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HERE COMES THE FLOOD: THE CLIMATE RISK OF RESIDENTIAL MORTGAGES IN RIMINI

by Ivan Faiella* and Luciano Lavecchia*

Abstract

This paper seeks to assess the expected reduction of the residual debt for the purchase of properties included in the mortgage portfolio of some banking intermediaries operating in an area particularly exposed to the risk of coastal flooding (Rimini) by evaluating different scenarios, including the implementation of an adaptation intervention (the Parco del Mare). For these analyses, we cross-referenced the data on bank assets from a sample of banks with the data on expected damages (distinguished by scenario and return periods) elaborated by researchers at the Centro Euro-Mediterraneo sui Cambiamenti Climatici Foundation (CMCC). The estimated losses, in relation to the value of the properties by census section, were applied to the mortgage portfolio of the banks participating in the project. The results show that the coastal barrier significantly reduces the losses in the mortgage portfolio, highlighting a significant heterogeneity of the impact among the intermediaries involved. It is also emerges that the banking system needs to improve the quality of the information required to identify the assets exposed to such risk and to assess their vulnerability should the event materialize.

JEL Classification: Q54, Q51, G21, R32.

Keywords: climate change, coastal flooding, mortgages, data gap.

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Introduction[1]

Due to its morphological conformation and inadequate land use planning, Italy is particularly exposedto natural risks: both those not linked to climate (such as seismic risks) and those linked to the hydrological cycle, to the stability of the land (so-called hydrogeological risk) and to other extreme natural events (fires, heat waves, etc.). These events have a cost in terms of human lives and economic damage[2].

In Italy, the value of homes exposed to flood risk would be close to 1,000 billion euros at 2020 values, about a quarter of the total overall value, with an expected annual loss estimated at around 3 billion euros (Loberto and Spuri, 2023). Repeated flood events leave behind huge damages, even more critical given the poor insurance coverage (so-called *protection gap*)[3].

Climate change is already showing its impacts on natural balances by increasing the frequency and intensity of some extreme meteorological phenomena (Bassetti, 2024). According to a taxonomy of physical risk, the effects of climate change can be of chronic type, as in the case of the progressive deviation of temperatures and precipitation from their historical trends, or of acute type, as in the case of natural events which, although they occur with low frequency, when they occur, have a significant impact on the affected territories (such as floods or heat waves) and on the economic entities that operate there (Bernardini et al., 2021).

2024 was the warmest year on record globally[4], with a temperature of 1.5° C higher than the pre-industrial period. Also in Italy, the temperature trend shows a marked increase in recent years: the temperature anomalies compared to the historical average have always been positive since 1985 (with the sole exception of 1991 and 1996)[5]. An accurate assessment of climate risks is limited by the limited availability of information (Faiella and Lavecchia, 2024) and adequate methodologies (Campiglio et al., 2023). In particular, the individual intermediary needs an assessment that these risks are calculated at the level of each exposed asset (Bressan et al., 2024).

[1] We thank Enrico Bernardini, Laura Cerami, Aldo Letizia, Valeria Lionetti, Michele Loberto, Dario Marchese, Carlo Milani, Jaroslav Mysiak, Claudia Pasquini, Angelo Peppetti, Alessandra Sordi, Angela Tanno and colleagues from the banks involved in the project; the work also benefited from the discussion during a seminar organized by ABI in February 2025 and from the comments of Paolo Angelini and Patrizio Pagano. Special thanks go to Jaroslav Mysiak for patiently and kindly assisting us in analyzing the data produced by Amadio et al., 2022 and Michele Loberto and Matteo Spuri for providing us with the data on house values used in Loberto and Spuri (2023). We remain solely responsible for any errors or inaccuracies in the text.

[2] Between 1980 and 2022, extreme weather events in Italy caused 21,760 deaths and 111 billion euros, respectively 10 and 17 percent of the total from the EU-27 (European Environment Agency, 2024).

