business efficiency and effectiveness.

The structure of the entire process is formed by the risk identification process, which is the first step in risk management. Failure to identify risks can lead to inadequacy in the risk management process, which can have a serious impact on a company's resources.

2.1.1 Project Risk Management Process

The objective of risk management is to identify all the risks of a project and bring them down to an acceptable level: this makes it possible to move from emergency management to conscious management.[34] In general terms, the following situations can be identified: *certainty* (project constraint), certainty that a given event will occur; *positive risk* (opportunity), the probability of obtaining an advantage; *negative risk* (threat), probability of suffering harm; *fatality*, absolute unpredictability, impossibility of remedy.

The main phases of risk management are:

1. Risk analysis: consists of identifying and describing the most significant events that could occur during a project and generate threats or opportunities for a project. Risk can be analysed through the *cause/effects approach* or the *effects/causes approach*.

   In the first approach, the causes that can trigger certain events are listed and the consequences are assessed for each of them.

   Instead, in the second approach, the possible effects are considered by distinguishing them into positive and negative, and then the most effective course of action is identified so that the respective consequences may or may not occur.

   The risk analysis phase is in turn divided into two successive stages:

   (a) Risk identification: consists of defining and listing potential sources of risk. The process is sequential and connected: 1) identify the risk. 2) Assign a name or ID. 3) Complete description of the event. 4) Identify causes and origin 5) Identify consequences with their impact on time and costs. 6) Define when it may occur and the duration. 7) Assign a responsible person to deal with the identified risk and finally as an output process draw up a complete list. The main risk identification techniques can be divided into two parts:

      i. support techniques: the *interview* is a meeting between experts in the field and the project manager to gather useful information for the accurate identification of risks. The interviewer exposes the characteristics of the project and provides the project Work Breakdown Structure (WBS) and the assumptions/requirements of the final product or service. Another supporting technique is the *checklist*, a list prepared in-house by project type and design phase and based on the classification of risk factors, company history and experience. Each point on the checklist recalls circumstances that may give rise to damaging events. The main advantages of using checklists are their low cost, flexibility and ease of use; the disadvantage is that they limit

the search for risks to the proposed information, precluding an overall view of the problems.

ii. Analysis techniques includes:

- the what-if analysis: the meaning of this analysis is a simulation tool that tries to bring out all potential risk situations, with their occurrence processes in terms of causes, manifestations and consequences that may result.
  For each risk, it also highlights the countermeasures to be taken, taking into account the defences already adopted.
- the cause-effect diagram: makes possible to identify the undesirable effects of a project by identifying the causal chain backwards. It is also called an Ishikawa or fishbone diagram due to its final graphic configuration. The advantage of this technique is that it allows for analysing the problem in its entirety, identifying precise areas of data collection and enabling in-depth knowledge of the event.
- the swot analysis: is conducted on the strengths and weaknesses of the context of analysis (modifiable) and the opportunities and threats arising from the external context (non-modifiable).
- the event tree and the risk breakdown structure: is a procedure that considers an initial event and follows, using an inductive method, the different development paths that this event may have on the system. The main rules of application of this method are the definition of a complete list of initial events; the identification of subsequent events; the construction of an event tree for each initial event; the description of the consequences resulting from each path; the calculation of the probabilities of each path.
  The risk breakdown structure classifies risk events by employing a hierarchical system consisting of at least 3 or 4 levels of detail and helps to identify common risk causes, risk types and risk areas in a project. The use of the various risk identification techniques should generate lists showing the origin of the risk, with corresponding signs of occurrence for each specific project activity.

(b) Risk assessment: after identifying the particular risk units, the expected effects are assessed. The dimension of the actual scope of the hypothesised consequences is carried out with the aid of different techniques depending on whether a qualitative or quantitative assessment is desired. The objectives of the risk assessment phase are to dimension the extent of the consequences and to assign each risk a priority. Risk factor can be given by: R = P x I (table 2.1); where "P" is the probability index and "I" is the consequence index. The probability of occurrence of a risk event is

defined by a range from 1 to 5: 1 is highly unlikely (0-10%); 2 is unlikely (10-33%); 3 is as unlikely as likely (33-66%); 4 is likely (66-90%); 5 is highly likely (90-100%). For the consequence index, there is a range from I to V: I is very low; II is low; III is medium; IV is high and V is a critic.

R = P x I	I	II	III	IV	V
1	1	2	3	4	5
2	2	4	6	8	10
3	3	6	9	12	15
4	4	8	12	16	20
5	5	10	15	20	25

Table 2.1: Risk factor

Source: own elaboration, 2023

Risk assessment can be performed in the following ways: **qualitative**; **semi-quantitative** and **quantitative**.

- The qualitative mode assigns to R a scale of levels for both probabilities of occurrence and impact. To define the scale, one starts at the highest band (catastrophic or very high) and proceeds to the lowest band (negligible or low). The scale is then shifted first to the highest-value risk and then to the one considered acceptable. Probability can be determined in detail the more historical data is available.
- The semi-quantitative mode describes the P and I levels using numerical scales that refer to ranges of values useful to the assessor to have a homogeneous reference.
- The quantitative mode involves R = (P x I) / c (where c is the degree of checkability) and R = P x I x e (where e is the degree of avoidability). Based on these dimensions, it is also possible to associate an overall level of exposure to the project, which is defined with the following ratio: L(pj) = max (Ri) / Budget(pj) (where Ri is the identified risks for project pj and Budget is the economic amount of the risk reduction plan). L(pj) can be classified according to the following criterion: the level is high if $L(pj) > 0.5$; the level is low if $L(pj) < 0.2$; the level is medium if $0.2 < L(pj) < 0.5$.

In all risk assessment approaches, as much information as possible about the project and the nature of the risks is required. It is important to have precise facts about the project, such as a description of the context, the type of product, the project's objectives and needs, the limitations and boundary conditions, and the players involved.

Concerning risk, it is critical to concentrate on all potential sources of risk, which may be easily detected in the risk management report generated during the identification step.

2. Risk response: consists of two phases.

   (a) Scheduling: risk reduction measures are planned and scheduled. In risk analysis, a distinction can be made between external risks (weather, inflation, regulations, etc.) and internal risks. The former, which are not under the direct control of the project manager, offers no possibility of intervention; the latter, on the other hand, fall under the control of the project manager and can therefore be counteracted. Risk planning consists of 3 parts: objective; development and outcome. The objective consists of the identification of interventions to maximise opportunities and minimise threats. The development consists of identifying the process of realising the risk and applying corrective measures.

   (b) Monitoring: the evolution of the risk is verified to search for interventions aimed at respecting and improving the time, economic and qualitative objectives. Project control must be seen as an action aimed at searching for possible interventions that can be carried out in the period remaining before the conclusion of the realisation process, to bring the project within the economic and time limits foreseen. To be effective, project control, conducted by the project manager, is divided into a series of successive steps: verification of risk occurrence; analysis of deviations from forecasts; identification of causes; evaluation of corrective actions with possible use of contingencies or recovery of the same; re-planning; updating of the risk management plan. Concerning the risk events that occur in the reality of the project, the project manager triggers the general risk management process to assess the possible effects on the overall result. Since these are events that, although unforeseen, have nevertheless occurred in the operational reality, it will not be necessary to develop the quantification and planning phases of this process. For each event, it will be necessary to proceed to assess the severity and time economic repercussions; identify possible countermeasures; dimension the additional cost of countermeasures; implement countermeasures; update the risk plan with the new threats.

2.2 Risks in Real Estate

2.2.1 Construction Risk

It is the risk of delivery times, non-compliance with project requirements, cost increases, technical inconvenience in the operation, and lack of completion of the operation. In this broad category of risk, the following risks (as determined by the type of partnership) may be found[35]:

- **Risk of design issue**: connected to the survival of necessary project modification interventions, resulting from design issues or omissions, such as having a significant impact on project timelines and costs.
- **Commissioning/stakeholder risk**: the risk that the task will not receive consent from other public subjects or the community (stakeholders about the task to be carried out), resulting in delays in implementation and the emergence of disputes, or, in extreme cases, with the procedure or assignment failing.
- **Administrative risk**: connected to significant delays or rejection in the issuance of authorizations (permissions, licences, clearance, etc.) by public and private entities, as well as the issuance of authorizations with prescriptions, tends to result in delays in implementation.
- **Expropriation risk**: linked to expropriation delays or higher expropriation costs due to erroneous planning and/or estimation.
- **Environmental risk**: the risk linked to soil conditions, as well as land reclamation due to soil contamination and risk of archaeological finds, resulting in delays in the implementation of the task and increased costs for environmental rehabilitation or archaeological protection. Inclement weather conditions, natural disasters, accessibility to the site, pollution and safety norms.
- **Risk of execution of the work different from the project**: linked to non-compliance with project standards. This risk can be related to time constraints.
- **Risk of an increase in the cost of production factors or of the inadequacy or unavailability of those provided for the project**.
- **Risk of erroneous valuation/estimation of construction costs**.
- **Possibility of work completion times deviating from those specified in the chronoprogram**.

- **Risk of contractual non-compliance of suppliers and subcontractors**.
- **Risk of unreliability and inadequacy of the technology used**.
- **Risk of interference above and below services** linked to the presence in the sections affected by the work of services of various kinds (e.g. water, gas, electricity, cables, optical fibre, etc.).
- **Risk of design change**: risk associated with the need for requests by the grantor for design changes not resulting from design errors and/or omissions.
- **Risk of delay in project approval**: risk related to the delay in the approval of the executive project.
- **Land cost**: usability, restrictions, local authorities.

2.2.2 Market Risk

The category of market risk represents the "externalises" of risk or rather the criticality attributable to external, exogenous forces that may affect a property or the wider property market. So, the cause may be linked to changes in supply or demand due to the population variations of a city, or macroeconomics characteristics i.e. interest rate increases, and unplanned inflation increases. The market risk level covers spatial markets in terms of supply and demand, and capital markets in terms of availability and return requirements.

- **Demand and supply**: the critical issues under consideration are related to the cyclical nature of the market which introduces the risk that there may be a significant divergence between the supply of new volumes and the demand for the same asset.
- **Capital risks**: in the long term, the value proposition in real estate is driven 70-80% by the relationship between supply and demand and 20-30% by trends and availability of capital. Periodically, this equation is reversed, creating unsustainable periods in which real estate is over or undervalued based on available capital flows.

Demand Risk

It is the risk linked to the different volumes of demand for the service that the concessionaire must satisfy, namely the risk linked to the lack of users and therefore cash flows. Demand risk, which may not depend on the quality of the services provided by the economic operator, is generally an element of the usual "economic risk" borne by every operator in a market economy. Within this general category of risk, the following risks are distinguished:

- **Risk of contraction in market demand**: namely a reduction in overall market demand for the service, which is also reflected in that of the economic operator.
- **Risk of contraction of specific demand or competition risk**: linked to the emergence in the reference market of a competitive offer from other operators that erodes part of the demand.

2.2.3 Financial risk

The financial risk takes the form of an increase in interest rates and/or failure to repay one or more loan instalments, increasing costs or the inability to continue with the operation. Vacillating exchange rates, material costs, market demand, improper estimation, inflation, payment delays, unmanaged cash flow and financial incompetence of contractors pose a huge threat of financial risks in a project. This risk will increase the volatility of net cash flows, i.e. those cash flows after the effect of the financial structure.

2.2.4 Risk of the building's environment

This building's environment represents the negative impact due to an element connected to the environment of a property. The "element" can reduce the property's attractiveness (as well as its value) or public health. Soil contamination, the presence of asbestos and a non-seismic building are examples of elements that can be the reason for a decrease in value.

2.2.5 Legislative-Political risk

Deriving from changes in the regulatory framework and programmatic political decisions that cannot be foreseen in the contract, law and order, bribery, payment failure by the government, increase in taxes and change in government. This risk may also entail, in extreme cases, termination of the procedure or awarding of the contract. Real estate is impacted by many laws either positively or negatively. It depends even on the type of State: for a federal state, the law is at a local level so the risk can decrease, as USA, Germany or Switzerland instead in the centralised states the diversification should reduce the level of the risk.

2.2.6 Availability Risk

It is the risk connected with the concessionaire's ability to provide the contractual services agreed upon, in terms of both volume and the quality standards envisaged. Risk of total or partial unavailability of the work about the technical and functional standards established by the contract, also due to technical obsolescence; need to perform more ordinary and extraordinary maintenance than those foreseen and quantified in the PEF, for deficiencies construction or deficiency in the performance of previous acts of maintenance. This general risk category may include the following risks:

- **Extraordinary maintenance risk**: unanticipated, resulting, for example, from inadequate design or construction, or deficiencies in ordinary maintenance, resulting in increased costs.

- **Risk of total or partial unavailability of the facility to be made available and/or the services to be provided**.

- **Performance risk**: namely the risk that the facility made available or the services provided do not comply with the key performance indicators (KPI) drawn up in advance concerning the subject and characteristics of the contract or the pre-established technical and functional standards, resulting in a reduction in revenues;

- **Risk of technical obsolescence and residual value**: related to a more rapid technical obsolescence of plants, affecting maintenance costs and/or pre-established technical and functional standards. The risk that the value of the asset is lower than expected at the end of the contract and the extent to which public authorities have the option to acquire the asset.

- **Risk of operator failure**: risk that the operator fails or is inadequate for the provision of services according to the established standards.

2.2.7 Management risk

The management risk relates to a variety of factors, including the need to market the spaces that will be leased, the collection of rent, or the oversight of the property's quality to perform ordinary and extraordinary maintenance at the best time. Risk of increased management costs compared to those estimated in the bid. Risk of services being provided in a manner different from the times and standards agreed upon. Risk of failure the provision of services.

2.2.8 Liquidity risk

Finding a balance between the speed of the sale and the amount of the transaction is necessary. Depending on the market's stage, waiting is frequently necessary to sell a property for its market value. For instance, a study conducted in Great Britain revealed that it takes ten months on average to sell a commercial property; therefore, lowering the price would be necessary to speed up the process.

2.2.9 Environmental and Man-made risk

Site conditions, earthquakes, volcanic, weather-hydrogeological and hydraulic, tidal waves, and forest fires are recognized as disasters or catastrophes by the competent authority. These events are increasing due to the change in the climate that is going to impact many sectors.

2.2.10 General Project Risks

- **Risk of insolvency**: of the parties who must pay for the services offered.
- **Industrial relations risk**: linked to relations with other parties (social partners) that have a negative influence on the costs and times of execution.
- **Insurance risk**: risk of increased insurance costs. Risk of insurance impossibility.

In addition to the risks mentioned above, there are a series of risks that, as a rule, remain allocated to the grantor, defined as force majeure, which must be specifically identified in the contract. By way of example, the following can be considered force majeure cases:

- **Strikes or protests risk**: except for those involving the contractor of works or services covered by the PPP contract.
- **Wars or acts of hostility risk**: including terrorist acts, sabotage, vandalism and riots, insurrection and other civil unrest.
- **Explosions, radiations, and chemical contamination risk**.
- **Epidemics and contagions risk**.
- **Unavailability of electricity, gas or water supply** for reasons not attributable to the administration, the economic operator or third parties entrusted with works or services covered by the contract.

- **Unforeseen and unforeseeable impossibility risk**: due to the third party, to access raw materials and/or services necessary to carry out the intervention.

In any case, the economic risk linked to economic cycles and borne by producers in their field of activity cannot be considered force majeure.

2.3 Risks allocation to the Real Estate scheme

Remembering the schematisation shown in figure 1.3, it is critical to understand how the risks described in the preceding section are connected to the various markets and sectors. The following are the risks allocated to each market or sector.

- **Private market**.

  The private market contains the risks listed in the figure 2.1.

Figure 2.1: Risks linked to Private Market

Source: own elaboration, 2023

- **Public sector**.

  The public sector contains the risks listed in the figure 2.2.

Figure 2.2: Risks linked to Public Sector.

Source: own elaboration, 2023

- **Construction sector**.

  The construction sector contains the risks listed in the figure 2.3.

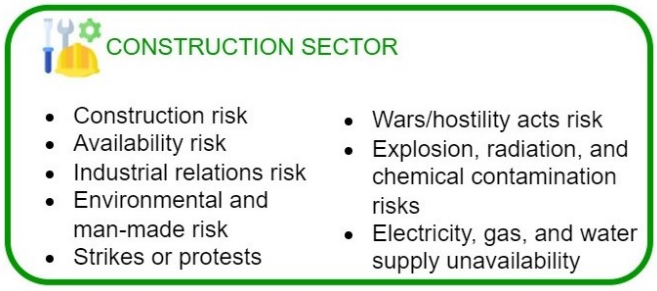


Figure 2.3: Risks linked to Construction Sector.

Source: own elaboration, 2023

- **Space Sector**

  The risks linked to the space sector are market risk, and the demand and supply sub-risk; the building's environment risk, management risk.

Figure 2.4: Risks linked to Space Sector.

Source: own elaboration, 2023

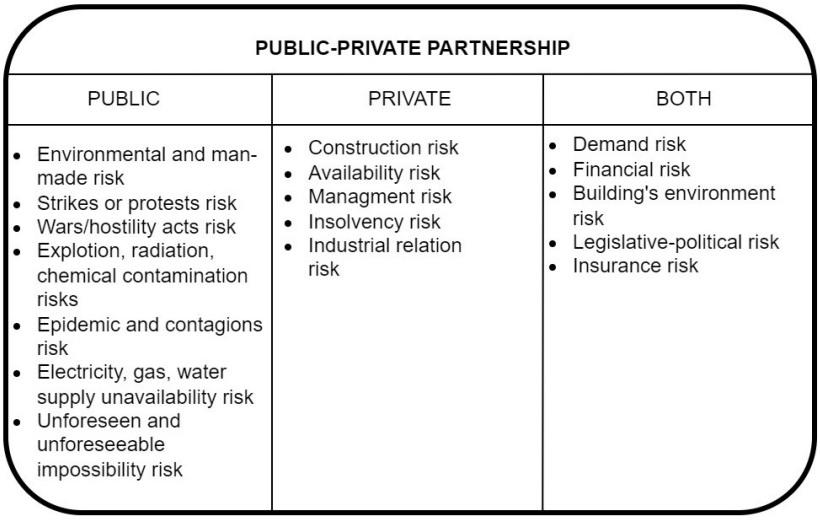
- **Financial market**.

  The financial market, subdivided into investment and capital market contains the risks listed in the figure 2.5.

Figure 2.5: Risks linked to the Financial Market, subdivided into Investment and Capital market.

Source: own elaboration, 2023

- **Public-Private partnership**. Bearing in mind that PPP is used to assign risks properly between the parties, the allocation is shown in figure 2.6. To be a PPP contract the private operator has to take on, at least, the construction risk and one availability risk or demand risk (usually the availability risk is taken on by the private operator).



PUBLIC-PRIVATE PARTNERSHIP		
PUBLIC	PRIVATE	BOTH
• Environmental and man-made risk • Strikes or protests risk • Wars/hostility acts risk • Explotion, radiation, chemical contamination risks • Epidemic and contagions risk • Electricity, gas, water supply unavailability risk • Unforeseen and unforeseeable impossibility risk	• Construction risk • Availability risk • Managment risk • Insolvency risk • Industrial relation risk	• Demand risk • Financial risk • Building's environment risk • Legislative-political risk • Insurance risk

Figure 2.6: Risks linked to Public-Private Partnership.

Source: own elaboration, 2023

2.4 Work plan with an outline of the property development process related

For real estate developers to keep under control every building realization phase is critical due to the best achievement in terms of time, quality, and price. For this reason, some countries have and follow a plan of work (not whole countries); e.g. Europe has a plan of work related to ACE (Architects Council of Europe), UK follows the one related by RIBA (Royal Institute of British Architects) and Italy follow the D.Lgs. 50/16 and ss.mm.ii. All of them are not the same but they have the same goals: to create a road map for the project team to follow to promote consistency from one stage to the next and to provide crucial direction to customers embarking on their first and maybe only building project. In general, the main phases are the same and then going specifically there can be more, less or just different stages.

