

LUISS



Master of Science in Law, Digital Innovation and Sustainability
Department of Law

Course of Earth Science, Sustainable Development and Climate Change Impacts

Implementing and Financing Nature-Based Solutions in Earth Science:
Leveraging the NRRP Towards Sustainable Investment for Climate and Environmental Objectives

Prof. Luna Kappler
SUPERVISOR

Prof. Christian Fernando Iaione
CO-SUPERVISOR

Maria Vittoria Mori 630593
CANDIDATE

Academic Year 2022/2023

Abstract

This thesis aims to explore the crucial role of nature-based solutions (NBS) in the field of Earth Sciences and to understand how these solutions can be financed in Italy through the National Recovery and Resilience Plan (NRRP or in Italian “Piano Nazionale di Ripresa e Resilienza”, PNRR). NBS is a practical approach to mitigating the impacts of climate change, including the loss of biodiversity and ecosystems, by working in harmony with the natural environment. As this dissertation highlights, despite recognising NBS’s potential through research, science, and policy, there are still challenges in implementing and financing these solutions. The central research question of this thesis is “How can Nature-Based Solutions (NBS) be effectively implemented and financed using NRRP to promote sustainable investments in Earth Science and achieve climate and environmental objectives in Italy?”. This question investigates the feasibility of implementing NBS in Italy and its potential to support sustainable development per European and international guidelines. The research conducted in this thesis will provide insights into the most effective strategies for promoting sustainable investments in NBS in Italy, which can contribute to biodiversity conservation, climate change mitigation, and environmental sustainability goals. It also explores the alignment of NBS with the United Nations Agenda 2030 and Sustainable Development Goals (SDGs), emphasising the importance of sustainable investments in NBS. The methodology through which this research is conducted is primarily qualitative. It implies performing empirical research through a survey analysis and interviews with Earth Science and Green and Sustainable Finance experts. The findings will support ongoing efforts to create a more sustainable and resilient future for Italy and the planet, emphasising the importance of working towards sustainable development through innovative and eco-friendly solutions. This thesis contributes to Italy’s sustainable development by addressing environmental challenges and identifying financing and implementation strategies for NBS, supporting the country’s progress towards the 2030 Agenda goals.

Implementing and Financing Nature-Based Solutions in Earth Science: Leveraging the NRRP Towards Sustainable Investment for Climate and Environmental Objectives

Table of Contents

1. Introduction	6
2. Literature Review: Theory for the Implementation and Financing of NBS through the NRRP	11
2.1 Nature-Based Solutions	11
2.1.1 NBS: definition and classification	11
2.1.2 NBS: advantages, challenges, and feasibility	14
2.2 NRRP: Green Revolution and Ecological Transition	19
2.2.1 Next Generation EU and Green Transition	19
2.2.2 Italian NRRP	21
2.2.3 NRRP and Public Tenders	25
2.3 Implementing and Financing NBS	29
3. Research Question	31
4. Methods	33
4.1 Survey	33
4.2 Interview with Professor of Green and Sustainable Finance	34
4.3 Interview with MASAF's Task Force for the Implementation of the NRRP	35
5. Results	35
5.1 Results of the Survey	35
5.2 Results of the Interview with Professor of Green and Sustainable Finance	41
5.3 Results of the Interview with MASAF's Task Force for the Implementation of the NRRP	44
6. Discussion	48
7. Conclusion	58
Annex	62
Annex 1	62
Annex 2	75
References	77
Summary	82

Table of Figures

Tables

Table 1: NBS Classification	13
Table 2: SDG and NBS.....	17
Table 3: NRRP Mission 2.....	22
Table 4: Total Funding of Mission 2	24
Table 5: Public Tenders of Mission 2.....	26
Table 6: MASAF’s Public Tenders of Mission 2	46

Figures

Figure 1: Survey Q7.....	36
Figure 2: Survey Q13.....	38
Figure 3: Survey Q18.....	40

1. Introduction

Climate change is a phenomenon that has far-reaching implications, among which nature loss is a pressing issue that requires immediate attention. The potential consequences of climate change include elevated temperatures, rising sea levels, increased ocean acidification, and heightened occurrences of extreme weather events, all of which have detrimental effects on ecosystems, wildlife, and natural resources¹. The release of the 2022 State of the Global Climate report by the World Meteorological Organization (WMO) reveals the unprecedented impact of greenhouse gases on the Earth's atmosphere, oceans and land. In 2022, climate change continued to affect regions across the globe, from high-altitude mountains to deep ocean depths, with communities experiencing the devastating consequences and costs of droughts, floods, and heatwaves². These widespread natural calamities have lately happened worldwide, adding to the mounting evidence of the impending threat of climate change.

Italy is a particularly prone region to such climate events, as mentioned in the preamble to the National Recovery and Resilience Plan (NRRP) signed by the former President of the Italian Council of Ministers, Mario Draghi³. Italy was, indeed, subjected to increasing heat waves and droughts in recent years. According to the “Istituto Superiore per la Protezione e la Ricerca Ambientale” (Ispra), the most threatened locations are the coastlines, deltas and floodplains, as they are likely to be subject to the effects of rising sea levels and heavy rainfall⁴. Weather patterns such as heatwaves have a multitude of consequences, resulting in inadequate rainfall, leading to the depletion of rivers, limited agricultural productivity, but also restricted access to potable water for daily use. Thus, natural phenomena not only affect the natural landscape but also potentially affect human health, livelihoods, and general well-being considerably⁵.

Human activity's prioritisation of short-term economic growth over environmental protection has significantly damaged the Earth's ecosystems. Therefore, contemporary worldwide societies are facing a multitude of sustainability challenges. The issues are not limited to climate change but run the entire spectrum from youth unemployment to demographic changes, environmental degradation, sustainable energy and migration. Accordingly, it is urgent to undertake coordinated efforts to address the prevailing obstacles and simultaneously design strategies to prepare for the future, given the rapid rate of global change and the rising expectations of a growing world population⁶.

¹ Di Pirro, E., Roebeling, P., Sallustio, L., Marchetti, M., & Lasserre, B. (2023). Cost-effectiveness of nature-based solutions under different implementation scenarios: A national perspective for Italian urban areas. *Land*, 12(3), 603.

² World Meteorological Organization. (2023). 2022 State of the Global Climate. *WMO Annual Report Highlights Continuous Advance of Climate Change*. Retrieved April 26, 2023, from <https://public.wmo.int/en/media/press-release/wmo-annual-report-highlights-continuous-advance-of-climate-change>.

³ Governo italiano, Presidenza del Consiglio dei ministri. (2022). *Piano Nazionale di Ripresa e Resilienza (PNRR)*. Italia Domani - Portale PNRR. Retrieved March 15, 2023, from <https://www.italiadomani.gov.it/content/sogei-ng/it/it/home.html>

⁴ *Ibidem*.

⁵ Lhotka, O., & Kyselý, J. (2022). The 2021 European heat wave in the context of past major heat waves. *Earth and Space Science*, 9(11).

⁶ Communication from the Commission of 22 November 2016 to the European Parliament, the Council, the Economic and Social Committee and the Committee of the Regions, COM(2016)739 final, on *Next steps for a sustainable European future: European action for sustainability*.

Measures to combat climate change contribute towards environmental protection and the preservation of the Earth. Hence, in recognition of the urgency to restore the world's damaged ecosystems, the United Nations General Assembly passed Resolution 73/284, designating the years 2021-2030 as the United Nations Decade on Ecosystem Restoration (hereafter "UN Decade")⁷. The initiative aims to unite governments, businesses, civil society, and individuals to undertake massive efforts towards restoring degraded ecosystems and ensuring the planet's long-term survival.

The European Union (EU) has been at the forefront of promoting the global environmental agenda and developing policies and instruments to ensure sustainable development. Environmental protection has been a paramount concern. Indeed, the Treaty on the Functioning of the European Union constitutes the legal foundation for the EU's environmental action, explicitly fighting against climate change and promoting measures to solve environmental problems, as stated in the third paragraph of Article 3⁸.

Moreover, throughout its history, the EU has enacted numerous laws, regulations, policies, and instruments to foster sustainable development in its Member States or the international arena. As a matter of fact, in 2015, a significant milestone was reached in the global pursuit of sustainable development. The EU has significantly contributed to advancing global environmental protection efforts by facilitating the acceptance and implementation of international agreements such as the Paris Agreement on Climate Change and the UN 2030 Agenda for Sustainable Development (referred to as the "2030 Agenda"). The former is an international treaty signed in 2015 by almost all countries worldwide, including all EU member states. The agreement recognises the need for ecological preservation and adaptation to achieve its goals. In its introduction, the Paris Agreement acknowledges the significance of safeguarding the integrity of all ecosystems, highlighting the importance of adaptation as a means of protecting both livelihoods and ecosystems.

The 2030 Agenda was adopted by the United Nations General Assembly and centres on the 17 Sustainable Development Goals (SDGs), recognising the importance of addressing negative global patterns affecting society, the economy, and the environment⁹. It has successfully integrated the interconnected economic, social, and environmental dimensions of sustainable development harmoniously. Consequently, this agenda constitutes a unique piece in that it represents an international agreement acknowledging the interdependency of peace, security, justice, and social inclusion and their ability to mutually reinforce each other¹⁰.

⁷ United Nations. (2021). Principles for Ecosystem Restoration to guide the United Nations decade 2021–2030 |. UN Decade on Restoration. Retrieved April 3, 2023, from <https://www.decadeonrestoration.org/publications/principles-ecosystem-restoration-guide-united-nations-decade-2021-2030>

⁸ European Union (2012). Consolidated versions of the Treaty on European Union and the Treaty on the Functioning of the European Union. *Official Journal of the European Union*, 55(C-326).

⁹ Communication from the Commission of 22 November 2016 to the European Parliament, the Council, the Economic and Social Committee and the Committee of the Regions, COM(2016)739 final, on *Next steps for a sustainable European future: European action for sustainability*.

¹⁰ *Ibidem*.

Settled by the international agreements, the new European targets indicated the ecological transition as the basis of the new Italian and European development model. Taking action to reduce polluting emissions, prevent and counteract land disruption, and minimise the impact of production activities on the environment is necessary to improve the quality of life and environmental safety and leave a greener country and a more sustainable economy to future generations¹¹. It is a cornerstone of the Next Generation EU initiative and a crucial principle for future growth.

Besides, the EU released a package of policy initiatives in 2019 under the European Green Deal (EGD) with the target of achieving net zero greenhouse gas (GHG) emissions by 2050. The EGD is, indeed, the lead venture of the European Commission, aiming at turning Europe into the first climate-neutral continent before 2050. It seeks to guarantee that EU policies will contribute to this goal. Accordingly, the European Commission proposed the European Climate Law in 2020, shifting the 2030 climate objective to a reduction of the EU's net GHG emissions by at least 55% compared to levels in 1990¹²¹³.

Nature-based solutions (NBS) have emerged in international policy and industry as a promising approach to address global environmental challenges, such as biodiversity loss, climate change, and ecosystem degradation, gaining growing prominence since there is mounting evidence of the various advantages that individuals may derive from interacting with nature¹⁴. NBS refer to actions that are inspired by, supported by, or imitative of nature to address environmental, social, and economic challenges sustainably. NBS refers to the use and leverage of natural systems or processes to provide solutions to societal challenges while also supporting ecological integrity, such as the ability to regulate water flows and store carbon, to achieve desired outcomes, including reducing disaster risk and enhancing human well-being¹⁵. It is a unique concept based on the recognition that some societal challenges arise from a failure to acknowledge ecological limitations and that nature can provide valuable knowledge for designing sustainable alternatives¹⁶.

Achieving the objectives set out by the Paris Agreement necessitates an ambitious reduction in emissions emanating from fossil fuels and other industrial activities, as per the latest scientific research. NBS emerged as a viable approach to addressing sustainable development in the scenario of the climate change negotiations in Paris, recommended as a strategy to mitigate and cope with climate change, safe water, food,

¹¹ Governo italiano, Presidenza del Consiglio dei ministri. (2022). Piano Nazionale di Ripresa e Resilienza (PNRR). Italia Domani - Portale PNRR. Retrieved March 15, 2023, from <https://www.italiadomani.gov.it/content/sogei-ng/it/it/home.html>

¹² European Parliament and European Council (2021). Regulation (EU) 2021/1119 of the European Parliament and of the Council of 30 June 2021 establishing the framework for achieving climate neutrality and amending Regulations (EC) No 401/2009 and (EU) 2018/1999 ('European Climate Law'). *Official Journal of the European Union*, 1(L-234).

¹³ European Commission, Commission Staff Working Document. (2021). Impact Assessment Report. Accompanying the document: Proposal for a regulation of the European Parliament and of the Council establishing a carbon border adjustment mechanism, SWD(2021)643 final. Retrieved May 21, 2023, from <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A52021SC0643>.

¹⁴ Chausson, A., Turner, B., Seddon, D., Chabaneix, N., Girardin, C. A., Kapos, V., Key, I., Roe, D., Smith, A., Woroniecki, S., & Seddon, N. (2020). Mapping the effectiveness of nature-based solutions for climate change adaptation. *Global Change Biology*, 26(11), 6134–6155.

¹⁵ European Commission, Directorate-General for Research and Innovation, (2015). Towards an EU research and innovation policy agenda for nature-based solutions & re-naturing cities: final report of the Horizon 2020 expert group on 'Nature-based solutions and re-naturing cities': (full version), *Publications Office of the European Union*.

¹⁶ *Ibidem*.

and energy supplies, eradicate poverty, and foster economic, making a significant contribution towards achieving the SDGs' purpose throughout the world¹⁷.

The use of NBS holds paramount importance in tackling the issue of climate change while simultaneously offering advantages such as adaptation. NBS, according to research, may promote social innovation in cities and hasten the transition to sustainability. They accomplish this by encouraging creative planning and governance and new models for business, finance, institutions, and society with a holistic approach to such social concerns¹⁸. By collaborating with nature, NBS has the potential to foster a more sustainable future for all.

Consequently, governments and organisations around the world recognise the urgency of promoting sustainable investments to address these challenges. Multiple European Union programs have been designed to promote NBS. The European Commission (EC) has also acknowledged the multifunctional concept of NBS as a strategic framework for supporting sustainability. To promote sustainable development, the EC aims to establish the EU as a global leader in NBS. Additionally, the Research and Innovation Roadmap of the EC intends to promote NBS at both the European and international levels. Consequently, the EC has funded various NBS projects, platforms, and networks through Horizon 2020 (H2020), the Seventh Framework Programme (FP7), and other similar initiatives¹⁹.

Notwithstanding the potential benefits of nature-based solutions, significant gaps remain in their financing. Only a modest part of governmental climate mitigation funding is allocated to nature-based initiatives, although opportunities abound for integrating it into a variety of industries throughout Europe. Therefore, increasing funding and support for nature-based solutions is essential to promote their more comprehensive implementation and their contribution to mitigating climate change. Perhaps, the deterrent to this economic development of nature has so far been the economic model that prioritises short-term economic growth over environmental protection, causing significant damage to the Earth's ecosystems. This has led the financial market to underestimate the essential benefits of nature, which are, in truth, vital to society's current and future prosperity²⁰.

Fortunately, the business community recognises the importance of nature, with more than half of the world's GDP moderately or highly dependent on it. Protecting and restoring natural resources and incorporating the value of nature into our economic system is in our best interest. The EU taxonomy for sustainable finance is a commendable initiative that aids this awareness in the business community, providing a common framework for identifying economic activities that contribute to the transition to a green and low-

¹⁷ Pauleit, S., Zölch, T., Hansen, R., Randrup, T. B., & Konijnendijk van den Bosch, C. (2017). Nature-based solutions and climate change – four shades of Green. *Theory and Practice of Urban Sustainability Transitions*, 29–49.

¹⁸ Communication from the Commission of 22 November 2016 to the European Parliament, the Council, the Economic and Social Committee and the Committee of the Regions, COM(2016)739 final, on *Next steps for a sustainable European future: European action for sustainability*.

¹⁹ Faivre, N., Fritz, M., Freitas, T., de Boissezon, B., & Vandewoestijne, S. (2017). Nature-based solutions in the EU: Innovating with nature to address social, economic and environmental challenges. *Environmental Research*, 159, 509–518.

²⁰ United Nations Environment Programme. (2021). State of Finance for Nature: Tripling investments in nature-based solutions by 2030. United Nations Environment Programme.

carbon economy. The taxonomy sets technical criteria based on indicators and metrics to determine whether an economic activity meets science-based targets for nature, defining six environmental objectives that an economic activity must meet to be considered sustainable²¹.

Hence, as a European member state, Italy is the recipient of the mentioned European norms and agreements. Nevertheless, Article 9 of the Italian Constitution highlights how the Italian Republic and the State legislation explicitly preserve the environment, biodiversity, and ecosystems, in the interest of future generations²². Therefore, it is not merely a matter of being receptive to EU agreements and obligations but of actively being a subject and guarantor of environmental protection.

Italy is also the recipient of the European Recovery and Resilience Facility (RRF) funds, establishing the National Recovery and Resilience Plan (NRRP). The Italian government announced this plan in 2021, intending to resolve the COVID-19 pandemic's economic and social repercussions and some structural issues facing the Italian economy. It envisages investments in several areas, including ecological transition, digitalisation, health and education. In particular, Mission 2 (M2) of the NRRP concerns the ecological transition and the green revolution, aiming at climate neutrality by 2050. To achieve this milestone, the NRRP foresees several interventions, including promoting energy efficiency, implementing renewable energy, reducing the use of fossil fuels, promoting sustainable mobility and reducing greenhouse gas emissions. It also contains investments in sustainable agriculture and the protection of biodiversity. On a broader level, this mission of the NRRP seeks to address the challenge of climate change and to promote sustainable development of the Italian economy²³.

Despite the growing interest and the potential benefits of NBS, their implementation and financing still need to be improved in the Italian context due to its unique ecological landscape and economic circumstances. Consequently, this thesis will investigate the following research question:

How can Nature-Based Solutions (NBS) be effectively implemented and financed using NRRP to promote sustainable investments in Earth Science and achieve climate and environmental objectives in Italy?

By examining existing literature on NBS and using qualitative research consisting of interviews with green finance and Earth science experts, this thesis seeks to provide insights into the most effective strategies for promoting sustainable investments that support biodiversity conservation, climate change mitigation, and environmental sustainability goals in Italy. By addressing this question, this thesis aims to contribute to the ongoing efforts to create a more sustainable and resilient future for Italy. Thus, nature's importance in tackling environmental, social, and economic challenges is becoming more widely acknowledged²⁴.

²¹ United Nations Environment Programme. (2021). State of Finance for Nature: Tripling investments in nature-based solutions by 2030. United Nations Environment Programme.

