



# Title: Climate Change Adaptation Finance: Financial Instruments and Funding Sources

Deliverable 7.1: Pathways of funding requirements and portfolios  
of potential funding sources

WP7 Financial issues and financing instruments/ Business models

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## LIST OF ABBREVIATIONS

AUEB: Athens University of Economics and Business

IPCC: Intergovernmental Panel on Climate Change

AR6: IPCC Assessment Report 'no.6'

PPP: Public Private Partnerships

## EXECUTIVE SUMMARY

This is the first of the five WP7 deliverables, a work package which aims to develop the portfolios of financial instruments and financing sources, as well as the business models to support the portfolios of solutions identified in ARSINOE case studies.

The goal of this deliverable is to:

1. Identify the State of Play in relation to climate change adaptation finance in the regions of the project's Case Studies. It will explore and create a catalogue of the available financial instruments and potential funding sources.
2. Outline Barriers to climate change adaptation finance in the EU regions to help case studies and key stakeholders to clearly understand the main factors that influence Adaptation Finance.
3. Provide a classification of the problems faced in the project's Case Studies, as well as the type of stakeholders involved.

This deliverable consists of the base to work on developing the financing pathways and business plans tailor made for ARSINOE case studies (Task 7.2) and the design of efficient financial instruments to support the portfolios of financing solutions (Task 7.3). It consists a thorough desk research to catalogue, the available financial sources, as well as local barriers to climate change Adaptation, thus identifying any possible gaps which needs to be considered upon building the Financing Pathways of ARSINOE.

## 1.0 INTRODUCTION

### 1.1 Scope of the Deliverable

The key objectives of this deliverable are to help regions and key stakeholders to clearly understand the main factors that influence Adaptation Finance. The purpose is to catalogue the available financial instruments to EU regions and define and assess barriers for adaptation finance both in terms of attracting the necessary financial resources and of harnessing funds for efficient adaptation projects. This encompasses a comprehensive literature review on available financial instruments and barriers to adaptation finance, collating insights on the challenges and solutions in adaptation finance.

### 1.2 Overview

This deliverable is structured as follows:

- Section 2 provides a description of the Financial Instruments and Financing Sources.
- Section 3 provides a desk research in relation to the Barriers to Climate Change Adaptation Finance, faced by the EU regions and the regions of the ARSINOE's case studies.
- Provide an analysis of the key stakeholders in the Case Studies, together with a classification of the problems faced by the case studies.
- Will provide a catalogue of financing sources, financial instruments and Barriers on Adaptation finance to assist on Tasks 7.2 and 7.3 to build tailor made financing portfolios for the ARSINOE case studies.

A list of references is provided as an annex.

## 2.0 Financing the Climate transition

This section presents the results of AUEB's desk research on the State of Play on the underlying European regions in relation to existing financial instruments and mechanisms towards financing the climate transition. Figure 1 display the relationship between the different types of finance, we will refer to through this report.

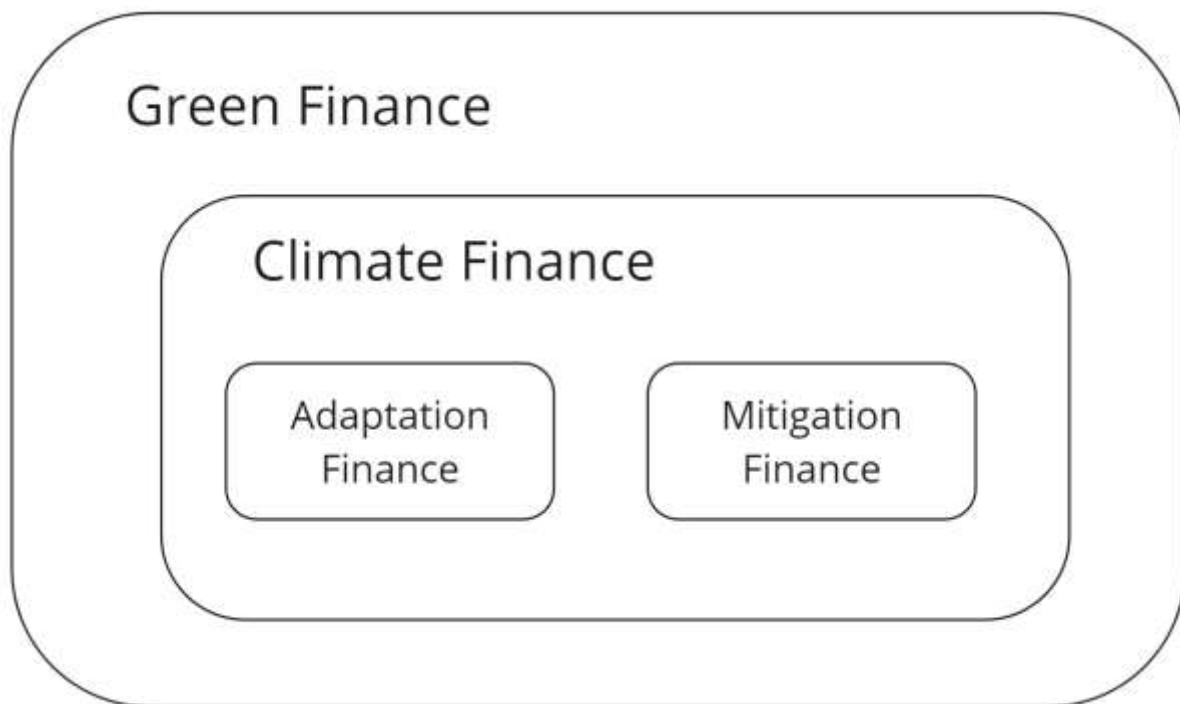


Figure 1 Green and Climate Finance

Green finance is finance that supports action on the full range of environmental issues, including climate change, pollution reduction and biodiversity. On the other hand, Climate finance is a subset of green finance, that seeks to support mitigation and adaptation actions that will address climate change. Consequently, mitigation finance refers to activities aiming to mitigate or adapt to the impacts of climate change, while adaptation finance refers to financing actions which refer to CC adaptation and resilience. Green Finance, also covers more broadly the following categories: Green Bonds, Green Loans, Sustainable Banking and Socially Responsible Investing (SRI), Green Funds, Regulations and Standards including Environmental, Social, and Governance (ESG) Criteria, Green Insurance and Green Certification. The next sections provide a more thorough analysis of the financing sources and financial instruments to support the transition to sustainability.

### 2.1 Background

The European Union strongly supports the transition to a low-carbon, more resource-efficient and sustainable economy. This is part of the EU's efforts to achieve its climate and energy goals in line with the Paris Agreement and the 2030 UN Sustainable Development Goals (SDGs).

To deliver on climate, environmental and social sustainability goals, major private and public investments are needed. The EU and its member states are the largest provider of public climate finance in the world, with €23.04 billion provided in 2021. The European Green Deal further underlined the need to mobilise private financial and capital flows to green investments.

Climate change is the single most important challenge facing humanity in the 21st century. The IPCC in its Synthesis Report (IPCC, 2023) underlines that “Human activities, principally through emissions of greenhouse gases, have unequivocally caused global warming, with global surface temperature reaching 1.1°C above 1850–1900 in 2011–2020”. Meeting the objectives of the 2015 Paris Agreement, a legally binding international treaty on climate change requires decisive and collaborative action over the years to come to mitigate the adverse effects of human activities on environmental resources, biodiversity and livelihoods across the globe (e.g. through the abatement of GHG emissions) as well as to enhance the communities’ capabilities to adapt to elevated risks stemming from climate change. The European Commission has set ambitious climate targets enshrined in the European Green Deal and underpinned in the EU Climate Law. Climate change mitigation is in the epicenter of the policy initiatives, whereby the Fit for 55 package aims at reducing GHG emissions 55% compared to 1990 by the year 2030. Moreover, adaptation to climate change also receives significant attention through the specific EU mission under the same name.

Financing EU regions, sectors and corporations is pivotal to the mitigation and adaptation process. Access to tailored financial instruments is essential for public and private research entities in their efforts to provide solutions aimed at climate change mitigation through green technologies and increased awareness. Moreover, the depth of the financial system and, specifically, the sophistication of the stock market is a catalyst for green innovations developed by the private sector (de Haas & Popov, 2023). A robust financial sector with specific functions earmarked to promoting green transformation is a key element in national, regional and international financial systems. On top of the well-known barriers to finance for innovation associated with the public good attributes of innovative output and lack of tangible collateral (Brown et al, 2012), finance for green innovation is hindered by the interaction of environmental externalities and externalities pertinent to technology development (Jaffe et al, 2005). Having said that, the gap in adaptation finance has been widening, in fact, resulting from a greater need to adapt to climate change in Europe and a lower capacity in public finance due to COVID-19. The 2020 States and Trends in Adaptation Report underlines that “we need a five- to ten-fold increase in adaptation finance.”. Spending in adaptation in 2017-2018 annually averaged about US\$30 billion and in 2019-2020 about US\$46 billion globally, bringing adaptation’s total share of climate finance to just 7%, versus 93% allocated to mitigation finance. Addressing this gap will require a scale-up of public, private, and blended finance, and new actors and financial instruments, tailor made to different regional and local needs as climate change impacts are very unequal distributed.

The EU has put forward a bevy of financial programs and financial instruments to funnel funds towards green activities, designed to serve different environmental tasks (broadly mitigation and adaptation, but also more nuanced activities) and to reach across the spectrum of stakeholders in industry, academia, research, the public sector and the civil society.

