



PIISA
Piloting Innovative Insurance
Solutions for Adaptation

D1.4 Focused market reviews in WP3 pilot areas



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Artificial Intelligence (AI) was used to enhance the clarity of certain aspects in this document. The AI tools used in this document are ChatGPT Plus and Elicit. AI was used in chapters 3, 4, and 5. The purpose was to extract information from certain annual reports of insurance companies to facilitate the research process, as well as to enhance English fluency. The authors retain full accountability for the content and its accuracy.

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Summary

This deliverable, *D1.4 Focused Market Reviews in WP3 Pilot Sectors/Areas*, is part of the PIISA (Piloting Innovative Insurance Solutions for Adaptation) project, which focuses on developing and testing insurance solutions that enhance resilience against climate risks across Europe. Led by the consortium's Work Package 1 (WP1), this report evaluates the insurance market landscape in key sectors, specifically agriculture, forestry, and urban green infrastructure, and assesses opportunities for climate adaptation through innovative insurance solutions. This research spans multiple European regions, including Finland, Spain, Italy, France, the Netherlands, Portugal, and Germany, selected for their high exposure to climate risks like droughts, wildfires, and severe storms.

Objectives and Scope

The primary objective of this deliverable is to assess the current insurance market's capacity to mitigate climate risks in critical sectors and regions and to identify gaps where innovative insurance solutions, such as parametric insurance and Nature-based solutions (NBS), could add value. This report specifically supports the overarching PIISA goal of driving the adoption of insurance models that encourage proactive adaptation to climate change. Through WP3, PIISA implements pilot activities across the agricultural, forestry, and urban green infrastructure sectors, aiming to test the feasibility of novel insurance products designed for climate resilience.

Methodology

The research methodology involves a combination of survey data, market reviews, and case studies. Surveys conducted by POLIMI (Politecnico di Milano) captured climate awareness and perceptions among European citizens, providing foundational insights into public demand and barriers to insurance adoption (Chapter 3). LGI led the desk-based research and market reviews, utilizing industry reports, academic literature, and data from insurance companies across the sectors and regions of focus (Chapter 4). The multi-source approach enabled a comprehensive understanding of the market dynamics and challenges faced in integrating climate adaptation solutions within traditional insurance models.

Key findings from the survey results and analysis conducted by POLIMI

The survey analysis conducted by POLIMI (Politecnico di Milano) within Chapter 3 of this deliverable reveals essential insights into European citizens' climate change awareness, risk perceptions, and attitudes towards climate-related insurance products. The survey engaged 951 respondents from six European countries, capturing cross-regional perspectives on climate risks, climate adaptation awareness, and insurance solutions.

- Climate Change Awareness and Perceptions:
 - A significant 87% of European citizens express concern about climate change, with more than half being moderately concerned and 33% highly concerned. Future expectations reinforce this concern, as 65% of respondents anticipate an increase in the frequency and severity of climate-related events, such as storms, floods, and droughts.

- The analysis also reveals a significant link between education and climate awareness, with respondents holding higher educational qualifications showing greater concern and understanding of climate risks.
- Perceived Risks of Natural Hazards:
 - European citizens prioritize risk from more frequently encountered natural hazards, particularly meteorological events such as heavy rainfall, hail, and storms. The 36% of them view heavy rainfall as a medium-high risk. This suggests a higher awareness for those natural hazards that directly impact daily life.
 - While geophysical hazards, like earthquakes and volcanic eruptions, are perceived as lower-risk due to their infrequency, citizens living in hazard-exposed regions report higher risk perception, particularly for geographically specific hazards.
- Experience with Climate-Induced Economic Losses:
 - Around 76% of respondents reported experiencing at least one natural hazard in the last five years, with 26% incurring economic losses, primarily from meteorological events. Despite the relatively high incidence of climate-related events, many citizens remain uninsured, particularly against lower-frequency but high-impact events.
- Barriers to Insurance Adoption:
 - Key barriers include a lack of awareness about insurance options for climate risks and a perception that these risks are not significant enough to warrant insurance. Despite the diffused risk awareness, 56% of respondents mention that natural hazards do not represent a significant enough risk that can increase the propensity of acquiring an insurance coverage
 - Financial constraints and trust in insurance providers also emerged as notable obstacles, highlighting the need for simplified, transparent insurance products.
- Nature-based solutions (NBS) Awareness and Willingness to Co-Finance:
 - Approximately half of respondents are familiar with NBS, with the 49% of them expressing a willingness to co-finance projects related to climate adaptation. However, 47.2% prefer the financial responsibilities to be managed by public or private institutions rather than individuals, underscoring a reliance on institutional support.
 - Financial incentives, such as premium discounts and insurance policy coverage for NBS, were the most effective motivators for encouraging individual investment in climate-resilient infrastructure.
- Low Awareness and Adoption of Parametric Insurance Solutions:
 - Despite the limited offer of parametric insurance solution, awareness among European citizens seems quite diffuse, with about 1 European out of 5 familiar with the concept of parametric. Among those aware, one-third have acquired

parametric policies, primarily covering flood, storm, and wildfire risks, showing a clear interest once awareness is established.

- The primary barriers to parametric insurance adoption mirror those for traditional insurance, with high costs, lack of state incentives, and limited awareness being critical deterrents.

Key findings from the Market Review Conducted by LGI

The market review conducted by LGI in Chapter 4 provides a comprehensive overview of insurance products and services across agriculture, green roof infrastructure, and forestry sectors in selected European regions. This assessment focuses on each sector's current climate risk exposure, existing insurance solutions, and potential areas for integrating innovative insurance solutions.

- Agriculture Insurance (Finland, Spain, Italy):
 - Climate risks such as droughts, extreme weather, and frost are escalating in agriculture, with limited insurance options available in countries like Finland. Spain and Italy, on the other hand, have more extensive multi-peril crop insurance programs, often subsidized as part of public-private partnerships.
 - Index-based and parametric insurance models, which trigger payouts based on objective weather data rather than damage assessments, are recommended as cost-effective options to reduce administrative expenses and encourage broader adoption.
 - In Finland, the insurance market remains small and constrained, limiting farmers' capacity to address climate-related risks. Insurance uptake is low, and innovative options like parametric insurance could fill significant coverage gaps in regions facing frequent droughts or frost.
- Green Roof Insurance (France, The Netherlands):
 - Green roofs contribute significantly to urban climate resilience by managing stormwater, and promoting biodiversity. However, insurance products specifically tailored to green roofs are scarce.
 - In France and the Netherlands, pilot projects suggest potential for creating insurance incentives, such as premium discounts or coverage specific to NBS, to encourage property owners to adopt green roof installations. Such measures can make urban areas more resilient while reducing insurers' long-term risk exposure.
 - Integrating NBS coverage and providing incentives for urban resilience projects could drive greater adoption of green roofs, particularly in cities like Paris and Amsterdam, where green infrastructure is expanding rapidly.
- Forestry Insurance (Portugal, Germany):
 - Forestry sectors in fire-prone regions like Portugal and Germany face climate challenges from fires, storms, and droughts, with limited insurance options available to address the frequency and intensity of these events.

- LGI highlights a need for comprehensive forestry insurance products that incorporate both biotic (pest, disease) and abiotic (fire, storm) coverage. Despite the prevalence of parametric insurance solutions globally, their adoption in forestry remains low due to limited awareness and cost barriers.
- Emphasizing wildfire prevention through insurance coverage for adaptive practices, such as creating firebreaks or maintaining defensible spaces, could foster resilience within the forestry sector and reduce the overall risk burden.

Key findings from the comparative analysis of insurance solutions across regions and sectors

The comparative analysis in Chapter 5 highlights significant variations in climate change perceptions, insurance adoption rates as well as barriers across the studied European regions. Key findings from this cross-comparative analysis include:

- **Climate Change Awareness and Perceptions Across Regions:**
 - Citizens across the studied regions express high levels of concern regarding climate change impacts, though the degree of perceived urgency varies. Regions experiencing frequent climate-related events, such as Portugal and Spain, report a heightened perception of risk from hazards like droughts and wildfires.
 - The data reveals that climate change awareness is influenced by education, past experiences with climate events, and local geographic vulnerability, with citizens in climate-sensitive areas showing greater readiness to implement adaptation measures.
- **Insurance Uptake and Coverage Gaps:**
 - Insurance adoption rates remain limited across all regions and sectors, with over half of surveyed citizens not insured against any climate-related risks.
- **Regional Differences in Insurance Awareness and Barriers:**
 - Despite the majority of surveyed citizens remains unfamiliar with parametric solutions, also because the limited offer from insurance companies, some countries show interesting data with 1 citizen out of 3 familiar with the concept. Financial constraints, lack of trust in insurance providers, and complex policy structures are cited as major barriers to insurance adoption across regions.

Conclusion and recommendations

The report concludes with strategic recommendations to enhance the insurance sector's role in supporting climate adaptation:

- **Encourage insurance innovations:** Pilot parametric insurance products in regions experiencing repetitive climate events, demonstrating effectiveness in providing rapid, objective payouts that enhance resilience for farmers, urban developers, and forestry stakeholders.

- **Promote public awareness and education:** Raise awareness of parametric and NBS-inclusive insurance options, clarifying the financial and environmental benefits to encourage broader public engagement and adoption.
- **Support public-private partnerships:** Expand funding and policy support for climate risk insurance in agriculture and forestry sectors, enabling co-investment in climate-resilient infrastructure and green initiatives.
- **Incentivize Nature-based solutions:** Develop insurance incentives tied to NBS adoption, such as premium discounts for implementing green roofs and other sustainable urban solutions, fostering a proactive adaptation culture.

This deliverable establishes a foundational understanding of the European insurance market's current landscape and highlights the opportunity for innovative insurance solutions to build climate resilience in vulnerable sectors. By addressing both public awareness and structural challenges, the PIISA project can support a scalable framework for integrating climate adaptation within the insurance sector across Europe.

Keywords

PIISA Project, Climate Adaptation, Insurance Solutions, Parametric Insurance, Nature-based solutions (NBS), Green Roofs, Forestry Insurance, Agricultural Insurance, Urban Green Infrastructure, Public-Private Partnerships, Climate Resilience, Risk Perception, Climate Risk Management, Innovative Insurance, Survey Analysis, Market Review, Environmental Risk, Sustainable Practices, Wildfire Management, Extreme Weather Events, Public Awareness, Insurance Uptake, Policy Support, Drought Management, Green Deal, Ecosystem Services, Sustainable Forestry, Climate Mitigation.

Abbreviations and acronyms

Acronym	Description
AFM	Authority for the Financial Markets (Netherlands)
BMEL	Federal Ministry of Food and Agriculture (Germany)
CAP	Common Agricultural Policy
CINEA	European Climate, Infrastructure and Environment Executive Agency
DNB	Dutch Central Bank
EFB	European Federation of Green Roof Associations
ENESA	Entidad Estatal de Seguros Agrarios (Spanish State Entity for Agricultural Insurance)
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
FMI	Finnish Meteorological Institute
GFIA	Global Federation of Insurance Associations
IPCC	Intergovernmental Panel on Climate Change
ISMEA	Istituto di Servizi per il Mercato Agricolo Alimentare (Institute of Services for the Agricultural Food Market)
NBS	Nature Based Solutions
OECD	Organisation for Economic Co-operation and Development
PIISA	Piloting Innovative Insurance Solutions for Adaptation
POLIMI	Politecnico di Milano
UAV	Unmanned Aerial Vehicle
UNFCCC	United Nations Framework Convention on Climate Change
WP	Work Package
WTW	Willis Towers Watson (insurance brokerage)

1 Introduction

1.1 Purpose and scope of Deliverable D1.4

This deliverable, titled "Focused Market Reviews in WP3 Pilot Sectors/Areas," is a key output of Work Package 1 (WP1) within the PIISA (Piloting Innovative Insurance Solutions for Adaptation) project. It provides comprehensive market reviews in sectors critical to climate adaptation, such as agriculture, forestry, and urban green infrastructure (e.g., green roofs). The objective is to analyse the current state of insurance markets in these sectors, assess innovative insurance solutions, and explore their potential to support climate adaptation efforts across diverse European regions.

A central focus of this deliverable is the detailed analysis of insurance products and services related to climate risks, including droughts, floods, and storms. This analysis aligns with PIISA's broader goal, as outlined in the Grant Agreement, of fostering new insurance solutions that enable households, businesses, and public authorities to manage climate risks more effectively.

Additionally, this deliverable integrates findings from surveys conducted by POLIMI (Politecnico di Milano), which assessed climate change awareness and perceptions across several European countries. These surveys capture insights into how citizens perceive climate-related risks and their engagement with insurance solutions. The results provide valuable context for the market review, offering a broader understanding of public demand for climate-related insurance products and highlighting barriers to their adoption.

The primary aim of Deliverable D1.4 is to explore the intersection of insurance products with climate-related risks and Nature-based solutions (NBS). It investigates how the insurance sector, particularly in climate-sensitive industries, can innovate and adapt to address growing climate risks. The findings help to identify gaps in current market solutions and uncover opportunities for innovative insurance products that incentivize proactive adaptation measures.

This document also draws from Work Package 3 (WP3), which focuses on implementing pilot projects in sectors like food and agriculture, green infrastructure, and forestry. These projects are spread across countries such as Finland, Spain, Italy, France, the Netherlands, Portugal, and Germany. Deliverable D1.4 covers these regions, ensuring a comprehensive and comparative analysis of how climate risks are perceived, managed, and insured across different contexts.

This deliverable is a joint effort between LGI and POLIMI, with LGI leading the market review and POLIMI contributing through survey research and data analysis. Together, they provide a comprehensive view of the insurance landscape in the targeted sectors, blending market insights with public perceptions of climate risks.

In conclusion, Deliverable D1.4 aims to provide an in-depth review of existing insurance solutions and assess how they can be expanded or adapted to support climate adaptation, particularly within WP3's pilot sectors. By doing so, it contributes to PIISA's mission of integrating climate adaptation into insurance markets, enhancing resilience, and promoting sustainable, innovative solutions.

1.2 Overview of WP3 pilot sectors/areas

Work Package 3 (WP3) within the PIISA project focuses on implementing pilot activities that aim to test and validate innovative insurance solutions for climate adaptation. The pilot sectors and areas under WP3 include agriculture, forestry, and urban green infrastructure, all of which face increasing risks due to climate change.

The pilot activities are organized around five key initiatives:

1. **Green Roof Insurances (Task 3.2.1):** This pilot focuses on developing insurance models for green roofs in urban settings, starting in cities across the Netherlands, the Mediterranean region, and Finland. Green roofs are an important Nature-based solutions (NBS) for enhancing urban resilience by mitigating stormwater runoff, reducing energy consumption, improving urban biodiversity, and the protection of building and roof structures against weather damages (hail, storms, etc.). The goal of this pilot is to create tailored insurance products that can encourage the wider adoption of green roofs by covering the associated risks and providing financial incentives for property owners. Also, this pilot will provide a cost-benefit analyses of green roofs to show their economic viability, by including the wider social and environmental benefits in the cost-benefit analysis.
2. **Dashboard for Citizens (Task 3.2.2):** A digital dashboard is being developed to assist homeowners in managing soil subsidence risks, which are exacerbated by climate change. The dashboard will provide real-time climate data and financial tools, helping citizens in cities like Lyon and Helsinki make informed decisions regarding adaptation measures and the associated insurance options.
3. **Insurance Services for Agriculture (Task 3.3):** Agricultural activities, especially in Finland and France, are increasingly exposed to risks such as droughts and extreme weather. This pilot aims to assess the feasibility of parametric and carbon insurance products tailored to farmers. These insurance solutions will be designed to cover specific crop risks and to incentivize climate-smart agricultural practices, helping to secure food production while reducing environmental impacts.
4. **Forest Insurances (Task 3.4.1):** Forestry in regions like Germany and Portugal faces threats from both biotic (pests and diseases) and abiotic (fires and droughts) risks. This pilot will co-develop new insurance products that offer comprehensive coverage against these risks, helping forest owners manage climate change impacts. The products will be tested in various socio-economic contexts to ensure they meet the needs of different stakeholders and can be scaled across other regions in Europe.
5. **Wildfire Insurances (Task 3.4.2):** Wildfires, particularly in southern Europe, are a growing threat to both natural and built environments. This pilot focuses on developing innovative insurance instruments that support proactive wildfire adaptation measures. The aim is to introduce new products that reward preventive actions, such as firebreaks and other risk reduction measures, thereby reducing both the frequency and intensity of wildfires.

The choice of countries and sectors addressed in this deliverable is closely aligned with the focus of Work Package 3 (WP3), which targets regions and industries that are particularly vulnerable to climate risks. According to WP3's objectives, the pilot activities focus on countries such as Finland, Spain, Italy, France, the Netherlands, Portugal, and Germany because these regions face a range of climate-related hazards, from droughts and floods to wildfires and storms. These countries were selected to ensure a representative sample of different climatic, geographical, and economic conditions within Europe, allowing the project to test and refine innovative insurance solutions across diverse environments. Similarly, sectors such as

agriculture, forestry, and urban green infrastructure were chosen due to their critical importance in adapting to climate change and their direct exposure to climate risks. By focusing on these specific countries and sectors, WP3 aims to develop scalable and adaptable insurance products that can promote climate resilience across Europe.

2 Methodology

The methodology for this report on focused market reviews in WP3 pilot sectors/areas follows a structured and systematic approach to comprehensively understand the insurance market dynamics within the context of climate adaptation. This research methodology is divided into two components of data collection: The survey data collection the desk-research data collection methods for market reviews.

2.1 Description of the research approach

The research approach adopted for this report is qualitative and exploratory, aimed at uncovering detailed insights into the state of the insurance markets in the targeted sectors and regions. The study employs a combination of literature reviews, expert consultations, and case study analyses to gather and synthesize information. This approach takes into account different perspectives to build a clear and thorough understanding of the market conditions, trends, and innovations within the insurance sector, particularly concerning climate-related risks.

A significant component of the research involves examining existing insurance products and services, understanding the regulatory frameworks governing these markets, and assessing the integration of innovative and Nature-based solutions (NBS) in insurance solutions. The research approach is designed to identify gaps and opportunities within the market, providing a basis for recommendations and strategic interventions to enhance insurance uptake and resilience in the face of climate change.

2.1.1 Data collection methods for the survey conducted by POLIMI

To assess the awareness and perception of climate change among European citizens, a survey was conducted using an online questionnaire (CAWI survey) targeting a sample of adult citizens from six European countries: Finland (Helsinki), France (Paris), Germany (Berlin), Italy (Milan), the Netherlands (Amsterdam), and Spain (Barcelona), selected to cover all European regions relevant to the pilots of this Horizon Europe project. To ensure representativeness of the population, POLIMI employed a quota sampling approach (Lawrence Neuman, 2014; Demmers et al., 2018). Independent t-tests on gender and age showed no significant difference between the sample and the population characteristics (Table 1).

Table 1 Survey Sample features and one sample t-test p-values

Country	#	Sample feature	Eurostat data (2023) ¹	Sample average age	Eurostat data (2023)
Finland	210	Female = 53%; Male = 47%	Female = 51%; Male = 49%	44.05	43.40
		0.582		0.558	
France	100	Female = 53%; Male = 47%	Female = 52%; Male = 48%	42.22	42.20
		0.841		0.990	
Germany	114	Female = 52%; Male = 48%	Female = 51%; Male = 49%	43.40	45.80
		0.733		0.090	
Italy	207	Female = 52%; Male = 48%	Female = 51%; Male = 49%	46.11	48
		0.730		0.087	
Netherland	210	Female = 50%; Male = 50%	Female = 50%; Male = 50%	41.09	42.70
		0.885		0.099	
Spain	110	Female = 51%; Male = 49%	Female = 51%; Male = 49%	46.23	45.10
		0.983		0.335	

In total, POLIMI received 951 completed questionnaires. This selection ensures wide geographical representation across key regions of Europe and key regions for the development of the PIISA project, allowing so for cross-country comparisons.

The questionnaire was initially developed in English, then shared with the PIISA project consortium partners for review. Partners were encouraged to provide feedback on potential weaknesses and suggest additional insights to ensure the questions were relevant across different countries. After integrating the feedback, the final version of the questionnaire was pre-tested by one scholar and three PhD students from Politecnico di Milano to check for readability, question flow, and potential biases. Following this, the questionnaire was translated into the six languages corresponding to the target countries to facilitate the citizens from different European regions who would respond, and the translations were reviewed by native-language partners from each country to ensure linguistic accuracy and cultural appropriateness.

The sample was proportionally distributed across the six nations. Data was collected anonymously over a specified period, with participation being voluntary. Respondents were informed of the survey's purpose, their rights, and assured that their responses would remain confidential. No personally identifiable information was collected, ensuring anonymity. Descriptive statistics, such as percentages and means, were used to summarize key findings related to climate change awareness, perceptions of risk, and protective measures taken, particularly regarding insurance solutions. Cross-tabulations were applied to explore differences across demographic groups (e.g., by country, age, and gender), and statistical

¹ Demography of Europe - 2023 edition: <https://ec.europa.eu/eurostat/web/interactive-publications/demography-2023#population-structure>

tests such as chi-square were conducted to determine the significance of observed differences.

2.1.2 Data collection methods for the market reviews conducted by LGI

The data collection process for the market reviews conducted by LGI involved multiple sources and methods to ensure robustness and reliability of the findings. The primary data sources included a comprehensive literature review, detailed case studies, and direct data from insurance companies. These diverse sources provided a holistic view of the insurance markets in various pilot sectors and regions. Firstly, a thorough review of existing literature, including academic papers, industry reports, and policy documents, was conducted. This review provided foundational knowledge and context for understanding the insurance markets in the pilot sectors and regions. Key sources included publications from the European Commission, industry reports from major insurance companies, and scholarly articles focusing on climate risk and insurance. This literature review offered essential background information that shaped the overall framework of the market analysis.

Secondly, detailed case studies were developed to illustrate the current state of insurance markets, the types of insurance products available, and the innovative solutions being implemented in specific countries and sectors. The focus of the case studies included pilot sectors such as food and agriculture, green roof insurance, and forestry in countries like Finland, Spain, Italy, France, the Netherlands, Portugal, and Germany. These case studies provided concrete examples and in-depth insights into how different markets and sectors are responding to emerging challenges, particularly related to climate risk. Furthermore, data was collected directly from insurance companies operating in the pilot sectors and regions. This involved reviewing annual reports, financial statements, and product brochures to gather information on product solutions, market share, and innovative insurance solutions. Additionally, the data collection included insights into green investments and sustainability initiatives undertaken by major insurance companies in these regions, further highlighting the evolving landscape of the insurance sector in response to climate challenges.

Lastly, all the collected data was systematically analysed and integrated to produce a coherent and comprehensive market review. The analysis identified key trends, challenges, and opportunities within the insurance markets across the pilot sectors and regions. Comparative analyses were conducted to highlight differences and similarities, offering a nuanced understanding of the market landscape.

3 Survey: results and analysis

3.1 Introduction

Nowadays, as also mentioned in the World Economic Forum², environmental risks dominate the global risk landscape, both in the short and long term. As highlighted in the PIISA Project's D1.1 report (Ceolotto et al., 2024), the global climate is changing (IPCC, 2014). This shift is causing widespread impacts on both natural and human systems, including the displacement of millions of people, severe interruptions to business activities, disruptions in the agricultural sector leading to higher levels of food insecurity, tens of billions of dollars in economic losses, and hundreds of thousands of casualties (IPCC, 2014; Wing et al., 2021; WMO, 2020, 2023). The annual hazards related to natural hazards has steadily increased, with annual losses arising from approximately \$421 billion in 2011 to over \$3 trillion in 2022 (GFIA, 2023), and this trend is expected to continue into the future.

This section of the document explores the awareness and perception of climate change and the associated environmental risks among European citizens. Particularly, it will examine how citizens perceive the risks linked to specific natural hazards and the protective measures they are taking against these risks, with a particular focus on insurance solutions.

We will take in consideration natural hazards coherently with the EU Disaster Risk Management Knowledge Centre classification (Poljanšek et al., 2017). Natural hazards can be broadly divided into three main types of phenomena: (i) geophysical phenomena, such as earthquakes, volcanic eruptions, and tsunamis; (ii) hydrological phenomena, including floods, landslides, and tidal activities; and (iii) meteorological, climatological, and biological phenomena, encompassing storms, rainstorm, hail storm, cyclones and hurricanes as regard for meteorological, wildfires, extreme temperatures and droughts as regard for climatological, and biotic risks as regard for biological (like epidemics and pests). This report narrows its attention on geophysical, hydrological, meteorological and climatological natural phenomena. Within these categories, we examine a total of 11 specific natural hazards:

- Meteorological: Hail; Heavy rainfall; Hurricane / Tornado; Storm.
- Climatological: Drought; Wildfire.
- Hydrological: Flood; Landslide
- Geophysical: Earthquake; Tsunami; Volcanic eruption; Tsunami

This section of the document will be structured as follow, in section 3.2 we analyse climate change awareness and concern levels regarding specific natural hazard-related risks among 951 citizens from six European countries (Finland, France, Germany, Italy, Netherland and Spain). In section 3.3, we evaluate the actual impact of these natural events in terms of both experience and the financial losses suffered. We explore the role of Nature-based solutions (NBS) in climate adaptation, investigating citizens' awareness and willingness to co-finance these solutions (section 3.4). Finally, in section 3.5 we assess citizens' knowledge of insurance solutions to protect against these risks and in subsection 3.5.1 we examine the knowledge and adoption of parametric insurance solutions, along with the associated incentives and barriers to purchasing these policies.'

² Global Risk Report 2024: <https://www.weforum.org/publications/global-risks-report-2024/>

3.2 Climate Change Awareness

In the first section of this report, we explore the climate change awareness and concern levels among citizens living in different European regions. This analysis encompasses not only the current state of concern regarding climate change but also delves into future expectations and perceptions. By examining both present and anticipated concerns, we aim to provide a comprehensive overview of how climate change is viewed across different areas of Europe.

We begin by assessing the overall concern about climate change, highlighting the varying degrees of awareness and worry among the population. This sets the stage for an investigation into how citizens perceive the potential increase in the frequency and severity of natural phenomena in their areas. Understanding these future-oriented concerns is crucial for gauging the public's readiness to support and engage in climate action. Furthermore, we dissect the perceived risk associated with the natural phenomena and the specific types of natural hazards. This approach reveals how different threats are prioritized by the public. Overall, this section provides a detailed snapshot of climate change awareness in different European regions, capturing both immediate concerns and long-term expectations about climate change.

The survey results shows that **87% of European citizens express concern about the climate change** (Fig. 1). Among these citizens, more than half are moderately concerned (54%), while the 33% are seriously concerned about the climate change. This suggests that only a 13% of the population does not perceive climate change as an immediate and critical issue. Specifically, the percentage of citizens not concerned about climate change decreases to 9% among those with a bachelor's degree or higher education level, while it rises to 25% among those with only a primary education. This indicates that the education plays a key role in shaping citizens perception on the risks arising from climate change. From a statistical perspective, the relationship between education level and climate change concern resulted significant when grouping the education levels into 3 categories: i) no education or primary; ii) lower or upper secondary; iii) higher education (Bachelor's, Master's, PhD) (chi-test p-value=0.014).

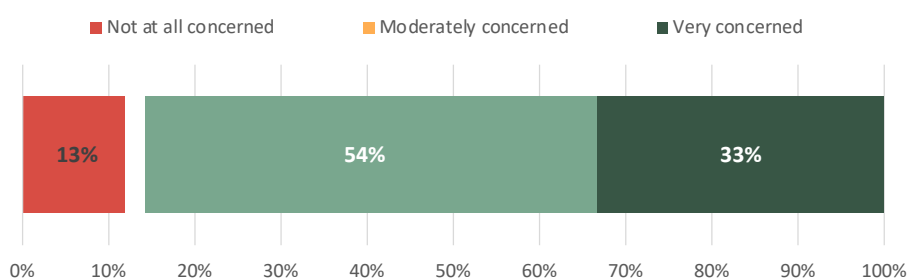


Figure 1: Concerns about climate change. Source: proprietary data on 951 European citizens

Aligned with escalating signals of climate change, the survey reveals that climate change is becoming a concern for many European citizens. And this sentiment strengths notably when considering future implications. According to the survey, 43% of respondents believes that climate change will significantly increase the frequency and severity of extreme natural hazards in their area. Additionally, 22% express a strong belief that these impacts will be profound. Combined, these figures indicate that nearly two-thirds (65%) of the European population anticipates a rise in extreme natural hazards due to climate change (Fig. 2).

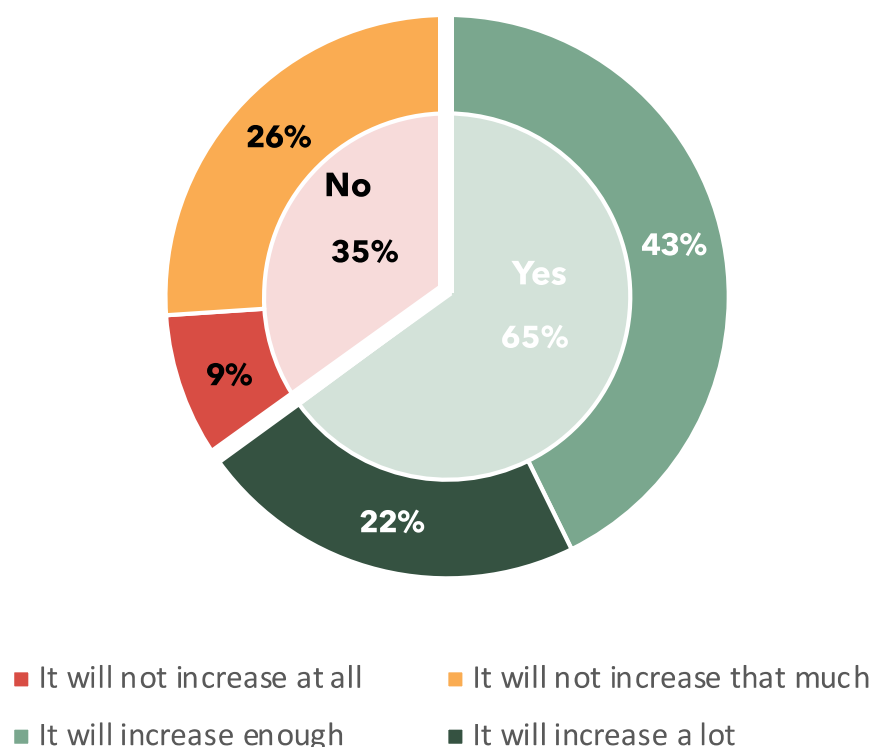


Figure 2: Perceptions on the increase in frequency and severity of climate change. Source: proprietary data on 951 European citizens

When comparing current concerns with future perceptions, an interesting pattern emerges (Fig. 3). The vast majority (55%) of the 13% of respondents that are currently not at all concerned about climate change expresses skepticism about its future impact on extreme natural hazards. Notably, among those currently not concerned about climate change, the majority remain doubtful about the future increase in the frequency and severity of natural hazards due to climate change. This highlights a consistent scepticism among a small but notable segment of the population, which also represents over the 78% of those who do not believe that climate change will increase extreme natural hazards in the future.

Those who are currently exhibiting a moderate concern about climate change are divided in their future outlook. In terms of their perceptions of future increases in frequency and severity of climate-related events, 34% believe there will be "not so much" of an increase, while 49% foresee a "moderate" increase. These individuals make up 70% and 63%, respectively, of the population in these two future perception categories. Finally, it is important to note that among those who are currently highly concerned about climate change, the majority (more than 88%) also expresses concern about the future escalation of climate-related hazards. Specifically, 45% of them are "moderately" concerned, while 43% are "very" concerned about the increase in the frequency and severity of natural hazards due to climate change. These observations reflect a strong overlap between present concerns and future perceptions regarding climate change among European citizens, with those already worried about the current state of the climate also apprehensive about its potential to worsen. Indeed, among the 87% of respondents who currently express concern about climate change, over two-thirds (73%) also exhibit moderate to high concern about the increasing frequency and severity of climate-related events.

This indicates that, in addition to immediate concerns, there is widespread awareness that the current climate situation may deteriorate further in the future.

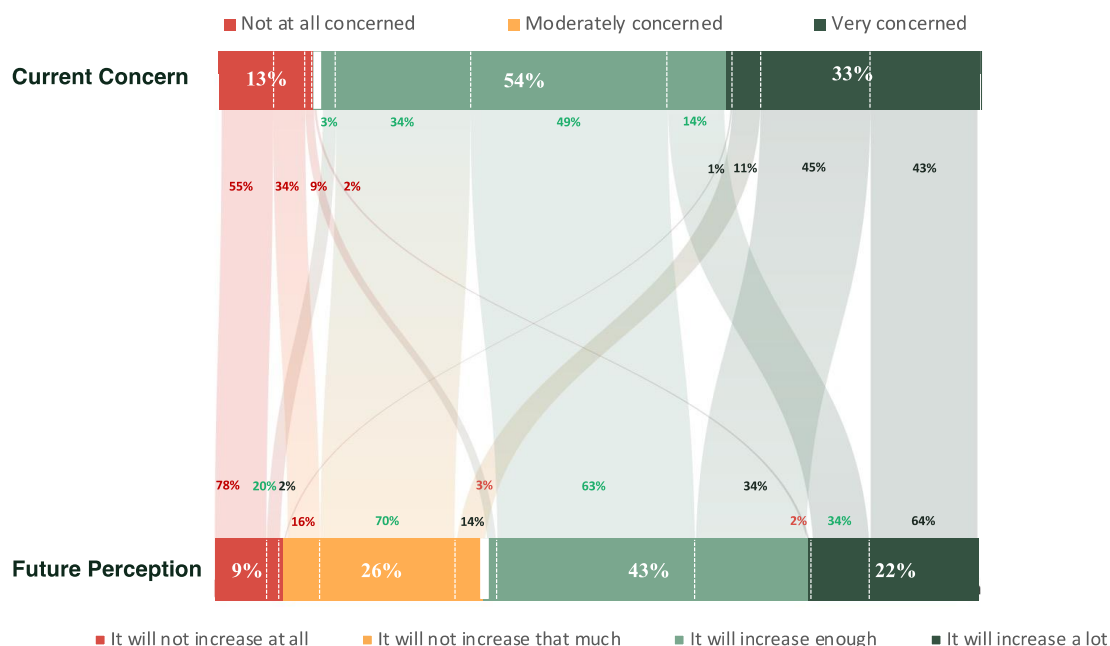


Figure 3: Relation between current concern level and future perception on the increase in frequency and severity of climate change. Source: proprietary data on 951 European citizens.

In addition to the general perception of climate change, we conducted an analysis to explore how European citizens perceive each specific natural hazards. The results indicate that European citizens associate varying levels of perceived risk with different types of natural phenomena.

Following Poljanšek et al. (2017) classification of natural phenomena, the data reveals that meteorological phenomena are perceived as the riskiest, followed by climatological, hydrological, and finally, geological events (Fig. 4). The figure 4 shows the weighted average of the risk perception level associated with the four natural phenomena mentioned above. The perception level ranges from 1 (null) to 5 (high).

This may suggest that citizens may view events with higher frequency or familiarity as more dangerous, while perceiving less frequent or seemingly unlikely events, such as geophysical phenomena like earthquakes, tsunamis, and volcanic eruptions, as less risky.

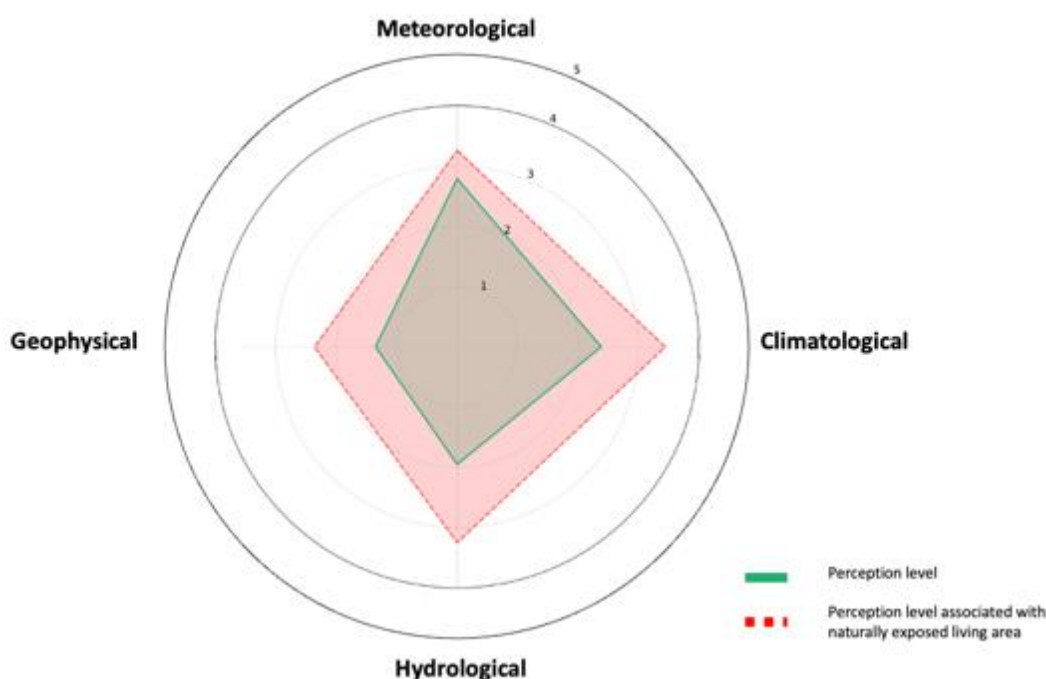


Figure 4: Perceptions on the risk associated to different natural phenomena (from 1-null to 5-high).
Source: proprietary data on 951 European citizens.

A deeper analysis of risk perception towards specific natural hazards shows that the top three perceived risks are meteorological phenomena (Fig. 5). Specifically, heavy rainfall, hail, and storms are identified as the highest-risk hazards, with average risk perception levels around 3.2 on a scale of 5. This suggests that European citizens generally perceive these events as moderately risky. Heavy rainfall stands out as the most concerning hazard, with only 7% of respondents perceiving no risk, 36% viewing it as a medium-high risk, and 8% identifying it as a high risk. This indicates widespread awareness of the potential consequences of heavy rainfall, such as flooding and damage to infrastructures. Similarly, hail and storms also rank high in terms of perceived risk, with 8% and 7% of respondents, respectively, viewing them as high-risk, and 31% and 30% as medium-high risk.

Following the meteorological phenomena, there are climatological and hydrological disasters. Wildfires, for instance, are a notable concern, with 4% of respondents perceiving them as high risk and 11% as medium-high. The rising frequency and severity of wildfires in certain parts of Europe may likely contribute to this perception. Floods also evoke moderate concern, with 2% of respondents viewing them as high-risk and 14% as medium-high. This may suggest that while wildfires and floods are recognized as significant threats, they are not perceived with the same urgency as heavy rainfall and storms. Droughts, too, are seen as moderate risks, with 4% of respondents viewing them as high-risk and 21% as medium-high, potentially reflecting an understanding of the long-term impacts on agriculture and water resources, albeit with less immediate concern.

Geophysical phenomena, such as earthquakes, tsunamis, and volcanic eruptions, are generally perceived as lower risky. For instance, 86% of respondents see no risk of volcanic eruption, 82% perceive no risk of tsunami, and 55% view earthquakes as no risk, with 33% considering them low risky.

This may suggest that those natural hazards that are either less frequent or more geographically specific, overall result in a non-primary concern for most European citizens.

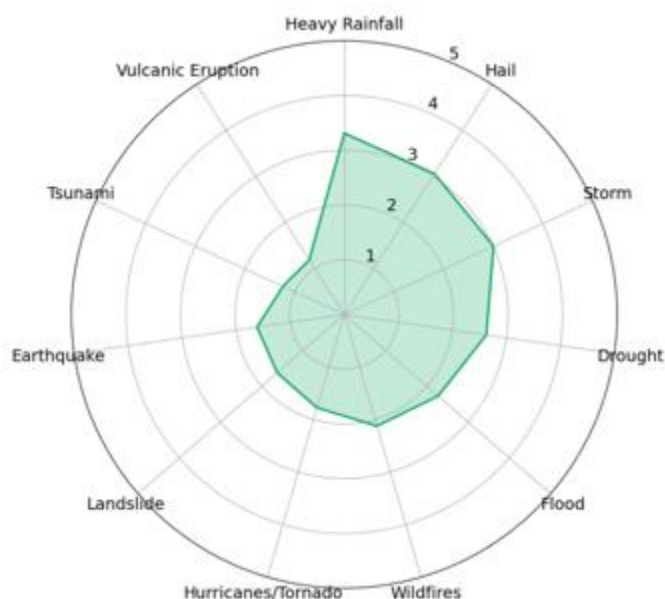


Figure 5: Perceptions on the risk associated to different natural hazards (from 1-null to 5-high).
Source: proprietary data on 951 European citizens.

What we have discussed so far reflects the average perception across the entire European sample. However, geographical specificity is a crucial factor to consider. As previously mentioned, risk perception varies based on the respondent's geographic location and the proximity of their houses to areas exposed to specific natural hazards. Results show that when considering the factor of living in areas exposed to natural hazards, the risk perception increases (Fig. 4; Fig. 6).

The comparison between risk perception and the respondent's geographic area clearly shows that those living in areas they believe to be exposed to specific natural hazards perceive much higher levels of risk. Across all categories of natural phenomena, risk perception increases by approximately one point on the scale (Fig. 4). Figure 6 illustrates how proximity to high-risk areas significantly elevates the perception of risk toward specific natural hazards. Specifically, for geographically specific events such as earthquakes, risk perception rises by around two points (Fig. 6).

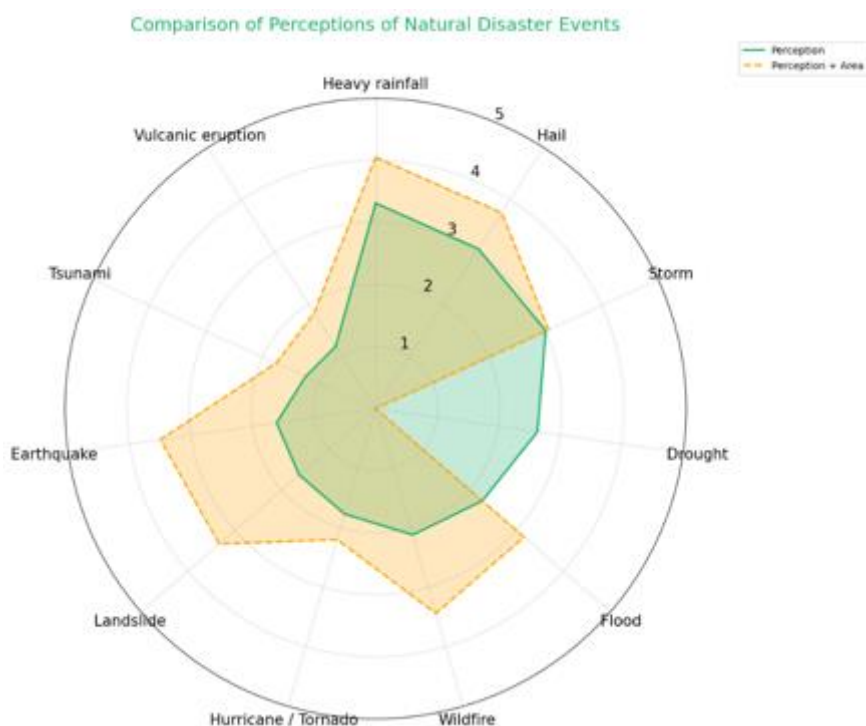


Figure 6: Perceptions on the risk associated to different natural hazards (from 1-null to 5-high).
Source: proprietary data on 951 European citizens

Overall, the survey data reveals a pattern where European citizens are more concerned about natural hazard that are common and more likely to affect their daily lives, such as heavy rainfall, storms, hail, drought and floods. The varying perception of risks among European citizens highlights the importance of understanding and addressing the specific concerns related to different types of extreme weather events.

3.3 Damages from Climate Change

In this second section, we delve into the impact of climate change related events on European citizens. While section 3.2 examined the awareness and concern levels regarding climate change, this section focuses on the tangible financial impacts that extreme weather events have had on individuals. Understanding the extent of these economic losses is crucial for comprehending the full scope of climate change's impact.

We will explore the various types of natural hazards that have caused economic losses, looking at both recurrent and less frequent occurrences. This analysis will help to identify which hazards are most damaging and how these hazards are perceived in terms of risk by the public. Furthermore, this section will address the financial compensation received by those who have suffered economic losses due to natural hazards. By examining the sources of compensation, we aim to highlight what European citizens rely on in the case of natural events, thus identifying any potential gaps in support and assessing citizens' dependence on various forms of financial recovery, such as the activation of appropriate insurance coverage.

Overall, this section aims to provide a comprehensive overview of the damages caused by climate change, shedding light on the financial challenges faced by European citizens and the mechanisms available to mitigate these impacts.

The survey data reveals that the 76% of European citizens have experienced at least one natural hazard in the last five years. This significant percentage underscores the widespread impact of climate change across Europe, affecting a substantial portion of the population. Despite the wide occurrence of these natural hazards, only a minority (26%) of European citizens report having suffered economic losses as a result. However, while the percentage of financial losses is considerably lower than the overall impact of natural hazards, it is important to emphasize that one in four European citizens have faced economic losses related to climate change over the past five years.

A substantial portion of these losses is attributed to meteorological phenomena, events more frequent than other types of hazards and, as a result, perceived as a greater threat by European citizens. Approximately 73% of respondents indicated that they had been affected by meteorological phenomena in the last five years, with 24% experiencing related economic losses. Specifically, 16.8% reported losses from heavy rainfall, 15.7% from hail, and 13.9% from storms (Fig. 7). These figures closely align with the high-risk perception related to these phenomena, underscoring a strong correlation between perceived risk and actual economic impact.

In line with these concerns, climatological and hydrological events follow in terms of both frequency and impact. About 36% of European citizens reported being affected by climatological events (such as droughts and wildfires), while 21% experienced the effects of hydrological events (such as floods and landslides). Droughts and floods also stand out as significant contributors to economic losses, with approximately 7% of respondents reporting financial damages linked to each of these events.

An interesting pattern emerges when comparing financial losses with the experience of natural events. Indeed, as we can see from Figure 7, the gap between experiencing a natural hazard and financial losses narrows as we move to the right toward the less frequently experienced hazards. This indicates that the natural hazards experienced less often by European citizens are also the ones most likely to result in financial losses. Survey results reveals that geophysical phenomena, although the least experienced by European citizens, have the highest impact on financial losses. Approximately 86% of Europeans who experienced one of these natural hazards (earthquake, tsunami and volcanic eruption) also reported financial losses. Following this, hydrological phenomena, the second least common among Europeans, show a loss-to-experience ratio of 59%. Lastly, meteorological and climatological events follow with 33% and 29%, respectively.

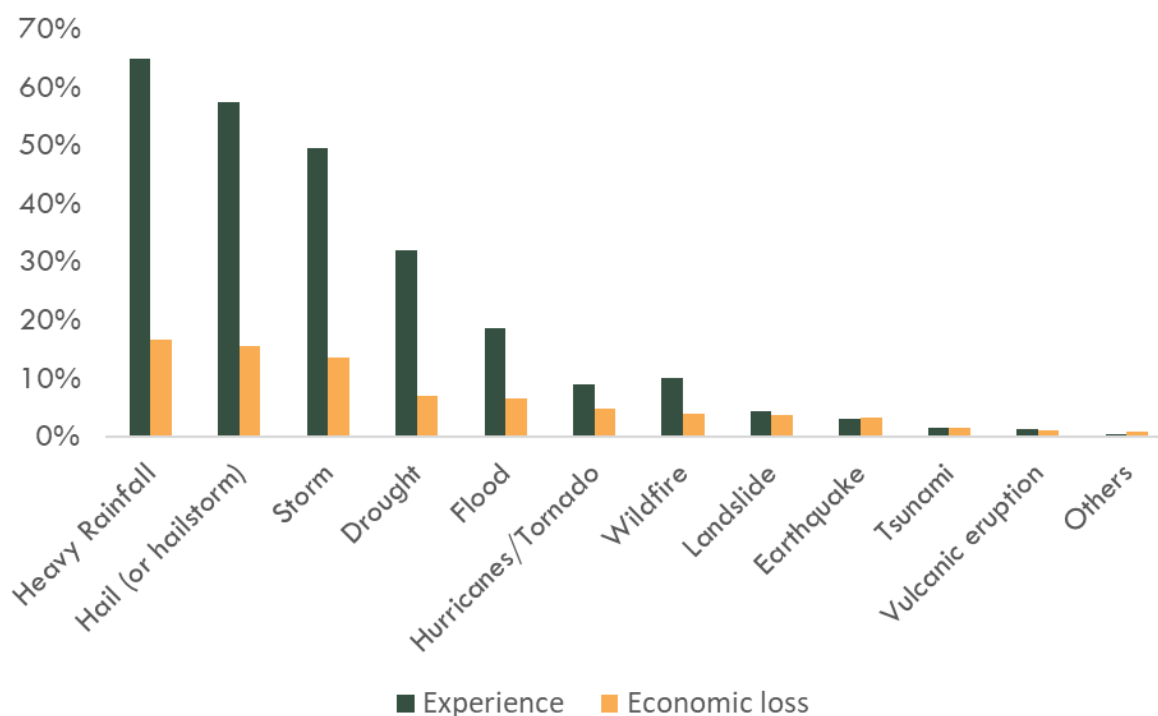


Figure 7: percentage on the experience of natural hazard and on the associated financial losses.
Source: proprietary data on 951 European citizens.

For the economic loss suffered, some received a compensation. Among those who did receive the compensation, the vast majority (84%) obtained it through insurance companies (Fig. 8). This indicates that insurance is the primary mechanism for financial recovery from climate-related damages for most people. Additionally, 11.5% of compensated individuals received financial aid from the government. Interestingly, a substantial portion of this 11.5% reported experiencing damages from specific natural hazards. Among those who received government compensation, 47% had been affected by landslides, 63% by floods, 32% by earthquakes, and 53% by droughts. This suggests that government compensation is more likely to be provided to those impacted by less frequent but severe natural hazards, such as hydrological and geophysical events. In contrast, the percentages of individuals who received insurance compensation for the same hazards were considerably lower: 17% for landslides, 24% for floods, 14% for earthquakes, and 28% for droughts. This data indicates that insurance primarily covers meteorological phenomena, highlighting that European citizens tend to insure themselves against hazards perceived as more common, as we have previously seen for hazards such as heavy rainfall, hail, and storms. It is also important to note that government compensation is not limited to less frequent events; a notable percentage of respondents also reported government repayment for damages from meteorological phenomena. This may reflect the growing frequency and intensity of extreme weather events, which has outpaced the capacity of insurance solutions to provide comprehensive coverage.