2.4.1 Comparison of ACE, RIBA and D.Lgs. 50/16 and ss.mm.ii.

- The plan of work-related by ACE, as shown in the figure 2.7, is composed of:
  1. Phase I - **Intervention preparation**. Pre-design and design are sub-phases.
     The pre-design is subdivided into *initiative* and *initiation*.
     The design is subdivided into *concept design*, *preliminary design*, *developed design* and *detailed design*.
  2. Phase II - **Intervention realization**.
  3. Phase III - **Life time & maintenance**.
  4. Phase IV - **Life end**.
- The plan of work-related by RIBA, as shown in the figure 2.8, is composed of:
  1. Phase I - **Intervention preparation**. Pre-design and design are sub-phases.
     The pre-design is subdivided into the *strategic definition* and *preparation and brief* stages.
     The design phase consists of *concept design*, *developed design* and *technical design*. Unlike the ACE's design phase, in the RIBA there is no preliminary design stage.
  2. Phase II - **Intervention realization**.
     It is subdivided into *construction* and *handover and close out* of the building.

3. Phase III - **Life time**.

RIBA does not take into account the building's end of life.

- Plan of work by UNI 10723:1998 The plan of work by UNI 10723:1998 has the following sub-phases:

1. Phase I - **Intervention preparation**. Pre-design and design are sub-phases.

   The pre-design is subdivided into the *intervention identification* and *meta-design* stages.

   The design is subdivided into *design* and *programming*.

2. Phase II - **Intervention realization**.
3. Phase III - **Life time**. It is subdivided into management and maintenance stages.

UNI 10723:1998 does not take into account the building's end of life.

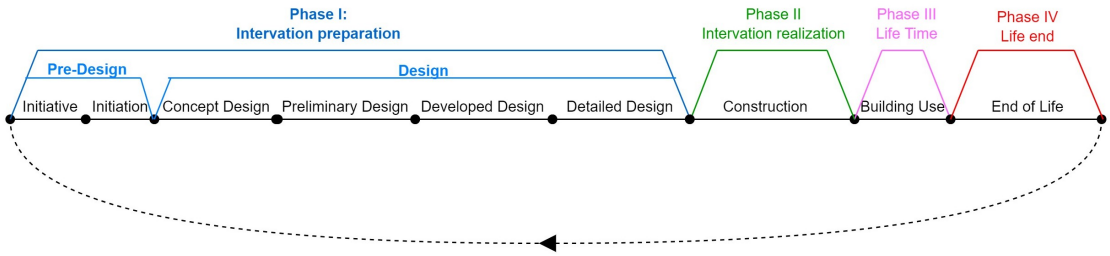


Figure 2.7: Plan of Work by ACE

Source: own elaboration, 2023

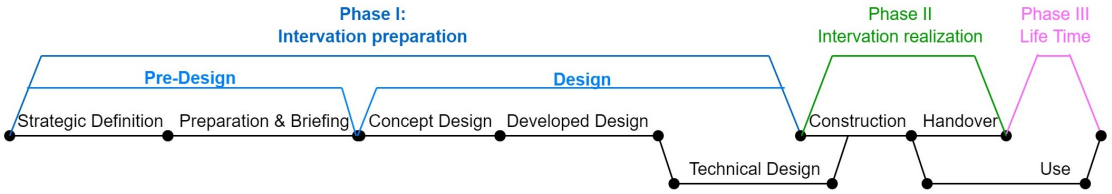


Figure 2.8: Plan of Work by RIBA

Source: own elaboration, 2023

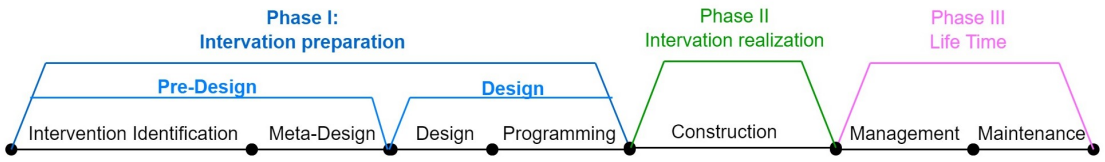


Figure 2.9: Plan of Work by UNI 10723:1998

Source: own elaboration, 2023

2.4.2 Definitive plan of Work

The analysis of the three types of the plan of work above permitted us to enunciate a plan of work that represents the life cycle assessment (LCA) theory and includes the whole phases and stages. It is important to clarify that the detail degree used in a plan of work depends on the importance of the construction in terms of dimension, investment value, quality, etc...

Looking at the figure 2.10 the following is explained:

1. Phase I - **Intervention preparation**. Pre-design and design are sub-phases.

   The **pre-design** is subdivided into two stages:

   - Strategic definition: is the stage at which the necessity for a building becomes apparent and is established[1]; identifying the best way to meet the client's needs.

     The tasks of this stage are to define *client requirements* (the project budget is very important); to make a *market study* (appraise future requirements and market conditions for a specific project) and a *business case* (describe the viability, likelihood of success and project risks).

   - Preparation and briefing: when the project objectives are adequately specified, establishing the brief's details, a choice to proceed with design may be made[2]. The stage's objective is to identify the information requirements for each project stage. This involves thinking about how to leverage new digital survey techniques to help with the design process, the requirement for asset information upon handover, and how new technology may help develop better and quicker design processes.

[1]EN 16310 definition

[2]EN 16310 definition

The tasks of this stage are:

- project initiation: analyze client and user requirements. Compile information on regulatory, infrastructure, and geotechnical conditions. Site investigations including surveys of existing buildings and structures.
- feasibility study: outline fundamental planning ideas and potential building techniques. Examine how the project will achieve the specified needs and goals. Inform the customer of the technical and statutory limits that the project must meet. Investigate and assess anticipated budget needs.
- project brief: investigate and determine the needs and expectations of clients and users. Create a project brief, and a room and function schedule.

Talking, instead, of the **design** this is subdivided into four stages:

- Concept design: a collection of vital project ideas is developed, commencing with the design work stage and taking into account the constraints[3]. This stage must be approved by the customer and must be by the Project Brief.

  The tasks are to review the major components of the brief if the client has already established it, or the objectives and requirements that the project must achieve. Create idea sketches and do preliminary research. Prepare concept design concepts that contain design options and are translated into drawings at an appropriate scale (typically 1:500-1:200), as well as a preliminary design report and an initial cost estimate.

- Preliminary design: where a project design is created that provides a wide insight into planning aspects, functional organisation, spatial structure, and overall look, allowing the customer to make strategic decisions between functional concepts and solutions envisaged[4].

  Create the concept design and alternatives that have been authorised by the client and examined with the authorities. Prepare project graphic presentations for conversations with the client and other relevant parties. Create a collection of preliminary design drawings at an appropriate scale (usually 1:200-1:100) that includes floor plans, sections, elevations, and 3D modelling. Create technical reports that describe design options.

[3]ISO 16813

[4]EN 16310 definition

- Developed design: the project is outlined in such depth that stakeholders have a clear understanding of the ultimate result's qualities and the cost of implementation can be determined[5].

  The tasks are to develop the accepted preliminary design to a suitable level, giving the fundamental information necessary for the issuance of contract plans and specifications. Prepare a collection of completed design drawings including floor plans, sections, and elevations to identify the project's size, appearance, main technological solutions, materials, and construction elements at an acceptable scale (typically 1:100-1:50). Produce a written specification and description of the works explaining the nature of the works and outlining the technical standards for each independent trade. Calculate building expenses using conventional pricing and, if necessary, create bills of quantities.

- Technical design: where the project is completely specified in technical depth so that building, manufacture, and equipment installation may take place[6]. This stage will end after the construction of the building has already started.

  The tasks are to refine the design to give execution and detailed drawings at the desired scale (typically 1:50, 1:20, 1:10, 1:5, 1:1). Provide construction calculations and specifications to allow contractors to build the project. Determine all aspects, including furniture and other project-specific features. Recalculate building costs using typical pricing and, if possible, bills of quantities that include quotes from specialist subcontractors. Create a project execution plan.

2. Phase II - **Intervention realization**.

   Construction is the stage at which the design is constructed in compliance with the contract documents, legislation, and client requirements.

   The tasks during this phase are:

   - Pre-Construction: contract administration, contract review, and project objectives must all be prepared.
   - Inspection: oversee the building contract's execution. Monitor construction progress and plan adherence. Inspect contractors' activity and work execution. Consider the drawings of contractors. Conduct a random check of the materials and craftsmanship quality. Complete final design

[5]EN 16310 definition

[6]EN 16310 definition of «technical design»

details clarification before implementation. Changes requested by the customer are processed, and application instructions are issued to contractors. Check and authorise payment requests submitted by contractors.

- Commissioning: check that all work has been completed in line with the contract and that the building is fit for use and by the rules and permissions received. Organize the legislative processes required to open the building if necessary. Supervise the creation of as-built documentation.

3. Phase III - **Life time**. Handover and close out and use and maintenance of the building are sub-phases, and they start at the same moment.

   Handover and close of the building: is the stage after final inspections for workmanship and conformity with contract documents.

   The task is to, as the guarantee periods begin, supervise the transfer to the customer and building users and supervise the distribution of as-built documentation and final accounts.

   The **use and maintenance** is the stage at which the building and its external works are put to for the function for which they were constructed.

   The tasks of this phase are:

   - Operation: assist the customer in making the best possible use of his investment. Review of project performance and any additional project information as needed.
   - Maintenance: advice on building maintenance and exterior work to protect the client's investment. Possibly assistance with facility management, training, environmental monitoring, life-cycle strategy, and energy-waste-water management methods.

4. Phase IV - **Life end**. The stage at which a building has reached the end of its useful life and will be renovated or demolished[7].

   The following tasks are taken into account:

   - Audit: conduct an end-of-life audit. Recommend a strategy for demolition and/or rehabilitation.
   - Revamping: provide services for a new cycle taking the built asset through phases from I to III.

[7]EN 16310 definition

- Dismantling: allow for plant shutdown and site closure. Identify services (electricity, gas, fluids, etc.) to decommission the facility safely. Request all appropriate closure permits. Identify raw resources and waste; pick recyclable items. Arrange for the removal and treatment of contaminated materials, as well as the demolition of structures and the treatment and/or removal of polluted soil and groundwater. Select a suitable landfill if necessary. Inspect equipment disassembly and service disconnections. Coordination of demolition under controlled conditions is required to safeguard the health and safety of site workers and the general public. Propose strategies to reduce noise, air pollution, and groundwater contamination.

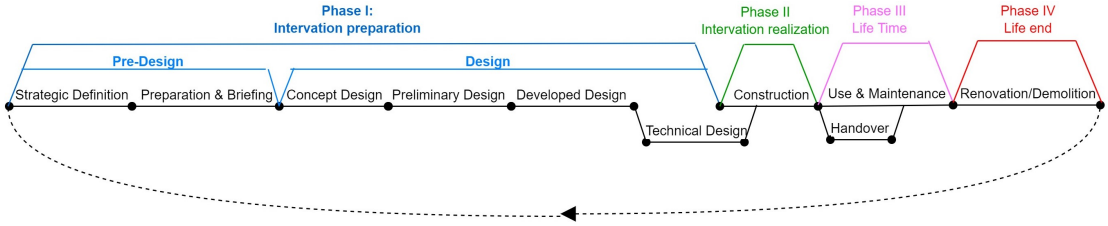


Figure 2.10: Definitive Plan of Work

Source: own elaboration, 2023

2.4.3 Outline of the property development process

The building project must be examined by the relevant building authority before it can be legally built. In the best-case scenario, the construction project is granted a building permit. A building permit is necessary for any building construction, alteration, destruction, or change of use. The construction permit is given if the project conforms with all applicable regulations, including the planning and building regulatory legislation. A construction permit application must be submitted to the local building authority or the building supervisory authority.

The building permit (in terms of documents required, types of construction that require it, timelines, and costs) changes from country to country. For example, in this research, the Italian situation is shown in figure 2.11.

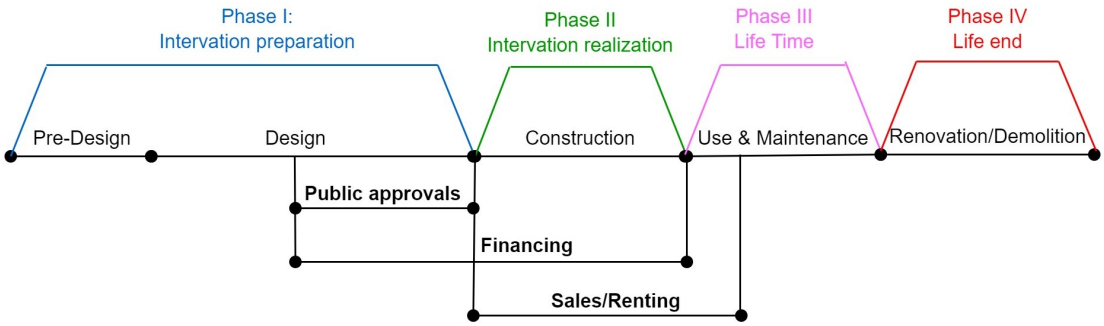


Figure 2.11: Outline of the property development process

Source: own elaboration, 2023

To start with the construction, public approvals with construction permission are required. The most important thing to bear in mind is the deadline for starting work, which cannot be more than one year from the issuance of the building permit (figure 2.12).

There is also a deadline to be met concerning the end of construction, which is three years from the start of work. If a one-year extension is not sought before the deadline, the permit for the incomplete component automatically expires. An extension may be granted by reasoned decision in the event of unforeseen events beyond the permit holder's control, or in consideration of the size of the work to be carried out its specific technical-constructive characteristics, or of technical-execution difficulties that have arisen after the start of work, or in the case of public works, the financing of which is envisaged over several fiscal years.[36]

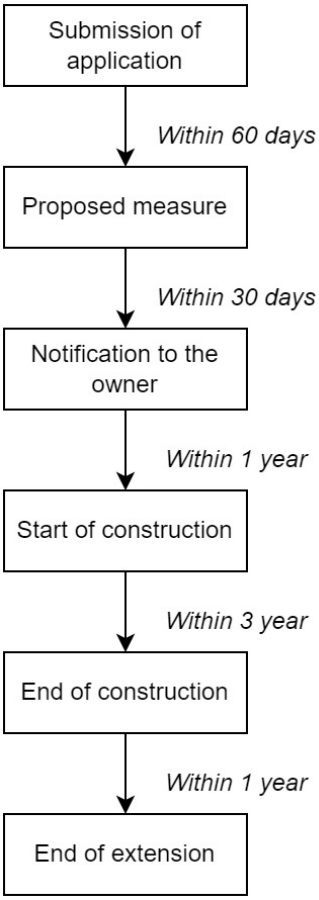


Figure 2.12: Outline of construction permission.

Source: own elaboration, 2023

2.4.4 Risks related to owing and renting

Section 1.4.1 and 1.4.3 explain respectively the population living in their own homes (70%) or rented houses (30%), and the prices to purchase or rent houses in Europe. It was therefore considered interesting to place the risks explained in section 2.2 in the case of buying and selling and renting, as shown in the figure 2.13. Therefore, this subdivision was considered (keeping the same colours for graphic clarity) to place the risks to the outline of the property development process (section 2.4.3). The collocation (as depicted in the images in the section 2.4.5) indicates when the risk may come out, obviously from a methodological point of view risks are analysed and taken into account as early as possible, usually starting in the pre-design phase and then gradually going into more detail with the design phase.