[3] The flood in Emilia-Romagna in May 2023 caused damages of 9.8 billion euros and insured losses of 600 million. During the flood in Tuscany in November 2023, losses were valued at 2 billion and insurance reimbursements of 500 million euros. Furthermore, it turns out that, at a national level, only 44 percent of civilian homes have coverage against fires, and about 5 percent also have coverage for floods and earthquakes. Insurance coverage is therefore minimal compared to the size of the risk (ANIA, 2024).

[4] Unlike temperatures, the indicator measuring precipitation anomaly does not show clear trends.

[5] "Copernicus: 2024 virtually certain to be the warmest year and first year above 1.5°C", press release, 7 November 2024.

In this paper, we focus on chronic phenomena related to climate change and in particular on coastal flood risk and its effects on the financial system, based on data with a high level of granularity regarding the value of exposed assets. In particular, we present a preliminary assessment of the impact on the **mortgage portfolio of banks exposed to coastal risk**[6] whose assets are located in the **city of Rimini**. The choice of Rimini is linked to the implementation ofa coastal defense intervention in the southern area of the city, the Sea Park, with a height of 2.8 meters above sea level, for a total cost of 33.3 million euros. An extension to the northern area of the city is already financed and under construction.

The exercise aims to show the different stakeholders what information is needed, and with what level of spatial detail, with the aim of providing a tool, in particular to financial intermediaries, to be able to proceed with an estimate of the physical risks of climate change, integrating in their standard procedures of information collection those data that are fundamental for credit granting assessments to be as accurate as possible.

The problem[7]

To understand how climate change impacts can materialize in financial risks, it is first necessary to assess how much of the financial assets are exposed to such risks. The assessment at the level of individual intermediaries is a complex process, made even more difficult by the lack of detailed data on the exact geographical location of the individual entities exposed to the risk.

Although many analyses have been developed on the topic in recent years (Faiella and Natoli, 2018; Meucci and Rinaldi, 2022), the quantification of climate risks, particularly physical ones, for the financialsystem is still not very mature. Before an evaluation, it is important to define the basic logic of the risk metrics. Economic risk (*R*) linked to a climate shock for an agent or an economic activity is commonly defined as the product of three components: i) the expected probability that a given event will occur with a certain level of intensity (*H-Hazard*); ii) the value of the assets exposed to such events (*E-Exposure*); iii) the expected loss per exposed unit, or vulnerability (*V-Vulnerabilities*). Risk is the product of these three components: $\boldsymbol{R} = \boldsymbol{H} * \boldsymbol{E} * \boldsymbol{V}$[8].

The estimate of the first component identifies the areas at greatest risk, for example based on

[6] The definition of flood in force in our legal system is that of Legislative Decree 49/2010, namely "*temporary flooding, including with transport or mobilization of sediments even at high density, of areas that are not normally covered by water. This includes flooding caused by lakes, rivers, streams, possibly artificial drainage networks, anyother surface water body even with a temporary regime, natural or artificial, the* ***marine floods*** *of coastal areas and excludes flooding caused by sewage systems*".

[7] This section is partly based on Chapter 5 of Bernardini et al. (2021).

[8] This approach is compared with the three concepts underlying the credit rating system of an intermediary, PD, LGD and EAD: the first indicates the probability that a counterparty will default within a one-year horizon (Probability of default, PD); the second is the loss for the institution in the event of default (Loss given default, LGD); the third considers the intermediary's exposure at the time of default (Exposure to default, EAD).

the characteristics of the territory and the climate scenarios at the local level; the second superimposes information on the economic value of the elements at risk (population, infrastructure, businesses, cultural heritage, ...) to the territorial areas; the third requires an assessment of the factors that make the exposed units more vulnerable (e.g. for floods the lower floors of buildings) and of the value of the latter.

This type of definition usually refers to the risk of a single event, but is commonly used to describe the overall risk given by a sequence of possible climatic events over a future time horizon. If used for this purpose by varying only the Hazard, this identity implicitly assumes that exposure and vulnerability, which also vary with adaptive capacity (e.g. by increasing insurance coverage), do not change over the time frame under study.