But it is also worth noticing that a significant portion of those who have suffered economic losses due to climate events have not received any financial compensation.

Specifically, over 48% of respondents reported not receiving any economic compensation for the damages suffered.



Figure 8: Financial compensation mechanisms for damages or losses suffered from extreme weather events. Source: proprietary data on 243 European citizens.

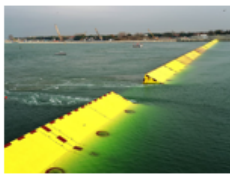
In conclusion, the disparity in compensation sources suggests that government aid is more prevalent among those who have faced severe natural hazards, while insurance companies mainly cover more common meteorological-related phenomena. Although insurance plays a crucial role in financial recovery, a significant portion of the population remains uncompensated. Moreover, government support appears to be directed toward those affected by more severe, less frequent events, underscoring the need for a more comprehensive approach to managing the financial impacts of climate change.

3.4 Nature Based Solutions (NBS)

Climate adaptation encompasses strategies to lessen the vulnerability of human and natural systems against the impacts of climate change. These strategies are generally categorized into Nature-based solutions (NBS), Grey Infrastructure, and Hybrid Solutions (Box 1).

Our focus will be on Nature-based solutions (NBS). NBS enable to address risks (such as flood risks, or heat island effects), while also providing multiple co-benefits such as conserving, restoring, rehabilitating, or creating ecosystems (PIISA Project, 2024).

Box 1 – Description of Nature-based solutions (NBS), Grey Infrastructures and Hybrid solutions.
Source: own elaboration.

	Nature-Based Solutions (NBS) Refer to strategic approaches that utilize natural processes to mitigate climate impacts and enhance resilience. NBS harness ecosystems to absorb and store carbon dioxide, regulate local climates, and reduce vulnerability to extreme weather events, such as floods, heatwaves, and hurricanes. <i>For example: plant deep-rooted vegetation on riverbank slopes to prevent flooding; use bacteria to promote plant growth and prevent drought; green roof to reduce heat and improve house temperature</i>
	Grey Infrastructure Refers to constructions designed to manage or manipulate natural resources and environmental conditions, providing immediate solutions to environmental challenges. These structures, often made from materials like concrete and steel, are designed for water management, flood control, and transportation. <i>For example: concrete breakwaters, and seawalls against coastal erosion; artificial dams and artificial river drain to prevent flooding</i>
	Hybrid solutions Refer to approaches that combine Nature-Based Solutions (NBS) and Grey Infrastructure to enhance climate resilience and adaptability, merging engineered structures with natural elements to protect against climate impacts while supporting ecosystem health. <i>For example: mobile sea walls naturally activated to prevent floods; desalination of water to prevent drought</i>

Survey data show that nearly **half of the respondents** (49.2%, Fig. 9) **are familiar with NBS**, suggesting a significant appreciation for environmental integration into urban planning. Grey Infrastructure is recognized by 38.4% of the population, and Hybrid Solutions, which represent a blend of natural and engineered defenses, are known to about 28%. A notable 33.9% is unaware of any such measures, pointing to a critical gap in public interest and engagement.

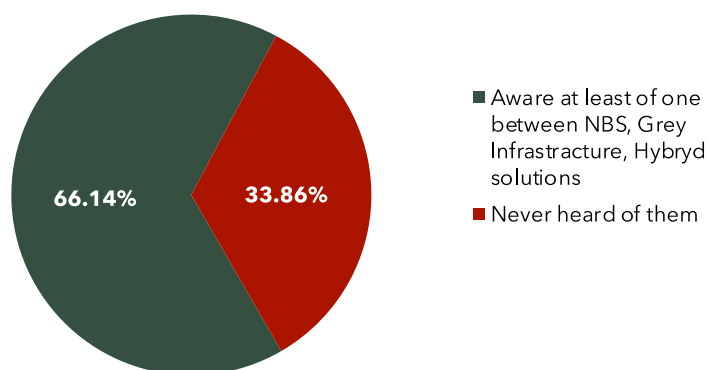


Figure 9: awareness of climate adaptation risk reduction measures. Source: proprietary data on 951 European citizens.

It is therefore important to assess whether, beyond simply being aware of NBS solutions, citizens truly appreciate their benefits to the point of considering co-financing these measures. In this regard, we observe a notable split in opinions. Approximately 52.8% of respondents is open to co-finance projects to implement Nature-based solutions (NBS) in order to reduce the effects of climate change, indicating a proactive stance towards personal investment in climate adaptation measures.

However, nearly an equal fraction, 47.2%, prefer that such financial responsibilities be managed by public authorities or private companies, indicating reliance on institutional rather than individual action.

From the data on co-financing Nature-based solutions (NBS), it is evident that citizens willingness to invest is nuanced and varies depending on the involvement of different stakeholders. Around 25.9% of respondents (Fig. 10) would consider co-financing if local governmental and institutional support were part of the funding mix, with similar results considering a contribution from European Institutions, with 23.3% open to finance such measures, implying that the perceived legitimacy and effectiveness of NBS projects increase when backed by formal institutions. Another 23.4% express readiness to co-finance when private companies are involved. Meanwhile, the community aspect holds notable sway, with 21.5% of respondents inclined to contribute if their neighbors and fellow citizens also participate.

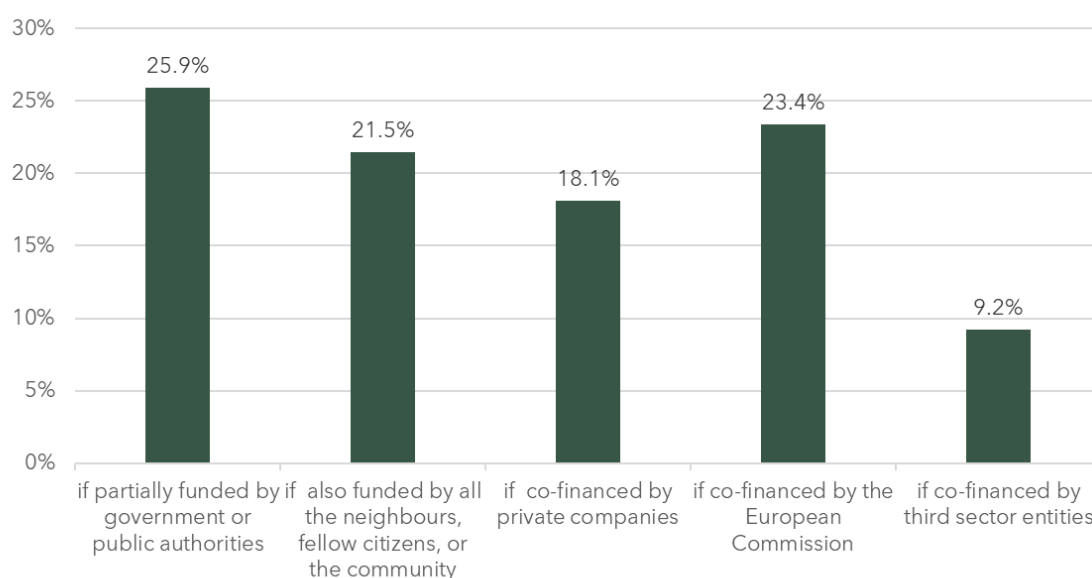


Figure 10: Availability to co-finance projects for the implementation of Nature-based solutions. Source: proprietary data on 629 European citizens

To assess whether this willingness to co-finance can be influenced somehow, we analyzed the potential incentives that might increase such propensity. Figure 11 illustrates the variety of incentives that could potentially enhance people's willingness to invest in Nature-based solutions (NBS) for climate adaptation. A significant 30.3% of respondents indicates that financial incentives such as discounts on insurance premiums for implementing NBS are the most compelling. This suggests that direct financial savings could motivate a larger segment of the population to engage in environmentally sustainable practices. Following behind, 19.6% would consider investing if the NBS were protected by an insurance policy, highlighting the importance of safeguarding their investments against potential risks. Additionally, 18.7% of participants are motivated by the prospect of clear and tangible environmental benefits that align with their sustainability goals, reflecting a strong alignment between personal values and environmental action. Support and guidance from insurance companies, which can demystify the process and increase confidence in NBS, would motivate 13.1% of respondents. Increased awareness and information about NBS would also help, with 12.9% indicating that better understanding could spur their financial participation. Notable, also, a substantial 41.5% of respondents stated that none of the listed incentives would enhance their willingness to invest

in NBS, pointing to potential challenges in convincing a significant portion of the population about the value and effectiveness of such solutions.

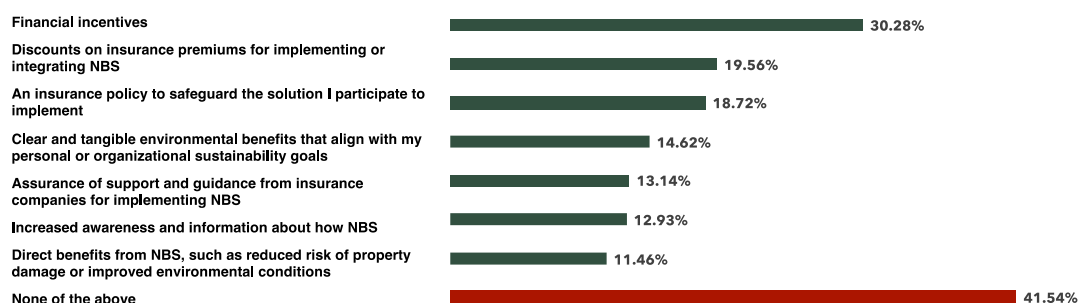


Figure 11: Willingness to invest in Nature Based Solutions. Source: proprietary data on 951 European citizens.

3.5 Insurance level

This final section examines the level of insurance coverage among European citizens in relation to climate-related risks. Additionally, it explores the barriers preventing citizens from obtaining specific insurance coverage against natural hazards, as well as potential incentives that could encourage greater uptake.

The results reveal that insurance coverage for climate-related risks is limited across Europe. **More than half (58%) of the respondents reported not being insured against any climate-related risks.** Regardless of the type of natural hazard, the percentage of insured individuals remains low, with no single natural phenomena category exceeding 23% coverage (Fig. 12). A breakdown shows that meteorological phenomena are the most commonly insured, with 23% of respondents holding coverage. Hydrological and climatological phenomena follow closely, with 13% and 10% coverage, respectively. Geophysical events, which are perceived as lower risk, have the lowest coverage, with only 5% of citizens insured. Even when examining specific natural hazards with a higher perceived risk, such as hail, storms, and heavy rainfall, the insurance coverage remains relatively low, at 32%, 27%, and 24%, respectively (Fig. 13).

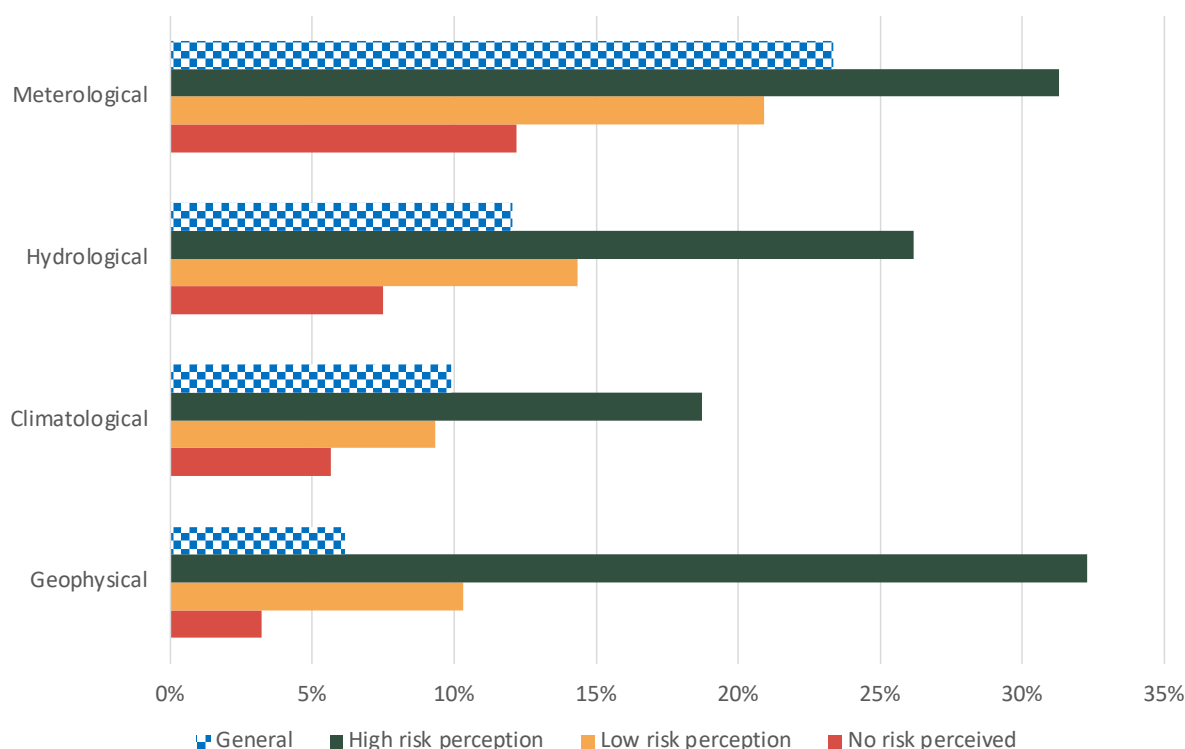


Figure 12: Insurance coverage against natural phenomena per different classes of risk perception.
Source: proprietary data on 951 European citizens.

An interesting insight arises when comparing insurance coverage with individual concerns about specific natural hazards. Including in the analysis the level of concern expressed by European citizens about climate change over specific natural phenomena, a more nuanced picture emerges (Fig. 13). Among those who reported high or medium-high concern for specific natural phenomena, the insurance coverage rates increase significantly. For instance, among citizens who perceive meteorological and hydrological phenomena as high or medium-high risky, the insurance coverage increases to 31%, marking an 8 and 18 percentage-point increase, respectively. Notably, among those who perceive geophysical phenomena as high-risk, 29% are insured. However, this statistic is skewed, as only 1.5% of the sample views these events as highly risky. When breaking it down by specific natural hazards, the data reveals that citizens who perceive hail, storms, and heavy rainfall as high-concern show higher insurance rates of 42%, 38%, and 30%, respectively, compared to just 18%, 15%, and 10% among those who do not associate these hazards with significant risk.

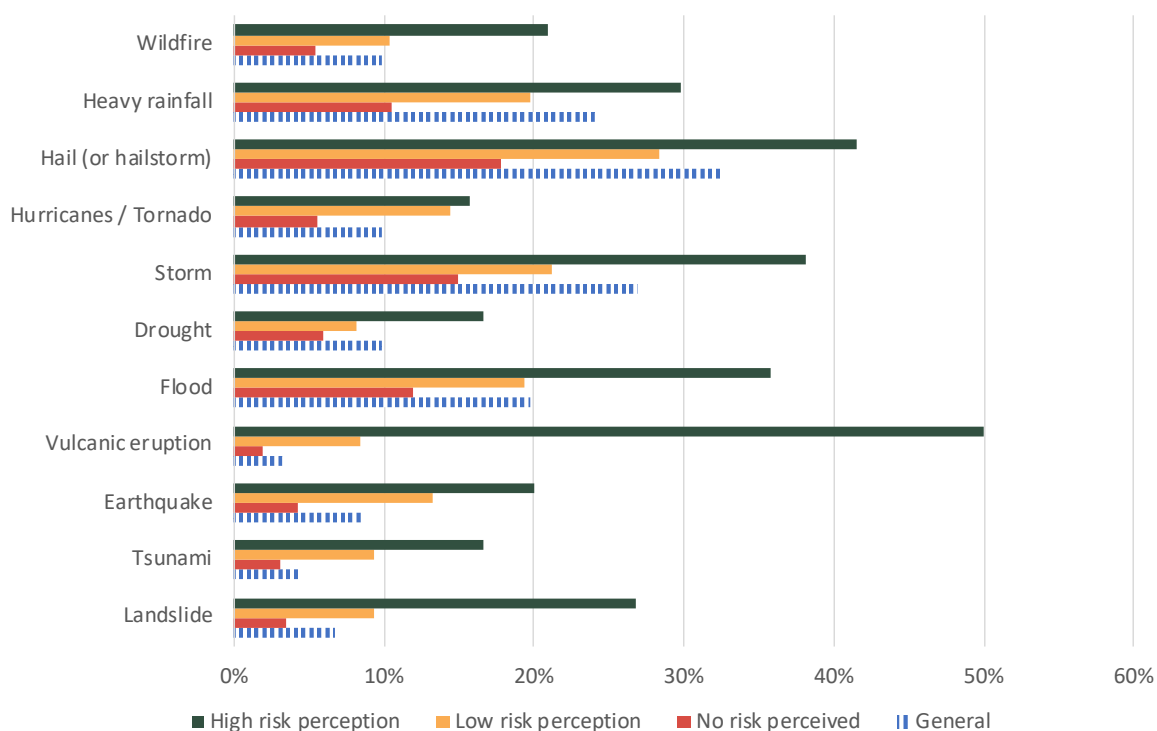


Figure 13: Insurance coverage against natural hazard per different classes of risk perception. Source: proprietary data on 951 European citizens.

Given the previous results, which showed that a significant portion of European citizens (58%) are not insured against any climate-related risks, it is essential to explore and understand the barriers preventing them from obtaining insurance coverage. To this end, we asked respondents who have at least one uninsured natural phenomena associated risk (85% of the sample) to identify the reasons for their lack of coverage.

The primary barrier, cited by 56.3% of respondents, is the perception that natural hazards do not pose a significant enough risk to push European citizens acquiring an insurance coverage (Fig. 14). This finding contrasts sharply with the earlier data on citizens' risk perception. Indeed, around 60% of European citizens reported perceiving at least one natural hazard as a medium-high or high risk. For example, by just considering heavy rainfall, 49.7% of respondents viewed it as medium-high or high risk, indicating a clear discrepancy between risk perception and the decision to acquire and insurance coverage. Among the 56.3% who stated they do not perceive natural hazards as a risk to be insured, 88% had, in fact, previously indicated that they perceived at least one natural hazard as medium-high or high risk. This suggests that while citizens may acknowledge the potential danger of these hazards when asked to reflect on their impact, but they may not feel personally at risk or may not see insurance as a necessary protective measure;

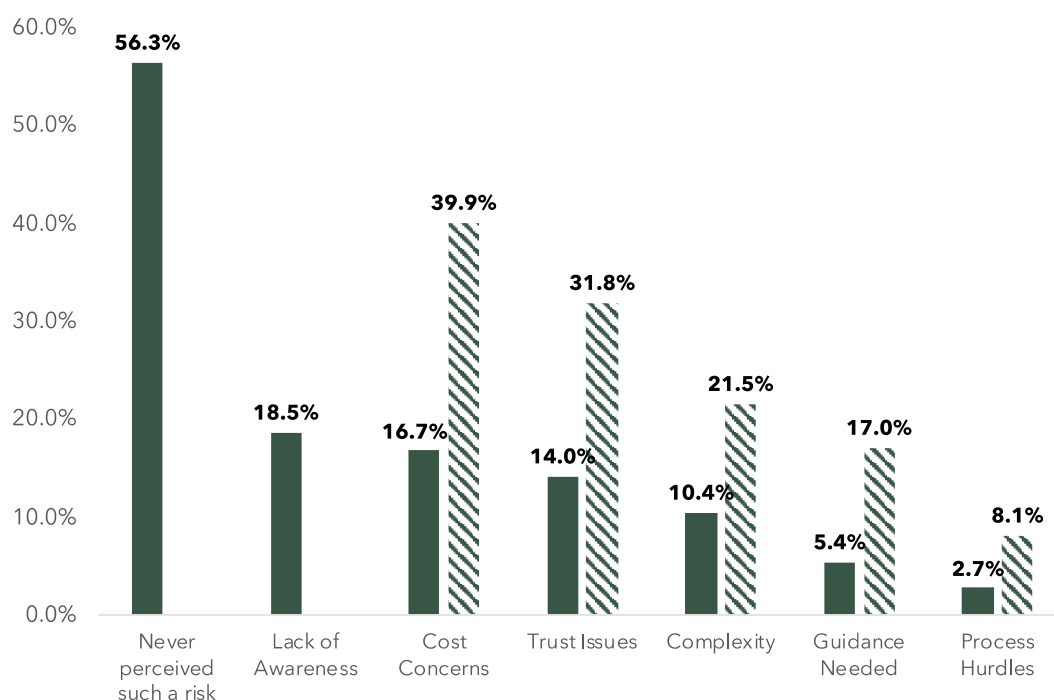


Figure 14: Barriers to insurance adoption. Source: proprietary data on 815 European citizens.

The second most common barrier, noted by 18.5% of respondents, is a lack of awareness about the availability of specific insurance policies for natural hazards. This highlights a significant gap in public knowledge, both about the potential economic impacts of natural hazards and the existence of insurance products designed to mitigate these risks.

These two barriers underscore the need for better public education about the economic consequences of natural hazards and the availability of insurance solutions. Citizens need clearer information not only about the risks but also about how insurance can help protect against the financial impacts of these events. In fact, a significant portion — 72.6% of European citizens — either do not perceive natural hazards as a risk or are unaware of the existence of insurance solutions that could protect them from these risks.

Shifting focus to the other barriers, these are more closely tied to the insurance process itself rather than risk perception or awareness. Financial constraints also emerge as a barrier with 16.7% of respondents citing cost concerns. However, this percentage isn't particularly high within the overall sample. This could be because those who mentioned the first two barriers — either not perceiving the risk of natural hazards or being unaware of insurance solutions — are unlikely to consider additional issues related to the insurance process or the decision to insure against natural hazard risks. Consequently, it is worthy to isolate the data by excluding these two groups of barriers and focusing only on respondents who both “perceive such risks” and are “aware” of insurance solutions. Doing so results in a significant rise in the remaining concerns, as shown in Figure 14. Specifically, cost concerns nearly triple, increasing from 16.7% to 39.9%.

Trust issues with insurance providers were reported by 14% of respondents, reflecting a notable level of skepticism regarding the reliability and effectiveness of insurance services. Additionally, 10.4% of respondents highlighted the complexity of insurance policies as a

barrier, underscoring the need for simpler and more transparent insurance products. A smaller portion of respondents cited the need for more guidance (5.4%) and process-related hurdles (2.7%) as further obstacles to obtaining insurance. However, when refining the sample to include only those European citizens who both “perceive such risks” and are “aware” of insurance solutions, these figures more than double across all categories. Trust issues rise sharply from 14% to 31.8%, complexity concerns grow from 10.4% to 21.5%, and the need for guidance and process-related challenges more than triple, reaching 17% and 8.1% respectively.

Given the low prevalence of insurance coverage and significant barriers to purchasing policies, it is crucial to understand what might motivate European citizens to enhance their current insurance protection levels against climate change-related risks (Fig. 15). It does not seem to be a single, straightforward solution to this issue. In fact, 35.3% of respondents stated that no factors could influence their decision to seek additional coverage, regardless of any potential incentives. That said, more affordable premiums could be a key motivator for many European citizens, as the cost of insurance is a predominant concern. Over 40% of respondents identified this economic barrier as the most significant, indicating that for many, the decision to insure against climate change is more about financial viability than the perceived severity of the risks. Interestingly, even among the 80% of respondents who did not initially cite cost as a barrier, more than 35% still expressed a desire for lower premiums as an incentive to purchase insurance.

Although cost is not the only barrier, the data on incentives suggests that addressing this issue could make citizens more likely to consider purchasing insurance, especially once they become more aware of the available solutions. Other incentives, while less impactful, still play a role. For example, 20.2% of respondents mentioned that government assurance might instill more confidence in insurance products, while 20.0% cited better coverage as a motivating factor, indicating a demand for clearer benefits and broader risk coverage. Additionally, 18.6% of respondents indicated that more information would help them decide, and 15.9% would be influenced by increased support. Simplifying the insurance process was noted by 10.0% of respondents as a factor that could encourage them to enhance their protection.

These insights highlight the need for targeted strategies to address the cost barrier and improve the overall appeal of insurance policies. While the primary barrier is cost, the data also highlight opportunities for improving trust and understanding through government involvement, better information dissemination, enhanced support, and process simplification.

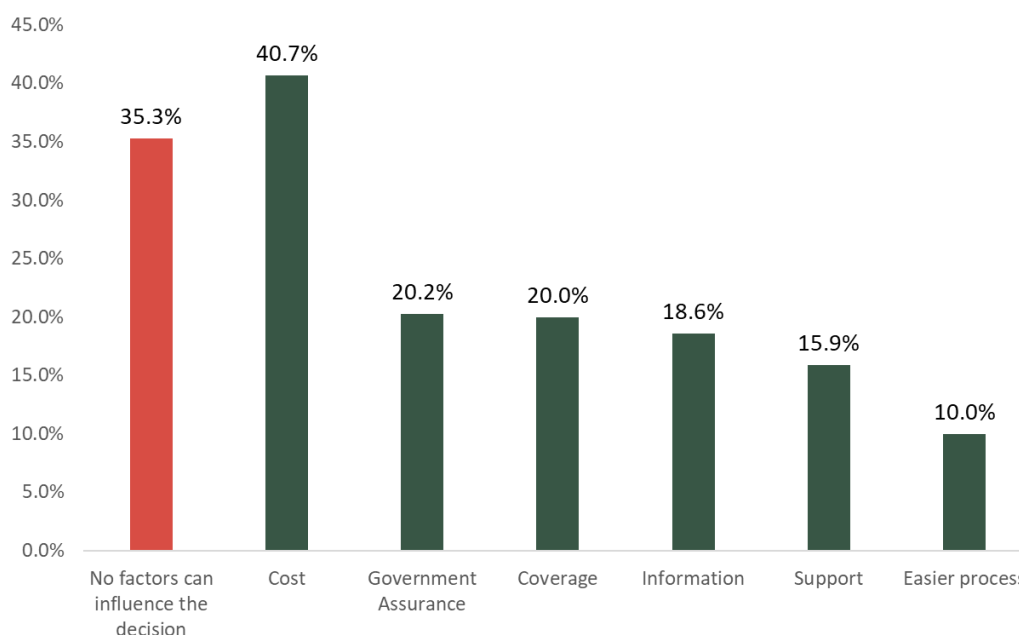


Figure 15: Incentives to insurance. Source: proprietary data on 951 European citizens.

3.5.1 A deep dive into parametric insurance solutions

Parametric insurance represents an alternative risk transfer mechanism that offers a novel approach to insurance against natural disasters. Parametric solutions are a type of insurance that makes an almost-immediate payment upon the occurrence of a triggering event, such as when a key hazard variable is observed to exceed a predefined threshold. The trigger can be represented by the happening of an event (cyclones or typhoons for example), or by the absence of an event (e.g. no rain), or by reaching a given level (e.g. rainfall higher than a predefined threshold), excess or lack of wind, flood, snow or frost, wildfire, earthquake, thunderstorm, heat wave. In line with the results presented within this report, the triggering events can be categorized into the four categories of natural phenomena, for instance:

- Meteorological events: excess or lack of rainfall; excess or lack of wind; snow or frost; cyclones or typhoons; thunderstorm.
- Climatological events: wildfires; heat waves; drought.
- Hydrological events: flooding.
- Geophysical events: earthquake.

This subsection will first present the level of awareness among European citizens regarding these innovative insurance solutions to protect against climate change. Then, it will explore both those who have and have not purchased these solutions. First, we will investigate which specific solutions have been acquired, aiming to understand which natural hazards citizens are seeking protection from. Following this, we will examine the barriers preventing the purchase of these solutions.

Analyzing the awareness and the diffusion of these innovative solutions in different European regions, the results show that a significant majority, 81.5%, of respondents have never heard of parametric insurance. However, this result should take in consideration that parametric insurance products are not so widespread in Europe. Indeed, the offer of this products from

insurance companies is still limited. With 1 European citizen out of 5 familiar with the concept of parametric insurance, the level of awareness within the general population seems quite diffuse (Fig. 16).

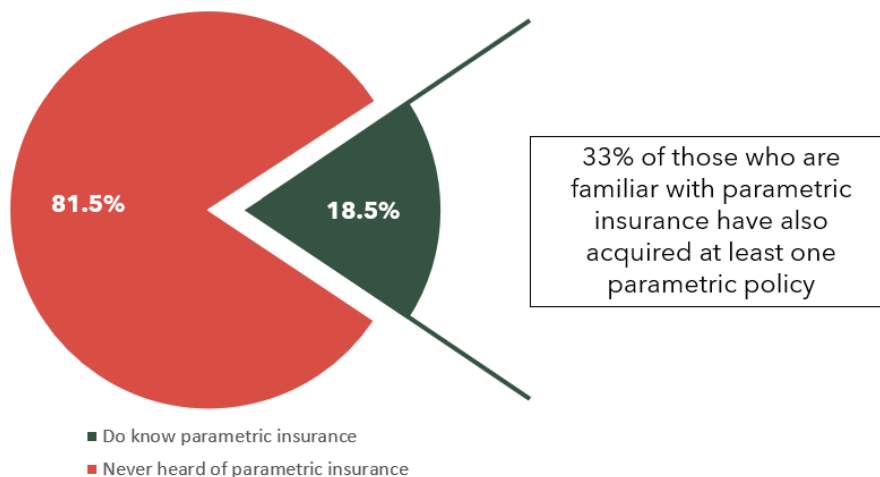


Figure 16: Parametric insurance awareness. Source: proprietary data on 951 European citizens.

Further analysis reveals that among the 18.5% who is familiar with parametric insurance, the 33% have taken the step of acquiring at least one parametric policy for natural hazards. This figure highlights a potential for this product, since it indicates that the conversion rate among those who are aware is still relevant (one third), suggesting that increasing awareness could potentially lead to higher adoption rates.

Considering the entire sample of European citizens just the 7% understand and also utilize such insurance solutions to mitigate the risks associated with natural disasters. They are primarily homeowners (55%) who tend to purchase parametric policies specifically indexed to cover floods, storms, and wildfires. Among those who have purchased at least one parametric insurance policy, the data illustrates a clear preference for certain types of risks (Fig. 17). Rainfall emerges as the most insured event, with 16% of the parametric policies specifically covering this risk. This prominence likely reflects the high impact and frequency of rainfall-related incidents that can lead to substantial losses. Closely following are floods, which are covered by 14% of the policies. The concentration on rainfall and flood risks not only highlights the frequency and impact of these events but also underscores the ability of parametric insurance to provide rapid payouts based on objective parameters, making it an attractive option for managing such unpredictable yet common risks.

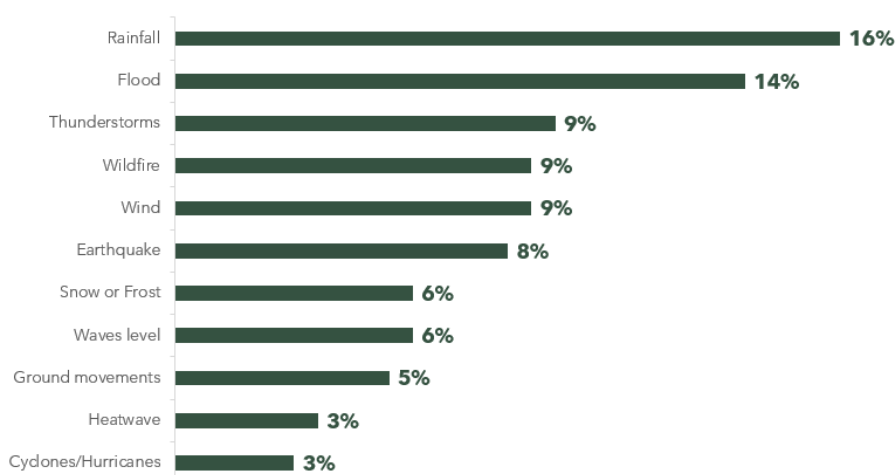


Figure 17: Parametric policies diffusion. Source: proprietary data on 66 European citizens.

The survey also indicates a considerable coverage of other natural phenomena such as thunderstorms, wildfires, and wind, each securing 9% of the policies. This shows a balanced concern for a variety of events that can similarly disrupt lives and cause extensive property damage. Earthquakes are slightly less covered but still notable at 8%, pointing to a recognition of seismic risks in certain regions.

On the other hand, events like snow or frost and changes in wave levels each account for 6% of the coverage, while ground movements are covered by 5% of the policies. The lower percentages for heatwaves and cyclones or hurricanes, each at 3%, suggest these may be perceived as less frequent risks in the surveyed areas.

As previously mentioned, parametric insurance products are still not widespread among the offerings of insurance companies. This limited diffusion emerges as the primary barrier for European citizens in adopting these innovative solutions, which provide a novel approach to insuring against natural disasters. Indeed, approximately 40% of citizens report a lack of awareness about such insurance products, as they were unaware that specific parametric products existed and, additionally, they do not know which insurance providers to approach to purchase a parametric insurance policy. Therefore, it is primarily necessary for insurance providers to make an effort to market these products and make them accessible to the European public. However, this is not the only barrier to the adoption of these products. Similar to traditional insurance products, cost concerns and trust issues represent additional challenges.

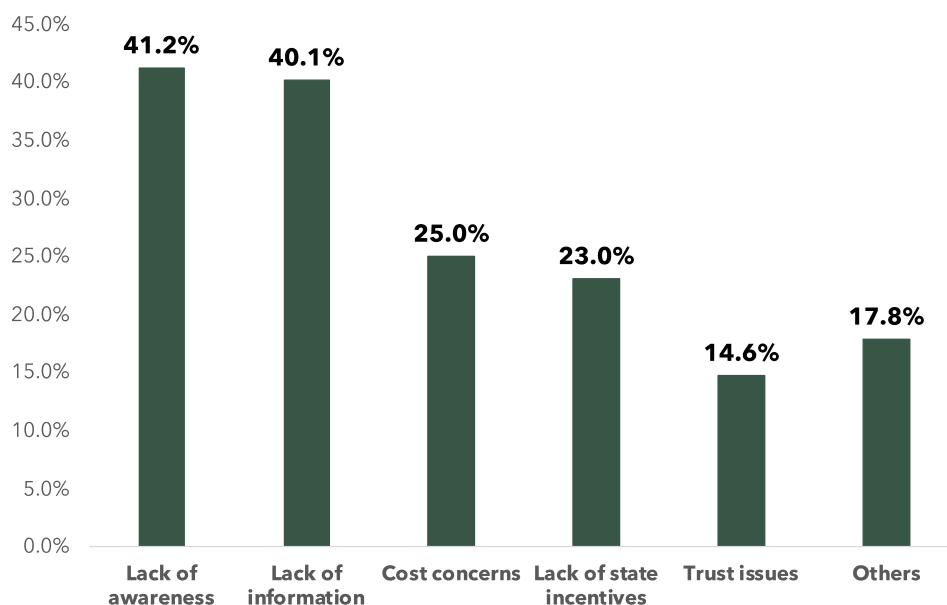


Figure 18: Barriers to parametric insurance. Source: proprietary data on 951 European citizens

When comparing traditional insurance solutions with parametric ones, it becomes evident that the latter are significantly less familiar to the European public. The percentage of people unaware of parametric solutions is almost three times higher than for traditional insurance (41.2% vs. 18.5%; Fig. 19). This figure is influenced by the limited diffusion of parametric products highlighting the need of a greater and more accessible offer. Another factor contributing to scepticism among European citizens is the concern over costs. The pricing structure of parametric solutions is less intuitive than that of traditional insurance, leading to greater cost concerns, reflected in a significantly higher figure for parametric options. Finally, the remaining three barriers show similar data between the two types of solutions. In particular, the comparable levels of trust issues may be attributed to the fact that the same insurance companies typically offer both traditional and parametric solutions.

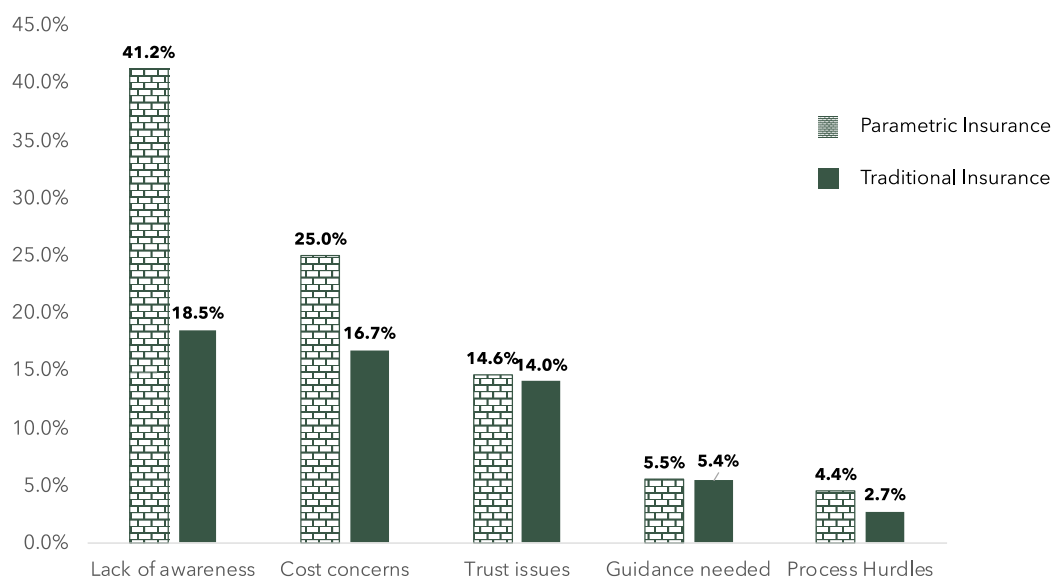


Figure 19: Barriers to parametric and traditional insurance. Source: proprietary data on 951 European citizens.

4 Focused market review in WP3 sectors/areas

4.1 Food and Agriculture

Agricultural insurance schemes play a critical role in stabilizing the incomes of farmers and mitigating the risks associated with agricultural production in Europe. These schemes are part of the Common Agricultural Policy (CAP), which includes a risk management toolbox aimed at supporting farmers in coping with the unpredictable nature of farming, such as adverse climatic events, diseases, and market volatility (Bielza, Conte, Dittmann, Gallego, & Stroblmair, 2008).

In 2018, the risk management toolbox of the CAP was further extended. It now authorizes member states to increase support rates for crop and livestock insurance to 70 per cent of premiums and to annually inject payments into mutual funds. In Europe, agricultural insurance is, therefore, primarily managed through public-private partnerships, with substantial variations across member states due to different local contexts and risks (Meuwissen, Mey, & van Asseldonk, 2018). In general, crop insurance is more prevalent than livestock insurance, with countries like France, Spain, and Italy having some of the largest multi-peril crop insurance programs (Bielza, Conte, Dittmann, Gallego, & Stroblmair, 2008).

These insurance schemes are crucial for the agricultural sector as they provide a safety net that helps farmers manage risks, ensuring food security and the sustainability of rural economies. The CAP supports these schemes by allowing subsidies for insurance premiums, mutual funds, and income stabilization tools, which can cover losses due to climatic events, diseases, and pest infestations (Meuwissen, Mey, & van Asseldonk, 2018).

This market review will examine the agricultural insurance markets in Finland, Spain, and Italy, focusing on the current market conditions, the main insurance products and services available, and the integration of Nature-based solutions in regional insurance schemes.

4.1.1 Finland

4.1.1.1 Current state of the food and agriculture market in Finland

Finland is the most forested country in Europe, with 75% of its land covered by forests, and 95% of the country categorized as rural areas. These rural areas host around 39.5% of the total population and are home to approximately 44,500 agricultural holdings with an average farm size of 51 hectares (European Commission, 2023). The majority of these farms are family-owned. In 2020, out of the 134,000 individuals engaged in farm work in Finland, 70% were either farmers themselves or their relatives. Approximately 9,000 farms, which represent about 20% of all agricultural holdings in the country, employed paid staff.

Most farms use a mixed-farming model that often combines crop production with livestock farming. The principal crops grown in Finland include cereals such as barley, oats, and wheat, alongside potatoes and sugar beets. Additionally, Finland has a robust dairy and meat production sector, with dairy farming being particularly significant. Organic farming is gaining prominence in Finland, reflecting the country's commitment to sustainable agricultural practices (Ministry of Agriculture and Forestry, s.d.).

Despite these advanced practices, the overall profitability of the agricultural sector remains low (European Commission, 2023). This is largely due to the country's challenging climatic conditions characterized with long, cold winters and short growing seasons, which significantly limit agricultural productivity and increase operational costs.

As climate change continues to increase the incidence of extreme weather events, the need for effective climate insurance becomes more pressing. Finnish farmers are facing more frequent occurrences of early summer droughts and heavy rains during critical periods such as the harvest season. These weather patterns are increasingly unpredictable, resulting in fluctuating crop yields and posing a serious threat to the economic stability of the farming sector (Hilden, et al., 2005).

The low profitability of the agricultural sector is directly reflected in the incomes of Finnish farmers, many of whom struggle to achieve a sustainable livelihood. Enhancing farm profitability, increasing productivity, boosting income levels, and adding value to agricultural products are critical objectives that need to be addressed to secure the future of Finnish agriculture. Additionally, attracting younger generations to farming is essential to ensuring the sector's long-term viability and food security (European Commission, 2023).

Due to challenging weather conditions, Finland is significantly dependent on imports to meet its agricultural and food production needs. In 2022, the total value of Finnish imports of agricultural and related products exceeded €8 billion. This reliance underscores the importance of global trade in ensuring food security in Finland, as domestic production alone is often insufficient to meet demand under the country's harsh climatic conditions (International Trade Administration, 2023) **Figure 20** and **Figure 21** provide of the value of agricultural products exported from and imported to Finland.

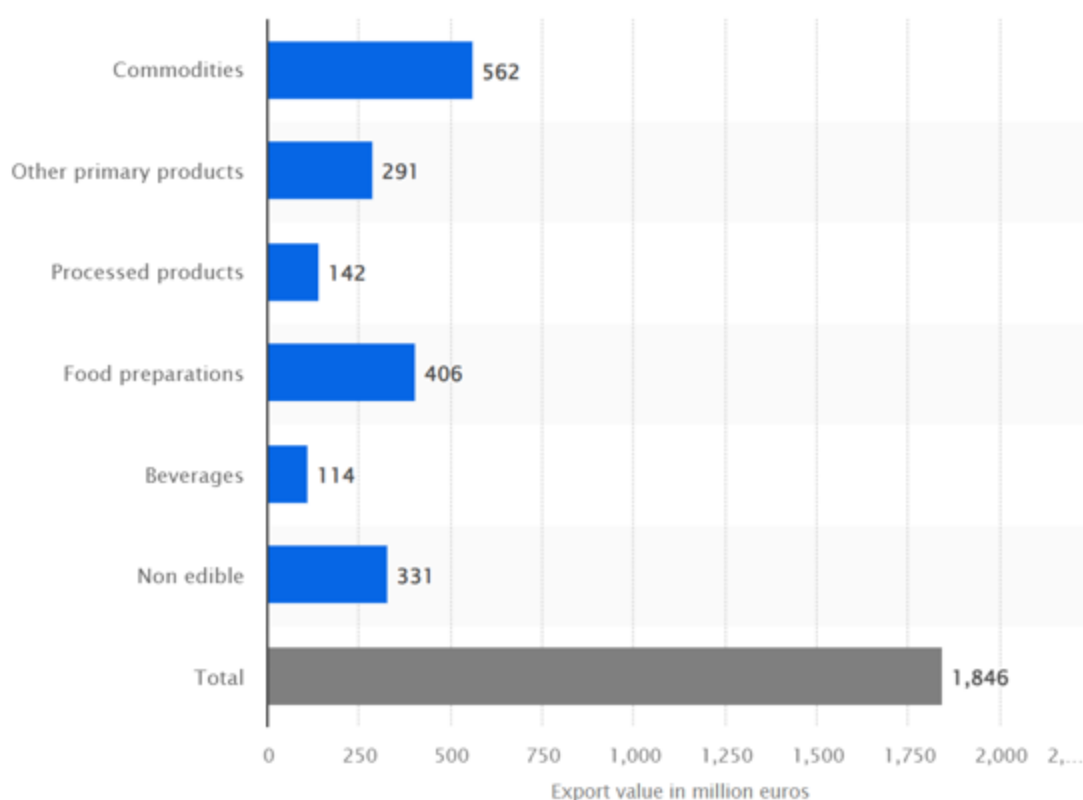


Figure 20 Value of agricultural products exported from Finland in 2020, by type (in million euros)

Source: Statista

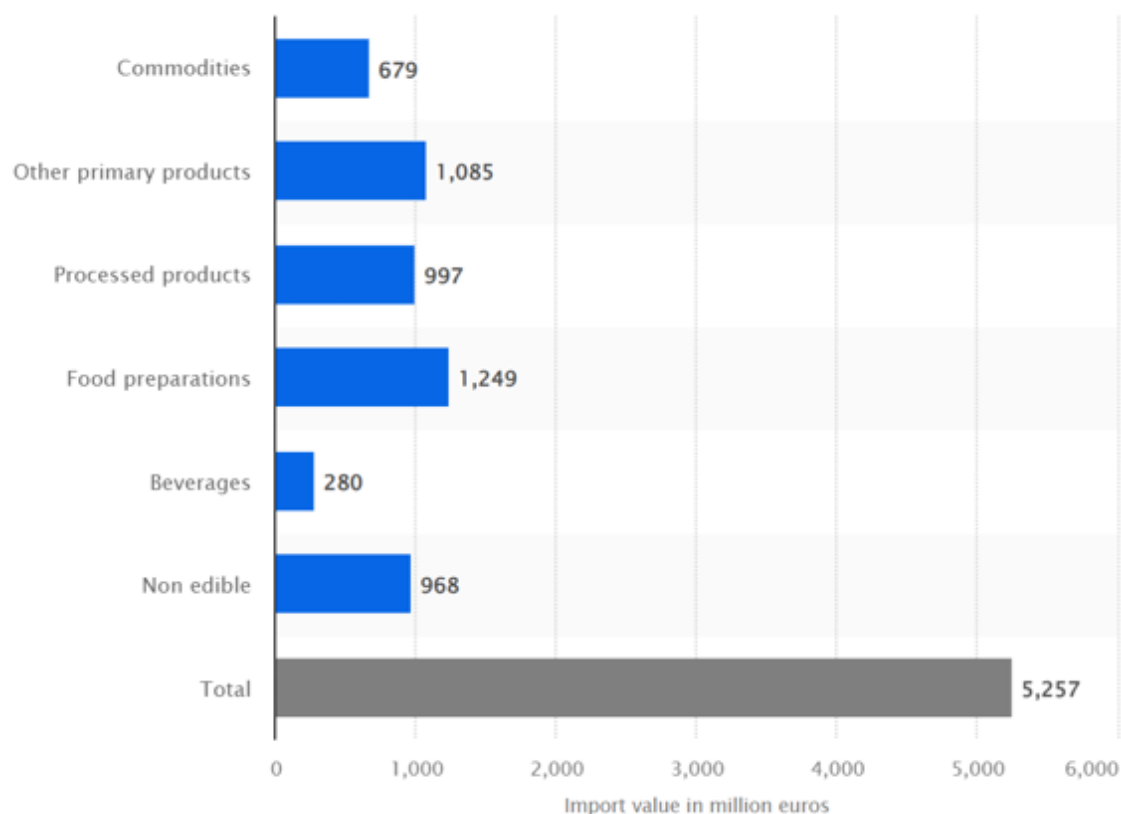


Figure 21 Value of agricultural products imported to Finland in 2020, by type (in million euros)

Source: Statista

4.1.1.2 Current state of the food and agriculture insurance market in Finland

a. Public agriculture insurance schemes

The climate insurance market in Finland is currently characterized by limited product solutions and low uptake among farmers. Historically, the Finnish government provided a Crop Damage Compensation (CDC) scheme, which covered weather-induced crop losses free of charge for farmers. However, this scheme was terminated in 2015 due to issues related to moral hazard and basis risk (Eerola, et al., 2024). Moral hazard occurred as many farmers regularly collected payments, reducing their incentive to implement effective risk management practices on their farms (Myyrä & Pietola, 2011) (Liesivaara, 2017). Basis risk was another significant problem, as compensation payments were based on individual farm yields compared with regional average yields, which often did not accurately reflect the actual damage experienced by farmers operating at higher yield levels (Liesivaara, 2017).

Since the termination of the CDC scheme, the market has struggled to develop robust alternatives. Currently, there is only one commercial multi-peril crop insurance (MPCI) policy available in Finland. This policy covers various weather conditions but requires a total crop loss for payouts, which involves high administrative costs and low appeal among farmers (Eerola, et al., 2024). The high administrative costs are primarily due to the need for third-party inspectors to confirm claims, which requires on-site farm visits. Despite the inspectors' professionalism, obtaining complete information about all the causes of crop damage remains challenging and resource-intensive (Eerola, et al., 2024).

This complex and costly claim verification process, combined with the requirement for total crop destruction to trigger payouts, has resulted in minimal adoption of MPCl policies by Finnish farmers.

Innovative approaches, including parametric or index-based insurance, have been proposed but are not yet widely implemented in Finland. Parametric insurance could address some of the costly issues by tying payouts to specific weather parameters, such as precipitation levels or temperature, thereby reducing the need for costly on-site inspections (Eerola, et al., 2024). However, the small market size in Finland means that developing a generic insurance product that suits the majority of farmers is more practical than creating highly specialized parametric products (Eerola, et al., 2024).

b. Private agriculture insurance schemes

The agricultural insurance market in Finland is not as extensive as in some other European countries, and with limited publicly-available solutions, the market primarily dominated by a few major insurance companies that offer a range of products for the farming communities. These products typically include crop insurance, livestock insurance, and coverage for farm property and machinery. Despite the growing recognition of climate change impacts, such as increased frequency of extreme weather events, and the need for proactive risk management, the uptake of private insurance solutions among Finnish farmers remains low.

c. Estimated market share of major insurance companies in Finland

Based on the annual reports for 2022, **Table 2** provides an overview of the 10 non-life insurance companies in Finland with the largest market share. It is important to note that not all of these companies offer agricultural insurance; many of them focus more on private and business insurance products.