The flagship initiative in the field of climate finance in the EU is the LIFE program, created in 1992, which underpins the transformation towards a sustainable, circular, energy-efficient, and resilient economy in line with the Net-zero path through deep demonstrations, dissemination of best practices in the field, capacity building, and governance projects[1]. The LIFE program features four sub-programs, namely (i) Nature and Biodiversity, (ii) Circular Economy and Quality of Life, (iii) Climate Change Mitigation and Adaptation, and (iv) Clean Energy Transition. The strategy for the 2021 - 2027 period is the distinction between Strategic Integrated Projects (SIPs) and Strategic Nature Projects (SNAPs), targeted to EU authorities at regional, multiregional, national, or transnational scale, with the objective to implement the strategies identified by the EU Green Deal.

Considering the catalyzing role of innovation in the fulfillment of the EU's climate and resilience agenda (Van Reenen & Teichgraber, 2022; Joltreau and Sommerfield, 2019, de Haas & Popov, 2023), there is an array of funding opportunities for stakeholders in the innovation system at the EU level. More specifically, the HORIZON EU program supports the creation and better diffusion of excellent knowledge and technologies by funding ambitious research and innovation projects (inter alia) in the field of green technologies through its 95.5 € billion budgets for the 2021-27 period. A novelty compared to the HORIZON 2020 project (2014-2020) is the creation of "Missions", defined as multidisciplinary actions across intended to achieve an inspirational, ambitious and measurable goals within a set timeframe, through the mobilization of international cooperation schemes with a sizeable impact for society. Prominence is given to the Mission: Adaptation to climate change, including societal transformation, nonetheless four out of five missions are directly linked to tackling climate change and shaping pathways to green transformation[2]. Moreover, stakeholders engaged in innovative, low-carbon technologies are eligible to receive funding from the EU Innovation Fund. Large-scale and low-scale projects (with the cutting point set at € 7.5 million) are funded with the aim to spur low-carbon technologies and processes through the involvement of the EU in sharing the risks with the private sector. The majority of the funds is raised by the EU Emissions Trading Scheme (EU ETS), complemented by unspent funds from the NER300 programme. Finally, initially designed as a response to the COVID 19 Pandemic, the Recovery and Resilience Facility (RRF) is a material instrument towards the region's goals associated with climate neutrality by 2050. The mechanism provides €723.8 billion (in current prices) in loans (€385.8 billion) and grants (€338 billion) available for EU countries to finance coherent and measurable projects on green and digital transformation, social cohesion, smart and sustainable growth and bolstering resilience. The RRF also supports the objectives outlined in the REPowerEU plan, aiming to thwart the region's dependence on Russian fossil fuels. Having set that, the funding provided by the RRF is earmarked to the adoption and maturity of alternative energy sources, through enhanced funding for investments in renewable energy and green technologies.

Apart from EU initiatives and funding schemes, public and private entities that need to finance activities related to climate change mitigation and adaptation can tap additional sources. It goes without saying that public and regional authorities have access to revenues from taxation, but can also muster funds for green investments by curtailing other subsidies and public spending and implying user charges for utilities and other amenities (e.g., road transport). Private companies delivering climate solutions relying on external financing traditionally use debt or

equity instruments in cooperation with financial institutions, predominantly banks. Although climate finance has steadily increased over the last decade, and new instruments as green bonds, debt for nature swaps and CAT bonds are available, reaching USD 632 billion in 2020 (CPI, 2021), innovative companies in the field of green technology face barriers in accessing traditional loans and debt instruments, due to the gap in information, the increased uncertainty and the lack of tangible collateral when intangible capital is the firm's main asset. Hence, it is imperative that the financial system is developed and deep, where the stock market provides opportunities for equity financing of green projects and where a venture capital market allocated towards ambitious and risky green projects can thrive.

Given the mismatch between traditional financing sources and projects related to green technology, mitigation and adaptation, novel financial instruments and funding schemes are gaining importance for stakeholders in the climate sector. Multilateral Development Banks (MDBs) have been increasing climate finance and instruments tailored to SDG completion based on their institutional expertise. Their programs are a source of non-negligible funds especially for national and regional governments, but also for private-public partnerships aligned to the 2030 climate targets. Institutional investors aside, the instrument gaining traction in the climate finance landscape is the Green Bond, a fixed-income debt instrument that is used to finance projects that contribute to the climate targets. The World Bank defines them as "Fixed income, liquid financial instruments used to raise funds dedicated to climate mitigation, adaptation, and other environment-friendly projects", however there is no universal definition. Nonetheless, independent authorities such as the International Capital Market Association (ICMA) have set up guidelines to characterize bond issuances from corporations or public entities based predominantly on the use of proceeds, project evaluation and selection management of proceeds and impact reporting. Among the issuers of green bonds, financial institutions (mainly large commercial banks) stand out as they raise substantial amounts of financial capital and act as intermediaries in financing green projects for the private and the public sector. The green bond market is relatively young, with the EU leading the way after the issuance of the EIB's Climate Awareness Bonds in 2007. However, the development has been exponential, with global issuance totaling USD 470 billion from 2014 to 2018 and reaching 570 USD billion in 2021 alone (Anyfantaki et al, 2022).

To sum up, financial resources and instruments for the green transformation have been gaining significant traction in the EU ecosystem and worldwide. Having said that, climate finance flows still appear to be significantly lower than the ones with meeting the Paris Agreement and the realization of the SDGs. The Climate Policy Initiative (CPI) estimates the required increase in climate finance at a rate of 590% compared to 2020 levels to meet international 2030 targets. The financial system needs greater resources and substantial to shift funding towards adaptation and mitigation activities and spearhead green innovation.

## 2.2 Catalogue of Financing Sources and Financial Instruments

This subsection provides an extensive list of the available financing sources and financial instruments, available to the ARSINOE case studies to support climate change adaptation finance.

### 2.2.1 Financing Sources

Figure 2 depicts the Main Financing Sources in the European Regions. The Main categories consists of Public, Private and the Voluntary sectors.

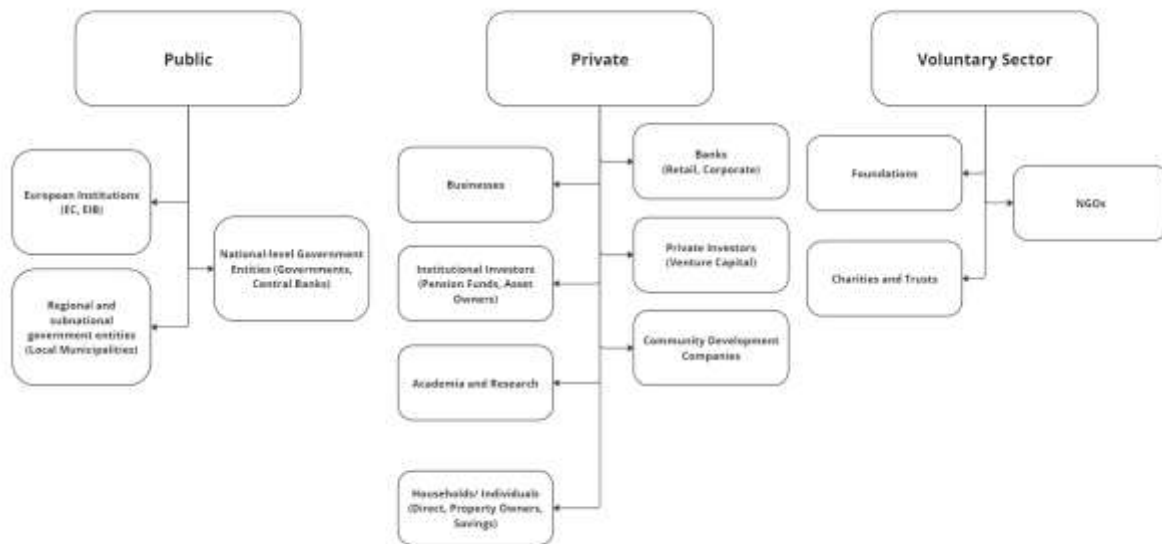


Figure 2-List of Financing Sources

#### **Public**

The European Commission provides a range of finance for climate change adaptation, as well as includes adaptation as a required component in many of its programmes, such as European Regional Development Fund. Moreover, The European Investment Bank is the lending arm of the European Union (European Investment Bank, n.d.). The bank focuses on climate and environmental sustainability, innovation, digital and human capital, sustainable energy and natural resources, sustainable cities and regions, SMEs and Cohesion.

National Governments can supply funds and finance, which are more tailored to national conditions, such as particular risks or hazards, or policy objectives. Financing priorities tend to be informed by the preparation of National Adaptation Plans and Strategies which set national priorities. Moreover, central banks can also supply finance for adaptation, through operations such as quantitative easing or refinancing in the economy.

Regions can draw on their own public resources to support adaptation, allocating a portion of overall operating budgets to support or deliver adaptation.

Also, Regions can work with local municipalities to collectively progress adaptation. This can either be through the provision of direct resources into a regional initiative, but also indirectly through facilitating collaborative approaches to adaptation planning and implementation

#### **Private**

Businesses can provide funding in a variety of ways, including directly investing their own working capital in adaptation for their own benefit, co-financing projects with both public and private goods, and collecting taxes and charges that can be used for adaptation planning and delivery by others.