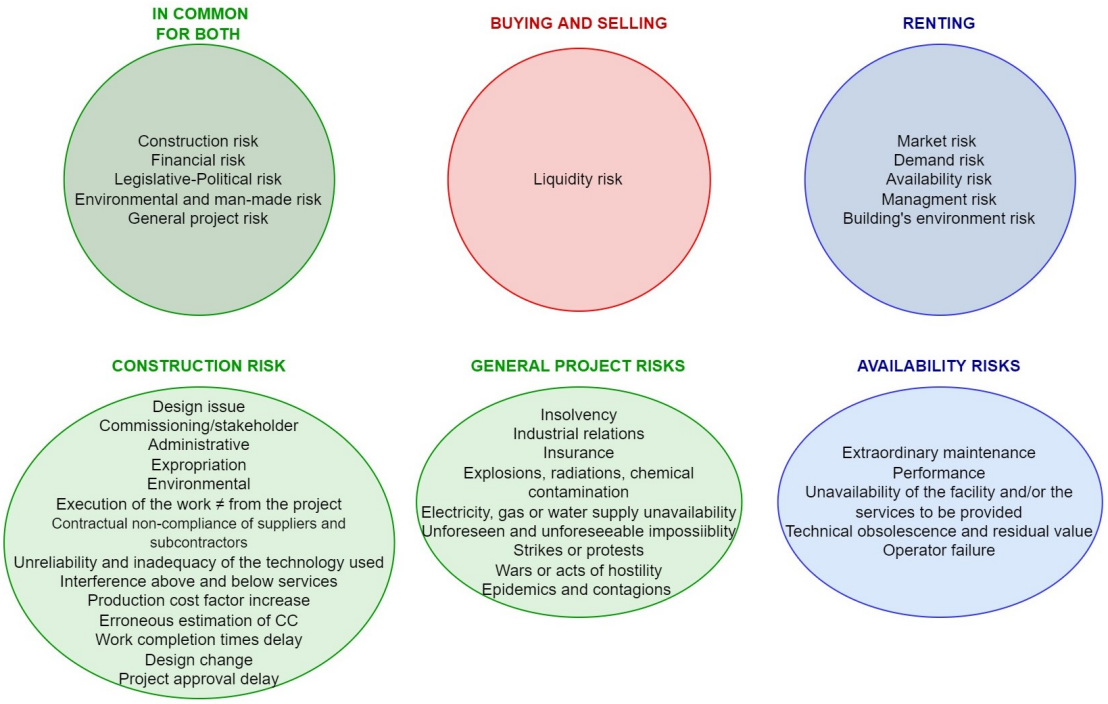


Figure 2.13: Risks categorised to owing and renting

Source: own elaboration, 2023

2.4.5 Risks linked to the outline of the property development process

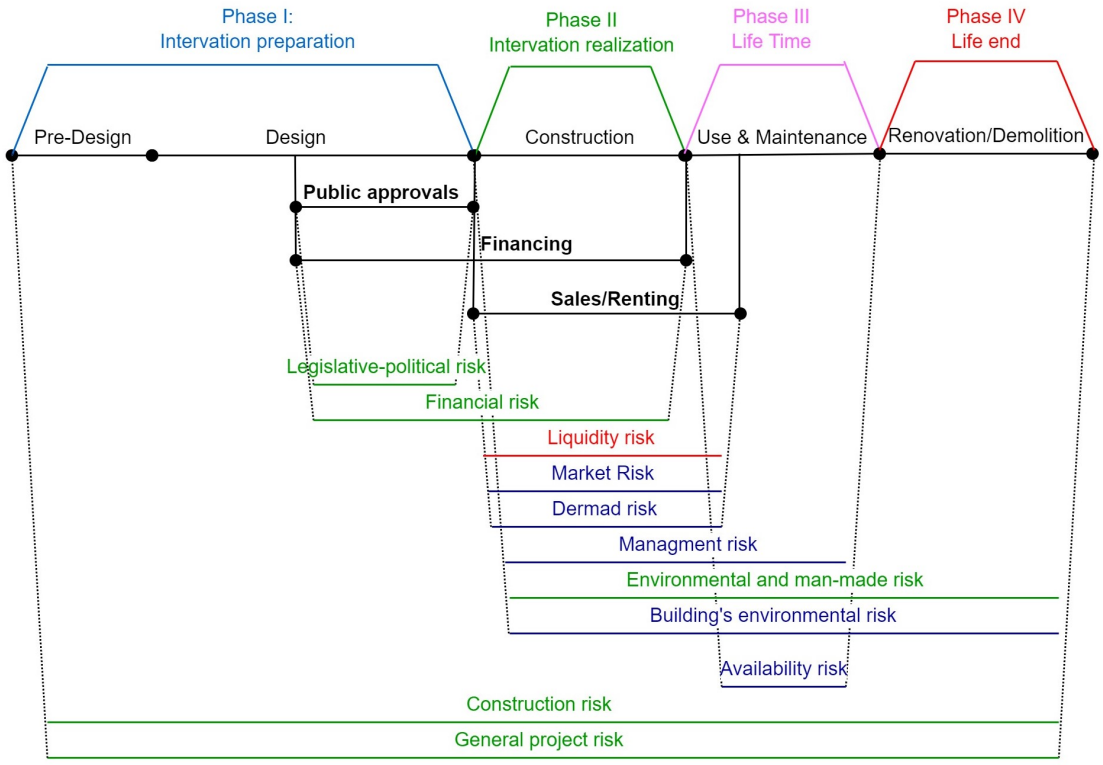


Figure 2.14: Risks linked to the outline of the property development process

Source: own elaboration, 2023

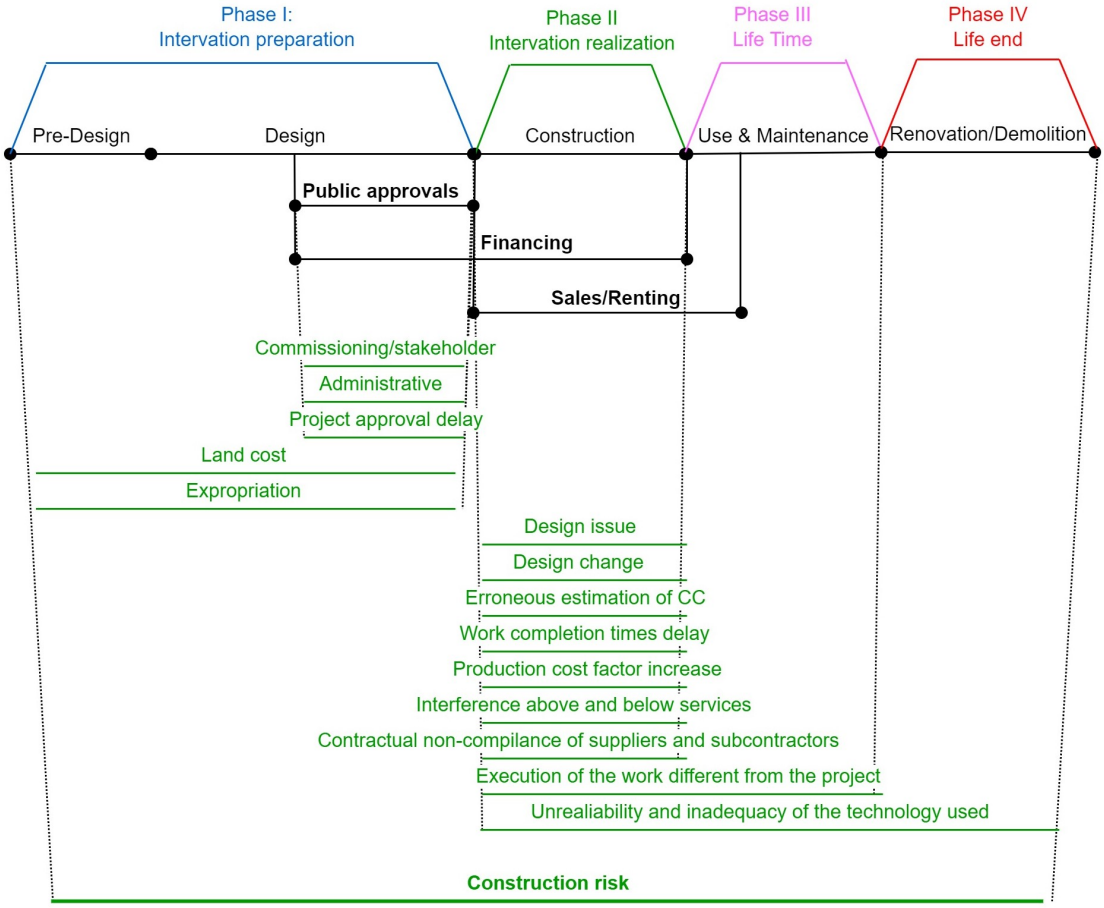


Figure 2.15: Construction risks linked to the outline of the property development process

Source: own elaboration, 2023

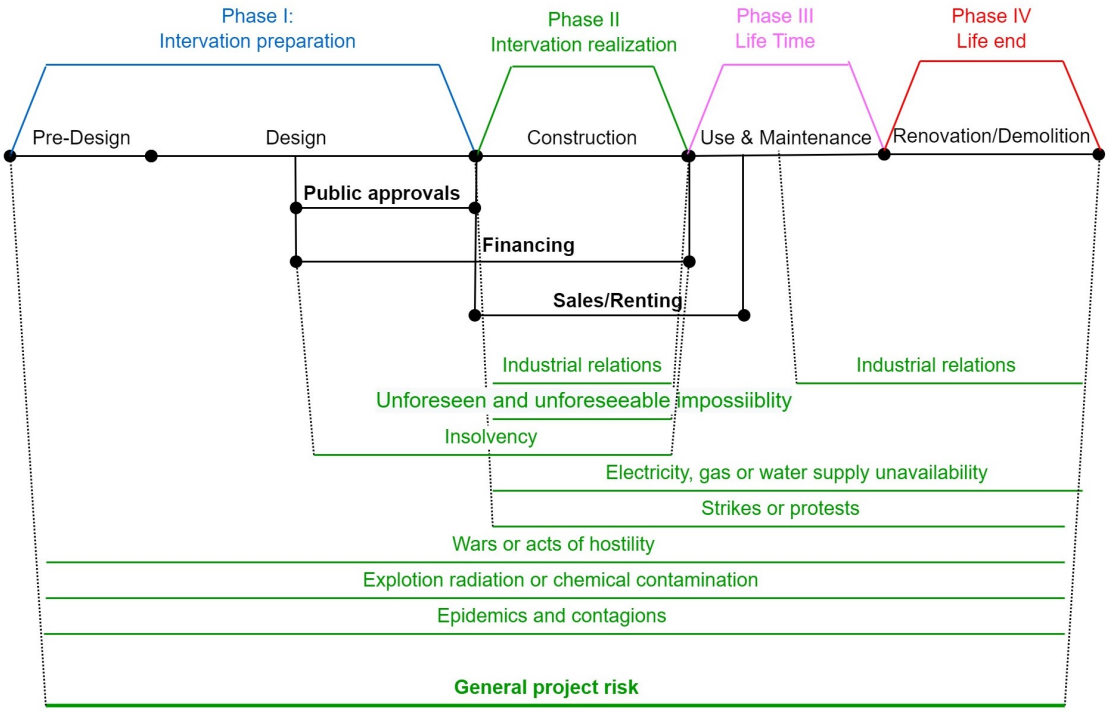


Figure 2.16: General project risks linked to the outline of the property development process

Source: own elaboration, 2023

2.5 Summary of the chapter

The goal of the second chapter is to identify and explain the risks that affect the feasibility of a real estate development project.

Macro-categories of these risks are construction risk, market risk, financial risk, risk of the building's environment, legislative-political risk, availability risk, management risk, liquidity risk, environmental and man-made risk, and general project risk.

Once all of the risks that might affect a real estate project have been identified, they have been assigned to the markets and sectors of the general real estate scheme in figure 1.3 chapter one. One of the most essential classifications is referring to the public-private partnership by its very nature since one of the reasons why the PPP is employed is the clarity and simplicity of risk allocation between public and private parties.

Consequently, a work plan was established using the life cycle assessment (LCA) theory, outlining the entire process of building realisation and then integrating the outline of the property development process into the work of plan. Three works of plan issued by ACE, RIBA, and Legislative Decree 50/16 e ss.mm.ii were examined, "exploded," and brought together to generate the outcome of the work of plan. Finally, after all of the risks associated with purchasing and selling, and renting have been identified, this later risk subdivision is linked to the outline of the property development process.

Chapter 3

Environmental and man-made risks in real estate

Nowadays, climate change is causing increasingly extreme, frequent and devastating weather phenomena. In other words, changes in climatic conditions are causing extreme situations and disastrous events, compromising the 'health' of the planet and the safety of those who live on it. There are no exclusions of sectors, all are affected by climate change. The construction sector is one of the most impactful from the point of view of emissions, and is therefore a source of pollution, as well as structural, social, and economic adjustment on the territory. Real estate, being the engine of the construction sector, has a high sensitivity to climate change. So, investors have recently made net-zero commitments, regulators have set reporting requirements, governments have implemented legislation aimed at reducing emissions, employees have demanded action, and tenants have sought more sustainable buildings. Simultaneously, the growing physical repercussions of climate change are becoming more apparent as populations suffer storms, floods, fires, excessive heat, and other risks[37]. This chapter will specifically study the latter topic with a point of view regarding the environmental and man-made risks in the Italian real estate. Following there is a list of the environmental and man-made risks in Italy:

- Land consumption and contamination risk;
- Earthquake risk;
- Volcanic risk: Stromboli, Etna, Campi Flegrei, Vulcano, Vesuvio, Ischia;

- Weather-hydrogeological and hydraulic risk:
  - Thunderstorms and lightning;
  - Floods;
  - Snow and frost;
  - Subsidence and deepening;
  - Winds and sea storms;
  - Rain and hail showers;
  - Landslides;
  - Avalanches;
  - Coastal erosion;
- Sea level rise;
- Temperature rise;
- Melting of Alpine glaciers;
- Tidal wave risk;
- Forest fires risk.

In the following sections some of these phenomena will be studied. Explaining how a real estate developer might consider the impact of these phenomena, first from a standard point of view and then from a specific point of view, in the investment phase and thus in the feasibility assessment of a project.

3.1 How Real Estate is impacted by natural disaster?

Nowadays natural disaster are more and more increasing in severity and frequency. Due to the improvement of construction technology, materials [...] in terms of quality, precision, environmental impact[1] and cost are increasing the value of properties and so there is more sensitivity to consider how natural disaster, in addition to all other types of risk, impact a property's value. This is the present challenge that investors are trying to win and they feel the market changes resulting from natural disaster very much. The real estate market's reaction to a natural disaster is determined by a variety of factors:

- Extent of the damage. The value of a home with extensive damage will naturally be more impacted by a natural disaster than a home with minimal damage. Even if the damage is repaired, if historical evidence of previous disasters remains, it can lower the value of a home.
- Localization of the damage. Natural disasters have the potential to affect nearly every property in a given area.
- Demand for the location. Locals in many parts of the country are accustomed to natural disasters that occur on a regular basis. Homeowners are aware of the risks but still choose to live there. After all, there are very few places on the planet that are immune to some form of national disaster.
- Insurance policies and practices. Following a natural disaster, they have a significant impact on property values. If insurance companies expect the disaster to happen again, they may raise homeowner's insurance rates to offset the risk. This would drive up the cost of home-ownership in those areas, potentially reducing demand. If demand falls, home values will most likely fall as well. Insurance companies, on the other hand, frequently allow construction in disaster-prone areas.

[1]The goal of new technologies and materials is to decrease the emissions of a building, the use of cooling and heating systems.

3.2 Standard scheme of a real estate development process taking care of the environmental risks

To date, especially in Italy, few developers have carried out a risk analysis of phenomena caused by climate change or catastrophic events in general. To go down this road, regulations and directives with standardized analysis and evaluation processes would have to be introduced. Figure 3.1 shows a possible standard process that could be followed by real estate developers for an investment evaluation.

Therefore, a developer should analyse the area in which the investment is located under the social, economic, geographical, climatic, and environmental aspect. So the first question comes naturally: *can the area be prone to any environmental risk?* If no, the developer can go ahead with the feasibility evaluation, which is divided into parametric and specific evaluations (the feasibility evaluation will not be dealt with a specific in this research). On the other hand, if the area is prone to any environmental risks, the developer should proceed with specific analysis of each possible risk. These analyses are conducted to understand if the risk is too high to compromise the feasibility of the intervention or not. In the positive case, and if the risk can not be mitigated, the developer has to accept that the investment is not possible at all. If the risk is too high and there is a way to mitigate it, the feasibility evaluation can proceed, but the developer has to take care of the cost of the mitigation actions. These costs are not only referred to in the pre-design/design phase (the one just explained), but they also include the actions to be taken in the construction phase and the use & maintenance phase, and so it is important to consider, in the feasibility evaluation, the modalities, duration, and costs during all the phases. At the end of the feasibility evaluation, the developer will understand if the investment is worth it or not.

The section 3.3.1 will explain how the land contamination risk is approached, looking at what happens within the analysis of the possible risk. The same process is explained in the section 3.4.1 regarding the earthquake risk; the section 3.5.1 regarding the landslide risk; the section 3.6.1 regarding the flood risk; and the section 3.7.1 regarding the coastal erosion risk.

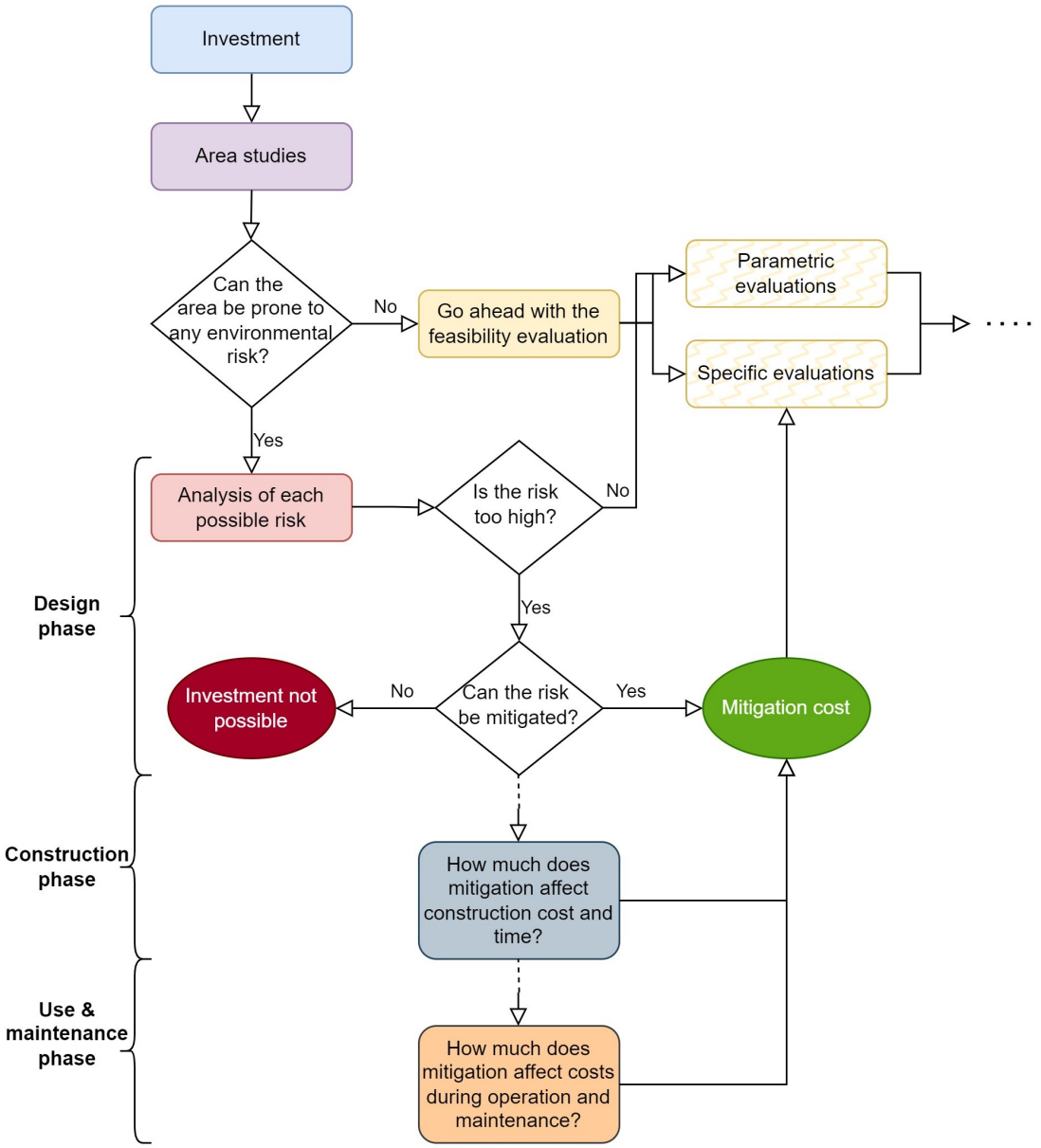


Figure 3.1: Standard process to evaluate environmental risks for a Real Estate developer.

Source: own elaboration, 2023

3.3 Land consumption and contamination risk

Soil is the top layer of the earth's crust, made up of mineral components, organic materials, water, air, and living organisms. It is the interface between land, air, and water and is home to a significant portion of the biosphere. Soil is a finite resource that is practically non-renewable due to its extraordinarily long formation period. So, natural soil must be safeguarded and preserved for future generations. Land consumption is the loss of a basic, restricted, and non-renewable environmental resource as a result of the utilization of an area that was formerly agricultural, natural, or semi-natural with artificial cover. Land consumption, land degradation and loss of functions of our ecosystems continue at an unsustainable rate and, in the last year, almost two square metres every second of agricultural and natural areas have been replaced by new construction sites, buildings, infrastructure or other artificial covers.

In Italy **artificial land cover** has now reached 7.13% (7.02% in 2015, 6.76% in 2006) compared to the EU average of 4.2%. Between 2020 and 2021, **land consumption** increased by 69.1 km2. This is in contrast to the **restoration** of natural areas due to the transition from consumed to non-consumed soil, which amounts to 5.8 km2. **Net land consumption** (63.3 km2) is calculated by balancing soil consumption with the growth in agricultural, natural, and semi-natural areas caused by rehabilitation, demolition, de-permeabilisation, and renaturation.[38] The biggest source of soil deterioration in Europe is **soil sealing**, which is the permanent covering of a portion of the land and its soil with artificial materials (such as asphalt or concrete) for the construction of buildings and roads. It increases the risk of flooding, contributes to climate change, threatens biodiversity, causes the loss of fertile agricultural land and natural and semi-natural areas, and, in conjunction with urban sprawl, contributes to the progressive and systematic destruction of the landscape, particularly rural areas, as well as the loss of the ability to regulate natural cycles and mitigate local thermal effects. These and other data regarding the changes between 2020 and 2021 are shown in the table 3.1.

Land consumption is classified as permanent and reversible.

- Permanent land consumption: buildings, paved roads, railways, airports, ports, car parks, sports fields, courtyards, permanent paved greenhouses, landfills.

- Reversible land consumption: unpaved roads, construction sites and other clay areas (car parks, sports fields, courtyards, permanent deposits of material), non-naturalised mining areas, quarries in the stratum, ground-mounted photovoltaic systems.