²² Costituzione della Repubblica Italiana. (1948). Articolo 9.

²³ Governo Italiano, Presidenza del Consiglio dei ministri. (2022). *Piano Nazionale di Ripresa e Resilienza (PNRR)*. Italia Domani - Portale PNRR. Retrieved March 15, 2023, from <https://www.italiadomani.gov.it/content/sogei-ng/it/it/home.html>

²⁴ Di Pirro, E., Roebeling, P., Sallustio, L., Marchetti, M., & Lasserre, B. (2023). Cost-effectiveness of nature-based solutions under different implementation scenarios: A national perspective for Italian urban areas. *Land*, 12(3), 603.

2. Literature Review: Theory for the Implementation and Financing of NBS through the NRRP

The upcoming chapter of the thesis will delve into the literature review, investigating the theory behind implementing and financing nature-based solutions (NBS) in Earth Science towards sustainable investments that will enable the attainment of climatic and environmental goals within the framework of the Italian National Recovery and Resilience Plan (NRRP). The literature review will be divided into three sections, each providing an overview of the critical components of understanding the theory behind NBS and the NRRP.

The first paragraph will introduce NBS, their benefits, and their potential to mitigate the impact of climate change by offering ecosystem services. It will aim to provide a general understanding of NBS and how they relate to the European Union's environmental policies and the Sustainable Development Goals (SDGs) in the context of the thesis.

The second paragraph will focus on the Italian NRRP and its mission. This section will explore Mission 2 on the Green Revolution and Ecological Transition, examining the NRRP's investments in Italy. This section aims to provide a comprehensive overview of the NRRP and the investments it suggests in the green mission and NBS as it pertains to the thesis.

The third paragraph will focus on implementing and funding NBS through the NRRP. This section will examine the challenges and opportunities associated with putting NBS into practice within the framework of the NRRP, including funding, stakeholder participation, monitoring, and evaluation. This section explains the difficulties and possibilities of implementing NBS through the NRRP.

In conclusion, this chapter on the literature review provides a comprehensive overview of the theory behind implementing and financing NBS within the NRRP. By exploring the significant possibilities and difficulties of implementing NBS, the study aims to identify critical factors that must be addressed to ensure effective implementation and support achieving climatic and environmental objectives.

2.1 Nature-Based Solutions

2.1.1 NBS: definition and classification

The NBS concept has emerged as a reasonably recent response to climate change at large and associated daily challenges for both societies and international organisations²⁵. In 2016, the European Commission defined nature-based solutions as “solutions that are inspired and supported by nature, which are cost-effective, simultaneously provide environmental, social and economic benefits and help build resilience. Such solutions bring more, and more diverse, nature and natural features and processes into cities, landscapes, and seascapes, through locally adapted, resource-efficient, and systemic interventions”²⁶. According to the International Union for Conservation of Nature (IUCN), NBSs are actions that conserve, sustainably manage,

²⁵ United Nations Environment Programme and International Union for Conservation of Nature. (2021). Nature-based solutions for climate change mitigation. Retrieved March 20, 2023, from <https://www.unep.org/resources/report/nature-based-solutions-climate-change-mitigation>

²⁶ European Commission. (2016). Nature-based solutions. Research and innovation. Retrieved March 17, 2023, from https://research-and-innovation.ec.europa.eu/research-area/environment/nature-based-solutions_en

and restore natural or modified ecosystems while ensuring human well-being and biodiversity benefits²⁷. Whereas the IUCN definition states the importance of a well-managed or restored ecosystem being the core of any NBS, the EC has a broader definition underlining the importance of solutions that utilise nature and are guided and supported by it²⁸. In other words, the latter cares about the need to use nature not only as a source of solutions but also as a source of inspiration to create innovative solutions that can meet current challenges. Overall, the NBS notion encompasses each of these components, and the core is the practical use of alternative solutions that operate directly alongside the ecosystems themselves to combat climate challenges. The ultimate purpose is unchanged: to improve livelihoods' sustainability and protect both biodiversity and natural ecosystems. Furthermore, the mentioned report acknowledges NBS as progressively being a cost-effective and long-term solution to environmental challenges like global warming, water scarcity, and biodiversity loss²⁹.

The given dual definition of the same concept appears relevant for the subsequent delineation of NBS types. Indeed, NBS can be classified considering whether used to improve living solutions or created from them to maintain, sustainably manage, restore, or develop ecosystems that may be natural, modified, or new³⁰. Hence, they fall into two main categories, namely “Natural or Seminal Ecosystems” and “Artificial Surfaces or Systems”³¹. In the first category, three different types of NBS can be tracked down. Type 1 means better management of existing ecosystems. Solutions classified as NBS Type 1 provide more effective utilisation of already-existing natural or naturalistic environments through non-physical changes. Enhancing an ecosystem's utilisation requires modifying how it is handled and how neighbouring ecosystems are maintained, as it indirectly impacts the concerned ecosystem, altering how the ecosystem's resources are utilised. Type 2 is restoration and partial reclamation of existing ecosystems, meaning that these procedures exclusively comprise approaches for re-establishing ecosystems³². Therefore, physical changes may be required. Type 3 lies in the sphere of the complete reclamation or creation of novel ecosystems. Thus, it entails both the formation of new ecosystems and the significant alteration of existing ones, both on a broad scale and to a significant extent. The higher the Type of NBS (ranging from 1 to 3), the more physical and engineering influence on the environment must be made³³. Type 3 can also be found in the mentioned second category of Artificial Surfaces or Systems³⁴.

Table 1 below summarises the threefold division mentioned above.

²⁷ Cohen-Shacham, E., Maginnis, S., Janzen, C., & Walters, G. (2016). Nature-based solutions to address global societal challenges. *International Union for Conservation of Nature (IUCN)*, XIII, 1–114.

²⁸ *Ibidem*.

²⁹ *Ibidem*.

³⁰ *Ibidem*.

³¹ Babí Almenar, J., Elliot, T., Rugani, B., Philippe, B., Navarrete Gutierrez, T., Sonnemann, G., & Geneletti, D. (2021). Nexus between nature-based solutions, Ecosystem Services and urban challenges. *Land Use Policy*, 100, 1–22.

³² *Ibidem*.

³³ Babí Almenar, J., Elliot, T., Rugani, B., Philippe, B., Navarrete Gutierrez, T., Sonnemann, G., & Geneletti, D. (2021). Nexus between nature-based solutions, Ecosystem Services and urban challenges. *Land Use Policy*, 100, 1–22.

³⁴ European Commission, General Directorate for the Environment. (2014). Mapping and assessment of ecosystems and their services : an analytical framework for ecosystem assessments under action 5 of the EU biodiversity strategy to 2020: discussion paper – final, April 2013, *Publications Office of the European Union*.

Table 1: NBS Classification

Nature-Based Solutions	Natural or Seminatural Ecosystems	Type 1 - Better Management of Existing Ecosystems
		Type 2 - Restoration and Partial Reclamation of Existing Ecosystems
		Type 3 - Complete Reclamation or Creation of Novel Ecosystems
	Artificial Surfaces or Systems	Type 3 - Complete Reclamation or Creation of Novel Ecosystems

Sources: (European Commission and General Directorate for the Environment, 2014; Cohen-Shacham, E. et al., 2016; Babí Almenar, J. et al., 2021), elaborated by the author.

The first column on the left shows the umbrella concept of NBS, while the second column already covers an initial subdivision between natural and artificial NBS. The third column shows the triple distribution of NBS types referring to the category Natural or Seminatural Ecosystems. It can be read from the above table that the category Artificial Surfaces or Systems has only Type 3 of NBS in common with the first since it is the creation of Novel Ecosystems, in this case, artificial.

Due to its comprehensive category resolution and compatibility with other classification modes, the Mapping Europe's Ecosystems (MAES) classification of ecosystem species was chosen as the most suitable, as used and encouraged by the European Commission to assess ecosystem services in Europe³⁵. Regarding the categories, the three types of NBS all pertain to activities that are in some manner applied to ecosystems, making it necessary to organise NBS according to ecosystem types³⁶. Accordingly, NBS have wide-ranging applicability. As numerous academic studies have evidenced, they stand to be deployed in multiple urban and natural landscape areas, including coastal areas, water management, forests and forestry and agriculture³⁷. So, NBS can be implemented in landscapes that refer to marine and rural ecosystems, but more research has been conducted on the last one³⁸. Indeed, mitigation solutions focus more on forests, grasslands, and agriculture

³⁵ Babí Almenar, J., Elliot, T., Rugani, B., Philippe, B., Navarrete Gutierrez, T., Sonnemann, G., & Geneletti, D. (2021). Nexus between nature-based solutions, Ecosystem Services and urban challenges. *Land Use Policy*, 100, 1–22.

³⁶ *Ibidem*.

³⁷ European Environment Agency (EEA). (2021). Nature-based solutions in Europe: Policy, knowledge and practice for climate change adaptation and Disaster Risk Reduction. *Publications Office of the European Union*, 1, 1–164.

³⁸ Babí Almenar, J., Elliot, T., Rugani, B., Philippe, B., Navarrete Gutierrez, T., Sonnemann, G., & Geneletti, D. (2021). Nexus between nature-based solutions, Ecosystem Services and urban challenges. *Land Use Policy*, 100, 1–22.

than other ecosystems, as forests have the highest potential for overall mitigation, followed by grasslands and agriculture³⁹.

Accordingly, the following paragraph presents an overview of the scientific literature on NBS, including advantages, challenges, and feasibility.

2.1.2 NBS: advantages, challenges, and feasibility

In contemporary times, evidence indicates that nature-based solutions hold considerable potential in tackling global environmental challenges, including climate change, biodiversity loss, and ecosystem degradation. Consequently, NBS has garnered increasing attention in international policy and industry as a promising mechanism to address these challenges. A growing body of evidence demonstrates the benefits individuals can obtain from engaging with nature, rendering NBS an attractive alternative to mitigate climate change. Chausson et al. developed a systematic global map of evidence on the effectiveness of nature-based treatments to guide policymakers and practitioners in mitigating the consequences of climate change and hydro-meteorological hazards through NBS. The map shows that ecosystems, where nature-based operations have taken place have minimised climate-harmful consequences⁴⁰. It is also important to note that climate, biodiversity, and society are interrelated issues that require a holistic approach to tackle effectively. This integration of concerns is captured by the acronym CBS (climate-biodiversity-society)⁴¹.

According to research conducted by the UN Environmental Programme and the IUCN, NBS offer a wide range of benefits for the environment and human well-being, making them equally or more effective alternatives to traditional methods for mitigating climate change impacts^{42,43}. The ability to provide benefits makes NBS an appealing option for reducing climate change. Indeed, advantages include biodiversity preservation, the establishment of sustainable livelihoods, and retention and restoration of ecosystem services from wetlands, forests, croplands, grazing areas, and other coastal habitats that support human health and well-being, boosting human resilience and allowing individuals to cope with the adverse effects of climate change⁴⁴.

However, the success of NBS initiatives depends on having a solid evidence-based foundation that supports their implementation on a global scale. Although there is growing interest in adopting NBS policies, there is still a lack of empirical evidence to support their effectiveness in practice. Promoting more practical

³⁹ United Nations Environment Programme and International Union for Conservation of Nature. (2021). Nature-based solutions for climate change mitigation. Retrieved March 20, 2023, from <https://www.unep.org/resources/report/nature-based-solutions-climate-change-mitigation>

⁴⁰ Chausson, A., Turner, B., Seddon, D., Chabaneix, N., Girardin, C. A., Kapos, V., Key, I., Roe, D., Smith, A., Woroniecki, S., & Seddon, N. (2020). Mapping the effectiveness of nature-based solutions for climate change adaptation. *Global Change Biology*, 26(11), 6134–6155.

⁴¹ Goodwin, S., Olazabal, M., Castro, A. J., & Pascual, U. (2023). Global mapping of urban nature-based solutions for climate change adaptation. *Nature Sustainability*, 1-12.

⁴² *Ibidem*.

⁴³ Chausson, A., Turner, B., Seddon, D., Chabaneix, N., Girardin, C. A., Kapos, V., Key, I., Roe, D., Smith, A., Woroniecki, S., & Seddon, N. (2020). Mapping the effectiveness of nature-based solutions for climate change adaptation. *Global Change Biology*, 26(11), 6134–6155.

⁴⁴ United Nations Environment Programme and International Union for Conservation of Nature. (2021). Nature-based solutions for climate change mitigation. Retrieved March 20, 2023, from <https://www.unep.org/resources/report/nature-based-solutions-climate-change-mitigation>

activities that can enhance the widespread application of NBS for climate change adaptation and mitigation is essential. Indeed, numerous groups are working to promote the implementation of policies that could raise the widespread application of NBS as a resource for climate change adaptation and mitigation⁴⁵.

The European Environment Agency (EEA) recognises that NBS can directly contribute to reducing catastrophe risk and adapting to climate change. The Agency has emphasised the relationship between NBS and several fundamental socioeconomic issues that affect the applicability of NBS in this context. Each SDG includes or benefits from disaster risk reduction and adaptation to climate change⁴⁶. Moreover, as previously remarked, NBS have multiple applications in areas related to human well-being and the environment, establishing a connection between the SDGs and NBS. Generally, environmental quality, including air quality and waste management; public health and well-being; sustainable economic growth and decent employment, including green jobs; and climate change mitigation are social concerns where NBS might offer advantages⁴⁷.

The adoption of the United Nations' SDGs and the Paris Agreement on climate change has further increased the demand for nature-based solutions that can help achieve these goals. Financing NBS can contribute to achieving the SDGs in several ways. Primarily, amplifying investments in renewable energy sources is essential to pursue European objectives effectively. This entails advocating for electric mobility in urban, regional, and electric transport systems to curtail air pollution. Furthermore, integrating advanced digital technologies throughout the energy supply chain significantly optimises energy utilisation. Simultaneously, developing efficient energy storage systems is pivotal in enhancing overall energy efficiency. Equally critical is establishing intelligent and automated energy efficiency systems within smart buildings. Embracing a circular economy model that regards waste as a valuable resource fosters both regeneration and sustainability. Finally, the reduction of pesticide application and the expansion of organic farming areas within the agroecological model framework can minimise emissions and mitigate the health and environmental repercussions associated with intensive farming practices⁴⁸.

NBS can lower the vulnerability of human societies to climate change and shocks, boosting our ability to adapt to those climate change issues that would still be present in a net zero world⁴⁹. Sustainable Development Goal 2, Zero Hunger, aims to promote sustainable agriculture and enhance food security to eradicate hunger and malnutrition. To this end, nature-based solutions play a core societal role in supporting sustainable land use and agricultural practices that sustain healthy soil, biodiversity, and ecosystem services⁵⁰.

⁴⁵ Chausson, A., Turner, B., Seddon, D., Chabaneix, N., Girardin, C. A., Kapos, V., Key, I., Roe, D., Smith, A., Woroniecki, S., & Seddon, N. (2020). Mapping the effectiveness of nature-based solutions for climate change adaptation. *Global Change Biology*, 26(11), 6134–6155.

⁴⁶ United Nations. (2015). *The 17 goals | Sustainable Development*. United Nations - Department of Economic and Social Affairs. Retrieved April 3, 2023, from <https://sdgs.un.org/goals>

⁴⁷ European Environment Agency (EEA). (2021). Nature-based solutions in Europe: Policy, knowledge and practice for climate change adaptation and Disaster Risk Reduction. *Publications Office of the European Union*, 1, 1–164.

⁴⁸ Rotondo, F., Perchinunno, P., L'Abbate, S., & Mongelli, L. (2022). Ecological transition and sustainable development: Integrated Statistical Indicators to support public policies. *Scientific Reports*, 12(1), 1–12.

⁴⁹ United Nations Environment Programme and International Union for Conservation of Nature. (2021). Nature-based solutions for climate change mitigation. Retrieved March 20, 2023, from <https://www.unep.org/resources/report/nature-based-solutions-climate-change-mitigation>

⁵⁰ European Environment Agency (EEA). (2021). Nature-based solutions in Europe: Policy, knowledge and practice for climate change adaptation and Disaster Risk Reduction. *Publications Office of the European Union*, 1, 1–164.

Similarly, SDG 3, Good Health and Well-being, aims to ensure equitable access to quality healthcare and the ability to live a healthy life. In this context, NBS might offer advantages by providing ecosystem services that sustain public health and well-being⁵¹. Related to the latter, SDG 6, Clean Water and Sanitation, aims to ensure that people worldwide can access affordable and safe water and sanitation services. NBS can substantially contribute to achieving this goal by safeguarding and rehabilitating watersheds, wetlands, and other natural ecosystems that provide clean water and regulate water flows through water management and create more blue spaces⁵².

SDG 8, Decent Work and Economic Growth, also intends to support inclusive and sustained economic growth and productive employment for all. Nature-based solutions can assist in accomplishing this by encouraging the creation of green jobs in new or renewed fields such as forestry, ecotourism, and agriculture. SDG 10, Reduced Inequalities, aims to decrease inequalities within and among countries by promoting social, economic, and political inclusion. Nature-based solutions can assist in achieving this goal by providing ecosystem services that sustain the livelihoods and well-being of marginalised communities through promoting social justice, cohesion, and equity, lowering risks for social groups particularly vulnerable to climate change. Similarly, SDG 11, Sustainable Cities and Communities, aspires to develop inclusive and sustainable cities and human settlements as core societal challenges. In this context, nature-based solutions contribute by providing green infrastructure that promotes biodiversity, regulates urban heat, and mitigates air and water pollution. Moreover, SDG 12, Responsible Consumption and Production, intends to encourage sustainable consumption and production practices. Through NBS, environmental quality, including air quality and waste management, can be achieved due to the promotion of circular economies and the reduction of waste by adopting natural materials and processes⁵³.

Climate change mitigation is one of the other social concerns where NBS might offer advantages by implementing sustainable practices that reduce greenhouse gas emissions⁵⁴. NBS can lessen exposure to climate-related dangers⁵⁵. Additionally, the restoration of biodiversity and climate change are among the issues for which NBS and other ecosystem-based approaches have been advocated, as per the decisions of the UN Convention on Biological Diversity⁵⁶. SDG 13, Climate Action, strives to address climate change and its effects urgently. Multiple published studies have determined that it is plausible to achieve a minimum reduction of 5 gigatons of carbon dioxide annually by 2030 and 10 gigatons of carbon dioxide annually by

⁵¹ European Environment Agency (EEA). (2021). Nature-based solutions in Europe: Policy, knowledge and practice for climate change adaptation and Disaster Risk Reduction. *Publications Office of the European Union*, 1, 1–164.

⁵² *Ibidem*.

⁵³ *Ibidem*.

⁵⁴ *Ibidem*.