The data

The methodology for estimating expected losses for banks' mortgage portfolios is based on theexploitation of various information sources and on a complex process (Figure 1).

For the coastal risk estimation, we used the work of Amadio et al. (2022): the authors analyze the coastal flood risk according to different climate scenarios[9] assessing the extent of sea level rise along the northern Adriatic coast of Emilia-Romagna, specifically in Rimini and Cesenatico, in 2050 and 2100. Using a hydrodynamic inundation model, alternative sea-level scenarios are compared, also considering the impact of planned and hypothetical coastal zone renewal projects with respect to the historical situation, and the potential economic damages are estimated through a flood damage function and also calculating the annual variation based on the expected sea level changes[10]. Finally, a cost-benefit analysis was conducted to evaluate the benefits deriving from the reduction of damages linked to adaptation interventions (specifically the aforementioned Parco del Mare).

The data on which the analysis is based, available online[11], contain information on the damages expected in 2050 and 2100 and vary under different hypotheses: based on the return periods[12] (RP) of the 1, 10, 100 and 250 year events, with and without adaptation interventions, in this specific case the construction of a coastal defence (defended scenario – "DEF" vs a base scenario – "BAU").

In particular, the minimum and maximum damage values are available at the single building

[9] The authors agreed with the municipality of Rimini to use an intermediate emissions scenario (RCP 4.5) that corresponds to an average sea level rise of 0.53 meters by 2100. The authors also performed the estimates using a high emissions scenario (RCP 8.5) and stated that the results in 2050 (the period of analysis of this work) do not change significantly.

[10] The determinants of damage are basically the height of the water and the duration of the flood. The estimated damages are direct damages referring exclusively to buildings, excluding damages to roads, monuments or other infrastructures, as well as damages.

[11] Amadio et al. (2022) provide the database relating to Rimini and Cesenatico online.

[12] The return period expresses the probability that a certain event will occur in a given year. In the case of a flood, the return period defines the probability that an event of a certain intensity will occur within any year.

level, calculated based on the model described in Amadio et al. (2022)[13]; scenarios and probabilities are combined together to calculate the expected damage value for each year, i.e. the damage that would occur in a given year if the impacts of all flood probabilities were evenly distributed over time[14].

Starting from this granular data, we proceed to calculate a distribution of damage by census section (1,783 sections for the city of Rimini based on the 2011 census; Figure 2), in relation to the residential heritage[15], thus obtaining for each section an estimate of the minimum, maximum and average damage. The choice to focus on the residential heritage reduces the sections to 1,327. Of these, only 561 present an estimate of the damage (in the other 766 cases the value is not available in the data of Amadio et al., 2022), and in 204 the details regarding the minimum and maximum damage are available (in the remaining cases the estimate of the damage is equal to zero in all scenarios).

For our analyses, which consider 6 scenarios[16]- identified by crossing the two scenarios DEF and BAU with return periods of 10, 100 and 250 years[17]- we assume that the damages expected in 2050[18] suddenly materialize. Furthermore, for the census sections considered we add to this information the estimates of the overall value of residential properties taken from Loberto and Spuri (2023), thus obtaining an estimate of how much of the value is eroded by coastal flood damage in the 6 cases considered (with a distribution of this incidence obtainable on the basis of minimum, average and maximum values).

This dataset is linked to the information on the banking system's exposure in the area under analysis. In particular, in September 2023 the Risk, Control and Sustainability Office of the Italian Banking Association (ABI) sent a request for expression of interest to participate in a data collection on mortgages granted to natural persons that contained the information described in Table 1 in the appendix and that had at least 5 years of residual duration[19]. Three of the 16 banks operating in the Rimini area responded to this request for interest, representing 23.9 percent of total loans and

[13] For confidentiality reasons and to allow the merging of scenario information with that on the value of houses in Loberto and Spuri (2023) it is necessary to aggregate the information on the damage available for the single building at the census section level.

[14] The authors use as an estimator of the expected damage the sum of the product of the fractions of the exceedance probabilities (for a definition see the appendix of Loberto and Spuri, 2023) and the corresponding damage.