Land consumption [km2]	69.1
Restoration [km2]	5.8
Net land consumption [km2]	63.3
Permanent land consumption [km2]	13.6
Waterproofing of already reversibly consumed areas [km2]	11.9
Overall waterproofing [km2]	25.5
Increase in other covers not taken into account [km2]	8.9
New areas with a surface area of less than 1,000 m2 [km2]	8.2

Table 3.1: Estimated annual land consumption between 2020 and 2021

Source: ISPRA elaborations on SNPA cartography, 2022

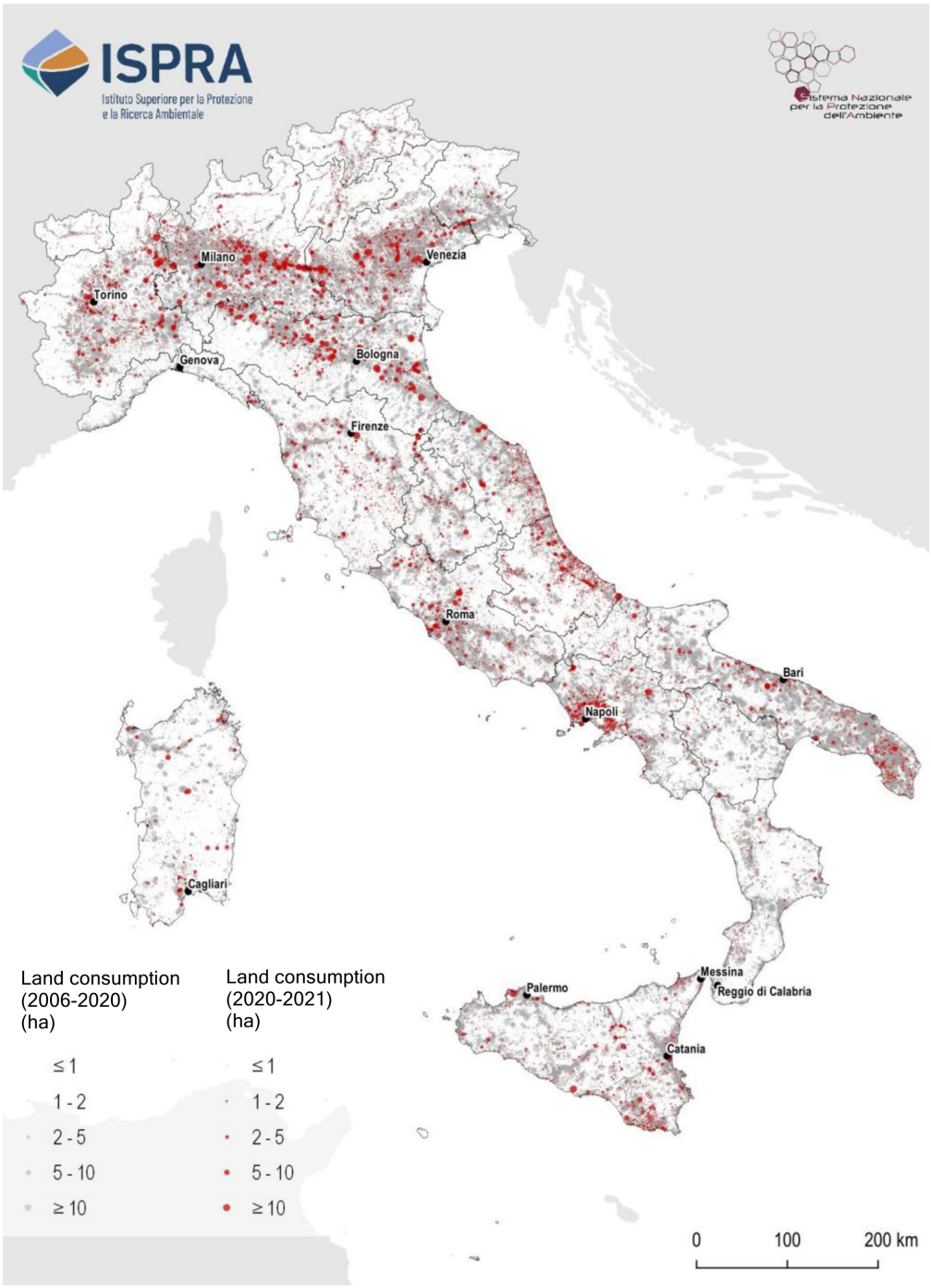


Figure 3.2: Location of the main changes due to soil consumption between 2006 and 2021.

Source: ISPRA elaborations on SNPA cartography, 2022

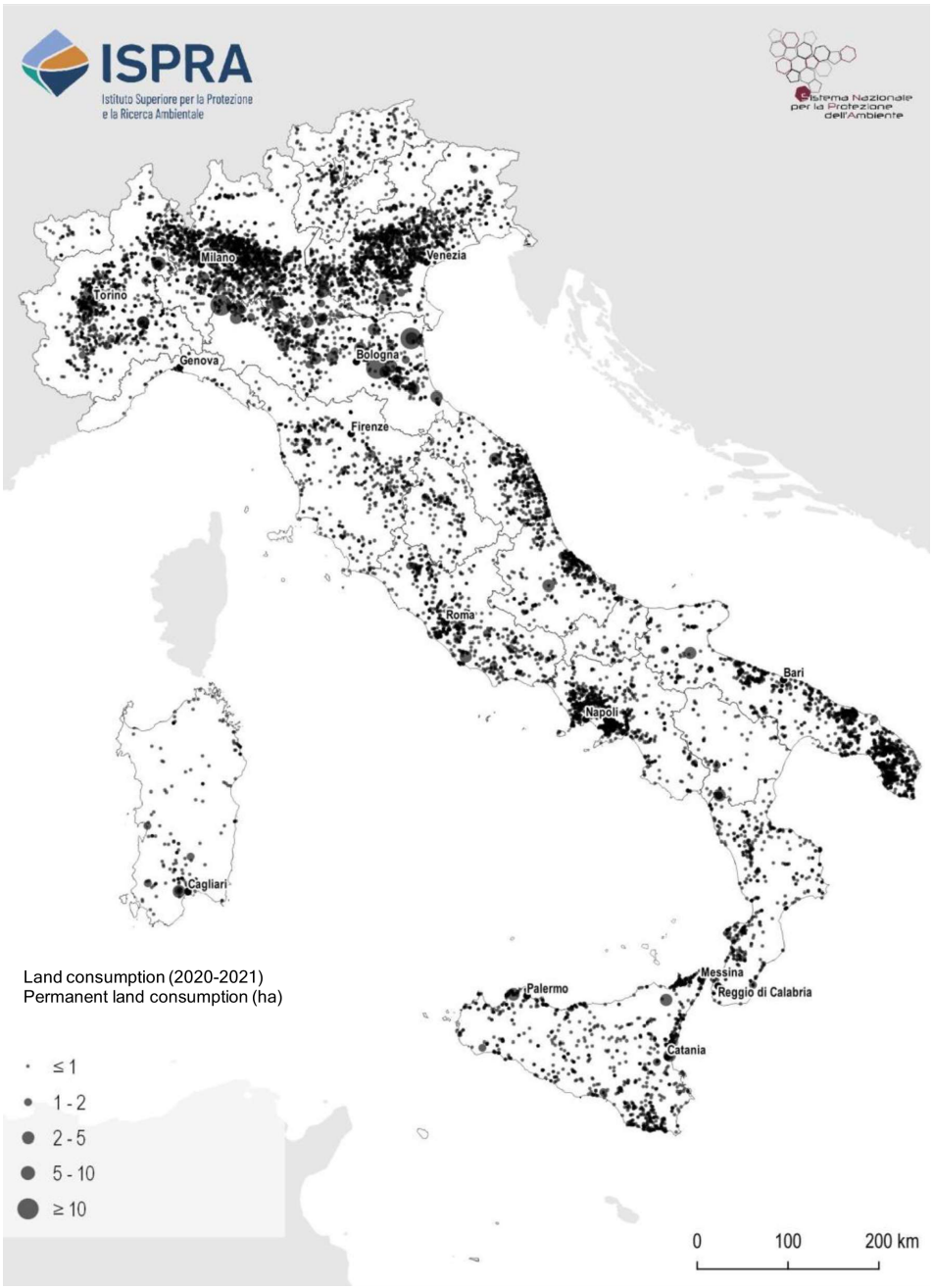


Figure 3.3: Location of major changes due to permanent land consumption between 2020 and 2021.

Source: ISPRA elaborations on SNPA cartography, 2022

As showed in the table of the figure 3.4 and in the figure 3.5, the highest percentage values of consumed soil are in Lombardy (12.12%), Veneto (11.90%), Campania (10.49%), Emilia Romagna (8.90%), Puglia (8.20%), Lazio (8.13%), Friuli Venezia-Giulia (8.00%) and Liguria (7.25%). These regions overtake the national average of consumed soil (7.13%).

Soil consumption is less intense in protected areas (where 65 hectares more have been recorded in the last year) and in mountain areas. On the other hand, it is evident in areas subject to landscape protection restrictions (+1,037 hectares), within 10 km from the sea (+1,284 hectares), in areas with medium hydraulic hazard (+767 hectares), in areas with landslide hazard (+286 hectares) and in areas with seismic hazard (+1,852 hectares).

Region	Soil consumed 2021 (ha)	Soil consumed 2021 (%)
Piemonte	169.655	6,68
Valle d'Aosta	7.001	2,15
Lombardia	289.386	12,12
Liguria	39.299	7,25
Nord-Ovest	***505.341***	***8,72***
Friuli-Venezia Giulia	63.375	8,00
Trentino-Alto Adige	41.624	3,06
Emilia-Romagna	200.320	8,90
Veneto	218.230	11,90
Nord-Est	***523.549***	***8,40***
Umbria	44.543	5,27
Marche	64.751	6,94
Toscana	141.827	6,17
Lazio	139.918	8,13
Centro	***391.039***	***6,75***
Basilicata	31.701	3,17
Molise	17.414	3,92
Abruzzo	54.210	5,02
Calabria	76.319	5,06
Puglia	158.695	8,20
Campania	142.625	10,49
Sud	***480.963***	***6,56***
Sardegna	80.029	3,32
Sicilia	167.590	6,52
Islands	***247.619***	***4,97***
ITALIA	**2.148.512**	**7,13**

Figure 3.4: Soil consumption indicators at regional level.

Source: ISPRA elaborations on SNPA cartography, 2022

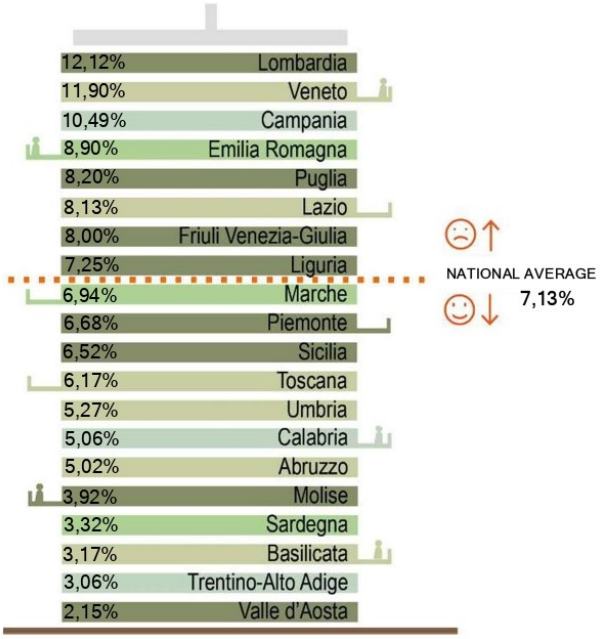


Figure 3.5: Comparison of the percentage of consumed soil per region (2021) with the national average.

Source: ISPRA elaborations on SNPA cartography, 2022

Finally, built-up areas (table in the figure 3.6) in Italy surpass 5400 km2, accounting for 1.8% of the national territory and 25% of total land consumption. Lombardy has the most built-up area (837 km2 or 3.5% of the total region), followed by Veneto (717 km2 or 3.9% of the regional territory); furthermore, Veneto has the highest rate of land covered by buildings (32.9%), followed by Piedmont (29.8%), Lombardy (28.9%), Emilia Romagna (26,3%), and Campania (25.8%).

Region	Soil consumed for buildings (ha)	Soil consumed for buildings (%)	Land consumed for buildings compared to total land consumed (%)	Land consumed per building per capita (m^2/ab)
Piemonte	50.611	2,0	29,8	118
Valle d'Aosta	1.188	0,4	17,0	96
Lombardia	83.707	3,5	28,9	84
Trentino-Alto Adige	7.911	0,6	19,0	73
Veneto	71.699	3,9	32,9	147
Friuli-Venezia Giulia	15.676	2,0	24,7	130
Liguria	9.099	1,7	23,2	60
Emilia-Romagna	52.690	2,3	26,3	119
Toscana	33.073	1,4	23,3	90
Umbria	8.868	1,0	19,9	102
Marche	14.867	1,6	23,0	99
Lazio	31.685	1,8	22,6	55
Abruzzo	11.798	1,1	21,8	92
Molise	3.122	0,7	17,9	106
Campania	36.784	2,7	25,8	65
Puglia	34.350	1,8	21,6	87
Basilicata	4.311	0,4	13,6	79
Calabria	15.303	1,0	20,1	82
Sicilia	37.821	1,5	22,6	78
Sardegna	15.512	0,6	19,4	98
ITALIA	540.073	1,8	25,1	91

Figure 3.6: Consumed land 2021 for built-up areas

Source: ISPRA elaborations on SNPA cartography, 2022

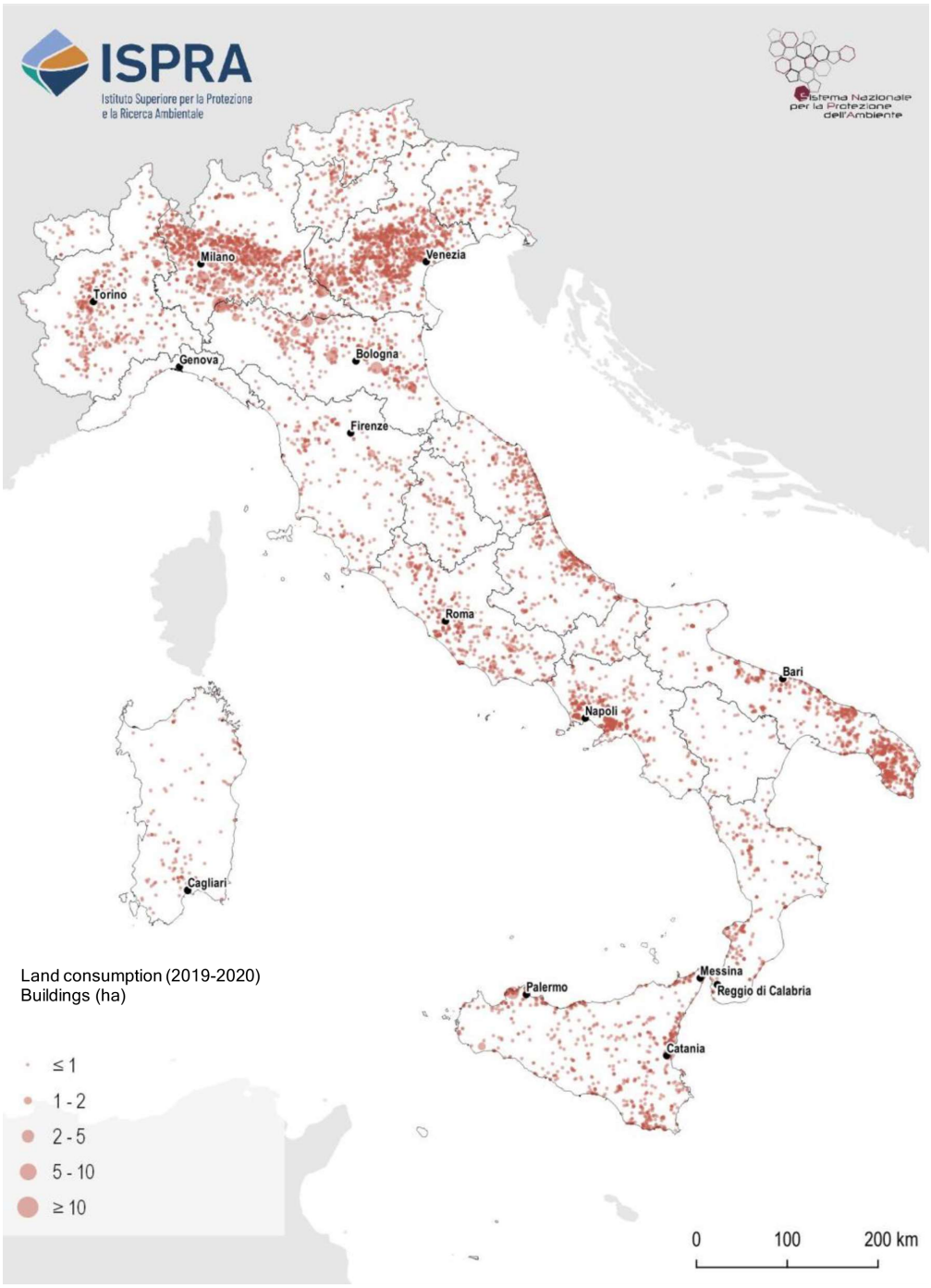


Figure 3.7: Location of major changes due to land consumption for new buildings between 2020 and 2021

Source: ISPRA elaborations on SNPA cartography, 2022

3.3.1 Land consumption and contamination risk in Real Estate

The commission of the European Union approved a strategy for land consumption. The strategy establishes a framework and real methods to conserve and restore soils and assure their sustainable usage. It establishes a vision and objectives for healthy soils by 2050, with tangible steps to be implemented by 2030. The target that most impacts the real estate development are to **reduce net land consumption** and the **hierarchy of land consumption**:

1. Avoid: as far as possible, avoid further soil consumption and sealing.

2. Reuse: If soil consumption or sealing cannot be avoided, it is desirable to reuse previously consumed or sealed soil (for the same or different land use), for example, by building demolition, reclamation, de-sealing, or densification of soil.

3. Minimise: if consumption or sealing of land, as well as re-use of land, cannot be avoided, then land in previously less favourable circumstances should be consumed or sealed (e.g. avoid healthy forests or fertile agricultural land).

4. Compensate: if soil consumption or sealing occurs, mitigating or compensating measures should be used to minimise ecosystem service loss (e.g. infiltration and rainwater harvesting for water absorption, green roofs for water retention and biodiversity; green buildings for cooling; urban farms and gardens for biomass production)

There are regulations at national and regional levels that control and limit land consumption. Therefore, a developer must analyse in which area the investment is located in terms of the possibility of soil consumption (if new construction), status and compliance with regulations. Where possible, renovation or demolition and new construction are preferable (thus avoiding the consumption of more natural soil); furthermore, in the latter case, an analysis will be carried out to check whether there are any pollutants in the soil, with subsequent soil remediation in the positive case. If negative, or after soil remediation, and if there are no other risks (e.g. erosion, landslide, earthquake risk, etc..) the developer can proceed with the feasibility analysis.

In general, a real estate developer who wants to invest in new construction (or reconstruction after a demolition) has to make a soil analysis regarding the possible contamination of the land. So, if the land is not contaminated the developer can go ahead with the feasibility evaluation, otherwise he/she needs a **health-environment risk analysis** (figure 3.8).

The latter is currently the most sophisticated decision-support tool in the management of contaminated sites, allowing for the quantitative assessment of the risks to human health associated with the presence of contaminants in environmental matrices. The creation of the Conceptual Model of the Site (MCS) serves as the foundation for the application of risk analysis, based on the recognition and parameterization of the primary three following aspects: the *source of contamination*; the *routes of migration of pollutants through environmental matrices*; *targets or receptors of the contamination on the site or its surroundings*. Only when all three elements are present and interconnected at a specific location can risk to human health be determined.[39]

The risk (R) posed by a contaminated location is determined by the following formula: R = E x T; where E is the contaminant's chronic daily consumption and T is the contaminant's toxicity.

The risk analysis technique can be carried out in either direct (forward mode) or reverse mode (backward mode). Knowing the concentration at the source of contamination allows the direct mode to estimate the health risk for the exposed receptor, whether it is located near the site (on-site) or at a set distance (off-site). Instead, after determining the amount of health risk deemed acceptable for the exposed receptor, the inverse mode calculates the maximum concentration at the source consistent with the risk acceptability condition.[40]

Finally, the estimated risk is compared with the acceptability criteria defined by the regulations: risk threshold concentrations. If the estimated risk is minor then the risk threshold concentrations are possible to go ahead with the feasibility evaluation, otherwise, a soil reclamation is needed and the developer has to annotate the price for this process in the feasibility evaluation.

Operating in presence of contaminated soil can lead to a profit that is not worth investing in because there is a process to follow (figure 3.8) first of all to find out if there is such a risk and then to see if the risk exceeds the risk threshold concentrations by having to proceed with remediation.