⁵⁵ United Nations Environment Programme and International Union for Conservation of Nature. (2021). Nature-based solutions for climate change mitigation. Retrieved March 20, 2023, from <https://www.unep.org/resources/report/nature-based-solutions-climate-change-mitigation>

⁵⁶ Faivre, N., Fritz, M., Freitas, T., de Boissezon, B., & Vandewoestijne, S. (2017). Nature-based solutions in the EU: Innovating with nature to address social, economic and environmental challenges. *Environmental Research*, 159, 509–518.

2050 through the utilisation of NBS⁵⁷. Nonetheless, there exist several variables which create uncertainty concerning these estimates. SDG 14, Life Below Water, seeks to conserve and sustainably use marine resources, oceans, and seas for sustainable development. In this regard, nature-based solutions can help preserve and restore marine and coastal ecosystems⁵⁸. Additionally, SDG 15, Life on Land, endeavours to protect, restore, and promote sustainable usage of terrestrial ecosystems, manage forests sustainably, combat desertification, and halt and reverse biodiversity loss and land degradation. The implementation of NBS can contribute to this objective as it enhances habitat preservation and biodiversity loss reduction, also through the creation of greener spaces⁵⁹.

Table 2 below summarises the association, as mentioned earlier from the EEA report on NBS for Policy, knowledge and practice for climate change adaptation and Disaster Risk Reduction in Europe.

Table 2: SDG and NBS

	SDG Goal	Goal Description	Relating NBS
2	Zero Hunger	End hunger, food security, improved nutrition, sustainable agriculture.	Sustainable land use and agriculture practices.
3	Good Health and Well-being	Healthy lives, well-being.	Ecosystem services to support human health and well-being.
6	Clean Water and Sanitation	Sustainable management of water, sanitation for all.	Water management and creation of more blue spaces.
8	Decent Work and Economic Growth	Inclusive, sustainable economic growth, productive employment, decent work.	Creation of green jobs.
10	Reduced Inequalities	Reduce inequalities, through social, economic, and political inclusion.	Ecosystem services for marginalized communities.
11	Sustainable Cities and Communities	Inclusive, safe, resilient, and sustainable cities and human settlements.	Urban green infrastructure, creation of greener spaces.
12	Responsible Consumption and Production	Sustainable consumption and production patterns.	Environmental quality.
13	Climate Action	Urgent action to combat climate change and its impacts.	Sustainable practices against GHG emissions.

⁵⁷ United Nations Environment Programme and International Union for Conservation of Nature. (2021). Nature-based solutions for climate change mitigation. Retrieved March 20, 2023, from <https://www.unep.org/resources/report/nature-based-solutions-climate-change-mitigation>.

⁵⁸ European Environment Agency (EEA). (2021). Nature-based solutions in Europe: Policy, knowledge and practice for climate change adaptation and Disaster Risk Reduction. *Publications Office of the European Union*, 1, 1–164.

⁵⁹ *Ibidem*.

14	Life Below Water	Conservation and sustainable use of oceans, seas, and marine resources.	Protection and restoration of marine and coastal ecosystems.
15	Life on Land	Preserve terrestrial ecosystems, combat desertification, halt and reverse land degradation and biodiversity loss.	Protection and restoration of terrestrial ecosystems, creation of greener spaces.

Sources: (EEA, 2021; UNEP and IUCN, 2021), elaborated by the author.

According to the MEA, ecosystem services are the services generated by natural systems to benefit humans, so they are the multiple benefits ecosystems provide to humankind. Ecosystem services can be divided into three categories: regulation, culture, and provision of services. Regulation services involve the natural regulation of atmospheric gases, climate, water, erosion, and pollination, among other things. Additionally, they provide habitats for biodiversity and prevent hydrogeological disruptions. Cultural services are the benefits that ecosystems provide to humans in the form of aesthetic, recreational, educational, spiritual, and artistic experiences. These services contribute to human well-being and quality of life. Provision services refer to ecosystems' tangible goods, including food, fresh water, and raw materials⁶⁰.

Moreover, they offer biological variability, which is essential for ecosystems' long-term resilience and ability to adapt to environmental changes⁶¹. Therefore, the correlation between ecosystem services and nature-based solutions is that NBS can contribute to ecosystem services by restoring or enhancing the natural systems that provide these services. In turn, providing ecosystem services is crucial for the success and sustainability of NBS, as they rely on healthy and functioning ecosystems to deliver their benefits.

By adopting just and resilient natural-based solutions that support biodiversity conservation, enhance ecosystems, and increase community resilience to climate change, the pressing problems of climate collapse and biodiversity loss may be resolved. These solutions provide secure livelihoods, job opportunities, and effective management of food and forestry systems while utilising evidence-based action and community participation. As a result, these concerns serve as a stark reminder of the critical need to safeguard our planet as an ecological necessity and a socio-economic imperative⁶². This is a unique opportunity for implementing solid and resilient NBS during the Covid-19 pandemic, using a strategic approach that minimises the risk of climate change feedback and impacts⁶³.

However, ensuring NBS fulfils the expectation of their long-term contribution to global objectives requires guidelines to lead their implementation⁶⁴. Policies are essential to ensure that these solutions can fully

⁶⁰ MEA. (2005). Ecosystems and human well-being: Synthesis. Millennium ecosystem assessment. *World Health*, 1134, 25-60.

⁶¹ *Ibidem*,

⁶² Di Pirro, E., Roebeling, P., Sallustio, L., Marchetti, M., & Lasserre, B. (2023). Cost-effectiveness of nature-based solutions under different implementation scenarios: A national perspective for Italian urban areas. *Land*, 12(3), 603.

⁶³ United Nations Environment Programme and International Union for Conservation of Nature. (2021). Nature-based solutions for climate change mitigation. Retrieved March 20, 2023, from <https://www.unep.org/resources/report/nature-based-solutions-climate-change-mitigation>

⁶⁴ European Environment Agency (EEA). (2021). Nature-based solutions in Europe: Policy, knowledge and practice for climate change adaptation and Disaster Risk Reduction. *Publications Office of the European Union*, 1, 1–164.

leverage their potential to address the challenges of climate and biodiversity crises while contributing to SDGs⁶⁵.

2.2 NRRP: Green Revolution and Ecological Transition

2.2.1 Next Generation EU and Green Transition

“Today is a truly historic day for our European Union. We successfully conducted the first funding operation for NextGenerationEU. As a strong Union, we are raising money at the markets together and investing in a common recovery from this crisis. It is an investment in our single market. And even more importantly, it is an investment in the future of Europe’s next generations as they face the challenges of digitisation and climate change. Money can now start flowing to help reshaping our continent, to build a greener, more digital and more resilient Europe. I will now visit every Member State, to see NextGenerationEU impact on the ground” affirmed European Commission President Ursula von der Leyen⁶⁶.

The Next Generation EU (NGEU) initiative is the European Union’s response to the Covid-19 pandemic crisis, which has impacted economies and societies across the globe. The NGEU seeks to create investments and reforms to accelerate the ecological and digital transition, improve worker training, and achieve better gender, territorial, and generational equity. As stipulated in Regulation (EU) 2021/241 of the European Parliament and of the Council of 12 February 2021, establishing the Recovery and Resilience Facility (RRF), the funds allocated to each state are to be distributed over six funding pillars, which aim to foster a resilient European economy. These pillars include green transition; digital transformation; smart, sustainable and inclusive growth; social and territorial cohesion; health and economic, social and institutional resilience; and policies for new generations, children and youth⁶⁷.

Through the NGEU, the Recovery and Resilience Facility (RRF) was established in 2021 as a supporting financial tool for the EU Member States. It will remain in force for six years, ending on 31 December 2026. It is part of a comprehensive response that aims to lessen the economic and social effects of the coronavirus pandemic and improve the sustainability, resilience, and preparedness of European economies and societies for the opportunities and challenges of green and digital transitions. The RRF contributes to the EU’s objective of achieving carbon neutrality by 2050, putting Europe on the digital transformation and sustainability path, and stimulating countries’ development⁶⁸.

It is a short-term tool for recovery and enables the European Commission (EC) to raise money to support Member States in implementing reforms and investments that are in line with EU priorities and deal

⁶⁵ Seddon, N., Chausson, A., Berry, P., Girardin, C. A., Smith, A., & Turner, B. (2020). Understanding the value and limits of nature-based solutions to climate change and other global challenges. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 375(1794), 1–12.

⁶⁶ European Commission. (2021). NextGenerationEU: European Commission raises €20 billion in first transaction to support Europe's recovery. NextGenerationEU. Retrieved April 14, 2023, from https://ec.europa.eu/commission/presscorner/detail/en/IP_21_2982.

⁶⁷ European Parliament and Council. (2021). Regulation (EU) 2021/241 of the European Parliament and of the Council of 12 February 2021 establishing the Recovery and Resilience Facility. *Official Journal of the European Union*, 17(L-57).

⁶⁸ *Ibidem*.

with the difficulties mentioned in country-specific recommendations made within the framework of the European Semester for the coordination of economic and social policy. It makes grants (338 billion euros) and loans (385.8 billion euros) totalling 723.8 billion euros available. The whole NGEU breakdown amounts to 806.9 billion euros. The Facility is supported by other funds, namely the ReactEU for 50.6 billion euros, the Horizon Europe for 5.4 billion euros, the InvestEU for 6.1 billion euros, the Rural Development fund for 8.1 billion euros, the Just Transition Fund (JTS) for 10.9 billion euros and, lastly, RescEU for 2 billion euros⁶⁹.

In order to be eligible to receive financing up to a predetermined allocation, the RRF requires Member States to submit a package of investments and reforms called the National Recovery and Resilience Plan (Piano Nazionale di Ripresa e Resilienza, henceforth NRRP) to the EC. The Commission is responsible for granting payments after a group of milestones and targets has been achieved. Member States must provide a detailed explanation of how their plans contribute to achieving the set environmental, energy, and climate objectives. Each plan outlines the investments and changes that must be implemented by the end of 2026, and results-based planning guides the RFF. It means that the payments are linked to the performance. Indeed, the NRRP must contribute to the achievement of environmental goals set at the EU level through the use of state-of-the-art digital technologies, the preservation of water and marine resources, the transition to a circular economy, the reduction and recycling of waste, the prevention of pollution and the protection and restoration of healthy ecosystems, such as forests, wetlands, peat bogs and coastal areas, as well as the planting of trees and the promotion of urban vegetation. When a Member State has fulfilled the agreed-upon milestones and targets, it can request financial support from the Commission. Then, payments will become available after the Economic and Financial Committee determines that benchmarks and criteria for implementing the plans' changes and investments are met⁷⁰.

Of the six funding pillars, the functional strategic axis for this dissertation is that of the Green Transition, which directly stems from the European Green Deal (EGD) and the dual EU target of reaching climate neutrality by the year 2050 and reducing GHG emissions by 55% by the year 2030 against 1990^{71,72}. Member States are expected to outline the impact of reforms and investments on the abatement of GHG emissions, the use of renewable energy sources, energy efficiency, the integration of energy systems, the implementation of clean energy technologies and electricity interconnection⁷³. Furthermore, the NGEU regulation stipulates that a minimum of 37% of the investment and reform expenditure proposed in the NRRP must be directed towards achieving climate objectives. Additionally, all measures within the Green Transition

⁶⁹ European Parliament and Council. (2021). Regulation (EU) 2021/241 of the European Parliament and of the Council of 12 February 2021 establishing the Recovery and Resilience Facility. *Official Journal of the European Union*, 17(L-57).

⁷⁰ *Ibidem*.

⁷¹ European Parliament and Council (2021). Regulation (EU) 2021/1119 of the European Parliament and of the Council of 30 June 2021 establishing the framework for achieving climate neutrality and amending Regulations (EC) No 401/2009 and (EU) 2018/1999 ('European Climate Law'). *Official Journal of the European Union*, 1(L-234).

⁷² European Commission, Commission Staff Working Document. (2021). Impact Assessment Report. Accompanying the document: Proposal for a regulation of the European Parliament and of the Council establishing a carbon border adjustment mechanism, SWD(2021)643 final. Retrieved May 21, 2023, from <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A52021SC0643>.

⁷³ European Parliament and Council. (2021). Regulation (EU) 2021/241 of the European Parliament and of the Council of 12 February 2021 establishing the Recovery and Resilience Facility. *Official Journal of the European Union*, 17(L-57).

funding pillar must comply with the principle of Do No Significant Harm to the environment (DNSH), which serves as a crucial environmental norm that promotes investments in environmentally friendly and sustainable initiatives, aligning with the objectives of the Green Deal⁷⁴. Therefore, in the upcoming chapter focused on Implementing and Financing NBS, the compliance of NBS initiatives with the DNSH principle and their potential for achieving climate objectives will be thoroughly examined.

2.2.2 Italian NRRP

On an absolute value basis, Italy is set to receive the largest amount of funding under the NGEU, with a total of 191.5 billion euros guaranteed over the next five years. Of this amount, 68.9 billion euros are non-reimbursable grants, while the remaining 122.6 billion euros are loans. Indeed, through the former President of the Italian Council of Ministers, Mario Draghi, the country has expressed a strong commitment to fully utilizing its financing capacity through RRF loans, which are expected to help overcome the obstacles that have hindered the country's economic growth in recent decades⁷⁵. In addition to this resource, 30.6 billion euros is being financed through the Complementary Fund, established by Italian Decree-Law No. 59 of 6 May 2021. A sum of 13 billion euros is available through the REACT-EU programme, which will be spent in 2021-2023 per EU regulations⁷⁶.

The Italian NRRP is structured into sixteen components: digitalization, innovation, competitiveness, culture and tourism; green revolution and ecological transition; infrastructure for sustainable mobility; education and research; inclusion and cohesion; and health⁷⁷. The components are further clustered into six missions aligned with the six pillars mentioned in the RRF, upon which the NGEU ought to centre. The missions prioritize initiatives common to the EU, such as digitalization and innovation, green transition, and social inclusion. Hence, this aligns with the EU's environmental norms, particularly with the environmental principle of DNSH. The latter is a primary requirement for receiving money from the EU, specifying that the measures stated in national NRRPs may not result in any substantial environmental impact and requiring that all planned measures in the domain of Green Transition comply strictly with environmentally friendly and sustainable initiatives, fulfilling the Green Deal's objectives and settling a threshold of 37% of the funding for the ecological transformation mission⁷⁸. Therefore, the NRRP meets the parameters set by the European regulations on the quotas for green and digital projects⁷⁹.

⁷⁴ European Commission. (2022). Integration of environmental dimensions in public finances – Implementing the ‘Do No Significant Harm’ (DNSH) principle in public funding programmes. Reform Support. Retrieved April 6, 2023, from https://reform-support.ec.europa.eu/integration-environmental-dimensions-public-finances_en

⁷⁵ Governo italiano, Presidenza del Consiglio dei ministri. (2022). Piano Nazionale di Ripresa e Resilienza (PNRR). Italia Domani - Portale PNRR. Retrieved March 15, 2023, from <https://www.italiadomani.gov.it/content/sogei-ng/it/it/home.html>

⁷⁶ *Ibidem*.

⁷⁷ *Ibidem*.

⁷⁸ Governo italiano, Presidenza del Consiglio dei ministri. (2022). Il principio DNSH (do no significant harm) nel PNRR. Italia Domani - Portale PNRR. Retrieved April 6, 2023, from <https://www.italiadomani.gov.it/content/sogei-ng/it/it/Interventi/dnsh.html>

⁷⁹ Governo italiano, Presidenza del Consiglio dei ministri. (2022). Piano Nazionale di Ripresa e Resilienza (PNRR). Italia Domani - Portale PNRR. Retrieved March 15, 2023, from <https://www.italiadomani.gov.it/content/sogei-ng/it/it/home.html>

This work will focus on the second mission of the Italian NRRP, the Green Revolution and Ecological Transition. This mission addresses critical issues related to sustainable agriculture, circular economy, energy transition, sustainable transportation, the energy efficiency of buildings, water resources, and pollution to increase the economic system's sustainability and achieve a just and inclusive transition to a society with no net environmental effect⁸⁰. The Green Revolution and Ecological Transition mission is divided into four components, each addressing vital sustainability issues.

The first component, M2C1, focuses on Sustainable Agriculture and Circular Economy and aims to achieve full environmental sustainability through two main objectives. Firstly, by improving waste management and promoting the circular economy through modernization and the development of new waste treatment plants. Secondly, by creating an innovative and sustainable agricultural and food supply chain, reducing environmental impact through such green supply chains. The NRRP allocates 5.27 billion euros for C1. At the same time, M2C2 focuses on Energy Transition and Sustainable Mobility, supporting the use of renewable energy sources, including hydrogen, and the renewal of public transport with low-emission vehicles. Moreover, the aim is to develop leadership and knowledge in energy transition sectors, build competitive supply chains, reduce technology imports, and strengthen R&D in innovative areas. For Component 2, the allocated funds are 23.78 billion euros. The third component, M2C3, on Energy Efficiency and Building Renovation, focuses on strengthening energy efficiency by increasing the efficiency of both public and private buildings, also through the *Superbonus* measure. To improve reliability, safety, and flexibility of building efficiency, the plan allocates resources of 15.36 billion euros. The fourth component, M2C4, also focuses on the Protection of Territory and Water Resources, which amounts to 15.06 billion euros. Finally, the total amount settled into the NRRP for Mission 2 is 59.47 billion euros⁸¹.

The following tables identify billions of euros divided into the four components of Mission 2 of the National Recovery and Resilience Plan (NRRP). Table 3 summarises the billions of euros allocated by the NRRP to each component.

Table 3: NRRP Mission 2

Components of Mission 2	NRRP (in billion euros)
M2C1 - Sustainable Agriculture and Circular Economy	5.27
M2C2 - Energy Transition and Sustainable Mobility	23.78
M2C3 - Energy Efficiency and Building Renovation	15.36
M2C4 - Protection of Territory and Water Resources	15.06
Total Mission 2	59.47

Source: (Governo italiano, 2021a), elaborated by the author.

⁸⁰ Governo italiano, Presidenza del Consiglio dei ministri. (2022). Piano Nazionale di Ripresa e Resilienza (PNRR). Italia Domani - Portale PNRR. Retrieved March 15, 2023, from <https://www.italiadomani.gov.it/content/sogei-ng/it/it/home.html>

⁸¹ Governo italiano. (2021). Rivoluzione verde e transizione ecologica. Retrieved March 20, 2023 from <https://www.governo.it/it/approfondimento/rivoluzione-verde-e-transizione-ecologica/16703>

All these components are particularly relevant to nature-based solutions in terms of addressing issues such as sustainable agriculture and forest management; sustainable mobility, with a focus on the dissemination of low environmental impact means of transport and the redevelopment of urban spaces; energy redevelopment of buildings, with the adoption of innovative and sustainable solutions; and finally, waste management, with the promotion of separate waste collection and waste reduction. Lastly, Mission 2 addresses issues of territorial security and environmental sustainability, such as the mitigation of hydrogeological risks, the protection of green areas and biodiversity, the reduction of water and soil pollution, and the availability of water resources that are essential for ensuring the health of citizens and attracting investments⁸².