Banks can incentivize adaptation by screening its loan book, providing products and services that provide adaptation finance, and ensuring that the proceeds it invests while holding for clients are resilient to climate change or supporting investment in adaptation and resilience companies. Institutional Investors have a significant potential to increase subnational pension fund investment in climate resilient infrastructure because it aligns with city or regional needs, but blended finance is likely to be required to provide the desired returns. Also, Private investors can provide their own resources towards, adaptation and resilience. Moreover, Regions can work collaboratively with Universities, Colleges and Schools to finance a wide range of activities. Finally, Individuals and Households can also support adaptation through a variety of methods, such as investing in Green and Climate-Focused Funds or donating to environmental organizations and NGOs that work on climate adaptation projects.

#### ***Voluntary Sector***

NGOs typically focus on influencing policy or debate, acting as knowledge brokers, or developing others' capacity and capabilities. They have access to non-profit funding streams that regions do not, and they can be used to facilitate innovative projects, partnerships, and governance arrangements.

#### 2.2.2 Financial Instruments

Similarly, to sources, there is broad agreement on a set of financial instruments that includes grants, debt (concessionary loans, market rate loans, bonds), equity, guarantees, and then the addition of other forms of finance or arrangements (public-private partnerships, insurance, and so on).

Several efforts have been made to catalogue the various financial instruments that can be used for adaptation. (Negreiros et al., 2021; NetZeroCities<sup>1</sup>). Figure 3 summarizes the set of available instruments.

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<sup>1</sup> <https://netzerocities.eu/>

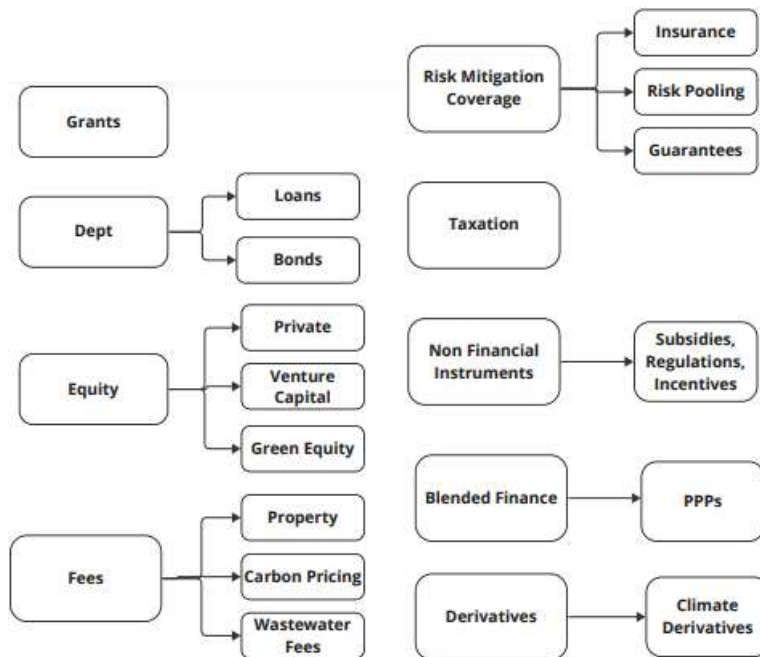


Figure 3 List of Financial Instruments

Grants are a critical form of adaptation finance for addressing the impacts of climate change, particularly in vulnerable and developing regions. They are financial contributions that do not require repayment and are provided by governments, international organizations, philanthropic foundations, and other sources to support specific adaptation projects and initiatives.

Using debt as a source of adaptation finance is a more complex and nuanced approach compared to grants because debt requires repayment with interest. However, it can still play a role in financing adaptation efforts, especially when combined with other financial instruments. Governments in vulnerable and developing countries may issue sovereign debt instruments, such as bonds, to raise funds for adaptation projects. These bonds are typically backed by the government's creditworthiness and revenue-raising capacity. The funds raised through sovereign debt can be used to finance adaptation infrastructure, disaster resilience, and capacity-building initiatives. Multilateral development banks and international financial institutions may provide loans or concessional finance to countries for climate adaptation projects. These loans often have more favourable terms, longer repayment periods, and lower interest rates than commercial debt. The World Bank, for example, offers climate finance programs and loans for adaptation and resilience projects. Other types of debt and loans include Balance sheet lending, commercial loans, concessional loans, credit lines, syndicated loans, subordinate loans, crowdfunding, debentures and revolving funds.

Blended finance combines different sources of funding, including debt, grants, and private sector investments, to finance adaptation initiatives. This approach aims to leverage public and private capital to maximize the impact of adaptation projects. It can involve concessional loans, guarantees, or risk-sharing mechanisms to attract private sector participation.

Green bonds are debt securities issued by governments, corporations, or financial institutions specifically for climate and environmental projects, including adaptation. The proceeds from green bonds are earmarked for projects that have positive environmental and climate benefits. Local governments in vulnerable areas may issue municipal bonds to finance adaptation projects at the community level. These bonds are repaid through local revenues, property taxes, or other revenue streams.

Businesses and organizations in vulnerable sectors may take out loans to finance adaptation measures, such as upgrading infrastructure to withstand climate impacts or investing in more resilient supply chains.

Insurance-Linked Securities (ILS): are financial instruments used to transfer insurance risk to capital markets. Catastrophe bonds, a type of ILS, can provide funds for post-disaster recovery and adaptation efforts in exchange for higher interest payments if a specific climate-related event occurs.

Using equity as a source of adaptation finance involves raising funds by selling ownership stakes in projects, ventures, or assets related to climate adaptation efforts. Equity financing can come from various sources, including investors, public-private partnerships, and equity-based financial instruments.

Using fees as a source of adaptation finance involves collecting charges or fees from various sources to fund climate adaptation efforts. These fees can be imposed at different levels, such as national, regional, or local, and can target various sectors and activities that contribute to or are affected by climate change. Examples include: Carbon Pricing, Environmental Impact Fees, Water and Resource Fees, Infrastructure Resilience Fees, Tourism and Recreation Fees, Transportation Fees, insurance Premiums, Environmental Services fees and Energy Transition fees.

Risk mitigation coverage, such as insurance and reinsurance, can play a significant role in climate adaptation finance by providing financial protection against climate-related risks and disasters. These mechanisms help individuals, businesses, and governments manage the financial impact of extreme weather events, natural disasters, and other climate-related hazards

Taxation (such as Carbon, Environmental and Resource extraction taxes) can be a significant source of climate adaptation finance when governments levy taxes or impose fees on various activities, sectors, or carbon-intensive industries and then allocate the revenue generated toward climate adaptation efforts. This approach can help fund resilience-building projects, climate preparedness initiatives, and strategies to address the impacts of climate change.

Non-financial securities, such as climate insurance pools, performance guarantees and risk sharing facilities) often in the form of guarantees, collateral, or risk-sharing mechanisms, can also serve as a source of climate adaptation finance. While they may not provide direct funding, they can help mobilize financial resources from private investors, lenders, and other stakeholders for adaptation projects.

Derivatives, financial instruments whose value is derived from an underlying asset or index, can be used creatively to support climate adaptation finance. While derivatives themselves do not provide direct funding for adaptation projects, they can serve as risk management tools and financial mechanisms to enhance the availability of capital for climate resilience initiatives.

Blended finance is a financing approach that combines public and private sector funds, often with the involvement of development finance institutions (DFIs) and impact investors, to mobilize additional capital for sustainable development projects. It is increasingly being used as a source of climate adaptation finance to support resilience-building initiatives. Some blended finance initiatives are specifically designed to address climate adaptation challenges, such as financing resilient infrastructure, enhancing water resource management, or supporting sustainable agriculture practices. Multilateral organizations, such as the Green Climate Fund (GCF) and the Climate Investment Funds (CIFs), use blended finance to mobilize funds for climate adaptation projects in developing countries. Blended finance can be applied to various climate adaptation projects and sectors, including disaster risk reduction, infrastructure resilience, agriculture, water management, and coastal protection. It enables the efficient use of public funds to attract private investments, expanding the pool of financial resources available for adaptation efforts.

## 3. BARRIERS TO ADAPTATION FINANCE

### 3.1 Background

The IPCC AR6 (2023) lists a number of major obstacles to adaptation, including a lack of funding, of private sector and citizen involvement, of funding mobilisation (including for research), of political commitment, of climate literacy, of research and/or slow and low uptake of adaptation science, and a lack of urgency. Despite this, the issue of maladaptation is crucial to the process of adapting to climate change because negative climate impacts decrease the financial resources available by causing losses and damages and by impeding national economic growth, which further increases the financial challenges of adaptation, especially for developing and least developed countries. More specifically, the report highlights the continued existence of barriers both inside and outside the financial sector in the field of adaptation finance.

The underestimation of climate-related risks, poor evaluation of investment opportunities and their long-term effects, regional mismatches in financial markets between available capital and investment needs, home-bias factors, economic distress in countries, and limited institutional development are some of the obstacles to the functioning of financial markets at the regional, national, and international levels. In addition, barriers to adaptation finance outside of the traditional financial sector include underdeveloped capital markets, unattractive risk-return profiles, a lack of scientific knowledge to ensure standardisation, aggregation, scalability, and replication of investment opportunities, and insufficient local and national innovation systems to support transformative and successful adaptation projects. This report focuses on Barriers to Adaptation Finance, underscoring the effect of each barrier on

- (i) attracting financial resources for regional adaptation plans and
- (ii) leveraging financial resources for maximum efficiency of adaptation strategies.