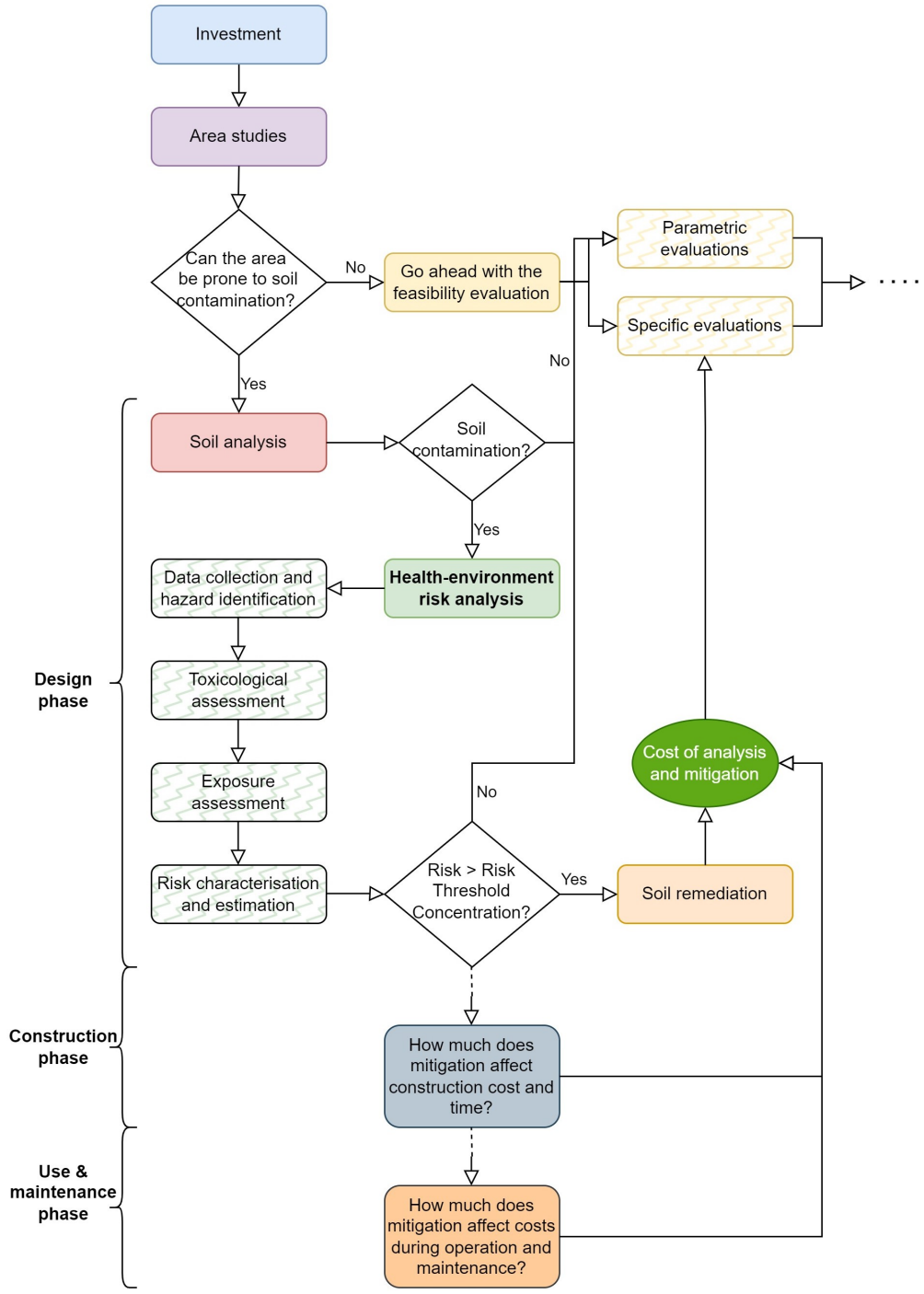


Figure 3.8: Process to evaluate the soil contamination risk for a Real Estate developer

Source: own elaboration, 2023

3.4 Earthquake Risk

The seismicity of the Italian peninsula is connected to its specific geographical location, since it is positioned in the convergence zone between the African and Eurasian sods and is susceptible to intense compression stresses, causing rock blocks to overlap.[41]

Although the entire national territory is seismic - and all Italian municipalities can be damaged by earthquakes - the strongest tremors are concentrated in specific areas: in North-Eastern Italy (Friuli Venezia Giulia and Veneto), in Western Liguria, in the Northern Apennines (from Garfagnana to Rimini), and all along the Central and Southern Apennines, in Calabria, and Eastern Sicily.[42]

Seismic risk is determined by a combo of hazard, vulnerability, and exposure and is a measure of the damage that may be predicted in a particular time interval dependent on the kind of seismicity, building resistance, and anthropization (nature, quality, and quantity of exposed property). Because of the frequency and severity of the phenomena, Italy has a medium-high seismic hazard; a very high vulnerability, due to the fragility of the architectural, infrastructural, industrial, productive, and service legacy; and a very high exposure, due to population density and the presence of a unique historical, artistic and monumental heritage. As a result, the peninsula faces significant seismic risk in terms of human casualties, building damage, and direct and indirect costs resulting from an earthquake. The earthquakes that have devastated the peninsula have caused significant economic damage, estimated at roughly 135 billion euros over the previous forty years and utilised for post-event rehabilitation and reconstruction. To this must be added the implications of historical, artistic, and monumental legacies that cannot be turned into commercial worth.

3.4.1 Earthquake Risk in Real Estate

In terms of investment convenience, the seismic risk is the only one that can not be avoided in Italy. "Avoid" refers to the impossibility of considering making a feasibility evaluation due to the more or less uniform territory in terms of seismic hazard. In other words, a real estate developer does not compare different properties or locations because he/she has to follow the seismic regulations, in any case, so the earthquake hazard does not change the feasibility evaluation. The only case that a developer can evaluate is in specific cases. For example, to invest in an area there can be the possibility of having either free land or existing property (figure 3.10) Assuming that the existing property needs seismic adaptations, can a new building be more convenient in terms of money, reliability, and demand?

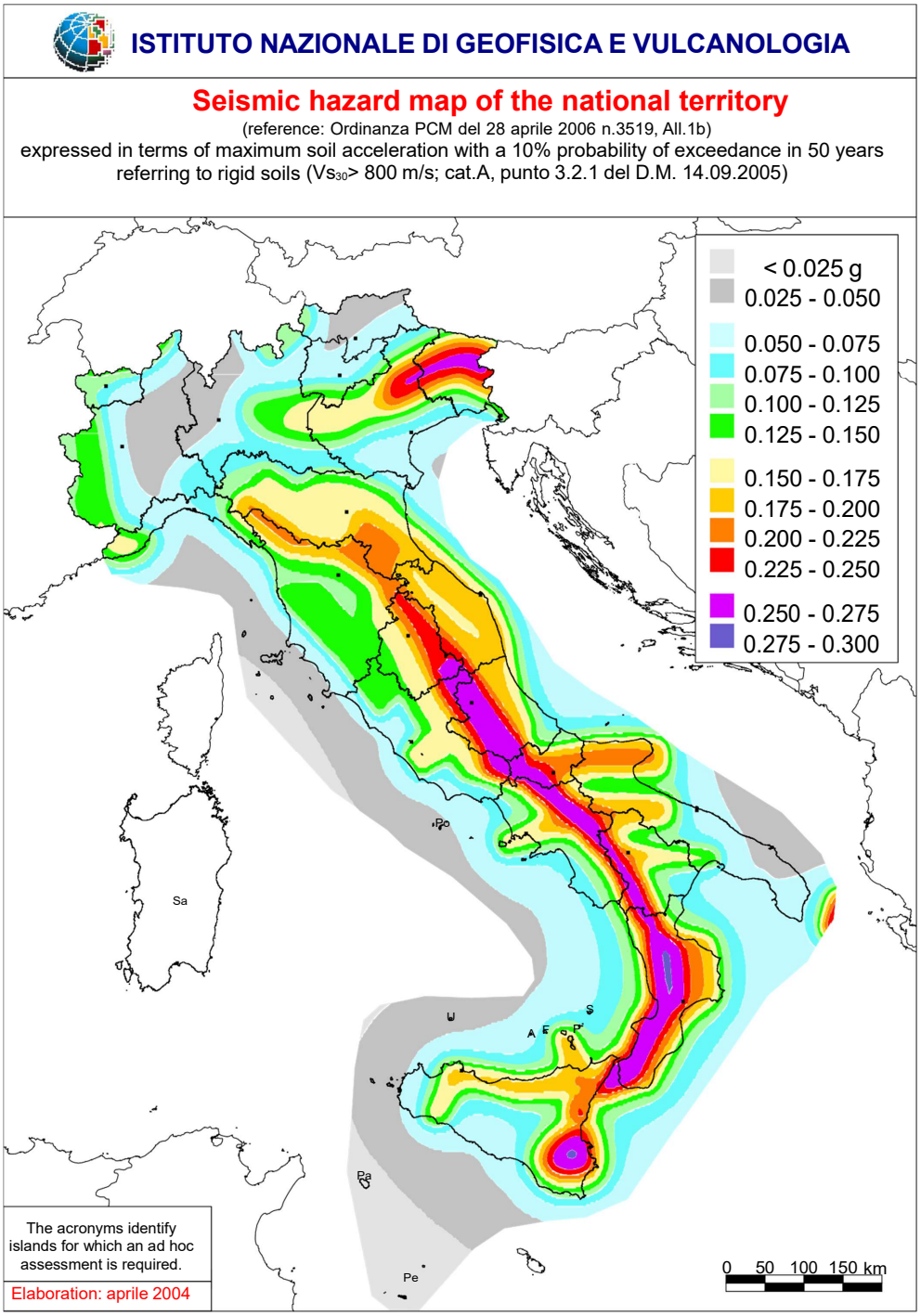


Figure 3.9: Seismic hazard map of the Italian territory

Source: INGV, 2006.

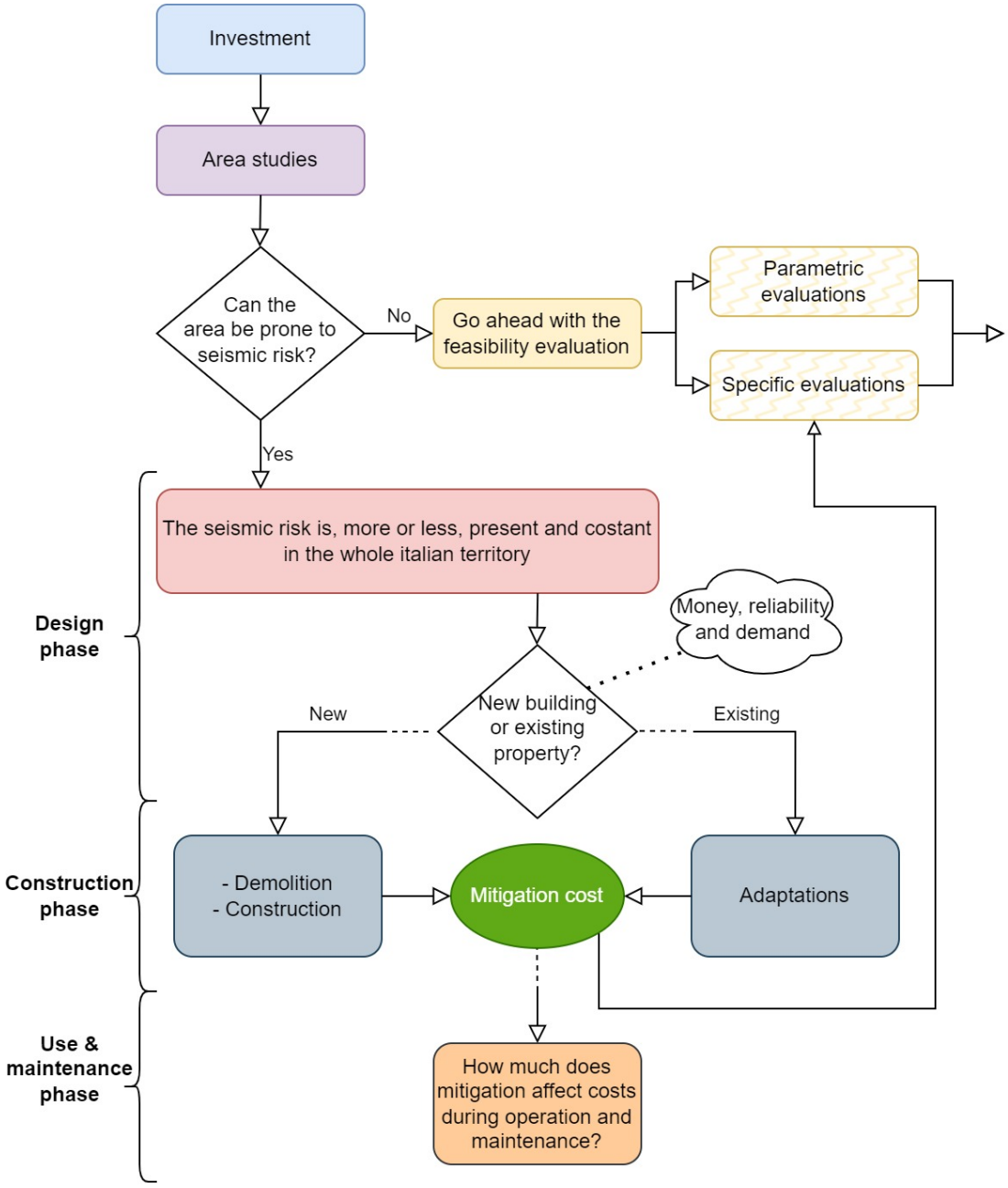


Figure 3.10: Process to evaluate the seismic risk for a real estate developer

Source: own elaboration, 2023.

3.5 Landslides risk

Landslides are extremely widespread phenomena due to the geological and morphological characteristics of the Italian territory, which is 75% mountain-hilly[43]. About one-third of the total landslides in Italy are rapid kinematic phenomena (collapses, rapid mud and debris flow), characterised by high speeds, up to a few metres per second, and high destructiveness. The landslides surveyed in the Inventory of Italy are one of the European countries most affected by landslides, with 625.000 landslides covering an area of 24.000 km2, equal to 7.9% of the national territory. A picture of the distribution of landslides in Italy can be obtained from the landslide index, equal to the ratio between the landslide area and the total surface, calculated on a 1 km mesh (Figure 3.11). The IFFI Inventory (inventory of landslide phenomena in Italy) is the most complete and detailed landslide database in Italy. From the analysis of the PAI implementation rules, the interventions allowed based on the landslide hazard classification are:

- **very high landslide hazard**: interventions strictly necessary to reduce the vulnerability of existing buildings and to improve the protection of public safety, without increases in surface area or volume and changes in intended use; reclamation works and accommodation of landslides; ordinary and extraordinary maintenance works; the construction of new linear and network infrastructures provided for by law, declared essential, not relocatable and lacking technically and economically sustainable design alternatives; practices for the correct agricultural and forestry activities; interventions aimed at the reclamation of contaminated sites; interventions of consolidation and conservative restoration of cultural heritage protected under current regulations.

- **high landslide hazard**: in addition to the interventions allowed in the areas of very high risk, the extension of existing buildings for hygienic-sanitary adaptation and the construction of new wastewater treatment plants and the extension of existing ones are also allowed, subject to a compatibility study of the work with the existing state of instability.

- **medium landslide hazard**: eligible interventions are those provided for in the territorial and urban planning instruments. The intervention must guarantee safety, stability and the non-alteration of geomorphological processes.

- **moderate landslide hazard**: any type of intervention foreseen by the territorial and urban planning instruments is generally allowed.

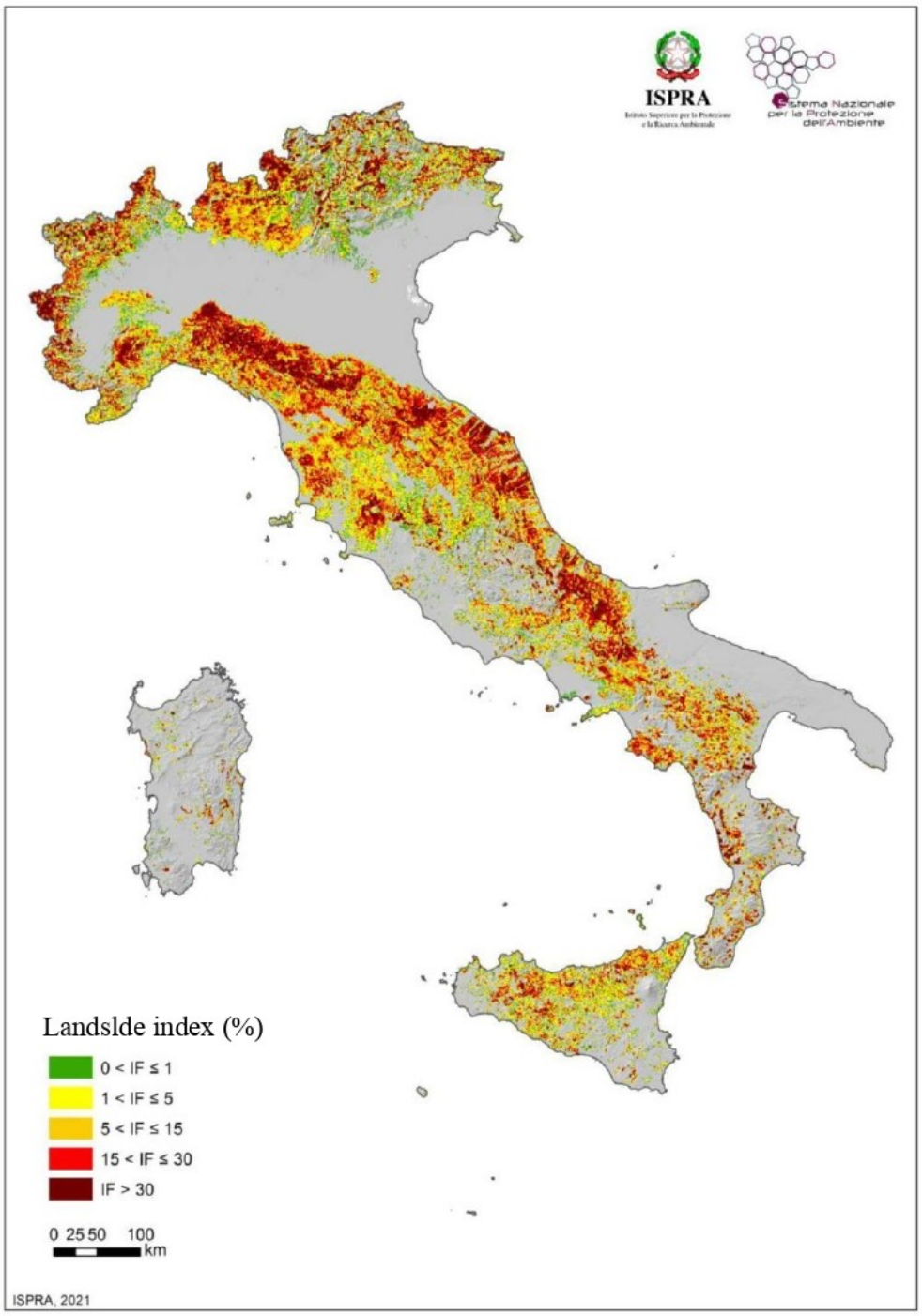


Figure 3.11: Percentage landslide index (IFFI Inventory landslide area/cell area × 100) on a mesh of side 1 km

Source: Dissesto idrogeologico in Italia: pericolosità e indicatori di rischio. A. Triglia, C. Iadanza et alt., 2021

The total surface area in Italy of the PAI (Piano di Assetto Idrogeologico – "hydrogeological management plan") landslide hazard areas and warning areas is 60.481 km2 (20% of the national territory). The area of **very high landslide hazard** is 9.495 km2 (3,1%), **high hazard** is 16.891 km2 (5,6%), **medium hazard** is 14.551 km2 (4,8%), **moderate hazard** is 12.556 km2 (4,2%) and the **attention areas** are 6.988 km2 (2,3%). If the highest hazard classes (high P3 and very high P4) are taken into account, which are subject to the most restrictive land use restrictions, the areas amount to 26.385 km2 or 8,7% of the national territory.