Table 2 Estimating Market Share of Major Insurance Companies in Finland in 2023

Insurance company	Total revenue (Billion €)	Operating Income (Billion €)	Client Base/Policy Holders(Million)	Green Investments	Estimated Market Share (%) (from statista)
 OP-Pohjola Pohjola Insurance	1.66	0.354	Not specified	Not specified	32.6%
 LocalTapiola	1.408	0.494	1.8	Not specified	26.4%
 if P&C Insurance	5.19	0.132	Not specified	Not specified	21.1%
 Fennia Group	0.831	0.086	Not specified	Not specified	9.9%
 Turva	0.151	0.0118	1.3	Not specified	2.8%
 Pohjantähti	0.1182	0.0141	Not specified	Not specified	2.4%
 Alandia Group	0.0826	0.0042	Not specified	Not specified	1.7%
 POP Insurance	0.02245	0.0893	Not specified	Not specified	1%
 Patient Insurance Company	Not specified	Not specified	Not specified	Not specified	0.6%
 Garantia	0.019	0.0235	Not specified	Not specified	0.5%

Sources: Pohjola Insurance Report UN 2023, LocalTapiola Group's financial statement presentation for 1 January–31 December 2023, If Annual Report 2023, Fennia Sustainability Report 2023, Fennia Report of the Board of Directors and Financial Statements 2023, Pohjantähti Annual Report 2023, Alandia Financial Statement and Annual report for 2023, POP Bank Group Annual Report 2023, POP Bank Group Financial Statement release 2023, Patient Insurance Centre Annual Report 2023, Garantia Solvency and Financial Condition Report 2023

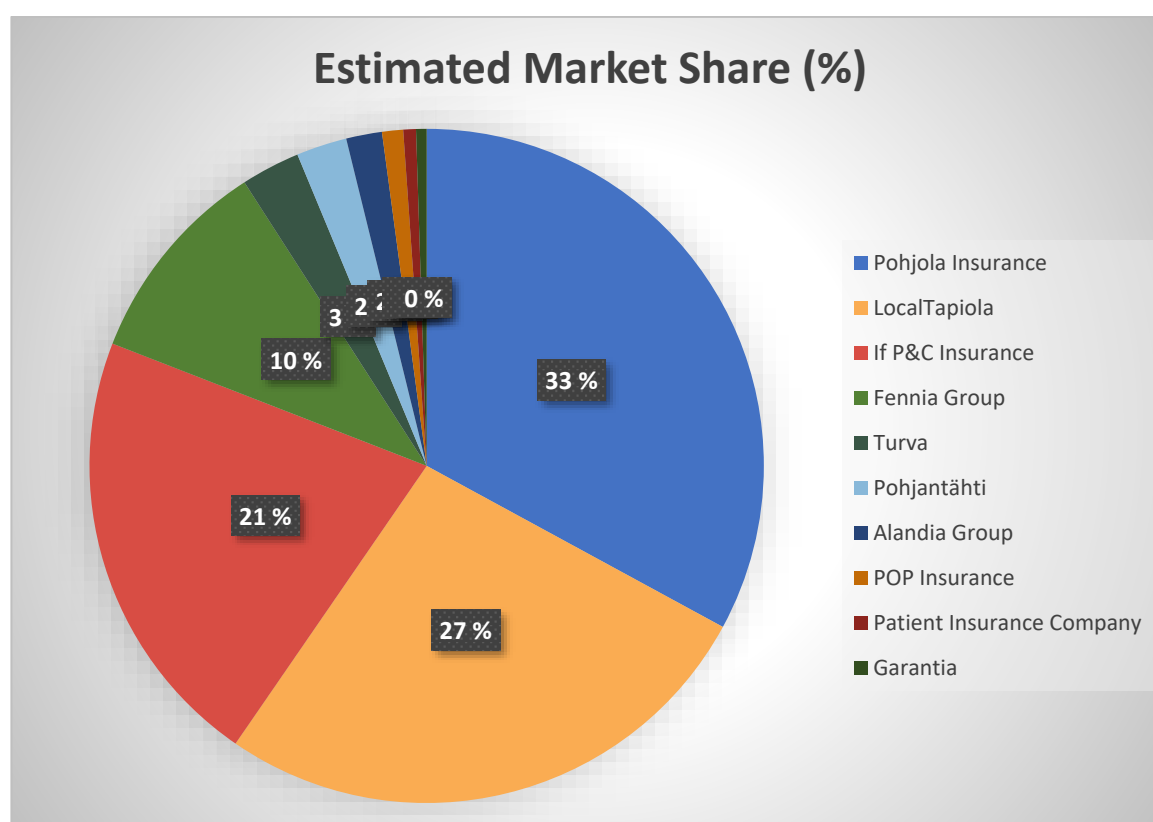


Figure 22 Estimated Market Share of Major Insurance Companies in Finland

- In table 2 above, it is evident that in 2023, Pohjola Insurance leads the market with €1.66 billion in total revenue and a 32.6% market share, followed by LocalTapiola (€1.408 billion, 26.4%) and If P&C Insurance (€5.19 billion, 21.1%).
- LocalTapiola, despite lower revenue than If P&C Insurance, has a higher operating income (€0.494 billion vs. €0.132 billion), indicating different profitability structures across companies.
- LocalTapiola and Turva are the only companies with specified policyholder numbers, serving 1.8 million and 1.3 million clients, respectively. Other companies do not have detailed client base data in the table.
- Figure 22 on the left illustrates the estimated market share, highlighting the top 3 companies: Pohjola Insurance as the market leader with 33%, followed by LocalTapiola at 27% and If P&C Insurance at 21%.

4.1.1.3 Analysis of insurance products/services

In Finland, several insurance companies offer agricultural insurance products. These insurers provide comprehensive solutions that cover not only agricultural production, such as crops and livestock, but also farm property, infrastructure, and the well-being and safety of farmers themselves. **Table 3** outlines the key insurance providers and the specific coverage options they offer.

Table 3 Key insurance providers and coverage options in Finland

Insurance company	Description	Coverage features
LocalTapiola 	LocalTapiola is one of the largest mutual insurance companies in Finland, and it plays a significant role in the agricultural insurance market. The crop insurance specifically covers damage from adverse weather conditions such as frost, drought, and excessive rainfall, which are directly related to climate risks.	• Crop Insurance: LocalTapiola offers crop insurance that covers a wide range of risks, including damage caused by adverse weather conditions such as frost, drought, and excessive rainfall. This insurance is crucial for safeguarding farmers' incomes, especially in Finland's unpredictable climate. • Livestock Insurance: The company also provides livestock insurance, covering risks such as diseases, accidents, and mortality. This is particularly important for dairy and beef farmers, given the high value of livestock in Finland. • Farm Property Insurance: LocalTapiola offers insurance for farm properties and machinery, protecting against risks such as fire, theft, and natural disasters. This ensures that farmers can quickly recover from unforeseen events that might otherwise disrupt their operations.
OP Financial Group (OP Ryhmä) 	OP Financial Group is a major player in the Finnish insurance market, providing a broad range of financial and insurance services against extreme weather events and other climate-related risks, such as pests and diseases.	• Crop Insurance: OP offers crop insurance that covers losses due to adverse weather conditions, pests, and other environmental factors. The insurance is designed to help farmers manage the financial risks associated with crop failures. • Livestock Insurance: OP's livestock insurance products cover the costs associated with the loss of animals due to disease, accidents, and other unforeseen events. This type of insurance is crucial for ensuring the financial stability of livestock farmers. • Farm Machinery and Equipment Insurance: OP also provides insurance for farm machinery and equipment, protecting against risks such as damage, theft, and breakdowns. This coverage helps farmers avoid significant financial losses and maintain their productivity.
Fennia Group 	Fennia is a smaller, but significant player in the Finnish insurance market, offering specialized insurance products for businesses, including those in the agricultural sector.	• Agricultural Insurance: Fennia offers a comprehensive agricultural insurance package that includes coverage for crops, livestock, and farm property. The company's products are designed to protect farmers from a wide range of risks, including those related to natural disasters, accidents, and equipment failure. • Liability Insurance: Fennia also provides liability insurance for farmers, covering potential legal costs and damages associated with accidents or negligence on the farm. This type of insurance is essential for protecting farmers from financial losses due to legal claims.
If P&C Insurance 	If P&C Insurance is one of the leading providers of non-life insurance in the Nordic region, including Finland. The company offers a range of insurance products for the agricultural sector, focusing on comprehensive risk management solutions for climate-related risks such as storms, floods, and droughts.	• Farm Insurance: If provides an all-inclusive farm insurance product that covers buildings, machinery, livestock, and crops. This package is designed to protect against a wide array of risks, from natural disasters to operational disruptions. • Business Interruption Insurance: If also offers business interruption insurance, which is particularly valuable for farmers. This insurance compensates for lost income due to events that temporarily halt farming operations, such as severe weather or machinery breakdowns. • Environmental Liability Insurance: Recognizing the importance of environmental stewardship, If offers environmental liability insurance to cover the costs of environmental damage that might occur as a result of farming activities. This type of insurance is increasingly important in a world where environmental regulations are becoming stricter.
Pohjola Insurance 	Pohjola Insurance, a part of the OP Financial Group, is one of Finland's leading insurance companies, offering a wide range of insurance products, including those specifically designed for the agricultural sector.	• Comprehensive Farm Insurance: Pohjola offers comprehensive farm insurance that includes coverage for crops, livestock, buildings, and machinery. This package is designed to provide farmers with complete protection against various risks that could affect their operations. • Livestock Insurance: Similar to other major players, Pohjola provides livestock insurance that covers the costs associated with the death or illness of animals due to unforeseen events. This is particularly important for ensuring the financial stability of dairy and meat producers. • Crop Insurance: Pohjola's crop insurance products cover damages caused by adverse weather conditions, diseases, and pests, helping to safeguard farmers' revenues in the face of unpredictable climate challenges.

4.1.1.4 Analysis of innovative insurance solutions and Nature-based solutions

While insurance companies do not yet integrate NBS as a risk measurement, many insurance companies in Finland do provide consulting services and incentives aimed at encouraging farmers to adopt better agricultural practices (Table 4). These initiatives are designed to help farmers manage risks more effectively, improve productivity, and enhance sustainability. By offering expert advice on topics such as crop management, livestock health, and farm safety, these insurers play a proactive role in supporting the overall development of the agricultural sector.

Table 4 Key insurance providers and climate change policies incentives in Finland

Insurance company	Special incentives / climate change policies
LocalTapiola 	LocalTapiola is actively involved in promoting sustainable agricultural practices through its broader risk management services. The company offers advisory services to farmers on how to manage and mitigate risks, including those related to climate change. LocalTapiola's risk management advice often includes recommendations on sustainable land use, crop rotation, and the use of cover crops to improve soil health and reduce vulnerability to weather extremes.
OP Financial Group (OP Ryhmä) 	OP Financial Group emphasizes the importance of sustainable farming practices as part of their overall risk management strategy. OP offers financial incentives, such as discounts on insurance premiums for farmers who adopt sustainable practices that reduce their environmental impact, including those that enhance soil health and reduce chemical inputs.
Fennia Group 	Fennia offers consulting services that focus on risk management and sustainability in farming. The company provides advice on how to implement sustainable agricultural practices that can reduce vulnerability to climate risks. This includes promoting the use of environmentally friendly technologies, improved land management practices, and efficient water use.
If P&C Insurance 	If P&C Insurance is a strong advocate for sustainable practices in the agricultural sector. The company offers extensive risk management services that include advice on sustainable farming techniques.

Pohjola Insurance



Pohjola Insurance, as part of OP Financial Group, provide incentives such as reduced premiums for adopting practices that mitigate climate risks.

While specific climate insurance products in Finland do not yet fully incorporate Nature-based solutions (NBS), there is growing recognition of their potential, as these solutions are increasingly being integrated into strategies for managing climate risks and supporting agricultural resilience. These solutions focus on leveraging natural processes and ecosystems to mitigate the impacts of climate change, thereby reducing the risk to crops and enhancing the sustainability of farming practices.

One prominent example of NBS in Finland is the management and restoration of wetlands, which help in regulating water cycles and reducing the impacts of floods and droughts. Wetlands act as natural buffers, absorbing excess rainfall and releasing water during dry periods, which is crucial for maintaining soil moisture levels and protecting agricultural lands (Sarkki, Haanpää, & Heikkinen, 2024).

Additionally, In Southwest Finland, the RESIST project is implementing Nature-based solutions to enhance climate resilience in agricultural areas and mitigate against the winter floods and spring droughts. Farmers in the region are adopting practices such as planting winter crops to boost irrigation and root growth during the spring. Additionally, rain gardens are being used to manage stormwater runoff and reduce flooding. These measures are part of a broader strategy to integrate NBS into climate adaptation efforts, supported by the RESIST project and involving local stakeholders to ensure sustainable and scalable solutions. It is essential that NBS solutions are small-scale, cost-effective, and low-maintenance because farmers lack the space, time, and resources for large-scale interventions (RESIST, 2023).

In summary, while the direct integration of NBS into climate insurance products in Finland is still under developed, there are significant efforts to incorporate these solutions into broader climate adaptation strategies.

4.1.1.5 NBS case studies

Many NBS projects have been implemented in Finland. Due to the majority of the land being covered by forestry and agricultural areas, the country continuously cares and explores ways to improve and maintain its natural landscapes. Finnish NBS projects have included reforestation initiatives, wetland restoration, and the promotion of sustainable forestry practices, all aimed at maintaining the ecological balance and resilience of these landscapes. Finnish NBS projects have included reforestation initiatives, wetland restoration, and the promotion of sustainable forestry practices, all aimed at maintaining the ecological balance and resilience of these landscapes. The implementation of NBS in Finland also extends to urban areas, where projects such as green roofs, urban wetlands, and sustainable drainage systems have been introduced to enhance the resilience of cities to climate-related impacts while improving the quality of life for residents (Nordic co-operation, 20204) (Natural Resources Institute Finland (Luke) , 2024).

Case Study 1: Natural Climate Solutions, Varsinais-Suomi region



In Southwest Finland, farmers in the Varsinais-Suomi region are adopting Nature-based solutions (NBS) to combat climate change impacts such as prolonged droughts and increased winter rainfall. These measures include planting winter crops to prevent soil erosion, reducing fertilizers, and using crop rotation with grassland to enhance soil carbon content. The region also employs rain gardens to manage stormwater runoff. These initiatives are part of the RESIST project, aiming to enhance climate resilience using sustainable practices (RESIST, 2023)

Case Study 3: NBS to manage hydro-meteo risks



The OPERANDUM project in Finland focuses on implementing Nature-based solutions (NBS) to tackle hydro-meteorological risks, specifically targeting flood management and erosion control in agricultural areas. The project integrates innovative techniques such as constructed wetlands, buffer zones that slow down water flow and help retain nutrients, and re-meandering of streams to enhance water retention and soil stability. These measures aim to reduce flood peaks, improve water quality, and increase biodiversity, contributing to sustainable land use and climate resilience in the region (Operandum, 2024).

Case Study 2: Stream and Watershed Restoration in Finland



In Finland, the Mätäsoja Stream and Watershed Restoration project, led by Metsähallitus Wildlife Service, focuses on enhancing biodiversity and mitigating climate change. Supported by the Nordic Council of Ministers, this initiative involves restoring peatlands and stream areas to sequester carbon and improve ecological networks. The project collaborates with the University of Oulu to gather new data on Nature-based solutions (NetworkNature, 2023).

Case Study 4: S-UMMATION Project



Launched by the Finnish government, this program includes various projects aimed at promoting climate-friendly agriculture. One of the key components is enhancing the use of wetlands and riparian zones to filter runoff from agricultural lands, thereby reducing nutrient pollution in waterways. This approach not only helps improve water quality but also supports biodiversity in agricultural landscapes (Nordic Council of Ministers, 2024).

These four case studies illustrate Finland's proactive approach to leveraging Nature-based solutions (NBS) to address climate change and environmental challenges. From promoting climate-resilient agricultural practices in the Varsinais-Suomi region to restoring streams and peatlands for carbon sequestration, these initiatives highlight the integration of sustainable land use, biodiversity enhancement, and water management. Projects such as the OPERANDUM and S-UMMATION further demonstrate how NBS can mitigate hydro-meteorological risks and reduce nutrient runoff, promoting healthier ecosystems and greater climate resilience. Collectively, these efforts underscore the vital role of nature-based approaches in fostering sustainable development and adapting to climate impacts.

4.1.1.6 Challenges, future trends and opportunities

a. Challenges in the Finish agriculture sector

The agricultural sector in Finland operates within a unique context shaped by its northern latitude. One of the most significant challenges faced by Finnish agriculture is the impact of climate change. The country's farming sector is highly susceptible to variations in weather patterns, including increased frequency and severity of extreme weather events such as droughts, floods, and unseasonal frosts. These conditions threaten crop yields, livestock health, and overall farm productivity. Additionally, the short growing season and low temperatures limit the variety of crops that can be cultivated, further exacerbating the vulnerability of Finnish agriculture to climate variability. Moreover, Finnish farmers face high production costs, partly due to the country's remote location and harsh climate, which necessitate greater inputs for heating, feed, and machinery maintenance. The low profitability in agriculture, reduces the uptake of the insurance market and the attractiveness for younger generations to work in the sector (European Commission, 2024). Furthermore, the CAP's evolving framework requires farmers to comply with stringent environmental and sustainability standards, which, while beneficial in the long term, can increase short-term costs and operational complexities for farmers (European Commission, 2024).

b. Future trends in the Finish agricultural and insurance sector

One main trend within the finish agriculture market is the increasing focus on organic farming. Currently, already 14,4% of Finland's agricultural land is dedicated to organic farming (European Commission, 2024). Technological innovation is another key trend shaping the future of Finnish agriculture. The adoption of digital tools, such as precision farming technologies, remote sensing, and data analytics, is enabling farmers to optimize inputs, improve crop yields, and reduce environmental impact. These technologies also offer new opportunities for monitoring and managing risks, making them increasingly valuable in the context of agricultural insurance.

c. Opportunities in the Finish agricultural and insurance sector

The challenges and trends in Finnish agriculture are creating significant opportunities for the agricultural insurance market. As climate change intensifies, the demand for insurance products that can protect farmers from the financial impact of extreme weather events is expected to grow. Insurers have the opportunity to develop new products that address these emerging risks, such as parametric insurance, which provides payouts based on specific weather triggers rather than actual losses. Furthermore, the adoption of digital technologies within agricultural insurance offers considerable potential. By utilizing data from precision farming tools, remote sensors, and satellite imagery, insurers can enhance risk assessment, customize policies to the specific needs of individual farms, and expedite the claims process. This technological advancement not only improves the accuracy and efficiency of insurance services but also helps reduce administrative costs, making these products more appealing to farmers. Lastly, insurance companies should explore the integration of Nature-based solutions (NBS) as a proactive risk-reduction strategy for farmers. Beyond their existing consulting services, these insurers could actively support the implementation of NBS, which have the potential to substantially mitigate the impacts of climate-related risks. By facilitating the adoption of practices such as reforestation, wetland restoration, and sustainable water management, insurance companies can not only help farmers build resilience but also reduce the overall risk exposure, potentially leading to lower insurance premiums and more sustainable agricultural practices.

4.1.2 Spain

4.1.2.1 Current state of the food and agriculture market in Spain

Spain's agricultural sector is a cornerstone of its economy, playing a critical role in social, territorial, environmental, and economic dimensions. Generating nearly €140 billion in revenue and employing over 440,000 people, the Spanish agri-food industry stands as the country's leading manufacturing sector (ICEX, s.d.). The sector's final agricultural production is nearly €50 billion, accounting for 2.5% of the country's GDP. Beyond its economic contributions, agriculture plays a crucial role in job creation, stabilizing rural populations, and preserving ecosystems (ENESA, 2019). Half of all land in Spain is used for agricultural or livestock activities, with 33% used as farmland and 16% as meadows or pasture. Moreover, the Spanish agrifood exports have continued to grow over the last year, with a special focus on both fruits and vegetable exports. Spain's agri-food exports reached a historic in 2022, totalling €60,118 million, marking an 11% increase compared to 2020 (La Moncloa, s.d.).

The agricultural sector is a key component of Spain's economy. In 2022, the value of agricultural production in Spain surpassed €63 billion, while the sector's total income reached €27 billion. Figure 23 and Figure 24 illustrate the trends in agricultural income and production value in Spain from 2015 to 2022.



Figure 23 Income of the agriculture sector in Spain from 2015 to 2022(in million euros)

Source: Statista



Figure 24 Agricultural production value in Spain from 2014 to 2022(in million euros)

Source: Statista

Agricultural insurance is essential in Spain due to the significant exposure of the agricultural sector to weather-related risks. The sector faces a wide array of risks, particularly severe weather events like natural disasters, which can lead to direct losses of crops and livestock as well as indirect losses through price fluctuations and changes in the availability of raw materials. Wildfires, droughts, and floods have increasingly impacted agricultural production in Spain. The records indicate that severe droughts during the first four months of both 2022 and 2023 caused significant damage to crops across Spain. As the country entered the summer, its reservoirs held nearly 20% less water than usual, exacerbating the situation. Over 80% of the farmlands were impacted, leading to substantial losses in food production. Wine production, in particular, hit an all-time low for some producers in 2022. These fluctuations in agricultural output have had severe economic consequences, with fruit and vegetable prices rising by 5.6% and 15.6%, respectively, in 2022. Overall, Spain's agricultural sector lost 6% of its total value, amounting to over €550 million (New Zealand Ministry of Foreign Affairs and Trade, 2023). Agricultural insurance mitigates these risks by providing financial stability and resilience, enabling farmers to manage uncertainties and sustain their livelihoods in the face of adverse weather conditions.

4.1.2.2 Current state of the food and agriculture insurance market in Spain

a. Public-Private insurance schemes

The agricultural insurance market in Spain is recognized as one of the most advanced and comprehensive in Europe, covering a wide range of agricultural productions and risks. Established over 45 years ago, the Spanish Agricultural Insurance Scheme (SAIS) is a mixed public-private system designed to offer extensive coverage for crop, livestock, aquaculture, and forestry productions against uncontrollable natural phenomena and other risks (ENESA, 2019).

The system operates on a public-private partnership model, involving the Spanish government, private insurance companies, and farmers' associations, as seen in **Figure 26**. The Ministry of Agriculture, Fisheries, and Food (MAPA), through the Entidad Estatal de Seguros Agrarios (ENESA), is responsible for the overall administration and regulation of the agricultural insurance system. ENESA coordinates the annual insurance plans, grants subsidies, and collaborates with regional governments to enhance the system's effectiveness (ENESA, 2019). The Insurance Compensation Consortium (CCS) acts as the public reinsurer, providing reinsurance support to private insurers and ensuring the system's financial stability by covering excessive claims that exceed private insurers' capacities (ENESA, 2010).

Agroseguro is a pool of private insurance companies that underwrites and manages agricultural insurance policies. Agroseguro handles policy issuance, premium collection, claims assessment, and payment, operating under a co-insurance system where risks are shared among participating insurers (Agroseguro, 2023). **Figure 25** provides the co-insurers part of Agroseguro.



Figure 25: Agroseguro coinsurance companies

Farmers and Livestock Breeders are the primary beneficiaries of the agricultural insurance system. Participation is voluntary, allowing farmers to choose the insurance products that best suit their needs. Farmers' organizations and agri-food cooperatives play a significant role in promoting the system and ensuring that the insurance products meet the sector's needs (ENESA, 2019).

Flow chart of the organisation of the Spanish Agricultural Insurance System

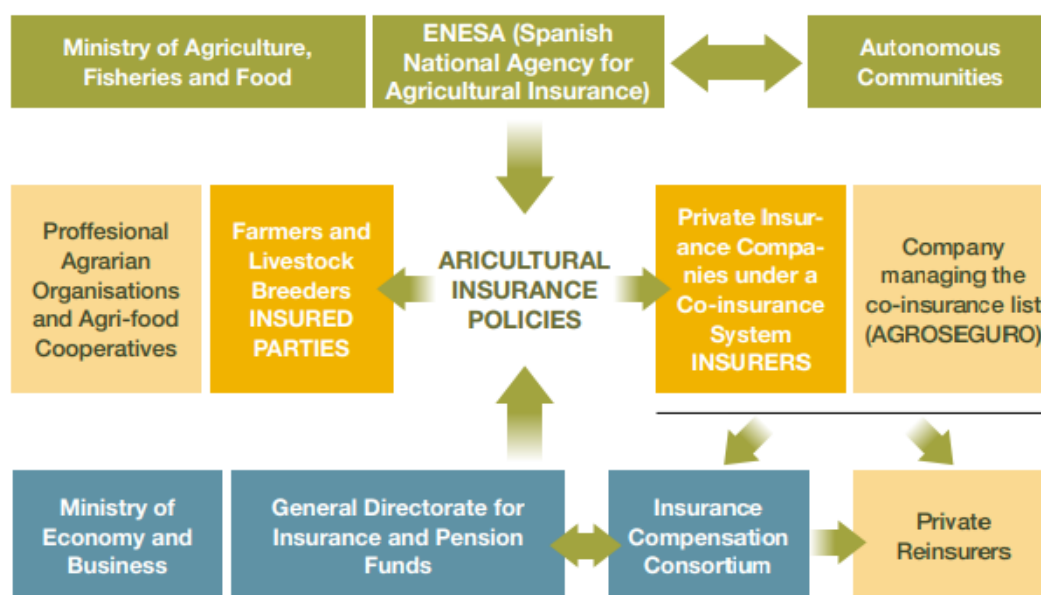


Figure 26: Flow chart of the organization of the Spanish Agricultural Insurance System

(ENESA, 2019)

The public-private insurance model in Spain leverages the strengths of both sectors, providing strong coverage for farmers. The involvement of private insurance companies operating within a co-insurance pool allows for the effective distribution of risk and expertise in underwriting and claims management. On the public side, the Ministry of Agriculture, Fisheries, Food and Environment, coordinates, supervises and promotes the insurance system. Additionally, provides subsidies, which make insurance premiums affordable for the insured (Agropelayo, 2018).

b. Agriculture insurance claims and premiums

In 2023, the total premiums collected amounted to €1 billion, marking a 17% growth from 2022. The insured capital reached €16.92 billion, demonstrating the system's extensive reach and the high level of participation among Spanish farmers (Agroseguro, 2023). The system is designed to ensure prompt compensation for insured losses. In 2023, total claims amounted to €1.24 billion, with major events like droughts, hailstorms, and frosts causing significant damage to agricultural productions as seen in **Figure 27** (Agroseguro, 2023). Additionally, **Figure 28** provides an overview of the evolution of insurance claims and premiums.



Figure 27 Agriculture insurance claims in 2023

(Agroseguro, 2023)

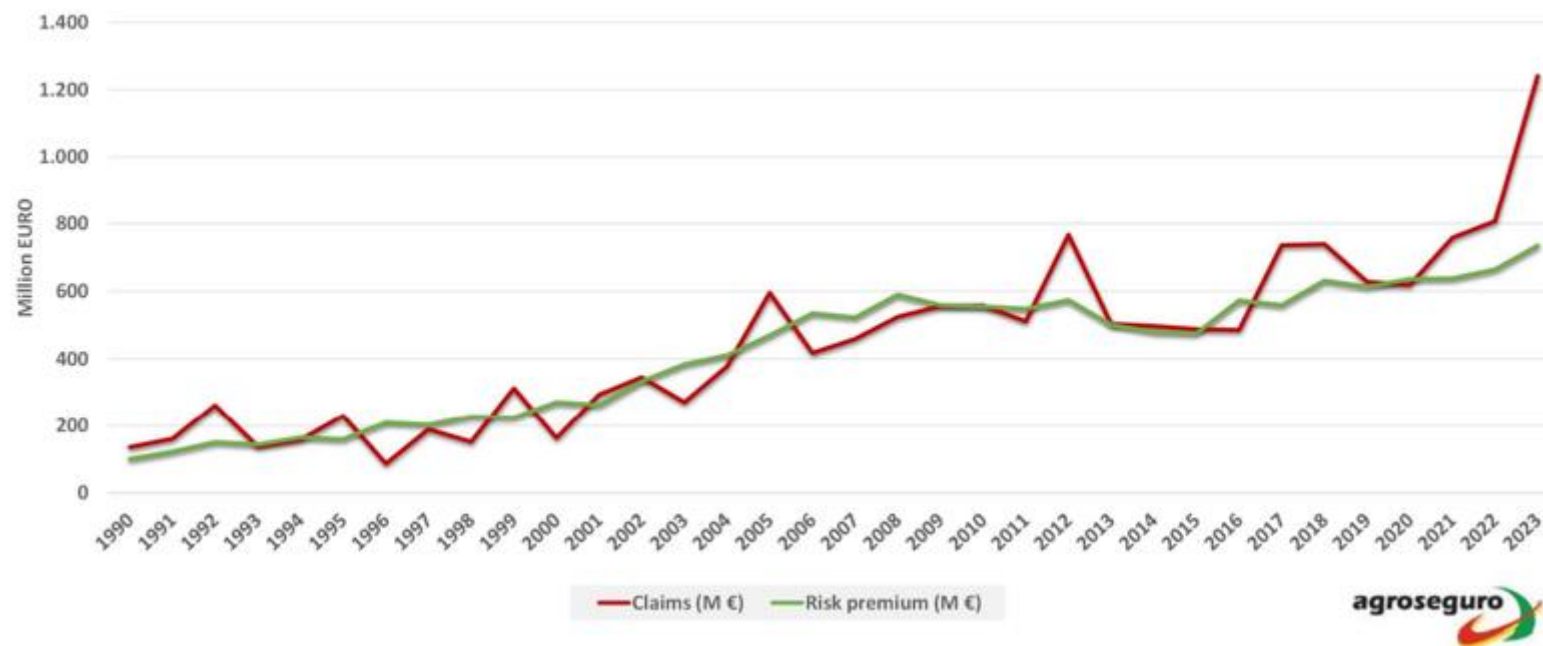


Figure 28 Evolution of insurance claims and premiums

(Agroseguro, 2023)

c. Estimated market share of major insurance companies in Spain

While the Spanish agricultural insurance market is based on a public-private model, where private insurance companies get pooled together to strengthen the insurance offering, it is still of interest to identify the 10 main insurance companies in Spain (Table 5) and analyse their key financial metrics, market presence and green investments. Important to note is that most of the insurance companies in this list, do not form part of the Agroseguro insurance pool. Instead, the insurance companies of Agroseguro tend to be smaller scale and more specific to the agricultural sector.

Table 5 Estimating Market Share of Major Insurance Companies in Spain in 2023

Insurance company	Total revenue (Billion €)	Operating Income (Billion €)	Client Base/Policy Holders(Million)	Green Investments	Estimated Market Share (%) (from Statista)
 VidaCaixa	5.32	1.47	Not detailed	€3 billion in green bonds, €1.7 billion in social bonds, €302 million in sustainability linked bonds and €770 million in sustainable bonds	11.9
 Mapfre	€24	1.28	30	Investments in green bonds (example: €35 million in 2019)	11.3
 Mutua Madrileña	7.1	0.677	16.9	Mutua Madrileña has invested in various green bonds and funds, including the "Mutua fondo Transición Energética," which is part of their green investment portfolio, but the exact amount for 2023 is not explicitly detailed.	10
 Grupo Catalana Occidente	5.8	0.616	4.5	sustainable investment represented 54% of their total investments and funds in 2023	4.9
 Allianz Seguros	Not detailed	0.769*	Not detailed	Specific numbers not detailed	4.7
 Axa Seguros	3.2	0.21	3.5	AXA Seguros green investments amounted to €530 million	4.6
 Generali España	2.39	0.1	Not detailed	In 2023 Generali issued its 4th green bond, €500 million Tier 2, in accordance with its Sustainability Bond Framework.	3.8
 Zurich	2.02	Not detailed	Not detailed	Impact investments consisted of in €6.279 billion social and sustainability bonds,	3.7
 Santalucia	4.47	0.197	7.2	Specific numbers not detailed	3.6
 Satander Seguros	2.62	Not detailed	Not detailed	€220 billion in green finance since 2019	3.4
 Grupo Helvetia	0.358	0.289	7.2	€192 million in green bonds	2.9

Sources: Cuantas Anuales 2023 VidaCaixa, 2023 VidaCaixa Sustainability report, integrated report 2023 Mapfre, MM Grupo Mutua Informe de Actividades y Responsabilidades Corporative 2023, MM Grupo Mutua Informe de Cuantas Anuales 2023, Annual Consolidated Financial Report GCO 2023, Sustainability Report GCO 2023, Anual Report 2023 Allianz SE, Informe de Sostenibilidad AXA España 2023, Axa Group Annual Integrated Report 2023, Report of the Financial Situation and Solvency Generali 2023, Zurich Insurance Group Annual Report 2023, Informe Annual Integrado 2023 Santalucia, Informe sobre la Situación Financiera y de Solvencia 2023, Annual Report 2023 Helvetia

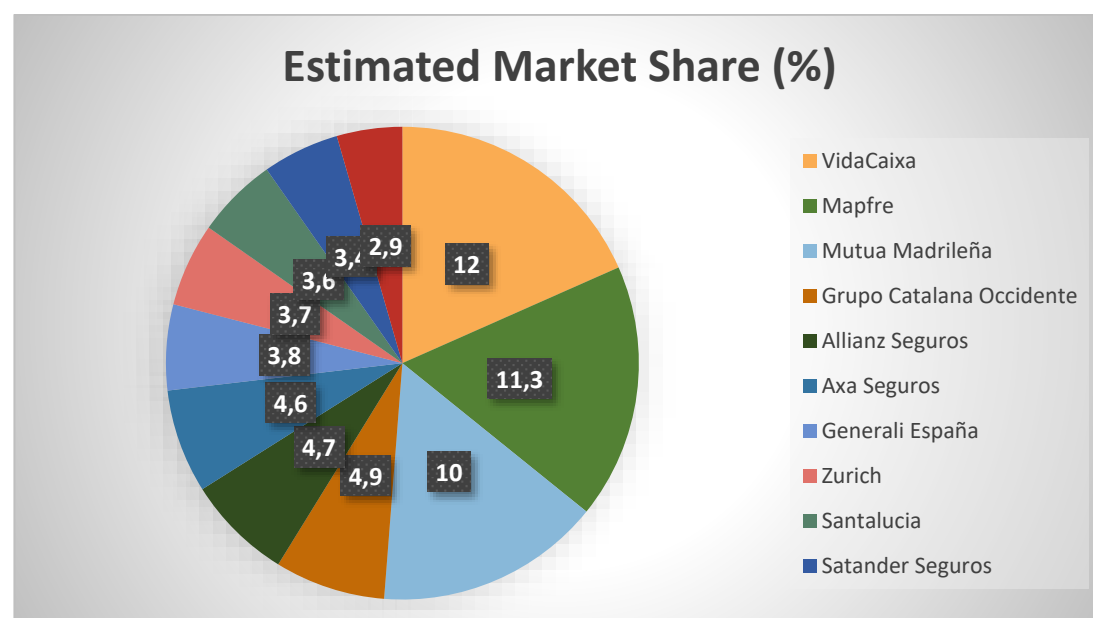


Figure 29 Estimated Market Share of Major Insurance Companies in Spain

- In table 5 above, it is evident that Mapfre leads in revenue with €24 billion, holding a significant position in the market compared to its competitors, followed by VidaCaixa at €15.32 billion and Zurich at €15.65 billion.
- Mutua Madrileña and Grupo Catalana Occidente report €7.1 billion and €5.8 billion in revenue, respectively, reflecting moderate market shares in the Spanish insurance industry.
- Figure 29 on the left illustrates the estimated market share, highlighting the top 3 companies: VidaCaixa as the market leader with 12%, followed by Mapfre at 11% and Mutua Madrileña at 10%.

4.1.2.3 Analysis of insurance products/services

The Spanish Agriculture Insurance System covers virtually all climatic risks affecting agricultural exploitations, including hail, rain, frost, drought, floods, winds, fire, wildlife and diseases for over 45 different agricultural products, covering various types of crops (fruits, wine grapes, nuts..), livestock (sheep, cattle, horses..), aquaculture (fish..), and forestry products (Agroseguro, 2023).

The crop insurance model in Spain is highly structured to address the diverse and specific needs of agricultural producers. This model is primarily based on a modular approach, offering varying levels of coverage through different modules.

Table 6 Modules of farm insurance in Spain

Module 1	Module 2	Module 3
its cover level was designed to deal with very serious damage that results in losses of more than 30% of the production insured in the entire holding.	some of the main risks for each product and exceptional damage are compensated for the losses they cause in each of the plots, and the remaining risks are compensated for the damage they cause in the entire holding.	all risks are compensated for the losses they cause in each plot.

While the module types in **Table 6** provide a general overview on how farmers can protect their risk, The Spanish Agricultural Insurance System provides this variety of module packages tailored to different crops, allowing farmers to choose coverage that best suits their specific needs and risk levels. These modules are designed to align with the unique characteristics and risks associated with each crop type, ensuring comprehensive protection. This approach allows farmers to select the most appropriate insurance coverage based on their individual agricultural crops, activities and the specific risks they face, offering a flexible and customized risk management solution (ENESA, 2019).

An example of available insurance modules for citrus crops, including oranges, mandarins, limes, lemons, and grapefruits, is depicted in **Figure 30 30**. The citrus crop insurance offers four distinct modules, each providing different coverage. **Figure 30** specifically details the coverage provided by each module for hail damage on citrus crops (Agroseguro, 2024).

- Hailstorm

Production guarantee

Calculation Compensation

Minimum Indemnifiable

Deductible

MÓDULO	MÓDULO	MÓDULO	MÓDULO
1	2	3	P
Operation	Plot	Plot	Plot
30%	10%	10%	10%
ELIGIBLE BETWEEN: ABSOLUTA: 30% ABSOLUTA: 20% ABSOLUTA: 10%	ELIGIBLE BETWEEN: DAMAGES: 10% ABSOLUTA: 10%	ELIGIBLE BETWEEN: DAMAGES: 10% ABSOLUTA: 10%	ELIGIBLE BETWEEN: DAMAGES: 10% ABSOLUTA: 10%
Más info – Módulo 1	Más info – Módulo 2	Más info – Módulo 3	Más info – Módulo P

Figure 30 Insurance models for Citrus crops - hail coverage

In addition to these modular options, Spain also offers index-based insurance policies, which utilize vegetation indices derived from satellite data to estimate losses due to drought and other climatic factors (ENESA, 2019).

4.1.2.4 Analysis of innovative insurance solutions and Nature-based solutions

Currently, Nature-based solutions (NBS) are not deeply integrated into the agricultural insurance schemes provided in Spain. While insurance programs, such as those managed by Agroseguro, focus on providing financial compensation for losses due to adverse weather events and other risks, they do not systematically incorporate NBS into their risk assessment or premium determination processes. However, the Spanish government and the Common Agricultural Policy (CAP) provide financial incentives for farmers to adopt sustainable agricultural practices that align with NBS principles. These incentives include payments for practices such as crop rotation, maintaining soil cover, direct sowing, organic farming, and conservation agriculture, all aimed at improving soil health, enhancing biodiversity, and reducing greenhouse gas emissions. Through the CAP's eco-schemes and rural development measures, farmers receive financial support for implementing these environmentally beneficial practices, helping to mitigate climate risks indirectly by promoting more resilient agricultural systems (Ministry of Agriculture, Fisheries and Food, 2023).

Although the insurance companies within Agroseguro offer coverage through a co-insurance pool—where they collectively participate in the same insurance scheme—they may also provide their own specialized agricultural insurance products or enhance their coverage with additional services. **Table 7 7** presents an overview of some of the companies within Agroseguro, highlighting their specific coverages and incentives for climate-resilient practices. While the primary insurance products cover common risks, some companies within Agroseguro also offer specialized agricultural insurance options that extend beyond climate-related risks, including coverage for accidents, temporary disability, and broken machinery. In addition to offering insurance, some companies provide services and training to enhance agricultural practices among their clients. Seguros RGA also distributes newsletters on farming and livestock practices, featuring the latest news and techniques to inform and educate farmers and hunters.

Table 7 Key insurance providers and coverage options in Spain

Insurance company		Coverage features	Special incentives / climate change policies
	Axa Spain	AXA offers comprehensive agricultural insurance products, including coverage for damages caused by climatic events such as hail, frost, drought, and floods. Their policies can cover crops, livestock, and even infrastructure related to agricultural activities	Not specified
	Mapfre	MAPFRE provides comprehensive coverage, including specialized insurance for various crops, livestock, and forestry. Their products cover a wide range of natural risks like drought, hail, frost, and floods.	MAPFRE encourages farmers to adopt sustainable practices and risk management strategies. They are involved in providing education and tools to help farmers manage risks better, which can indirectly support climate-resilient practices
	Generali España	Generali offers multi-risk insurance products that cover a wide range of agricultural risks, including adverse weather conditions, pest infestations, and disease outbreaks	Not specified
	Agropelayo	Agro Pelayo is known for its extensive agricultural insurance solutions that cover various risks including hail, frost, drought, and other climatic adversities. They provide coverage tailored to the specific needs of farmers, including multi-risk insurance that is essential for crop and livestock protection. Next to Agropelayo's standard insurance, Agropelayo's Agroplus insurance offers an additional premium (sobreprecio) on top of the compensation provided by the standard agricultural insurance policy. This extra compensation is designed to cover specific risks such as hail, and optionally fire	Agropelayo does not explicitly offer incentives for climate-adaptive practices, but their comprehensive risk management solutions encourage better farm management, which may include sustainable practices as part of reducing overall risk
	Seguros RGA	Seguros RGA provides a variety of single and multi-risk insurance products tailored to the needs of farmers and agricultural businesses. These products typically include coverage for crops, livestock, machinery, facilities and other farming-related risks.	Regarding additional services, Seguros RGA does offer incentives to encourage farmers to adopt practices that reduce their climate risk. These services may include technical advice, training, and support in implementing sustainable farming practices that help mitigate the effects of climate change.

Sources: Website of companies

4.1.2.5 NBS case studies

While NBS are not directly integrated in insurance schemes for the agricultural market, the agricultural sector is implementing more NBS projects to reduce the impact of the climate crisis. Such solutions are both used within the agricultural landscape as well as in cities to reduce the impact of heatwaves and greenhouse gas emissions.

Case Study 1: Agroforestry, Navas de San Juan



The Navas de San Juan case study highlights the implementation of Nature-based solutions (NBS) to promote sustainable agriculture. This initiative, part of the Covenant of Mayors for Climate and Energy, focused on regenerative practices in olive groves, including agroforestry and cover cropping, to improve soil health and carbon sequestration. Local farmers were engaged through workshops and training, fostering community-driven climate adaptation and sustainability efforts. The NBS project received funding from regional grants and local government's own funds (Covenant of Mayors - Europe, 2024).

Case Study 3: Animals in farming, Malaga



In Spanish agricultural practices, a notable Nature-Based Solution (NBS) is the use of animals in farming. In Málaga, Spain, mules are utilized in vineyards, providing several advantages over machinery. These benefits include lower greenhouse gas emissions, higher energy efficiency, prevention of soil compaction, additional manure production, natural weed and pest control, and effective fire risk management (Food and Agriculture Organization of the United States, 2022).

Case Study 2: Enhancing resilience to climate change, Barcelona



Barcelona's Nature-based solutions (NbS) initiative focuses on enhancing urban resilience to climate change by integrating green infrastructure and biodiversity into urban planning. Key measures include the development of urban green corridors, urban vegetable gardens, street tree networks, and the restoration of peri-urban forests and coastal dunes. These efforts aim to improve air quality, mitigate the urban heat island effect, and boost ecosystem services (Oppla, 2023).

Case Study 4: Urban carbon sink, Valladolid



In Valladolid, Spain, the "Urban Carbon Sink" project involves planting trees to maximize carbon sequestration and increase shade areas. This initiative helps to purify the air by removing pollutants such as Nitrogen Dioxide (NO₂), Ozone (O₃), Sulphur Dioxide (SO₂). The urban green areas created also regulate stormwater infiltration, reduce urban heat island effects, improve air quality, and provide habitats for species, recreational spaces, and nature education for residents (URBAN GreenUP, s.d.).

The four case studies collectively showcase the diverse and innovative use of Nature-based solutions (NBS) across different contexts in Spain, illustrating the potential for environmental and social benefits through sustainable practices. In Navas de San Juan, agroforestry and regenerative agriculture practices in olive groves improve soil health and carbon sequestration while fostering community engagement. Barcelona exemplifies urban resilience through green infrastructure, enhancing biodiversity and mitigating climate change impacts. In Malaga, the integration of animals in farming reduces emissions and promotes more sustainable vineyard management. Lastly, Valladolid's urban carbon sink project highlights the role of tree planting in air purification, climate regulation, and creating multifunctional urban green spaces. Together, these cases underscore the importance of NBS in addressing climate change, promoting sustainability, and enhancing both rural and urban environments.

4.1.2.6 Challenges, future trends and opportunities

a. Challenges in the Spanish agriculture sector

Spain's agricultural sector faces several challenges, largely driven by environmental, economic, and regulatory factors. The most pressing challenge is climate change, which has intensified the frequency and severity of extreme weather events, such as droughts, floods, and hailstorms, directly impacting crop yields and livestock production. These climatic changes introduce uncertainty and increase the risk of significant financial losses for farmers, making the agricultural sector highly vulnerable (ENESA, 2019).

Another critical challenge is the market volatility associated with global agricultural commodity prices. Fluctuations in prices can significantly affect farmers' incomes, particularly in the context of global competition and changing demand patterns. Moreover, the ongoing adaptation to the European Union's Common Agricultural Policy (CAP) reforms, which emphasize sustainability and environmental protection, requires Spanish farmers to adopt new practices that can sometimes be costly and complex (European Commission, 2023).

b. Future Trends in the Spanish agricultural sector and insurance

As climate-related risks grow, the future of agricultural insurance in Spain is expected to evolve accordingly. One significant trend is the increasing adoption of technology in insurance processes. Technologies such as remote sensing, drones, and high-resolution satellites are anticipated to play a crucial role in improving risk assessment, enhancing the accuracy of damage evaluations, and expediting the claims process (ENESA, 2019). This technological integration is vital for maintaining the sustainability of the insurance system in the face of increasingly unpredictable weather patterns.

Furthermore, there is an ongoing effort to universalize insurance coverage across the agricultural sector. This involves increasing the penetration rate of insurance, particularly in underinsured sectors such as olive farming and small livestock operations. Universal coverage is seen as a key factor in enhancing the resilience of the agricultural sector to climate change and other risks (ENESA, 2019).

c. Opportunities in the Spanish agricultural sector and insurance

Despite these challenges, there are numerous opportunities for innovation and growth in Spain's agricultural sector and its insurance market. The rising demand for sustainable and organic produce presents a significant opportunity for Spanish farmers, especially given the country's diverse climatic conditions that allow for the cultivation of a wide range of crops. This demand aligns with the EU's sustainability goals, potentially opening new markets for Spanish agricultural products. The public-private partnerships in the agriculture insurance market in Spain have provided clear opportunities to develop more accessible and affordable insurance options tailored to the specific needs of small and medium-sized farms, which are often underinsured. The pool of companies and stakeholders in the public-private partnerships could be expanded to include new participants, such as technology firms and environmental organizations, to drive innovation in insurance solutions and ensure they are aligned with current market trends and emerging climate risks. Additionally, as Spain continues to be a leader in agricultural practices within the European Union, there is potential for the country to export its successful agricultural insurance model to other regions, particularly those in the developing world. By sharing its expertise, Spain can contribute to global food security and help other nations mitigate the risks posed by climate change.

4.1.3 Italy

4.1.3.1 Current state of the food and agricultural market in Italy

Italy's agricultural sector is a significant part of its economy, contributing about 2% to the national GDP, making it one of the largest agricultural economies in the European Union (European Commission, 2024). **Figure 31** provides an overview how much percent the agricultural sector contributes to Italy's total GDP.

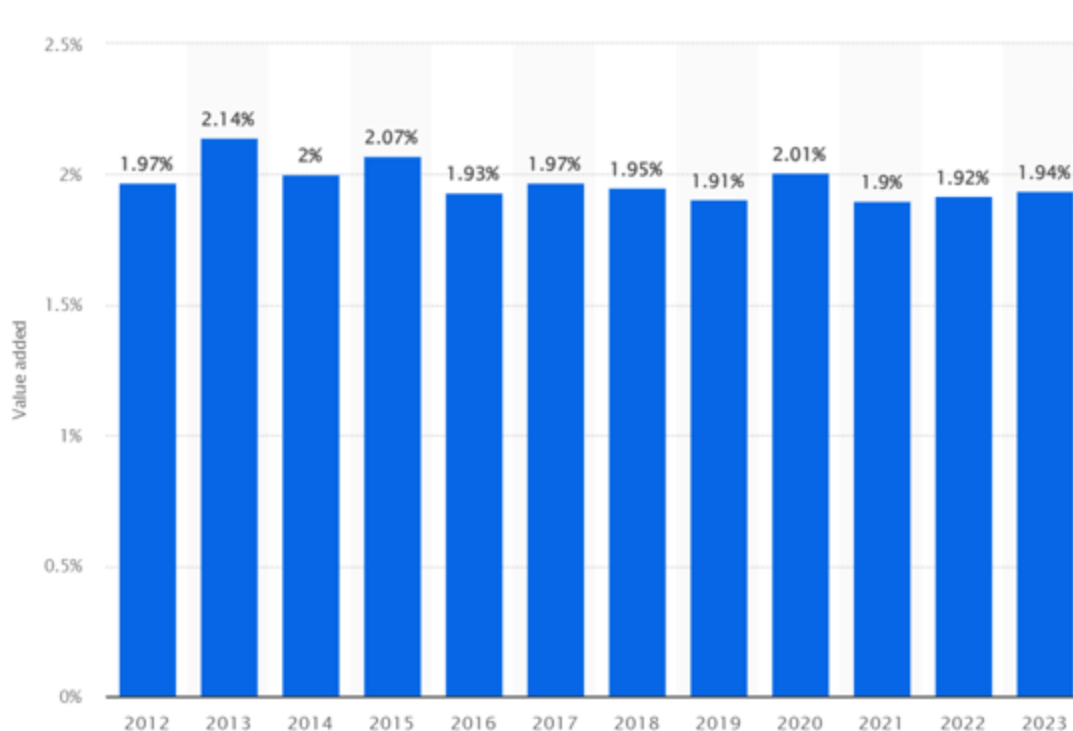


Figure 31 Agriculture value added as a share of GDP* in Italy between 2012 and 2023

Source: Statista

Due to the difference characteristics between northern and southern regions in Italy, the agricultural sector benefits from a wide range of agricultural products. The northern regions of Italy primarily produce grains, soybeans, meat, and dairy products, while the southern regions are known for fruits, vegetables, olive oil, wine, and durum wheat. Italian agri-food products are renowned globally, driving high demand and resulting in exports valued at over 62 billion euros in 2023, as seen in **Figure 32**. This figure represents the total export value of Italian agri-food products by destination region. Europe emerged as the leading importer, accounting for approximately 46 billion euros in purchases of Italian food products.