### 3.2 Classification of Barriers to Climate Change Adaptation Finance

This section provides a comprehensive literature review including articles and studies on developed nations in Europe and elsewhere that seemed to share traits with the case study regions for the project. Because we prefer to concentrate on the most recent climate change adaptation finance barriers reported on the literature review, which offers accurate and up-to-date information and knowledge, we eliminated publications from before 2000 from the literature review.

The barriers are classified into five broad categories namely

- (i) economic and market barriers;
- (ii) socio-cultural and behavioral barriers;
- (iii) knowledge and awareness barriers;
- (iv) technological barriers and
- (v) political and institutional barriers.

Regarding the latter category, this report underlines regional and national attributes which may not constitute barriers *per se*, but nonetheless shape regional capacity for adaptation.

### 3.2.1 Economic and Market barriers

#### **Lack of funds and high costs:**

The lack of funding continues to be a major worry in the literature on climate finance. According to Ackerman (2009), there is a severe lack of funding and the implementation of mitigation and adaptation measures is extremely expensive. Chirisa et al.'s (2021) emphasis on the constraining effects of a lack of funding, which results in an obvious unwillingness or inability to integrate crucial adaptation practises and technologies, supports these views. According to Timilsina (2021), who discusses the lack of financial resources and the difficulties in luring private sector investments, this scarcity also affects the private sector. Savvidou et al. (2021) also draw attention to the issue of insufficient funding, which is exacerbated by a misguided strategy for focusing support and obstacles that prevent the implementation of crucial adaptation projects.

#### **Complexity and diversity of funding mechanisms:**

The complex diversity of climate, water, and biodiversity funds is examined by Altamirano (2021), who hypothesises that this diversity is causing systemic barriers, particularly for local stakeholders.

#### **Inadequacy of current financial systems and approaches:**

The inadequacy of conventional financial systems is a recurring theme in discussions of climate finance. Baatz (2018) offers a critical assessment of the lack of funding and touches on the moral conundrum surrounding historical excessive emitters. Das (2022), who identifies significant capacity gaps, broadens this perception of inadequacy. Not only do Kartez and Merrill (2016) highlight the lack of funding, but they also draw attention to the widespread ignorance of the urgency of adaptation. By Lipper et al. (2022), this conundrum of insufficient and inappropriate financing is distinguished. By highlighting the urgency of the situation and the inefficiency of resource allocation, Miller (2008) advances this discussion.

#### **Investment needs and transformative actions:**

In order to update energy systems, rethink the built environment, and implement infrastructural adaptations in the face of a changing climate, Bowen et al. (2014) highlight the enormous investments required.

#### **Coordination, fragmentation, and allocation challenges:**

Despite being present, financial efforts frequently suffer from poor management. According to Clark et al. (2018), funding is scarce and that poorly coordinated efforts frequently make interventions less effective.

**Financial capacity and targeting challenges:**

In their investigation of financial capacity, Pillay et al. (2017) draw attention to the uncertainties surrounding how climate change may affect us and the disconnect between investors' short-term objectives and the long-term benefits of investments. Sietz et al. (2008) describe a variety of difficulties in their study on Mozambique, which adds to this complexity. These difficulties range from personal constraints to wider network problems.

**Competition for funds:**

Similarly, to allocation challenges, the literature shows that researchers pay close attention to competition for funds. More specifically, de Bruin and Dellink (2011) emphasise the limitations of adaptation finance by emphasising both limited access to funds and competition for funds. The irreversibility of investment decisions due to financial scarcity is one of the factors that exacerbates competition for funds. According to de Bruin and Dellink (2011), it is critical to evaluate all possible options and make the best decisions that will result in the best possible funding and capital absorption for the greatest possible results in terms of society and climate change adaptation.

**Lack of human resources:**

Researchers examining similar issues in the existing literature (Moser et al., 2008; Biesbroek et al., 2009; Krysanova et al., 2010; Ford et al., 2010a; Martins and Ferreira, 2011; Aguiar et al., 2018) report that one of the most important reasons that pose barriers to climate change adaptation finance is the lack of human resources. Moser et al. (2008) emphasise that climate change adaptation strategies may fail due to a lack of human resources. It has been observed that not only is the available capacity of human capital limited, but that the phenomenon of brain drain has exacerbated the situation. Labour markets across the continent are not functioning in the same way, revealing mismatches between skills in demand and skills in supply. Furthermore, macroeconomic factors and growth paths differ, resulting in extremely high unemployment rates in the EU south, particularly in Greek and Spanish regions.

**Lack of skilled personnel and insufficient staff to analyse information:**

Following the analysis on the lack of human resources, the researchers consider the availability of specialized personnel who can focus and delve sufficiently into the ways of managing climate change, the analysis of available information and the proper utilization of financial resources in order to address the causes and also of the results of this phenomenon. Bryan et al. (2009), Ford et al. (2010b) and Moser and Ekstrom (2012) highlight the insufficient number of skilled personnel who can gather and scientifically analyze collective information in an effort to implement the most appropriate solution to the climate change problem at hand, while Biesbroek et al. (2009) underlining that one of the main factors leading to this situation is the lack of knowledge about the existing situation of the area that they should manage as well as the importance and effects of climate change. Figure 4 shows the fragmentation with respect to knowledge workers in the EU. Regions in Spain, Greece and Eastern Europe struggle to find

people with skills necessary for transformative adaptation.

### Knowledge workers 2022

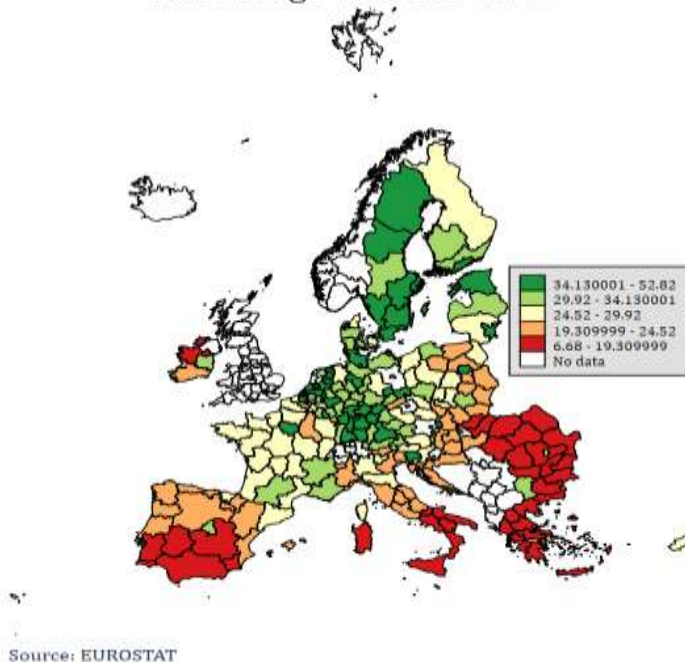


Figure 4 Knowledge Workers

#### **Lack of public demand:**

Due to the lack of knowledge, not only of the personnel but also of the citizens, Mosel and Ekstrom (2012) emphasize the fact that society does not seek immediate response and management of climate change. This lack of public demand leads policymakers to devote more time and funds to other social issues, limiting the funds that can be allocated to climate change adaptation finance.

#### **Conflicts with other more pressing developing issues:**

Society, along with the scientific community, has to tackle more than one developing issue simultaneously, making prioritization a difficult process since the criteria of the process are not clear and moral rules that can identify the significance of each developing issue do not exist. This barrier has been mentioned in the literature by multiple researchers (Storbjörk, 2007; Moser et al., 2008; Brown et al., 2010).

#### **Time frame and conflicted time scales:**

The short amount of time we have, along with the urgent need for solutions to issues related to climate change and other pressing developing problems in several regions, lengthens the competitive time scales. The amount of time we have to address all of these significant issues and their implications is constrained, claim Allman et al. (2004). Simultaneously, however, time should be allocated to other equally important issues, leading policy makers to a quagmire regarding the rational management of the available time between conflicted developing issues (Few et al., 2007; Biesbroek et al., 2009; Burch, 2010; Ford et al., 2010b; Biesbroek et al., 2011;

de Bruin and Dellink, 2011; Sutton and Tobin, 2011; McNamara et al., 2011; Aguiar et al., 2018).

**Climate concerns in development strategies:**

Mitchell, Tanner, and Wilkinson (2006) discussed the insufficient research on integrating climate change concerns within Poverty Reduction Strategy Papers (PRSPs). Given PRSPs' central role in shaping a nation's developmental blueprint, it's essential to incorporate a climate-focused lens. Przulski & Hallegatte (2010) delved into the complexities of financial support for climate adaptation. They highlighted issues around vague concepts and the difficulty in defining and quantifying terms like "additionality" and "incremental cost." The research also emphasized the importance of clear strategies and raised concerns about ownership rights.

**Macroeconomic Factors:**

Adger (2000) focuses on the macroeconomic variables that could affect a region's capacity to draw in funding for climate change. According to Adger (2000), one of the most significant factors could be the degree of poverty, as each country or region's government will set priorities and give its citizens' living conditions a high level of importance, investing money in efforts to raise their standard of living above the poverty line. Similar to this, Reckien et al. (2015) mention unemployment rate as a crucial macroeconomic factor, particularly to the regions that seem to be less developed than the rest of the country.