Hazard related to the magnitude of landslide phenomena		Likely frequency			
		high 1 - 30 years	medium 30 - 100 years	low 100 - 300 years	ancient landslides (> 300 years) and paleo-landslides
Magnitude classes	6 - 9	P4	P4	P3	P1
	3 - 4	P3	P3	P2	
	1 - 2	P2	P1	P1	

Figure 3.12: Iteration matrix for hazard assessment of landslide phenomena

Source: Dissesto idrogeologico in Italia: pericolosità e indicatori di rischio. A. Triglia, C. Iadanza et alt., 2021

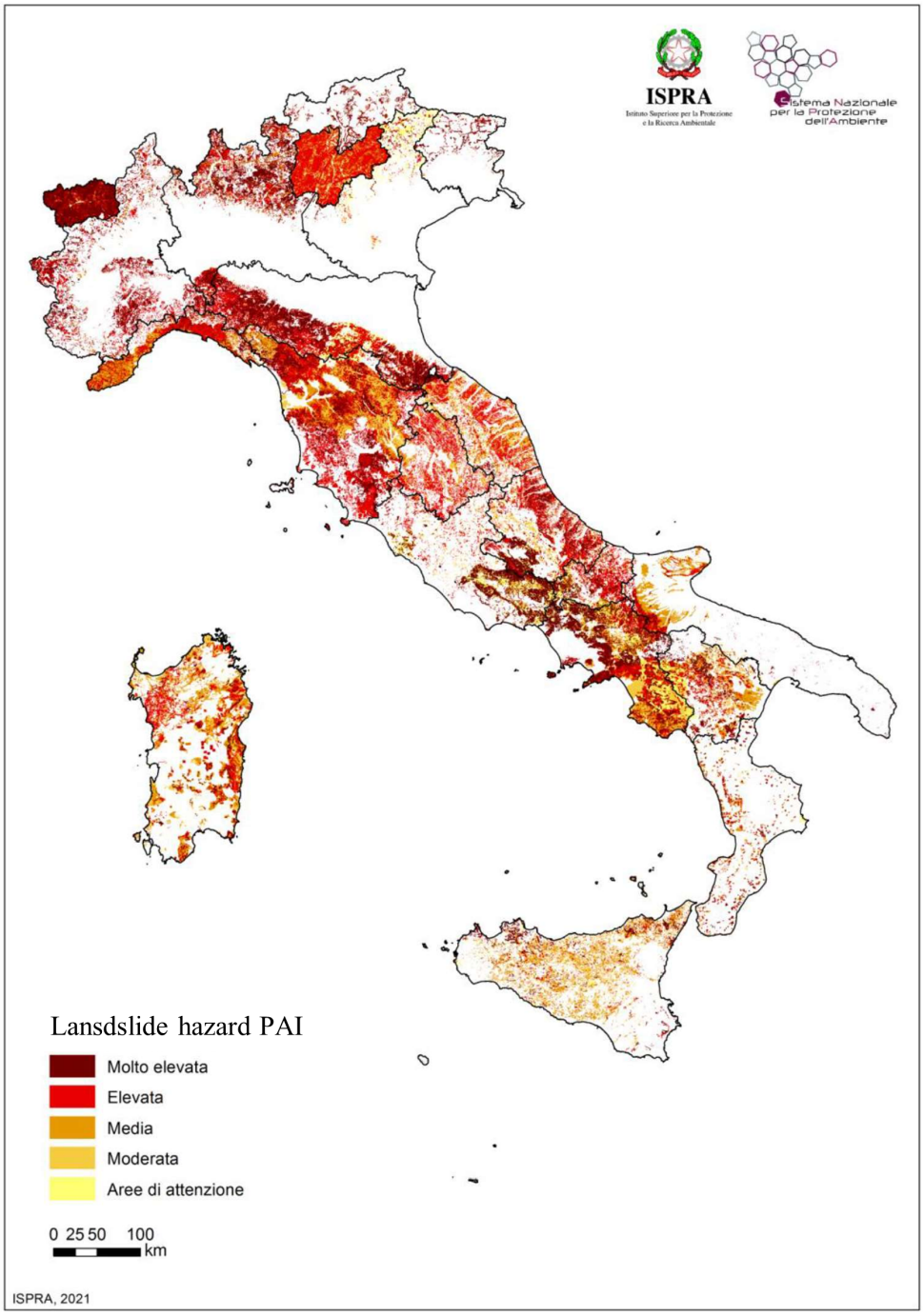


Figure 3.13: PAI landslide hazard area

Source: Dissesto idrogeologico in Italia: pericolosità e indicatori di rischio. A. Triglia, C. Iadanza et alt., 2021

3.5.1 Landslide risk in real estate

Landslides are the seventh most lethal natural catastrophe in the world, causing significant economic damage in many countries. As previously mentioned, landslide risk is widespread in Italy and, if not adequately considered, can cause damage or destruction of buildings, infrastructure, and any other structure, causing economic loss, loss of historical and building heritage, and, in the worst cases, death. Investing in an area prone to this risk can be unprofitable and put people at risk if appropriate mitigation actions are not implemented. So, an adequate knowledge of the triggering variables as well as the physical and economic repercussions is critical for developing more refined landslide risk management, mitigation measures, and land use policies. As a result, a developer must consider the interconnection between physical and economic exposure, i.e. the "economic landslide susceptibility", which is the probability of landslide occurrence in an area-weighted for its socio-economic exposure while taking real-estate market values into account; this approach is described in a research paper (Economic landslide susceptibility under a socio-economic perspective: an application to Umbria Region (Central Italy).[44]

In general, a real estate developer who wants to invest in new construction (renovation or reconstruction after a demolition) has to figure out if he/she is evaluating a landslide-prone area (through a study of the area), in the event of a negative response, the feasibility assessment can proceed; otherwise, the developer can proceed with the approach just introduced concerning the "economic landslide susceptibility" calculation (figure 3.15). The study of the area is conducted in geography, geological, morphological ways. Following that, three separate data sources are employed to estimate the economic landslide susceptibility:

- the raster landslide susceptibility map (S(land)): is defined as the probability of a landslide occurring in a certain location depending on local topography characteristics, defining "where" landslides may occur.
- the vector map of real estate market values from the Italian Revenue Agency's OMI (Osservatorio del Mercato Immobiliare) database: it gives information on real estate prices for different types of buildings. The databes provide: separation of municipalities into geographical regions that are as uniform as possible in terms of the predominant category of real estate market (typically residential); collection of economic data for individual real estate units; data processing; calculation and update of real estate unit quotations.
- It is possible to correlate information on the quantity and intended use category of buildings with each census polygon. The following details are picked for each polygon: the number of residential buildings; the number of buildings for commercial, production, service sector, offices, hotels, and so on; and the total number of inhabitants. Since the quantification of the real economic

impact due to landslides is widely underestimated if not ignored, in many hilly and mountainous areas the effective impacts on the economic system are very high and the evaluation of the landslide economic susceptibility could be of particular relevance in regional or national level. So, if there was a map for the whole country about these data, every developer, investor, stakeholder etc.. could have a repeatable and simple-to-implement tool for mapping landslide vulnerability and assessing economic risk. In conclusion, quantifying prospective losses can help determine where to minimise and how many economic resources to invest based on a cost-benefit analysis.

Having the data just described, it is possible to proceed with the economic susceptibility estimation for an "i" ISTAT census zone, as in the figure 3.14.

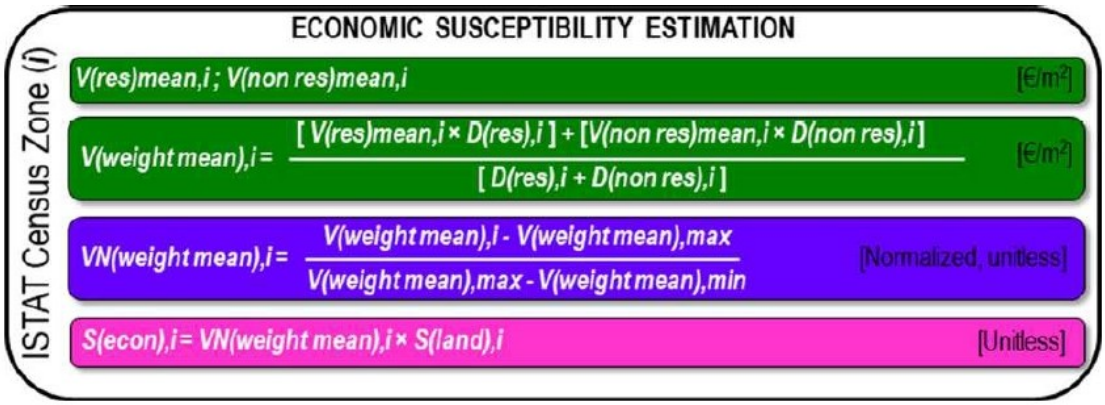


Figure 3.14: Economic susceptibility estimation for an "i" ISTAT census zone

Source: Economic landslide susceptibility under a socio-economic perspective: an application to Umbria Region (Central Italy). M. Donnini, M. Modica et alt., 2020.

V(res)mean,i and *V(non res)mean,i* are, respectively, the mean estate market value for residential and non-residential properties in an "i" census zone and are given in €/m2. *D(res),i* and *D(non res),i* are, respectively, the density of residential and non-residential buildings within a "i" census zone and are given in number of buildings per km2. *VN(weight mean)*,i is the normalized weighted mean real estate market value assessed within an "i" census zone and ranges from 0 to 1.

V(weight mean),min and *V(weight mean),max* are, respectively, the lowest and highest weighted mean real estate market values observed in the study area and are given in €/m2. *S(econ),i* and *S(land),i* are, respectively, the economic landslide susceptibility and the landslide susceptibility, both of which are unitless and range from 0 to 1.

Using this method, a developer can understand how landslide risk affects a specific area (both regionally and non-regionally) in terms of potential economic losses. This is important for determining how much it is worthwhile to invest in a certain location, as well as if and what type of mitigation actions are required.

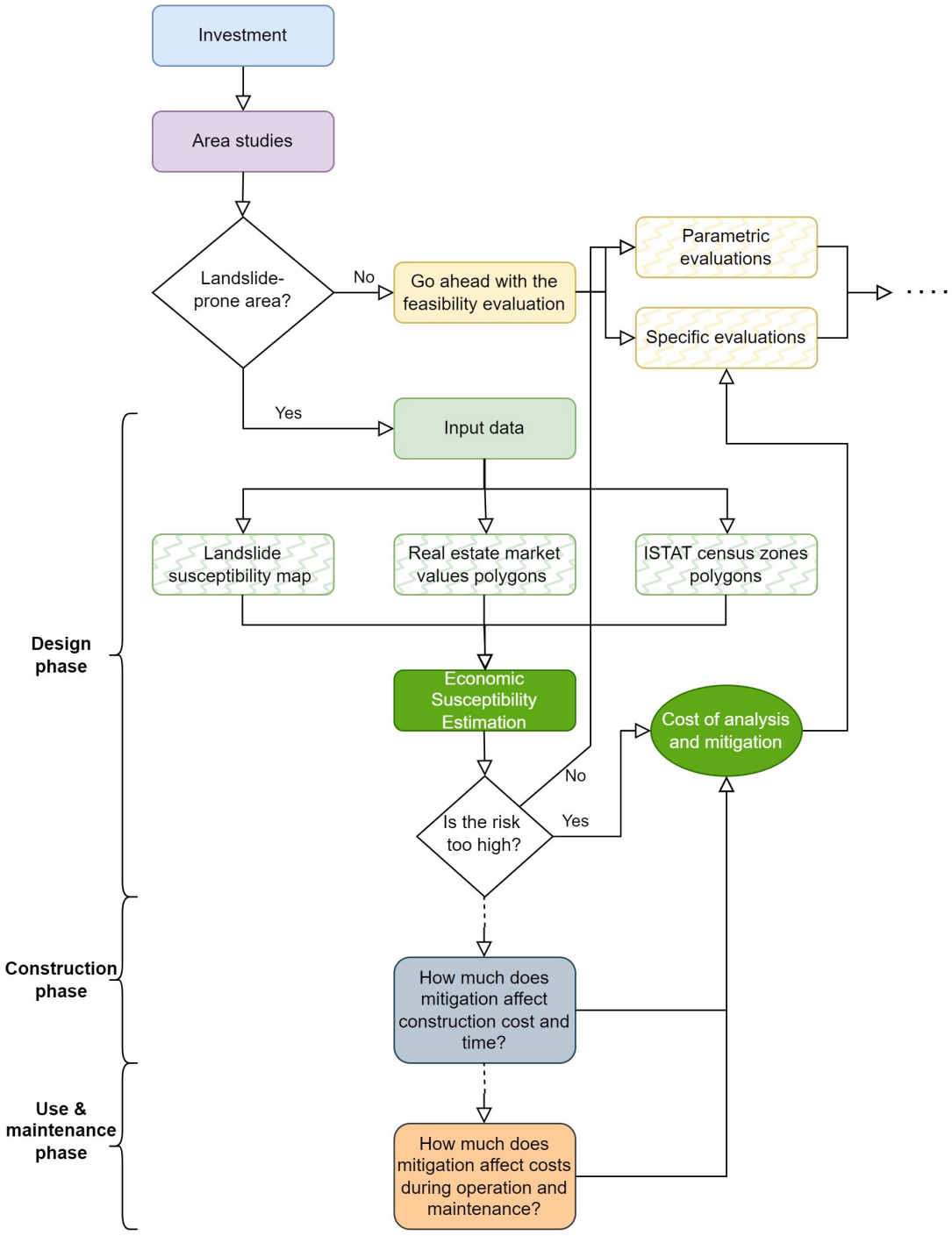


Figure 3.15: Process to evaluate the landslide risk for a real estate developer

Source: own elaboration, 2023.

3.6 Flood risk

Flood risk maps, according to the flood directive (FD), indicate the potential negative consequences for people, economic activities, the environment and cultural heritage (exposed elements). The ISPRA 2021 mosaic layers define the extent of the floodable areas over the entire national territory for each of the probability scenarios provided for:

- **High Probability Hazard** (**HPH**): with a covered area, in Italy, of 16224 km2, 5.4% of the national territory;
- **Medium Probability Hazard** (**MPH**): with a covered area, in Italy, of 30196 km2, 10% of the national territory;
- **Low Probability Hazard** (**LPH**): with a covered area, in Italy, of 42376 km2, 14% of the national territory.

Regarding the regional level, the percentages of possibly floodable land for the three hazard/probability scenario in Lombardy, Veneto, Friuli Venezia Giulia, Emilia Romagna, Toscana and Calabria are higher than those computed on a national scale. The percentages are shown in the table in figure 3.20.

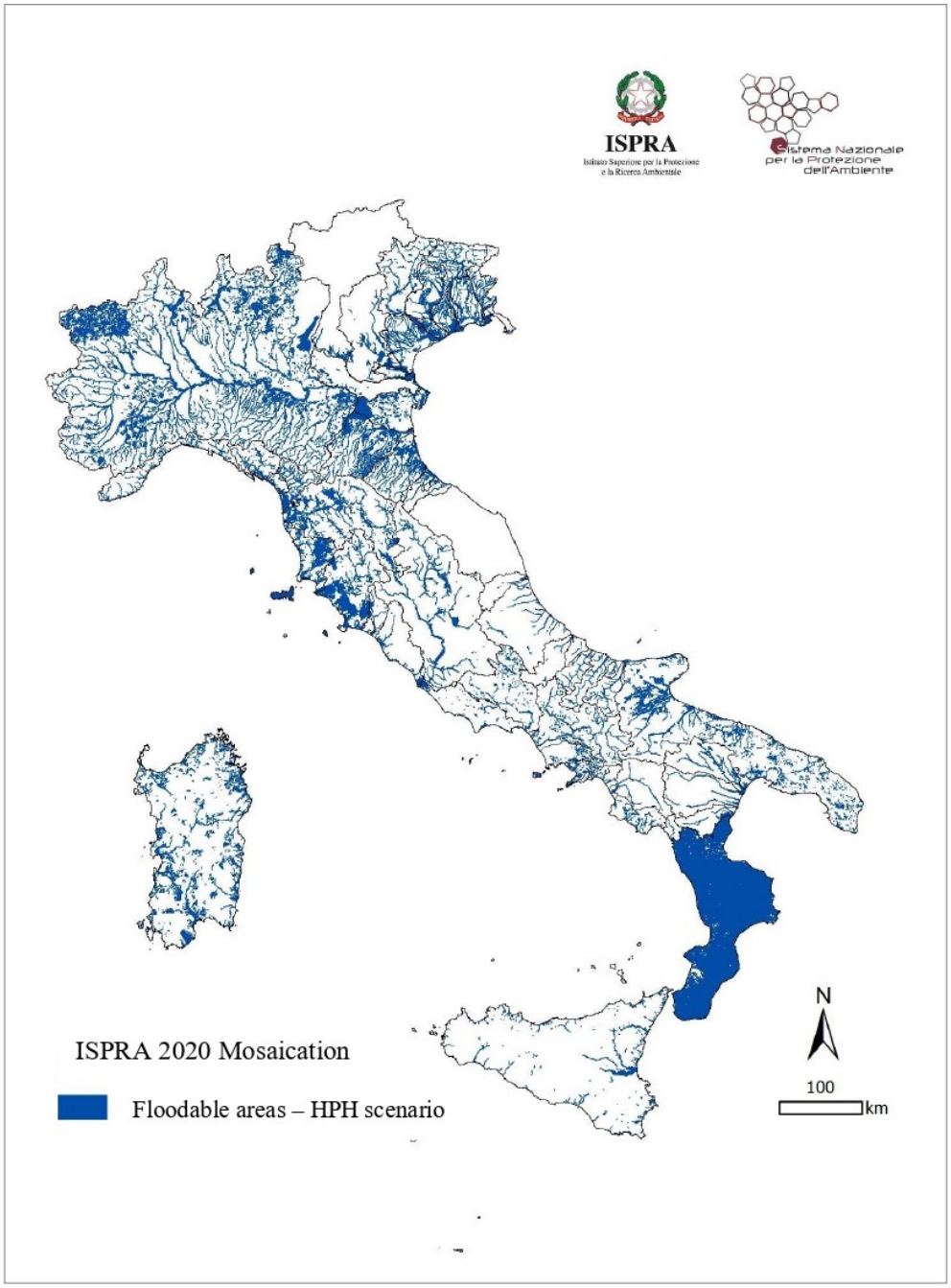


Figure 3.16: Floodable areas for high flood hazard scenario (High Probability Hazard – HPH)

Source: Dissesto idrogeologico in Italia: pericolosità e indicatori di rischio. A. Triglia, C. Iadanza et alt., 2021

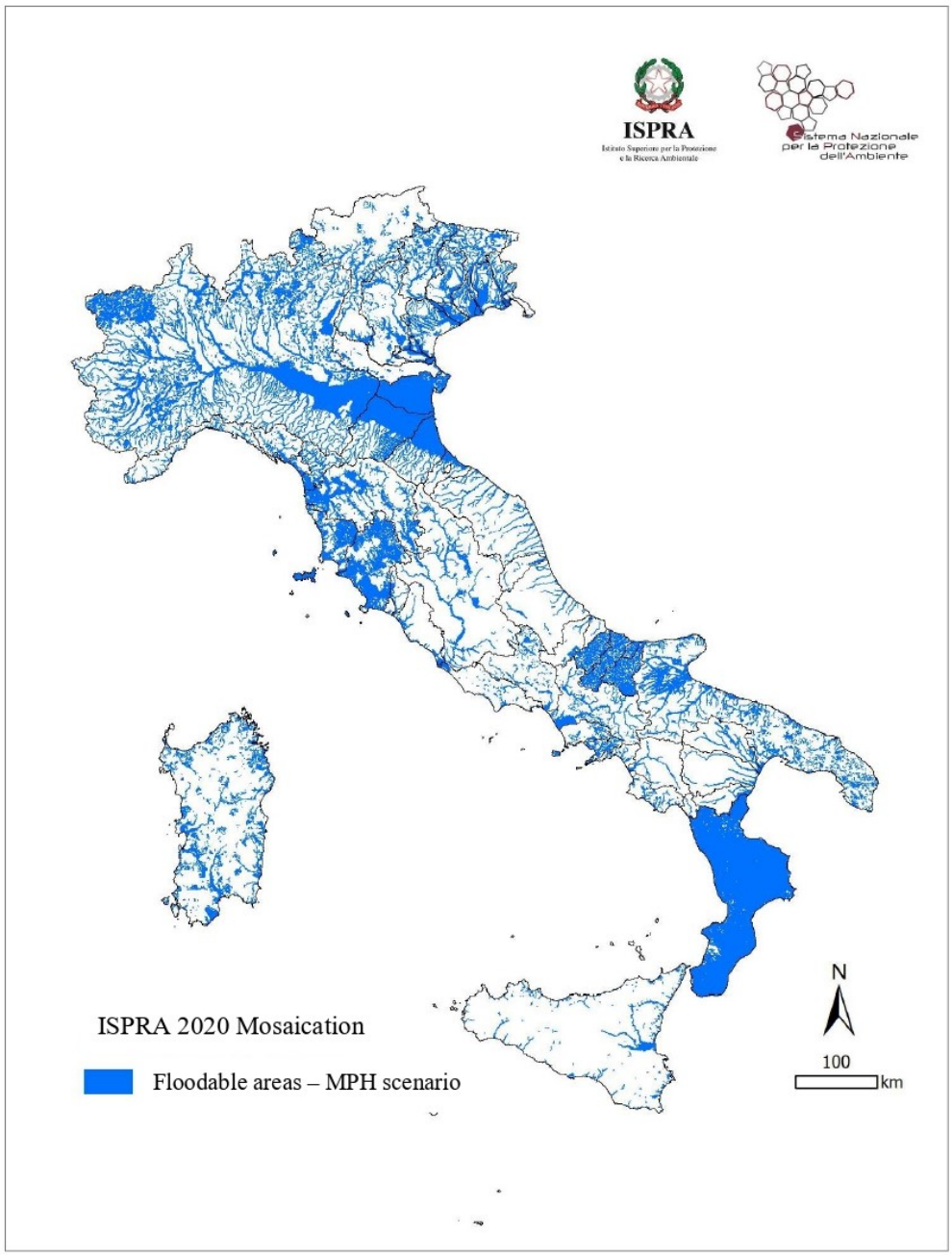


Figure 3.17: Floodable areas for medium flood hazard scenario (Medium Probability Hazard – MPH)