[15] Compared to the original database of Amadio et al. (2022), we select only the information referring to the following typologies: “Villas”, “Terraced houses”, “Sparse residential fabric”, “Compact and dense residential fabric” and “Urban residential fabric”.

[16] More information on climate scenarios for Italy can be found on the website of the Euro-Mediterranean Center on Climate Change (CMCC): https://www.cmcc.it/it/scenari-climatici-per-litalia.

[17] In the case of the one-year return period scenario, only 0.8 percent of observations report a non-zero damage estimate, a percentage that drops to 0.15 percent if we also consider observations for which no damage estimate is available. For these reasons, we have chosen not to consider this scenario.

[18] From a practical point of view, in 2050 most of the mortgages considered will be repaid; here, however, we imagine a scenario in which what is expected in 2050 suddenly comes true. In general, it should be kept in mind that climate risk assessments by their very nature adopt longer time horizons than those normally considered by the financial system (the problem that Mark Carney has called the “*tragedy of the horizons*”; Carney, 2015).

[19] The banks that provided the information stressed that the availability and accuracy of cadastral data would be essential for a correct reconciliation between loan and property. In fact, the same property can be used as collateral for multiple relationships (with a different mortgage grade, residual value of the mortgage or applied rate) and similarly, some loans could be guaranteed by multiple cadastral units that could also have the same address and street number.

approximately 11 percent of total mortgages to city customers at the end of 2022. Overall, information was provided on 4,213 mortgages for a value of 684.9 million euros and an average debt of 163 thousand euros (see Table 2).

As regards the different information collected, the availability of data is quite heterogeneous. Information on the type of rate was provided on 94 percent of the mortgage sample; the variable rate form prevails, but the value of the rate was provided by only one bank.

None of the banks provided information on the presence of insurance that covers natural risks and even on the property plan there is data for only 1 percent of the mortgages considered. Both this information, insurance and plan, are essential for a correct assessment of the expected loss in the event of coastal flooding.

Overall, data for the exact location of the properties is missing in a quarter of the observations. In 4.4 percent of the cases, the address appears to refer to areas outside the Municipality of Rimini and are therefore excluded; in 19 percent of the sample, the absence of the street number compromises the precision in assigning the areas used to connect the information (in the case of our work, the census sections). For the remaining ones, through the information on the addresses provided by the banks, it was possible to assign each financing a corresponding census section that served as a merge key with the dataset on expected damages.

Results

Of the 4,213 observations, 186 cases, equal to the aforementioned 4.4 percent, were eliminated because they did not correspond even approximately to the census sections of the city of Rimini. The remaining 4,027 observations refer to mortgages to customers resident in Rimini for a total amount of 657 million euros, an average value of 163 thousand euros and refer to 1,095 distinct census sections (Table 2).

By combining this information on mortgages with the reprocessing of the Amadio et al. (2022) archive, it is possible to obtain an estimate of the expected loss for each mortgage based on the following formula:

$$EAD_{m\in c|_{zs}} = m_{\in c} * \frac{EAD_{c|zs}}{V_c}, \text{ } z=min, med, max \text{ },$$

where the expected annual loss (*Expected Annual Damage - EAD*) of each mortgage, *m*, located in the census section, c – $EAD_{m\in c|_{z,s}}$ – assumes a minimum, average and maximum value (indicated by the suffix *z*) based on the scenario considered, *s*. In particular, the expected loss is given by the product of the value of the mortgage (in terms of residual debt) located in the census section c ($m_{\in c}$) and the ratio between the expected damage estimated in Amadio et al. (2022) ($EAD_{c|_{z,s}}$) and the average value of homes in the same section (V_c); this ratio is a measure of the expected reduction in the value of the property and is used to approximate the corresponding expected loss of the residual debt in each bank's mortgage portfolio.

Considering the information available for each census section from both sources, applying this estimator and aggregating the information by bank, an estimate of the expected loss, by bank, minimum, average and maximum in the six scenarios considered is obtained **for about a quarter of the mortgages provided**, 1,022 observations, referring to 343 census sections, for a value equal to 153.3 million euros and an average debt of 150 thousand euros (Table 3).