The stark differences in disposable income are shown in Figure 5. Many of the regions within the Eurozone still bear the scars of the 2009–2010 financial crisis, making economic recovery policies a top priority, sometimes at the expense of climate change mitigation.

Disposable income per capita 2022

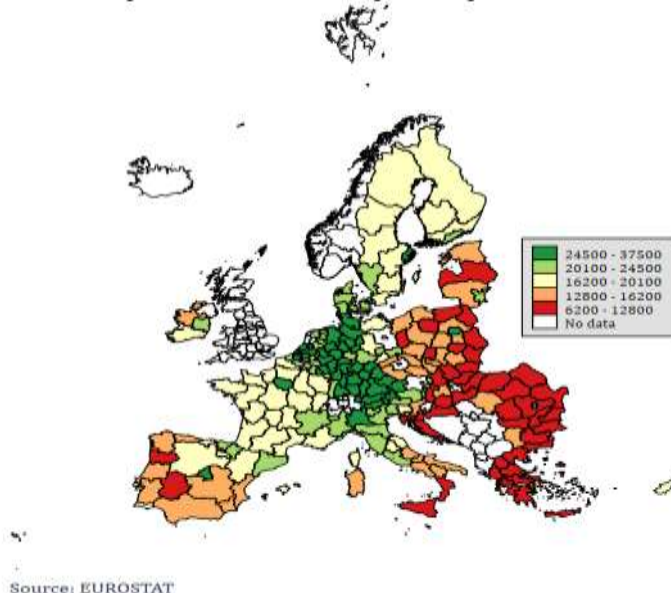


Figure 5 – Disposable Income per Capita

### 3.2.2 Socio-cultural and Behavioral barriers

#### **Lack of Commitment from Developed Countries:**

A significant problem is highlighted by Bouwer & Aerts (2006): developed countries are not demonstrating enough commitment to adapting to climate change. The researchers emphasize that in order to address these issues, climate change adaptation must take centre stage.

#### **Ethical Implications in Adaptation Financing:**

Dellink et al. (2009) examine the moral ramifications of financing for adaptation. To comprehend how nations ought to divide the cost of climate change adaptation, they look at concepts like deontology, solidarity, and consequentialism. In essence, the study looks at how these ethical standards are used to assess countries' financial contributions.

#### **Capacity Challenges and Commitment Issues:**

The study by Doshi and Garschagen (2020) focuses on the actual issues that weaker nations encounter. They identify two main challenges: the inability to efficiently manage and complete projects, and a glaring lack of commitment to addressing climate change among influential parties.

#### **Mobilization of Funds:**

Fankhauser et al. (2016) investigated how well investors could raise the money required for climate change adaptation. They discuss the causes and difficulties of this gap while highlighting the apparent shortfall in climate finance.

#### **Lack of Willingness to Act and Pay:**

A significant behavioral factor that affects climate change adaptation is mentioned by Biesbroek et al. (2011), underscoring the lack of motivation and willingness to take action to mitigate the effects of climate change. Jenkins (2012) highlights in their research the unwillingness of citizens to alter their behavior in response to the climate change phenomenon and, as a result, their willingness to pay in an effort to improve the current situation.

### 3.2.3 Knowledge and Awareness barriers

#### **Lack of awareness:**

The three most typical categories of knowledge on the subject of financing for climate change adaptation have been identified through literary analysis. According to Allman et al. (2004), the first and most important lack of awareness relates to the requirement for adaptation. Following the statement made by Allman et al. (2004), additional researchers (Koch et al., 2007, Amunden et al., 2010, Storbjörk, 2010, Burch, 2010, Biesbroek et al., 2010, Biesbroek et al., 2011) have noted a lack of awareness of the need for adaptation.

On the other hand, McEvoy et al. (2010) emphasize the importance of the lack of political awareness, highlighting that the members of society who are responsible for acting regarding the adaptation to climate change are lacking in knowledge and as a result of awareness on such a crucial issue. Last but not least, Brown et al. (2010) brought up the issue of the general population's lack of awareness, pointing out that this lack of knowledge stems from the previously mentioned scarcities and keeps people from being aware of and understanding the need for climate change adaptation.

**Lack of specialized knowledge:**

One of the most effective tools for foretelling and resolving significant social and environmental problems is a priori information and knowledge. Huang et al. (2011) report that one of the most prevalent barriers observed appear to be the lack of specialized knowledge within the government, following McEvoy et al. (2010) statement regarding the political unawareness, highlighting the need for collaboration between the academic community and society. On the other hand, Moser and Ekstrom (2010) rank the obstacles and highlight the absence of local experts who would be tasked with giving the government the data it needs to develop mitigation and adaptation plans. The last two knowledge gaps are closely related because they prevent research and the advancement of knowledge in the sciences (Moser and Ekstrom, 2010; Sietz et al., 2011; Aguiar et al., 2018). Because governments and the general public will both receive education and information from the scientific community, Aguiar et al. (2018) support the notion that the biggest knowledge barrier is a lack of scientific knowledge.

**Lack of attention, strategic planning and responsibility:**

In light of all the previous barriers mentioned in this section, we also need to address the barriers brought on, as stated in the literature, by a lack of knowledge and awareness. Political apathy and a lack of specialized knowledge within the government contribute to a lack of national attention regarding adaptation to climate change and adaptation finance (Ford et al., 2010a; Lebel et al., 2011; Amunden et al., 2010; Martins and Ferreira, 2011). The nations overlook the importance of climate change adaptation in favor of other urgent issues. The governments and responsible policy makers avoid developing preparedness plans as a result of this barrier, which prevents strategic planning and responses (Biesbroek et al., 2009; Lemieux et al., 2011; Measham et al., 2011). Another typical phenomenon was noticed. Avoiding obligations and responsibilities is another phenomenon that is prevalent in modern societies. Similar to this, it is often claimed that decision makers, most often governments, tend to externalize the responsibilities and place the blame on others in an effort to avoid taking action with regard to climate change and strategic planning for adaptation finance (Lorenzoni et al., 2007).

### 3.2.4 Technological barriers

#### **Lack of technical resources and ICT support:**

A technical system that can provide accurate data and information as well as support the registration of data and events that will then be analyzed by scientific and research teams in order to provide knowledge and information is mentioned by Allman et al. (2004) and Brown et al. (2010). Accurate and quick results that are useful for strategic planning will be produced by the proper data collection and processing. The percentage of homes with broadband access is displayed in Figure 6 as a measure of technological infrastructure. Having said that, a lack of broadband penetration creates a barrier for the general public's access to information and awareness.

Households with broadband access (%) 2022

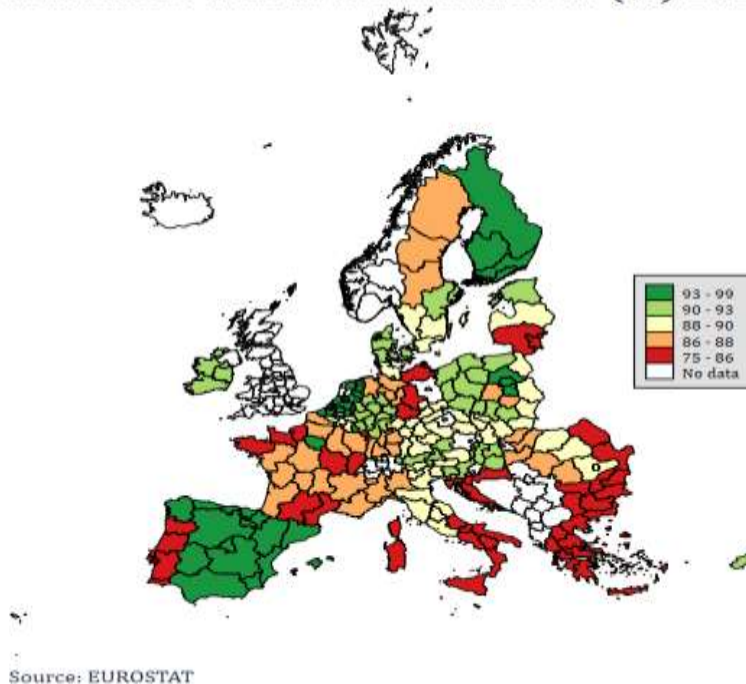


Figure 6 Share of Households with broadband access

#### **Poor performance by regional innovation:**

Burch (2010) emphasizes the limited education and research establishments and the subpar performance of regional innovation, particularly in developed countries and regions. Although it significantly catalyzes financial resources for transformational adaptation, regional innovation capacity does not pose a direct obstacle to the financing of adaptation. Particularly for projects involving the private sector directly or as a subcontractor for a public project, regional and national innovation systems can be useful sources of information for adaptation strategies. The geographic and regional concentration of R&D activities (particularly in Central Europe and Scandinavia). Spending on R&D is a crucial component of innovation, even though it works in tandem with numerous economic forces.

**Data gaps:**

In terms of empirical data on climate adaptation initiatives supported by the Global Environment Facility, Biagini et al. (2014) found a sizable gap. They made the point that incomplete data combined with insufficient funding can prevent well-informed decisions. This confluence of technical and financial problems could hinder successful climate adaptation initiatives. A significant problem was emphasized by Closset et al. (2018): the absence of trustworthy indicators to assess climate change vulnerability. Without these indicators, it becomes difficult to allocate resources efficiently, potentially leading to resource waste.