The Italian NRRP addresses these issues to make the country more resilient to climate change, protect nature and biodiversity, and ensure the safety and efficiency of the water system. Its emphasis on nature-based solutions (NBS) is particularly evident in this component as it is designed to address environmental challenges and promote a just transition to a net-zero economy, with a focus on strengthening the capacity to forecast the effects of climate change and combat its consequences on hydrogeological instability and land vulnerability. It also aims to allocate funds for safeguarding air quality, biodiversity, green areas, soil, and marine areas and ensuring sustainable and efficient management of water resources throughout the entire cycle. The NRRP recognises the importance of protecting Italy's unique heritage, which includes its natural, agricultural, and biodiversity ecosystems, with inestimable value in terms of nature and cultural, historical, and identity. Separate mention deserves the Protection of Territory and Water Resources component. It is, therefore, a distinctive element of Italy's economic development toward implementing and exploiting NBS, providing practical and sustainable solutions for the protection and restoration of ecosystems, prevention of soil erosion and restoration of soil fertility, control of flooding, and improvement of water quality. As highlighted in the analysis of the benefits of NBS, the improvements these solutions bring are not only for nature but also have a spill-over effect on the safety and security of societies. Through its focus on NBS, the Italian NRRP demonstrates a commitment to promoting sustainable development and addressing the pressing environmental challenges of our time⁸³.

Table 4 summarises the total sum of funds allocated to the four components of Mission 2, including additional funding sources. It reveals that apart from the NRRP, other funding sources exist, such as React EU, stated in the third column of Table 4, and supplemental funds specified in the fourth column of the same table, which are geared towards attaining the set objectives of the Mission.

⁸² Rotondo, F., Perchinunno, P., L'Abbate, S., & Mongelli, L. (2022). Ecological transition and sustainable development: Integrated Statistical Indicators to support public policies. *Scientific Reports*, 12(1), 1–12.

⁸³ Governo italiano, Presidenza del Consiglio dei ministri. (2022). Piano Nazionale di Ripresa e Resilienza (PNRR). Italia Domani - Portale PNRR. Retrieved March 15, 2023, from <https://www.italiadomani.gov.it/content/sogei-ng/it/it/home.html>

Table 4: Total Funding of Mission 2

Components of Mission 2	NRRP	React EU	Complementary Fund	Total
M2C1 - Sustainable Agriculture and Circular Economy	5.27	0.50	1.20	6.47
M2C2 - Energy Transition and Sustainable Mobility	23.78	0.18	1.40	25.36
M2C3 - Energy Efficiency and Building Renovation	15.36	0.32	6.56	22.24
M2C4 - Protection of Territory and Water Resources	15.06	0.31	0.00	15.37
Total Mission 2	59.47	1.31	9.16	69.94

Source: (Governo italiano, 2022a), elaborated by the author.

In comparison, Table 4 partly retains the same structure as Table 3. As a result, the four components of Mission 2 will still be present. The number of billions of euros allotted by the NRRP for each component is displayed in the second column, as seen in both tables, and its sum, which we recall is 59.47 billion euros, is displayed in the last row. In addition to the configuration of Table 3, Table 4 illustrates that the React EU provides funds for a total of 1.31 billion euros, divided as follows: 0.5 billion euros for M2C1 - Sustainable Agriculture and Circular Economy, 0.18 billion euros for M2C2 - Energy Transition and Sustainable Mobility, 0.32 billion Euros for M2C3 - Energy Efficiency and Building Renovation and 0.31 billion euros for M2C4 - Protection of Territory and Water Resources. Moreover, Complementary Funds have been identified for each component amounting to 1.2 billion euros, 1.4 billion euros and 6.56 billion Euros and are not allocated for the last component, totalling 9.16 billion euros.

The entire amount of Mission 2 is 69.94 euros, shared across the four components. M2C1 Sustainable Agriculture and Circular Economy receives 6.47 billion euros, M2C2 - Energy Transition and Sustainable Mobility receives 25.36 billion euros, M2C3 - Energy Efficiency and Building Renovation receive 22.24 billion euros, and M2C4 - Protection of Territory and Water Resources 15.37 billion euros.

The University Cattolica del Sacro Cuore report, compiled by the “Osservatorio sui Conti Pubblici Italiani” in 2022, concerns the Italian NRRP and the objectives it sets for the ecological transition. Already mentioned in the previous paragraph, the first requirement for green transition objectives is to allocate at least 37% of the resources provided by the European Union to measures that foster the green transition. The Italian NRRP allocates 37.5%, or 71.7 billion euros, of the available funds to environmental issues. The relevant consideration here is that Italy allocates the bare minimum of resources to green transition, only 0.5% more than the threshold set by EU guidelines. Moreover, it is noticeable that this data differs from those reported in Tables 3 and 4. To explain the above, the measures of the NRRP have been catalogued by the European Commission into “fields of action”, of which some are rated 100% green, whereas others are rated as 40%

green only. To assess whether a field of action was entirely or 40% green, the EC has considered both the investment nature and the expected benefit of the investment.

For this reason, the funds allocated to Mission 2 differ from the percentage of 37.5% of the overall NRRP, which aggregates together the nature of the investment and the expected benefit of interventions relating to other missions but with a green stance. Indeed, due to this partial consideration of some measures, the 71.7 billion euro qualified to be green corresponds to an aggregate amount of 88.8 billion euro of total investments. The Commission considered that out of the 281 sub-interventions provided for in the NRRP, 108 could be classified as green, of which 55 were 100% and 53 only 40%⁸⁴.

According to the Osservatorio, the NRRP envisages green investments falling into four main categories: the renovation of transport and public infrastructure into environmentally friendly infrastructures, the energy efficiency of buildings and supply facilities, investments in renewable energy and environmental protection and prevention measures. Of the 71.7 billion euros, constructing infrastructure for sustainable mobility accounts for 40% of investments, followed by energy efficiency at 30%, renewable energies for 14% and environmental prevention works for 15%. The alignment would seem to refer to the Mission 2 components, although the sub-interventions with a green impact belong to other missions⁸⁵. Therefore, despite what the Osservatorio reports, this research needs to trace the measures closely related to the implementation and financing of nature-based solutions within the broader framework of the NRRP. Accordingly, the following section will not consider all 108 sub-interventions but only the public tenders falling under the heading of Mission 2.

2.2.3 NRRP and Public Tenders

The public tenders published by Italian Ministries represent strategic initiatives and investments within the missions outlined in Table 4 of the Italian National Recovery and Resilience Plan. Mission 2, specifically designed to help Italy implement the guidelines of European and international climate change mitigation pacts, aims to promote long-term economic growth and sustainability. The four components of Mission 2 have specific objectives related to different aspects of the environmental and natural recovery challenge. Each component aims, in its specificity, to implement solutions to mitigate Italy's environmental impact, such as automotive and energy sustainability, circular economy and biodiversity protection. As shown in Table 5, each component consists of several subcategories of investments and lines of action, under the entire mission that occupies the macro-area of European and international green challenges, in line with the Paris Agreement, the EU Green Deal and more globally, the 2030 Agenda. The NRRP is essential in addressing Italy's environmental needs, promoting sustainable economic growth, and contributing to the global effort to combat climate change. Public tenders published by Italian Ministries can help ensure that the initiatives and investments outlined in the NRRP are implemented and contribute to the country's economic recovery and

⁸⁴ Brugnara, L., & Orlando, C. (2022). (rep.). 108 misure verdi: cosa fa il PNRR per la transizione ecologica (1–13). Milano, Italia: Osservatorio sui Conti Pubblici Italiani, Università Cattolica del Sacro Cuore.

⁸⁵ *Ibidem*.

sustainable development. This approach is aimed at ensuring that Italy’s recovery from the COVID-19 pandemic is sustainable, resilient, and aligned with global efforts to combat climate change.

Depending on the tenders that have been published, it is possible to trace back which components have been addressed. Accordingly, Table 5 provides a summary in ascending order of component, investment, and line of action of the relevant public tenders and the holder Italian Ministry: MASE - *Ministero dell’Ambiente e della Sicurezza Energetica*, MASAF - *Ministero dell’Agricoltura, della Sovranità alimentare e delle Foreste*, DARA - *Dipartimento per gli Affari regionali e le Autonomie*, MIMIT- *Ministero delle Imprese e del Made in Italy*, MIM - *Ministero dell’Istruzione e del Merito*, MIT - *Ministero delle Infrastrutture e dei Trasporti*⁸⁶.

Table 5: Public Tenders of Mission 2

Component 1	Investments	Italian Ministry	Public Tender
Investment 1.1 – Line of action A	Construction of new waste management plants and modernization of existing plants	MASE	Improvement and mechanization of the municipal waste collection network
Investment 1.1 – Line of action B	Construction of new waste management plants and modernization of existing plants	MASE	Modernization (expansion of existing plants) and construction of new treatment/recycling plants for municipal waste from separate collection.
Investment 1.1 – Line of action C	Construction of new waste management plants and modernization of existing plants	MASE	Modernization (expansion of existing plants) and construction of new innovative treatment/recycling plants for the disposal of absorbent materials for personal use (PAD), sewage sludge, leather waste and textile waste.
Investment 1.2 – Line of action A	Modernization and construction of new facilities for the improvement of collection, logistics and recycling of waste electrical and electronic equipment including wind	MASE	Modernization (including expansion of existing facilities) and construction of new facilities for the improvement of the collection, logistics and recycling of waste electrical and electronic

⁸⁶ Governo italiano, Presidenza del Consiglio dei ministri. (2021). Bandi e Avvisi delle Amministrazioni Titolari. Italia Domani - Portale PNRR. Retrieved April 18, 2023, from <https://www.italiadomani.gov.it/it/opportunita/bandi-amministrazioni-titolari.html?orderby=%40jcr%3Acontent%2Fstatus&sort=asc>

	turbine blades and photovoltaic panels		equipment (WEEE) including wind turbine blades and photovoltaic panels
Investment 1.2 – Line of action C	Creation of new plants for recycling plastic waste, including plastic waste in the sea Marine litter	MASE	Realization of new plants for the recycling of plastic waste (through mechanical recycling, chemical recycling, Plastic Hubs), including plastic waste in the Marine litter.
Investment 1.2 – Line of action D	Circular economy flagship projects	MASE	Infrastructure for the collection of pre-consumer and post-consumer textile fractions, modernization of plant engineering and construction of new plants for the recycling of textile fractions from a systemic viewpoint known as Textile Hubs
Investment 2.1	Logistics development for the agri-food, fisheries and aquaculture, forestry, floriculture, and nursery sectors	MASAF	Public Notice for the Development of Agri-Food Logistics of Wholesale Agri-Food Markets
Investment 2.1	Logistics development for the agri-food, fisheries and aquaculture, forestry, floriculture, and nursery sectors	MASAF	Development of Agri-Food Logistics by Improving the Logistics Capacity of Ports
Investment 2.1	Logistics development for the agri-food, fisheries and aquaculture, forestry, floriculture, and nursery sectors	MASAF	Agri-food Logistics Contracts - Modalities and deadlines for applications for access to the facilities provided to support tangible and intangible investments in agri-food logistics to reduce environmental and economic costs and to support innovation in production processes
Investment 3.2	Green Communities	DARA	Submission of Intervention Proposals for the implementation of Green Communities development plans
M2C1	Agri-solar Park	MASAF	Agri-solar Park

Component 2	Investments	Italian Ministry	Public Tender
Investment 3.5	Hydrogen R&D	MASE	Selection of project proposals for fundamental research activities in the field of renewable energy, hydrogen, grid, and sustainable mobility
Investment 5.3	Electric buses (industrial sector)	MIMIT	Development contracts. Support international, industrial and research and development leadership in the field of electric buses
M2C2	Renewables and Batteries	MIMIT	Development Contracts. Batteries and Renewables
M2C2	Manufacturing in brownfield sites	MASE	Invitation to autonomous regions/provinces to express interest in the selection of proposals for the construction of green hydrogen production sites on brownfield sites
Component 3	Investments	Italian Ministry	Public Tender
M2C3	Construction of new schools by replacing buildings	MIM	Building New, Innovative, Sustainable, Safe and Inclusive Schools
Component 4	Investments	Italian Ministry	Public Tender
Investment 4.2	Reduction of losses in water distribution networks, including digitization and monitoring of networks	MIT	Submission of proposals for interventions aimed at reducing leakages in water distribution networks, including digitization and monitoring of networks
M2C4	Investing in the resilience of the irrigated agricultural system for better water management	MASAF	Mipaaf Decree no. 29915 of 30/06/2021 approving the eligibility and selection criteria of the projects in the DANIA database

Source: (Governo italiano, 2021b), elaborated by the author.

2.3 Implementing and Financing NBS

Funds allocated by the Italian state signal a shift towards a transformation of the economy based on ecological transition and environmental protection. Due to an economic model prioritising short-term economic growth over environmental protection, the damage that human activity has caused to Earth's ecosystems is significant. A fundamental shift in our mindset and relationship with nature is needed to prevent further damage and stay within the planetary boundaries. Unfortunately, the financial market undervalues the essential benefits of nature that are vital for current and future prosperity. It is crucial to incorporate the value of nature into the economic system in a meaningful way. Fortunately, there is a growing recognition in the business community of the importance of nature. More than half of the world's GDP is moderately or highly dependent on nature as agriculture, food and beverage, and construction sectors⁸⁷. Hence, it is in our best interest to protect and restore natural resources and incorporate the value of nature into our economic system.

The EU taxonomy for sustainable finance is an excellent initiative aiding this awareness in the business community. The latter is a classification system for sustainable economic activities developed by the EU to provide a common framework for identifying economic activities contributing to the transition to a green and low-carbon economy. In addition, it sets technical criteria for determining whether an economic activity meets science-based targets for nature based on a number of indicators and metrics⁸⁸. It defines six environmental objectives that must be met by an economic activity to be considered sustainable: climate change mitigation, climate change adaptation, sustainable use and protection of water and marine resources, transition to a circular economy, pollution prevention and control, and protection and restoration of biodiversity and ecosystems⁸⁹. These objectives can also be tracked down in the DNSH principle.

The DNSH principle is a fundamental pillar of the Italian NRRP as it ensures that public investments are consistent with the EU's sustainable development goals and do not cause significant damage to the environment, human health and society⁹⁰. To implement the sustainable finance principle, DNSH assessments are conducted to evaluate the direct and indirect long-term effects of each financed intervention. The proposed projects and reforms are evaluated based on the DNSH criteria and European guidelines, and their effects on the six environmental objectives are traced to four distinct scenarios. Scenario 1 occurs when a measure has no or minimal impact on the environmental objective. In such cases, the measure complies with the DNSH principle and requires no further assessment. In scenario 2, the measure substantially and directly contributes to achieving the environmental objective with a ratio of 100% and therefore complies with the DNSH principle without further evaluation. In scenario 3, the measure contributes "substantially" to the environmental target

⁸⁷ United Nations Environment Programme. (2021). *State of Finance for Nature: Tripling investments in nature-based solutions by 2030*. United Nations Environment Programme.

⁸⁸ European Commission. (2021). Commission Delegated Regulation (EU) 2021/2139 of 4 June 2021 supplementing Regulation (EU) 2020/852 of the European Parliament and of the Council by establishing the technical screening criteria for determining the conditions under which an economic activity qualifies as contributing substantially to climate change mitigation or climate change adaptation and for determining whether that economic activity causes no significant harm to any of the other environmental objectives. *Official Journal of the European Union*, L442.

⁸⁹ *Ibidem*.

⁹⁰ Governo italiano, Presidenza del Consiglio dei ministri. (2022). Il principio DNSH (do no significant harm) nel PNRR. Italia Domani - Portale PNRR. Retrieved April 6, 2023, from <https://www.italiadomani.gov.it/content/sogei-ng/it/it/Interventi/dnsh.html>

but not with a 100% coefficient. In this case, a more thorough assessment is required to determine whether the measure complies with the DNSH principle and whether it requires special conditions to be implemented. Finally, in scenario 4, a measure may negatively affect one or more environmental objectives. It requires a comprehensive DNSH assessment to determine whether it can be sustainably implemented and what conditions it must fulfil to comply with the DNSH principle. Once these scenarios are identified, two approaches for DNSH assessments can be defined. Then, the simplified approach is adopted if an intervention falls into one of the first three scenarios. In contrast, the in-depth analysis and the necessary conditions to be met are adopted for investments and reforms with a higher risk of affecting one or more environmental objectives, such as those in the energy, transport, or waste management sectors, or for interventions that aim to make a significant contribution to climate change mitigation⁹¹.

Despite the potential benefits, a modest part of governmental climate mitigation funding is allocated to nature-based initiatives⁹². However, opportunities abound for integrating nature-based solutions into a variety of industries throughout Europe⁹³. Thus, increasing funding and support for NBS is essential to promote their more comprehensive implementation and contribution to mitigating climate change.

The 2018 First Assessment Report on biodiversity measurement approaches for business and financial institutions highlights that various sources, including public bodies, private organisations, and communities, can fund biodiversity initiatives. Public bodies, such as municipalities, can provide subsidies or issue green bonds to encourage the adoption of green roofs or promote biodiversity in real estate development. The public sector enables private investment in nature-based solutions (NBS) and increases investment levels. However, several challenges hinder such investments. These include a lack of cash flow in existing NBS projects and unfavourable regulations that limit funding mechanisms, making them inadequate and small-scale⁹⁴.

Additionally, public funding that supports environmentally harmful practices may discourage NBS investments and create an uneven playing field, making it difficult to achieve environmental goals⁹⁵. This is where the Do Not Significant Harm tool becomes crucial, as it can help overcome barriers and promote sustainable nature-based practices. To further elaborate, the DNSH principle mandates that public investments be directed towards NBS that do not cause significant harm to the environment, human health, and society, thereby ensuring long-term sustainability. This requires public investments in NBS to be consistent with the European Taxonomy and sustainable finance, thereby guaranteeing the financing of projects with positive environmental and social impacts. Promoting NBS has been the focus of creative, sustainable business concepts. To ensure that NBS can significantly contribute to mitigating climate change, it is crucial to

⁹¹ Governo italiano, Presidenza del Consiglio dei ministri. (2022). Il principio DNSH (do no significant harm) nel PNRR. Italia Domani - Portale PNRR. Retrieved April 6, 2023, from <https://www.italiadomani.gov.it/content/sogei-ng/it/Interventi/dnsh.html>

⁹² United Nations Environment Programme and International Union for Conservation of Nature. (2021). Nature-based solutions for climate change mitigation. Retrieved March 20, 2023, from <https://www.unep.org/resources/report/nature-based-solutions-climate-change-mitigation>

⁹³ European Environment Agency (EEA). (2021). Nature-based solutions in Europe: Policy, knowledge and practice for climate change adaptation and Disaster Risk Reduction. *Publications Office of the European Union*, 1, 1–164.