Data analysis suggests the following (Table 4):

1. adaptation measures such as the introduction of a coastal defence lead to a significant reduction in expected losses: in the presence of adaptation and considering a return period of 100 years, the incidence of such losses is halved on average (from 10.3 to 5.9 percent of the total mortgage portfolio);
2. there is great heterogeneity in the exposure of the different banks: the percentage of the mortgage portfolio compromised by an event with a 100-year return period varies between 6.8 and 13.2 percent in the baseline scenario and is reduced to a range between 3.7 and 7.8 percent in the case of a scenario with adaptation.

Conclusions

The paper estimates the expected reduction of the residual debt for the purchase of properties included in the mortgage portfolio of some banking intermediaries operating in a territory particularly exposed to the risk of coastal flooding (Rimini), considering different scenarios that also include an adaptation intervention (the Parco del Mare). These losses, related to the value of the properties by census section, are applied to the mortgage portfolio of the banks participating in the project.

The results show a significant heterogeneity of the impact among intermediaries. Furthermore, the coastal barrier significantly reduces losses in the mortgage portfolio (not eliminating them given the partial completion of the barrier). Considering that over a third of the Italian population resides in coastal municipalities[20], that the population density is almost double and that tourist pressure is increasing (ISTAT, 2022), intermediaries must carefully evaluate whether the value of the assets

[20] Coastal municipalities are defined by Eurostat as "municipalities located on the coast or having at least 50 percent of their surface area less than 10 km from the sea". As of 1 January 2019, there were 1,166 municipalities, 14.7 percent of the total, located in 15 regions (ISTAT, 2022).

guaranteeing the loans incorporates all the risks (including those of coastal erosion) or not.

The choice of scenarios and reference variables (the return times in our case) depend on the sensitivity and strategic choices of the intermediary.

We also believe that our simple exercise is useful to highlight some suggestions regarding the datacollection process and in particular:

1. the lack of a standardized questionnaire makes data collection by banks complex and does notallow uniform comparisons and aggregations of information;
2. the presence of incorrect information in the addresses provided and, sometimes, the lack of fundamental information (such as the street number) make the geolocation of the property imprecise, invalidating the correct risk assessment in approximately one-fifth of the cases, a significant value;
3. the lack of information on the dwelling plan does not allow a complete analysis of vulnerability (ground-floor apartments are more exposed to the risk of flooding than thoseon the upper floors)[21];
4. also the reporting of insurance policies against catastrophe risks, which also indicate a lower vulnerability and riskiness for the intermediary, are not available. It would be important for the intermediary to acquire this information also for loans already granted;
5. in general it would be desirable to provide automatic compilation and/or validation tools directly in the banks' management systems, so as to assist officials when compiling information. Comparison with land registry data would allow for further verification of congruence (e.g. for the plan and the correctness of the addresses).

Finally, the proposed approach can be extended to other physical risks (e.g. hydrogeological risk) and to other variables of interest for intermediaries (value of properties given as collateral, PD and LGD, interest rate levels). However, this extension requires that the set of available information has an adequate level of granularity, that the information collected is correct to minimize errors when combined with other sources and that these are easily available to analysts who must provide for the evaluation of these risks.

[21] The lack of information on the plan, moreover, seems to be widespread among the major European banks – see "Climate-related data for the real estate sector: challenges and solutions", Supervision newsletter, Single supervisory mechanism, 13 November 2024.

Bibliography

Amadio, M., Essenfelder, A.H., Bagli, S., Marzi, S., Mazzoli, P., Mysiak, J., and Roberts, S. (2022), “Cost– benefit analysis of coastal flood defense measures in the North Adriatic Sea”, Nat. Hazards Earth Syst.Sci., 22, 265–286, https://doi.org/10.5194/nhess-22-265-2022.

ANIA 2024, ANIA hearing at the Chamber of Deputies for “C. 589 Trancassini, C. 647 Braga and C. 1632 Government, containing Provisions for the management of emergencies of national importance and post-disaster reconstruction", April 11, 2024

Bassetti F. (2024), “Are extreme events in the Mediterranean the new normal?”, Foresight Newsletter, October 3.