Source: Dissesto idrogeologico in Italia: pericolosità e indicatori di rischio. A. Triglia, C. Iadanza et alt., 2021

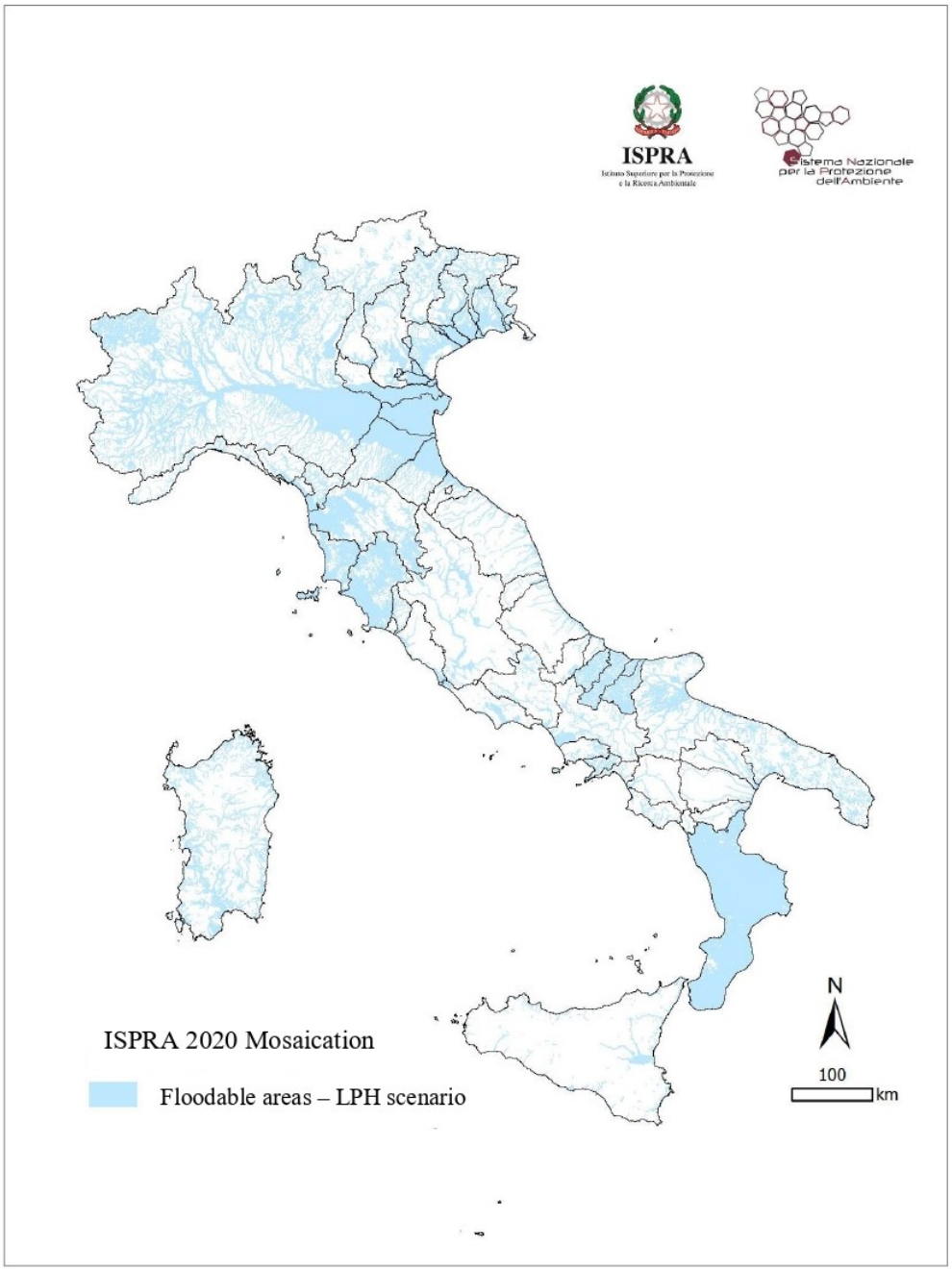


Figure 3.18: Floodable areas for low flood hazard scenario (Low Probability Hazard – LPH)

Source: Dissesto idrogeologico in Italia: pericolosità e indicatori di rischio. A. Triglia, C. Iadanza et alt., 2021

ID	Region	Regional area	Hydraulic hazard areas - Scenari FD e D.Lgs. 49/2010					
			High - HPH		Medium - MPH		Low - LPH	
		km^2	km^2	%	km^2	%	km^2	%
1	**Piemonte**	25.387	1.288,5	5,1	2.108,2	8,3	3.294,9	13,0
2	**Valle D'Aosta**	3.261	163,9	5,0	238,5	7,3	300,8	9,2
3	**Lombardia**	23.863	1.877,3	7,9	2.428,1	10,2	4.843,4	20,3
4	**Trentino-Alto Adige**	13.605	0,6	0,0	351,2	2,6	351,3	2,6
	Bolzano	7.398	0,0	0,0	70,9	1,0	70,9	1,0
	Trento	6.207	0,6	0,0	280,3	4,5	280,4	4,5
5	**Veneto**	18.345	1.835,9	10,0	2.435,5	13,3	5.900,5	32,2
6	**Friuli Venezia Giulia**	7.933	763,5	9,6	1.156,1	14,6	1.702,6	21,5
7	**Liguria**	5.416	115,5	2,1	155,9	2,9	192,0	3,5
8	**Emilia-Romagna**	22.445	2.599,6	11,6	10.235,4	45,6	10.617,6	47,3
9	**Toscana**	22.987	1.413,2	6,1	2.794,5	12,2	4.877,2	21,2
10	**Umbria**	8.464	251,8	3,0	368,6	4,4	509,6	6,0
11	**Marche**	9.401	12,6	0,1	253,1	2,7	372,8	4,0
12	**Lazio**	17.232	442,5	2,6	594,6	3,5	975,7	5,7
13	**Abruzzo**	10.832	140,0	1,3	239,7	2,2	428,8	4,0
14	**Molise**	4.460	87,6	2,0	250,4	5,6	272,4	6,1
15	**Campania**	13.671	340,3	2,5	777,8	5,7	841,4	6,2
16	**Puglia**	19.541	790,0	4,0	1.357,1	6,9	1.597,1	8,2
17	**Basilicata**	10.073	264,1	2,6	349,2	3,5	378,9	3,8
18	**Calabria**	15.222	2.604,9	17,1	2.622,6	17,2	2.661,3	17,5
19	**Sicilia**	25.833	405,1	1,6	505,0	2,0	581,1	2,2
20	**Sardegna**	24.100	826,9	3,4	974,0	4,0	1.676,4	7,0
	Total Italy	**302.068**	**16.224**	**5,4**	**30.196**	**10,0**	**42.376**	**14,0**

Figure 3.19: Floodable area values in the Italian Regions for the different flood probability scenarios expressed in absolute terms (km2) and percentages (%) with respect to the total area of each Region. ID is the Istat code of the Region

Source: Dissesto idrogeologico in Italia: pericolosità e indicatori di rischio. A. Triglia, C. Iadanza et alt., 2021

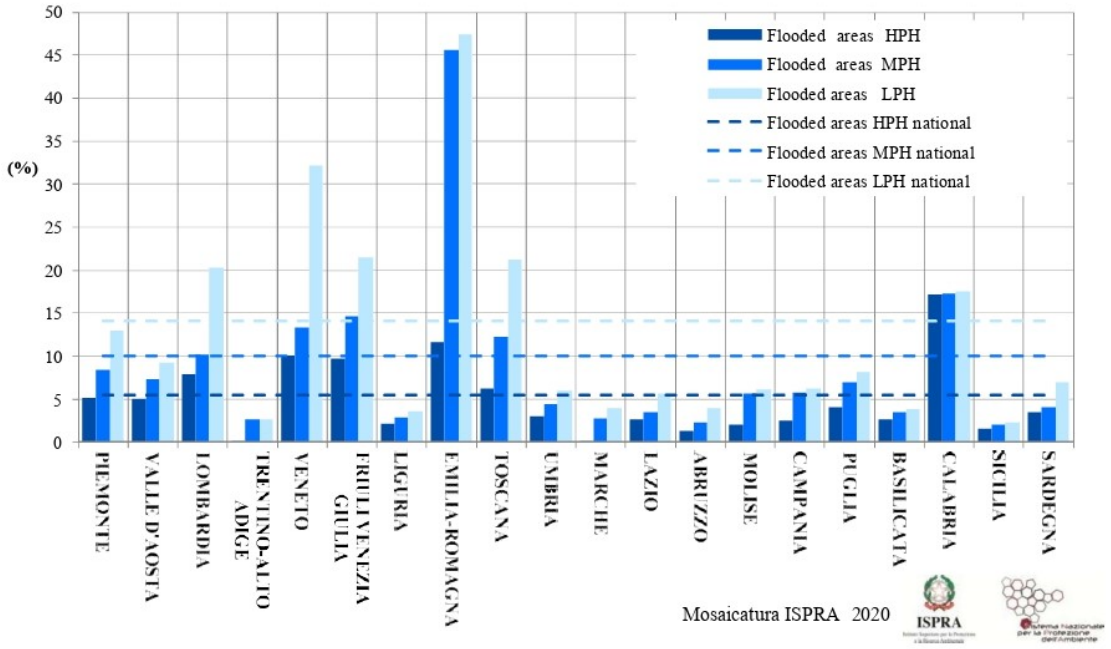


Figure 3.20: Percentage of the regional territory affected by floodable areas for the three flood probability scenarios and values calculated on a national scale

Source: Dissesto idrogeologico in Italia: pericolosità e indicatori di rischio. A. Triglia, C. Iadanza et alt., 2021

3.6.1 Flood risk in real estate

"*Floods are natural phenomena. However, one of the causes of the increased frequency of floods is undoubtedly the high level of anthropisation and widespread sealing of the land, which, by preventing the infiltration of rain into the ground, increase the quantities and velocities of water flowing towards the rivers. Failure to clean them and the presence of debris or vegetation that makes the ordinary flow of waterless easy is another important cause.*" This is the definition given by the department of the "Protezione Civile"[45].

The main natural causes of flooding are the overflowing of the sea, inland waterways, flash floods, and rising sea levels. As for human activities, the cause is soil consumption (making the ground impermeable). To avoid and minimise the impact of such an event it is possible to operate both through structural interventions such as embankments, retention reservoirs, spillways, and halyards, and non-structural interventions, such as those for land management or emergency management: in the latter case, the preparation of the warning system, the drafting of emergency plans, and the implementation of an efficient coordination system for

the activities envisaged in the plans themselves are fundamental[45].

At this point, the developer has to analyse how much high the risk is. Based on the scenario in which the area is located, high probability hazard (HPH), medium probability hazard (MPH) and low probability hazard (LPH), and analysing the structural and non-structural interventions applied in this area the risk is estimated as follows: **risk = hazard x value of exhibited good x vulnerability**.

The *hazard* expresses the magnitude of the flood and the probability of its occurrence over a longer or shorter period.

Vulnerability can be expressed as the expected damage, i.e. the percentage of reduction in value that the calamitous phenomenon produces on the asset. Vulnerability is normally proportional to the intensity of the phenomenon. So, the developer can work on the vulnerability to reduce or mitigate the risk operating on the types and construction characteristics of the asset itself.

The developer should follow the next steps to mitigate the risk:

- consider flood effects on the building that can be divided into two categories:
  - actions induced by the presence of water: horizontal hydro-static thrust, buoyancy thrust and contamination due to immersion;
  - velocity-induced action of the current: hydrodynamic thrust, the impact of objects carried by the flood and the undermining of foundations.
- implementing mitigation construction methods, e.g. elevating the existing structure, waterproofing, driven flooding, barriers.

  In conclusion, considering that it is possible to mitigate the risk, the developer has to quantify the mitigation costs to understand if the investment is profitable and how profitable it is. Instead, if the mitigation is not possible the developer has to change the area of the investment or relocate the building somewhere else.[46]

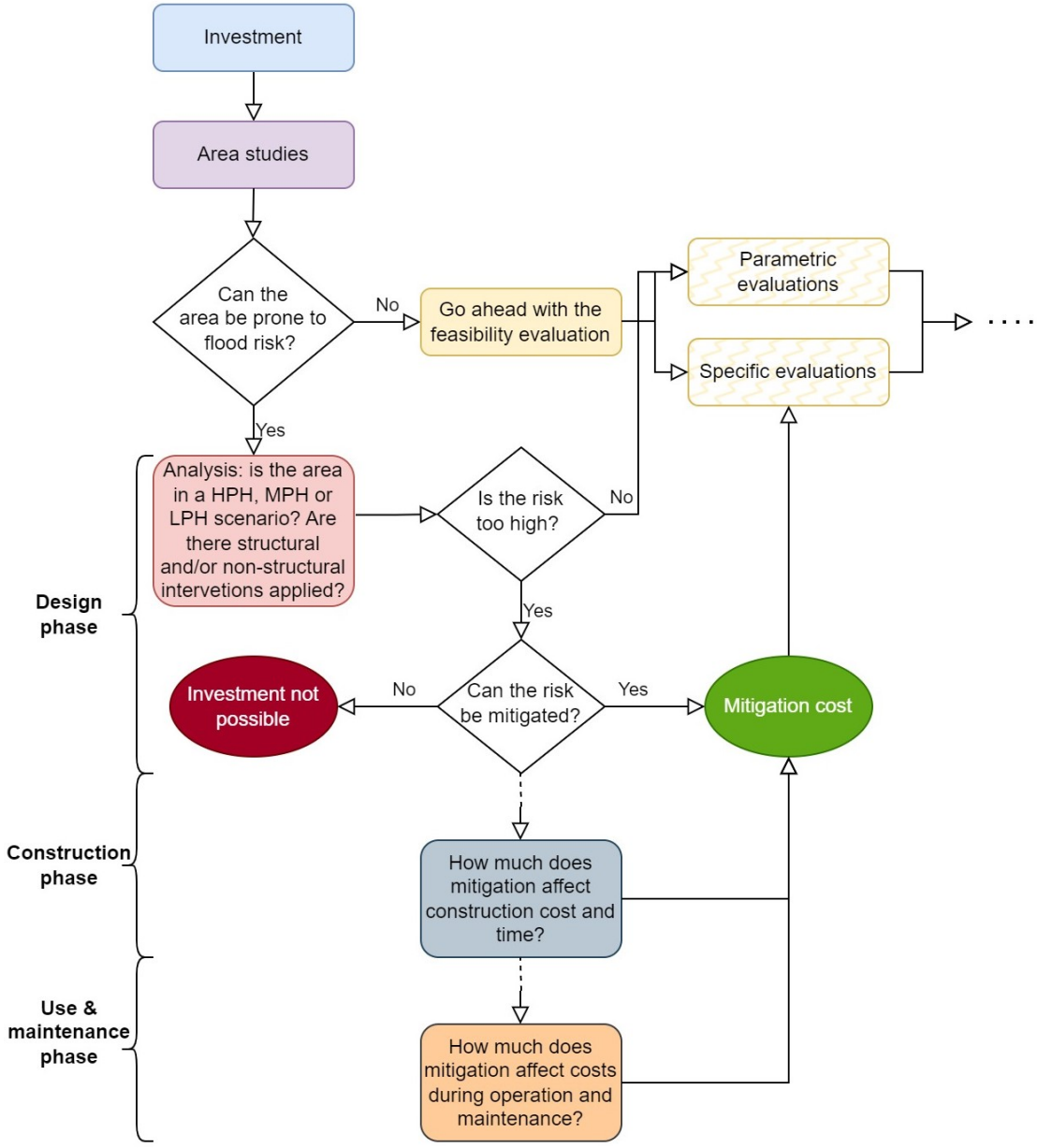


Figure 3.21: Process to evaluate the flooding risk for a real estate developer

Source: own elaboration, 2023.

3.7 Coastal Erosion

Geomorphological changes and catastrophic coastline retreat are threatening Italy's coastal districts. Natural processes inherent in the coastal environment (wave motion, tide, sea currents, etc.) are the real cause of this degradation, to which must be added anthropic factors related to strong urbanisation and the concentration of maritime and land-based socio-economic activities along the coast, which, in addition to suffering the consequences, contribute by intervening directly and indirectly in natural coastal dynamic processes. Of the approximately 8300 km of coastline, 7500 km are still natural (around the 90%), i.e. free of maritime and coastal protection structures built close to the shore.

2660 km of the coasts are high, while more than 4700 km are low coasts, about 70% of which are pebbly or sandy beaches, the most vulnerable to the action of the sea and subject to erosion processes, now mainly of anthropogenic origin. Coastal areas are the territories mostly occupied by residential settlements, commercial and tourist activities, and land and sea transport infrastructures. Population density on the coasts is more than double the national average.

According to ISTAT data, the inhabitants living permanently in the 646 coastal municipalities are about 16.9 million, corresponding to 30% of the national population, concentrated in a territory of 43000 km2, or about 13% of the national territory. As a result, phenomena inherent to the coastal environment (erosion, sea storms, flooding) represent a threat to urban and productive settlements along the shoreline. Studies carried out on a national scale have shown that from 1950 to 1999, 46% of the low coasts have been modified by more than 25 metres and, even considering the areas that have been reclaimed from the sea through filling works and partially naturalised over the years, the stretches of coastline undergoing erosion (1170 km) are greater than those undergoing progress.