⁹⁴ *Ibidem*.

⁹⁵ *Ibidem*.

implement necessary safeguards, carbon accounting frameworks, and government schemes that are strictly enforced.

Furthermore, adequate financing must ensure successful implementation⁹⁶. To address these challenges, governments, donors, and multilateral development banks (MDBs) can provide public sources of capital through grants and concessional finance. The National Recovery and Resilience Plan (NRRP) adheres to sustainable finance principles, creating an environment that enables the implementation and scaling up of NBS. This will remove barriers to the flow of funds and accelerate investment development. By doing so, we can effectively tackle the challenges of climate change and environmental degradation while promoting sustainable economic growth and development⁹⁷.

Private sector entities have the potential to play various roles in NBS implementation, including those of investors, developers, market infrastructure creators, customers, and beneficiaries. Private organisations may invest in biodiversity initiatives to increase customer value or meet building requirements. Nature-based solutions present an attractive opportunity for the private sector to access new sources of revenue, increase business resilience, reduce costs, and contribute to corporate reputation and sustainability goals. The private sector's interest in NBS is evidenced by the emergence of several private sector-led initiatives in recent years. These initiatives reflect a growing recognition of the value of NBS and the potential for private sector engagement in their implementation. As such, the private sector is essential in advancing NBS as a viable and practical approach to address pressing environmental challenges⁹⁸.

Communities and citizens can also play a role in funding biodiversity initiatives. For example, they may crowdfund the installation of green roofs on neighbouring buildings or donate to organisations that promote biodiversity. In addition to these initiatives' financial benefits, they can raise awareness and promote a sense of stewardship for the environment. Indeed, biodiversity initiatives typically benefit from a combination of funding sources, including public bodies, private organisations, and communities or citizens⁹⁹.

3. Research Question

This thesis investigates how nature-based solutions (NBS) can be effectively implemented and financed using NRRP to promote sustainable investments in Earth Science and achieve climate and environmental objectives. Consequently, the research question reads as follows:

How can nature-based solutions (NBS) be effectively implemented and financed using NRRP to promote sustainable investments in Earth Science and achieve climate and environmental objectives in Italy?

⁹⁶ European Environment Agency (EEA). (2021). Nature-based solutions in Europe: Policy, knowledge and practice for climate change adaptation and Disaster Risk Reduction. *Publications Office of the European Union*, 1, 1–164.

⁹⁷ United Nations Environment Programme. (2021). *State of Finance for Nature: Tripling investments in nature-based solutions by 2030*. United Nations Environment Programme.

⁹⁸ *Ibidem*.

⁹⁹ *Ibidem*.

The theoretical premises in Chapter 2 of the literature review serve as a foundation for this research question. By examining existing literature on NBS, this thesis provides insights into the most effective strategies for promoting sustainable investments in Italy.

Nature-based solutions (NBS) represent a novel and innovative approach that involves leveraging natural ecosystems and processes to address environmental and social challenges. Thus, comprehending the effective implementation and financing of NBS can significantly contribute to the promotion of sustainable development, not only in Italy but also worldwide. The National Recovery and Resilience Plan (NRRP) represents a crucial investment strategy to support Italy's economic recovery from the COVID-19 pandemic. Emphasizing the fundamental principles outlined in the United Nations Agenda 2030 and the SDGs as the guiding framework for COVID-19 recovery can be translated into practical implementation. Seizing the recovery phase as a genuine opportunity is imperative to ensure the adoption of appropriate measures for the future¹⁰⁰.

Its endeavour to promote sustainable investments in Earth Science and achieving climate and environmental objectives will have far-reaching implications for Italy's future development. Italy confronts several environmental challenges, including soil degradation, loss of biodiversity, and climate change, that require efficient and innovative solutions. Implementing NBS can mitigate some of these issues, and understanding how to finance and implement NBS using NRRP can be instrumental in achieving Italy's environmental objectives.

The ultimate goal of this research is to contribute to the ongoing efforts to create a more sustainable and resilient future for Italy and the planet. Achieving sustainable development requires a comprehensive and multi-disciplinary policy approach that addresses economic, social, and environmental challenges in an integrated manner¹⁰¹. It is imperative to combat climate change jointly by reducing greenhouse gas emissions and transitioning to a sustainable, low-carbon economy through collective efforts from governments, businesses, and individuals. This thesis aims to contribute to this effort by identifying effective strategies for promoting sustainable investments in NBS, which can help achieve climate and environmental goals in Italy.

Conducting qualitative research through interviews with green finance and Earth science experts enables the optimal analysis of how the implementation and financing of the considered nature-based solutions can lead to achieving sustainability strategies in Italy in compliance with European and international sustainability and climate change principles and guidelines.

¹⁰⁰ Ascani, A., Faggian, A., & Montresor, S. (2021). The geography of Covid-19 and the structure of local economies: The case of Italy. *Journal of Regional Science*, 61(2), 407–441.

¹⁰¹ Communication from the Commission of 22 November 2016 to the European Parliament, the Council, the Economic and Social Committee and the Committee of the Regions, COM(2016)739 final, on *Next steps for a sustainable European future: European action for sustainability*.

4. Methods

The methodology employed in this dissertation is qualitative and encompasses two levels of analysis. This approach aims to comprehensively understand financing aspects and implement nature-based solutions in Italy through NRRP funds.

The first level of analysis pertains to the social aspect of the topic. It is conducted using an empirical methodology in the form of a survey administered through Qualtrics to a sample of the Italian population¹⁰². The poll was distributed to a sample of professionals working in areas connected to environmental sustainability, either through their firms or those for whom they work or based on the nature of their academic study on the topic at hand. This survey was voluntary, and respondents were allowed to participate at their discretion.

The second level of analysis pertains to the technical aspect of the topic. This approach seeks to provide a more in-depth understanding of the technical aspects of financing and implementing nature-based solutions in Italy through NRRP funds. It aims to investigate it from a purely technical perspective. It is accomplished through interviews and insights from experts in sustainable finance and stakeholders.

A comprehensive understanding of the subject matter can be obtained by combining the social and technical aspects of financing and implementing nature-based solutions in Italy through NRRP funds. This approach enables the researcher and allows the thesis to explore the topic in detail and draw meaningful conclusions that can inform future research and policymaking. Using two distinct levels of analysis in this dissertation provides a well-rounded perspective on the topic at hand.

4.1 Survey

The survey to gauge the overall perception of NBS and NRRP among the general Italian population involves 160 participants. It employs the Empirical method, which systematically collects factual data through observation, experimentation, and analysis. The survey was administered to a selected sample of people working in sectors related to environmental sustainability, either through their own companies or those in which they work or according to the nature of their studies related to the issues. The questionnaire is structured into three sections, each addressing a specific area of interest¹⁰³.

The first section of the questionnaire comprises four questions aimed at collecting demographic data from the participants, including their gender, age, educational background, and occupation. This section is crucial in ensuring that the sample population represents diverse individuals, providing a more accurate representation of the Italian population's perception of NBS and NRRP.

The second section of the survey focuses on NBS and includes five questions related to this area of interest. The questions aim to evaluate the Italian public's knowledge of NBS, determining the level of

¹⁰² Qualtrics is a US online platform for quantitative statistical analysis conducted through online surveys. It was launched in 2017 and has been referenced and utilised in multiple research and academic journals.

¹⁰³ The questionnaire can be viewed and executed at the link below:
https://qfreeaccountssjc1.az1.qualtrics.com/jfe/form/SV_cUCeUMUmgOUZkXk

awareness and understanding of NBS among the general population. The tenth question is designed to bridge the NBS section of the survey with the NRRP section by inquiring about the respondents' views on the role of the government in supporting and promoting the implementation of such initiatives. This question is crucial in understanding the level of trust the Italian public has in the government to implement NRRP effectively.

The third section of the survey focuses on NRRP knowledge and comprises six questions. This section aims to evaluate the level of awareness of the Italian public regarding the M2, including its objectives, benefits, and potential impact on Italy's future.

Generally, the survey aims to provide a comprehensive understanding of a sample of the Italian population's perception of NBS and NRRP, highlighting the areas that require more attention and improvement in the promotion and implementation of nature-based solutions in Italy.

4.2 Interview with Professor of Green and Sustainable Finance

A Green and Sustainable Finance professor is interviewed to acquire qualitative data on methods for implementing and financing nature-based solutions. As mentioned, Mission 2, entitled Green Revolution and Ecological Transition, focuses on adopting sustainable agricultural practices, fighting against hydrogeological instability, protecting biodiversity, the circular economy, and developing renewable energy sources. The interview shows that in the National Recovery and Resilience Plan (NRRP), two components deal with environmental impact within Mission 2: C1 and C4. Components 1 and 4 deal specifically with Sustainable Agriculture and Circular Economy and the Protection of Territory and Water Resources, respectively. Both aim to reduce the environmental impact of human activities, promoting the adoption of technologies and processes with a low environmental impact and the spread of sustainable practices, consequently moving towards nature-based solutions. In this way, the NRRP intends to support the country's transition towards a more sustainable and environmentally friendly economy, in line with the European Union's objectives.

The efficacy of finance for the agricultural industry, its distribution, and the challenges associated with its administration are all raised for discussion. Furthermore, the evaluation of the efficacy of government initiatives to support agriculture, the conversion of land from intensive to regenerative agriculture, the relationship between sustainable finance, sustainable agriculture, and taxonomy, and the implications of this relationship on common agricultural policies are all investigated. Aspects of the decline of medium-term investments in the Italian farm sector and potential remedies, the function of banks in financing Italian agriculture, the use of artificial intelligence by banks to evaluate the needs of agricultural producers, and the current state of medium- and long-term financing in the Italian agricultural sector are also covered. Furthermore, the economic difficulties of altering the agrarian environment are investigated as possible ways to promote the economics of uncultivated lands, stimulate biodiversity and animal migration routes, and lower the usage of fertilizers and herbicides. Finally, questions are raised regarding the structural intervention policies required to promote biodiversity in agriculture and forestry, particularly in terms of managing water resources and addressing the challenges of creating animal corridors to promote biodiversity in agriculture, as

well as the issue of traditional agriculture in Italy and how it can be transformed to reduce greenhouse gas emissions and protect the environment. The professor's insights on finance initiatives are reported in this thesis.

4.3 Interview with MASAF's Task Force for the Implementation of the NRRP

The interview of an executive at MASAF (Ministero dell'agricoltura, della sovranità alimentare e delle foreste) was chosen to study the empirical methodology in the thesis on financing Nature-Based Solutions through the NRRP. The decision was based on the interviewee's direct experience and expertise in agriculture, food sovereignty and forestry and the interviewee's position of responsibility within the ministry. The given opinions and knowledge of nature-based solutions and financing policies were considered crucial for a deep understanding of the topic addressed in the thesis. Moreover, the interview with the expert provided a unique opportunity to obtain firsthand information on the Italian government's stance regarding nature-based solutions and financing policies concerning the NRRP.

Various aspects of implementing nature-based solutions in Italy through the NRRP are examined during the interview. Specifically, the role of natural solutions in addressing environmental and climate challenges is discussed, as well as strategies that could be adopted to ensure their success in Italy. The geographic areas and types of ecosystems that could benefit the most from natural solutions are also explored, along with the main political and social challenges that could hinder their effective implementation. The interview also examines how the NRRP could support collaboration between the public and private sectors to promote the implementation of natural solutions in Italy. Additionally, the synergies between natural solutions and other actions outlined in the NRRP, such as energy efficiency, green infrastructure, sustainable mobility, and environmental protection, are considered. The upcoming focus in Italy will be on exploring the possibilities for sustainable growth by implementing natural solutions. The discussion will also examine how the National Recovery and Resilience Plan (NRRP) can effectively facilitate increased investments in this field.

Overall, the NRRP represents an unprecedented opportunity for Italy to invest in nature-based solutions, support economic growth and create jobs while addressing our time's environmental and climate challenges. In the results section, paragraph 5.3 of this thesis, the expert's insights on finance initiatives are reported.

5. Results

5.1 Results of the Survey

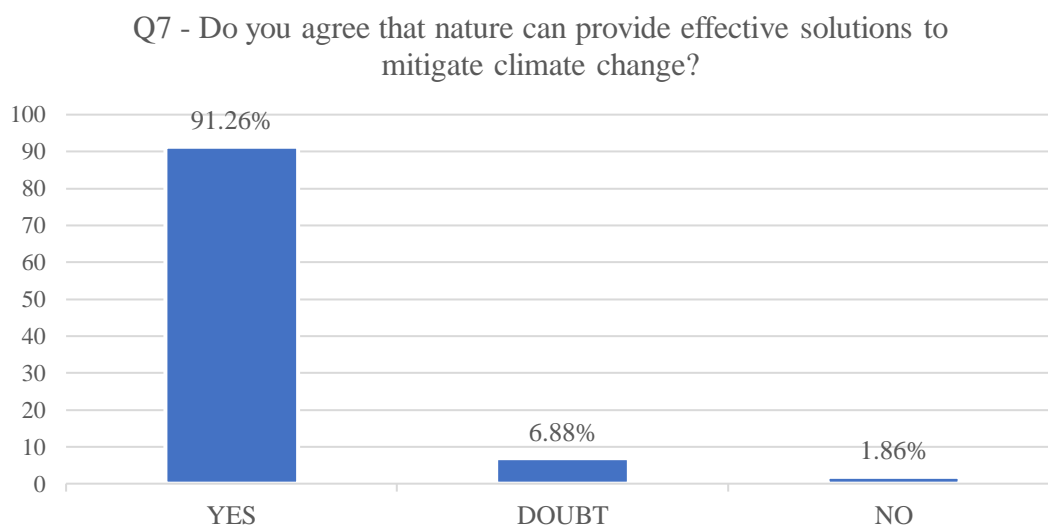
To obtain an impression of the perception of the issue of this piece of work, a survey has been conducted on a total sample of 160 people selected from people working in areas related to environmental sustainability, either through their own companies or those in which they work, or by type of study related to these issues. The poll consists of 19 questions aimed at understanding how widespread the knowledge of NBS

and NRRP is among the Italian public. The first section consists of 4 questions about the demographic data of the survey respondents: gender, age, level of education and occupation. The population distribution in this survey figures as indicated in the following ratio: 48.75% are aged 18-24; 23.13% are aged 25-30; 3.75% are aged 31-40; 5.00% are aged 41-50 and 19.38% are aged over 50. The lowest educational qualification is the high school diploma, for a percentage of 21.25%, and the higher academic level is the PhD, for a rate of 3.13%. A more even distribution is found in the case of bachelor's degrees, equal to 36.88%, and master's degrees, equivalent to 38.75%.

The second section concerns the topic of NBS. It emerges from Q5 - Have you ever heard of Nature-Based Solutions? that 50.32% of the respondents are informed about NBS. Conversely, 27.39% need to be made aware of this approach. Meanwhile, the remainder of the respondents are unfamiliar with the topic but have already heard of NBS, thus being placed in the mid-range within this distribution. From this standpoint, a fundamental element is an explanation given in Q6, which did not require a response but provided a synthetic and comprehensive description of nature-based solutions, offering a background for proceeding with the subsequent questions. Indeed, Q7 inquired whether the respondent agreed with nature as a solution to climate change mitigation. More than 9 out of 10 (91.26%) respondents gave an overwhelmingly positive answer regarding using NBS to mitigate climate change's effects. By contrast, a mere 6.88% responded in a state of doubt. Three of the 160 respondents responded that NBS would not be an adequate solution to achieve the stated purpose.

Figure 1 below represents the distribution.

Figure 1: Survey Q7



Source: data retrieved from the survey and elaborated by the author.

Circa one-third of the respondents in Q8 and Q9 have reported being active in the field of sustainability, joining existing projects through donations or participation in public or private projects and initiatives. Some of these also have ambitions for which NRRP funds would be helpful for implementation. Some people would

be interested in having funds because they are inclined to exploit them. According to the responses, such funds would incentivise the percentage of people who would already be willing to invest in a more sustainable future on their own.

Several categories can be found among the affirmative answers. Ten answers are directed to donations for organisations involved in biodiversity protection, among which WWF, 3Bee, Treedom, Forestami and Forestiamo insieme l'Italia promoted by Conad are mentioned. Furthermore, eight answers note workplace initiatives about the promotion of green policies and the protection of biodiversity, including taking care of the "No Net Loss" initiative for a multinational energy utility, Life Cycle Assessments (LCA), buyers of eco-friendly products, not tested on animals and with recyclable packaging, less plastic initiatives in the workplace, designing sustainable city solutions and energy companies dealing with green energy initiatives, as zero carbon emissions and zero plastic initiatives. An additional eight people actively engage in volunteer initiatives, citing what has been reported by interviewees are green weeks and eco-days, i.e., times dedicated to creating workshops and communal roundtables in which to discuss initiatives and actively refer to cleaning up natural sites, among which both parks and beaches are mentioned, plastic collections with the Plastic Free association, taking part in projects such as LIFE on carbon footprint and the dynamic organic farming project. Nevertheless, in the interest of this thesis work, it is the sustainable investment initiatives being pursued by some respondents that are of interest. In addition to a crowdfunding initiative and investments in funds supporting green initiatives, three projects are explained in more detail:

1. Shades of Blue start-up is developing a certification system to protect and maintain river waters.
2. An off-site growing project aims to create vegetables with 90% less water than a soil-based crop.
3. BioFavole, a family-run organic farm practising biological and sustainable agriculture, is a rural project that preserves the value of nature and biodiversity among orchards full of bees and ladybirds.