### 3.2.5 Political, Institutional and Governance barriers

**Lack of co-operation and multilevel communication**

Evans et al. (2011) and Fayazi et al. (2020) focus their studies on the political and governance barriers regarding climate change adaptation finance. Initially, Evans et al. (2011) state that a **lack of cooperation within and between sectors** has been observed leading to inefficient activities that could help in the proper absorption of financial resources. On the other hand, Fayazi et al. (2020) underline the limited communication. The lack of multilevel communication, as mentioned by Fayazi et al. (2020), creates gaps and incomplete knowledge that hinders proper and effective management.

**Governance failures**

In their study, McNamara et al. (2011) discuss the governance issues surrounding adaptation to climate change and financing for adaptation. According to Moser and Ekstrom (2012), decision-makers may be trying to avoid and abdicate any responsibilities, which results in a lack of leadership (on the part of both elected members and organization staff). On the relationships between communities, governments, and scientists, it is obvious that a lack of leadership and the externalization of responsibilities result in a loss of credibility (Gross et al., 2011). According to Moser and Ekstrom (2012), each government's lack of vision, political will, and commitment can also contribute to distrust between community members and citizens by making the government member appear careless and lacking in a development and adaptation strategy. The majority of regions, according to Gross et al. (2011), lack management structures with long-term perspectives. This claim is connected to that made by McClure and Baker (2018) regarding the ambiguity of state planning policies and the potential lack of short-term climate change adaptation plans in local government priorities. The analysis above makes it clear that barriers and capabilities typically manifest in two ways through the process of adaptation financing. They obstruct two procedures: first, the process of accumulating the necessary financial resources; and second, the procedure of using funds to generate successful adaptation projects. Table 1 provides a summary of the various ways that barriers are used across the major categories mentioned in this section.

**Table 1 Barriers to Climate Finance**

Type of Barrier	Access to Finance	Leveraging Financial Resources	Examples
<b>Economic Barriers</b>	Poor identification of type of adaptation needs and portfolio of financial solutions	Lack of a bankable investment project, planning and mobilizing diverse stakeholders at the regional and national level	Inadequate Human Capital results in misidentification of financial needs and poor delivery of adaptation projects
	Inadequate capabilities of local actors to quantify and attract finance	Financial resources allocated to targets other than adaptation	
<b>Technological Barriers</b>	Regions and Firms do not meet the criteria for Finance	low presence of Innovative firms and innovation systems to apply complex adaptation (transformational) solutions	low growth firms in backward sectors face elevated impediments in frontier financing and lack the capabilities to deliver innovative solutions
		Poor dissemination due to lack of infrastructure to facilitate synergies	Lack of Functioning Innovation Systems stymies dissemination of knowledge
<b>Socio-Cultural Barriers</b>	poor evaluation of adaptation finance needs	Poor estimation of budget allocations required and inability to shape public-private solutions	Inadequate Community Engagement fails to assess Adaptation needs
		allocation of scarce financial resources to other projects	Governance Failures misdirect scarce financial resources away from impactful projects
<b>Knowledge &amp; Awareness</b>	No identification of funding opportunities and procedures, EU projects	no identification of actors (private & research sector) to efficiently design, implement and monitor an adaptation project	Lack of data and Information results in underestimation of needs and lack of awareness on existing solutions
	inadequate estimation of financing needs for adaptation and financial opportunities	poor identification of actors to engage, inadequate design of bankable adaptation projects	
<b>Political, Institutional and Governance barriers</b>	Adaptation Needs not high in Priorities	Mismanagement of Funds	Poor governance focuses on short-term policies
	Lack of mechanism to identify and assess investment plans		Corruption yields rents but not efficient adaptation projects

## 4. ARSINOE – CASE STUDIES – Key Stakeholders

Details regarding the mapping on Case Studies were gathered from WP2 reports following the completion of the 1st Living Labs (LL)<sup>2</sup>. The important aspects in relation to WP7 are the Key Challenges, the main as well as the Key Stakeholders and the Horizon for Planning.

The Table 2 classifies the Hazards per Case Study as expressed through the identification of their Core themes and Key Challenges. These provide an evidence of the needs of ARSINOE case studies and can be a roadmap to the financial instruments, presented in previous sections, required to mitigate against different climatic hazards.

Table 2 ARSINOE Case Studies and Hazards

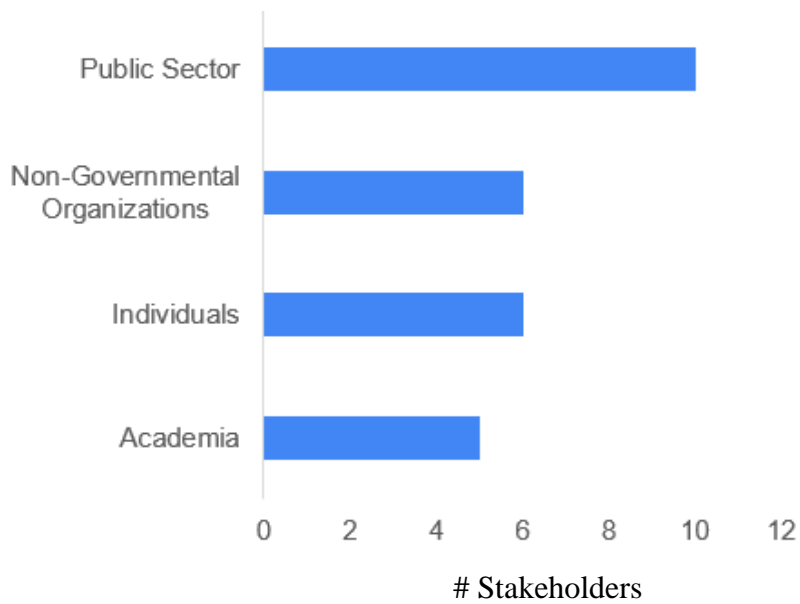
	<i>Heatwaves Extreme Heat</i>	<i>Flooding</i>	<i>Wind Waves</i>	<i>Drought</i>	<i>Water Quantity- Quality</i>	<i>Biodiversity</i>	<i>Precipitation</i>	<i>Land Use</i>	<i>Ecosystem Services</i>	<i>Economic Financing</i>	<i>Horizon</i>
CS1	X					X					2050
CS2	X		X							X	2040- 2060
CS3				X	X						2050
CS4	X				X		X				2050
CS5								X			2050
CS6				X		X		X	X		2050
CS7		X								X	2050
CS8		X									2050
CS9								X			2050

For example, adaptation finance for heatwaves can be facilitated through various financial instruments that provide funding and support for projects and initiatives aimed at reducing vulnerabilities to extreme heat events. These financial instruments help mobilize resources to enhance resilience and mitigate the impacts of heatwaves.

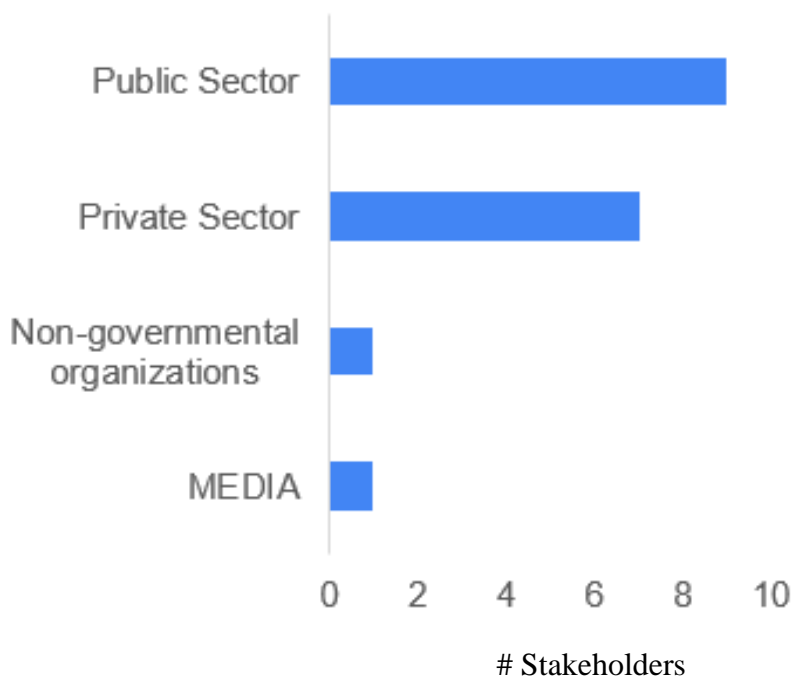
The Key stakeholders of each case study, is also of great importance, as different stakeholders will have different level of access to the financing sources as presented in section 2. Based on the classifications of Stakeholders performed in WP2 and focusing only on those which are classified as of high influence and high interest, the following displays present the histogram of the different stakeholder mix in the ARSINOE case studies.

<sup>2</sup> The relevant details from the reports are included in the Appendix.