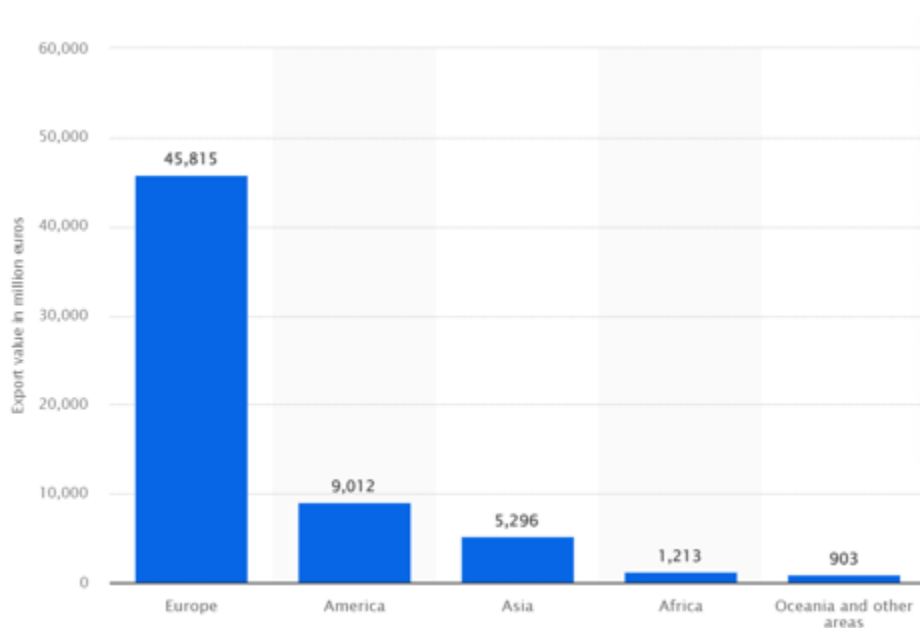


Figure 32 Value of agri-food products exported from Italy in 2023, by destination area (in million euros)

Figure 33 offers a detailed breakdown of the leading agri-food exports in 2023 by product type, revealing that the top categories include cereals and rice, wine and must, and vegetable products.

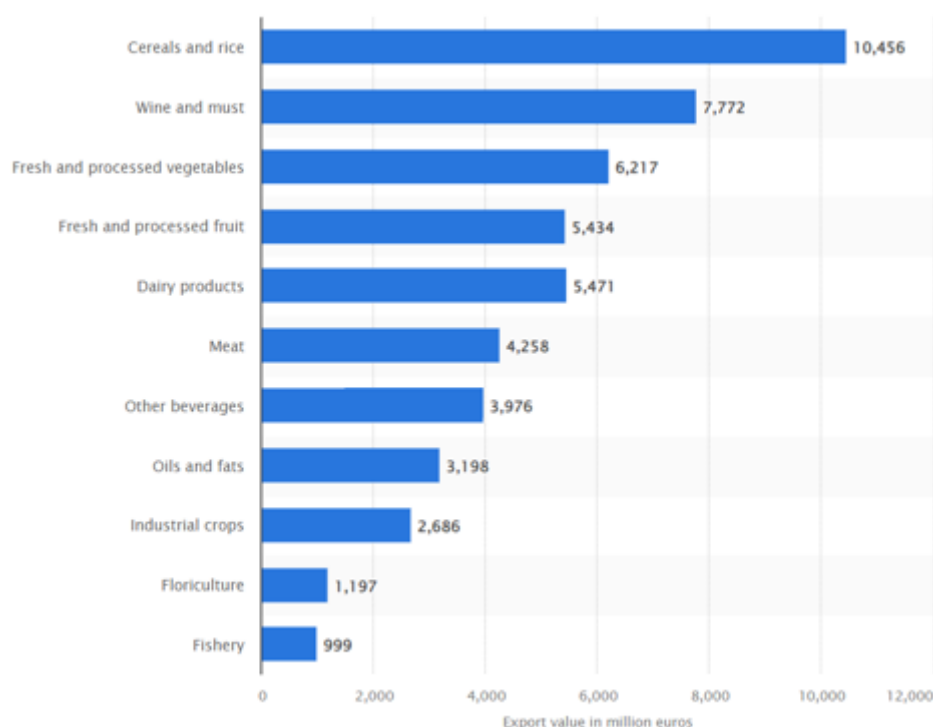


Figure 33 Leading agri-food exports values in Italy in 2023, by product type (in million euros)

Source: Statista

In general, the profitability in Italy's agriculture has seen a steady growth. The country has approximately 1.1 million farms covering 12.6 million hectares, with more 50% of the land

classified as agricultural land and with around 4% of the population employed in farming (European Commission, 2024). Organic farming has also expanded significantly, covering over 2.3 million hectares of farm land in 2023, with Sicily ranking first with over 387 thousand hectares of land used for organic farming (Ozbun, 2023).

Italy is increasingly vulnerable to climate risks due to its diverse geography, which includes mountains, coastal and lowland areas. Italy faces a high frequency of extreme weather events such as hail, frost, drought, and floods, which can cause significant damage to crops and livestock. One of the most pressing climate risks in Italy is the increased frequency and intensity of extreme weather events. In recent years, Italy has been hit by several severe storms and floods, particularly in northern regions. Droughts are another major climate risk for Italy, particularly in the southern and central regions, which are increasingly affected by water scarcity. The combination of prolonged droughts and heatwaves has also contributed to an increase in wildfires, particularly in southern Italy and Sardinia, where thousands of hectares of forest and agricultural land are lost each year (Carzedda & Gallenti, 2021).

While climate risks affect the entire country, the highest concentration of insured agricultural values is found in northern Italy, driven by high-value crops like wine grapes and apples, which are highly susceptible to weather-related damage. This has spurred a demand for comprehensive insurance coverage in the region (ISMEA, 2022). But also Southern Italy, historically underinsured, has seen significant growth in insurance adoption to protect against rising temperatures and decreased rainfall.

4.1.3.2 Current state of the food and agricultural insurance market in Italy

a. Public-private insurance schemes

The Italian agriculture insurance market has evolved significantly, transitioning from a predominantly public system to a highly subsidized Public-Private Partnership (PPP) model. This shift has been crucial in maintaining affordable premiums and expanding the range of insurance products available to farmers. Several public and private bodies are involved in the Italian agriculture insurance market. Several public and private bodies are involved in the Italian agriculture insurance market. The Institute of Services for the Agricultural and Food Market (ISMEA) is a key public body managing agricultural insurance schemes, providing data, and supporting risk management initiatives. ISMEA's role includes collecting and analysing data to help tailor insurance products to the needs of the agricultural sector and offering financial support to make insurance more accessible to farmers (ISMEA, 2022). The National Solidarity Fund (NSF) supports both ex-ante and ex-post interventions, subsidizing insurance premiums for crops, livestock, and farm structures, and providing compensation for losses not covered by insurance policies (ISMEA, 2022). Private insurance companies offer various insurance products, often in collaboration with public bodies, to cover a wide range of agricultural risks. The collaboration between public institutions and private insurers helps maintain affordable premiums and expand coverage options, enabling the development of innovative insurance products tailored to the specific needs of the agricultural sector (Carzedda & Gallenti, 2021).

b. Regional insurance market characteristics

A policy reform in 2015 introduced new types of insurance contracts, known as "packages," which were designed to provide coverage against different sets of adversities, offering greater flexibility and tailored protection to farmers. This reform correlated with an increase in the value of the purchased insurance, reflecting a shift towards insuring higher-value crops and more

comprehensive risk coverage (Santeramo, Russo, & Lamonaca, 2023). **Figure 34** provides an overview of the evolution of insured values, premiums and number of firms from 2019 till 2021. The figures show insurance demands are higher in northern regions, where more specific and high-value crops are cultivated.

Insured values (EUR)					
Geographical macro-area	2019	2020	2021*	Var. 20/19	Var. 21/20
North	4,940,572,387	4,932,667,033	5,203,047,301	-0.2%	5.5%
Center	572,480,459	581,602,980	511,934,051	1.6%	-12.0%
South	651,343,109	718,531,213	791,420,425	10.3%	10.1%
ITALY	6,164,395,955	6,232,801,226	6,506,401,777	1.1%	4.4%

Premiums (EUR)					
Geographical macro-area	2019	2020	2021*	Var. 20/19	Var. 21/20
North	417,388,385	461,976,782	502,551,248	10.7%	8.8%
Center	35,990,943	39,067,234	40,170,951	8.5%	2.8%
South	48,678,535	59,480,641	68,052,471	22.2%	14.4%
ITALY	502,057,863	560,524,657	610,774,670	11.6%	9.0%

Number of firms					
Geographical macro-area	2019	2020	2021*	Var. 20/19	Var. 21/20
North	48,813	48,088	48,005	-1.5%	-0.2%
Center	5,359	5,286	4,762	-1.4%	-9.9%
South	11,347	11,692	11,775	3.0%	0.7%
ITALY	65,519	65,017	64,492	-0.8%	-0.8%

(*) Estimated values

Figure 34 Evolution of insured values, premiums and number of firms in North, Centre and South Italy
(ISMEA, 2022)

c. Estimated market share of major insurance companies in Italy

Before diving into the specific insurance products and services available in Italy for the agriculture sector, **Table 8** provides an overview of the top 10 non-life insurance companies in Italy based on their 2023 annual reports and websites³. Important to note is that, while these companies are the biggest non-life insurance companies in the market, they might not all specifically provide agricultural insurance schemes.

Table 8 Estimating Market Share of Major Insurance Companies in Italy in 2023

Insurance company	Total revenue (Billion €)	Operating Income (Billion €)	Client Base/Policy Holders(Million)	Green Investments	Estimated Market Share (%) (Individual market revenue/Total market revenue x 100)
 Generali Italy	27.3	2	Not detailed	€ 8.5 - € 9.5 billion in new green and sustainable investments by 2025	50.50
 UnipolSai	15.1	0.624	16.8	Unipol Group plans to increase impact investment from 862 million in 2021 to 1.3 billion in 2024	27.9
 Allianz	0.011229	Not detailed	Not detailed	Specific numbers not detailed	0.02
 AXA	5	Not detailed	Not detailed	AXA green investments as a whole group amounted to €530 million	9.25
 Reale Mutua	1.68	0.0186	1.4	1 million Euros in ESG projects	3.10
 Zurich	1.67	Not detailed	Not detailed	Impact investments consisted of in €6.279 billion social and sustainability bonds,	3.08
 Vittoria Assicurazioni	1.22	0.146	Not detailed	Not detailed	2.25
 Cattolica Assicurazioni	0.023	0.521	Not detailed	Not detailed	0.04
 Groupama Assicurazioni	1.235	0.0011	1.5	Not detailed	2.28
 Sara	0.824	0.000111	Not detailed	Not detailed	1.52

Sources: UnipolSai Annual Report 2023, UnipolSai Website, Generali website, Axa Annual Financial Report 2023, Reale Group Integrated Consolidated Financial Statement 2023, Annual Report 2023 Zurich Group, 2023 Annual Report & Accounts Vittoria, Cattolica Assicurazioni 2023 Report, 2023 Annual Report Groupama Group, Sara Assicurazioni Bilancio Consolidato 2023

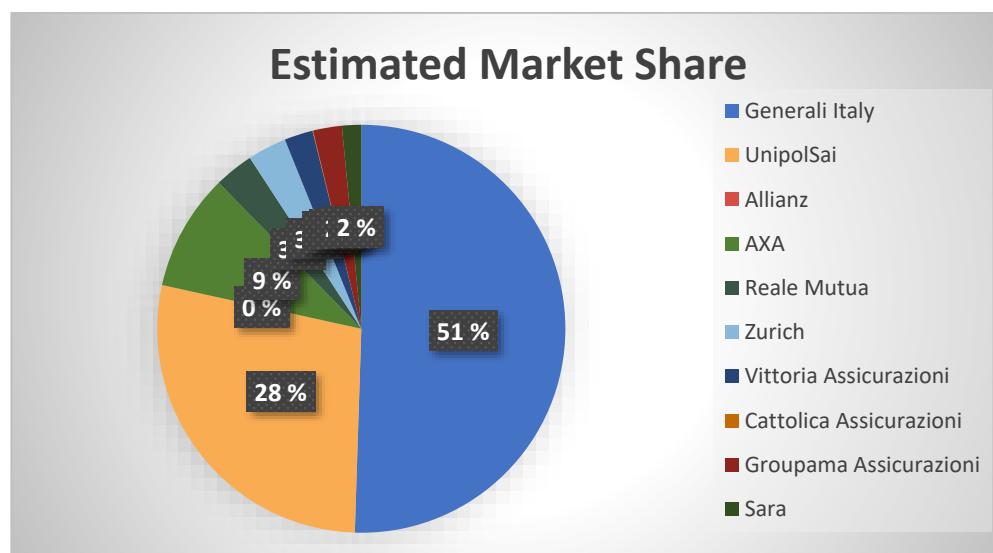


Figure 35 Estimated Market Share of Major Insurance Companies in Italy

- Table 8 above shows that Generali Italy leads in total revenue (€27.3 billion) and market share (50.5%), with a significant focus on green investments, targeting up to €9.5 billion by 2025.
- UnipolSai has the second-highest market share (27.9%) and is increasing its impact investments from €862 million to €1.3 billion by 2024, while also serving 16.8 million policyholders.
- Allianz shows a significantly lower revenue (€0.011229 billion) and market share (0.02%) compared to others, with no detailed figures on its green investments or client base. Other smaller companies like AXA, Reale Mutua, and Zurich also have modest market shares and focus on ESG or green initiatives.
- Figure 35 shows the estimated market share distribution per company.

³ The market share estimates presented in this analysis are derived from the 2023 annual reports of the ten major insurance companies operating in Italy. While this study focuses on these leading firms, it's important to recognize that there are other insurance providers in the Italian market. The ten companies were selected to offer a comprehensive overview of market dynamics and their respective shares. However, the overall market share of these companies may vary if additional insurers were included in the analysis. Therefore, the market share percentages provided here are approximate, based on factors such as total revenue and operating income as reported by the companies. These figures are indicative and should be interpreted within the context of this study.

4.1.3.3 Analysis of insurance products/services

a. Public subsidised insurance packages

The introduction of "package" contracts in 2015 diversified the insurance solutions in Italy. These packages provide varying levels of coverage, tailored to different combinations of risks. For instance, Package A covers all adversities, while Package B includes coverage for catastrophic events like floods and droughts, along with at least one frequent peril such as hail or intense wind. Package C and its variant C1 cover at least three frequent adversities, with optional coverage for additional risks like sunstroke and temperature fluctuations. Package D is designed to cover all catastrophic adversities (Santeramo, Russo, & Lamonaca, 2023). An overview of the insurance packages are provided in **Figure 36**. The packages were introduced to increase flexibility and cater to the specific needs of different types of farms, contributing to an increase in the insured value per hectare.

Year	Contract	Adversities								
		Catastrophic			Frequency				Accessory	
		Flood	Frost and hoarfrost	Drought	Hail	Intense wind	Heavy rain	Excessive snow	Sunstroke and warm wind	Temperature leap
'10-'12	Mono-risk	1 adversity								
'10-'14	Multi-risks	All the adversities								
'10-'14	Pluri-risks	3 adversities								
'15	Package A	All the adversities								
'15	Package B	All the adversities			At last 1				Optional	
'15	Package C				At last 3				Optional	
'15	Package C1	Mandatory			At last 3					
'15	Package D	All the adversities								

Figure 36 Adversities covered by different types of insurance contracts

(Santeramo, Russo, & Lamonaca, 2023)

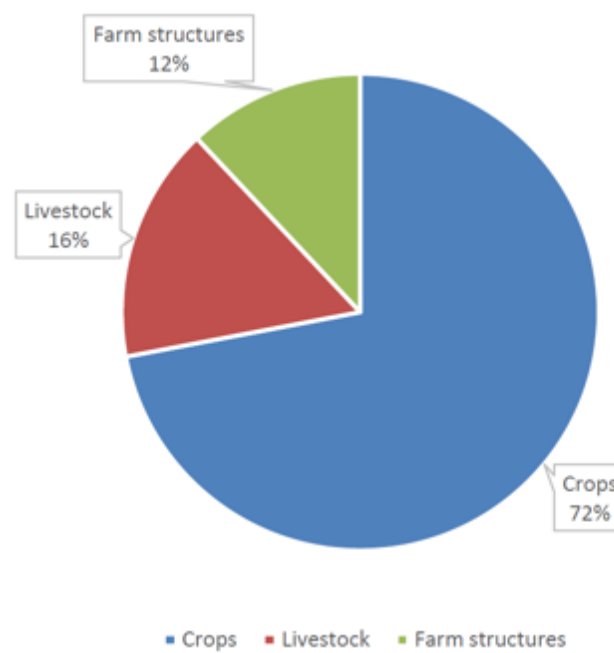


Figure 37 Market share by insured product value in 2019

(Carzedda & Gallenti, 2021)

Amongst agricultural products, crop insurance is the most prevalent in the insurance market (Fig. 36). Analysing insurance coverage across different crops reveals that those with strong export potential, such as wine grapes, apples, rice, tomatoes, and grain, tend to have higher insurance levels. This trend underscores the critical role of insurance in protecting and enhancing the "Made in Italy" brand, as illustrated in **Figure 38**.



Product	EUR thousand	Share %	Var. 21/20
Wine grapes	2,085,273	32.0%	4.7%
Apples	700,930	10.8%	5.2%
Rice	500,233	7.7%	18.0%
Industrial tomato	474,774	7.3%	16.0%
Grain corn	432,358	6.6%	12.4%
Corn for silage	264,788	4.1%	2.6%
Kiwi	167,679	2.6%	-0.8%
Tobacco	144,607	2.2%	-2.3%
Common wheat	141,029	2.2%	9.6%
Soy	127,469	2.0%	25.3%
Nectarines	106,124	1.6%	18.7%
Pears	104,650	1.6%	-43.2%
Durum wheat	83,066	1.3%	37.8%
biomass corn	82,520	1.3%	12.5%
Apricots	82,251	1.3%	43.3%
Other products	1,008,650	15.5%	-7.1%
Total	6,506,402	100%	4.4%

Figure 38 The main products for insured values in 2021

(ISMEA, 2022)

The integration of innovative insurance tools, such as index-based insurance, has also been notable. These tool uses predefined indices (e.g., rainfall levels, temperature) to trigger payouts, providing a more objective and timely response to adverse events. This type of insurance reduces the administrative burden and potential disputes over claims, making it a practical choice for many farmers (Carzedda & Gallenti, 2021).

b. Private insurance products & services

Next to the public subsidised crop insurance packages, there are also private insurance firms providing private insurance products to cover farmers from climate risk. **Table 9** provides an overview of some available insurance solutions.

Table 9 Private insurance products in Italy

Insurance company	Coverage features	Additional coverage or impact
 Generali Italy	Generali offers parametric insurance solutions for the agricultural industry addressing crop damage and livestock due to weather related events (frost, fail, drought..)	Generali Italy has a subsidiary called Genagricola, which is a large agricultural company. While not directly an insurance service, it highlights Generali's strong involvement in the agricultural sector. Moreover Generali invests in agriculture technologies such as self-driving factors and the use of drones to improve the treatment and monitoring of crops.
 UnipolSai	While not their main focus, UnipolSai does have some insurance projects in agriculture, specifically wine crops. However details of the agriculture insurance services and products are not available.	UnipolSai is actively involved in climate risk insurance for the agriculture sector in Italy. Through its LIFE ADA (ADaptation in Agriculture) project , UnipolSai focuses on increasing the resilience of Italian farmers to the impacts of climate change.
 AgriSompo	AgriSompo provides various insurance products against crop losses caused by hail, fire, or lightning	AgriSompo's Xtra Bundle combines the most popular plans into one affordable package: Hail, Wind, Replant, and Early Plant coverage
 Allianz	Allianz Universe Agriculture protects your agricultural business with a multi-risk policy that can offer various guarantees. The fire guarantee protects Buildings, Contents, Machinery, Stocks and Products, Agricultural Machinery and others from fires	Allianz also provides agriculture coverage against theft, third party liability and product liability
 Reale Mutua	Reale Mutua has Agrireale , which is their insurance line for the agriculture companies. This insurance protects crops and farm businesses against extreme weather, fires, theft, earthquakes, floods, and more. The insurance is customizable to the needs of farmers.	Next to crop insurance, Reale Mutua also protects electronic equipment of farms through their insurance line Real Electronica .
 Zurich	Zurich offers agricultural insurance products specifically designed to protect farmers from various risks including weather, crop loss, and equipment damage.	Zurich Extra-Irrigation is a parametric solution designed to manage unexpected irrigation costs that arise during particularly dry seasons, based on data related to rainfall and evapotranspiration. Zurich Italy and xFarm Technologies have launched an innovative project aimed at transforming the agricultural sector. By integrating insurance with advanced technologies, they are introducing parametric insurance solutions. These solutions enable damage assessment based on scientific parameters,
 Vittoria Assicurazioni	Vittoria provides multi-risk insurance for agricultural businesses to protect against damages caused by accidental events such as theft and fires	No details
 Cattolica Assicurazioni	Cattolica offers a specialized agricultural insurance line designed to protect farmers, their operations, and their crops. This insurance provides comprehensive coverage throughout the entire production process, safeguarding the business against risks like weather-related events, including hail and drought.	Active Impresa Agricola di Cattolica is the flexible and customizable policy for agricultural companies and agritourism. In fact, it offers specific guarantees to protect the business and assets in addition to digital protection
 Groupama Assicurazioni	Groupama provides protection against various atmospheric events and fires	Their policies also cover livestock, fodder, tanks, machinery, and buildings. The supply chain of both wine and oil can also be insured offering a 360-degree protection.

4.1.3.4 Analysis of innovative insurance solutions and Nature-based solutions

The analysis of insurance products and services reveals that NBS have yet to be integrated into insurance solutions for the Italian agricultural market. However some insurance companies are actively involved in projects aimed at strengthening the agriculture sector, improving farmer's skills and enhancing adaptation strategies to endure climate change. UnipolSai, for instance, is a key partner in the [Life ADA](#) (Adaptation in Agriculture) project. This initiative brings together various stakeholders to understand the impacts of climate change, manage risks, and develop adaptation strategies that reduce exposure while improving insurability. The project promotes a range of adaptation measures, many of which incorporate Nature-based solutions, leveraging natural systems to boost crop quality and resilience in the face of climate shifts. Specifically the project provides farmers with the tools and knowledge on soil management, water conservation and agroforestry to build resilience. **Figure 39** provides examples of some techniques that help reduce soil erosion and improve water retention, showing how NBS can serve as risk-reducing strategies while supporting sustainable agricultural practices.

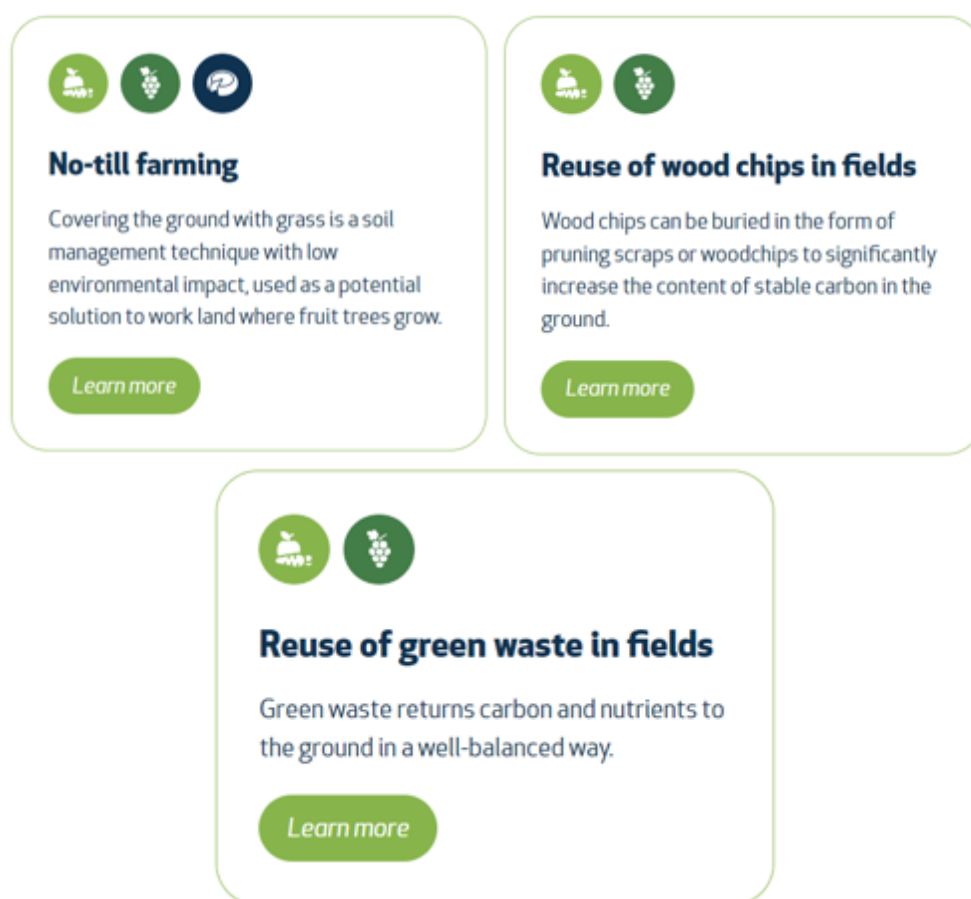


Figure 39 Adaptation strategies from LIFE ADA project

4.1.3.5 NBS case studies

While NBS are not fully integrated in insurance schemes, many Italian organizations and companies invest in NBS to improve their agricultural practices and build their resilience. These practices are designed to enhance water retention, reduce soil erosion, and lower agricultural emissions, ultimately leading to improved farming techniques and higher crop quality.

Case Study 1: dry-stone walling, Assisi-Spoleto



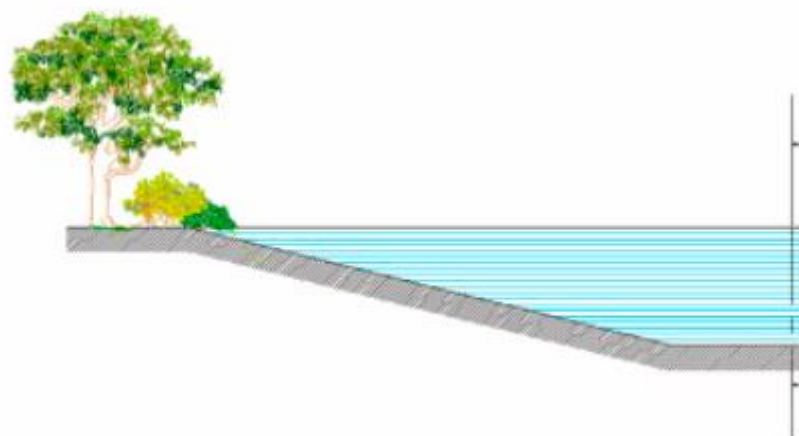
Dry-stone walling, a technique also used in Italy, offers numerous benefits. It prevents soil erosion, creates more soil by increasing surface area, enhances water infiltration, supports productivity, provides new ecological niches, supports biodiversity, and creates unique landscapes that attract tourism (Food and Agriculture Organization of the United States, 2022).

Case Study 2: animals in farming, Assisi-Spoleto



In Italian agricultural practices, a notable Nature-Based Solution (NBS) is the use of animals in farming. In Assisi-Spoleto, Italy, sheep are utilized among olive groves, providing several advantages over machinery. These benefits include lower greenhouse gas emissions, higher energy efficiency, prevention of soil compaction, additional manure production, natural weed and pest control, and effective fire risk management (Food and Agriculture Organization of the United States, 2022).

Case Study 3: Natural water retention ponds, Northern Italy



In northern Italy, natural water retention ponds are employed as a sustainable water management practice, particularly in agricultural settings. These ponds are designed to capture and store excess rainwater, which helps mitigate flood risks and promote groundwater recharge. By doing so, they enhance water availability for crops during dry periods, improve water quality by filtering pollutants, and support local biodiversity by providing habitats for various aquatic species (Staccione, Broccoli, Mazzoli, Bagli, & Mysiak, 2021).

Case Study 4: Urban Forests and Green Areas, Brescia



In Brescia, a northern Italian city, urban forests and green spaces have been implemented as part of the redevelopment of brownfield sites. The project aims to enhance urban sustainability and resilience by providing ecosystem services such as air purification, temperature regulation, and improved biodiversity (Uforest, 2024).

These four case studies from different regions of Italy illustrate the diverse and innovative applications of Nature-based solutions (NBS) in both rural and urban settings. From dry-stone walling in Assisi-Spoleto, which enhances soil health and biodiversity, to the integration of animals in farming for sustainable agriculture, these practices demonstrate how traditional methods can offer modern environmental benefits. The use of natural water retention ponds in Northern Italy shows the importance of sustainable water management for agriculture and flood prevention, while Brescia's urban forests highlight the role of green infrastructure in enhancing urban resilience. Collectively, these initiatives showcase the potential of NBS to improve environmental sustainability, support biodiversity, and provide ecosystem services that benefit both rural and urban communities.

4.1.3.6 Challenges, future trends and opportunities

a. Challenges in the Italian agriculture sector

Italy's agriculture faces rising threats from climate change, with increasingly frequent and severe events such as droughts, floods, and extreme weather conditions. These phenomena result in significant crop damage, livestock losses, and diminished productivity. The impacts vary regionally, with southern Italy experiencing prolonged droughts, while northern Italy is more prone to intense flooding. Despite the growing risks, regional disparities exist in how farmers respond to these challenges. In northern Italy farmers are more inclined to insure their crops. By contrast, farmers in the south demonstrate a lower willingness to invest in insurance schemes (ISMEA, 2022).

One significant factor behind this reluctance is the limited market penetration of Italy's subsidized public-private partnership (PPP) insurance system. The public intervention tends to benefit farms that are already financially stable and do not require substantial external assistance. These farms tend to be larger, more diversified, and better equipped to handle risks, meaning they are less reliant on financial aid. As a result, the public funds are being directed toward farmers who are not in urgent need, rather than being targeted at smaller or more vulnerable farms that could benefit the most from financial support. Moreover, by providing substantial subsidies, the public sector reduces the incentive for farmers to purchase private insurance. Since subsidized insurance is often cheaper or more accessible, farmers might be less inclined to explore or invest in private insurance products. This suppresses the growth of the private insurance market. Although private insurance companies tend to offer more adaptable products tailored to the evolving climate risks, many farmers remain hesitant to invest in these services due to higher premiums. (Carzedda & Gallenti, 2021).

b. Future trends in the Italian agricultural and insurance sector

The EU's Green Deal and Italy's commitment to sustainability are pushing the agricultural sector towards more environmentally friendly practices. Organic farming, regenerative agriculture, and the use of Nature-based solutions are expected to grow. Italy has strong potential to lead in this field, given its tradition of small-scale farming and the rising consumer demand for sustainable, high-quality products (Ozbun, 2023). According to Italy's CAP strategy, the country will approximately allocate 2 billion euros to organic farming to achieve European Green Deal's objective of transforming 25% of agricultural land to organic farming by 2027 (European Commission, 2024). Moreover, Italy is looking to invest in agricultural innovation and digitalisation through digital tools and mechanisation for farmers to improve processes, increase efficiency and reduce waste to provide more sustainable crops (European Commission, 2024).

c. Opportunities in the Italian agricultural and insurance sector

One key opportunity for Italy's agricultural insurance sector is to expand its public-private partnership by engaging private companies more actively in developing joint risk management products. This collaboration can help private insurers diversify and reduce their own risk exposure. As a result, they can lower insurance premiums, making the products more affordable and accessible for farmers. Moreover, there is a growing opportunity for insurance firms to invest in climate-resilient projects to promote Nature-based solutions in farming techniques. Insurers could incentivise farmers to implement Nature-based solutions by offering lower premiums, reducing the long-term risk of both farmers and insurance companies, while promoting sustainable practices.

4.2 Green Roof Insurances

4.2.1 France

4.2.1.1 Current state of the green roof market in France

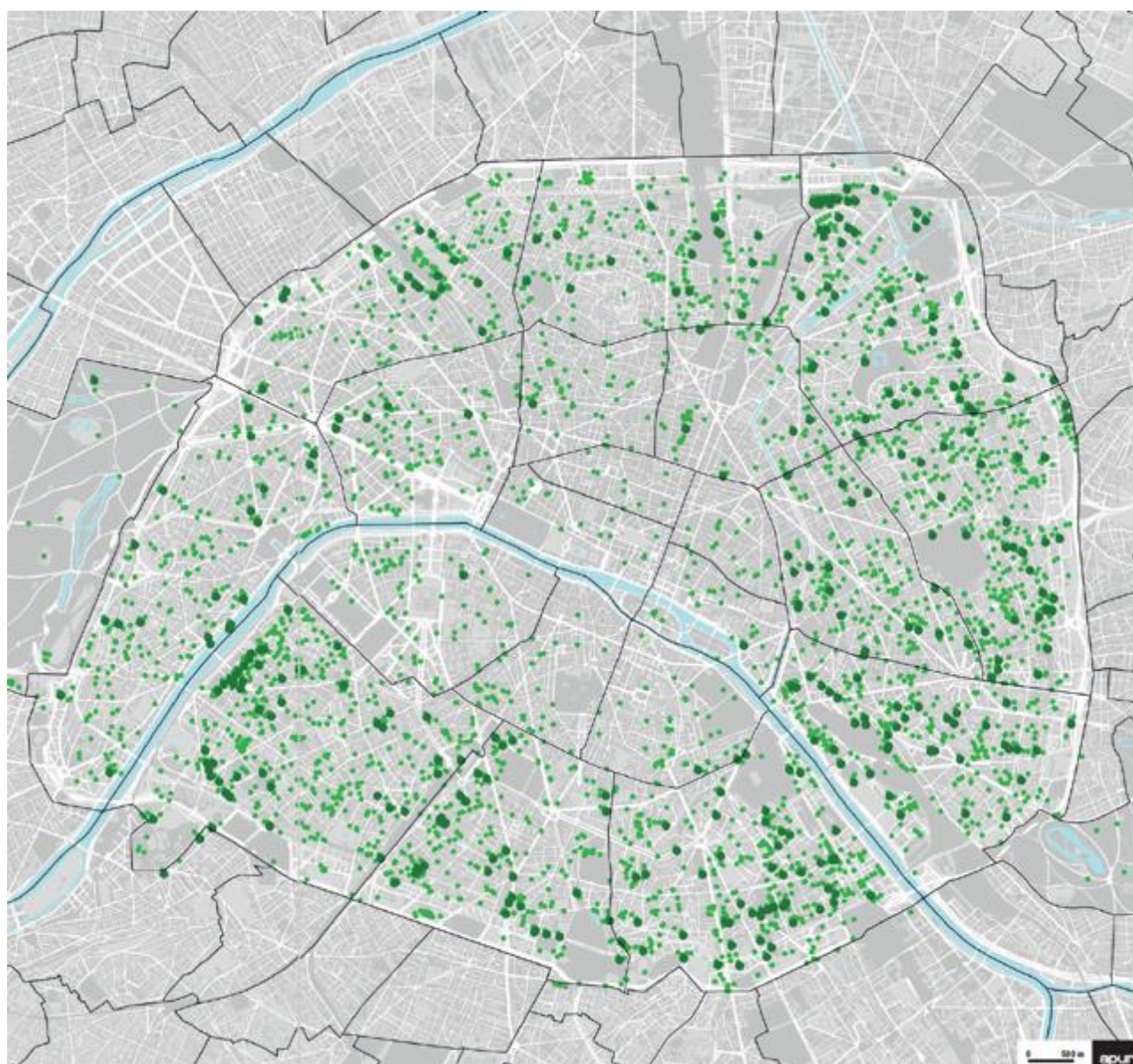
In recent years, green roofs have gained significant popularity in France due to their numerous environmental benefits and the support of urban planning policies. Considered as sustainable urban solutions, these vegetated roofs can be most seen in cities such as Paris, Lyon and Bordeaux. They help manage stormwater, increase urban biodiversity, and improve air quality. French cities are promoting green roof installations through various incentives and regulatory measures (French Ministry of Ecological Transition, 2023; OECD, 2023).

The green roofing market in France is poised for significant growth, with a potential coverage of 10 million square meters identified for 2020 (Businesscoot, 2023). The global green roof market has also experienced robust expansion, valued at nearly \$7.19 billion in 2020 and projected to reach \$12.5 billion by 2026, growing at a compound annual growth rate (CAGR) of 9.7%. North America currently leads the market, followed by Europe and Asia (Businesscoot, 2023).

The increasing urbanization in France and the need for improved environmental performance are primary drivers of growth in the green roofing sector (Businesscoot, 2023). This demand is largely driven by the public sector, which is motivated by the benefits of urban agriculture and sustainability. Despite the high initial costs, both private and public sectors are investing in green roofs for energy savings, enhanced biodiversity, and reduced environmental impact. Supportive state policies and subsidies are also facilitating this growth (Businesscoot, 2023).

The French green roofing market is characterized by a mix of small specialized players and a few large construction companies, with most materials being produced domestically. The market's sales range between €78 million and €221 million (Due to the market's relative youth, price competition remains moderate, and research and development (R&D) are crucial for product and service innovation. Maintenance costs for green roofs vary between €5 and €10 per square meter annually, with intensive roofs being the most expensive, averaging €170 per square meter (Businesscoot, 2023).

As for to the capital and since 2021, Paris has approximately 3,452 buildings with green roofs that cover more than 100 square meters, indicating a significant adoption of green roofing in the city. Among these, 360 buildings feature green roofs larger than 500 square meters. Additionally, urban agriculture is also thriving, with 213 roofs supporting agricultural activities, either professionally or as a leisure activity (Apur, 2022). **Figure 40** below shows the concentration and distribution of green roofs larger than 100 m² and 500 m² in Paris.



- Toitures végétalisées de plus de 500 m²
- Toitures végétalisées de plus de 100 m²

Figure 40: Green roofs larger than 100 and 500 m² in Paris

Source: Apur, 2022.

The French market, although smaller than early adopters like Germany, has seen a steady increase in green roof installations. In recent years, France has added 1.3 million square meters of green roofs, accounting for 8% to 25% of the total new annual roofing surfaces (Businesscoot, 2023). The market primarily focuses on integrating green roofs into new constructions, with renovations playing a smaller role (Businesscoot, 2023).

More than half of the French population, approximately 57%, are willing to invest in home insulation, including green roofing. This growing interest from private individuals is bolstered by state subsidies and incentives, such as the Île-de-France region offering up to €20 per square meter for greening projects (Businesscoot, 2023).

The increasing interest in green roofs, driven by their environmental benefits and supportive policies, highlights the need for comprehensive insurance products to protect these investments. As the green roofing market continues to grow, the demand for specialized insurance coverage tailored to the unique risks and maintenance requirements of green roofs becomes increasingly important. The following sections will examine the current state of the insurance sector in France in general, and specifically the various products available to address this expanding demand of green roofs and eco-friendly initiatives.

4.2.1.2 Current state of the insurance market in France

The French insurance sector is a well-regulated and diverse market, comprising both public and private entities. The sector includes various types of insurance policies such as life, health, property, and casualty insurance. Key players include private insurance companies like AXA, mutual insurance companies like MAIF, and public reinsurance institutions like the Caisse Centrale de Réassurance (CCR).

The French insurance market is characterized by:

- **Private Insurance Companies:** These entities offer a range of insurance products and operate on a profit-making basis. AXA is one of the largest and most prominent private insurers in France.
- **Mutual Insurance Companies:** These are owned by their policyholders and operate primarily for their benefit rather than for profit. MAIF is a significant example in this category.
- **Public Entities:** The CCR provides reinsurance for natural disasters with state backing, ensuring the stability and solvency of insurers facing large-scale claims.

When it comes to regulation, the insurance sector in France is regulated by the “Autorité de Contrôle Prudentiel et de Résolution (ACPR)”, which ensures the financial stability and compliance of insurance companies with relevant laws and regulations. The sector operates under the EU Solvency II directive, which mandates stringent capital requirements and risk management standards to protect policyholders. Additionally, the “Catastrophes Naturelles (Cat Nat)” regime, introduced in 1982, is a key feature, as it provides state-backed coverage for natural disasters, with mandatory participation by all property insurance policies.

Furthermore, according to Axa (2023), the general sense of vulnerability has increased over the past years, with 84% of experts feeling more vulnerable nationally than five years ago, and 73% locally. Despite this, confidence in insurers to mitigate future risks is high, with 93% of experts and 74% of the general population viewing insurers' roles as crucial.

Additionally the market is undergoing digital transformation, with insurers leveraging technology to enhance customer experience, improve efficiency, and better assess risks through advanced analytics.

Consequently, the French insurance market is evolving to address the unique challenges posed by climate change, including the integration of green roofs in urban infrastructure.

Insurers are cautious about providing coverage for green roofs due to concerns about structural integrity, potential water damage, and maintenance requirements. Comprehensive assessments of building structures and waterproofing systems are typically required before granting coverage (Langrenney, Le Cozannet, & Merad, 2023).

To address these challenges, the French insurance market is developing specialized products tailored to the specific risks associated with green roofs. These products focus on ensuring structural integrity, effective water management, and the maintenance of vegetated systems. Financial incentives and tailored insurance policies are being considered to encourage the adoption and maintenance of green roofs, which can help mitigate urban heat islands and manage stormwater runoff (Langrenney et al., 2023).

Public-private partnerships are playing a crucial role in creating insurance solutions that support sustainable infrastructure. By developing specialized insurance models that cater to the unique risks of green roofs, these partnerships aim to enhance urban resilience to climate impacts. The proactive involvement of insurers in preventive measures and adaptive strategies, including the integration of green roofs in urban planning, is essential for mitigating risks and maximizing the benefits of these installations (Langrenney et al., 2023).

The adaptation of the insurance sector to these emerging trends is critical for addressing the unique challenges posed by green roofs and other sustainable infrastructure. By focusing on structural assessments, developing tailored policies, and promoting preventive measures, the French insurance market aims to mitigate risks and harness the benefits of green roofs. This approach aligns with broader sustainability and climate resilience goals, highlighting the important role of insurers in facilitating the transition to more resilient urban environments (Langrenney et al., 2023).

Nonetheless and despite these initiatives, the insurance market for green roofs in France remains underdeveloped. Insurance products specifically tailored for green roofs are not widely advertised or standardized. As a result, specialized insurance products for green roofs are limited, and premiums are relatively high compared to traditional roof insurance (Paris Municipality Urban Planning Department, 2023). However, as sustainability becomes a priority, more insurers are likely to develop and promote such products.

Insurers in France typically require comprehensive assessments of building structures and waterproofing systems before providing coverage. This cautious approach is due to concerns over potential structural damage, water leakage, and the upkeep of the vegetation (OECD, 2023). While traditional property insurance typically includes coverage for green roofs, there has been a growing need for specialized insurance products to cater to their specific maintenance and risk requirements (AXA France, 2023; MAIF, 2023).

The potential market for green roof insurance is growing as cities and businesses invest in sustainable infrastructure to combat climate change. Thus, insurers that offer specialized coverage for green roofs can differentiate themselves and attract environmentally conscious customers.

In the following section, the market share of major insurance companies in France will be estimated and assessed to understand the key players in the market, their green investments, and their green policies.

a. Estimating market share of major insurance companies in France

Based on the annual reports for the year 2023, LGI conducted a comprehensive analysis of the key financial metrics, market presence, and green investments for each of the 10 major insurance companies in the French insurance sector. Table 10 below presents the results of the market share analysis⁴.

Table 10 Estimating Market Share of Major Insurance Companies in France in 2023

Insurance company	Total revenue (Billion €)	Operating Income (Billion €)	Client Base/Policy Holders(Million)	Green Investments	Estimated Market Share (%) (Individual market revenue/Total market revenue x 100)
 Crédit Agricole Assurances	32.4	2.411	14	€12 billion in green bonds, €2.5 billion in sustainable bonds	17.38
 Axa France	27.243	2.006	6.3	€29.9 billion (green bonds, infrastructure, and real estate investments)	14.62
 Covéa (MAAF, MMA, GMF)	26.8	1.5	11.4	Not specified	14.38
 CNP ASSURANCES	22.6	2.114	27	Not specified	12.13
 Macif	17.43	1.04	5.8	Not specified	9.35
 Société Générale Assurances	14.9	0.358	15	€330 million in positive impact finance, €370+ million in green bonds	7.99
 AG2R La Mondiale	14.4	0.43	15	€10 million invested in Goodvest	7.73
 Groupama	14.0	0.627	6	Not specified	7.51
 Allianz France	11.9	1.2	5.2	€4.4 billion in green assets, including €2.2 billion in green bonds	6.39
 MAIF	4.7	0.023	4	Not specified	2.52

Source: AXA Universal Registration Document 2023 -MAIF Annual Report 2023 - Groupama Annual Report 2023 - Covéa Annual Report 2023 - Allianz France Annual Report 2023 - Crédit Agricole Assurances Annual Report 2023 - Société Générale Assurances Annual Report 2023 - Macif Annual Report 2023 - AG2R La Mondiale Annual Report 2023 - CNP Assurances Annual Report 2023

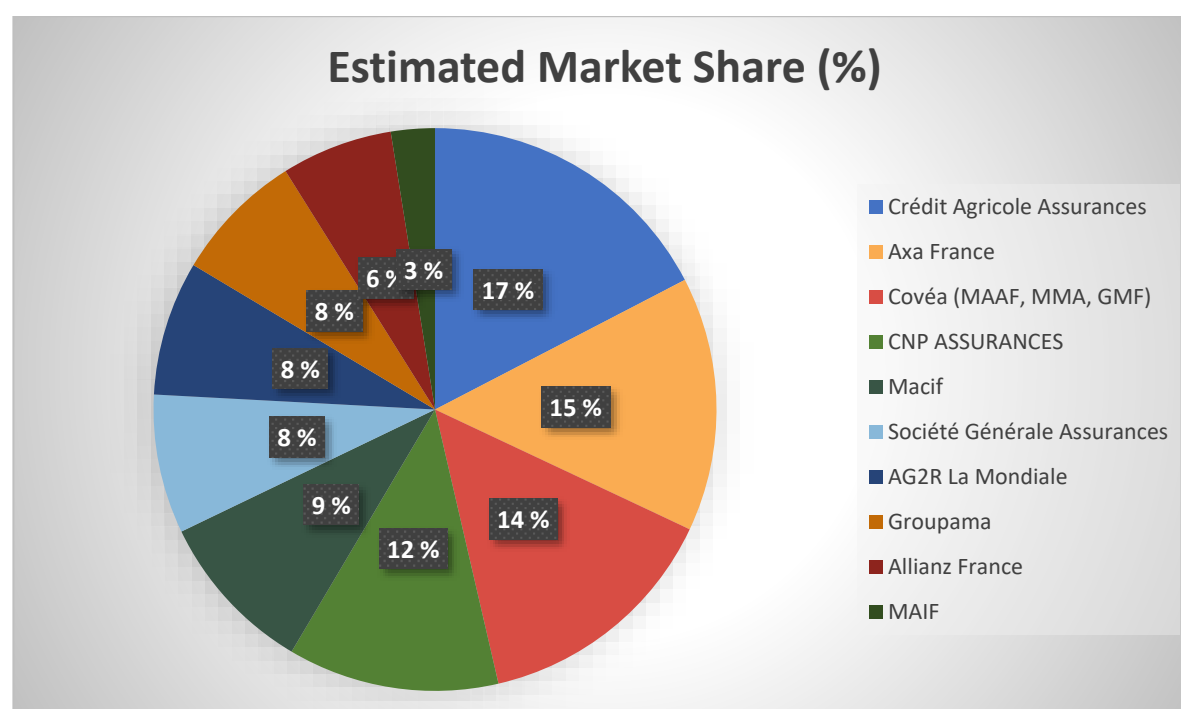


Figure 41 Estimated Market Share of Major Insurance Companies in France

- In table 10 above, it is evident that in 2023, Crédit Agricole Assurances led the insurance market with a total revenue of €32.4 billion and an operating income of €2.4 billion, serving 14 million clients, and investing €14.5 billion in green assets.
- Axa France reported €27.2 billion in revenue and €2.8 in operating income, while Covéa recorded €26.8 billion in revenue and €2.1 billion in operating income.
- CNP Assurances followed with a revenue of €22.6 billion, an operating income of €2 billion catering to 27 million clients and policy holders in 2023.
- Figure 41 on the left illustrates the estimated market share, highlighting the top 3 companies: Crédit Agricole Assurances as the market leader with 17.3%, followed by AXA France at 14.6% and Covéa at 14.3%.

⁴The market share estimates presented in this analysis are derived from the 2023 annual reports of the ten major insurance companies operating in France. While this study focuses on these leading firms, it's important to recognize that there are other insurance providers in the French market. The ten companies were selected to offer a comprehensive overview of market dynamics and their respective shares. However, the overall market share of these companies may vary if additional insurers were included in the analysis. Therefore, the market share percentages provided here are approximate, based on factors such as total revenue and operating income as reported by the companies. These figures are indicative and should be interpreted within the context of this study.