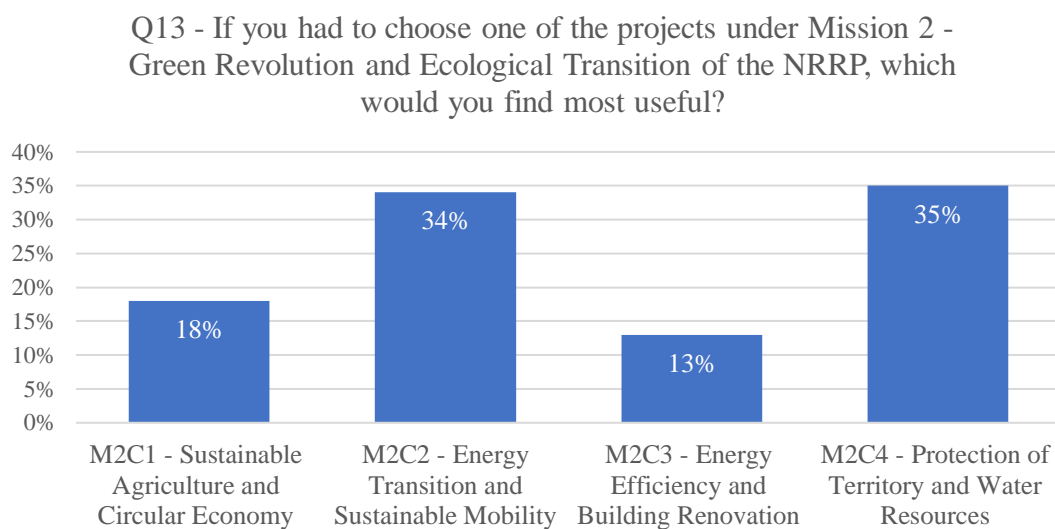
Q10 is used as a bridging question from the specific NBS section of the survey to the NRRP one, asking about the opinion on the role of the government apparatus in promoting and supporting the implementation of this type of initiative. Despite the highlighted interest in these natural and sustainable development projects, the reported data on the perception of the government's role in these matters is disappointing. On a distribution scale ranging from 1 to 5, where 5 indicates "highly appropriate support", and 1 indicates "highly inappropriate support" from the state for this issue, the average is 3.1, i.e., barely neutral. Still, most people in the voting distribution voted 2, i.e., fairly inappropriate.

The third section is intended to deal with NRRP-related knowledge questions. Hence, Q11 - Are you familiar with the National Recovery and Resilience Plan (NRRP)? It serves to identify the truthfulness of the previous information. Namely, it shows a thorough knowledge of the NRRP for 22.50% of the respondents and a general understanding of the NRRP for almost half (47.50%). Consequently, the total is around 70% of

people knowledgeable about the plan’s provisions. No one would consider learning how the NRRP might support nature-based solutions useless. According to the survey, nearly three-quarters of the respondents either regard understanding these processes as valuable or essential. The remaining quarter takes a more neutral stance in this regard. However, no negative response to the question emerges.

Additionally, Q13 - If you had to choose one of the projects under Mission 2 - Green Revolution and Ecological Transition of the NRRP, which would you find most useful? This reveals an exciting data element for this thesis. Data from Q13 are grouped underneath in Figure 2.

Figure 2: Survey Q13



Source: data retrieved from the survey and elaborated by the author.

M2C4 - Protection of Territory and Water Resources is the component that mainly stands out and receives 35% of the responses. Reporting the opinions collected to motivate the chosen option, it emerges that protecting land and water resources is crucial for achieving sustainability and ensuring citizens’ good quality of life. Water is a fundamental element for preserving life, and its scarcity is becoming an increasingly urgent due to climate change and human activities. It is also a strategic resource for the territory and its preservation, as it enables cultivation, breeding, and the production of wealth in a circular manner. All three remaining pillars of sustainability - energy transition, circular economy, and building renovation - are highly dependent on the efficiency and existence of water resources. Although all the other pillars are essential, protecting land and water resources is the basis for trying to save the planet. The M2C4 project, which focuses on the protection of land and water resources, is considered by many to be the most urgent and necessary area for allocating resources made available by the EU. However, the water waste issue in Italy is still critical and requires immediate government intervention.

Furthermore, the protection of land and water resources is not only important for environmental reasons but also for preserving biodiversity and natural resources. These are fundamental elements for ecosystems that are well balanced between human and genuine presence that goes beyond the exploitation of

resources and towards a livelihood that goes hand in hand with environmental protection. While the other pillars of sustainability can be pursued through standard processes and market solutions, protecting land and water resources requires personal commitment from the government and local administrations. Although climate change is a global issue, securing the ground, where possible, is crucial and avoiding wasting water due to obsolete pipelines. It is necessary to prevent further deforestation and combat the limited availability of water resources, which puts our ecosystem at risk.

Underneath, merely by one percentage point, is M2C2 - Energy Transition and Sustainable Mobility. The opinions expressed on M2C2 are many, but they all agree that energy consumption and mobility are significant contributors to global warming and need to be addressed urgently for a sustainable future. The transition to clean energy is seen as the century's biggest challenge, and alternative sources must be found as the current resources are limited, expensive and polluting. This would also help reduce harmful emissions and achieve the goal of reducing GHG emissions. Sustainable mobility is a crucial solution to problems like traffic and pollution in cities, which is essential for the psychophysical improvement of people's lives. Governments must create affordable and efficient means of transport to reduce charges and environmental impact while encouraging social interaction. The energy transition and sustainable mobility are seen as the most urgent and compelling areas for intervention, with benefits that can be seen immediately and on a large scale. The NRRP offers substantial liquidity that can be used for infrastructure and R&D, making this the opportune time to invest in these areas.

M2C1 - Sustainable Agriculture and Circular Economy ranks third with a total score of about 18%. The opinions regarding the M2C1 pillar are diverse. However, all recognise the importance of agriculture as an entire sector for human life. Many highlight the need for agriculture to return to being a priority and emphasise the consequences of neglecting it, such as not knowing what we eat or where we live. Some also mention the high consumption of resources and the sensitivity to climate conditions that farming activities and livestock entail. Others suggest that sustainable agriculture is a valid method for maintaining a regular natural ecosystem and is suitable for both the environment and health. Some argue that agriculture is one of the most impactful sectors and requires urgent intervention.

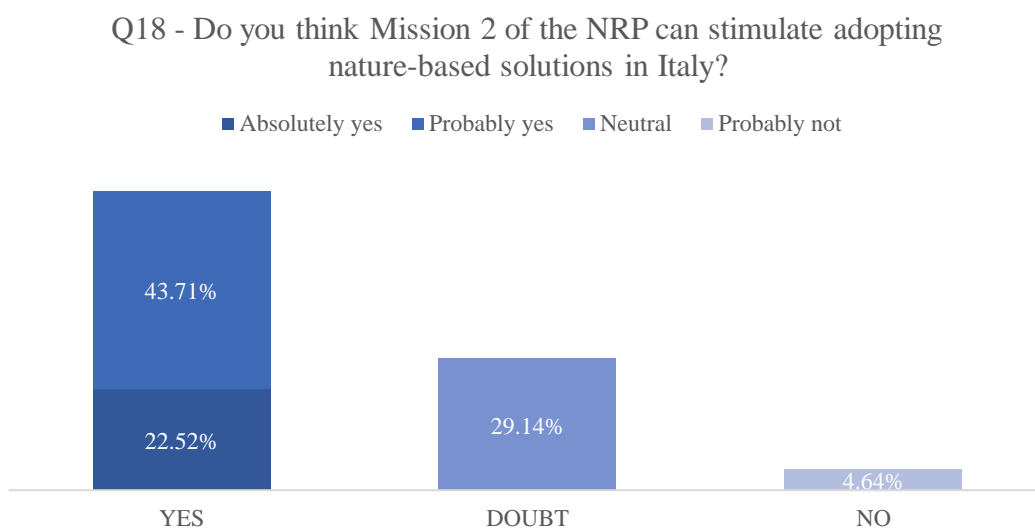
Overall, while the opinions vary, they all agree on the importance of sustainable agriculture and its impact on human life and the environment. In contrast, others point out that the sector brings food to our tables and that we all consume food from agriculture daily, making it a good starting point for intervention. In addition, reducing the scale of trades into circular economies would entail all the following projects, requiring fewer resources. Finally, one opinion highlights that during a research project on technology and sustainability, climate-smart agriculture was the technology most mentioned in the analysed papers, suggesting that it is a successful option for intervention.

Finally, M2C3 - Energy Efficiency and Building Renovation is ranked last with 13%. Lastly, according to some respondents voting for M2C3, it is essential as it focuses on the energy efficiency and renovation of buildings, which is crucial since the building industry is a significant contributor to CO₂ emissions. It is urgent

to make urban lifestyles sustainable by improving energy efficiency and greening buildings. Renovating buildings and implementing sustainable measures will reduce energy consumption and save costs. Therefore, energy efficiency is critical, and the building renovation is on par with other sustainability projects in terms of importance.

Q18 - Do you think Mission 2 of the NRP can stimulate adopting nature-based solutions in Italy? The data is more uneven on this question, with 22.52% answering “absolutely yes” and 43.71% saying “probably yes”, converging in 66.23% affirmative answers. However, there is also a percentage of 29.14% who are uncertain whether the NRRP can be a stimulus for the implementation of NBS in Italy. The lowest figure is “probably not” at 4.64%. Data is represented in Figure 3 below.

Figure 3: Survey Q18



Source: data retrieved from the survey and elaborated by the author.

The respondents have provided various opinions on addressing environmental problems and promoting sustainability. One essential suggestion is the implementation of nature-based solutions, such as planting trees, increasing green areas, taking care of forests, reducing food waste and producing less toxic waste, managing the waste disposal without polluting, producing clean energy, and reducing discharges. Programs of study in primary schools are also recommended to increase awareness about sustainability. The respondents suggest that more local actions and policies are needed to harness the potential of NBS in a bottom-up approach. Targeted communication that is not intrusive is also essential to raise awareness about sustainability. Some respondents also suggest the need for open innovation systems between private companies that provide funds and local communities that offer spaces to co-create initiatives with great media resonance. Initiatives that reward those promoting NBS with money and recognition, such as tax discounts, are also recommended.

Renewable energy, more solar panels in cities, and encouraging public transport or eco-friendly shareable vehicles are also suggested. Green roofs, urban agriculture, and wetlands are also viable options. The respondents also offer optimising consumption and reducing waste as a crucial step towards sustainability.

People training campaigns, improving use in farming, applying the Common Agricultural Policy well, using NBS to decontaminate polluted sites, and saying no to fossil fuels are also mentioned. Other recommendations include cleaning our oceans, less intensive meat production, and reusing utilities. There is a consensus among the respondents that funds and incentives are needed to invest in sectors that promote sustainability. Investing in hydrogen energy, synthetic fuels, not just electric motors or solutions, is also recommended. Education at all levels, including university courses, in-depth courses in primary and secondary schools, and adding a course on environmental protection to company safety courses is also suggested. Economic support for farmers to support investment costs is also proposed. Reducing waste through recycling and reuse is also mentioned, as is promoting accessible urban gardens and orchards for everyone. Overall, the respondents believe raising awareness and financing NBS implementation is critical to addressing environmental problems such as climate change, loss of biodiversity, and water scarcity.

5.2 Results of the Interview with Professor of Green and Sustainable Finance

The Professor discusses financial matters in this interview, emphasising the need to know who would benefit from financing. He highlights in the interview the significance of having explicit knowledge of the goals and purposes of the funding and the requirement to evaluate the real impact of this investment in the context of the agricultural sector in particular and biodiversity as a result. Instead of concentrating just on private funding, it is crucial to examine the impact of the financing and comprehend the goal of the public measure for which the funds are meant since the latter cannot alter the agricultural system by funding a single private entrepreneur.

The sustainable finance expert believes that verifying key financial measures is essential to ensure a positive impact on the economy. This verification requires a methodological analysis based on the nature of the measure itself and its effect on agriculture. For example, in the case of funding for converting land from intensive farming to regenerative farming, it is crucial to consider who will use the money and what criteria should be applied in selecting the farmer who will receive the funding.

It is essential to distinguish between infrastructure support and directly effective measures impacting agricultural land's economic and soil transformation. In the case of public funding, there needs to be an idea behind it, such as a business plan that supports the whole chain and not just an individual farmer. In general, the public measure goes to support a system as a whole, helping to bear the costs of creating a business plan and achieve specific goals such as reducing carbon production or connecting pipelines to address problems such as the salinisation of farmland in some parts of Italy.

In agriculture, it is essential to accurately assess public measures to support this area, such as those indicated in the NRRP. It is important to analyse the specific function of these measures and how they fit within sustainable finance, as agriculture does not fall within the European taxonomy and thus requires ad hoc accounting for sustainable finance management.

Within this framework, the Common Agricultural Policy (CAP) of the European Union becomes crucial to harness funds for sustainable agriculture. Indeed, the transition from intensive to regenerative agriculture will take time and financial support. The CAP is based on the principles of natural capital, which must be respected to ensure the long-term sustainability of agriculture. Agricultural policies must be designed to support the entire farming community and comply with sustainable finance principles. To provide the effectiveness of these policies, accurate assessment and transparent accounting of sustainable agricultural finance and activities are necessary. This is the only way to ensure sustainable agriculture and a positive impact on the economy in the long term.

The agricultural sector is going through a difficult period characterised by a significant investment reduction, as shown by the Bank of Italy data cited by the Professor in the interview. From 2011-2021, there has been a sharp decrease in medium-term investments in the Italian agricultural sector. Currently, outstanding loans in the agrarian sector amount to less than EUR 10 billion, of which EUR 6 billion are dedicated to the real estate sector of agricultural facilities. However, the most significant investments are concentrated in the wine-growing sector, representing an industrial agribusiness with a high liquidity index. On the other hand, the banking system focuses mainly on financing wine-growing companies, neglecting those with small plots of land that often need access to financing. When it does exist, the funding of the agricultural sector is mainly intended to support short-term activities, such as seed purchase, harvesting and equipment maintenance. At the same time, medium- and long-term investments are scarce. Therefore, it is important to increase investment in the agricultural sector to ensure sustainable growth and improve the resilience of the agricultural system.

The current context shows little focus on the agricultural sector, which is poorly digitised and capitalised. The latter makes it difficult for banks to provide finance to these realities. However, before intervening in the banking system, it is necessary to work on the general transformation of the agricultural sector to solve structural problems. The goal must be to ensure more significant equity and sustainability in agriculture through proper governance and reliable data to invest. For example, some banks, such as Credit Agricole, already use artificial intelligence software to determine the food and water needed for animals and cultivation. However, it is important to emphasise that finance alone cannot solve the economy's structural problems. According to the expert, one of the solutions is a strategic and profound approach to transform the current food production and distribution system. Sustainable finance and the Common Agricultural Policy (CAP) aim to develop sustainable agriculture.

The process used by the Professor is a gap analysis to understand how we got to this situation. In the past, 70 per cent of people's disposable income was spent on buying food, while only 30 per cent was spent on other expenses. With the advent of large-scale distribution and intensive farming, the cost of food fell, leading to a decrease in income for agriculture and a consequent increase in CO2 emissions. It has created an economic system of overproducing and overdistributing, typical of globalisation. However sustainable finance can contribute to the transformation of this system, but this requires a strategic vision and a profound change of the approach to agriculture to ensure more significant equity and sustainability. The transformation of the

agricultural ecosystem requires greater financial resilience of the sector and increased disposable income for agriculture. However, the agriculture business model cannot be sustained solely by public funding, as this could reduce citizens' disposable income and the need to forego goods and services to support agriculture. The expert suggests that investment in the agricultural system requires public intervention to sustain costs and create opportunities for young farmers. However, dependence on public funding could create economic instability for young farmers, making the issue complex and mainly financial.

Globalisation and intensive agriculture have led to a reduction in farmers' income and an increase in CO₂ emissions, creating a zero-economy ecosystem that overproduces and overdistributes. Sustainable finance can contribute to the transformation of this system, but the situation requires a profound shift in the approach to agriculture. Furthermore, the expert argues that transforming the approach to agriculture requires a greater focus on strategic vision at both the Italian and European levels. In short, changing the agricultural ecosystem requires targeted public interventions and a greater emphasis on a strategic vision to ensure more significant equity and sustainability in agriculture.

The main problem that needs to be addressed is managing and balancing the ecosystem of agriculture and natural capital, which poses a considerable political challenge to avoid ecosystem destruction. Furthermore, the availability of fertile land is decreasing, so an intelligent forestation strategy is needed. It is essential to focus on regenerative agriculture and the regenerative economy, but only if the human capital of agriculture is sustainable.

The sustainability of agriculture requires a balance between the creation of economic value and the preservation of the environment, with a focus on the sustainability of agriculture's human capital. A transfer of resources is necessary to achieve these goals, particularly an adequate income for agriculture. The support policy is crucial, with state aid being an effective solution for small farms. Furthermore, it is essential to create social buffers for farmers and to analyse how to create value for them. In summary, the problem of sustainable use of the ecosystem for agriculture requires a comprehensive approach involving not only policy but also the creation of new economic models and the sustainability of agriculture's human capital.

According to the sustainable finance expert, biodiversity is a central issue for forestry and agriculture, particularly water management. Structural intervention policies must consider the entire ecosystem and contribute to creating more resistant plants and more efficient water use. In this context, agriculture may need less water and use different sources, not only drinking water. Furthermore, promoting biodiversity requires the creation of more resilient plants that do not need herbicides and fertilisers, as well as corridors for animals. However, promoting biodiversity in Italy is still challenging, as plots are often too small, and no animal corridors exist. Thus, to address issues related to promoting biodiversity, it is essential to involve various stakeholders, such as Enel and others, and adopt a strategic approach considering the entire ecosystem. In summary, the biodiversity action plan should consider different issues related to its promotion, such as the creation of corridors for animals, the promotion of resistant plants and the more efficient use of water and involve different stakeholders in a strategic and comprehensive approach.

According to the expert, biodiversity is central to forestry and agriculture, especially water management. Structural intervention policies must consider the entire ecosystem and favour the creation of more resistant plants and more efficient water use. In this way, agriculture could require less water and use different sources besides drinking water. Furthermore, creating more resilient plants that do not require herbicides and fertilisers and creating corridors for animals is essential to promote biodiversity. However, this is still a challenge in Italy, as cultivated areas are often too small, and no animal corridors exist.

Although the Common Agricultural Policy (CAP) is trying to solve the problem of Italian agriculture, the expert believes that more needs to be done to protect the environment and traditional Italian agriculture. The expert points out that the disappearance of conventional agriculture in Italy has deep historical and social roots that have had disastrous consequences for the environment and greenhouse gas emissions. The agricultural sector is a major contributor to pollutant emissions. However, a lack of funding and political interest has prevented the industry from decarbonising, leading to increased pollutant emissions. For this reason, the expert believes there is a need to transform the agricultural value chain by promoting the economy of uncultivated areas and converting them into biodiversity, creating corridors for animals and reducing the use of herbicides and fertilisers. This transformation could significantly impact the environment and biodiversity without resorting to ecosystem-damaging solutions, such as killing animals deemed harmful to cultivation.