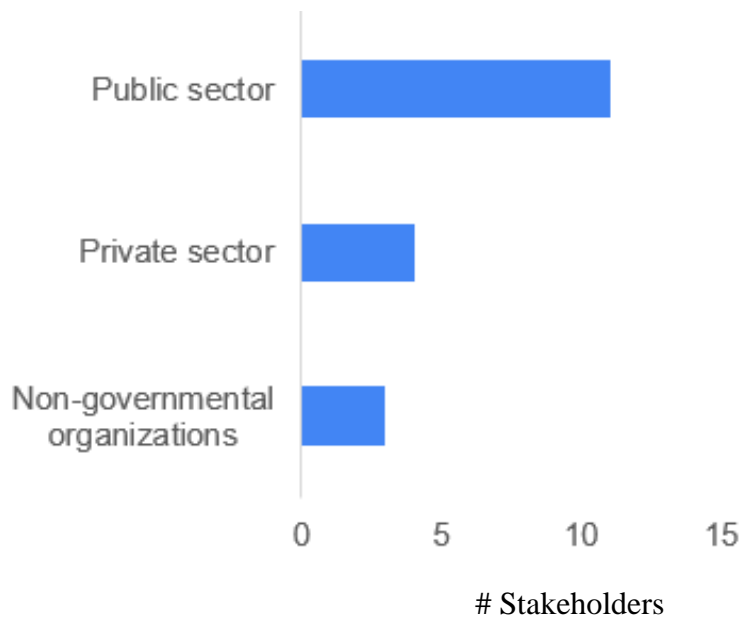
Display 1- CS1 Athens



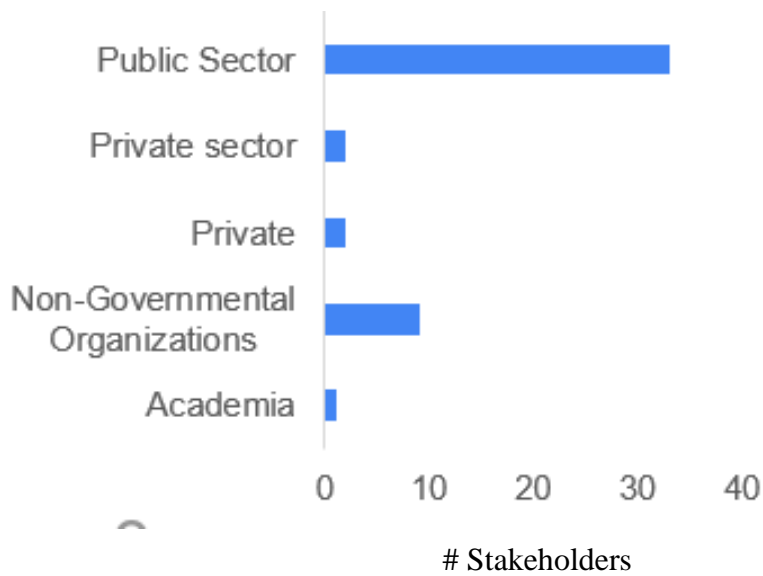
Display 2 CS2 Mediterranean Port:



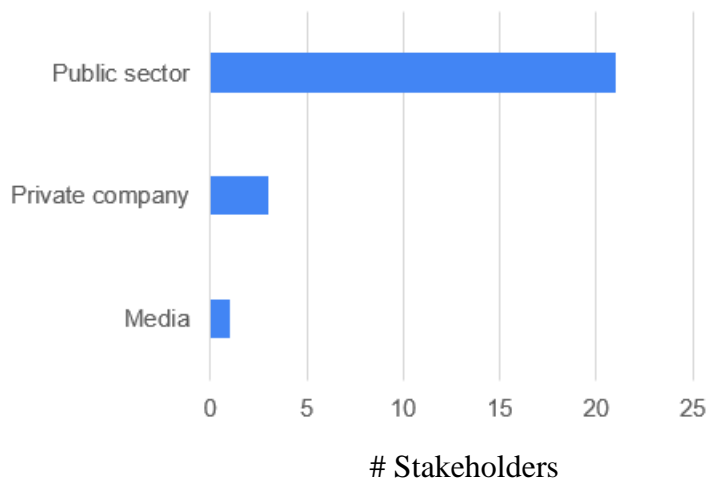
Display 3 CS3 Main River



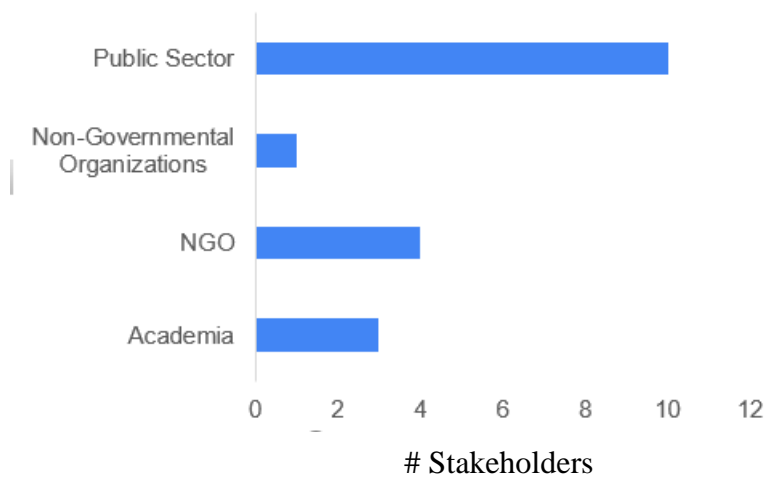
Display 4 – CS 4 Prespa Lakes



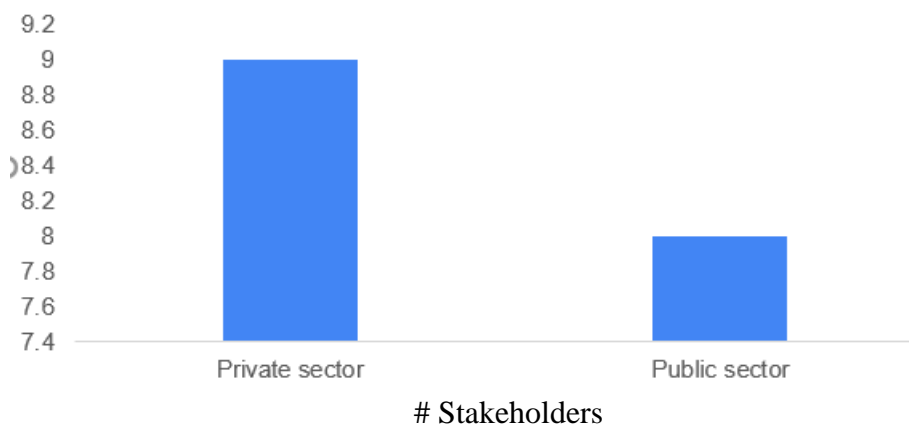
Display 5 CS5 Canary Islands



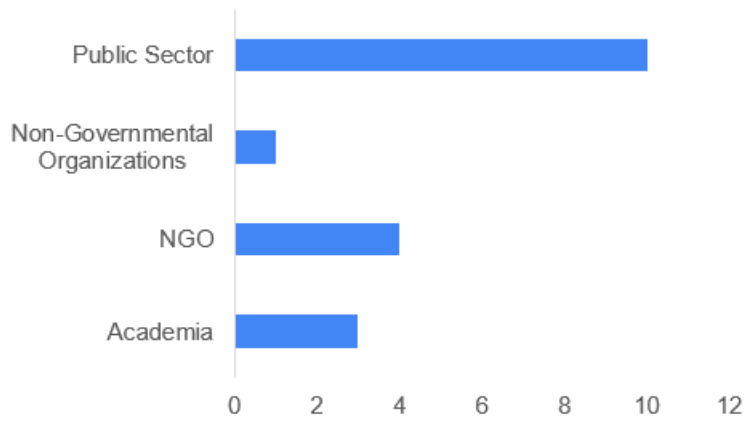
Display 6 CS6 Black Sea



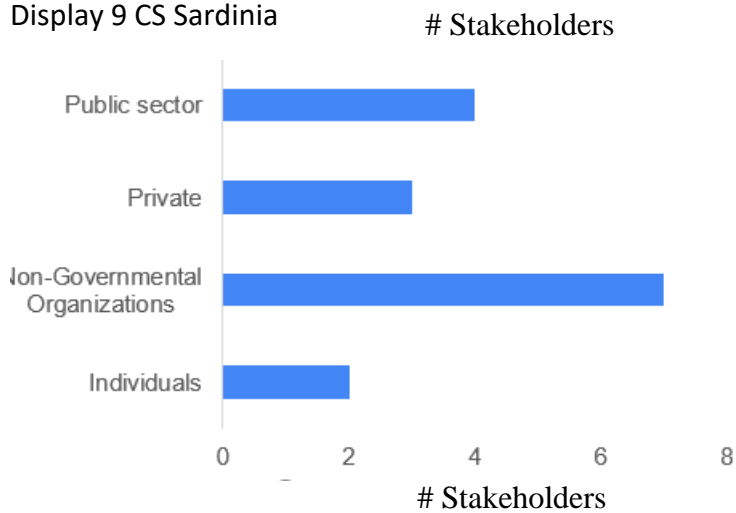
Display 7 CS7 Denmark



Display 8 Torbay



Display 9 CS Sardinia



As it is apparent the majority of ARSINOE case studies's Key stakeholders refer to the Public Sector and so their access to adaptation finance will be different than WP7 for example, where all key stakeholders are of the Private sector, or CSNon-Governmental 9 where the majority of the stakeholders belong to Non-Governmental Organisation.