Bernardini et al. (2021) “Central banks, climate risks and sustainable finance”, Questions of Economics and Finance, No. 608, Bank of Italy, March 2021.

Bressan, G. et al. (2024), “Asset-level assessment of climate physical risk matters for adaptation finance”, Nat Commun 15, 5371. https://doi.org/10.1038/s41467-024-48820-1.

Campiglio E. et al (2023), “Climate-related risks in financial assets”, Journal of Economic Surveys, 37,950–992. https://doi.org/10.1111/joes.12525.

Carney Mark (2015), “Breaking the tragedy of the horizon - climate change and financial stability”, speech given at Lloyd's of London on 29 September.

Faiella I. and F. Natoli (2018), “Natural catastrophes and bank lending: the case of flood risk in Italy”,Economic and Financial Issues, N. 457, Bank of Italy, October 2018.

Faiella I. and L. Lavecchia (2023), “More data for the transition”, Le Scienze, August.

ISPRA (2024), “The climate in Italy in 2023”.

ISTAT (2022), “Anthropogenic activities and coastal health. Territorial indicators of risk and sustainability forcoastal and island areas in Italy and the European Union”.

Loberto M. and Spuri M. (2023) “The impact of flood risk on real estate wealth in Italy”, Economic and Financial Issues, No. 768, Bank of Italy, May 2023.

McNamara DE et al (2024), “Policy and market forces delay real estate price declines on the US coast”, Nature communications, 15, 2209.

Meucci G. and F. Rinaldi (2022), “Bank exposure to climate-related physical risk in Italy: an assessment basedon AnaCredit data on loans to non-financial corporations” Questions of Economics and Finance, No. 706 Bank of Italy, July 2022.

Appendix

Table 1 – Information collected by banks

Variable	Description and coding
Id	Loan ID issued
Property address (street)	Text with the street name
Property address (street number)	Text with the street number
House plan (if available)	Multiple choice box (ground floor; first floor; second floor or above)
Residual debt as of 12/31/2022 (mortgages with residual duration >=5 years)	Value in euros of the residual debt (k+interest) at the end of 2022
Mortgage value associated with the loan in euros	Value in Euro of the collateral associated with the loan
Interest rate charged (fixed or variable)	Multiple choice box (fixed; variable)
Presence of natural disaster insurance (yes/no/don't know)	Multiple choice box (yes; no; don't know)
Insured value (if insurance present)	Value in Euro of the insured amount (if insurance present)
Interest rate charged (fixed or variable)	Multiple choice box (ground floor; first floor; second floor or above)

Table 2 – Descriptive statistics on mortgages

(millions of euros, units, euros, percentage values)

	Residual debt as of 31 dec 2022	No. of mortgages	Average debt (€)
Bank 1	494.8	2,629	188,435
Bank 2	144	1,275	112,935
Bank 3	18.6	123	151,061
Total	657.4	4,027	163.371
	Type of rate applied (in % total)		
	Fixed	Variable	Mixed
Bank 1*	17.6	79.0	0.6
Bank 2	65.6	31.4	3.1
Bank 3	2.4	97.6	0.0
Total	32.4	64.5	1.4

Source: our calculations. * 2.7 percent of Bank 1 observations do not report information on the type of rate

Table 3 – Descriptive statistics on mortgages for which there is information on expected losses

(euros and units)

	Residual debt as of 31 dec 2022	No. of mortgages	Average debt
Bank 1	114,057.014	653	174,666
Bank 2	34,914.693	336	103,913
Bank 3	4,261.908	33	129,149
Total	153,233.615	1,022	149,935

Source: our elaborations.