4.2.1.3 Analysis of insurance products/services

In France, the integration of green roofs into urban environments is supported by various insurance products designed to mitigate financial risks associated with their installation and maintenance. These insurance policies are crucial for promoting sustainable urban development and enhancing biodiversity in cities (OECD, 2023).

a. Comprehensive coverage and maintenance

Green roof insurance policies typically cover a wide range of risks, including weather-related damage, fire risks, and structural issues. Coverage extends to water infiltration and plant health, ensuring the roof remains functional. Advanced policies also include ongoing maintenance, such as regular inspections, irrigation, plant replacement, and pest control, which is essential for maintaining the long-term sustainability of green roofs (Berardi et al., 2014; Bevilacqua, 2021).

b. Incentives and sustainability

Government policies, such as subsidies and tax reductions, encourage the installation of green roofs by offsetting initial costs. The French government has introduced financial incentives under the Biodiversity Act to promote green infrastructure (Jovanović et al., 2020). In addition, insurers are offering premium discounts for buildings that demonstrate environmental benefits, such as energy savings or effective stormwater management. These initiatives enhance the environmental performance of buildings and promote widespread adoption of green roofing technologies (OECD, 2023; Mihalakakou et al., 2023).

c. Risk management and environmental benefits

Insurance companies are increasingly incorporating sustainability measures into their policies. This includes promoting the use of native, climate-resilient plants and efficient irrigation systems, which help mitigate risks and maximize the environmental benefits of green roofs. Insurers are also beginning to reward buildings that meet specific environmental standards with reduced premiums, further incentivizing sustainable practices (Basu et al., 2021).

d. Market overview

Major insurance companies in France have expanded their solutions to include comprehensive green roof coverage as part of broader property insurance policies. These policies protect against traditional risks while addressing the unique needs of green roofs, supporting both their maintenance and sustainability (Duffaut et al., 2022; Liberalesso et al., 2020).

e. Insurance products/services offered by major insurance companies

While none of the companies explicitly mention green roof insurance in their 2023 annual reports, they offer comprehensive environmental risk coverage and integrate sustainability measures. Their focus on eco-friendly practices and climate-related risk mitigation suggests potential flexibility in providing coverage for green roof infrastructure within broader property insurance plans. **Table 11** below provides specific examples from the aforementioned major insurance companies, taken from their respective 2023 annual reports.

Table 11 Overview of Sustainability Initiatives and Green Roof Coverage in Major French Insurance Companies (2023)

Insurance company	Focus on Sustainability	Key Sustainability Initiatives
 Axa France	Strong commitments towards sustainability, including investments in green assets and climate-related risks	Reducing carbon footprint of underwriting, increasing investments in renewable energy, €29.9 billion allocated to green assets by 2030.
 MAIF	Focuses on eco-friendly buildings and sustainable construction practices.	Offers insurance for sustainable buildings but primarily focuses on broader sustainable practices.
 Groupama	Covers natural disasters and environmental risks as part of comprehensive building insurance plans.	Focus on environmental risk and natural disaster coverage in buildings.
 Cov��	Emphasizes sustainability and integrates eco-friendly practices into their solutions.	Focuses on sustainability and eco-friendly investments.
 Allianz France	Focuses on climate risks and environmental sustainability through their insurance solutions.	Emphasizes climate resilience and environmental sustainability in products.
 Cr��dit Agricole Assurances	Committed to sustainable investments and green projects.	Supports sustainability projects and green investments.
 Soci��t�� G��n��rale Assurances	Emphasizes ESG criteria and sustainable practices within their solutions.	Integrates ESG standards and focuses on sustainability.
 Macif	Focuses on promoting eco-friendly initiatives through their products.	Promotes eco-friendly insurance products and practices.
 AG2R La Mondiale	Covers natural disasters and supports sustainable construction practices through insurance products.	Focuses on natural disaster coverage and sustainability in building practices.
 CNP ASSURANCES	Heavily invested in green assets and sustainability initiatives.	Committed to sustainability and investments in green assets.

4.2.1.4 Analysis of innovative insurance solutions and Nature-based solutions

In France, the intersection of innovative insurance policies and Nature-based solutions (NBS) is increasingly relevant, particularly in the context of green roofs. These policies are essential for promoting sustainable urban development and enhancing resilience against environmental risks. The integration of NBS into green roof insurance products reflects this trend, aiming to leverage natural processes to mitigate risks and enhance urban sustainability (EFB, 2023).

a. Innovative insurance policies for green roofs

Insurance policies in France are progressively including comprehensive coverage for green roofs, addressing risks such as structural damage, water infiltration, and vegetation health. These policies often integrate incentives for sustainable practices. For instance, policies provide discounts for using native plants and water-efficient irrigation systems, which enhance the resilience and ecological benefits of green roofs (Toxopeus & Polzin, 2021).

One example is the policy framework that supports the installation and maintenance of green roofs through financial incentives such as subsidies and tax breaks. These incentives are designed to offset initial costs and encourage property owners to adopt green roofing technologies, contributing to urban biodiversity and climate resilience (Duffaut et al., 2022).

b. Parametric insurance

Parametric insurance is another innovative product gaining traction. This type of insurance pays out based on predefined events, such as extreme weather conditions, rather than actual loss assessments. Parametric policies offer quicker payouts and reduce the administrative burden associated with traditional claims processes.

These policies are particularly beneficial for green roofs, which can be impacted by weather events like heavy rainfall or prolonged droughts (Veerkamp et al., 2021).

Insurers like AXA are exploring parametric insurance, which bases payouts on predefined environmental parameters rather than assessed damage. For green roofs, this might cover damage from excessive rainfall or prolonged droughts, with automatic payouts triggered by specific weather conditions. This approach simplifies the claims process and provides quicker financial support to policyholders, reducing administrative burdens and enhancing green roof resilience (AXA France, 2023).

Parametric Insurance is identified to have the following applications:

1. **Weather Extremes:** Parametric insurance can cover green roofs against damage from extreme weather events such as heavy rainfall, hailstorms, or droughts. For instance, if a specific threshold of rainfall or wind speed is exceeded, the insurance policy is automatically activated, providing immediate financial support for repairs and maintenance (AXA France, 2023).
2. **Drought Management:** During prolonged droughts, green roofs can suffer from vegetation stress and potential loss of plant life. Parametric insurance can offer payouts when rainfall falls below a certain level, enabling property owners to invest in supplemental irrigation and other drought mitigation measures.
3. **Heatwaves:** Excessive heat can damage green roofs by causing plant desiccation and soil degradation. Parametric insurance can cover these risks by setting temperature thresholds that, when exceeded, trigger financial compensation for cooling measures and soil treatment.

c. Performance-based insurance

Performance-based insurance products offer incentives based on the ecological and environmental performance of green roofs. For instance, policies might incentivize green roofs that demonstrate significant energy savings, enhanced stormwater management, or increased biodiversity. These performance metrics encourage property owners to maintain and optimize their green roofs. For example, a green roof that significantly reduces energy consumption for heating and cooling might qualify for lower insurance premiums due to the reduced risk associated with its enhanced environmental performance (MAIF, 2023).

d. Nature-based solutions and insurance integration

Nature-based solutions are increasingly being integrated into insurance products to promote sustainability and resilience.

For example, insurance policies are now covering the costs of installing and maintaining green roofs, which provide numerous ecological benefits, including improved air quality, enhanced biodiversity, and reduced urban heat islands (Martire et al., 2022). By offering financial protection and incentives for these green infrastructure projects, insurance companies are helping to mainstream NBS in urban planning.

Innovative insurance products are also focusing on the broader ecosystem services provided by green roofs. Policies that include coverage for ecosystem services encourage property owners to maintain high biodiversity levels and implement sustainable management practices.

These insurance products align financial incentives with ecological outcomes, promoting practices that enhance ecosystem resilience and reduce environmental risks (Calliari et al., 2022). Furthermore, regulatory frameworks are evolving to support the integration of NBS into urban planning and insurance products. Policies that mandate or incentivize the installation of green roofs on new and existing buildings are being implemented, creating a favorable environment for the growth of green roof insurance. These regulatory measures ensure that NBS are not only adopted but also maintained effectively, providing continuous environmental and social benefits (Basu et al., 2021).

Subsequently, **Table 12 12** below provides a comprehensive comparison of the insurance products, maintenance provisions, and NBS involvement/special incentives for eco-friendly and sustainable practices offered by major insurance companies in France, as detailed in their 2023 annual reports and their respective websites.

Table 12 Comparative Analysis of Insurance Companies in France Covering Green Roofs and Offering Special Incentives for Eco-Friendly and Sustainable Practices (2023)

Insurance company		Details on NBS involvement	Coverage features	Special incentives/climate change policies
	Axa France	Involved in substantial green investments, focusing on climate resilience.	General environmental risk coverage and multirisk habitation insurance could potentially cover aspects related to green roofs under broader categories like property damage or environmental liability.	Discounts for sustainable practices/ Decarbonization targets for 2030/ Green roof insurance, renewable energy investments.
	MAIF	Supports various eco-friendly projects, including green infrastructure.	Eco-friendly building focus: comprehensive insurance coverage for various aspects of home and garden, including coverage for outdoor installations like pergolas, terraces, and other external structures through their "jardin+" option	Sustainable construction practices
	Groupama	Engages in projects related to natural disaster risk reduction and resilience.	General climate risk management, property damage or environmental risks	Sustainable practices and investments
	Covéa (MAAF, MMA, GMF)	Invests in sustainable projects, with a focus on reducing environmental impact.	General sustainability focus	Sustainable and eco-friendly practices
	Allianz France	Actively invests in green bonds and supports climate-related initiatives.	Sustainability-focused insurance: renewable energy installations and other outdoor installations	Climate risk and sustainability focus
	Crédit Agricole Assurances	Significant investments in green and renewable energy projects.	Green investments focus	Support for green investments
	Société Générale Assurances	Supports green finance initiatives and sustainable development goals.	ESG and sustainability criteria – home and property insurance	ESG criteria integration
	Macif	Engages in eco-friendly insurance products, promoting sustainability.	Eco-friendly initiatives focus	Promoting eco-friendly initiatives
	AG2R La Mondiale	Focuses on sustainable construction and disaster risk reduction projects.	coverage for various home structures and installations due to partnership with MAIF	Supporting sustainable construction
	CNP ASSURANCES	Invested heavily in green assets and supports biodiversity initiatives.	Sustainability and green assets	Significant green investments

4.2.1.5 NBS case studies

Case Study 1: Coastal Wetland Restoration in Normandy



In Normandy, France, the PACCo (Promoting Adaptation to Changing Coasts) project is a joint initiative between the EU program Interreg FCE and the Environment Agency. This project aims to restore 100 hectares of coastal wetland at the Saane Valley site. The restoration efforts include increasing connectivity between the river and its floodplain, moving a campsite, and building a new water treatment plant to prevent contamination and improve water quality at local beaches. These measures help in flood management, carbon absorption, and provide benefits for both people and wildlife (Nature-based solutions Initiative, 2023).

Case Study 3: Success in Paris' Green Infrastructure



Paris has implemented extensive green infrastructure projects, including green roofs and walls, supported by insurance policies from companies like Groupama. These projects aim to reduce urban heat, manage stormwater, and increase urban green spaces. The city's "Vegetalisation du bâti" program provides financial incentives and technical support for green infrastructure, which is backed by comprehensive insurance coverage that ensures the longevity and effectiveness of these installations (Paris Municipality Urban Planning Department, 2023).

Case Study 2: AXA and Flood Management



AXA France is actively involved in projects that integrate NBS for flood management. In collaboration with local municipalities, AXA supports the creation of natural flood barriers and wetlands that absorb excess rainwater, thus preventing urban flooding. These initiatives are part of AXA's broader strategy to enhance urban resilience against climate change through Nature-based solutions (AXA XL, 2023).

Case Study 4: Collaborative NBS Projects in Isère-Amont



In Isère-Amont, a region in Southeast France, a collaborative project involving the Isère Department, the Water Agency Rhône Méditerranée Corse, and local intercommunalities, along with the State through the Barnier Fund and PAPI funds, aims to protect urbanized areas from flooding by using floodable fields as natural buffers. This project aligns with the GEMAPI policy, which promotes integrated water cycle governance at the intercommunal level. The project includes creating 16 flood expansion areas to hold around 35 million cubic meters of water, protecting the city of Grenoble and enhancing the local natural heritage (Egis Group, 2023; Urban GreenUP, 2023).

The implementation of Nature-based solutions (NBS) across various regions in France showcases the significant role these projects play in enhancing urban sustainability and climate resilience. From the coastal wetland restoration in Saane Valley to AXA's flood management initiatives, and Paris' extensive green infrastructure projects, each case study highlights the diverse applications and substantial benefits of NBS. These projects not only address environmental challenges but also provide social and economic advantages, such as improved air quality, enhanced biodiversity, and reduced urban heat islands.

Insurance solutions tailored to support NBS are crucial in ensuring the long-term success and sustainability of these initiatives. By offering comprehensive coverage options that address the unique risks and maintenance needs of NBS, insurance companies can incentivize the adoption and proper upkeep of green infrastructure. Innovative products like parametric and performance-based insurance provide timely financial support and reward environmental performance, fostering a proactive approach to risk management and climate adaptation.

Overall, the synergy between NBS projects and innovative insurance solutions represents a forward-thinking strategy to tackle climate change and promote urban resilience. As the demand for sustainable development continues to grow, the collaboration between insurers, local governments, and environmental organizations will be essential in driving the widespread adoption and success of NBS initiatives.

4.2.1.6 Challenges, future trends and opportunities

a. Challenges in the French green roofs sector

Despite the growing adoption of green roofs and the development of specialized insurance products, several challenges remain. The relatively high initial cost of installing green roofs can be a barrier for some property owners. Additionally, the need for regular maintenance and the potential for damage from severe weather events pose ongoing risks. However, these challenges also present opportunities for insurers to innovate and offer products addressing these specific needs. By providing comprehensive coverage and incentivizing best practices in green roof maintenance, insurers can promote the adoption of green roofs and support urban sustainability efforts (EFB, 2023).

b. Future trends in the French green roofs and insurance sector

That being said, the future of green roof insurance in France is promising. Growing awareness of climate change and the need for sustainable urban development are driving demand for green roofs. Insurers are also expected to expand their solutions to meet this demand, incorporating new technologies and innovative solutions (OECD, 2023).

Advanced digital tools and data analytics are set to revolutionize the assessment and management of green roof risks. Of these tools, real-time monitoring systems can provide data on roof performance, helping insurers offer customized coverage options, whereas data analytics can identify performance patterns, enabling insurers to develop more precise and cost-effective products (European Environment Agency, 2022).

Another emerging trend is the development of community-based insurance models. These models pool resources and risks among multiple property owners, reducing individual premiums and making green roof insurance more affordable. These approaches also promote collective maintenance, ensuring the long-term sustainability of green roofs (OECD, 2023).

The integration of NBS into insurance products offers many benefits:

- **Risk Reduction:** By leveraging natural processes, NBS can reduce the risk of damage from extreme weather events, lowering insurance claims and premiums.
- **Enhanced Resilience:** NBS contribute to the overall resilience of urban areas by providing ecosystem services such as flood management, temperature regulation, and biodiversity enhancement.
- **Cost Efficiency:** Implementing NBS can be more cost-effective than traditional grey infrastructure, providing long-term savings for both insurers and property owners.
- **Sustainability:** Promoting NBS through insurance products aligns with broader sustainability goals, supporting climate adaptation and mitigation efforts.

c. Opportunities in the French green roofs and insurance sector

The seamless integration of Nature-based solutions (NBS) into insurance products not only fortifies urban resilience against climate change but also drives sustainable urban development. As insurers develop more sophisticated and responsive products, such as parametric and performance-based insurance, they contribute significantly to the widespread adoption of green roofs and other NBS initiatives. This synergy between innovative insurance solutions and nature-based strategies underscores the insurance sector's pivotal role in fostering urban sustainability.

4.2.2 The Netherlands

4.2.2.1 Current state of the green roof market in The Netherlands

The green roof market in the Netherlands has shown significant potential and growth over recent years. With a high population density and urbanization rate, there is an increasing demand for sustainable urban infrastructure. The adoption of green roofs is driven by their environmental benefits, including stormwater management, urban cooling, and enhancement of urban biodiversity.

Several municipalities in the Netherlands provide subsidies and incentives to promote the installation of green roofs. For instance, the city of Apeldoorn offers a subsidy of 30 EUR per square meter, covering up to 50% of the total roof cost (Boas Berg, Radziemska, Adamcová, & Vaverková, 2017). Additionally, the Erasmus MC Sophia Children's Hospital in Rotterdam received subsidies to build a 5,000 square meter green roof (Boas Berg et al., 2017). These initiatives are part of a broader trend of incorporating green infrastructure into urban planning, supported by both local and national policies.

According to the International Green Roof Association (IGRA), Amsterdam alone has around 200 green roofs, with a total surface area of about 120,000 m². Also, the city has a potential green roof area of approximately 400 hectares (Xie et al., 2023). Flat roofs in the capital occupy nearly 1,780 hectares, representing 70.9% of the city's roof areas. Of this, 396 hectares are identified as suitable for green roofs after excluding occupied surfaces (Xie et al., 2023).

Furthermore, Rotterdam has set an ambitious target to green 10 million square feet of rooftops by 2030. This initiative is part of the city's broader climate adaptation and resilience strategy. Additionally the city has received applications for over 30,000 square meters of green roofs, aiming for a total of 800,000 square meters by 2030 (Living Roofs, n.d.).

A study by López-Maciél et al. (2023) highlights that the city of Eindhoven has also seen a substantial increase in green roof installations, driven by the municipality's active promotion and the availability of financial incentives. This growth aligns with the Netherlands' overall strategy to enhance urban resilience and sustainability.

Several key drivers are contributing to the growth of the green roof market in the Netherlands:

1. **Environmental Regulations and Incentives:** The Dutch government and local municipalities have introduced various regulations and incentives to promote green roofs. These include subsidies for installation, tax benefits, and requirements for new buildings to incorporate green roofs if they meet certain criteria (Boas Berg et al., 2017; López-Maciél et al., 2023).
2. **Climate Adaptation and Resilience:** Green roofs play a critical role in climate adaptation strategies by managing stormwater runoff, and improving air quality. These benefits align with the Netherlands' broader climate resilience goals (Boas Berg et al., 2017).
3. **Public Awareness and Demand:** There is a growing public awareness of the environmental and health benefits of green roofs. This has led to increased demand from both private homeowners and commercial property developers (Boas Berg et al., 2017; Prins, 2021).

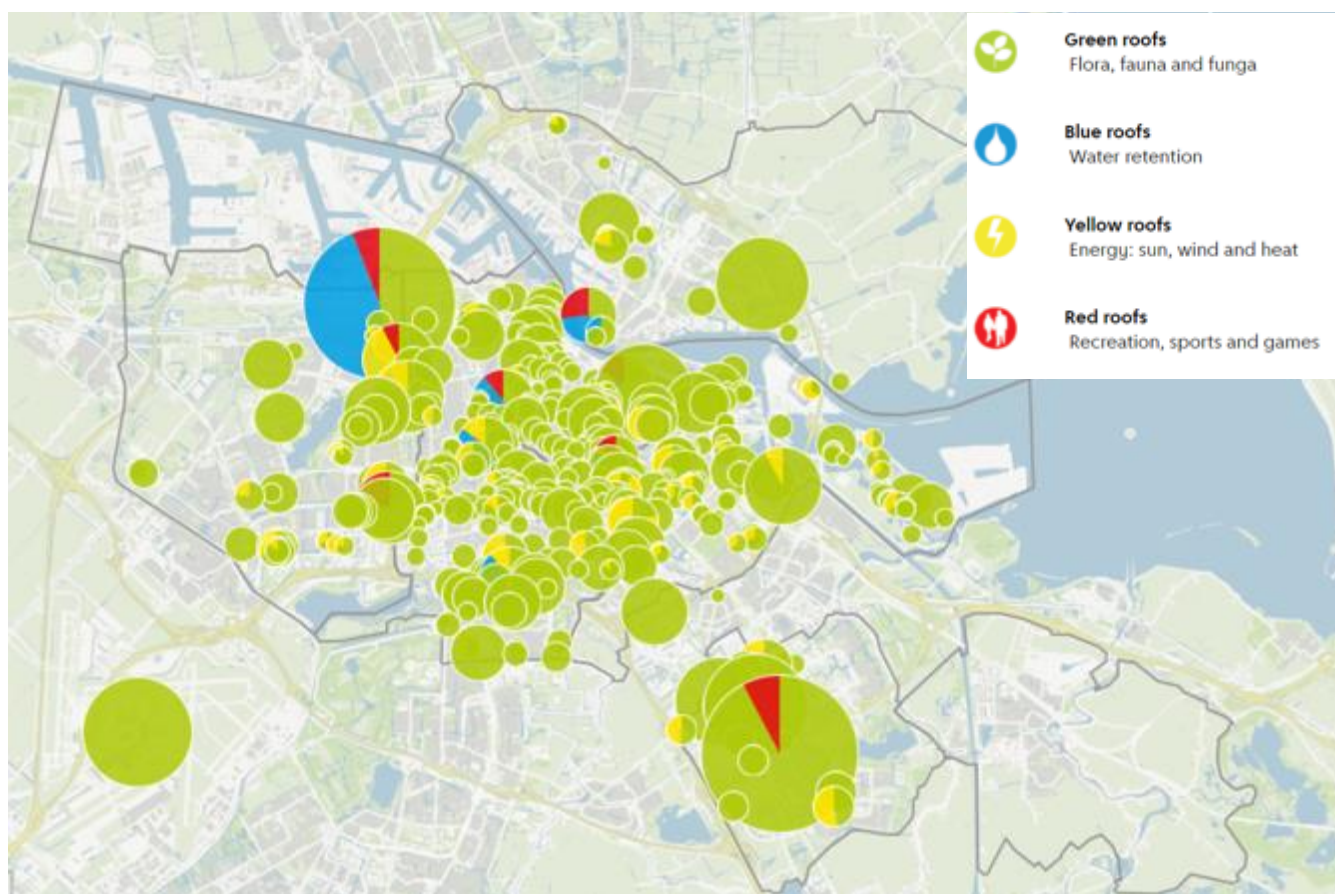


Figure 42 Green and multifunctional roofs in Amsterdam, 2024

Source: Municipality of Amsterdam (Space and Sustainability Unit) accessible at <https://maps.amsterdam.nl/dakenlandschap/>

Figure 42 above shows the distribution and concentration of Green roofs and multifunctional roofs in the city of Amsterdam.

The green roof market in the Netherlands is characterized by a diverse range of applications, from residential buildings to large commercial and public structures. Key characteristics include:

- **Diverse Green Roof Types:** The market offers various types of green roofs, including extensive green roofs with low-maintenance vegetation and intensive green roofs that can support larger plants and even small trees (Boas Berg et al., 2017; Prins, 2021).
- **Technological Innovation:** Dutch companies like Sempergreen BV are at the forefront of developing advanced green roof systems, including modular green roofs and biodiverse roofs that attract pollinators like bees and butterflies (Boas Berg et al., 2017).
- **Integrated Urban Planning:** Green roofs are increasingly integrated into broader urban planning initiatives aimed at creating sustainable and resilient cities. This includes the incorporation of green roofs into new building designs and retrofitting existing structures (Boas Berg et al., 2017; López-Macié et al., 2023).

The market for green roofs in the Netherlands is influenced by several trends and public interests:

- **Increased Public and Private Investment:** Both public and private sectors are investing heavily in green roof projects. This is driven by the recognition of the multiple benefits green roofs provide, including energy savings, improved air quality, and enhanced urban aesthetics (Boas Berg et al., 2017; López-Maciel et al., 2023).
- **Focus on Biodiversity:** There is a growing trend towards creating biodiverse green roofs that support urban wildlife, including birds, bees, and butterflies. These roofs are designed to enhance urban ecosystems and contribute to biodiversity conservation (Boas Berg et al., 2017; Prins, 2021).
- **Sustainable Development Goals:** The adoption of green roofs is aligned with the United Nations Sustainable Development Goals (SDGs), particularly those related to sustainable cities and communities, climate action, and life on land. This alignment further drives public and policy support for green roof initiatives (Boas Berg et al., 2017).

4.2.2.2 Current state of the green roof insurance market in The Netherlands

The Dutch insurance market is well-regulated and comprehensive, overseen by the Dutch Central Bank (De Nederlandsche Bank, DNB) and the Authority for the Financial Markets (AFM), which ensure market stability and consumer protection (Authority for the Financial Markets, 2022). This sector includes both private and public insurance, with private companies offering diverse products such as health, life, property, and casualty insurance, while public schemes cover social security areas like healthcare and unemployment benefits (OECD, 2020).

The private insurance sector in the Netherlands is highly competitive and innovative. Key players such as Nationale-Nederlanden, Achmea, Aegon, and ASR Nederland provide tailored products to meet various consumer needs (Dutch Central Bank, 2021).

The DNB monitors the financial health of these companies, ensuring they maintain sufficient capital reserves and comply with solvency requirements. Meanwhile, the AFM focuses on market conduct, promoting transparency and fairness in insurance product sales and management (Authority for the Financial Markets, 2022).

According to the PwC Insurance Banana Skins 2023 Netherlands Report, climate change is the top concern for the Dutch insurance industry, followed by regulation and cybercrime. Insurers face increasing claims from natural disasters, leading to pricing uncertainties and heightened underwriting risks. There is a recognized need to drive net-zero strategies and manage transition risks on assets (PwC, 2023). Additionally, AI is expected to revolutionize business processes, impacting risk management and operational efficiency. Insurers are aware of both the opportunities and threats posed by AI (PwC, 2023). Although the continuous growth of regulation is seen as a challenge, potentially slowing innovation, it also promotes higher management standards and better risk practices (PwC, 2023).

The Netherlands scored above average on the Preparedness Index, indicating a high level of readiness to handle identified risks compared to global counterparts. This reflects robust risk management and adaptive strategies within the industry (PwC, 2023).

As climate change challenges the insurance industry, the sector is developing specialized products and services to address these issues. Insurers are integrating climate resilience

measures and promoting sustainable urban infrastructure, such as green roofs, which are increasingly adopted in the Netherlands for their benefits in stormwater management, urban cooling, and biodiversity enhancement (Netherlands Enterprise Agency, 2020). Cities are incorporating green roofs into urban planning strategies to enhance climate resilience. Consequently, the demand for insurance products covering risks such as plant health, structural integrity, and water leakage is expected to rise.

Cities are increasingly incorporating green roofs into their urban planning strategies to enhance climate resilience (Netherlands Enterprise Agency, 2020). As green roofs become more integral to urban infrastructure, the demand for insurance products that cover potential risks, such as plant health, structural integrity, and water leakage, is expected to rise.

The Dutch insurance market is aligning its product solutions with broader environmental and climate goals. Insurers are collaborating with municipalities and urban planners to promote the adoption of green roofs and other Nature-based solutions (Living Roofs, n.d.). Additionally, Dutch property owners are becoming more environmentally conscious, recognizing the benefits of sustainable building practices. Green roofs not only contribute to environmental sustainability but also enhance property values and energy efficiency (Berardi, GhaffarianHoseini, & GhaffarianHoseini, 2014). This growing awareness increases the willingness of property owners to invest in green roofs and associated insurance policies to safeguard their investments.

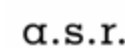
The potential market for green roof insurance in the Netherlands is promising. As the market continues to innovate and adapt, further development of specialized insurance products and greater integration of green infrastructure in urban planning are expected.

In the following section, the market share of major insurance companies in the Netherlands will be estimated and assessed to understand the key players in the market, their green investments, and their green policies.

4.2.2.2.1 Estimating market share of major insurance companies in The Netherlands

Based on the annual reports for the year 2023, LGI conducted a comprehensive analysis of the key financial metrics, market presence, and green investments for each of 10 major insurance companies in the Dutch insurance sector. Table 13 presents the results of the market share analysis.⁵

Table 13 Estimating Market Share of Major Insurance Companies in the Netherlands in 2023

Insurance company	Total revenue (Billion €)	Operating Income (Billion €)	Client Base/Policy holders (Million)	Green Investments	Estimated Market Share (%) (Individual market revenue/Total market revenue x 100)
 Nationale-Nederlanden	23.3	1.9	5	€10.752 billion (renewable energy, certified green buildings, and green bonds.)	19.6
 Achmea	22.3	0.628	10	€55 million (Achmea Investment Management Climate Infrastructure Fund)	18.75
 Zilveren Kruis (part of Achmea)	15.6	0.277	3.7	€55 million (Achmea Investment Management Climate Infrastructure Fund)	13.11
 VGZ	14	0.165	4.1	sustainable investment practices (Green Deal for the Healthcare Sector)	11.7
 Aegon	12.97	1.498	2	USD 1.8 billion (Global Short Dated High Yield Climate Transition Fund)	10.9
 CZ Group	10.5	0.088	3.7	Socially Responsible Investment (SRI) policy	8.82
 ASR Nederland	10.37	1.117	3.1	€2 billion in green bonds	8.71
 Menzis	7	0.150	2	Not specified	5.88
 Reaal (under Athora Netherlands)	2.2	0.559	2	sustainable investing and climate-focused initiatives	1.84
 Univé	0.683	0.13	1.1	commitment to sustainability and responsible investing	0.57

Source: Achmea Annual Report 2023 - Nationale-Nederlanden (NN Group) Annual Report 2023. – Aegon Annual Report 2023- ASR Nederland. Annual Report 2023 – VGZ Annual Report 2023 - CZ Group Annual Report 2023 – Menzis Annual Report 2023 – Univé Annual Report 2023 - Zilveren Kruis - Annual Report 2023 - Reaal (part of VIVAT) Annual Report 2023

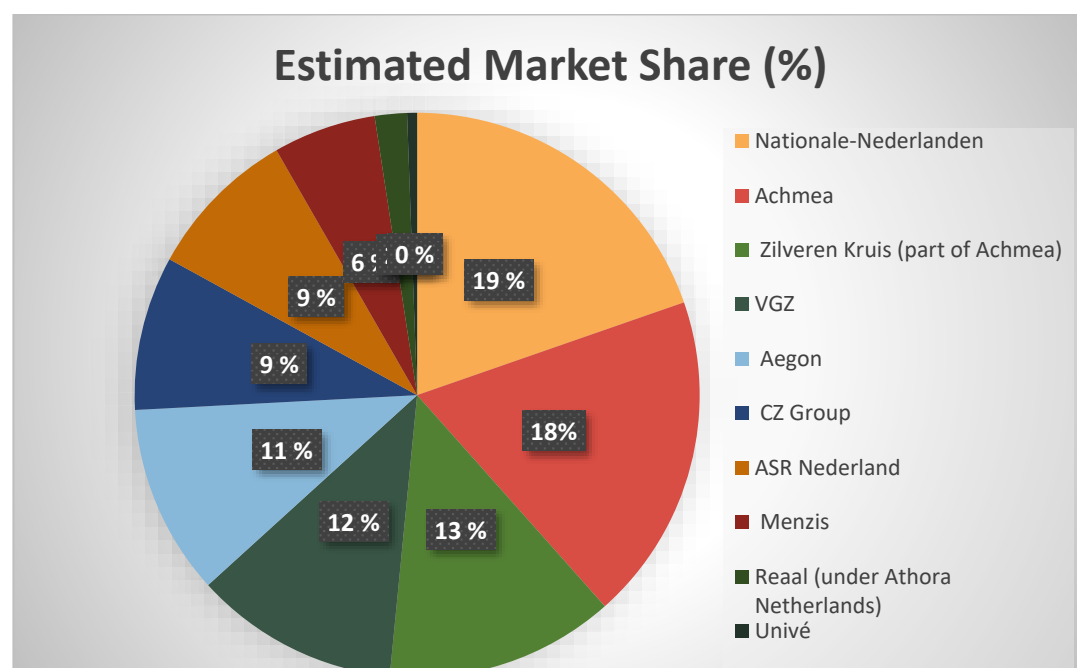


Figure 43 Estimated Market Share of Major Insurance Companies in the Netherlands

- Table 13 above shows that Nationale-Nederlanden leads with the highest total revenue (€23.3 billion) and market share (19.6%), followed by Achmea (€22.3 billion, 18.75%) and its subsidiary Zilveren Kruis (€15.6 billion, 13.11%).
- Most companies have significant investments in sustainable initiatives, with Achmea and its subsidiary Zilveren Kruis investing €55 million in climate infrastructure, while Nationale-Nederlanden has the largest green investment at €10.752 billion.
- Operating income varies widely, with Nationale-Nederlanden having the highest (€1.9 billion), and companies like CZ Group and VGZ having lower operating incomes despite large client bases.
- Figure 43 on the left illustrates the estimated market share, highlighting the top 3 companies: Nationale-Nederlanden as the market leader with 19%, followed by Achmea at 18% and Zilveren Kruis at 14%.

⁵ The market share estimates presented in this analysis are derived from the 2023 annual reports of the ten major insurance companies operating in the Netherlands. While this study focuses on these leading firms, it's important to recognize that there are other insurance providers in the Dutch market. The ten companies were selected to offer a comprehensive overview of market dynamics and their respective shares. However, the overall market share of these companies may vary if additional insurers were included in the analysis. Therefore, the market share percentages provided here are approximate, based on factors such as total revenue and operating income as reported by the companies. These figures are indicative and should be interpreted within the context of this study.

4.2.2.3 Analysis of insurance products/services

The Netherlands has been proactive in implementing green infrastructure solutions, such as green roofs, to enhance urban sustainability and address environmental challenges. Dutch insurance companies offer policies that address the unique risks and maintenance needs of green roofs, providing property owners with comprehensive coverage that includes structural protection, maintenance, and fire insurance.

a. Comprehensive coverage

Insurance policies for green roofs in the Netherlands typically encompass coverage for structural damage caused by severe weather, water infiltration, fire risks, and vegetation health. These policies often include regular maintenance services such as inspections, plant replacement, and pest control, ensuring that the green roof remains functional and sustainable over time (ING, 2022; Interpolis, 2022; NN Group, 2022). Replacement policies provide financial protection against unforeseen damage caused by natural disasters, vandalism, or wear and tear, allowing property owners to maintain the economic and environmental benefits of their green roofs (Foster et al., 2011).

b. Incentives and financial support

The Dutch government provides substantial support for green roofs through financial incentives, including subsidies and tax benefits. Municipalities often offer subsidies ranging from €10 to €30 per square meter, depending on the extent of green coverage (Liberalesso et al., 2020). The "Green Deal" initiative is another program that promotes green infrastructure by offsetting installation costs and encouraging urban sustainability (Bubalo et al., 2015).

c. Sustainability and risk management

To improve resilience and longevity, insurance companies in the Netherlands are integrating sustainability measures into their green roof policies. This includes promoting the use of native plants, implementing efficient irrigation systems, and even integrating renewable energy solutions where possible. These practices not only enhance the performance of green roofs but also contribute to broader environmental sustainability (Mihalakakou et al., 2023; Wijnberg, 2021).

d. Market overview

Major Dutch insurance companies are increasingly offering comprehensive green roof coverage within broader property insurance plans. These policies are designed to cover the unique risks and maintenance needs of green roofs, ensuring they remain viable long-term investments for property owners (Prins, 2021; Aegon, 2022). While not every company explicitly highlights green roofs in their annual reports, they are adapting their products to meet the growing demand for sustainable infrastructure.

Many major insurance companies in the Netherlands have expanded their solutions to include comprehensive coverage for green roofs. **Table 14** below provides specific examples from the aforementioned major insurance companies, taken from their respective 2023 annual reports.

Table 14 Overview of Sustainability Initiatives and Green Roof Coverage in Major Dutch Insurance Companies (2023)

Insurance company		Focus on Sustainability and Climate Adaptation	Green Roof Coverage	Key Sustainability Initiatives
	Achmea	Strong focus on climate adaptation, providing coverage for weather-related risks (e.g., floods, hail, thunderstorms) and offering advice on preventive measures.	Promotes green roofs indirectly by encouraging installation to mitigate hail and heavy rainfall risks.	Climate resilience, weather-related risk coverage, and promoting green infrastructure.
	Nationale-Nederlanden	Addresses climate risks (e.g., floods, storms) through property insurance and uses catastrophe models to assess and price risks related to extreme weather events.	Green roofs are indirectly supported through broader climate resilience insurance products.	Catastrophe risk modeling, climate change-related risk mitigation in property insurance
	Aegon	Focuses on climate-related risks in property insurance, adapting to climate change through broader risk management practices.	No explicit mention of green roofs, but climate resilience policies likely support such measures indirectly.	Climate change adaptation, broad risk management practices for extreme weather events.
	ASR Nederland	Promotes sustainability and climate adaptation through its insurance products, supporting environmentally friendly infrastructure.	No specific mention of green roofs, but products support sustainable practices.	Commitment to climate resilience and sustainability in property insurance.
	VGZ	Focuses primarily on health insurance, with limited involvement in property insurance and green roof coverage.	No direct green roof coverage, but broader sustainability initiatives support environmental awareness.	General environmental awareness and preventive health measures aligned with green infrastructure goals
	CZ Group	Primarily a health insurer, with no direct focus on property or green roof coverage.	No green roof coverage, but broader sustainability initiatives may indirectly support green infrastructure.	Sustainability commitment in health insurance, promoting environmental responsibility

D1.4 Focused market reviews in WP3 pilot areas

	Menzis	Primarily a health insurer, with no direct property insurance solutions related to green roofs.	No green roof coverage, but broader environmental responsibility initiatives may support green infrastructure indirectly.	Sustainability efforts focused on environmental and public health responsibility
	Univé	Committed to climate adaptation in property insurance, recognizing risks associated with extreme weather events and focusing on damage prevention.	No specific mention of green roofs, but policies support climate resilience and green infrastructure indirectly.	Preventing damage from extreme weather, focus on climate adaptation and risk management in property insurance.
	Zilveren Kruis	Part of Achmea, shares the broader focus on climate adaptation and promoting sustainability in property insurance.	Likely follows Achmea's approach in promoting green roofs as part of climate resilience strategy.	Climate resilience and sustainability in insurance, likely support for green infrastructure similar to Achmea.
	Reaal	Focuses on sustainability and climate resilience through property insurance solutions, addressing risks posed by climate change.	No explicit mention of green roofs, but the general focus on sustainability suggests indirect support for green roofs.	Sustainability and climate resilience in property insurance, likely support for environmentally friendly infrastructure.

4.2.2.4 Analysis of innovative insurance solutions and Nature-based solutions

The Netherlands has become a hub for innovative insurance solutions that integrate nature-based approaches to address climate change and enhance environmental resilience. Various Dutch insurance companies are leading the way in offering comprehensive policies that not only protect assets but also promote sustainability, as seen from the sections above.

a. Parametric insurance solutions

Similarly to France, parametric insurance solutions are on the rise in the Netherlands. Companies like Marsh McLennan are pioneering parametric insurance, which provides coverage based on predefined triggers, such as weather events. This type of insurance is particularly beneficial for covering risks associated with climate change, including extreme heat and flooding. Parametric solutions offer a cost-effective way to provide coverage for risks that are typically uninsurable under traditional models, thereby closing protection gaps for vulnerable communities (Marsh McLennan, 2023). Additionally, parametric policies provide quicker payouts and reduce administrative burdens, making them particularly suitable for green roofs affected by weather events like heavy rainfall or droughts (Veerkamp et al., 2021).

b. Nature-based insurance

Insurers are increasingly recognizing the value of Nature-based solutions (NbS) in mitigating environmental risks. For example, projects that restore and protect natural ecosystems such as wetlands, forests, and mangroves can significantly reduce the impact of climate extremes. These natural buffers can help limit flood damage, reduce wildfire risks, and even mitigate the effects of heatwaves. Insurance products in the Netherlands are therefore being developed to support and incentivize investments in these NbS, reflecting a shift towards sustainability and resilience in the insurance sector (Swiss Re, 2023).

Innovative insurance products are also focusing on the broader ecosystem services provided by green roofs. These policies incentivize property owners to maintain high biodiversity levels and implement sustainable management practices. By aligning financial incentives with ecological outcomes, these insurance products promote practices that enhance ecosystem resilience and reduce environmental risks (Calliari et al., 2022).

c. Innovative policies and incentives

Insurance policies in the Netherlands are increasingly offering comprehensive coverage for green roofs, addressing risks such as structural damage, water infiltration, and vegetation health. These policies often come with incentives for sustainable practices.

For instance, policies may offer discounts for using native plants and efficient irrigation systems, which enhance the ecological benefits of green roofs. This approach not only mitigates risks but also promotes sustainability (Toxopeus & Polzin, 2021). Additionally, the Dutch government provides subsidies for the installation of green roofs, which are contingent on the minimum area covered. Cities like Groningen, Hengelo, and Leeuwarden have specific requirements ranging from 6 to 30 square meters to qualify for these subsidies (Liberalesso et al., 2020). These financial incentives are crucial in encouraging the adoption of green roofs.

As mentioned in the sections above, Dutch private insurers are also incorporating green infrastructure into their policies. Achmea and Nationale-Nederlanden (NN Group), for instance, offer comprehensive coverage for green roofs, including installation, maintenance, and repair. These companies also provide financial incentives to encourage the adoption of sustainable

practices, aligning with broader environmental goals such as significant reductions in carbon emissions by 2030.

d. Technological integration

The adoption of advanced technologies is also driving innovation in the insurance sector. For example, the use of weather data and risk modelling tools allows insurers to better assess and price the risks associated with climate change.

This technological integration supports the development of more accurate and efficient insurance products that can adapt to the evolving environmental landscape.

Subsequently, Table 15 below provides a comprehensive comparison of the insurance products, maintenance provisions, and NBS involvement/special incentives for eco-friendly and sustainable practices offered by major insurance companies in the Netherlands, as detailed in their 2023 annual reports and their respective websites.

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Table 15 Comparative Analysis of Insurance Companies in the Netherlands Covering Green Roofs and Offering Special Incentives for Eco-Friendly and Sustainable Practices (2023)

Insurance company	Details on NBS involvement	Coverage features	Special incentives/climate change policies
 Achmea	Invests in climate resilience and green projects, including green roofs.	Coverage for weather damage, flooding due to non-primary flood defenses	Climate resilience support, advice on preventive measures, 40% reduction in carbon emissions by 2030
 Nationale-Nederlanden	Significant investments in climate solutions and green buildings.	Coverage for weather-related risks, including floods and severe storms	Use of catastrophe models to assess risks related to extreme weather, alignment with climate resilience strategies
 Aegon	Focuses on sustainability and climate resilience, though specific.	General climate-related risk coverage, indirect support for green roofs	Focus on climate adaptation in risk management practices
 ASR Nederland	Emphasizes sustainability in investments, with efforts to promote ecological resilience.	General sustainability-focused property insurance, indirect support for green infrastructure	Commitment to sustainability and climate resilience
 VGZ	Indirectly supports environmental health and climate resilience.	Not applicable (health insurer)	Broader sustainability initiatives, indirect support for climate resilience
 CZ Group	Indirect contribution to green initiatives through sustainability efforts.	Not applicable (health insurer)	Broader sustainability initiatives, indirect support for climate resilience
 Menzis	Indirectly supports climate resilience through broader sustainability goals.	Not applicable (health insurer)	Broader sustainability initiatives, indirect support for climate resilience
 Univé	Engaged in promoting climate resilience through property insurance.	Coverage for weather-related risks, indirect support for green infrastructure	Focus on preventing damage from climate-related risks
 Zilveren Kruis (part of Achmea)	Aligns with Achmea's green initiatives, likely supporting NBS.	Likely shares Achmea's features (weather damage, flooding due to non-primary flood defenses)	Aligned with Achmea's climate resilience and sustainability policies
 Reaal (part of VIVAT)	General sustainability efforts, no specific NBS projects detailed.	General sustainability-focused property insurance, indirect support for green infrastructure	Emphasis on sustainability and climate resilience

4.2.2.5 NBS case studies

Case Study 1: Sand Motor Project



The Sand Motor, located along the coast of The Hague's Kijkduin, is a prime example of using natural processes to maintain the coastline. This project uses a large volume of offshore sand that is distributed naturally by wind, waves, and tides, reducing flood risks and creating new habitats. The project involved collaboration between the Dutch government, private sector, and insurance companies, demonstrating a sustainable and cost-effective approach to coastal protection (World Bank, 2023).

Case Study 2: Marker Wadden



The Marker Wadden project aims to enhance biodiversity and improve water quality in Marker Lake. It involves the creation of artificial islands using dredged sediment, which supports ecosystem restoration and recreational opportunities. The project was financed through a unique collaboration between an NGO, private sector, and local governments, with insurance companies providing coverage for the construction and maintenance of the islands. This project showcases the multi-stakeholder approach and innovative financing mechanisms (World Bank, 2023).

Case Study 3: Room for the River Program



The city of Noordwaard implemented the "Room for the River" program to reduce flood risks by allowing more space for rivers to overflow safely. This approach includes relocating dikes and creating floodplains. The project involved multiple stakeholders, including insurance companies, which provided coverage for property and infrastructure modifications. This project highlights the importance of integrating insurance products with large-scale NBS initiatives to enhance urban resilience (World Bank, 2023).

Case Study 4: Building with Nature in the IJsselmeer Region



This project focuses on using natural materials and processes to strengthen dikes and create resilient coastlines in the IJsselmeer region. By integrating natural elements like reeds and willow mats, the project improves flood protection while enhancing biodiversity. Insurance companies played a crucial role by offering policies that cover the innovative construction methods and long-term maintenance of the nature-based structures. This collaboration underscores the role of insurance in supporting sustainable infrastructure (HKV, 2023).

The four case studies from the Netherlands demonstrate the transformative potential of Nature-based solutions (NBS) in enhancing environmental resilience and mitigating climate risks. While these projects have already shown significant benefits, the involvement of insurance companies in the future could further amplify these advantages. By offering tailored insurance products, companies can support the implementation, maintenance, and sustainability of NBS projects, providing financial backing and risk management.

The Sand Motor project, for example, benefits from natural coastal protection processes. Future insurance coverage could support ongoing maintenance and adaptation, ensuring long-term coastal resilience. Similarly, the Marker Wadden project enhances biodiversity and water quality through ecosystem restoration. Insurance companies can facilitate such projects by covering potential environmental and construction risks, thereby encouraging further investment and innovation. The Room for the River program's large-scale infrastructural adjustments to manage flood risks highlight the need for adaptable insurance policies. Insurance coverage could mitigate financial risks associated with property and infrastructure modifications, encouraging broader adoption of such flood management strategies. Lastly, Building with Nature in the IJsselmeer Region uses natural materials to strengthen flood defences. Insurance support for these innovative methods could enhance resilience and attract investment in sustainable infrastructure.

Similar to France and other European countries, the integration of NBS with innovative insurance solutions in the Netherlands is essential for building resilient and adaptive communities. Insurance companies have the potential to play an important role in this transition by developing products that support sustainable practices and provide financial security for NBS projects. This involvement will not only reduce financial risks but also promote the adoption of NBS, ensuring long-term ecological and economic benefits.

4.2.2.6 Challenges, future trends and opportunities

a. Challenges in the Dutch green roofs sector

Similar to France and other European countries, the adoption of green roofs in the Netherlands still faces several challenges, including high initial installation costs, maintenance complexities, and a lack of awareness among property owners. The upfront costs of installing green roofs can be a significant barrier, especially for private homeowners and smaller businesses. Maintenance of green roofs, which includes ensuring proper drainage, preventing root damage, and managing vegetation, requires specific expertise that may not be readily available or affordable for all property owners. Additionally, there is a general lack of awareness about the benefits of green roofs and the long-term cost savings they can provide through energy efficiency and increased property value (Wageningen University and Research, 2023; Mendonça et al., 2023).

b. Future trends in the Dutch green roofs and insurance sector

That being said, the future of green roof insurance in the Netherlands looks promising as insurers increasingly recognize the benefits of integrating Nature-based solutions (NBS) into their product solutions. Insurance companies can develop specialized policies that cover the unique risks associated with green roofs, such as plant health, structural integrity, and water leakage. These policies can also offer incentives for installing and maintaining green roofs, thereby encouraging more property owners to adopt these sustainable practices. For example, parametric insurance solutions that provide coverage based on predefined triggers like rainfall levels can be particularly effective in managing the risks associated with green roofs (RESILIO, 2023).

Moreover, innovative insurance solutions are emerging to address the specific needs of green roof installations. One such example is the development of smart blue-green roofs, which incorporate advanced technologies like sensors and remote-controlled valves to manage water storage and release based on real-time weather conditions. This not only enhances the functionality of green roofs but also provides additional protection against extreme weather events. The integration of such technologies into insurance products can offer comprehensive coverage and support for green roof maintenance and optimization (RESILIO, 2023).

c. Opportunities in the Dutch green roofs and insurance sector

When it comes to integrating NBS solutions into Dutch insurance products, the latter can offer numerous benefits, including enhanced urban resilience, reduced risk of property damage from extreme weather events, and promotion of biodiversity. As seen from the case studies above, insurance companies that provide coverage for NBS projects can help mitigate the financial risks associated with climate change while promoting sustainable urban development. (Wageningen University and Research, 2023).

In conclusion, the integration of green roofs and other NBS into the Dutch insurance market represents a significant opportunity to enhance environmental resilience and promote sustainable urban development. While challenges remain, the future trends and emerging innovative insurance solutions indicate a positive trajectory towards wider adoption. Insurance companies have a critical role to play in this transition by offering tailored products that address the unique risks and benefits of green roofs, ultimately contributing to a more resilient and sustainable future for urban areas in the Netherlands.

4.3 Forestry

4.3.1 Portugal

4.3.1.1 Current state of the forestry market in Portugal

Portugal's forestry sector plays a significant role in the national economy, contributing approximately 2.5% to the GDP, one of the highest in the European Union, surpassed only by Finland and Sweden (ClimateChangePost, n.d.). Forests cover about 35% of Portugal's land area, amounting to 3.2 million hectares, which includes broadleaved, coniferous, and mixed forests, predominantly in central and southwestern regions (SA Forestry Online, 2017). This constitutes a significant portion of the country's land use, as illustrated in Figure 44.