5.3 Results of the Interview with MASAF's Task Force for the Implementation of the NRRP

Regarding the view on nature-based solutions to environmental and climate challenges in Italy, it is undoubtedly linked to NRRP Mission 2, which includes measures related to the green revolution and ecological transition. At the national level, approximately 60 billion euros have been allocated to this mission, of which the MASAF is responsible for measures worth approximately 4 billion euros. Among these measures, there are several related to ecological transition. One prominent example is the agri-solar park, which involves photovoltaic innovation by installing systems above existing buildings such as farm sheds, thus avoiding occupying land. This is one of the primary measures. In addition, further details can be provided on measures in connection with the ecological transition, particularly concerning sustainable agriculture and biodiversity, which are the most relevant in this context. All these measures fall under Mission 2 of the NRRP, with the sub-component of sustainable agriculture and the circular economy. Among these, three measurements are particularly interesting for the paper. Component 1 includes agriculture, logistics, mechanisation and agricultural innovation measures. Component 4, on the other hand, concerns the resilience of the irrigation system, which is concerned with protecting the land and water resources. Component 4, instead, includes measures to ensure the resilience of the irrigation system, benefiting the protection of land and water resources.

Concerning the first measure on logistics in the agri-food sector has a financing ceiling of 800 million euros. It is called "Development of logistics in the agri-food sector". The main objective is to reduce the environmental impact of agri-food logistics, promote sustainability and improve product dissemination. This

measure is subdivided into three sub-measures concerning markets, ports and companies. In particular, 500 million euros have been allocated to businesses, which are the primary beneficiaries. Besides, part of the resources has been earmarked for un-privately owned ports and markets, which can be private or linked to public entities.

Another measure related to Component 1 concerns the agrisolar park to minimise the energy consumption of agri-food activities and improve productivity simultaneously. This measure has a budget of 1.5 billion euros, making it the most consistent. It has been divided into two central tenders: the first tender, amounting to 500 million euros, has already been completed, and projects and funding are currently underway; the second tender, amounting to 1 billion euros, is finalised. Discussions are now taking place with the European Commission. Once a final decision has been reached, the call will be published between June and July 2023.

The third measure falls under the competence of innovation mechanisation within Mission 2, Component 1, Investment 2.3. Although not directly related to the nature theme, being included in the same mission, the objective remains innovation and reduction of environmental impact. In particular, the aim is to modernise the machinery used by Italian farmers, including agricultural machinery and machinery to be replaced with new precision farming technologies. This will help improve the productivity and sustainability of the farm sector. The funding allocated to this measure is 500 million euros.

Another measure focuses on the irrigation agri-system, intending to improve the resilience of the system and better management of water resources. This measure focuses mainly on water resource management but is still linked to the general theme of nature-based solutions (NBS). This measure corresponds to Investment 4.3 of Component 4, which protects land and water resources. The objective is to increase the efficiency of irrigated agri-systems, involving irrigation consortia and agencies as beneficiaries. This will help foster resilience to climate change through existing and new projects. Ongoing projects include those financed by national laws or European funds, such as the 2019 Budget Law or the Cohesion Fund, which have been included as they are compatible with the principles of the NRRP. New projects, however, were financed by the decree of 30 September 2022 and included some 42 new projects that aim to improve water resource management to address the current drought problem.

Table 6 below summarises the tenders that MASAF is in charge of.

Table 6: MASAF's Public Tenders of Mission 2

Component 1	Investments	Public Tender	Fundings
Investment 2.1	Logistics development for the agri-food, fisheries and aquaculture, forestry, floriculture, and nursery sectors	Development of Agri-Food Logistics of Wholesale Agri-Food Markets	300 million euros
		Development of Agri-Food Logistics by Improving the Logistics Capacity of Ports	
		Agri-food Logistics Contracts for private business	500 million euros
M2C1	Agrisolar Park	Agrisolar Park	1.5 billion euros
Investment 2.3	Innovation mechanization	Modernize the machinery used by Italian farmers, including agricultural machinery and machinery to be replaced with new precision farming technologies	500 million euros
Component 4	Investments	Public Tender	Eligible Expenses
Investment 4.3	Investing in the resilience of the irrigated agricultural system for better water management	Increase the efficiency of irrigated agri-systems, involving irrigation consortia and agencies as beneficiaries to foster resilience to climate change through existing and new projects	1 billion euros
Total of Eligible Expenses of MASAF's Investments for M2: 3,8 billion euros			

Source: data retrieved from the interview and elaborated by the author.

The main objective is spreading knowledge about the economic and social benefits of green and digital investments. It is essential to provide more information than is currently available to reach a wider audience through appropriate dissemination of content. One relevant solution could be the implementation of training webinars at both sectoral and national levels. This would make it possible to involve agricultural entrepreneurs, agencies, and institutions, as there is often a perceived lack of direct connection between the public and private sectors. A strategic option could be the systematic organisation of webinars and training projects. Webinars are currently being planned in cooperation with the actors involved in the measure due to the support provided by Cassa Depositi e Prestiti and Invitalia, which offer technical assistance to foster training for potential beneficiaries of the NRRP measures.

The European strategy to improve energy efficiency envisages cross-compliance implementation, including the DNSH and environmental and climate tagging. DNSH requires that actions do not harm the

environment, in line with the principles of the Next Generation EU and national tenders. At least 37% of the resources must be earmarked for the ecological transition, based on the taxonomy for sustainable finance as defined by EU Regulation 2020/852. Every project must meet these criteria, and ministries must align with the DNSH and the taxonomy. Climate and environmental tagging require each project to comply with at least 37% environmental technology. These principles are linked to sustainable finance and the Common Agricultural Policy (CAP) for sustainable agriculture. Nevertheless, these issues and mechanisms are challenging.

The geographical areas that can benefit most from the NRRP are the islands and the southern regions. The funds' conditionality stipulates that 40% of the NRRP's resources must be mandatorily allocated to the south to improve Italy's territorial cohesion in line with the Cohesion Fund's objectives. The objective is to create synergies between national and European funds, such as the Cohesion Fund, with similar purposes. By working synergistically, the gap between the central and southern regions and those in the north can be reduced. The strategies include training, financial support, and the synergy of objectives and funds.

The NRRP can help mitigate the gaps, despite the limitations of the bureaucratic structure. However, some theoretically worthwhile and interesting projects may encounter practical difficulties in implementation. They were conceived in a different historical context than today, without considering the energy emergency that has led to higher prices and implementation challenges. Some measures are being reviewed and remodelled to address these challenges in cooperation with the European Commission. Each ministry has proposed changes to the submitted projects to adapt them better to meet the objectives of the NRRP, in line with the fund's missions. A crucial example of a mission is the ecological mission. Therefore, efforts are being made to overcome the limitations of the bureaucratic structure through this remodelling of measures.

Concerning investment support in the sector, the NRRP complements Repower EU, another investment instrument that shares the same missions and focuses on energy transition. To ensure efficient and effective energy policies, the Italian government and its ministries collaborate closely to propose and evaluate potential new measures and modifications to existing policies. This diligent and thorough approach helps ensure the country's energy needs are met sustainably and responsibly while promoting economic growth and development. The proposed initiatives aim to optimise investment goals in ecological and environmental aspects while mitigating environmental impact. Among these ventures are the agrisolar park and irrigation project, both demonstrating a commitment towards sustainable practices. The National Renewable Resources Program (NRRP) is diligently preparing to address challenges in the energy sector, focusing on achieving favourable outcomes for all stakeholders involved.

To ensure that the Italian government operates with a cohesive and effective strategy, it is imperative to establish robust and continuous synergies among the ministries. These strategic partnerships facilitate the development of long-term perspectives, fostering a collaborative approach to tackling complex issues and achieving our shared goals. They can leverage their expertise and resources to drive positive change and create sustainable outcomes for our citizens by working closely. This implies avoiding compartmentalization and

working in a coordinated manner with ministries such as MASE - *Ministero dell'Ambiente e della Sicurezza Energetica*, MASAF - *Ministero dell'Agricoltura, della Sovranità alimentare e delle Foreste*, and MIT - *Ministero delle Infrastrutture e dei Trasporti*, which are jointly in charge of implementing Mission 2 measures.. The primary objective is to elevate the level of collaboration and teamwork towards a collective effort that goes beyond the scope of individual pursuits. The ultimate goal is to establish a cohesive approach that can drive nationwide action, extending beyond the typical operations conducted at the ministry level. By employing this technique, policy implementation can be significantly enhanced, as it fosters efficacy and uniformity across all levels of the organisation.

6. Discussion

This thesis explores the effective implementation and financing of nature-based solutions (NBS) using the National Recovery and Resilience Plan (NRRP) to promote sustainable investments in Earth Science and achieve climate and environmental objectives in Italy. Reviewing existing literature on NBS, the thesis establishes a theoretical foundation. It offers insights into practical strategies for sustainable investments in Italy. NBS leverages natural ecosystems and processes to address environmental and social challenges. It is a novel approach aligned with the United Nations Agenda 2030 and Sustainable Development Goals (SDGs). The NRRP, aligned with the United Nations Agenda 2030 and SDGs, represents a crucial investment strategy for Italy's post-COVID-19 recovery. Seizing the recovery phase as an opportunity is vital for adopting appropriate measures for the future. The research aims to contribute to Italy's sustainable and resilient development by addressing environmental challenges and identifying strategies for financing and implementing NBS. Conducting qualitative research through interviews with experts in green finance and Earth science will enable a thorough analysis of how NBS implementation and financing can align with European and international sustainability and climate change principles. The research aims to contribute to Italy's sustainable and resilient development, addressing environmental challenges and achieving climate and environmental goals. By promoting NBS, the thesis supports Italy's sustainable future and the 2030 Agenda goals. Indeed, the structure of this paper implies the benefits of implementing nature-based solutions to achieve the 2030 Agenda goals. From this perspective, some SDG targets were identified that could be achieved through complementarity between some policies and the implementation of NBS measures.

In the second chapter of the thesis, a theoretical and positive view of nature-based solutions as an advantage and green innovation for the future is based. Within this chapter, examples of solutions and their feasibility are given. The NRRP Mission 2, which pertains to the Green Revolution and Ecological Transition, aligns with the SDGs, which cover various aspects of development. The 2030 Agenda places sustainable development at its core, encompassing economic, social, and environmental dimensions. The ecological transition necessitates technological innovation and societal change while upholding environmental sustainability criteria.

From a theoretical point of view, through the interconnection of all four components with what has been outlined in Chapter 2 about the SDGs goals, benefits emerge that cannot be neglected, which is also confirmed by the methodology results. It emphasises the urgency of taking ecological measures to combat climate change, protect oceans and marine resources, and manage forests to mitigate desertification. Strategic points and approaches must be carefully considered to ensure a successful ecological transition. Prioritising increased investments in renewable energy sources is crucial for pursuing European objectives effectively. This involves advocating for electric mobility in urban, regional, and transport systems to reduce air pollution. Integrating advanced digital technologies throughout the energy supply chain significantly optimises energy utilisation. Developing efficient energy storage systems is pivotal in enhancing overall energy efficiency. Establishing intelligent and automated energy efficiency systems within smart buildings is equally essential. Embracing a circular economy model, which values waste as a resource, promotes regeneration and sustainability. Lastly, reducing pesticide usage and expanding organic farming areas within the agroecological model offers potential solutions to minimise emissions and mitigate intensive farming practices' adverse health and environmental impacts¹⁰⁴. Such a proposal is likewise documented in the findings section of the social methodology. Many responses were indeed oriented towards this particular type of initiative.

Furthermore, all interviewees strongly supported utilising nature-based solutions to mitigate the effects of climate change. The literature also supports this viewpoint, highlighting NBS as an effective instrument for achieving various Sustainable Development Goals (SDGs), as indicated in Table 2. Additionally, concerning the financing of NBS, it aligns with the “Do No Significant Harm” (DNSH) criterion imposed by the European Union, as these solutions are natural and promote sustainable utilisation of nature, aiming to create an ecosystem that fosters climate change mitigation and resilience. This perspective is supported by both the literature presented in Chapter 2, in sections 2.1 and 2.3, and the responses of the interviewees and experts involved in the research. Consequently, the adopted methodology strengthens the hypothesis of funding and implementation of NBS in Italian infrastructure.

The literature in Chapter 2, paragraph 3 shows several initiatives related to the financing of NBSs, which are neither limited to public nor private financing but also include a combination of both approaches, such as through crowdfunding initiatives. However, the same chapter also addresses the main challenge of these solutions, which brings only advantages according to the available literature. The main challenge is, therefore, to identify ways of financing these solutions. Concerning the proposal of this paper, it would be relevant to analyse the initiatives proposed by the Italian NRRP. The latter is based on six interconnected pillars. However, to present an effective method of implementing and financing nature-based solutions to achieve environmental and climate goals in Italy, the relevant mission is Mission 2. As highlighted in the literature review, nature-based solutions constitute a new range of green innovations that encounter difficulties in defining themselves precisely. As a consequence, this lack of definitional clarity also leads to a lack of

¹⁰⁴ Rotondo, F., Perchinunno, P., L'Abbate, S., & Mongelli, L. (2022). Ecological transition and sustainable development: Integrated Statistical Indicators to support public policies. *Scientific Reports*, 12(1), 1–12.

adequate funding for NBS¹⁰⁵. This piece aims to identify how a financial instrument such as the Italian NRRP can seek to finance and implement nature-based solutions in the country, respecting the objectives and requirements set by the European Union.

However, despite the targets set by the European Union, which should act as a stimulus to direct funding towards environmentally friendly solutions, there still needs to be more certainty. Italy, through its 108 measures to improve environmental and climate sustainability, barely exceeds the 37% limit imposed by EU Regulation 241/2021¹⁰⁶. The Italian measures barely exceed this threshold, committing funds from the NRRP only 0.5% more than necessary. This still indicates a lag in sustainable innovation and the country's commitment to sustainability. The survey data confirms this situation, implying an average unsatisfactory or inappropriate perception of the government's interest in sustainability issues.

The methodology used to support this thesis is consistent with the precise direction of the NRRP funds for implementing NBS in the country. Hence, it confirms the predominance of M2C4, which relates to territory protection and water resource management, particularly from a social perspective. However, from a technical standpoint, experts in sustainable finance and the task force for NRRP implementation emphasise the importance of M2C4 and its inseparability from M2C1. The expert from the MASAF, which stands for Ministero dell'agricoltura, della sovranità alimentare e delle foreste (Ministry of Agriculture, Food Sovereignty and Forestry) task force for NRRP asserts that the main measures related to NBS can be identified in Component 1 and Component 4. This view is also shared by the professor of Green and Sustainable Finance, who believes these two sectors are closely interconnected and occupy a middle ground between supportive infrastructure measures and those that directly impact the country's economic transformation. The methodology results, especially at the technical level, highlight the central importance of components related to sustainable agriculture and the circular economy, which have a mutually beneficial relationship for NBS implementation.

The methodology employed underscores the need for methodological verification and analysis to finance and implement nature-based solutions. Currently, in Italy, no specific funds are exclusively dedicated to these solutions; instead, they are sub-understood in specific public tenders resulting from funding allocated through the PNRR. Regarding funding, the professor highlights a definite need for NBS to build a functioning system for sustainable agriculture and the circular economy, aspects related to M2C1 and directly impacting M2C4 concerning territory protection and water resource management. According to the professor, these two components progress on parallel paths, emphasising how one cannot exist without the other in creating a resilient ecosystem to address current climate and environmental challenges.

The MASAF measures fall under mission two of the NRRP, with sub-components M2C1 concerning sustainable agriculture and the circular economy and M2C4 on land and water resource protection. Thus,

¹⁰⁵ European Environment Agency (EEA). (2021). Nature-based solutions in Europe: Policy, knowledge and practice for climate change adaptation and Disaster Risk Reduction. *Publications Office of the European Union*, 1, 1–164.

¹⁰⁶ Brugnara, L., & Orlando, C. (2022). (rep.). 108 misure verdi: cosa fa il PNRR per la transizione ecologica (1–13). Milano, Italia: Osservatorio sui Conti Pubblici Italiani, Università Cattolica del Sacro Cuore.

regarding financing these two components, MASAF is responsible for measures worth approximately 4 billion euros, distributed over four components related to the ecological transition. Among these components, sustainable agriculture and biodiversity measures are most relevant to trace funds to finance NBS. In particular, three actions are particularly interesting for sustainable agriculture and the circular economy. Component 1 includes agrisolar and sustainable agriculture measures, logistics, mechanisation and agricultural innovation. Component 4, on the other hand, provides actions to ensure the resilience of the irrigation system to protect land and water resources. In contrast, the fourth measure concerns the resilience of the irrigation system, intending to preserve land and water resources.

According to the professor, increasing funding and support for NBS is crucial for their comprehensive implementation and contribution to mitigating climate change. Therefore, developing a business plan that supports the entire supply chain and not just an individual entrepreneur is necessary to implement such measures through public funding. The public action aims to support a system as a whole, contributing to the costs of creating a business plan and achieving climate and environmental goals in Italy. Successful implementation of NBS requires adequate financing, which can be facilitated by governments, donors, and multilateral development banks through grants and concessional finance¹⁰⁷¹⁰⁸. Private organisations and citizens can contribute to NBS through investments, donations, and crowdfunding. This benefits them by enhancing customer value, reducing costs, and supporting sustainability goals while encouraging environmental stewardship. Public bodies, private organisations, and communities can fund biodiversity initiatives. This is possible, for example, through the funds described in the interview by the MASAF expert and retrieved from national public tenders¹⁰⁹.

NBS have wide-ranging applicability and can be implemented in various landscapes, including coastal areas, water management, forests, forestry, and agriculture. However, as the methodology confirms, more research has been conducted on rural ecosystems¹¹⁰. According to both technicians, considering and addressing the sustainable agriculture component seems crucial. While the NRRP task force leader outlines the MASAF's current plans to pursue the goal of sustainable development, the professor draws a historical-economic framework to motivate why NBS should be implemented in the context of sustainable agriculture in Italy.

As mentioned, the first measure concerns logistics development in the agri-food sector, with maximum funding of 800 million euros. The main objective is to reduce the environmental impact of agri-food logistics and promote sustainability. It is divided into three sub-measures concerning markets, ports and businesses.

¹⁰⁷ European Environment Agency (EEA). (2021). Nature-based solutions in Europe: Policy, knowledge and practice for climate change adaptation and Disaster Risk Reduction. *Publications Office of the European Union*, 1, 1–164.

¹⁰⁸ United Nations Environment Programme. (2021). *State of Finance for Nature: Tripling investments in nature-based solutions by 2030*. United Nations Environment Programme.

¹⁰⁹ Governo italiano, Presidenza del Consiglio dei ministri. (2021). Bandi e Avvisi delle Amministrazioni Titolari. Italia Domani - Portale PNRR. Retrieved April 18, 2023, from <https://www.italiadomani.gov.it/it/opportunita/bandi-amministrazioni-titolari.html?orderby=%40jcr%3Acontent%2Fstatus&sort=asc>

¹¹⁰ European Environment Agency (EEA). (2021). Nature-based solutions in Europe: Policy, knowledge and practice for climate change adaptation and Disaster Risk Reduction. *Publications Office of the European Union*, 1, 1–164.