The analysis of shoreline changes between 2000 and 2007 has confirmed this trend: 37% of the coastline has changed by more than 5 metres and the eroding stretches of the coastline (895 km) are still greater than the advancing stretches (849 km). The retreat of the shoreline and the loss of marine-coastal areas are particularly evident and profound at river mouths. Whole sandy shores are strongly set back, with a loss of territory and its value both from an environmental and economic point of view. Despite numerous coastal conservation and restoration measures, beaches continue to lose surface area. Between 1999 and 2007, Italy's beaches lost 16 km2 compared to 15.2 km2 of areas undergoing progradation. The balance between the contrasting changes (progradation and retreat) and the stability of the coastline is still negative, and the difference between the surface area of beaches in Italy in 1999 (1222 km2) and 2007 (1216 km2) has shown that an additional 600000 m2 of sandy shores have been lost. Some sandy shores have further shrunk or in some cases have moved inland. The table in figure 3.22 shows

the regional synthesis of the length and percentage of progradation and erosion coasts and stable or stabilised coasts for the period 2007-2019. In all coastal regions, there is a widespread and low tendency for littoral stability; in other words, all coastal areas of the country are subject to important processes of littoral dynamics.

cod.	Region	Cost	Natural		Low		Low rib variation (>+/-5m) 2007-2019 period									
							Stable		Not defined		Modified					
											Total		Erosion		Advancement	
		km	*km*	%	*km*	%	*km*	%	*km*	%	*km*	%	*km*	%	*km*	%
5	**Veneto**	159	127	80,3%	127	100%	22	17,4%	4	3,2%	101	79,4%	36	28,2%	65	51,3%
6	**Friuli Venezia Giulia**	113	70	61,6%	66	95,3%	21	31,4%	27	41,2%	18	27,4%	7	10,8%	11	16,6%
7	**Liguria**	378	282	74,7%	126	44,7%	88	70,0%	2	1,2%	36	28,7%	15	12,1%	21	16,7%
8	**Emilia-Romagna**	125	106	84,9%	106	100%	26	24,4%	8	7,3%	72	68,3%	34	32,3%	38	36,0%
9	**Toscana**	648	601	92,7%	289	48,1%	162	55,9%	18	6,2%	110	37,9%	40	13,8%	70	24,1%
11	**Marche**	176	145	82,5%	134	92,5%	51	38,0%	0	0,0%	83	62,0%	22	16,3%	61	45,7%
12	**Lazio**	382	340	89,1%	255	74,8%	104	41,0%	0	0,1%	150	58,9%	76	29,7%	74	29,2%
13	**Abruzzo**	130	106	82,1%	105	98,5%	39	37,2%	0	0,0%	66	62,8%	23	21,7%	43	41,1%
14	**Molise**	37	32	87,7%	32	100%	9	28,3%	0	1,4%	23	70,3%	10	32,0%	12	38,3%
15	**Campania**	506	423	83,6%	218	51,6%	127	58,3%	0	0,0%	91	41,7%	46	21,1%	45	20,6%
16	**Puglia**	967	873	90,2%	673	77,2%	487	72,3%	15	2,2%	171	25,5%	95	14,1%	77	11,4%
17	**Basilicata**	67	65	97,4%	41	62,7%	9	23,0%	0	0,4%	31	76,6%	21	51,6%	10	25,0%
18	**Calabria**	738	666	90,3%	613	92,1%	272	44,4%	1	0,2%	340	55,4%	161	26,2%	179	29,2%
19	**Sicilia**	1.607	1.458	90,7%	1.089	74,7%	755	69,3%	31	2,9%	303	27,8%	139	12,8%	164	15,1%
20	**Sardegna**	2.147	2.069	96,4%	830	40,1%	627	75,6%	28	3,3%	175	21,1%	116	14,0%	58	7,0%
	Italia	**8.179**	**7.365**	**90,0%**	**4.706**	**63,9%**	**2.801**	**59,5%**	**134**	**2,9%**	**1.771**	**37,6%**	**841**	**17,9%**	**930**	**19,8%**

Figure 3.22: Coasts and changes over the period 2007-2019 on a regional basis

Source: Dissesto idrogeologico in Italia: pericolosità e indicatori di rischio. A. Triglia, C. Iadanza et alt., 2021

Coastal erosion puts densely occupied areas in crisis, increasing their exposure to the destructive effects of storm surges. To this end, numerous protective measures have been implemented over the years, with over 1,300 km of coastline protected by hard structures. In the most serious cases, rigid structures have been built along the shoreline, while in others, alternative solutions such as groins, reefs or mixed works have been adopted and tested, with the dual purpose of reducing the impact of waves during storms and counteracting erosion by promoting sedimentation processes. The number of artificially stabilised coastlines is gradually increasing, and between 2000 and 2007 a further 140 km were stabilised by coastal defence works.

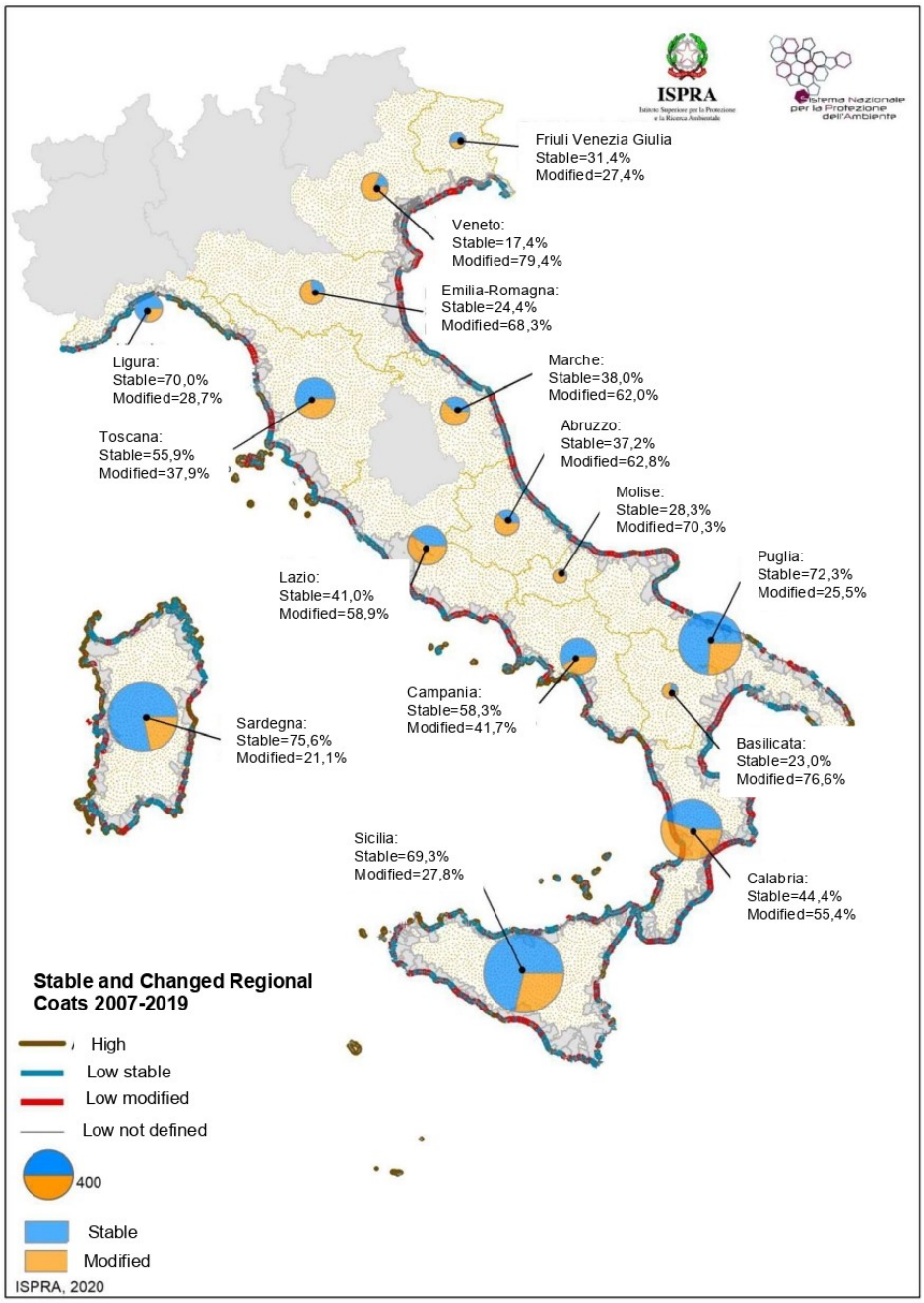


Figure 3.23: Stable and changed coastline over the period 2007-2019 and percentage on a regional basis

Source: Dissesto idrogeologico in Italia: pericolosità e indicatori di rischio. A. Triglia, C. Iadanza et alt., 2021

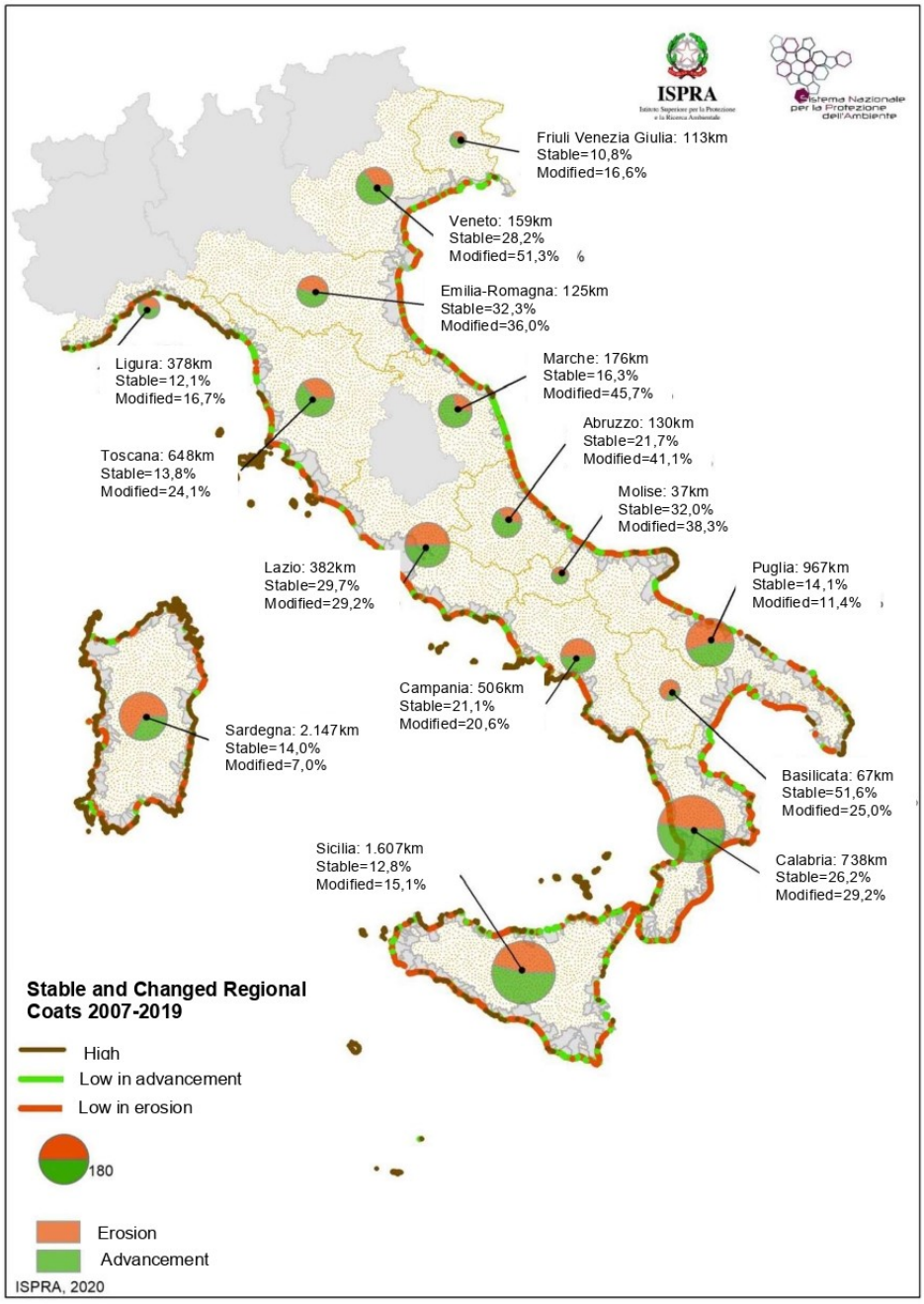


Figure 3.24: Regional coastline and percentage change 2007-2019 by erosion and advancement

Source: Dissesto idrogeologico in Italia: pericolosità e indicatori di rischio. A. Triglia, C. Iadanza et alt., 2021

3.7.1 Coastal erosion in real estate

The Italian peninsula, with its many coastlines, attracts many real estate investments close to the coast with the impossibility of not taking this risk into account. So, a real estate developer does not compare different properties or locations because he/she has to follow the coast erosion regulations in any case. The only case that a developer can evaluate is to invest in an area where there can be the possibility of having either free land or existing property (figure 3.25). Assuming that the existing property needs coastal erosion adaptations or to be relocated, can a new building be more convenient in terms of money, reliability, and demand?

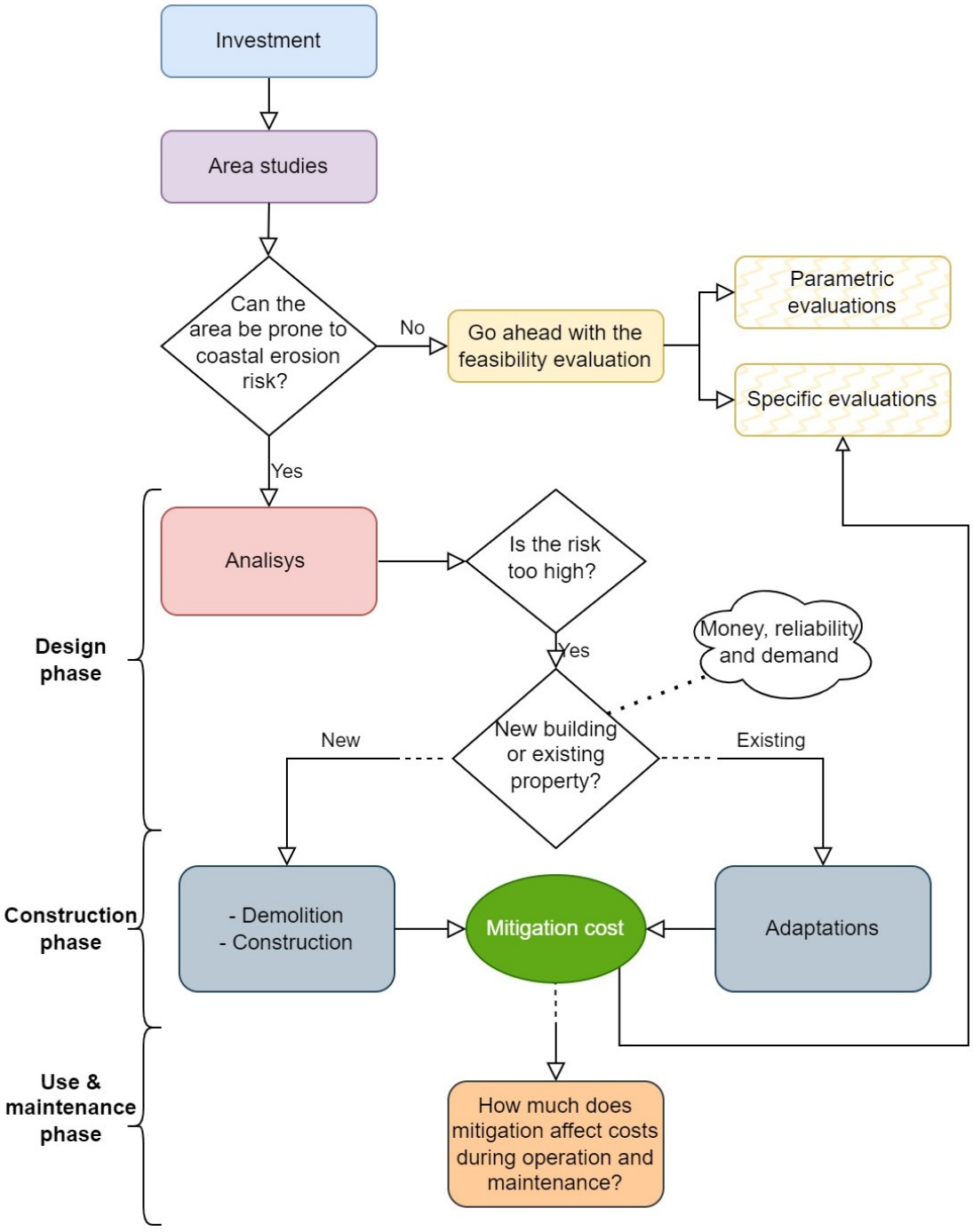


Figure 3.25: Process to evaluate the coastal erosion risk for a real estate developer

Source: own elaboration, 2023.

3.8 Sea level rise

The rising of the sea level is a phenomenon with the potential to alter the topography of the world's coasts. The primary drivers of rising sea levels are rising temperatures, the greenhouse effect, and melting glaciers. In Italy, the Venetian lagoon, the northern Adriatic, the Basento and Sicilian coasts and the Aeolian islands are among the areas which attract much attention regarding this topic.

The sea level along Italy's shores is expected to rise in the future decades, posing huge problems for coastal communities. According to scenarios predicted between now and 2100 on the NASA map released in the Sea Level Portal, the sea level is anticipated to rise by more than a metre, with considerably greater values if greenhouse gas emissions increase even more than they are present. However, Nasa's estimate, which is based on data from the IPCC (the United Nations agency that assesses climate change science), is subject to variances depending on cities, potential changes to the economic model used, and whether or not action has been made to cut greenhouse gas emissions. In either situation, there will be an increase in sea level, which will be around 30 centimetres in the best case and 80 centimetres in the worst case in 79 years.[47]

3.8.1 Sea level rise risk in real estate

This topic is addressed practically thanks to an interview held with Vittorio Nicolino, a real estate consultant and developer at N-Group Real Estate. Talking about investment in progress, a hotel located 6 metres above sea level in Moneglia (Liguria). The investment concerns the conversion of the hotel into flats for sale; an analysis was made regarding climate change and thus possible natural disasters in the area: due to the proximity to the sea, the first factor taken into consideration was the rising sea level. They took care of this topic without specific on-site analyses because for a private they are too expensive so, he said "*I used research from the National Oceanic and Atmospheric Administration (NOAA). This said that the average sea level has risen by more than 20 cm since 1880. Every year, the sea level rises by about 3.2 mm. Research from February 2022 shows that sea level rise is accelerating and is expected to reach 30 cm by 2050. This means that the increase expected over the next 30 years corresponds to that recorded over the last century. Knowing this and being on the lowest floor of the building, 7 metres above sea level, cannot be considered a risk*". Moreover, since the municipality has done major coastal defence works by inserting a breakwater in front of the private beach, they are certain that the sea has never risen above 3 metres even during storm surges. The latter was estimated through studies of the level of wear on the rocks underneath the building and the level of wear on the ground floor windows, those with the greatest exposure to sea waves (they were intact). This can only be

a good sign taking into account that the hotel had not been used for many years (thus lacking any kind of maintenance).

The second risk due to climate change is the risk of intense rainfall and therefore flooding. Concerning this risk, there will be an intervention on the risk mitigation side by designing water collection and disposal in a suitable way and with appropriate slopes (3%).

3.9 Summary of the chapter

The third chapter has the goal to consider the impact of environmental and man-made risks in real estate with a specific focus on the Italian situation.

Land consumption and contamination, earthquake, volcanic, sea level rise, temperature rise, melting of alpine, tidal wave, forest fires, and weather-hydrogeological and hydraulic are the risks which are currently a source of disaster in terms of intensity and frequency of occurrence.

The earth of this chapter is the standard scheme of a real estate development process taking care of the environmental risks. With a standard approach is easy for the developers to study and include the environmental risks in the development process. So, the approach will always have the same structure changing just the way to analyse and consider the specific risk.

After studying the impact of some of these risks in the Italian context, the standard scheme of a real estate development process for the specific risk was developed.

Finally, after interviewing an Italian investor and developer (V. Nicolino) and "talking" in a practical manner about an estimation concerning a hotel located in Liguria near the coast and six metres above sea level, it was thought interesting to address the risk due to rising sea levels from a practical perspective by analysing the example given. This approach was also conducted to realise the most common current way in which Italian developers operate.

Chapter 4

Conclusion

Referring to the first chapter it is feasible to observe that real estate is a very vast sector because it includes the construction sector, asset market, space sector, private market, public sector and financial market divided into investment and capital market. These sub-markets and sub-sectors are characterised by the risks set out in chapter two, so each risk lies in one or more of the sub-categories of the real estate sector. In this way, a developer has a clear idea about which risks affect which sub-category. Another collocation of the risks is made regarding the buying and selling and renting properties, then linking the risks, of both categories, to the outline of the property development process. The latter collocation is made considering in which phase of the building realisation the risk can come out. Regarding the heart of the research (environmental and man-made risks in real estate), the standard scheme of a real estate development process taking care of the environmental risks is considered by the author a really interesting starting point to structure a standard process helping developers to consider this 'family' of risks in their feasibility evaluations. This gives the possibility to understand either if the investment is worthwhile. The advantage is not just from the economic perspective of the developer, but even for the quality result, the safety of who will build or use the building and lastly, but not less important, the respect for the environment and climate change. It would be interesting to continue this research by applying this method to a case study to understand how economically an environmental risk affects the feasibility of a project.

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