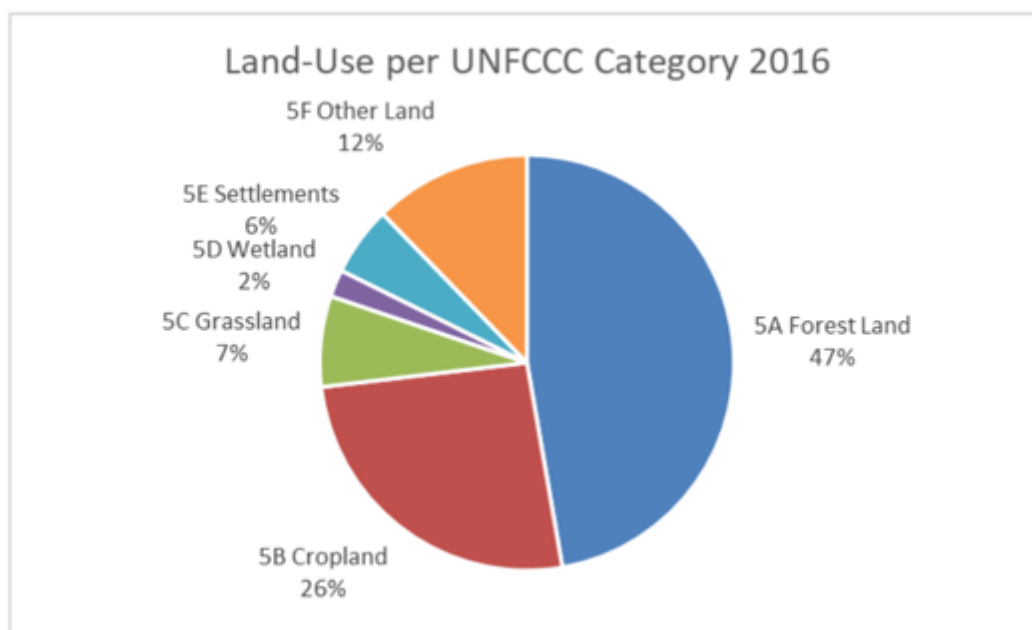


Figure 44 Land use per UNFCCC category

(Agencia Portuguesa Do Ambiente, 2020)

Portuguese forests are dominated by three main tree species: cork oak (*Quercus suber*), maritime pine (*Pinus pinaster*), and eucalyptus (*Eucalyptus globulus*) (Cruz, Ramos, Barata, & Ferreira, 2021). These species are extensively cultivated due to their economic value, particularly in the cork, paper, and timber industries. Cork oak forests cover around 720,000 hectares, maritime pine around 714,000 hectares, and eucalyptus approximately 844,000 hectares (Cruz, Ramos, Barata, & Ferreira, 2021).

The Forest Intervention Zones (ZIF), established by Decree-Law no. 127/2005 on August 5th, serve as a mechanism for the collective management of forest areas. The highly fragmented nature of land ownership, characterized by numerous small plots, has posed significant challenges to the socioeconomic development and competitiveness of the forestry sector. ZIFs aim to promote the sustainable management of forest areas by consolidating these small plots under unified management. This consolidation enables more effective planning and forest management, optimizing the productive potential while mitigating risks associated with fires and pests (Viegas, Batista, & Cordovil, 2023).

As of the end of 2021, there were 262 ZIFs in existence, covering approximately 1.856 million hectares, according to data from the Institute for Nature Conservation and Forests (ICNF), as shown in **Figure 45** on the right. These ZIFs are managed by 86 different entities and include over 29,000 members. It is important to note that the ZIFs currently cover a relatively small portion of the territory and are predominantly concentrated in the Alentejo and Ribatejo regions in central and southern Portugal. There is also a notable concentration in the central-north region, particularly in the western part of the Serra da Estrela (Viegas, Batista, & Cordovil, 2023).

This reorganization into ZIFs not only facilitates more effective forest management but also helps in addressing the challenges posed by fragmented land ownership, contributing to enhanced forest productivity and reduced risks from natural threats (Viegas, Batista, & Cordovil, 2023).



Figure 45 Distribution of Forest Intervention Zones

Source: ICNF, 2021

Forest ownership in Portugal is unique in the European context. Approximately 92% of forest land is privately owned, with only about 3% owned by public entities. The remaining forest land is integrated into community property, known as "Baldios" (Dias et al., 2023). This distribution presents challenges and opportunities for forest management, as private owners often have diverse objectives and resources for forest management. That being said, the public sector owns forests primarily managed by the state, while private ownership includes individual landowners, companies, and institutions such as The Navigator Company, which is a leading private sector forestry operator managing approximately 106 thousand hectares of woodlands (The Navigator Company, n.d.).

Portugal's forests are diverse, comprising mainly of pine, eucalyptus, and cork oak species. The growing stock of forests in Portugal has been increasing due to afforestation efforts and improved forest management practices. According to the National Forestry Inventory, the growing stock is estimated to be over 120 million cubic meters, with an annual increment of approximately 3.5 million cubic meters (UNECE, 2021). This positive trend contributes to the sustainability of forest resources and the country's carbon sequestration goals.

Forest management in Portugal is governed by a comprehensive framework of policies and regulations aimed at promoting sustainable forest practices. The National Forest Strategy outlines key objectives, including the conservation of biodiversity, enhancement of forest resilience, and promotion of forest-based economic activities (Silva Lusitana, 2021). Additionally, the Forest Management Plans (PGF) are mandatory for forest owners, ensuring that management practices align with national sustainability goals.

Challenges in forest management in Portugal are significant, with approximately 80% of the forests being unmanaged, which heightens their susceptibility to damage from fires, insects, and diseases. Contributing factors to this lack of management include inadequate silviculture practices, aggressive natural revegetation of abandoned agricultural plots, and insufficient economic incentives for biomass removal. Additionally, the fragmented nature of land ownership, characterized by numerous small and often neglected parcels, further complicates effective forest management (Beighley & Hyde, 2018).

Portuguese forests provide a wide range of ecological and economic benefits. Ecologically, forests contribute to biodiversity conservation, soil protection, and water regulation. Economically, they are a source of raw materials for the pulp and paper industry, cork production, and biomass energy. The forestry sector also supports rural development by providing employment opportunities and contributing to the local economy (PEFC, 2021).

This forestry sector supports diverse economic activities, including cork, timber, furniture and construction and pulp and paper production. The estimated total economic value of forest ecosystems in Portugal, which includes both market services (such as timber and non-timber products) and non-market services (like recreation, carbon sequestration, watershed protection, and biodiversity conservation), is approximately one billion euros. Notably, at least half of this economic value is derived from non-market ecosystem services (Beighley & Hyde, 2018).

Nonetheless, these functions are threatened by climate change and its effects on ecosystems. Because of Portugal's Mediterranean climate, characterized by very hot and dry summers followed by cold and rainy winters, the country faces a high risk of forest fires. Besides extreme weather, the demographic shift from rural to urban areas, leaving forested regions unattended, significantly increases the risk of wildfires (Beighley & Hyde, 2018).

Thus, the combination of weather conditions and human activities results in frequent and severe wildfire events. These fires not only damage the commercial value of timber but also entail significant costs for firefighting efforts and environmental rehabilitation (Pinheiro & Ribeiro, 2013).

Further statistics indicate that Portugal is one of the countries most affected by wildfires in Europe (Bergonse, et al., 2021), with an average of 80,000 hectares burned annually, except for a significant outlier in 2017, as shown in **Figure 46** below. (Statista, 2024).

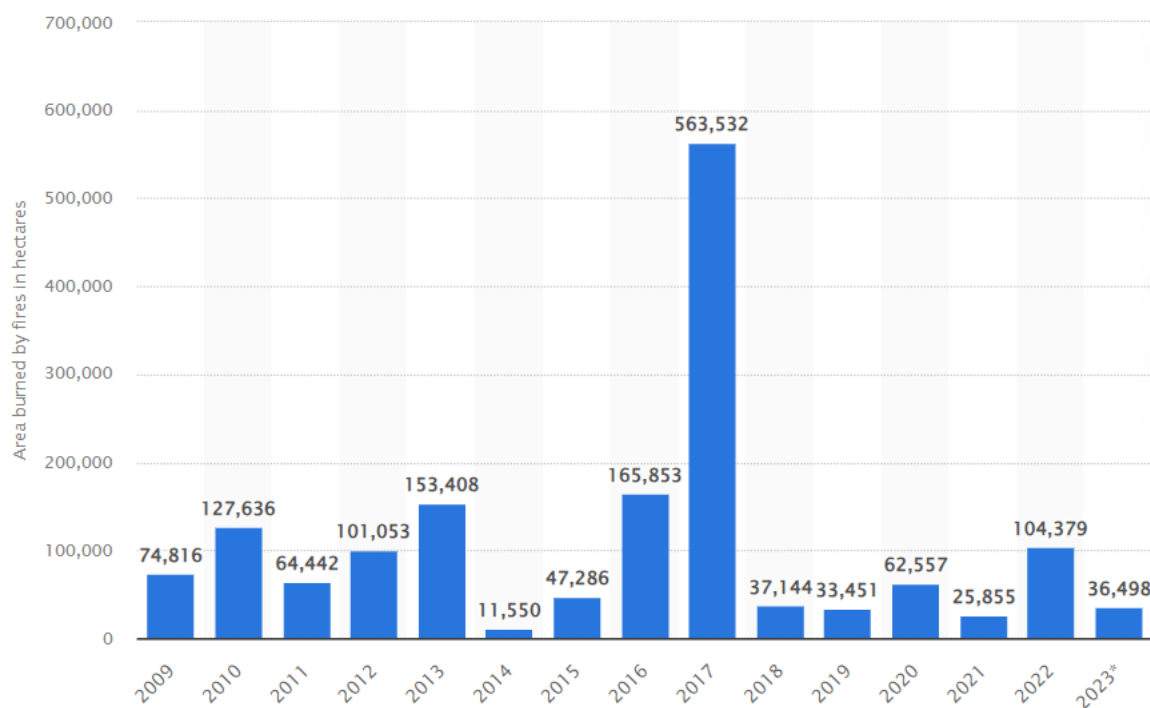


Figure 46 Area burned by wildfires in Portugal from 2009 – 2023

(Statista, 2024)

4.3.1.2 Current state of the forestry insurance market in Portugal

The insurance market in Portugal is well-regulated, with a strong framework overseen by the Autoridade de Supervisão de Seguros e Fundos de Pensões (ASF), the Portuguese Insurance and Pension Funds Supervisory Authority. The ASF ensures the stability and proper functioning of the insurance market, focusing on consumer protection and market integrity (ASF, n.d.). The market comprises various types of insurance, including life, health, property, and casualty insurance, provided by both domestic and international companies. Major players in the Portuguese insurance market include Fidelidade, Ageas, and Allianz, among others, which offer comprehensive insurance products to meet diverse consumer needs (Fidelidade, n.d.; Ageas, n.d.; Allianz, n.d.).

a. Insurance penetration for forest assets in Portugal

Forest insurance in Portugal involves both private and public entities. However, the market for forest insurance is underdeveloped, with limited participation from insurance companies. The primary coverage offered is against wildfires, which pose the most significant risk to forested areas in the country. However, insurance penetration remains low due to several challenges, including the high cost of premiums, the lack of mandatory insurance, and difficulties in assessing the true value of forest assets due to variability in species, stand age, and market prices. Recent studies highlight the need for better models to estimate 'fair' insurance premiums to make forest insurance more attractive to forest owners. These models need to incorporate various risk factors, including the frequency and severity of wildfires, to determine more accurate premiums and payout structures (Brunette & Couture, 2023).

Additionally, many insurers are reluctant to offer forest fire insurance due to the high risks and difficulties in accurately assessing the value of forest stands and the probability of fire occurrences (Pinheiro & Ribeiro, 2013) (The Portugal News, 2023). However, Portugal is not the only country with low uptake of forestry insurance coverage. Studies indicate that, on average, the amount people are willing to pay for forestry insurance premiums, around \$3.20 per \$1,000 of standing timber value, falls significantly short of current premium rates. (Deng, Munn, Coble, & YAO, 2015).

As a summary, the underdevelopment of the Portuguese forestry insurance market can be attributed to several factors (Pinheiro & Ribeiro, 2013):

1. **High Risk and Costs:** The high risk of forest fires in the Mediterranean climate leads to high insurance premiums, making it unaffordable for many forest owners.
2. **Lack of Mandatory Insurance:** Unlike other forms of insurance, forest fire insurance is not mandatory in Portugal, leading to high insurance premiums and low uptake among forest owners.
3. **Limited Insurance Provider Participation:** Few insurance companies are willing to offer forest fire insurance due to the complexities in risk assessment and valuation of forest properties.
4. **Insufficient Data and Models:** Accurate models to estimate the probability of fire occurrences and the value of forest stands are lacking, making it difficult for insurers to set fair premiums.

That being said, **Figure 47** below provides an overview of wildfire losses insurance between countries who have higher risk of wildfires, with Portugal only being insured for 10% of its wildfire losses (OECD, 2021).

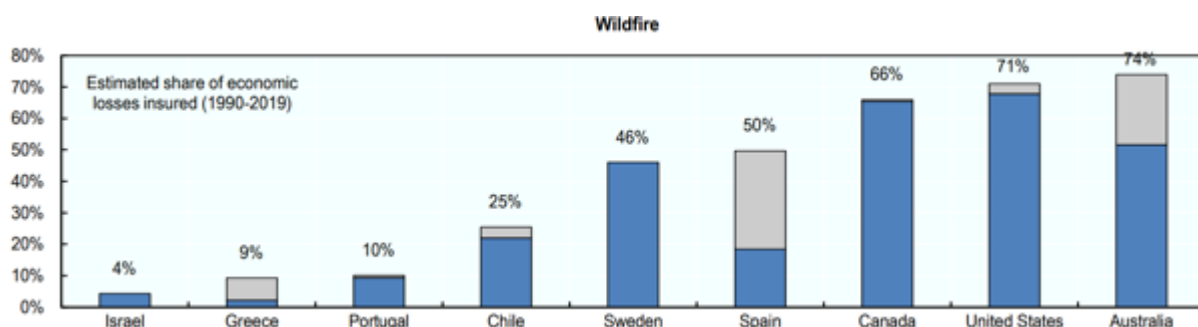


Figure 47 the aggregate share of all economic losses insured (1990-2019) (OECD, 2021)

The management and conservation of forests are guided by a comprehensive set of policies from both the Ministry of Agriculture and Forestry and the Ministry of Environment. These policies are designed to ensure the sustainable use of forest resources while preserving biodiversity and protecting ecosystems. One of the key elements of these efforts is the provision of public financial support aimed at mitigating risks and enhancing forest resilience. Specifically, more than EUR 61.6 million has been allocated by the European Commission in 2024 alone to restore forestry potential following natural disasters, such as forest fires and storms. This funding supports critical initiatives like fire prevention, reforestation, and the rehabilitation of degraded forest areas (European Commission, 2024).

Despite these investments, significant challenges remain in making forestry insurance schemes more affordable and accessible. Current insurance models are often costly, which limits their adoption among small-scale forest owners and operators. This gap in insurance coverage leaves many forested areas vulnerable to financial losses from natural disasters, undermining the broader goals of forest conservation and sustainable management. Addressing these challenges requires a coordinated approach, combining policy reforms, financial incentives, and public-private partnerships to develop more inclusive and cost-effective insurance solutions for the forestry sector (Pinheiro & Ribeiro, 2013).

b. Existing models on forest adaptation measures

Forest adaptation models in Portugal are becoming increasingly critical due to the rising threats from climate change, particularly in terms of shifting bioclimatic zones and increasing wildfire frequency. Current models focus on adapting forest management practices to maintain ecological and economic sustainability. These models incorporate various strategies such as selecting tree species that are more resilient to changing climate conditions, implementing mixed-species plantations, and modifying silvicultural practices to reduce fire risk. Additionally, there is a growing emphasis on integrating forest management with broader landscape-level planning to enhance resilience against climate-induced disturbances (Freitas et al., 2022).

c. Public wildfire adaptation measures

Public wildfire adaptation measures in Portugal have evolved significantly over the years, particularly in response to the devastating wildfires that have occurred frequently. The government has implemented a range of measures, including the establishment of firebreaks, controlled burns, and the creation of fire-adapted landscapes. Additionally, there are efforts to enhance community-based fire management practices, where local communities are involved in maintaining and monitoring fire-prone areas. These measures are supported by advanced remote sensing tools and data analysis to monitor vegetation cover and assess fire risks effectively (Alegria, 2023).

d. Subsidies and incentives for wildfire insurance for households

The Portuguese government offers various subsidies and incentives to encourage households to protect themselves against wildfire risks. These include financial support for installing fire-resistant materials in homes, tax incentives for purchasing fire insurance, and grants for participating in community-based fire prevention programs. Additionally, the government provides post-disaster assistance to households affected by wildfires, including funding for rebuilding and recovery efforts. These measures are part of a broader strategy to increase resilience at the household level, particularly in rural areas that are more vulnerable to wildfires (Alegria, 2022).

e. Tools, data sources, and ground truth for detecting forest damage in Portugal

In Portugal, detecting and monitoring forest damage caused by bark beetle infestations, wildfires, and windthrow relies on a combination of remote sensing technologies and ground-based data collection. High-resolution orthophotos and satellite imagery, such as those provided by Sentinel-2, are used to monitor forest health and detect early signs of infestations or damage. These tools enable the creation of detailed risk maps that support targeted interventions. Advanced machine learning models, such as convolutional neural networks, are increasingly used to analyse this data and predict the spread of infestations, enhancing early detection capabilities (Morais et al., 2023).

Ground truth data plays a crucial role in validating these remote sensing and model-based assessments. Collected through field surveys, this data helps calibrate and improve the accuracy of predictive models for various types of forest damage, including those caused by wildfires, windthrow, and bark beetles. In Portugal, ground truth data is gathered by governmental agencies, research institutions, and local communities. It serves as a vital tool for improving forest management strategies and ensuring the precision of interventions (Alegria, 2023).

Moreover, **Table 16** below provides a detailed overview of recent studies that have explored various aspects of wildfire, windthrow, and bark beetle damage in forests, specifically focusing on ground truth data collected in Portugal or similar climates.

Table 16 Comprehensive summary of recent research results related to ground truth data for wildfire, windthrow, and bark beetle damage in Portugal

Study	Topic	Results	Conclusion for Market Review
Candotti et al., 2022	Sentinel-2 based multi-temporal monitoring framework for wind and bark beetle detection and damage mapping.	The study implemented a monitoring framework using Sentinel-2 ⁶ data (2017-2020) with a mean overall accuracy of 89%. The framework was successful in distinguishing stressed stands, bark beetle-attacked canopies, and wind-felled patches. The framework proved useful for large-scale monitoring of forest health and could support the development of strategies to manage massive bark beetle outbreaks.	The use of Sentinel-2 data is effective for monitoring forest health at a regional scale and can significantly aid in managing bark beetle outbreaks. This approach can inform market strategies for forest insurance and management, emphasizing the importance of early detection in minimizing economic losses.
Alegria, 2023	Aboveground biomass mapping and fire potential severity assessment.	The study used Sentinel-2 imagery and NBR for assessing burn severity levels. The NDVI annual curve differentiated eucalypts from shrubland areas with an R ² of 0.76-0.77. The study provided relevant decision support tools for forest management, particularly in fire-prone regions.	The findings emphasize the critical role of remote sensing in forest management and the need for accurate ground truth data to enhance decision-making processes. The data support the market's need for precise fire risk assessment tools, which could be integrated into insurance models to better evaluate and mitigate wildfire risks.
Bárta et al., 2021	Early detection of bark beetle infestation in Norway spruce forests.	The study achieved 96% classification accuracy in detecting bark beetle infestation using Sentinel-2 data. The tasselled cap wetness (TCW) and NDVI indices were most effective in identifying early-stage infestations. The method was validated with field observations and proved to be a reliable tool for early detection of bark beetle infestations.	Early detection of bark beetle infestations is crucial for minimizing damage. The study highlights the importance of using spectral indices like TCW and NDVI in conjunction with ground truth data for early detection. Market assessment suggests that investing in early detection technologies could significantly reduce losses from bark beetle infestations, making it a viable area for investment and development in the forestry sector.

⁶ Sentinel-2 is a satellite mission developed by the European Space Agency (ESA) as part of the Copernicus program. It consists of a pair of Earth observation satellites, Sentinel-2A and Sentinel-2B, which provide high-resolution optical imagery of the Earth's surface. Sentinel-2 captures data in multiple spectral bands, including visible, near-infrared, and shortwave infrared wavelengths, making it particularly useful for monitoring vegetation, land cover changes, and environmental conditions. Its data is widely used in agriculture, forestry, and disaster management applications.

Rodman et al., 2021	Effects of bark beetle outbreaks on forest landscape pattern.	The study found that 39.5% of the Southern Rocky Mountains' subalpine forest area was affected by bark beetles, with 19.3% experiencing $\geq 70\%$ tree mortality. The RF models using LTS products predicted presence and severity with 80.3% accuracy and $R^2 = 0.68$. The study also observed that areas with high tree mortality were relatively small and isolated, indicating a patchy distribution of severe outbreaks.	The results suggest that bark beetle outbreaks lead to highly localized but severe forest damage. This indicates the need for targeted management interventions rather than blanket policies. For the market, this underscores the potential for developing localized insurance products and management services tailored to high-risk areas, offering targeted protection and mitigation strategies against bark beetle damage.
Nardi et al., 2022	Impact of wind disturbances on ongoing spruce bark beetle outbreaks.	The study found that wind-felled trees served as a hidden sink for bark beetle populations, leading to massive attacks on standing trees in subsequent years. The interaction between wind disturbances and bark beetle outbreaks led to a significant increase in tree mortality in the years following the windstorm.	The findings highlight the complex interactions between wind disturbances and bark beetle outbreaks, suggesting that windthrow areas require special attention in forest management. For the market, this indicates the potential for developing comprehensive management strategies that address both wind and bark beetle risks, potentially reducing the long-term impact on forest resources and associated economic losses.
Safonova et al., 2022	Detection of Norway spruce trees infested by bark beetle using UAV(Unmanned Aerial Vehicle) images and YOLO ⁷ architectures.	The study compared YOLOv2, YOLOv3, and YOLOv4 architectures for detecting bark beetle-infested trees using UAV images. YOLOv4 achieved the best results with a mean average precision of 95%. The application of artificial data augmentation improved model performance, highlighting the effectiveness of UAV-based detection methods for early-stage infestations.	The results suggest that UAV imagery combined with YOLO architectures is highly effective for early detection of bark beetle infestations. The market assessment indicates strong potential for deploying such technologies in forest management practices, particularly for large-scale monitoring and rapid response to infestations, thereby reducing potential economic losses from bark beetle outbreaks.

⁷ YOLO (You Only Look Once) is a type of deep learning algorithm used for object detection. Unlike traditional methods that require multiple passes through an image to detect objects, YOLO processes the entire image in a single pass, making it both fast and efficient. It divides the image into a grid and predicts bounding boxes and probabilities for each object within those boxes. YOLO is particularly well-suited for real-time detection tasks, such as identifying objects in images captured by drones or surveillance cameras.

Based on the information provided in the sections above, Figure 48 below provides a summary of the measures for forest risk management and adaptation within the Portuguese context.



Figure 48 Summary of Comprehensive Measures for Forest Risk Management and Adaptation in Portugal

f. Estimating market share of major insurance companies in Portugal

Based on the annual reports for the year 2023, LGI conducted a comprehensive analysis of the key financial metrics, market presence, and green investments for each of 10 major insurance companies in the Portuguese insurance sector. **Table 17** below presents the results of the market share analysis⁸.

Table 17 Estimating Market Share of Major Insurance Companies in Portugal in 2023

Insurance company	Total revenue (Billion €)	Operating Income (Billion €)	Client Base (Million)	Green Investments	Estimated Market Share (%) (Individual market revenue/Total market revenue x 100)
 Fidelidade	3.43	0.0836	2.3	Green Bonds, Sustainable Investments and Sustainable Real Estate	26.4
 Ageas Seguros	1.9	1.166	1.8	€13.2 billion in sustainable assets	14.6
 Allianz Portugal	1.9	Not found*	1.3	Similar to the group insurance group as a whole	14.6
 Ocidental Seguros	1.3	Not found*	1.2	€691.9 million in green bonds and €67 million in sustainable infrastructure.	10.0
 Generali Tranquilidade	1.2	0.204	1.9	promoting sustainability among small and medium-sized enterprises	9.2
 Montepio Seguros	1.13	0.223	0.605	sustainable financial investments and responsible investment practices	8.7
 Generali Seguros	0.9	Not found*	2	Generali Group: €9.5 billion for green and sustainable investments by 2025	6.9
 Zurich Portugal	0.8	Not found*	1	USD 7.9 billion investments in Green Bonds and Sustainability Projects	6.2
 Mapfre Seguros	0.233	0.411	0.600	investments related to renewable energy and sustainable mobility.	1.8
 Lusitania Seguros	0.2	Not found*	0.500	€500 million in sustainable investments	1.5

Source: Allianz Group *Annual Report 2023* – Ageas *Annual Report 2023* - Montepio Seguros *annual report 2023* – Fidelidade *Integrated Management Report 2023* - Generali Group *Annual Integrated Report and Consolidated Financial Statements 2023* - Lusitania *Relatório sobre a Solvência 2023* - Mapfre Seguros *Individual Annual Accounts 2023* - Ocidental Seguros *Sustainability Report 2023* - Tranquilidade.Q4 2023 *Financial Statements* - Zurich Portugal *Annual Report 2023*

*The figures available in the report are for the Insurance Group as a whole, without specific country breakdowns.

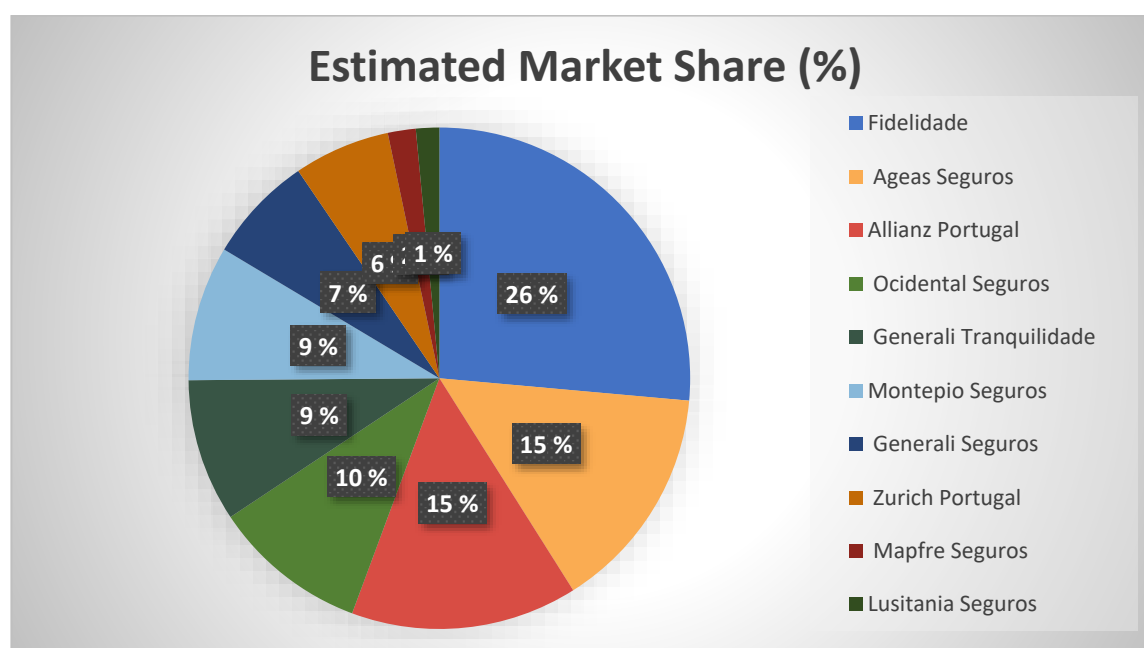


Figure 49 Estimated Market Share of Major Insurance Companies in Portugal

- Fidelidade leads the market with the highest estimated share of 26.4%, driven by diverse green investments, including green bonds, sustainable real estate, and other sustainable initiatives.
- Ageas Seguros and Allianz Portugal follow, each holding 14.6% of the market, with Ageas Seguros notably managing €13.2 billion in sustainable assets.
- Mapfre Seguros and Lusitania Seguros have the smallest market shares of 1.8% and 1.5% respectively, both focusing on green investments like renewable energy and sustainable mobility.
- **Figure 49** on the left illustrates the estimated market share, highlighting the top 3 companies: Fidelidade as the market leader followed by Ageas Seguros at 17% and Allianz Portugal.

⁸ The market share estimates presented in this analysis are derived from the 2023 annual reports of the ten major insurance companies operating in Portugal. While this study focuses on these leading firms, it's important to recognize that there are other insurance providers in the Portuguese market. The ten companies were selected to offer a comprehensive overview of market dynamics and their respective shares. However, the overall market share of these companies may vary if additional insurers were included in the analysis. Therefore, the market share percentages provided here are approximate, based on factors such as total revenue and operating income as reported by the companies. These figures are indicative and should be interpreted within the context of this study.

4.3.1.3 Analysis of insurance products/services

In Portugal, the insurance market for forests and forestry-related products is gradually evolving to address the challenges posed by climate change, wildfires, and biodiversity loss. The policies available in the market reflect a growing recognition of the need to protect forest assets while promoting sustainable management practices.

a. Comprehensive forest insurance coverage

The insurance sector in Portugal has been developing specialized products to cover the unique risks associated with the forestry sector. Forest insurance typically covers risks such as fire, storms, pests, and diseases, which are common threats to forestry operations. These insurance products are crucial for mitigating financial losses due to natural disasters and other unforeseen events that can significantly impact the forestry sector (Fern.org, 2019).

These insurance policies are comprised but not limited to the following:

1. **Fire Insurance:** Given the high incidence of forest fires in Portugal, fire insurance is a critical component of forestry insurance. This type of coverage provides compensation for losses due to fire, helping forest owners recover from devastating events.
2. **Storm Insurance:** Storms can cause substantial damage to forests, including uprooting trees and causing breakage. Insurance policies covering storm damage help mitigate the financial impact of such events on forest owners.
3. **Pest and Disease Insurance:** Forests are susceptible to various pests and diseases that can cause extensive damage. Insurance products that cover these risks are essential for maintaining the health and productivity of forests.
4. **Comprehensive Coverage:** Some insurance companies offer comprehensive forest insurance policies that include multiple risk coverages, providing a more holistic protection plan for forest owners. These policies often come with tailored features to meet the specific needs of different types of forests and forestry operations.

That being said, insurance companies in Portugal, such as Fidelidade and Ageas, have developed these specialized products to support the forestry sector. By providing financial security against various risks, these insurance products enable forest owners to manage their operations with greater confidence and sustainability (Fidelidade, n.d.; Ageas, n.d.).

Moreover, insurance products in Portugal that cover forest assets are designed to mitigate the financial risks associated with natural disasters, particularly wildfires, which are a significant concern in the region, as previously mentioned. These policies typically cover direct losses to timber and other forest products due to fire, storms, and pest infestations. However, the adoption of such insurance products among forest owners remains limited, partly due to the high premiums and complex underwriting processes (Lecina-Diaz et al., 2023).

b. Incentives for sustainable forest management

Some insurance policies in Portugal are increasingly incorporating incentives for sustainable forest management. For example, policies that offer lower premiums or additional coverage for forest owners who implement sustainable practices, such as reforestation with native species or the maintenance of biodiversity corridors, are becoming more common. These incentives align financial protection with ecological sustainability, encouraging forest owners to adopt practices that enhance the resilience of their forests (Fernandes & Simões, 2024).

c. Parametric insurance solutions

Parametric insurance, which pays out based on predefined environmental triggers rather than actual damage assessments, is gaining traction in Portugal. These insurance products are particularly useful in the context of wildfire risks, as they provide quicker payouts and reduce administrative complexities. For example, parametric policies linked to weather indices or satellite data can offer immediate financial relief to forest owners following a severe fire, allowing for quicker recovery and reforestation efforts (Loisel et al., 2020).

d. Insurance products/services offered by major insurance companies

To provide the commitment of major insurance companies towards sustainability and environmental stewardship, **Table 18 18** detail the specific policies, decarbonization targets, green investments, and insurance options related to forests and forestry management as reported by each of the top ten insurance companies in their 2023 annual reports. While none of the companies explicitly mention dedicated forestry-specific insurance solutions, they all demonstrate a commitment to sustainability and climate resilience, with indirect support for sustainable forestry practices through their broader environmental strategies and ESG initiatives.

Table 18 Overview of Sustainability Initiatives and Forestry-Related Insurance Practices in Portuguese Insurance Companies

Insurance company	Sustainability and Climate Adaptation Focus	Key Sustainability Initiatives
 Fidelidade	Strong focus on sustainability, with a commitment to carbon footprint reduction and promoting sustainable forestry practices. Established a Forestry Fund with an investment of €12 million aimed at sustainable forest and agricultural management.	Net-Zero Transition Plan, €12 million Forestry Fund, Article 9 SFDR classified by CMVM, promoting sustainable forestry.
 Ageas Seguros	Integrates ESG considerations into insurance products, promotes sustainable forest management and biodiversity conservation. Supports clients in adopting sustainable land use practices, helping them transition to greener business models.	Focus on green mobility, electric vehicles, sustainable forestry management, and biodiversity conservation.
 Montepio Seguros	Committed to sustainability and ESG principles, with a focus on contributing to national carbon neutrality goals by 2050. Integrates SDGs into activities and emphasizes ethics, transparency, and solidarity.	Commitment to carbon neutrality, integration of SDGs, sustainable financial investments aligned with ESG criteria.
 Allianz Portugal	Focuses on climate adaptation and decarbonization. Committed to reducing carbon emissions and increasing investments in sustainable forestry. Target of achieving net-zero emissions by 2050, with plans to invest €20 billion in climate solutions, including forestry, by 2030.	Decarbonization strategy, €20 billion investments in climate solutions, including sustainable forestry by 2030.
 Generali Seguros	Strong commitment to ESG and decarbonizing its insurance portfolio. Focuses on promoting sustainable practices, including renewable energy projects and climate resilience, with a goal to increase ESG-focused premiums by 5-7% CAGR by 2024.	Commitment to net-zero GHG emissions by 2050, focus on ESG insurance solutions and renewable energy projects.
 Zurich Portugal	Emphasis on decarbonization, climate resilience, and ecosystem restoration. Supports reforestation efforts and sustainable forest management practices. Launched the Zurich Forest project in Brazil for reforestation and natural capital investments.	Zurich Forest project, decarbonization targets, and support for sustainable forest management.

 Generali Tranquilidade (under Liberty Seguros)	Promotes sustainability, including sustainable forestry practices. The company supports biodiversity and natural resource conservation, though specific forestry insurance solutions are not mentioned.	Commitment to biodiversity and conservation, focus on environmentally friendly land use practices.
 Ocidental Seguros	Focuses on decarbonization and promoting sustainable forest management and biodiversity conservation. Supports sustainable practices through insurance products related to forestry and land use, although specific solutions are not detailed.	Supports sustainable forestry and biodiversity, investments in renewable energy projects, decarbonization focus.
 Mapfre Seguros	Committed to ESG integration into insurance products, supporting sustainable practices related to land use and forestry. Investments in renewable energy and environmentally friendly practices that contribute to forest conservation.	Investments in renewable energy, focus on ESG integration and natural resource conservation.
 Lusitania Seguros	Strong commitment to sustainability, particularly through investments in natural capital projects aimed at ecosystem restoration and forest conservation. Integrates ESG criteria into insurance products, particularly in sectors with environmental impact, like forestry.	Investments in natural capital projects, focus on forest conservation and ecosystem restoration, integration of ESG criteria in insurance.

The above analysis of the leading insurance companies operating in Portugal reveals a significant gap in the availability of dedicated insurance solutions tailored specifically for the forestry sector. While these companies have made notable progress in integrating broader Environmental, Social, and Governance (ESG) principles into their operations and investments, with some engaging in initiatives that indirectly support sustainable forestry management, the absence of targeted forestry insurance products is apparent.

Despite their strong commitments to decarbonization, biodiversity conservation, and sustainability, as reflected in their annual reports, there remains a clear need for these insurers to develop and offer specialized products that directly address the unique risks and opportunities associated with forestry and forestry-related industries. This gap highlights a crucial area for future development, where insurers can further align their products with the pressing needs of climate resilience and sustainable land use in Portugal, as well as innovative insurance solutions and nature based solutions, discussed in the sections below.

4.3.1.4 Analysis of innovative insurance solutions and Nature-based solutions

Nature-based solutions (NBS) are being increasingly integrated into forest insurance policies in Portugal. These solutions include measures such as reforestation, the creation of firebreaks using natural vegetation, and the restoration of wetlands. Insurance products that support NBS not only reduce the risk of catastrophic events but also contribute to the broader goals of climate adaptation and biodiversity conservation. Policies that include coverage for the costs associated with implementing NBS are becoming more prevalent, reflecting a shift towards more sustainable and resilient forest management practices (Valente et al., 2015).

Additionally, a 2023 study by de Abreu et al. highlighted the critical role of NBS in mitigating biodiversity loss and environmental disasters, emphasizing their integration into insurance products as a proactive risk management strategy (de Abreu et al., 2023).

Insurance products in Portugal have begun to offer comprehensive coverage that includes Nature-based solutions. For example, some policies now cover costs associated with reforestation efforts using native species, the creation of natural firebreaks, and the restoration of wetlands. These measures not only reduce the risk of catastrophic events like wildfires but also enhance the long-term ecological health of forest ecosystems. These policies provide financial incentives for forest owners to implement sustainable management practices, thereby aligning economic benefits with environmental sustainability (Martire et al., 2022).

Furthermore, parametric insurance is becoming a popular choice for managing risks in the Portuguese forestry sector. Unlike traditional insurance, which compensates for actual losses after they occur, parametric insurance pays out based on predefined triggers such as extreme weather conditions. This type of insurance is particularly relevant for forestry, where events like droughts and storms can have devastating effects. By linking payouts to specific environmental indicators, parametric insurance can provide immediate financial relief, enabling faster recovery and reforestation efforts (Loisel et al., 2020).

More so, recent technological advancements, such as the use of remote sensing and geographic information systems (GIS), have significantly enhanced the effectiveness of parametric insurance. These technologies allow for real-time monitoring of forest conditions, enabling more accurate and timely assessments of environmental triggers. This integration of technology with insurance products ensures that payouts are made quickly and accurately, reducing the financial burden on forest owners and enabling faster recovery (Surminski et al., 2015).

Also, the Portuguese government, in collaboration with insurance companies, has introduced subsidies and incentives to promote the adoption of NBS in forestry. These government initiatives are often implemented in partnership with insurance companies, creating a supportive environment for the widespread adoption of sustainable forestry practices.

For instance, forest owners who engage in practices such as the preservation of biodiversity corridors or the restoration of degraded lands can benefit from lower insurance premiums and additional coverage options (Fernandes & Simões, 2024). By lowering the financial barriers to implementing NBS, these policies encourage wider adoption of sustainable forestry practices (Valente et al., 2015).

Similar to other European countries, public-private partnerships are playing a crucial role in the development and implementation of NBS in Portugal. These collaborations bring together the

financial resources of the private sector and the regulatory and planning capabilities of the government to support large-scale forest management projects. Such partnerships are essential for scaling up NBS and ensuring their long-term sustainability (Veerkamp et al., 2021).

Subsequently, to provide a detailed comparative analysis of the leading insurance companies in Portugal and their solutions related to forest and forestry-related products, **Table 19** below outlines their involvement in Nature-based solutions (NBS), coverage features, forest protection policies, special incentives or climate change policies, and the number of insurers adhered to these policies based on their 2023 annual reports and their respective websites.

It should be reiterated that the comparative analysis below also reveals a significant gap in the availability of dedicated insurance solutions tailored specifically for the forestry sector, specifically when it comes to coverage features for forests or forest protection policies.

Table 19 Comparative Analysis of Insurance Companies in Portugal Covering Forests and/or Forestry Related Products Offering Special Incentives for Eco-Friendly and Sustainable Practices (2023)

Insurance company	Details on NBS involvement	Coverage features	Special incentives/climate change policies
 Fidelidade	Involved in promoting sustainable forestry management through the "Fundo de Florestas de Portugal"	Not specified	Net-Zero Transition Plan with a focus on carbon removal and sustainable forestry practices
 Ageas Seguros	Partnered with Go Forest for reforestation efforts	Coverage for storm, flood, and fire in relation to climate change events	Commitment to sustainable transport solutions, broader sustainability initiatives
 Montepio Seguros	Aligned with the Global Reporting Initiative (GRI) Standards and the United Nations' Agenda 2030 and ESG Considerations in Investments	Not specified	Commitment to reducing its carbon footprint and aligning with the national goal of carbon neutrality by 2050.
 Allianz Portugal	Engaged in investments supporting biodiversity and ecosystem restoration	Commercial insurance products that be tailored to meet the specific needs of forestry	Investments in sustainable forestry projects, aligned with global decarbonization goals
 Generali Seguros	ESG-aligned insurance solutions, indirectly supporting forest conservation	Catastrophe coverage, including climate-related perils	Commitment to promoting responsible behaviours and investments in environmental projects
 Zurich Portugal	Strong focus on climate resilience, Zurich Forest project supporting reforestation	Coverage for a range of natural catastrophes, including wildfires and floods	Investments in reforestation projects, sustainable insurance products for natural capital
 Generali Tranquilidade (under Liberty Seguros)	Sustainability initiatives supporting natural resource conservation, including forests	Commercial insurance products that be tailored to meet the specific needs of forestry	Commitment to biodiversity and natural resource conservation through sustainable practices
 Occidental Seguros	Focus on sustainable investment strategies, including natural capital and biodiversity	Commercial insurance products that be tailored to meet the specific needs of forestry	Support for sustainable forest management, investments in renewable energy to promote a cleaner energy future
 Mapfre Seguros	Supports sustainable practices in land use and forestry	multirisk and property insurance that could cover some risks associated with forestry, such as damage from natural disasters.	Investments in renewable energy, supporting land use sustainability
 Lusitania Seguros	Investments in natural capital projects, including forestry and biodiversity conservation	Not specified	Promotion of sustainable forestry management and biodiversity conservation

4.3.1.5 NBS case studies

Case Study 1: Resilient Forest Management in Serra da Estrela



The Serra da Estrela region in Portugal has been a focal point for implementing Nature-based solutions aimed at enhancing forest resilience. The project, supported by a consortium of insurance companies and local government bodies, focuses on integrating sustainable forestry practices with NBS to mitigate the impact of wildfires and storms. This initiative includes reforestation with native species, the establishment of natural firebreaks, and the restoration of riparian zones. Insurance companies involved in the project offer reduced premiums for forest owners who adopt these sustainable practices, thus aligning financial incentives with ecological outcomes (Veerkamp et al., 2021).

Case Study 3: Biodiversity and Fire Risk Management in the Alentejo Region



The Alentejo region, known for its extensive cork oak forests, has implemented a nature-based solution project aimed at preserving biodiversity while reducing fire risks. This project, supported by insurance companies and environmental NGOs, promotes the maintenance of biodiversity corridors and the use of traditional agroforestry practices. Insurance products tailored to this project offer coverage for both fire damage and biodiversity conservation efforts, incentivizing forest owners to engage in sustainable practices. The success of this initiative has led to a significant reduction in fire incidents and improved forest health in the region (Valente et al., 2015).

Case Study 2: NBS for Flood Management in Coimbra



In Coimbra, a collaborative project involving insurance firms and local authorities has focused on using NBS to manage pluvial flooding, which is a recurring issue in the region. The project involves the creation of green infrastructure, including the restoration of wetlands and the construction of permeable surfaces that enhance water infiltration. These NBS are complemented by insurance products that cover the maintenance of these green infrastructures, offering financial protection to property owners and municipalities. The project has demonstrated the effectiveness of NBS in reducing flood risks and lowering insurance claims related to flood damage (Pinto et al., 2021).

Case Study 4: Coastal Forest Restoration in the Algarve



In the Algarve, a project focused on coastal forest restoration has been implemented to protect against erosion and enhance biodiversity. The project involves the replanting of native species and the creation of natural barriers to reduce the impact of storms and rising sea levels. Insurance companies have played a key role by providing coverage for the restoration efforts and offering incentives for ongoing maintenance. This partnership has not only improved the resilience of coastal forests but also provided financial security to local communities that rely on these ecosystems (Linnerooth-Bayer et al., 2021).

As seen in similar European countries, these case studies illustrate the successful integration of Nature-based solutions within the insurance sector in Portugal. By aligning financial incentives with ecological goals, these projects have enhanced the resilience of forest ecosystems and reduced environmental risks. The collaboration between insurance companies, government bodies, and local communities has been instrumental in scaling up these initiatives, ensuring their long-term sustainability and impact.

4.3.1.6 Challenges, future trends and opportunities

a. Challenges in the Portuguese forestry sector

The forest insurance sector in Portugal faces several significant challenges. One of the primary challenges is the high risk associated with natural disasters, particularly wildfires, which are exacerbated by climate change. The increasing frequency and severity of wildfires have led to substantial financial losses and have made it difficult for insurance companies to assess and underwrite risks effectively (Sotirov et al., 2015). Additionally, there is a lack of standardized data and methodologies for evaluating the impacts of these events on forests, further complicating the development of tailored insurance products (Beighley & Hyde, 2009).

Another challenge is the relatively low adoption of insurance products among forest owners in Portugal. Many forest managers are either unaware of the available insurance options or consider them too expensive, leading to insufficient coverage. This gap in coverage increases the financial vulnerability of forest owners when disasters occur, highlighting the need for improved awareness and affordability of insurance products (Almeida, 2020).

Additionally, extreme fire events are projected to become more frequent across Southern Europe due to the impacts of climate change and land abandonment. A promising approach to mitigate wildfire risks is the implementation of "fire-smart" management. This involves strategic interventions on vegetation to create more fire-resistant environments, leveraging Nature-based solutions (NBS) that utilize and enhance natural processes. Such strategies not only aim to control fire regimes but also support biodiversity conservation and the sustainable provision of ecosystem services. While fire-smart management and NBS have not yet been integrated into insurance schemes, primarily due to the limited availability of insurance against forest destruction, Portuguese institutions and enterprises are actively investing in fire-smart strategies utilizing NBS to mitigate wildfire risks in Portugal (European Commission, 2018).

The FirESmart project, for example, tests this approach on two transboundary forest and natural landscapes spanning Spain and Portugal. By integrating ecological and socio-economic dimensions, FirESmart aims to reduce fire damage and support rural economies. By emphasizing fire-smart landscape management, such as replacing highly flammable areas with mixed systems of agroforestry—where trees and shrubs are integrated into crop and livestock systems—the project aims to enhance resilience against wildfires while preserving ecosystem health and services (FIRESMART, s.d.). This approach provides multiple benefits, including improved soil health, enhanced biodiversity, and greater resilience to extreme weather events like droughts and floods.

b. Future trends in the Portuguese forestry and Insurance sector

The future of forest insurance in Portugal is likely to be shaped by advancements in technology and the integration of Nature-based solutions (NBS). One emerging trend is the use of remote sensing and geographic information systems (GIS) to improve risk assessment and monitoring. These technologies enable insurers to gather real-time data on forest conditions, enhancing the accuracy of risk models and facilitating more responsive insurance policies (Valente et al., 2015).

Additionally, parametric insurance products are expected to gain prominence. These products, which pay out based on predefined triggers such as weather indices rather than actual loss assessments, offer quicker payouts and reduce administrative complexities. Parametric insurance is particularly relevant in the context of wildfires, where immediate financial relief is critical for recovery and reforestation efforts (Loisel et al., 2020).

c. Opportunities in the Portuguese forestry & insurance sector

Integrating Nature-based solutions into insurance products presents significant opportunities for enhancing forest resilience and sustainability in Portugal. NBS, such as reforestation, wetland restoration, and the creation of biodiversity corridors, not only mitigate environmental risks but also provide co-benefits such as carbon sequestration and enhanced biodiversity (Vizinho et al., 2021). Insurance products that support NBS can incentivize forest owners to adopt these practices, creating a synergistic relationship between financial protection and ecological health.

Furthermore, public-private partnerships offer a promising avenue for scaling up NBS initiatives. These partnerships can leverage financial resources and expertise from both the public and private sectors to support large-scale forest management projects. By aligning economic incentives with environmental goals, these collaborations can enhance the effectiveness and sustainability of NBS (Meuwissen & Mey, 2018).

In conclusion, the forest insurance sector in Portugal is at a pivotal point, facing considerable challenges but also promising opportunities. Addressing the impacts of climate change, improving risk assessment methods, and increasing insurance penetration are essential to strengthening the sector. The integration of advanced technologies and Nature-based solutions into insurance products offers a path forward, promoting sustainable forest management and enhancing resilience against environmental risks.

4.3.2 Germany

4.3.2.1 Current state of the forestry market in Germany

Germany's forestry sector is integral to its environmental and economic landscapes, covering approximately 32% of the country's territory with around 11.4 million hectares of forest (Federal Ministry of Food and Agriculture [BMEL], 2023). This forested area has been steadily expanding since World War II, adding more than 1.5 million hectares and supporting an estimated 90 billion trees, translating to roughly 1,000 trees per capita (BMEL, 2023).

As shown in **Figure 50** below, forest ownership in Germany is diverse:

- **Private Ownership:** About 48% of forests are privately owned. These private forests are often fragmented, with many smallholders managing less than 20 hectares each. Larger private owners (over 1,000 hectares) hold around 13% of the private forest area. Forestry cooperatives play a significant role in helping these smallholders manage their forests effectively, with around 3,500 cooperatives representing approximately 430,000 members and managing over 3.5 million hectares (BMEL, 2023).
- **State and Municipal Ownership:** State-owned forests account for 29%, while municipal and communal forests make up 19%. These forests are crucial for public services and local economies, especially in rural areas (BMEL, 2023).
- **Federal Ownership:** The federal government owns the remaining 4% of forests (BMEL, 2023).