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## APPENDIX

### Display 9 – ARSINOE Case Study Related Information

<b>CS#1: Athens Metropolitan Area</b>	
<b>Core Themes</b>	<i>Extreme heat</i>
<b>Key Challenges</b>	Extreme heat, accessibility, green and blue infrastructure, awareness raising and environmental education, governance and lack of communication, implications on health, tourism, economy, well-being, biodiversity, cultural heritage
<b>Main Sectors</b>	<i>Water, Energy, Transportation, Health, Urban Planning, biodiversity, tourism, culture, poverty or Socially vulnerable groups, construction</i>
<b>Key Actors</b>	Municipality of Athens, EYDAP, New Metropolitan Attica SA, Ministry of Culture, UrbanDig Project
<b>CS#2: Mediterranean ports</b>	
<b>A. Piraeus</b>	
<b>Core Themes</b>	<i>Most Critical Climate Change Negative Impacts (Heatwaves, Wind/Waves) to the Port Operations (Stop operations, increase of accidents, damage in goods, passenger's health), Port Infrastructure (Infrastructures to increase Energy Efficiency, Waste Management) and nearby community (Air/Water Pollution)</i>
<b>Key Challenges</b>	Heatwaves affecting port operations and has a direct impact on Terminal Users and Passengers.  Wind/ Intense rainfall which result in stopping Operations.
<b>Main Sectors</b>	<i>Water, Energy, Transportation, Health, Urban Planning, biodiversity, tourism, culture, poverty or Socially vulnerable groups, construction</i>
<b>Key Actors</b>	Port Authority, Terminal Users, Government and Municipality.
<b>CS#3: Main River (Germany)</b>	
<b>Core Themes</b>	<i>Water quantity, water quality, land use &amp; soil quality, infrastructure, governance</i>

<b>Key Challenges</b>	Climate change is causing more intense winter floods and significantly increased and more frequent drought in the Main region. High temperatures, heat waves and changing precipitation patterns lead to multiple challenges for public services, the environment, agriculture, forestry, fisheries and navigation. Discussion in the first Living Lab workshop centered on water quality, water quantity, infrastructure, land use and governance, and linkages between challenges in these areas.
<b>Main Sectors</b>	<i>Water, Energy, Agriculture, Shipping, Environmental NGOs</i>
<b>Key Actors</b>	<i>Agriculture, viticulture, utilities (water supply, waste water, energy), fisheries, environmental NGOs, shipping, authorities, forestry</i>
<b>CS#4: Prespa - Ohris Lakes</b>	
<b>Core Themes</b>	<i>Climate change indicators that are evident (temperatures, precipitations), water bodies status, sectors affected, sectors endangered in short and long terms, causes and consequences of water scarcity.</i>
<b>Key Challenges</b>	Insufficiently effective and rational use of water; strategies to be put in place; innovative solutions supported by business models to enhance climate adaptive use of water; improved collaboration and share of information among sectors, municipalities and countries
<b>Main Sectors</b>	<i>Water management, environmental systems (biodiversity), human health, hydro energy, agriculture, livestock farming, fishery, forestry, tourism, industry (SMEs), cultural heritage from Albania, Greece and North Macedonia</i>
<b>Key Actors</b>	<i>Ministries, Municipalities, water management communities, touristic facilities from Albania, Greece and North Macedonia</i>
<b>CS#5 Canary Islands</b>	
<b>Core Themes</b>	<i>Types of crops, subsidies, climate change, territorial planning, difficult access to water in some areas of the island, lack of technology in the sector.</i>
<b>Key Challenges</b>	Change in water management by 2040 from mixed to public; creation of population sensors with citizens; training farmers and equipping them with technology to help in the decision-making process.

<b>Main Sectors</b>	<i>Urban development, environment, water, agriculture</i>
<b>Key Actors</b>	<i>Water managers, environmental offices, universities, private companies</i>
<b>CS#6 Black Sea</b>	
<b>A. Bulgaria</b>	
<b>Core Themes</b>	<i>Types of crops, subsidies, climate change, territorial planning, difficult access to water in some areas of the island, lack of technology in the sector.</i>
<b>Key Challenges</b>	Extreme events (drying or flooding of certain areas), invasive species, infrastructure development, pollution (wood and plastic), beach and picnic activities in proximity of protected areas.
<b>Main Sectors</b>	<i>Water, infrastructure, nature and environmental protection, tourism</i>
<b>Key Actors</b>	<ol style="list-style-type: none"> <li>1. <i>Ministry of Environment and Water (MoEW) – not a GAP, but wishes to be involved at a later stage (Workshop 2 onwards; RIEW – Burgas is set to represent the ministry on local level)</i></li> <li>2. <i>Executive Environment Agency (EEA)</i></li> <li>3. <i>Road Infrastructure Agency (RIA)</i></li> <li>4. <i>National Institute of Meteorology and Hydrology (a contacted stakeholder in the project)</i></li> <li>5. <i>Black Sea Basin Directorate - Varna</i></li> </ol>
<b>CS#6 Black Sea</b>	
<b>B. Turkey</b>	
<b>Core Themes</b>	<i>Safety of ecosystem services</i>
<b>Key Challenges</b>	[urban development, tourism development, coastal population growth, temperature rise, energy generation, extreme events, lack of sectoral plans and policies, agriculture/livestock, wastewater discharge, governance, lack of conservation areas and identified key species, fishing/aquaculture, climate change]

<b>Main Sectors</b>	<i>[water, energy, agriculture/livestock, tourism, construction, health, waste management, urban management, fishing/aquaculture, ecosystem services]</i>
<b>Key Actors</b>	<i>[Public, local governments and municipalities, central government, private sector on tourism, fishing and aquaculture]</i>
<b>CS#6 Black Sea</b>	
<b>C. Romania</b>	
<b>Core Themes</b>	<i>Biodiversity; Drought; Intense precipitations; Sediments; Aquaculture / Fisheries; Societal behaviors; Regional development</i>
<b>Key Challenges</b>	<i>Eutrophication and biodiversity loss; Changes in hydrologic regime; Sediments transport / Erosion; Invasive species; How to preserve / restore the ecosystems services</i>
<b>Main Sectors</b>	<i>Aquaculture/Agriculture, Society, Environment (Eutrophication, Biodiversity), Tourism, Economy</i>
<b>Key Actors</b>	<i>Policy / local authorities;</i>
<b>CS#7: Southern Denmark</b>	
<b>Core Themes</b>	<i>Risk of flooding, Industrial development, Urban development, Connection between coast and city, Economy / Financing, Involvement of civil society</i>
<b>Key Challenges</b>	
<b>Main Sectors</b>	<i>Further improvement of Climate ready Esbjerg app Simple tailor-made solutions for buildings at the harbour-area.</i>
<b>Key Actors</b>	<i>Investors/decisionmakers, Citizens/landowners.</i>
<b>CS#8 Torbay and Devon Country</b>	
<b>Core Themes</b>	<i>Flooding &amp; related themes, such as health, community, services (infrastructure) and assets</i>
<b>Key Challenges</b>	<i>Interconnections amongst water, health, community &amp; infrastructure and ensuring resilience of all these during floods of multiple types</i>
<b>Main Sectors</b>	<i>Infrastructure (water, energy, NHS), planning</i>

<b>Key Actors</b>	<i>Stakeholders involved in Local Resilience Forum, local authority planners, engineers, community groups</i>
<b>CS#9 Sardinia</b>	
<b>Core Themes</b>	<ul style="list-style-type: none"> <li>• <i>Right for food access</i></li> <li>• <i>Food quality</i></li> <li>• <i>Sustainable crop management</i></li> <li>• <i>Limited resources (water, soil, fertilizers)</i></li> <li>• <i>Short chain regulation</i></li> <li>• <i>Awareness-raising, shared information, and training (for producers, consumers and policy makers)</i></li> </ul>
<b>Key Challenges</b>	<i>Enhancing sustainable food production, focus on adaptation to climate change, raising awareness in consumers, enhancing short chains by improving information on food safety and security</i>
<b>Main Sectors</b>	<i>Agriculture, environment, water, energy, handicraft, social</i>
<b>Key Actors</b>	<i>Agricultural unions, Handicraft unions, Regional Ministries of agriculture and environment</i>

Systems Innovation Approach (SIA) addresses the growing complexity, interdependencies and interconnectedness of modern societies and economies, focusing on the functions of the cross-sectoral system? as a whole? and on the variety of actors. The Climate Innovation Window (CIW) is the EU reference innovations marketplace for climate adaptation technologies. ARSINOE shapes the pathways to resilience by bringing together SIA and CIW, to build an ecosystem for climate change adaptation solutions. Within the ARSINOE ecosystem, pathways to solutions are co-created and co-designed by stakeholders, who can then select either existing CIW technologies, or technologies by new providers (or a combination) to form an innovation package. This package may be designed for implementation to a specific region, but its building blocks are transferable and re-usable; they can be re-adapted and updated. In this way, the user (region) gets an innovation package consisting of validated technologies (expanding the market for CIW); new technologies implemented in the specific local innovation package get the opportunity to be validated and become CIW members, while the society (citizens, stakeholders) benefits as a whole. ARSINOE applies a three-tier, approach: (a) using SIA it integrates multi-faceted technological, digital, business, governance and environmental aspects with social innovation for the development of adaptation pathways to climate change for specific regions; (b) it links with CIW to form innovation packages by matching innovators with end-users/regions; (c) it fosters the ecosystem sustainability and growth with cross-fertilization and replication across regions and scales. at European level and beyond. using specific



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