Table 4 - Expected losses as a share of mortgage portfolio

(percentage values)

	Baseline scenario (BAU), 10-year return period			**Defended scenario (DEF), 10-year return period**		
	min	average	Max	min	average	max
Banca 1	0.5	1.8	5.5	0.5	1.8	5.0
Banca 2	0.7	1.9	5.0	0.6	1.7	4.6
Banca 3	2.4	5.1	12.2	2.4	5.2	12.2
Totale	**0.6**	**1.9**	**5.5**	**0.6**	**1.9**	**5.1**
	Baseline scenario (BAU). 100-year return period			**Defended scenario (DEF). 100-year return period**		
	min	average	max	min	average	max
Banca 1	3.9	11.2	24.9	1.6	6.4	15.0
Banca 2	2.4	6.8	15.5	1.3	3.7	8.6
Banca 3	5.2	13.2	32.9	3.4	7.6	16.5
Totale	**3.6**	**10.3**	**23.0**	**1.6**	**5.9**	**13.6**
	Baseline scenario (BAU). 250-year return period			**Defended scenario (DEF). 250-year return period**		
	min	average	max	min	average	max
Banca 1	20.4	43.7	81.6	15.0	32.5	60.0
Banca 2	8.6	23.3	49.1	5.1	15.7	35.1
Banca 3	10.9	26.9	59.7	7.1	17.0	36.6
Totale	**17.6**	**38.7**	**73.9**	**12.6**	**28.4**	**53.9**

Source: our elaborations.

Figure 1 – Schema for the construction of the dataset and estimates

Amodio et al. (2022)

- Expected damages in 2050 and 2100 (min and max) for each building in the municipality of Rimini from coastal flooding
- Six scenarios varying according to return periods (RP10, 100, 250 years) with and without adaptation interventions
- Only the houses are selected and the expected damages are aggregated for 561 census sections obtaining a distribution of min, med, max damages (of the 1,327 sections of the city of Rimini 766 have no data)

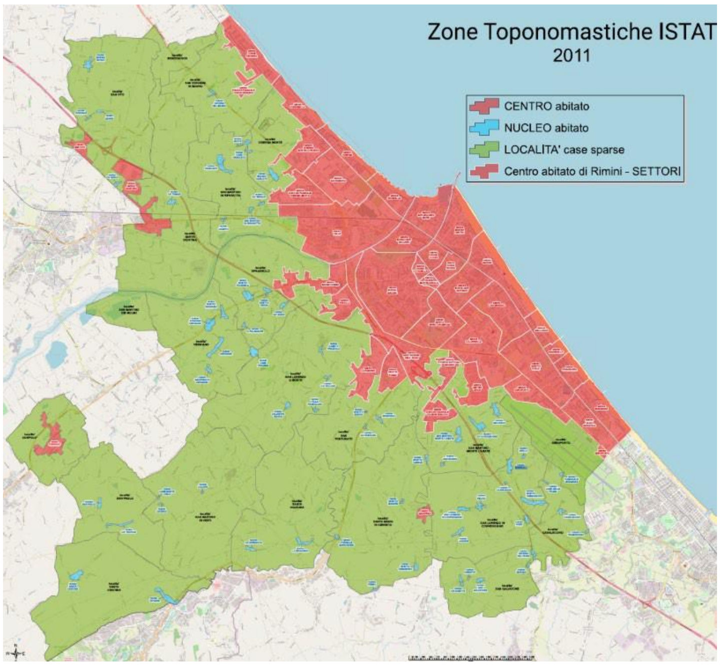
Loberto and Spuri (2023)

- The overall estimates of the value of residential properties by Loberto and Spuri (2023) are added toeach of the 561 selected sections
- Through the relationship between expected damage and these values, an estimate of the share of value lost in the sixscenarios is obtained for each census section

Information on mortgages provided

- Three of the 16 banks operating in Rimini provide information on 4,213 mortgages (address, floor, value, etc.)
- Through the addresses provided it is possible to assign each mortgage to a census section
- The expected loss rate for a given census tract is applied to mortgages in the same tract
- An estimate of the expected loss for each mortgage is obtained
- This loss can be related to the overall mortgage portfolio at bank level and in aggregate

Figure 2 - Overview of the municipality of Rimini with the census sections



Source: Municipality of Rimini (link)