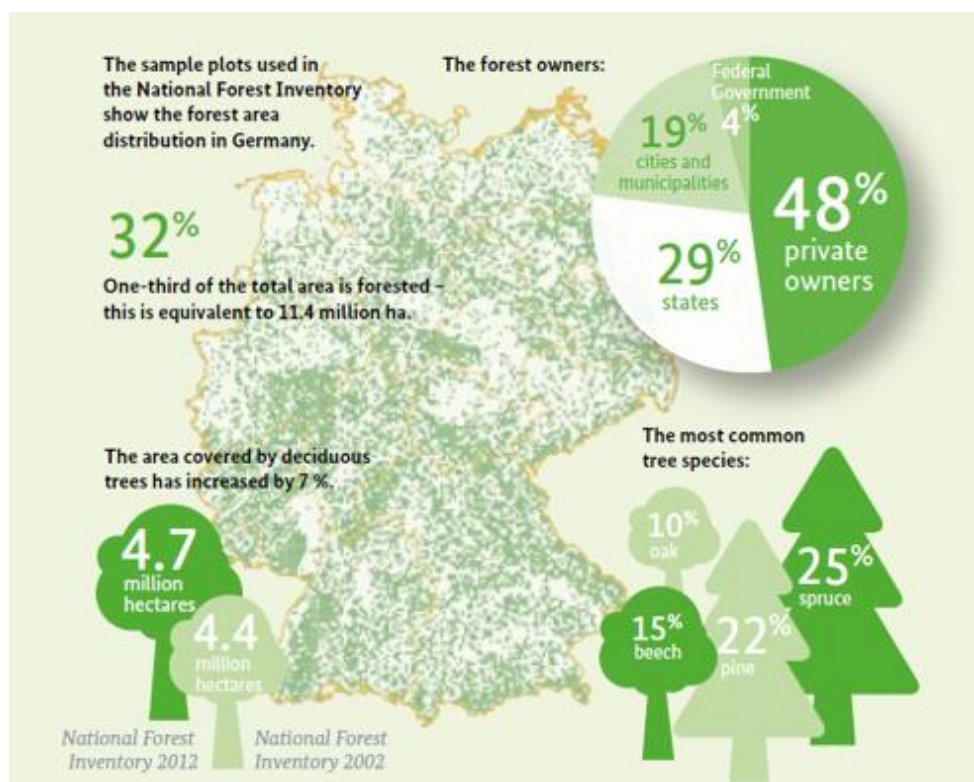


Figure 50 Forested area in Germany by area, ownership structure and tree species composition

Source: BMEL, 2023

On one hand, Germany's forests are notable for their substantial growing stock, which totals approximately 3.9 billion cubic meters. This places Germany among the top countries in

Europe for forest growing stock, second only to Russia (Federal Ministry of Food and Agriculture [BMEL], 2023). On average, the growing stock per hectare is about 358 cubic meters, a testament to the effective and sustainable forest management practices employed across the country (BMEL, 2023). The high growing stock is a result of several factors:

- Regulated reforestation: Continuous efforts in regulated reforestation have ensured that forests are replenished effectively.
- Promotion of natural regeneration: Around 85% of Germany's forest area regenerates naturally, which contributes to maintaining a healthy and sustainable forest ecosystem.
- Forest thinning and tending: Regular forest thinning and tending practices help to enhance the growth conditions for the most valuable trees.
- Selection cutting: This method promotes the growth of a variety of tree species and enhances forest structure.
- Longer production periods: Allowing trees to grow for longer periods before harvesting contributes to a higher volume of growing stock (BMEL, 2023).

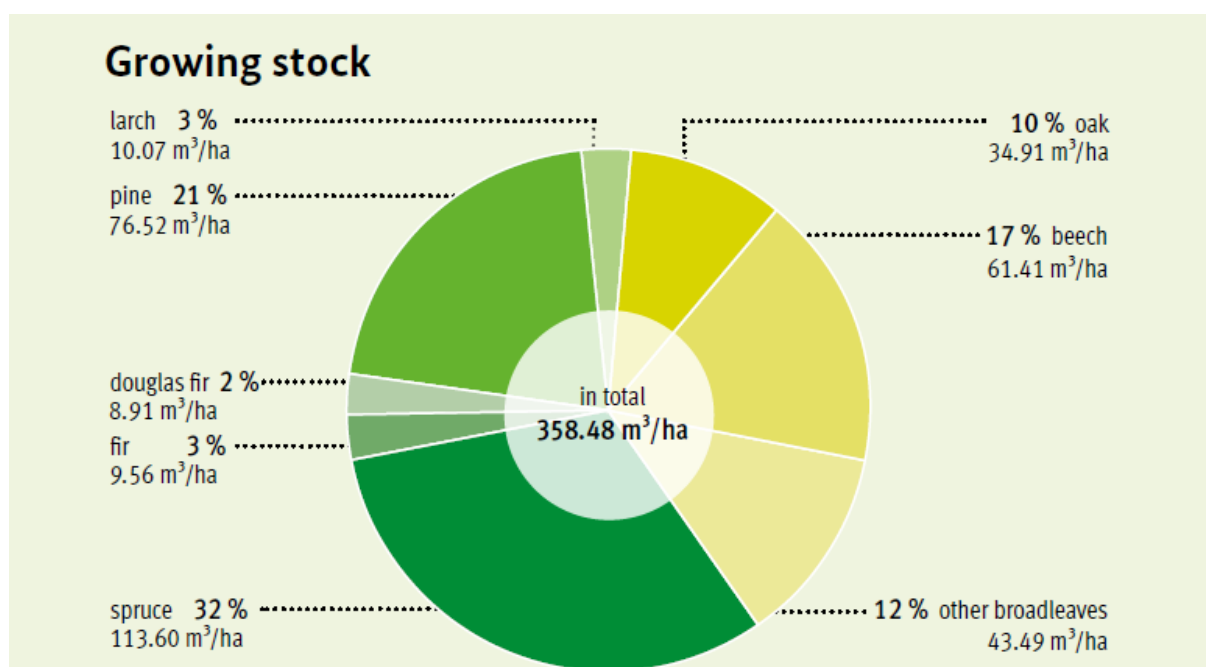


Figure 51 Growing stock by tree species per hectare in Germany's forests

Source: Thünen Institute, Carbon Inventory (2019)

Figure 51 above illustrates the distribution of growing stock by tree species per hectare in Germany's forests. The figure highlights the proportions and volumes of different tree species contributing to the total growing stock. As seen in the figure, Spruce constitutes the largest portion at 32%, with a growing stock of 113.60 m³/ha. Pine accounts for 21%, contributing 76.52 m³/ha. Beech and oak represent 17% and 10% of the growing stock, with 61.41 m³/ha and 34.91 m³/ha, respectively. Other broadleaves make up 12% (43.49 m³/ha), while larch and fir each comprise 3% (10.07 m³/ha and 9.56 m³/ha). Douglas fir is the smallest category at 2%, with a growing stock of 8.91 m³/ha. On the other hand, the annual increment, or the amount of wood that grows each year, is another important metric for forest productivity.

Due to the extreme spruce bark beetle calamity from 2018-2022 and the widespread failure of the spruce tree species, there may have been significant changes in timber stockpiling (no

current statistical data as a basis for calculation). The reassessment of storm damage potential (no more spruce at a regional level, decreasing interest in forest storm insurance due to reduced stock and age) would be necessary.

In Germany, the average annual increment is approximately 10.9 cubic meters per hectare. This results in a total annual wood growth of about 117 million cubic meters (BMEL, 2023).

This robust increment rate is indicative of the overall health and vitality of Germany's forests. It reflects successful forest management practices that balance timber production with ecological sustainability. Factors contributing to the high annual increment include:

- **Effective forest management:** Sustainable forest management practices that focus on long-term growth and health of the forest.
- **Favourable growing conditions:** Germany's climate and soil conditions are conducive to forest growth, which supports a high rate of annual increment.
- **Forest transformation:** Efforts to transform monoculture coniferous forests into more resilient mixed forests have improved growth rates and forest health (BMEL, 2023).

German forestry is characterized by sustainable and multifunctional management practices aimed at balancing ecological, economic, and social functions. The principle of sustainability, which originated in German forestry, highlights these practices. This approach ensures that forests can continue to provide timber, protect soil and water, sequester carbon, and offer recreational opportunities (BMEL, 2023).

The following policies and strategies have been identified as governing mechanisms in the Germany forestry sector:

- **Sustainable Forest Management (SFM):** SFM is guided by criteria established by the Ministerial Conference on the Protection of Forests in Europe (FOREST EUROPE), focusing on maintaining forest resources, ecosystem health, biodiversity, productive functions, and socio-economic benefits (BMEL, 2023).
- **Forest Strategy 2020:** This strategy outlines actions for climate protection, resource efficiency, biodiversity conservation, and socio-economic enhancement. It addresses challenges such as climate change, economic viability, and biodiversity loss, and sets the foundation for the upcoming Forest Strategy 2050 (BMEL, 2023).
- **Legal Framework:** The Federal Forest Act and state forest laws provide the legal foundation for forest conservation and management, emphasizing the protection of forests for their economic, environmental, and recreational functions. Additional regulations include the Forest Reproductive Material Act and the Timber Trade Protection Act, ensuring sustainable practices and combating illegal logging (BMEL, 2023).

German forests are vital for climate change mitigation, sequestering approximately 62 million tonnes of CO₂ annually. They also provide significant economic benefits, with the forestry and timber sectors employing around 750,000 people and generating substantial revenue, particularly in rural areas. The production and processing of timber, along with non-timber forest products, play crucial roles in the national economy (BMEL, 2023).

Forests hold a special place in German culture, offering recreational spaces for over 90% of the population. They are valued for their natural beauty, biodiversity, and contributions to health and well-being. Public access to forests for recreation is a deeply rooted right, contributing to the high quality of life in Germany (BMEL, 2023).

4.3.2.2 Current state of the forestry insurance market in Germany

Germany has a well-developed insurance market, regulated by the Federal Financial Supervisory Authority (BaFin). This sector includes a range of products such as health, life, property, and casualty insurance. The market operates under the European Union's Solvency II directive, ensuring that insurers maintain sufficient capital reserves to cover potential claims, thus protecting policyholders (Deloitte Insights, 2023; Marsh, 2024).

Key players in the German insurance market include Allianz, Munich Re, and Talanx, which provide comprehensive insurance solutions. The market is characterized by a strong emphasis on financial stability, transparency, and consumer protection. Additionally, digital transformation is increasingly influencing the sector, with insurers leveraging advanced analytics and technology to improve efficiency and customer service (WTW, 2024; Marsh, 2024). It must also be mentioned that AXA can be attributed a leading role, especially in the area of forest insurance.

a. Insurance penetration and adaptation models for forest management in Germany

In Germany, the need for comprehensive forest insurance coverage is becoming increasingly apparent in the face of climate change and natural disasters. Historically, many forest owners have relied on public compensation schemes rather than private insurance, leading to relatively low insurance penetration rates. A study by Elsasser et al. (2021) noted that despite the significant value of forest ecosystem services, insurance coverage remains limited. Average insurance rates for forest assets range from 0.5% to 2% of the insured value, depending on risk factors and coverage specifics.

Recent research by Nordmeyer, Musshoff, and Danne (2022) found a growing interest among German forest owners in index-based insurance models, with a preference for fixed payouts to ensure immediate liquidity after damage events. Similarly, Brunette et al. (2023) emphasized the increasing willingness-to-pay for forest insurance in Germany, particularly in disaster-prone regions. Some federal states have/had introduced subsidies that cover up to 50% of fire insurance premiums to make these policies more accessible (Brunette, Couture, & Garcia, 2020). This incentive has been discontinued in the meantime (since the beginning of the 2000s).

Alongside the evolving insurance landscape, forest adaptation models in Germany are helping forest owners build resilience against climate change. These models focus on strategies such as promoting mixed-species stands, selective thinning, and the cultivation of climate-resilient tree species. Fuchs (2024) explored the integration of economic strategies, such as bark beetle management and Douglas fir cultivation, into forest adaptation efforts. These models emphasize not only economic sustainability but also ecological benefits like biodiversity conservation and enhanced ecosystem services.

Together, these insurance solutions and adaptation models form a comprehensive approach to managing forest assets in Germany, addressing both financial risks and long-term ecological resilience.

b. Wildfire Management Strategies and Insurance Incentives in Germany

Public wildfire adaptation measures in Germany encompass a range of strategies aimed at reducing the risk and impact of wildfires.

These measures include the maintenance of firebreaks, public awareness campaigns, and prescribed burning practices. Recent advancements in remote sensing technologies have significantly improved the monitoring and management of forests, which is crucial for effective wildfire adaptation (Holzwarth et al., 2023). Federal and state governments provide financial support for these measures, recognizing their importance in proactive wildfire management. Firebreak maintenance and prescribed burning are critical in preventing the spread of wildfires and reducing fuel loads in forests. Public awareness campaigns also play a significant role in educating the community about wildfire risks and promoting behaviours that reduce fire hazards.

In addition to adaptation measures, several German states offer subsidies to make wildfire insurance more affordable for households, especially those in high-risk areas. For instance, some states provide subsidies covering up to 50% of fire insurance premiums for forest owners. This financial support aims to encourage more households to take up insurance policies, thereby enhancing their financial resilience against wildfire damages. Economic instruments for risk management highlight the importance of such subsidies in increasing insurance uptake (Mechler et al., 2022). These incentives are part of a broader strategy to improve overall disaster preparedness and reduce the economic burden on households following wildfire events. By making insurance more accessible and affordable, these subsidies promote a culture of risk management among forest owners and residents in fire-prone areas.

c. Tools, data sources, and ground truth for detecting forest disturbances in Germany

Bark beetle infestations, wildfires, and windthrow pose significant challenges to forest management in Germany. Advanced tools and data sources are essential for early detection and effective management of these disturbances. Remote sensing technologies, such as satellite imagery and drones, are widely used for monitoring large forest areas with high precision, enabling the early identification of bark beetle infestation hotspots and other disturbances.

Holzwarth et al. (2023) highlight the role of Earth-observation-based monitoring, particularly in bark beetle detection, where data from government databases, academic research, and private sector contributions are utilized to track forest health.

In addition, ground truth data is critical for validating remote sensing assessments and improving the accuracy of predictive models. This data, gathered through field surveys, is crucial for understanding the full impact of wildfires, windthrow, and bark beetle damage in Germany and boreal forests. Predictive models that integrate climatic, biological, and forest health data are also being developed to forecast potential outbreaks and inform proactive management strategies (Holzwarth et al., 2023). Together, these tools and ground-based data support the effective management of forest disturbances, helping to preserve forest ecosystems.,

Table 20 below summarizes the detailed results and conclusions from various studies conducted on forest disturbances, including insect and storm impacts, windthrow events, bark beetle infestations, and wildfire management, with a specific focus on Germany and boreal forests.

Table 20 Results and Conclusions of Studies on Forest Disturbances and Management Strategies in Germany and Boreal Forests

Study	Topic	Results	Conclusion for Market Review
Kosunen, 2020	Insect and storm disturbance in boreal forests	The study identified that site factors like soil fertility and topography significantly affect the severity of insect and storm disturbances. Bark beetle infestations are notably linked to shallow soils and water deficiencies. The reproductive cycle of insects is highly temperature-dependent.	The findings highlight the critical need for site-specific management strategies to mitigate the impacts of climate change-induced disturbances in boreal forests. The research underscores the importance of adaptive management to sustain forest ecosystem services.
Huo et al., 2023	Early detection of bark beetle infestation using remote sensing	This study demonstrated that early stages of bark beetle infestation can be detected using Sentinel-2 multi-temporal data. The green-attack stage showed significant changes in spectral signatures, which were effectively monitored using remote sensing technologies.	The results support the use of remote sensing for early detection and management of bark beetle infestations. This approach can help forest managers implement timely interventions, potentially reducing economic losses and ecological damage caused by infestations.
Stritih et al., 2024	Impact of windthrow on boreal forests and carbon balance	The study found that windthrow events lead to significant tree mortality, altering forest composition and carbon balance. The carbon release from dead wood is gradual, and site recovery depends on various factors including soil type and subsequent management practices.	Windthrow events pose a substantial risk to carbon storage in boreal forests. Effective post-disturbance management can mitigate some of the negative impacts, suggesting a need for policies that support rapid recovery and carbon sequestration efforts.
Labenski, 2024	Assessment of surface fuel loads using remote sensing	Using random forest modeling and multispectral satellite data, the study accurately quantified surface fuel loads in forested areas. The model predictions were validated against field data, showing high accuracy in estimating potential fire behavior and fuel distribution.	The research provides valuable insights into using remote sensing for fuel load assessment, aiding in wildfire management. Accurate fuel load maps can help in developing targeted mitigation strategies to prevent large-scale wildfires, thus protecting forest resources.
Mohr et al., 2024	Bark beetle outbreak patterns and ecosystem impacts	This study highlighted the increased frequency and intensity of bark beetle outbreaks due to climate change. It noted significant ecological impacts, including changes in forest structure and biodiversity. The study also discussed the economic implications of managing these outbreaks.	The findings emphasize the urgent need for adaptive forest management practices to address the rising threat of bark beetle outbreaks. The study suggests investing in monitoring and early intervention systems to minimize economic losses and ecological damage.

Based on the information provided in the sections above, Figure 52 below provides a summary of the measures for forest risk management and adaptation within the Germany context.

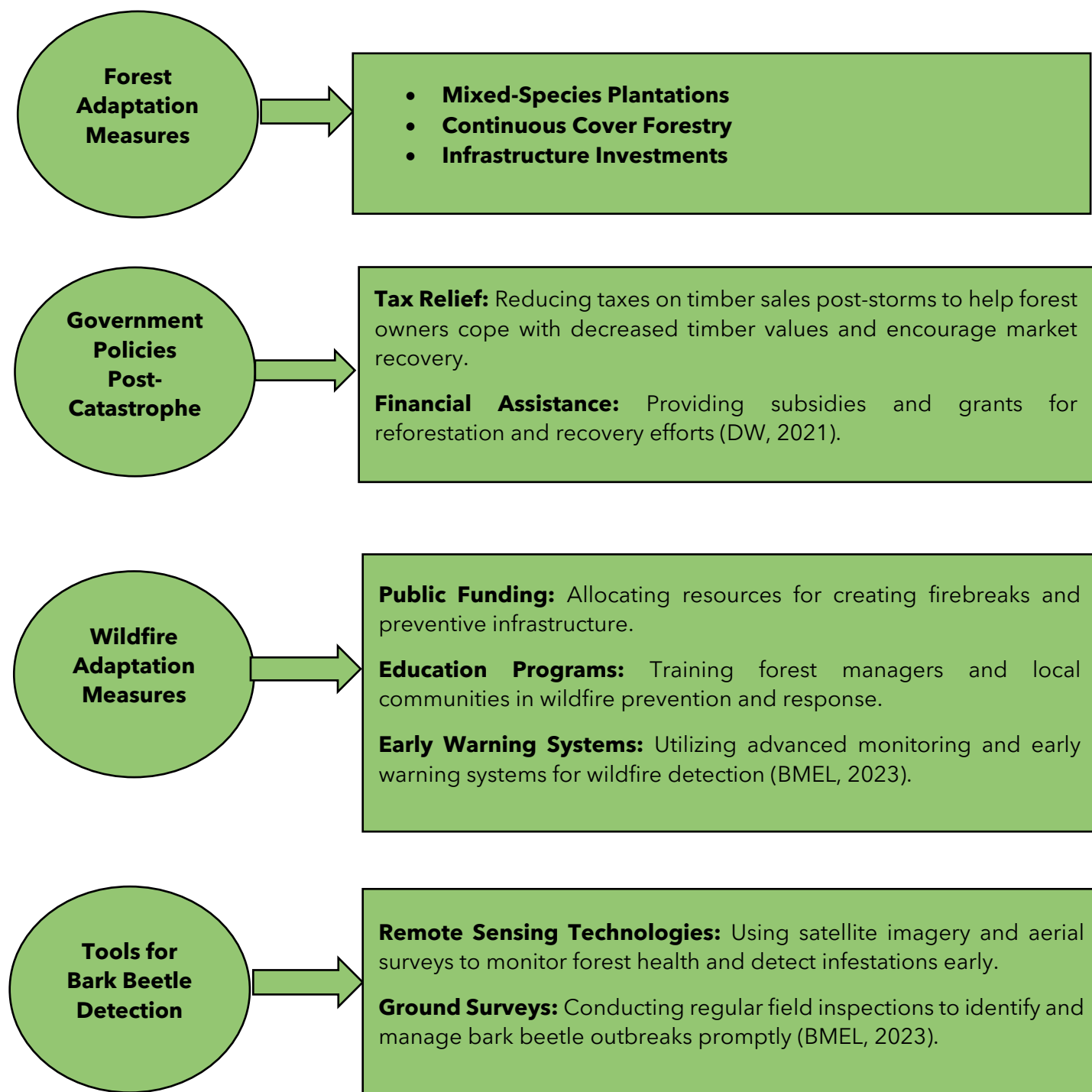


Figure 52 Summary of Comprehensive Measures for Forest Risk Management and Adaptation in Germany

d. Estimating market share of major insurance companies in Germany

Based on the annual reports for the year 2023, LGI conducted a comprehensive analysis of the key financial metrics, market presence, and green investments for each of 10 major insurance companies in the German insurance sector. **Table 21** below presents the results of the market share analysis⁹.

Table 21 Estimating Market Share of Major Insurance Companies in Germany in 2023

Insurance company	Total revenue (Billion €)	Operating Income (Billion €)	Client Base (Million)	Green Investments	Estimated Market Share (%) (Individual market revenue/Total market revenue x 100)
 Allianz Group	43.6	7.686	30	green and sustainable investments (renewable energy and infrastructure)	35.31%
 R+V Versicherung AG	19.8	0.1946	30	Strong focus on integrating ESG into its investment portfolio	16.03%
 Munich Re Group	17.554	5.702	13.8	€3.1 billion investments in renewable energies	14.21%
 AXA Versicherung AG	11.773	3.57	7.3	€29.9 billion (for the whole group)	9.53%
 HUK-COBURG Versicherungsgruppe	9.03	0.4508	13.1	sustainability initiatives - Telematik Plus tariff (eco-friendly driving)	7.31%
 Versicherungskammer Bayern	8.68	0.386	11.5	green investments in renewable energy, sustainable real estate	7.03%
 Gothaer Versicherungsbank VVaG	4.9	0.141	4	sustainable practices and broader sustainability commitments	3.97%
 LVM Konzern	4.487	0.349	3.832	green bonds and other environmentally-focused investments	3.63%
 Talanx AG	3.6	0.754	Not found*	investments in renewable energy and sustainable assets.	2.91%
 Debeka Lebensversicherungsverein	0.0422	0.0751	7.5	environmentally responsible investments	0.03%

Source: Allianz SE Annual Report 2023- Munich Re Group Annual Report 2023. – Talanx AG Annual Report 2023- HUK-COBURG Versicherungsgruppe Annual Report 2023 – LVM Versicherung Annual Report 2023 – AXA Group Annual Report 2023 – R+V Versicherung AG Annual Report 2023 – Gothaer Versicherungsbank VVaG Annual Report 2023 - Debeka Lebensversicherungsverein Annual Report 2023 Versicherungskammer Bayern Annual Report 2023.

*The figures available in the report are for the Insurance Group as a whole, without specific country breakdowns.

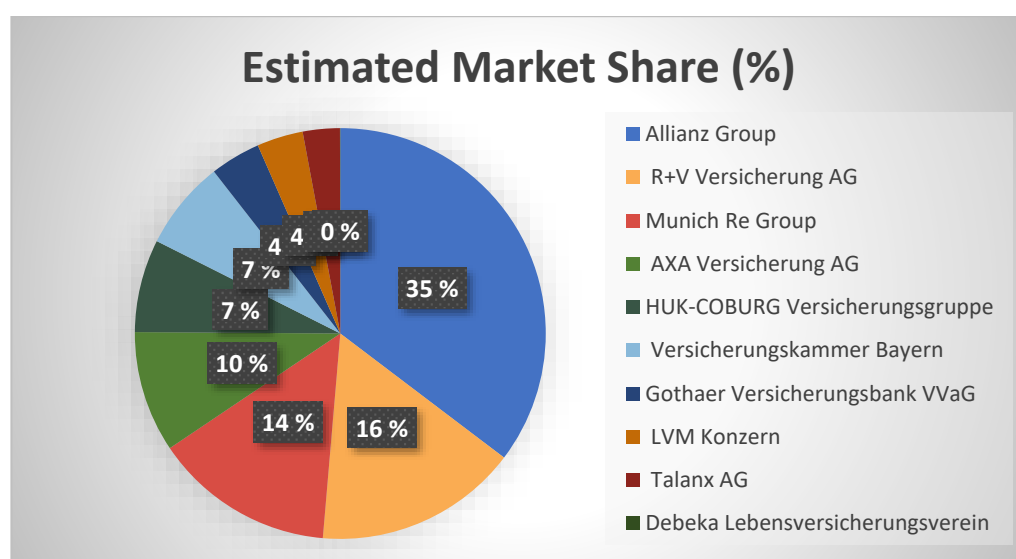


Figure 53 Estimated Market Share of Major Insurance Companies in Germany

- **Table 21** above show that Allianz Group leads with the highest market share of 35.31%, followed by R+V Versicherung AG at 16.03%, and Munich Re Group at 14.21%, based on their total revenue.
- Companies like Allianz Group and Munich Re Group have significant investments in renewable energy and sustainability, with Allianz Group focusing on green and sustainable investments and Munich Re Group investing €3.1 billion in renewable energies.
- The companies vary in client base and operating income, with Allianz Group having the largest client base of 30 million and a high operating income of €7.686 billion, while Debeka Lebensversicherungsverein has a small market share and a relatively modest operating income of €0.0751 billion.
- Figure 53 on the left shows the estimated market share distribution per company.

⁹ The market share estimates presented in this analysis are derived from the 2023 annual reports of the ten major insurance companies operating in Germany. While this study focuses on these leading firms, it's important to recognize that there are other insurance providers in the German market. The ten companies were selected to offer a comprehensive overview of market dynamics and their respective shares. However, the overall market share of these companies may vary if additional insurers were included in the analysis. Therefore, the market share percentages provided here are approximate, based on factors such as total revenue and operating income as reported by the companies. These figures are indicative and should be interpreted within the context of this study.

4.3.2.3 Analysis of insurance products/services

The insurance market in Germany has developed various products and services tailored to forest and forestry-related needs, including timber insurance, green solutions, and biodiversity protection. This analysis aims to provide a comprehensive overview of these insurance policies, highlighting their features and the roles they play in forest management and conservation.

Insurance for forests in Germany is designed to cover a variety of risks, including fire, storm damage, pest infestations, and other natural disasters. Given the significant economic and ecological value of forests, insurance products are tailored to mitigate the financial impacts of these risks on forest owners. Several insurance products have been identified:

1. **Fire Insurance:** Forest fire insurance is crucial due to the potential for extensive damage. Policies typically cover the costs associated with fire suppression, as well as the loss of timber and other forest products (BMEL, 2023).
2. **Storm Damage Insurance:** Storms are a common threat to German forests. Insurance against storm damage covers the costs of cleanup, replanting, and loss of timber (German Federal Statistical Office, 2023).
3. **Pest Infestation Insurance:** Forests are vulnerable to pests such as bark beetles, which can cause significant damage. Pest infestation insurance helps cover the costs of pest control and loss of timber due to pest damage (Thünen Institute, 2023).
4. **Multi-Peril Insurance:** Some insurers offer multi-peril insurance policies that cover a range of risks, providing comprehensive protection for forest owners. These policies are particularly beneficial for large-scale forest owners who face multiple threats (StartUs Insights, 2023).

a. Insurance policies for forests and timber

A study by Mann et al. (2022) discussed the governance innovations for forest ecosystem service provision across the EU, including Germany. It highlighted that insurance policies for forests typically cover damage caused by fire, storm, and pests. Timber insurance, specifically, is designed to protect the financial value of timber resources, ensuring that forest owners can recover economic losses from such events. These policies often integrate remote sensing technologies for better risk assessment and claim verification, making them more effective and reliable (Mann et al., 2022).

Furthermore, Brunette, Couture, and Foncel (2023) emphasize the importance of forest insurance for natural events in their overview, noting that the willingness-to-pay among German forest owners is higher compared to their European counterparts. This suggests a growing recognition of the value of insurance in safeguarding forest assets against unpredictable natural disturbances (Brunette et al., 2023).

b. Green solutions and biodiversity insurance

Insurance products are also evolving to support green solutions and biodiversity conservation. A report by Krumm, Schuck, and Rigling (2020) underscores the need for pragmatic and regionally-rooted management approaches to improve biodiversity conservation in European managed forests, including Germany. The study suggests that biodiversity conservation can be indirectly supported through insurance mechanisms that promote sustainable forest management practices (Krumm et al., 2020).

Additionally, Loisel, Brunette, and Couture (2020) explore the concept of integrating biodiversity values into forest insurance frameworks. Their research indicates that policies designed to protect forest biodiversity can serve as ecological insurance, reducing the variance in ecosystem services and enhancing forest resilience. This approach aligns with global calls for integrating biodiversity considerations into sector policies (Loisel et al., 2020).

c. Incentives for sustainable forest management

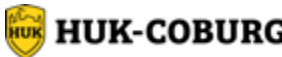
Winkel et al. (2022) provide insights into the multifunctionality of forests and the opportunities for integrating ecosystem services into forest management policies. They highlight that insurance schemes can incentivize sustainable practices by providing financial benefits for maintaining high biodiversity and ecosystem service levels. These incentives encourage forest owners to adopt practices that enhance resilience and reduce the likelihood of catastrophic losses (Winkel et al., 2022).

Also, Hahn et al. (2021) discuss the resilience value of alternative forest management adaptations to storms, noting that insurance policies can play a critical role in promoting these adaptations. By offering coverage that accounts for the ecological benefits of diverse and resilient forest structures, insurance products can support long-term sustainability and forest health (Hahn et al., 2021).

d. Insurance products/services offered by major insurance companies

To provide the commitment of major insurance companies towards sustainability and environmental stewardship, Table 22 below details the specific policies, decarbonization targets, green investments, and insurance options related to forests and forestry management as reported by each of the top ten insurance companies in their 2023 annual reports. While most companies do not explicitly mention dedicated forestry-related insurance solutions in their reports, those committed to sustainability are increasingly supporting broader environmental initiatives and eco-friendly practices, indirectly promoting forest resilience and sustainable land management.

Table 22 Overview of Sustainability Initiatives and Forestry-Related Insurance Practices in Portuguese Insurance Companies

Insurance company		Sustainability and Climate Resilience Focus	Green Solutions and Biodiversity in Forestry
	Allianz SE (Germany)	Committed to environmental stewardship and climate resilience. Aims for carbon neutrality by 2050 and aligns with Paris Agreement goals.	Supports sustainable forest management and provides financial incentives for eco-friendly, biodiversity-enhancing methods.
	Munich Re Group	Strong focus on addressing climate change through investments in renewable energy and green technologies. Aims for carbon neutrality by 2050.	No specific mention of green solutions or biodiversity in forestry.
	Talanx AG	Committed to sustainability with decarbonization targets and investments in green projects.	No specific mention of green solutions or biodiversity in forestry.
	R+V Versicherung AG	Focuses on reducing carbon footprint through renewable energy investments and aligning with global climate goals.	No specific mention of green solutions or biodiversity in forestry.
	HUK-COBURG Versicherungsgruppe	Emphasizes environmental protection and sustainability, invests in renewable energy, and aims to reduce greenhouse gas emissions.	No specific mention of green solutions or biodiversity in forestry.
	AXA Versicherung AG	Comprehensive approach to forest-related risks, including fire, storm damage, and pest infestations. Aims to reduce carbon emissions and invest in green technologies and renewable energy.	Provides financial incentives for sustainable forest management, supports reforestation and afforestation to enhance biodiversity and reduce carbon emissions.
	Debeka Lebensversicherungsverein	Committed to reducing carbon footprint through investments in renewable energy.	No specific mention of green solutions or biodiversity in forestry.

 Versicherungskammer Bayern	Aims for carbon neutrality by 2050 through investments in green technologies and renewable energy.	No specific mention of green solutions or biodiversity in forestry.
 LVM Konzern	Highlights sustainability goals, including carbon neutrality and investments in renewable energy.	No specific mention of green solutions or biodiversity in forestry.
 Gothaer Versicherungsbank VVG	Committed to environmental sustainability and reducing carbon emissions through investments in green technologies.	No specific mention of green solutions or biodiversity in forestry.

4.3.2.4 Analysis of innovative insurance solutions and Nature-based solutions

In Germany, innovative insurance policies and Nature-based solutions (NBS) are increasingly recognized as essential components in managing and mitigating environmental risks associated with forestry. These solutions integrate modern risk management approaches with ecological benefits, ensuring sustainable forest management and resilience against climate change. This section provides an overview of the innovative insurance products and Nature-based solutions related to forests, forestry products, and timber in Germany.

a. Innovative insurance policies

Comprehensive Forest Insurance Policies

One of the key innovative insurance products in Germany is comprehensive forest insurance, which includes coverage for natural disasters such as storms, fires, and pest infestations. These policies are designed to provide financial security to forest owners by covering both the direct damage to the forest and the economic losses related to timber production. According to Mann et al. (2022), these policies often include clauses that encourage sustainable forestry practices, thereby enhancing the overall resilience of forest ecosystems (Mann et al., 2022).

Parametric Insurance Solutions

Parametric insurance is another innovative product gaining traction in the German forestry sector. Unlike traditional insurance, parametric insurance pays out based on the occurrence of predefined events, such as a storm of a certain magnitude, rather than actual damage assessment. This approach ensures quicker payouts and reduces administrative burdens. For instance, parametric insurance policies are linked to weather indices, which are monitored through advanced remote sensing technologies, providing a more efficient risk management solution for forest owners (Prins, 2021).

Biodiversity and Ecosystem Service Insurance

Insurance products that focus on biodiversity and ecosystem services are emerging as crucial tools for forest conservation. These policies incentivize forest owners to maintain high biodiversity levels and protect ecosystem services by offering financial rewards for conservation efforts. According to Winkel et al. (2022), such insurance products are integrated with Nature-based solutions, promoting practices that enhance biodiversity and ecosystem resilience, such as the use of mixed-species plantations and the protection of natural habitats within commercial forests (Winkel et al., 2022).

b. Nature-based solutions (NBS)

Integration with Insurance Products

Nature-based solutions are increasingly being integrated into innovative insurance products. These solutions leverage natural processes to mitigate environmental risks and enhance the resilience of forest ecosystems. For example, green infrastructure projects, such as reforestation and wetland restoration, are covered under specialized insurance policies that support their implementation and maintenance. Toxopeus and Polzin (2017) highlight that these insurance products not only reduce financial risks but also contribute to broader environmental and social benefits, such as carbon sequestration and improved water quality (Toxopeus & Polzin, 2017).

Climate Adaptation and Disaster Risk Reduction

Nature-based solutions are particularly effective in climate adaptation and disaster risk reduction. Policies that encourage the adoption of NBS, such as the restoration of riparian buffers and the creation of firebreaks using native vegetation, are supported by insurance schemes that cover the costs of these interventions. Veerkamp et al. (2021) emphasize that integrating NBS into insurance frameworks enhances the overall effectiveness of disaster risk management strategies, providing a sustainable approach to addressing climate-related hazards (Veerkamp et al., 2021).

Public-Private Partnerships

The successful implementation of Nature-based solutions often involves collaboration between public and private sectors. Insurance companies in Germany are partnering with government agencies and non-governmental organizations to develop and promote NBS. These partnerships facilitate the sharing of resources and expertise, ensuring the scalability and sustainability of nature-based projects. Calliari et al. (2022) note that such collaborations are essential for creating resilient landscapes and communities, as they combine financial resources with ecological knowledge and community engagement (Calliari et al., 2022).

Subsequently, to provide a detailed comparative analysis of the leading insurance companies in Germany and their solutions related to forest and forestry-related products, **Table 23** below outlines their involvement in Nature-based solutions (NBS), coverage features, forest protection policies, special incentives or climate change policies, and the number of insurers adhered to these policies based on their 2023 annual reports and their respective websites.

Table 23 Comparative Analysis of Insurance Companies in Germany Covering Forests and/or Forestry Related Products Offering Special Incentives for Eco-Friendly and Sustainable Practices (2023)

Insurance company	Details on NBS involvement	Coverage features	Special incentives/climate change policies
 Allianz SE (Germany)	Actively involved in NBS projects, including reforestation and biodiversity conservation initiatives.	Coverage for potential risks such as property damage, liability, and environmental impacts that can affect forestry businesses.	Ambitious decarbonization targets, aiming for carbon neutrality by 2050. Significant investments in green projects and renewable energy.
 Munich Re Group	Supports NBS projects aimed at enhancing forest resilience and biodiversity.	Agricultural reinsurance solutions: insurance for forestry plantations, which includes risk management of planted trees including protection from storms, droughts, and other environmental risks.	Aims for carbon neutrality by 2050 and invests heavily in green technologies and renewable energy projects.
 Talanx AG	Involved in several NBS projects, focusing on reforestation and sustainable land use.	Coverage for property, liability, and other risks that may be relevant to forestry businesses under broader categories like agriculture or property insurance.	Ambitious decarbonization targets and invests in green projects to promote environmental sustainability.
 R+V Versicherung AG	Supports NBS initiatives aimed at enhancing forest health and biodiversity.	Agricultural insurance solutions = potentially cover aspects related to forestry, such as liability and property insurance within broader agricultural contexts.	Aims to reduce carbon footprint and invests in renewable energy and green technologies.
 HUK-COBURG Versicherungsgruppe	Involved in projects that promote sustainable forest management and biodiversity.	Not specified.	Invests in renewable energy projects and aims to achieve significant reductions in greenhouse gas emissions.
 AXA Versicherung AG	Supports NBS projects, including reforestation and sustainable land use initiatives.	Coverage for forest owners against fire, storms and personal and property damage, including options for environmental damage liability.	Ambitious decarbonization targets and invests heavily in green technologies and renewable energy.
 Debeka Lebensversicherungsverein	Supports NBS initiatives focused on reforestation and enhancing biodiversity.	Not specified.	Aims for significant reductions in greenhouse gas emissions and invests in renewable energy projects.
 Versicherungskammer Bayern	Involved in NBS projects that promote sustainable forestry and biodiversity conservation.	Not specified.	Invests in green technologies and renewable energy, aiming for carbon neutrality by 2050.
 LVM Konzern	Supports NBS projects aimed at sustainable forestry and biodiversity enhancement.	Agricultural insurance solutions = potentially cover aspects related to forestry, such as liability and property insurance within broader agricultural contexts	Aims to achieve carbon neutrality and invests in renewable energy projects.
 Gothaer Versicherungsbank VVaG	Supports NBS projects focused on reforestation and sustainable land use.	Agricultural insurance solutions = potentially cover aspects related to forestry, such as liability and property insurance within broader agricultural contexts	Invests in renewable energy and green technologies, aiming for carbon neutrality in its operations.

4.3.2.5 NBS case studies

Case Study 1: Flood Protection on the Isar River, Munich



The Isar River in Munich is a notable example of a successful Nature-Based Solution (NBS) project that involved collaboration with insurance companies. This project aimed to enhance flood protection while restoring natural river dynamics. The project included measures such as widening the riverbed, creating floodplains, and planting riparian vegetation to improve water retention and reduce flood peaks. Insurance companies played a critical role by providing financial support and risk assessments, ensuring that the NBS could offer reliable flood protection benefits. The collaboration demonstrated the effectiveness of integrating ecological restoration with flood management strategies, reducing insurance claims related to flood damage (Linnerooth-Bayer et al., 2023).

Case Study 3: NBS for Urban Resilience in Hamburg



Hamburg's urban resilience strategy includes multiple NBS projects aimed at enhancing biodiversity, reducing urban heat islands, and managing stormwater. One significant project is the creation of green roofs and walls across the city. Insurance companies have been involved by providing coverage for the installation and maintenance of these green infrastructures. These insurance products cover potential damages and maintenance costs, encouraging property owners to invest in NBS. The insurance policies also include clauses that promote the use of native plants and sustainable practices, contributing to the overall resilience of the urban environment (Calliari et al., 2022).

Case Study 2: Resilient Forest Management in the Black Forest



In the Black Forest region, an innovative insurance product was developed to support resilient forest management practices. This insurance policy covers forest owners against losses from natural disturbances such as storms, fires, and pest infestations. The policy also incentivizes sustainable forest management practices, such as mixed-species plantations and continuous cover forestry, which enhance forest resilience and biodiversity. This case study highlights the synergy between insurance companies and forest managers, where insurance products are designed to promote long-term ecological benefits and reduce the financial risks associated with forest management (Veerkamp et al., 2021).

Case Study 4: Forest Insurance and Ecosystem Services in Bavaria



In Bavaria, a comprehensive forest insurance policy has been developed that integrates coverage for ecosystem services. This policy provides financial protection against damages from natural events while also rewarding forest owners for maintaining high levels of biodiversity and ecosystem services. The insurance product covers the costs of implementing sustainable forest management practices, such as the preservation of old-growth trees and the creation of wildlife corridors. This innovative approach ensures that forest management practices contribute to the conservation of biodiversity and the provision of ecosystem services, aligning financial incentives with ecological benefits (Winkel et al., 2022).

As seen in similar European countries such as France and the Netherlands, these case studies illustrate the successful implementation of Nature-based solutions in Germany, facilitated by innovative insurance products and services. By integrating ecological restoration and sustainable practices into insurance policies, these projects demonstrate how financial mechanisms can support and enhance the resilience of both natural and urban environments. The collaboration between insurance companies and NBS projects not only reduces financial risks but also promotes long-term ecological and social benefits.

4.3.2.6 Challenges, future trends and opportunities

a. Challenges in the German forestry sector

The forest insurance sector in Germany faces several challenges that complicate effective risk management and policy implementation. One significant challenge is the increasing frequency and severity of natural disasters, such as storms, fires, and pest infestations, driven by climate change. These events lead to substantial economic losses and pose difficulties in assessing and underwriting forest risks accurately (Holzwarth et al., 2020). Additionally, there is a lack of standardized data and methods for evaluating the impacts of these events on forests, which hinders the development of tailored insurance products (Brunette & Couture, 2023). Another critical issue is the relatively low awareness and adoption of insurance products among forest owners. Many forest managers are either unaware of the available insurance options or find them too costly, leading to insufficient coverage. This gap in coverage exacerbates the financial vulnerability of forest owners when disasters strike, further stressing the importance of enhancing insurance penetration in this sector (Veerkamp et al., 2021).

b. Future trends in the German forestry and insurance sector

The future of forest insurance in Germany is likely to be shaped by advancements in technology and the increasing integration of Nature-based solutions. One emerging trend is the use of remote sensing and geographic information systems (GIS) to improve risk assessment and monitoring. These technologies enable insurers to gather real-time data on forest conditions, enhancing the accuracy of risk models and facilitating more responsive and dynamic insurance policies (Holzwarth et al., 2020).

Also, parametric insurance products, which pay out based on predefined triggers such as weather indices rather than actual loss assessments, are expected to gain prominence. These products offer quicker payouts and reduce administrative complexities, making them attractive to both insurers and forest owners. Moreover, they can be linked to specific environmental conditions, promoting proactive forest management practices that align with sustainability goals (Prins, 2021).

c. Opportunities in the German forestry and insurance sector

Integrating Nature-based solutions into insurance products presents a significant opportunity for enhancing forest resilience and sustainability. NBS, such as reforestation, wetland restoration, and the creation of biodiversity corridors, not only mitigate environmental risks but also provide co-benefits such as carbon sequestration and enhanced biodiversity (Toxopeus & Polzin, 2017). Insurance companies can develop policies that offer premium discounts or additional coverage for forest owners who implement NBS. These incentives can drive broader adoption of sustainable practices, contributing to the overall health and resilience of forest ecosystems. Additionally, public-private partnerships can be instrumental in scaling up these solutions, combining financial resources with ecological expertise to support large-scale NBS projects (Calliari et al., 2022).

In conclusion, the forest insurance sector in Germany is facing significant challenges but also promising opportunities. Addressing the impacts of climate change, improving risk assessment methods, and increasing insurance penetration are important to strengthening the sector. The integration of advanced technologies and Nature-based solutions into insurance products offers a path forward, promoting sustainable forest management and enhancing resilience against environmental risks.

5 Comparative analysis of survey results and market state

5.1 Introduction

This section provides a detailed cross-regional analysis of climate-related risk perception, impacts, and insurance coverage among European citizens across six specific countries: Finland, France, Germany, Italy, the Netherlands, and Spain. While previous sections examined these factors at an aggregated European level, here we aim to dissect the data at a country level to reveal unique geographic patterns and regional nuances in attitudes, experiences, and preparedness regarding climate-related hazards.

Through this country-specific examination, we aim to provide a comprehensive understanding of how climate change is perceived, experienced, and managed across each European region under analysis (Fig. 54). By identifying regional differences and commonalities, this analysis not only sheds light on the varying vulnerabilities and priorities across European countries but also highlights opportunities for tailored policy measures and insurance solutions to better support citizens in adapting to climate risks.

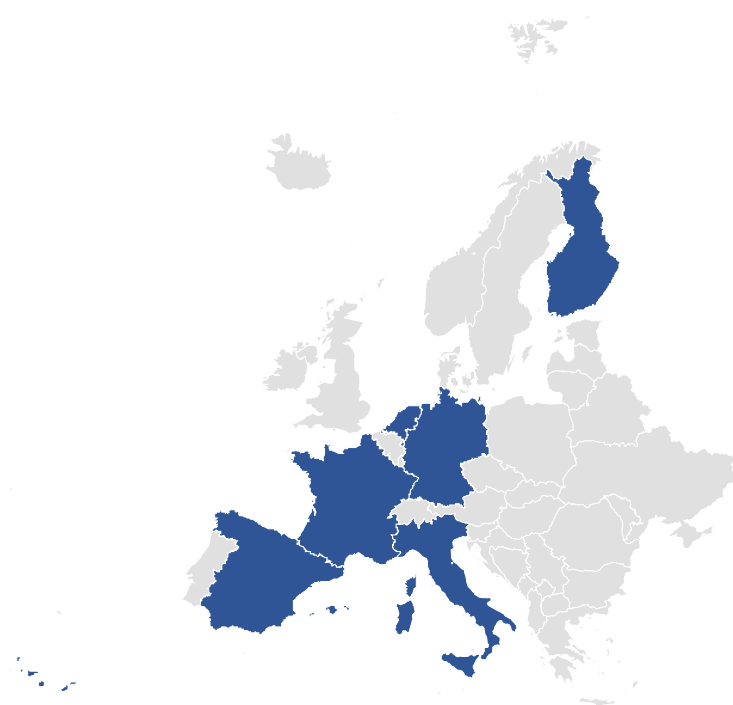


Figure 54: European countries under analysis

This section of the document will be structured as follow, in section 5.2 we analyse the climate change awareness and concern levels regarding specific natural hazard-related risks in each of the six European countries - Finland, France, Germany, Italy, Netherland and Spain. In section 5.3, we evaluate the actual impact of these natural events in terms of both experience and the financial losses suffered, specifically for each region. Finally, in section 5.4 we assess citizens' knowledge of insurance solutions to protect against these risks we explore which are the barrier and the incentives and barriers to purchasing these policies.

5.2 Climate Change Awareness (cross-region)

Delving deeper into the regional breakdown, we observe that the level of concern about climate change remains relatively consistent across the European areas analysed. Using a scale from 1 to 3 (1 indicating "not concerned at all," 2 "moderately concerned," and 3 "highly concerned"), we find that all countries are closely aligned, with the weighted average of responses ranging between 2.15 and 2.36. More specifically, among each considered European region, the percentage of citizens expressing concern about climate change spans from 80% to 90% (Figure 55), in line with the overall results previously mentioned. Indeed, in all regions, the share of citizens who reports being "not concerned at all" about climate change remains limited, ranging between 10% and 20% with the highest levels in Germany (19.3%) and the lowest in Spain (8.2%). One slight exception appears when examining the share of citizens who are "highly concerned" about climate change. Spain and Germany stand out in this regard, with over 40% of respondents in both countries expressing high concern — 44.5% in Spain and 40.4% in Germany — compared to an average of around 30% in other regions.

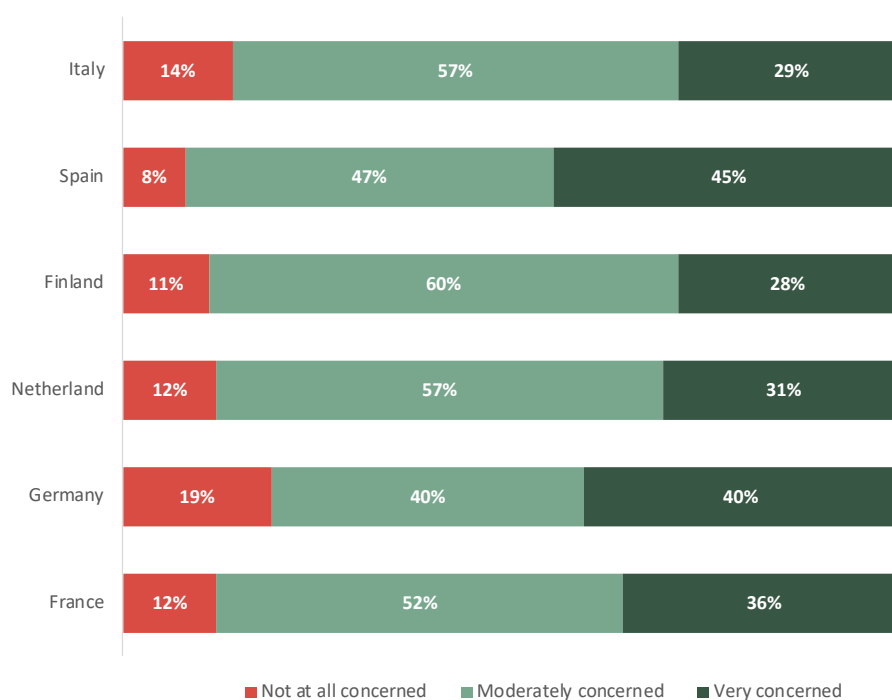


Figure 55: Concerns about climate change by country. Source: proprietary data on 951 European citizens

When considering future implications of climate change, we observe a similar alignment across European countries. The percentage of citizens who believe that climate change will increase the frequency and severity of natural hazards in their area remains high, ranging from 62% to 74% across the European regions (Figure 56). The only notable exception is Germany, where only 46% of citizens thinks that climate change will lead to an increase in the frequency and severity of natural hazards in their area, while 35% believes it will not increase that much. However, even in this case, when using a scale from 1 to 4 (1 – "it will not increase at all"; 2 – "it will not increase that much"; 3 – "it will increase enough"; 4 – "it will increase a lot") and looking at the weighted average of responses in each country, we find that European countries

remain largely aligned in their perceptions of future climate change impacts. The scores range from 2.39 (Germany) to 2.94 (Finland) across the regions, reflecting consistent expectations of increased extreme natural hazards across Europe.

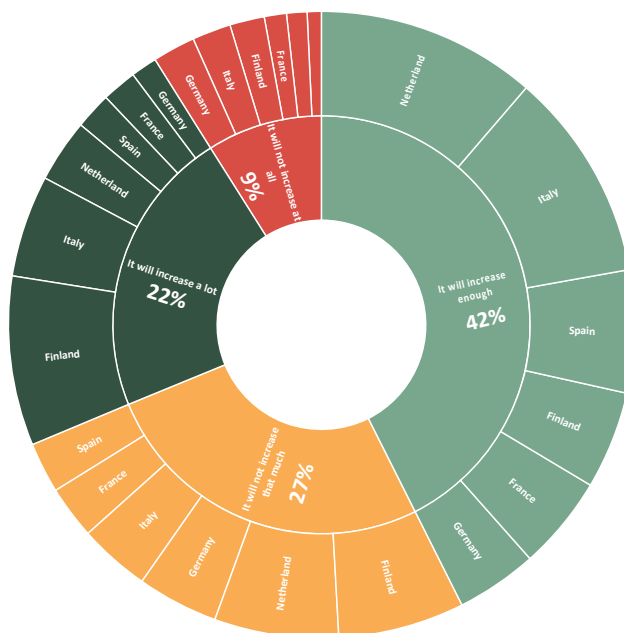


Figure 56: Frequency and severity of natural hazards in European regions. Source: proprietary data on 951 European citizens.

A deeper exploration of risk perception for specific natural hazards offers valuable insights into how European citizens perceive threats in their own regions. Geophysical factors, such as proximity to high-risk areas, play a significant role in shaping public perception, creating considerable regional variation in how natural hazards are viewed (Montz and Tobin, 2011). Despite these regional differences, there is a general consistency in how natural hazards are perceived across Europe, with meteorological phenomena — such as heavy rainfall, hail, and storms — emerging as the most widely recognized risks.

It is worth noting that from the detailed analysis of risk perception for specific natural phenomena (Poljanšek et al., 2017), no clear distinction emerges between the various countries (Figure 57). Indeed, the perception emerging from the citizens of each country under analysis closely aligns with the general European perception previously reported (Fig. 4), with meteorological phenomena perceived by all countries as the most hazardous, followed by climatological, hydrological, and geophysical.

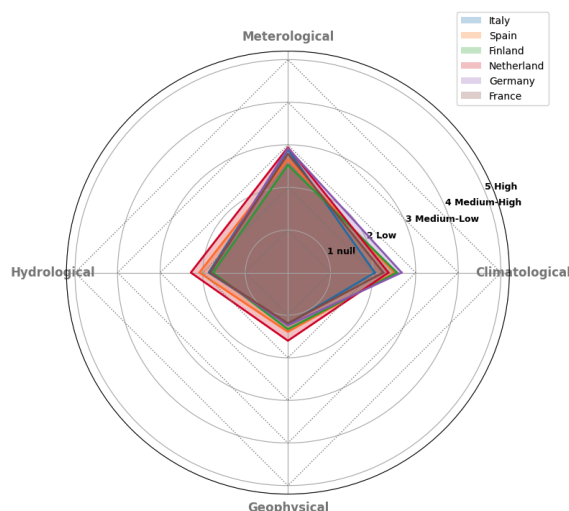


Figure 57: Perceptions on the risk associated to different natural phenomena (from 1-null to 5-high) by country. Source: proprietary data on 951 European citizens.

In this context, a deeper analysis of risk perception regarding specific natural hazards reveals notable differences in how citizens from the various countries under analysis perceive these risks (Fig. 58). For all the countries under review, the top three perceived risks predominantly involve meteorological phenomena, specifically heavy rainfall, hail, and storms, although their ranking varies by country. An exception is Spain, where drought — a climatological phenomenon — ranks third, preceding hail, which falls to fourth place (Fig. 58). This finding indicates a widespread awareness among European citizens of the potential consequences of natural hazards that they are more likely to experience, such as heavy rainfall, hail, and storms. Following these three primary risks, drought, wildfires, and floods are perceived as moderately risky, albeit in varying orders across countries. Notably, Germany and Finland, given their geographical characteristics, identify wildfires as a particularly significant natural hazard compared to other nations. This perception may be influenced by the increasing occurrence of wildfires in these areas, which can be exacerbated by the changing climate conditions. In contrast, drought is regarded as more hazardous in countries like Italy — where it ranks fourth among various natural hazards — and Spain, where it occupies the third position. The increased frequency of heatwaves and water shortages in these regions could contribute to heightened concern regarding drought among their populations. Interestingly, Dutch citizens also consider drought to be a higher risk (fourth place) than floods, which are perceived as fifth. However, when comparing across countries, the Netherlands rates floods as the most significant risk, followed closely by Italy and Spain. This suggests that Dutch population remains acutely aware of the potential impacts of flooding. The remaining risks, particularly tsunamis and volcanic eruptions, are generally regarded as low-risk or negligible across the surveyed regions, reflecting their infrequent occurrence in these specific European contexts. Overall, this section underscores the varying levels of risk perception associated with different natural hazards, influenced by geographic and environmental factors unique to each country.

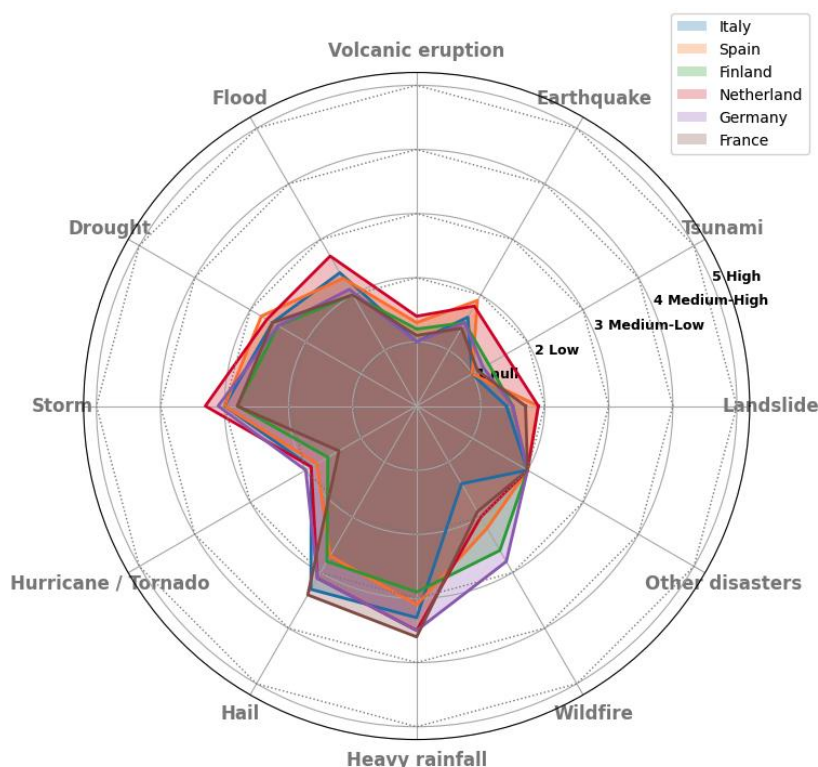


Figure 58: Perceptions on the risk associated to different natural hazards (from 1-null to 5-high) by country. Source: proprietary data on 951 European citizens.

5.3 Damages from Climate Change (cross-region)

The second section of Chapter 3 (3.3) deep dive into the detailed impact of climate change-related events on European citizens, focusing specifically on the tangible financial consequences that extreme weather events have had on individuals. At the European level, results indicate that 76% of citizens have experienced at least one natural hazard in the past five years, while one in four Europeans has faced economic losses related to these events during the same period.

However, when we break down these results by country, some variations emerge. In countries like Italy, Spain, and France, the percentage of citizens who have experienced at least one natural hazard is closely aligned with the European average, standing at 79%, 74%, and 77%, respectively. Differences emerge when examining Finland, Germany, and the Netherlands. In the first two countries, the impact of natural hazards appears to be less widespread among the population: only 66% of Finnish citizens reported having experienced at least one natural hazard in the last five years, while this figure increases slightly to 70% in Germany. In contrast, the situation in the Netherlands stands out, with a significant 86% of citizens reporting to have experienced at least one natural hazard during this period. This figure, as we will see later, is largely influenced by the heightened impact of natural hazards such as floods, storms, and hailstorms in the Netherlands compared to other European countries.

Turning to the economic losses resulting from these natural hazards, we observe a trend consistent with the aforementioned findings. Finland and Germany report the lowest

percentages of citizens claiming to have incurred financial losses due to natural hazards, with only 11% and 21% of citizens affected, respectively. Spain and France follow, with figures more in line with the European average.

Finally, Italy and the Netherlands show the highest percentages of citizens reporting economic losses (33% and 36%, respectively), which, as we will explore further, are largely driven by the impact of meteorological phenomena such as storms, hailstorms, and heavy rainfall that may lead to floods.

When examining the specific impact of climate change-related natural hazards across specific European regions, although the general trend is maintained, the data reveal significant variation between countries, both in the type of hazards experienced and their respective economic consequences. Figure 59 underscores that Italy, the Netherlands and France stand out as the regions most affected by a wide array of natural phenomena. This is particularly evident in meteorological phenomena, with heavy rainfall and hail emerging as the most frequent hazards in these two countries, as well as in France. Specifically, Italy reports the highest percentage of the population affected by heavy rainfall (72.9%) and hail (73.4%), closely followed by France (73.0% and 62.0%, respectively) and the Netherlands (68.6% and 60.5%, respectively). These figures highlight the prevalence and severity of meteorological events in these regions (Fig. 59).

In contrast, Finland presents an anomaly in the overall pattern. Figure 59 reveals a lower level of citizens declaring to have experienced the impact of natural phenomena. Going more in deep, with only 47.6% of respondents experiencing heavy rainfall and 46.7% hail (Fig. 59), Finland reports the lowest occurrence of these meteorological phenomena across the surveyed countries. This is indicative of Finland's distinct climate and environmental conditions compared to southern and western European nations. Nevertheless, the Netherlands again exhibits a notable exposure to storm events, with 60.5% of the population affected, followed by Italy (58.9%) and France (40.0%), further illustrating the vulnerability of these regions to frequent meteorological disturbances.

Climatological phenomena, droughts and wildfires, show a more uneven distribution across Europe. While Spain and Germany have higher incidences of wildfires (12.7% and 24.6%, respectively), droughts are relatively evenly spread, affecting roughly one-third of the population across most countries, with Germany reporting a slightly lower occurrence (22.8%). The impact of hydrological hazards — such as floods — displays a strong regional character, with Italy (30.4%), France (25.0%), and the Netherlands (22.4%) being the most affected.

When examining the specific impact of climate change-related natural hazards across European regions (Fig. 60), although the overall trend remains consistent, the data reveal significant variation between countries, both in the type of hazards experienced and their respective economic consequences. Figure 59 underscores that Italy, the Netherlands, and France stand out as the regions most affected by a wide array of natural phenomena. This is particularly evident in meteorological events, with heavy rainfall and hail emerging as the most frequent hazards in these regions. Specifically, Italy reports the highest percentage of the population affected by heavy rainfall (72.9%) and hail (73.4%), closely followed by France (73.0% and 62.0%, respectively) and the Netherlands (68.6% and 60.5%, respectively). These figures highlight the prevalence and severity of meteorological disturbances in these countries (Fig. 60).

Geophysical phenomena, such as earthquakes, tsunamis, and volcanic eruptions, remain rare across the analyzed regions. The overwhelming majority of citizens report not having experienced any of these events in the past five years. In contrast, moderate levels of impact are observed with hydrological and climatological phenomena. Floods, while less prevalent across most European regions, still affect a notable percentage of the population in the Netherlands, France, and Italy—22%, 25%, and 30%, respectively. Landslides, on the other hand, show a more consistent trend across all countries, affecting less than 10% of citizens.

Finland presents an anomaly in the overall pattern. Figure 59 clearly reveals a lower level of citizens declaring that they have experienced the impact of natural phenomena. Only 47.6% of Finnish respondents reported experiencing heavy rainfall, and 46.7% reported hail (Fig. 60), the lowest occurrence of these meteorological phenomena across the surveyed countries. This reflects Finland's distinct climate and environmental conditions compared to southern and western European nations. Nevertheless, the Netherlands continues to exhibit significant exposure to storm events, with 60.5% of the population affected, followed closely by Italy (58.9%) and France (40.0%), further illustrating the vulnerability of these regions to frequent meteorological disturbances.

Climatological phenomena, such as droughts and wildfires, show a more uneven distribution across Europe. While wildfires are particularly prevalent in Germany and Spain —24.6% and 12.7% of citizens affected, respectively — droughts display a broader but more balanced spread, affecting around 30% to 37% of the population across most regions. Germany is an outlier here, with only 22.8% of its population affected by droughts. In contrast, drought ranks higher as a concern in Spain and Italy, where it ranks fourth among various natural hazards.

Meteorological phenomena show the greatest variation across regions. Storms, for instance, have impacted approximately 45% of European citizens overall, with notable regional deviations. In Finland, only 36% of citizens report being affected by storms in the last five years, while in Italy and the Netherlands, the percentages are significantly higher at 58.9% and 60.5%, respectively. A similar pattern emerges with heavy rainfall, where 66% to 73% of citizens across most countries report having experienced this hazard, except for Finland, where the figure drops to 47.6%. The prevalence of hail follows a comparable trend, with 47% to 49% of citizens affected across Europe, except in the Netherlands, France, and Italy, where the figures rise to 60%, 62%, and 73.4%, respectively.

These findings underscore the diverse environmental risk landscapes across Europe, illustrating how specific regions are more vulnerable to particular types of natural hazards. Southern and western European countries, particularly Italy, France, and the Netherlands, face greater exposure to meteorological phenomena, while central and northern regions, such as Germany and Finland, show heightened concern for climatological hazards like wildfires and droughts. Understanding these regional differences is crucial for developing targeted adaptation strategies and enhancing resilience to future climate-related impacts.

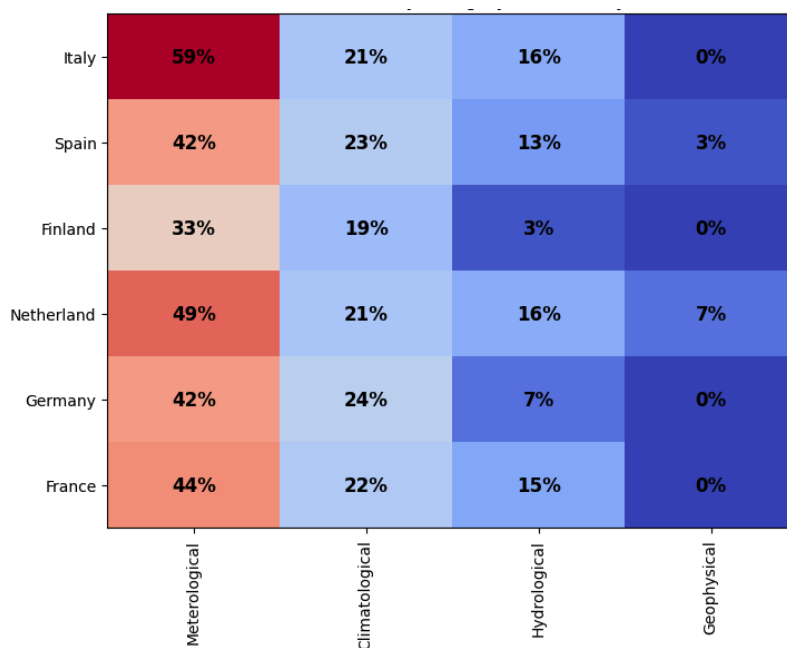


Figure 59: Natural phenomena experienced by country. Source: proprietary data on 951 European citizens

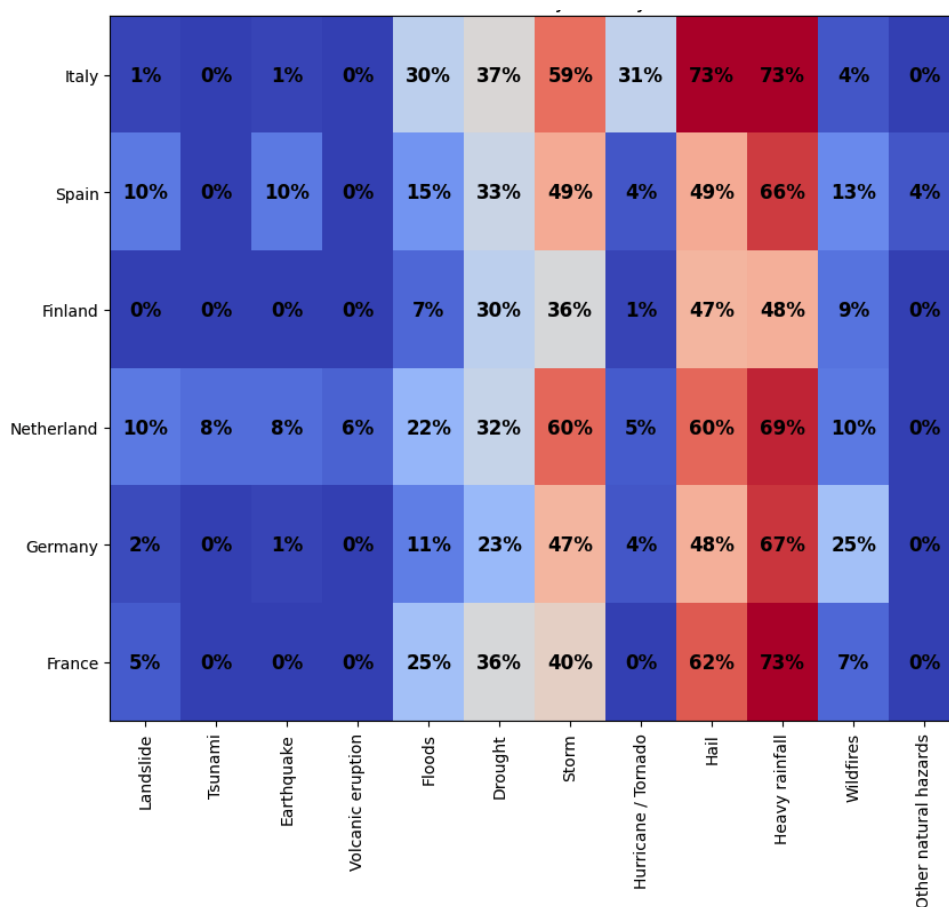


Figure 60: Natural hazards experienced by country. Source: proprietary data on 951 European citizens

Economic losses, as outlined in Figure 61, align with the distribution of these natural hazards. Meteorological events continue to stand out as the most frequent contributors to financial damage. Italy leads again, with 30% of respondents reporting losses from hail (Fig. 62), followed by heavy rainfall (22.7%) and storms (14.0%). The Netherlands and France follow a similar pattern, with significant economic repercussions from these same phenomena. Spain and Germany, on the other hand, report higher economic impacts from wildfires and droughts, reflecting their unique climate-related challenges.

Geophysical phenomena, though far less common, carry disproportionately high economic risks when they do occur. For example, while only a small fraction of the population in countries like Spain, and the Netherlands has experienced earthquakes or volcanic eruptions, the financial losses associated with these events are severe, as evidenced by the loss-to-experience ratio.

In conclusion, while meteorological hazards dominate both in frequency and economic impact across Europe, it is critical to recognize the regional nuances. Countries like Italy, France, and the Netherlands face recurring challenges from heavy rainfall, hail, and storms, leading to considerable financial strain. Meanwhile, countries such as Spain and Germany contend with climatological threats like droughts and wildfires, which, though less frequent, carry significant economic consequences.

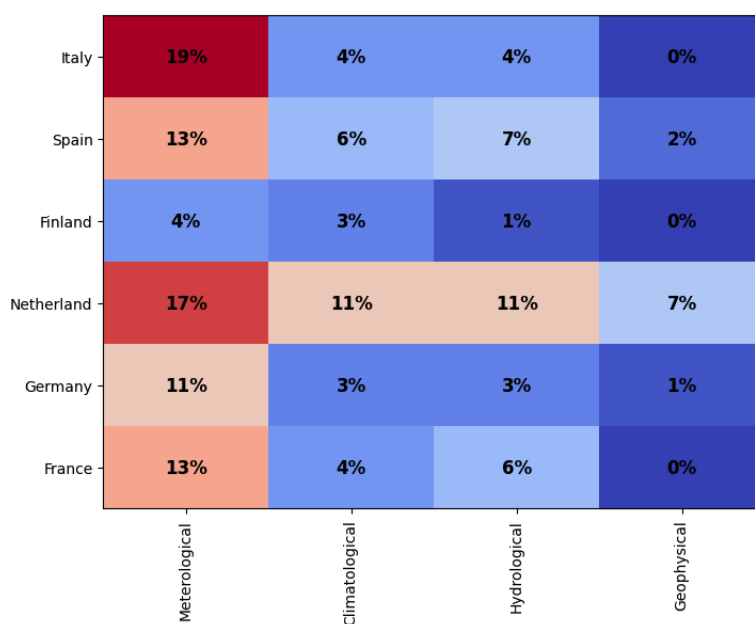


Figure 61: Economic losses suffered due to Natural Phenomena reported by country. Source: proprietary data on 951 European citizens

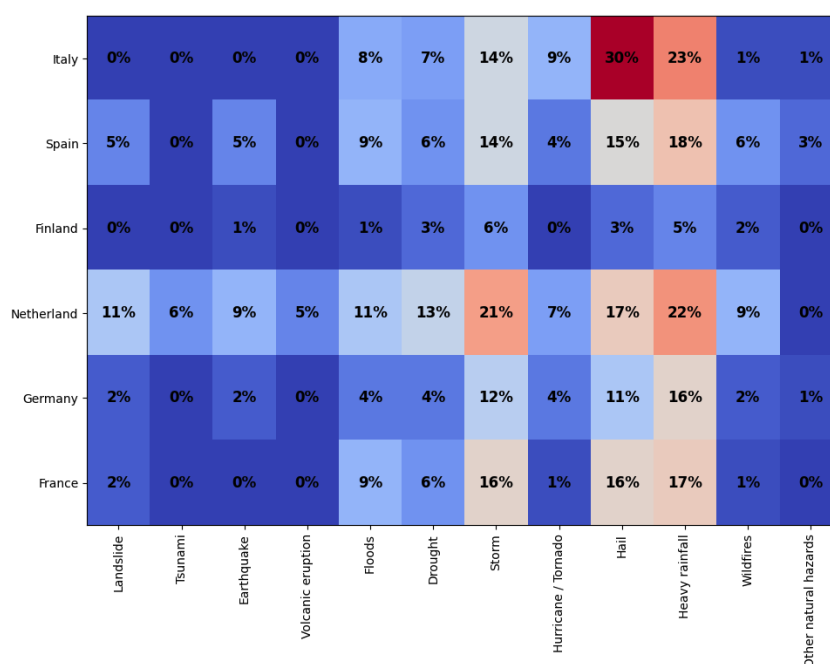


Figure 62: Economic losses suffered due to Natural Hazards reported by country. Source: proprietary data on 951 European citizens

Building on the general trends observed in section 3.3, it is essential to analyze how financial compensation for economic losses due to natural hazards varies across different European countries. On average, around half of the citizens in each country reported receiving some form of financial compensation for damages sustained from natural hazards. However, notable outliers include the Netherlands and France, where more than 60% of respondents indicated they had received compensation. This contrasts sharply with Germany, where less than 40% of the population reported any financial restitution for losses incurred due to natural events.

A closer examination reveals distinct patterns in the sources of compensation (Fig. 63). In countries like Italy and Finland, insurance is virtually the sole mechanism for financial recovery, with 41.2% of Italians and 43.5% of Finns who suffered economic losses reporting that they received compensation solely from insurance companies. In these regions, the role of government in providing financial aid is minimal or non-existent, with only 1.5% of Italians and no Finns receiving government support. In both these countries, insurance is the sole mechanism for recovery, covering 90% and 100% of citizens who received financial compensation, respectively.

In contrast, Spain, the Netherlands, and France present a more diversified compensation landscape. While insurance remains the primary means of recovery — covering 29.6% of Spaniards, 46.7% of Dutch citizens, and 50.0% of the French population — government involvement is significantly higher compared to other countries. Specifically, 14.8% of Spanish respondents, 10.7% of Dutch respondents and 15.4% of French respondents reported receiving compensation from government sources. This suggests that in these countries, government intervention plays a more prominent role in providing financial relief, especially for those affected by more severe or infrequent natural hazards.

Similarly, in these countries, although insurance remains the primary mechanism for recovery, covering 62%, 80%, and 76% of those who received financial compensation, the government is beginning to play an important role by reimbursing 31%, 18%, and 24% of citizens in these three countries who have received financial compensation, respectively.

Germany, consistent with the general trend of lower compensation figures, fall behind other European countries. Only 29.2% of German citizens who experienced economic losses received compensation from insurance, while 8.3% reported financial aid from the government or third parties. This relatively low level of compensation, both from insurance and government sources, highlights the greater vulnerability of German citizens to the financial impacts of natural hazards, indicating a potential gap in the country's financial recovery mechanisms. Indeed, even in this case, insurance remains the primary financial recovery mechanism (78%), but both the government and third-party support play a significant role in assisting those who have received financial compensation (22%).

Overall, these cross-regional differences underscore the varying levels of resilience among European countries when it comes to recovering from the economic consequences of climate-related natural hazards. While insurance plays a crucial role in most countries, particularly in Italy and Finland, the Netherlands and France stand out for their more balanced reliance on both insurance and government aid. Germany's lower levels of compensation, by both insurance and government, indicate the need for enhanced recovery frameworks to better support those affected by climate-induced losses.

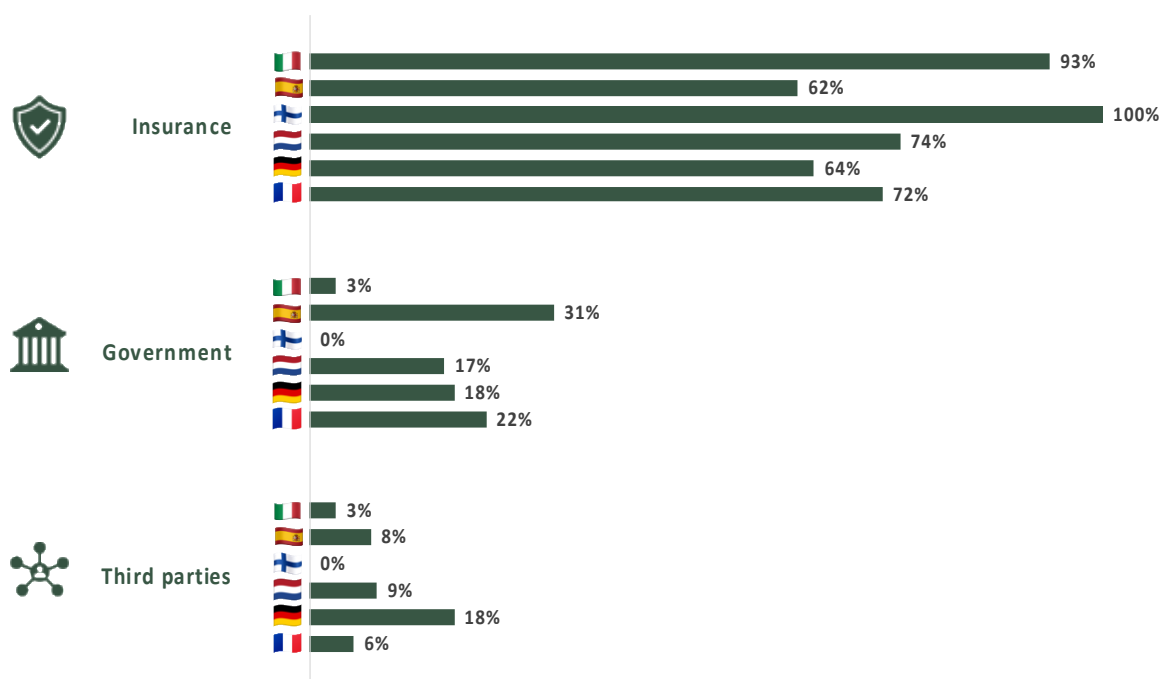


Figure 63: Financial compensation mechanisms for damages or losses suffered from extreme weather events by country. Source: proprietary data on 243 European citizens

5.4 Insurance level (cross-region)

In this final section of the cross-regional analysis, we explore the level of insurance coverage among citizens from different European countries in relation to climate-related risks. Additionally, and in line with the analysis presented in Section 3.5, we will examine the barriers preventing citizens from obtaining insurance coverage for natural hazards, as well as potential incentives to encourage greater uptake. This analysis aims to assess whether any regional specificities exist in terms of insurance coverage.

The results reveal that, compared to the overall European average, four of the six countries under analysis have a higher insurance coverage rate. In fact, insurance coverage for climate-related risks reaches or even exceeds half of the population in countries such as Spain (55.5%), Italy (50.2%), and the Netherlands (49%). The situation is slightly less favorable in France, where less than half (46%) of respondents reported being insured, although this is still better than the European average (42%). Finland and Germany stand out as particularly concerning cases, with 74.3% and 69.3% of citizens, respectively, reporting that they are not insured against any climate-related risks.

Breaking down the analysis further, the level of insurance coverage for specific natural hazards remains low across all countries, with the highest coverage rates only reaching around 30% to 35% for meteorological hazards. An exception is Italy, where the coverage rate for hail damage is remarkably high, with 50% of citizens insured against this hazard, meaning that one in two Italians is insured for hail-related damages.

As detailed in Figure 64, there is a clear preference for insurance coverage toward meteorological phenomena. Hail coverage is among the most widespread across the various European countries, peaking in Italy, where approximately one in two citizens is insured against this hazard. This is followed by France, the Netherlands, and Spain, where coverage rates against the risk arising from hail are 39%, 32.9%, and 30%, respectively. In Germany and Finland, hail coverage remains more limited, at 22.8% and 18.6%, respectively.

Next to hail, heavy rainfall and storms are the natural hazards with the highest coverage rates, particularly in the Netherlands and Spain. In the Netherlands, more than 37% of citizens are insured against the risks arising from storms, while 31.4% are covered for those coming from heavy rainfall. In Spain, the coverage rates for these two hazards are both around 33%. In other European countries, coverage rates for these hazards are more limited, with Finland showing particularly low rates — fewer than 15% of citizens report being insured against heavy rainfall.

For hydrological phenomena, insurance coverage, though more limited, remains widespread across various countries, especially in Spain (35.5%), the Netherlands (25.2%), and France (25%). In other countries, the coverage rates among citizens are more moderate, ranging between 10% and 15%.

Insurance coverage for droughts remains limited across all countries, with peaks of around 15% in Spain, the Netherlands, and France. Conversely, coverage against earthquakes is particularly notable in Spain, where 20.9% of citizens are insured against this geophysical hazard, the highest rate observed across the analyzed regions.

Wildfires show moderate levels of insurance coverage, particularly in Spain, Finland, France, and Germany, where coverage rates against this hazard are 15.5%, 15.7%, 12%, and 10.5%,

respectively. However, coverage remains limited overall, with most countries reporting low rates for wildfire insurance.

Finally, insurance coverage for tsunamis and volcanic eruptions is notably low, with fewer than 7% of citizens insured against these risks in any of the surveyed countries. This low rate likely reflects the lower perceived risk and occurrence of these hazards in most parts of Europe.

Overall, these findings highlight some disparity in insurance coverage across different natural hazards and European regions. Meteorological events such as hail, heavy rainfall, and storms receive the most coverage, while coverage for climatological and geophysical hazards remains limited.

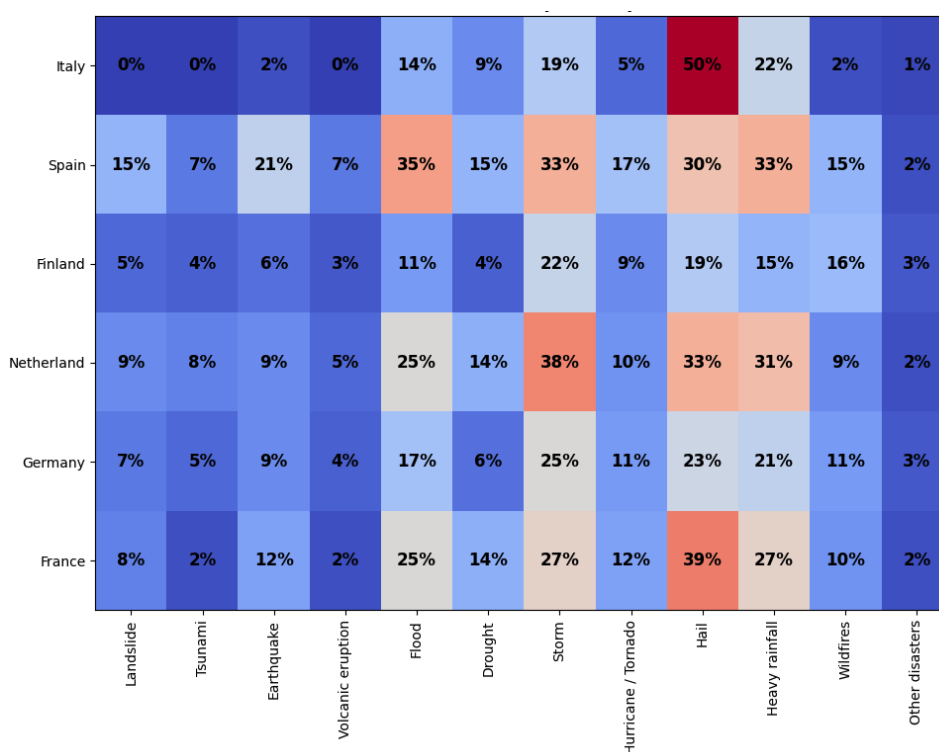


Figure 64: Insurance Coverage level for climate-relate hazards by country. Source: proprietary data on 951 European citizens

In line with the general European findings, the cross-regional analysis confirms that a significant portion of European citizens remain uninsured against every climate-related risks. As highlighted previously, the minority of citizens who do have coverage are primarily insured against meteorological phenomena. Given this context, it is essential to explore the barriers that prevent citizens in each country from obtaining adequate insurance coverage as we did in section 3.5. Accordingly, we analyzed responses from citizens with at least one uninsured climate-related risk to identify the specific reasons for their lack of coverage. This detailed examination allows us to highlights potential regional variations in barriers to insurance adoption.

The analysis reveals trends broadly consistent with the European average, but some notable regional differences emerge (Figure 65). The primary barrier, as observed across all countries, is the perception that natural hazards do not pose a significant risk to warrant insurance coverage. Italy, Finland, and France are particularly noteworthy in this regard, with 70.9%,

69.1%, and 64.1% of respondents, respectively, indicating that they have never perceived these risks. However, this finding can be attributed to two, opposite, distinct factors. For Italy and France, where citizens are highly exposed to meteorological phenomena and are comparatively well-insured against these specific phenomena, this response may reflect limited perceived risk for other types of natural hazards / natural phenomena with lower prevalence and economic impact. Conversely, in Finland, where citizens report the lowest incidence and economic impact of natural hazards, the limited perception of risk is consistent with the relatively low frequency of these events.

In other countries, the percentage of citizens who do not perceive natural hazards as a risk is closer to the European average of 56.3%, with Germany aligning at 54.9%. The Netherlands and Spain show lower proportions of citizens who report not perceiving risks, with only 38.9% and 27.4%, respectively. This lower rate in the Netherlands and Spain may be reflective of these countries' greater exposure and larger economic impacts from various natural hazards, as noted in earlier sections.

Beyond the barrier related to the perception of risk, the analysis highlights that none of the other barriers are cited by more than a quarter of citizens in any country, with *guidance needed* and *process hurdles* affecting fewer than 10% and 5% of respondents, respectively. *Cost concerns*, while generally not a primary barrier across Europe, show regional differences. For example, only 6.7% of Finnish respondents cite cost as a barrier, compared to higher percentages in Italy (19.1%), France (21.7%), and the Netherlands (24.7%). Similarly, *lack of awareness* is not widely seen as a barrier in most regions, with the exception of Spain, where 26.3% of citizens perceive it as an obstacle to obtaining insurance (Figure 65).

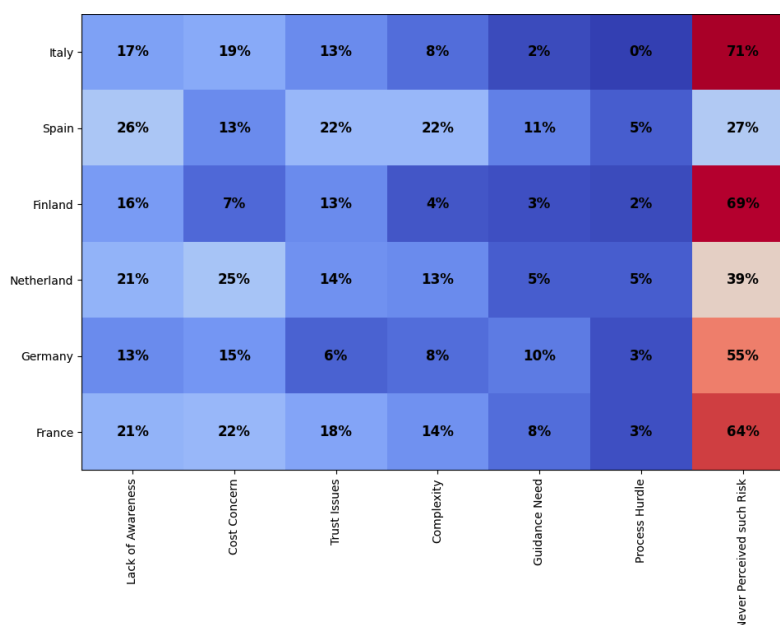


Figure 65: Barriers preventing insurance coverage by country. Source: proprietary data on 815 European citizens

Given the substantial proportion of respondents who do not perceive natural hazards as a risk, it is worthy to refine the data by excluding this barrier – *never perceived such a risk*. This approach, similar to the method applied in the general analysis, allows us to focus exclusively on those who acknowledge the risks yet remain uninsured. This adjustment reveals more

pronounced barriers across other categories, particularly *cost concerns*, *lack of awareness*, and *trust issues* (Figure 66).

Italy and France show the most significant increases across these categories. In both countries, approximately one in two respondents cites cost concerns, lack of awareness, and trust issues as barriers, with cost concerns reaching 63.8% in Italy. In other regions, more moderate increases are observed, with notable exceptions for the Netherlands and Germany in terms of cost concerns, where these barriers rise to 37.4% and 32.6%, respectively. Additionally, lack of awareness becomes a notable barrier in Finland and Spain, rising to 41.2% and 33.3%, respectively.

In conclusion, these findings highlight the diversity in barriers to insurance adoption across European regions. While the lack of perceived risk remains the primary obstacle, cost concerns, lack of awareness, and trust issues also play a significant role, especially when considering only respondents who acknowledge climate-related risks. Addressing these barriers through tailored public education, transparent insurance policies, and targeted incentives could promote broader insurance adoption and enhance resilience to climate-related impacts across Europe.

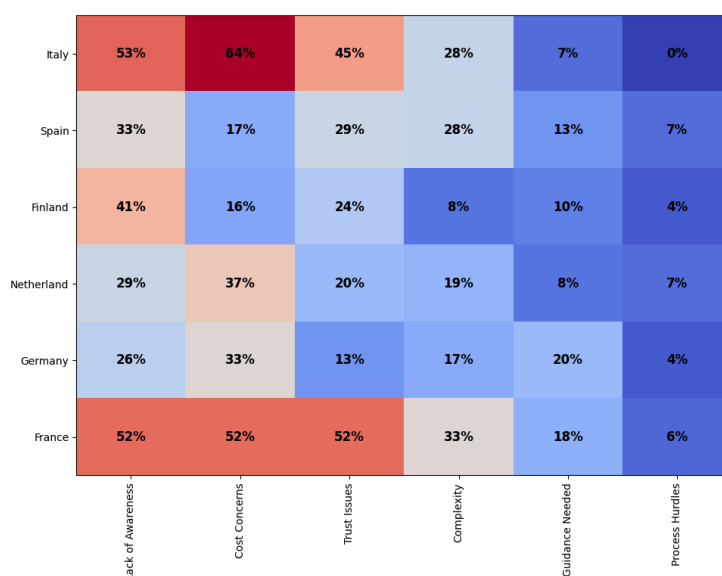


Figure 66: Barriers (excluding “never perceived such risk”) preventing insurance coverage by country.
Source: proprietary data on 815 European citizens

Given the low prevalence of insurance coverage and the significant barriers identified in previous analyses, it is crucial to understand what might motivate European citizens to enhance their insurance protection against climate-related risks (Figure 67). Similar to the general findings, there is no single, straightforward solution. In fact, a substantial proportion of citizens in each country indicated that no factors could influence their decision to seek additional coverage. This sentiment is particularly pronounced in Italy, Finland, and Germany, where 44.0%, 43.3%, and 45.6% of respondents, respectively, stated that no incentives would prompt them to purchase insurance.

Nevertheless, cost remains the most significant incentive across the majority of European countries. Lower premiums could motivate many citizens to consider insurance, especially in

Italy, Finland, and France, where 47.8%, 41.9%, and 49.0% of respondents, respectively, identified cost reduction as a key factor. This suggests that for many, the decision to insure against nature related hazards is primarily about financial feasibility rather than the perceived necessity of coverage. Conversely, in Spain and Germany, cost is less of a driver, with only 34.5% and 33.3% of respondents, respectively, viewing it as a primary incentive. In Spain, where only 17.4% initially cited cost as a barrier, this finding aligns with the limited financial concern previously observed.

Italy, Finland, and Germany also emerge as the most reluctant to adopt insurance, given that nearly half of their populations indicated that no factors could influence their decision to insure. On the other hand, citizens in Spain, France, and the Netherlands appear more receptive to various incentives. In France, beyond cost, government assurance, support, and access to dedicated information sessions are influential for more than 35% of respondents, suggesting a broader range of motivating factors in this region.

Other incentives, while less influential than cost, still play a role across countries. Government assurance appears to be a promising motivator, particularly in France (37.0%) and Spain (26.4%), where a significant portion of respondents indicated that they would feel more confident in insurance products with government involvement. Additionally, information dissemination is seen as a valuable incentive, especially in Italy and France, where 30.4% and 38.0% of respondents, respectively, stated that clearer information could encourage them to purchase insurance. This highlights a need for improved awareness around insurance benefits and procedures.

Support services, which may include personalized guidance through the insurance process, are viewed as important by 35.0% of French respondents and 25.1% of Italians, suggesting that citizens may feel more encouraged to adopt insurance if they have access to advisory resources.

In summary, these findings underscore the necessity for targeted strategies to address cost barriers while also enhancing the overall appeal of insurance products. While cost remains the most pressing issue, other incentives, such as government backing, better information dissemination, support services, and process simplification, offer valuable opportunities for increasing insurance uptake. Tailoring strategies to each country's unique profile could prove effective in fostering broader insurance adoption across Europe.



D1.4 Focused market reviews in WP3 pilot areas

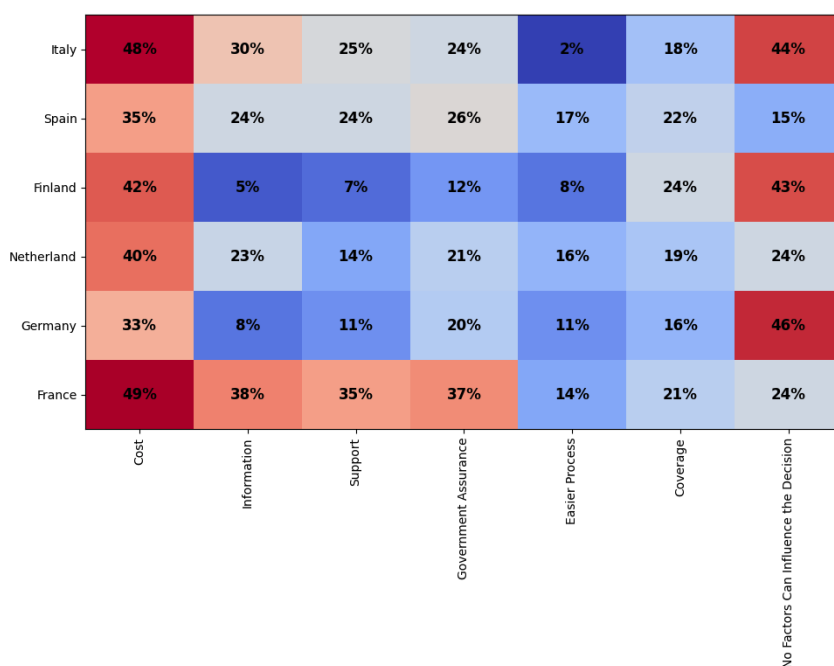


Figure 67: Incentives to increase insurance coverage by country. Source: proprietary data on 951 European citizens

6 Conclusion and recommendations

Deliverable D1.4 provides a thorough assessment of insurance markets in critical climate-sensitive sectors, such as agriculture, forestry, and urban green infrastructure, across key European regions. The report underscores the dual challenges posed by climate change to these sectors and highlights the pressing need for innovative insurance solutions that not only provide financial protection but also incentivize climate resilience and sustainable practices.

The analysis of insurance products in agriculture, forestry, and green infrastructure indicates that current market solutions, while beneficial, remain limited in addressing the full scope of climate-related risks. Across European regions, there is a noticeable disparity in insurance adoption rates and coverage for specific natural hazards. For instance, the report shows that while Spain and the Netherlands exhibit relatively high levels of insurance coverage for climate-related risks, countries like Germany and Finland report significantly lower adoption rates. This variation suggests a need for tailored insurance solutions that account for regional risk profiles and socio-economic contexts.

Insurance products in Germany and Portugal, for instance, are increasingly targeting risks from both biotic (pests) and abiotic (wildfires) threats. However, the effectiveness of these products relies heavily on adopting advanced technologies for risk assessment, such as remote sensing and data-driven predictive models, which allow for early detection and intervention. Integrating these technologies into insurance models can enhance the sector's resilience against escalating climate risks, as seen in the early detection of bark beetle infestations.

In agriculture, parametric insurance products are emerging as viable options to support farmers, particularly in regions where droughts and extreme weather are more frequent. This approach aligns well with climate-smart practices, as it encourages proactive risk management and sustainability. Additionally, urban green infrastructure insurance models, such as those for green roofs, offer pathways to mitigate urban climate risks by covering property owners for associated hazards, like stormwater runoff and structural damage from extreme weather. Such models can help expand the adoption of Nature-based solutions in cities across Europe, supporting broader climate adaptation goals.

Public perceptions of climate-related risks further support the need for innovative insurance products that can address specific concerns and enhance adaptive capacity. Survey data reveal a high level of awareness and concern about climate change impacts, particularly regarding the increase in frequency and severity of natural hazards. Yet, barriers to insurance adoption remain prevalent. Cost is the most significant obstacle across regions, followed by a lack of awareness about available solutions and the complexity of insurance products. Addressing these barriers is essential for promoting greater insurance coverage and resilience among European citizens.

This market review indicates that as climate risks continue to intensify, there is considerable potential for insurance innovation to mitigate these impacts. By addressing regional differences, adopting advanced risk assessment technologies, and enhancing public awareness, the insurance sector can play a pivotal role in Europe's climate adaptation strategy. The findings of this deliverable provide a clear roadmap for expanding climate-related insurance solutions that are adaptive, accessible, and aligned with sustainable practices.

The following recommendations aim to bridge existing gaps and capitalize on emerging opportunities within climate-related insurance:

- **Tailored Insurance Solutions:** Insurance products should be customized to align with the unique risk profiles and socio-economic conditions of each region. For example, regions prone to wildfires in Southern Europe would benefit from targeted wildfire insurance, while areas experiencing frequent hail or heavy rainfall should have specialized options. Custom solutions, such as parametric insurance for drought-affected agriculture, can significantly increase insurance uptake and resilience across Europe.
- **Integration of Advanced Technologies:** By integrating remote sensing, predictive analytics, and real-time climate data platforms, insurers can improve early detection and more accurately assess risks. Collaboration with technology providers will enhance insurance solutions, particularly in forestry and agriculture, where predictive models can inform proactive management and ultimately reduce losses. Such technology-driven models help make insurance solutions more cost-effective and targeted.
- **Enhanced Public Awareness and Incentives:** Raising public awareness of climate-related insurance and simplifying access are essential steps to overcome barriers to adoption. Collaboration between governments and insurers on educational initiatives can clarify the role of climate-related insurance and guide the public on available options. Financial incentives, such as premium discounts for those implementing risk-reducing measures (e.g., fire-resistant materials or sustainable agricultural practices), can further motivate adoption.
- **Expansion of Nature-Based Insurance Solutions:** Expanding insurance products that support Nature-based solutions—such as green roofs and sustainable forestry practices—strengthens resilience by promoting environmentally beneficial practices. Collaboration between insurers, urban planners, and forestry managers can help develop coverage options that encourage these practices, making adaptation efforts financially feasible for policyholders and beneficial to the environment.
- **Public-Private Partnerships:** Strong partnerships between governments and private insurers are crucial to scaling climate adaptation solutions. Public-private collaborations can provide subsidies or tax incentives to make insurance more affordable in high-risk regions. Additionally, governments can support the development of parametric insurance by supplying essential data resources and policy frameworks, ensuring innovative solutions reach vulnerable populations effectively.

In conclusion, this report underscores the critical role of innovative insurance solutions in strengthening climate resilience across Europe's most vulnerable sectors. By addressing regional disparities, integrating advanced technologies, and enhancing public awareness, the proposed strategies aim to mitigate the growing financial and environmental risks posed by climate change. The findings and recommendations provided here offer a clear pathway toward a more adaptive and sustainable insurance landscape, one that not only protects stakeholders but also actively contributes to Europe's broader climate adaptation goals. Continued collaboration among policymakers, insurers, and communities will be essential to translating these insights into tangible actions that enhance security and resilience in the face of future climate challenges.

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