The second measure involves the agrisolar park, intending to reduce the energy consumption of agri-food activities and improve their productivity. It has a budget of more than 1.5 billion euros. It is divided into two calls, one of which has already been completed and the other being finalised. The third measure concerns mechanisation innovation under M2C1, Investment 2.3. It aims to modernise the machinery used by Italian farmers, with funding of 500 million euros.

The professor emphasises that the disappearance of traditional agriculture in Italy has deep historical and social roots, with disastrous consequences for the environment and greenhouse gas emissions. Despite the agricultural sector being one of the main contributors to polluting emissions, the lack of funding and political interest has hindered the adoption of decarbonisation measures, leading to increased emissions. Although the Common Agricultural Policy (CAP) attempts to address the issue in Italy, more must be done to protect the environment and preserve traditional agriculture¹¹¹. A transformation of the agricultural value chain is necessary, focusing on the economy of uncultivated areas and their conversion into biodiversity zones. This transformation involves measures that fall within the broad scope of NBS. It could reduce the use of herbicides and fertilisers, create animal corridors, and significantly impact the environment and biodiversity. It is crucial to thoroughly assess public measures to support agriculture, as the NRRP outlines. Understanding their specific function and alignment with sustainable finance principles is essential, considering that agriculture still needs to be included in the European taxonomy.

Thus, the first thing to be done is understanding how to target funding. Exceptional accounting is required to manage the budget in an eco-sustainable manner. The EU's CAP plays a fundamental role in leveraging available funds and promoting the development of sustainable agriculture. Adequate evaluation of agricultural policies and transparent accounting for sustainable farming activities are essential to ensure comprehensive support for the farming community and uphold sustainable finance principles. In the current agricultural sector, there is a lack of attention towards agriculture, which remains under-digitised and undercapitalised, making it difficult for agrarian entities to access financing. Addressing the structural problems in agriculture is necessary before intervening in the banking system globally. Increasing investments in the agricultural sector is fundamental to ensure sustainable growth and improve the resilience of the farm system. This requires proper governance and reliable data for investments to promote equity and sustainability in agriculture. Intensive agriculture and large-scale distribution have significantly increased CO₂ emissions, creating an economic model of overproduction and oversupply. NBS could be a solution towards the mitigation of these consequences.

An additional proposed solution is to adopt a strategic and comprehensive approach to transform the current food production and distribution system. Sustainable finance can contribute to changing this system. However, it necessitates a strategic vision and a profound transformation of the approach to agriculture to ensure equity and sustainability. In conclusion, sustainable finance can contribute to transforming this system.

¹¹¹ European Commission. (2019). *The Common Agricultural Policy: Separating fact from fiction*. Agriculture and Rural Development. Retrieved May 22, 2023, from https://agriculture.ec.europa.eu/document/download/2bbc14c1-75e8-4fdd-842e-94c015dbfcaa_en.

However, a profound transformation of the approach to agriculture is necessary. Targeted public interventions and a broader strategic vision are essential to ensure equity and sustainability in agriculture.

As is evident throughout the discussion, there is cross-connection between sustainable agriculture and measures to protect land, biodiversity and water. Therefore, the last measure addressed by the MASAF expert is M2C4 Investment 4.3, which focuses on the irrigation agri-system to improve water management and system resilience. According to the technician, this measure is closely linked to the theme of NBS and M2C1. It includes ongoing projects and 42 new initiatives to address drought and its consequences.

The methodology recalls biodiversity as central to water resource management, requiring structural intervention policies promoting resilient territories and efficient water utilisation. The primary challenge is the equilibrium between the agricultural ecosystem and natural capital to prevent degradation. Implementing intelligent afforestation strategies is essential to counter the decline of fertile land. Ensuring the transfer of resources, including adequate income, is imperative and can be facilitated through supportive measures such as NBS. Engaging diverse stakeholders and adopting a comprehensive approach is indispensable to addressing the multifaceted challenges associated with biodiversity conservation, including the size of cultivated areas and the absence of wildlife corridors.

Undoubtedly, the opinions gathered emphasise the importance of protecting land and water resources to achieve sustainability and ensure inhabitants' quality of life. Water scarcity, caused by climate change and human activities, is becoming increasingly urgent, causing harmful alternating periods of drought and flooding¹¹². Water is essential for preserving life, enabling cultivation and the production of wealth and for the pillars of sustainability, such as the energy transition, the circular economy and the renovation of buildings. M2C4, focused on protecting land and water resources, is consequently considered by the population sample as the most urgent and necessary. However, Italy still faces water wastage problems that require government intervention, as emphasised by the technicians interviewed. Protecting land and water resources and conserving biodiversity and natural resources are fundamental for the environment. It requires a personal commitment from the government and local administrations that goes beyond the exploitation of resources for a balanced coexistence between man and nature. It also requires a commitment from the individual entrepreneurs to whom the funds can be allocated, as the three projects mentioned in Chapter 5, Section 1, on developing a vertical irrigation system that uses less land and 90% less water demonstrate. Securing land and preventing water wastage is crucial to combat climate change, deforestation and limited water availability, which pose a risk to our ecosystem.

The respondents suggested addressing environmental problems and promoting sustainability through NBS. They emphasise the importance of implementing NBS, such as afforestation, increasing green areas, forest conservation, reducing food and toxic waste, managing waste disposal responsibly, and promoting clean energy and reduced discharges. Interviewees also highlight the need for school educational programs to raise

¹¹² World Meteorological Organization. (2023). 2022 State of the Global Climate. *WMO Annual Report Highlights Continuous Advance of Climate Change*. Retrieved April 26, 2023, from <https://public.wmo.int/en/media/press-release/wmo-annual-report-highlights-continuous-advance-of-climate-change>.

awareness about sustainability. Technically speaking, it was recommended to provide training on sustainable investments through NRRP at all levels, including universities and schools, focusing on the corporate, public sector, and citizen training courses. Effective and non-intrusive communication is essential for spreading awareness. They suggest that local actions and policies harness the potential of NBS in a bottom-up approach. Many propose open innovation systems between private companies and local communities to co-create initiatives with media resonance.

Other suggestions include adopting renewable energy, installing solar panels in cities, encouraging eco-friendly transportation, implementing green roofs, urban agriculture, and wetlands. Optimising consumption and waste reduction are seen as crucial steps toward sustainability. Training campaigns, better farming practices, and leveraging NBS to decontaminate polluted sites are also mentioned. Respondents emphasise the importance of reducing reliance on fossil fuels, cleaning oceans, promoting sustainable meat production, and encouraging utility reuse. They advocate for funds and incentives to invest in sectors that promote sustainability, including hydrogen energy and synthetic fuels. Economic support for farmers to cover investment costs, waste reduction through recycling and reuse, and the promotion of accessible urban gardens and orchards are also suggested. Prevaling, the respondents believe raising awareness and providing financial support for NBS implementation are critical in addressing environmental challenges such as climate change, biodiversity loss, and water scarcity.

Creating social safety nets for implementing NBS and generating value for this sector is paramount. The impact of human activity on Earth's ecosystems has been severe due to an economic framework prioritising short-term economic growth over environmental preservation. Changing the approach and connection with nature is imperative to prevent further harm and remain within ecological limits. It is crucial to integrate the significance of nature into the economic system since the financial sector currently needs to be more accurate in the fundamental advantages of nature¹¹³. In recent years, there has been a growing acknowledgement within the business community of nature's immense value to the global economy. More than 50% of the world's GDP is directly or indirectly linked to the natural world, highlighting the critical role that ecosystems and biodiversity play in sustaining economic growth and development. This realisation has led many companies to adopt more sustainable practices and invest in conservation efforts, recognising that a healthy environment is essential for our planet's survival and long-term success¹¹⁴.

Businesses have enthusiastically accepted the EU's sustainable finance taxonomy. The DNSH principle, a vital element of the Italian National Recovery and Resilience Plan, ensures that public investments align with the EU's sustainable development objectives and avoid causing harm to the environment, human health, or society. DNSH assessments analyse the long-term effects of each financed intervention based on six environmental goals, identifying four possible scenarios: no or minimal impact, direct contribution, partial

¹¹³ United Nations Environment Programme. (2021). *State of Finance for Nature: Tripling investments in nature-based solutions by 2030*. United Nations Environment Programme.

¹¹⁴ *Ibidem*.

contribution, and negative impact. Higher-risk investments undergo a more thorough analysis¹¹⁵. Despite limited governmental funding for climate mitigation initiatives, there are opportunities to incorporate nature-based solutions into multiple industries¹¹⁶¹¹⁷.

This aligns with the European strategy to improve sustainable development. The latter includes the implementation of conditionalities, such as DNSH and environmental and climate tagging, to ensure environmental protection and promote sustainable initiatives¹¹⁸. DNSH requires compliance with the principles of the Next Generation EU and national calls, ensuring compliance with the criteria of the European climate change mitigation taxonomy; climate change adaptation; sustainable use and protection of water and marine resources; transition to a circular economy, including waste reduction and recycling; pollution prevention and control; and protection of biodiversity and ecosystem health¹¹⁹. Environmental and climate tagging requires each project to have a significant percentage of ecological components, at least 37%, to ensure sustainable agriculture. However, challenges like cash flow limitations and unfavourable regulations hinder investments. The DNSH principle can help overcome barriers and promote sustainable NBS practices by directing public investments toward projects with positive environmental and social impacts¹²⁰.

Therefore, to continue to be able to invest significantly in the country, all relevant ministries must fulfil these criteria in every project. The methodology shows that despite challenges related to the bureaucratic structure and the current energy emergency, the NRRP is reviewing and reshaping projects to address practical difficulties and ensure effective and consistent implementation of the ecological mission, creating value in this industry. This process aims to overcome bureaucratic limitations and ensure the success of the NRRP in promoting sustainable development and addressing energy challenges.

The public sector can be crucial in facilitating private investment in nature-based solutions (NBS), but several obstacles hinder its efficiency. One major challenge is the need for more cash flow in current NBS projects, which can be attributed to the high initial costs and extended time frames required for investors to recoup their investments. Regulatory barriers also limit funding mechanisms, rendering them unsuitable for large-scale investments. Overcoming these obstacles is critical to incentivise private investment in NBS and accelerate progress towards sustainability goals¹²¹.

¹¹⁵ Governo italiano, Presidenza del Consiglio dei ministri. (2022). Il principio DNSH (do no significant harm) nel PNRR. Italia Domani - Portale PNRR. Retrieved April 6, 2023, from <https://www.italiadomani.gov.it/content/sogei-ng/it/it/Interventi/dnsh.html>

¹¹⁶ United Nations Environment Programme and International Union for Conservation of Nature. (2021). Nature-based solutions for climate change mitigation. Retrieved March 20, 2023, from <https://www.unep.org/resources/report/nature-based-solutions-climate-change-mitigation>

¹¹⁷ European Environment Agency (EEA). (2021). Nature-based solutions in Europe: Policy, knowledge and practice for climate change adaptation and Disaster Risk Reduction. *Publications Office of the European Union*, 1, 1–164.

¹¹⁸ European Commission. (2022). Integration of environmental dimensions in public finances – Implementing the ‘Do No Significant Harm’ (DNSH) principle in public funding programmes. Reform Support. Retrieved April 6, 2023, from https://reform-support.ec.europa.eu/integration-environmental-dimensions-public-finances_en

¹¹⁹ European Parliament and Council (2020). Regulation (EU) 2020/852 of the European Parliament and of the Council of 18 June 2020 on the establishment of a framework to facilitate sustainable investment and amending Regulation (EU) 2019/2088. *Official Journal of the European Union*, 13(L-198).

¹²⁰ United Nations Environment Programme. (2021). *State of Finance for Nature: Tripling investments in nature-based solutions by 2030*. United Nations Environment Programme.

¹²¹ European Environment Agency (EEA). (2021). Nature-based solutions in Europe: Policy, knowledge and practice for climate change adaptation and Disaster Risk Reduction. *Publications Office of the European Union*, 1, 1–164.

According to the MASAF expert, the NRRP strategy fosters Italian and European territorial cohesion from the point of view of achievement objectives. Consistent with this principle, the objective is to create synergies between national funds, such as the NRRP, and European funds, such as the Cohesion Fund, to promote territorial cohesion and sustainable development. The RepowerEU supports investments in the energy sector¹²². It requires solid and constant relations between Italian ministries for measures to implement the plan if they have similar measures or fall within the same mission of the NRRP. Each ministry proposes new measures or modifications to improve efficiency and environmental sustainability, such as the agrisolar park or the irrigation project, which are related to M2C1 and M2C4 and reciprocal to each other for the benefits they can bring. They also touch on fields associated with M2C2 concerning renewable energies or M2C3 concerning the efficiency of buildings. Hence, as pointed out by the MASAF expert, it is through the strategy of synergy and cohesion that the NRRP addresses current and future challenges in the NBS sector, promoting balanced and inclusive growth at the national level.

This discussion analysed the motivations, results and possibilities of financing NBS initiatives via NRRP. Conceptually, a step forward relative to the literature in this analysis regarding the implementation of NBS in Italy was made through the intervention of the professor of sustainable finance. Indeed, the latter underlined a fundamental aspect of the diatribe concerning the financing of nature-based solutions from a more economic perspective, taking a step further and explaining how applying the regenerative economy concept could support sustainable development in the country.

Pursuing sustainability requires a concerted effort towards implementing regenerative agriculture and economy. While this is undoubtedly a critical aspect, it is equally important to prioritise the well-being and professional development of individuals involved in the agricultural sector. This approach ensures a sustainable and thriving agricultural system while at the same time maintaining the sustainability of human capital. By emphasising the people involved in the industry, we can create an environmentally friendly and socially responsible system. Doing so can make a world where people and the planet can thrive together. As per the expert in sustainable finance, implementing NBS under a regenerative economy model is a critical and progressive strategy. This approach emphasises restoring and enhancing natural ecosystems to achieve a sustainable and resilient economy. It integrates biodiversity-based practices and technologies to address environmental challenges while promoting economic growth. Implementing NBS under a regenerative economy model holds great potential for creating a healthier and more sustainable future for our planet.

The concept of a regenerative economy is a highly effective approach towards attaining climate and environmental targets while fostering sustainable development across the public and private sectors. By implementing intelligent evolution, this approach can be financially advantageous in the long run. The understanding of finances and its role in economic ecosystems must be transformed to align our economic and social systems with sustainability and regeneration. This transformation requires new thinking to navigate the

¹²² European Parliament and Council. (2021). Regulation (EU) 2021/241 of the European Parliament and of the Council of 12 February 2021 establishing the Recovery and Resilience Facility. *Official Journal of the European Union*, 17(L-57).

complex process of establishing a new economic and monetary paradigm. Drawing from the principles and mechanisms outlined in the regenerative economics literature, it can be redesigned sustainable development ecosystems to promote social, economic, and ecological regeneration. These efforts should focus on diversity, connectivity, and balancing resilience and efficiency¹²³.

To effectively address the ecological and social challenges of the modern era, it is necessary to establish a new financial paradigm. This paradigm must prioritise regenerative processes such as cross-scale circulation, participatory governance, symbiotic mutualism, collaboration, collective learning, and creative adaptation. It is imperative to undertake a comprehensive study of complex financial ecosystems and their relationship to sustainable development while also examining the role of finance in facilitating sustainability transitions. Additionally, exploring how unexpected events such as the COVID-19 pandemic can be leveraged to drive transformative changes towards sustainability is crucial. By effectively addressing these critical issues, a robust financial framework can be established that promotes sustainable development and effectively confronts the challenges of the current time¹²⁴.

When going through the recovery phase, it is imperative to understand that it presents a unique opportunity to implement vital measures that will have a lasting impact on the future. Therefore, it is crucial to approach this phase with careful consideration and a proactive mindset to ensure that the right strategies and initiatives are implemented for long-term success. A comprehensive recovery approach can create a brighter and more prosperous future¹²⁵. Adopting these measures on a broader scale within the NBS would undoubtedly play a pivotal role in facilitating the ecological transition and advancing towards a sustainable tomorrow. Incorporating such practices would reduce the carbon footprint and promote more eco-friendly approaches to conducting business, ultimately leading to a more sustainable future.

Emphasising the fundamental principles outlined in the United Nations Agenda 2030 and the SDGs as the guiding framework for COVID-19 recovery can be translated into practical implementation¹²⁶. From this standpoint, experts underscore the significance of a society dedicated to a more sustainable future in acknowledging the necessity of a substantial initiative, such as the National Recovery and Resilience Plan, with the aspiration of fostering intelligent progress. As a result, a future endeavour seeking to lead present funding towards a long-term outlook entails promoting a synergistic approach grounded in the principles championed by the European Union. These principles encompass environmental and climate tagging and the commitment to environmental protection through the Do No Significant Harm principle, serving as the nation's sustainable development bedrock.

¹²³ Alves, F. M., Santos, R., & Penha-Lopes, G. (2022). Revisiting the missing link: An ecological theory of money for a regenerative economy. *Sustainability*, 14(7), 4309–4327.

¹²⁴ *Ibidem*.

¹²⁵ Ascani, A., Faggian, A., & Montesor, S. (2021). The geography of Covid-19 and the structure of local economies: The case of Italy. *Journal of Regional Science*, 61(2), 407–441.

¹²⁶ *Ibidem*.

7. Conclusion

The thesis thoroughly investigates the effective implementation and financing of nature-based solutions (NBS) through the National Recovery and Resilience Plan (NRRP) to foster sustainable investments in Earth Science and attain climate and environmental objectives in Italy. NBS is an unparalleled strategy that harnesses the power of natural ecosystems and processes to combat environmental and social issues effectively. It fully aligns with the United Nations' Agenda 2030 and Sustainable Development Goals (SDGs). By extensively analysing previous research on NBS, this thesis has established a robust theoretical foundation and put forward effective strategies for sustainable investments within the country.

Utilising the NRRP as an investment strategy in alignment with the United Nations Agenda 2030 and SDGs is crucial for shaping a sustainable future. Thus, it is imperative to implement measures during this recovery phase to ensure Italy's sustainable and prosperous future. This thesis aims to assist Italy in achieving sustainable and resilient development by tackling environmental issues and establishing financing and implementation plans for NBS. By conducting a thorough analysis, it aims to investigate how NBS financing and implementation can align with European and international sustainability and climate change principles. The methodology involves qualitative research, including interviewing green finance and Earth science experts.

The research is crucial in advancing Italy's sustainable future and achieving the 2030 Agenda goals by promoting NBS. It highlights the undeniable benefits that come with the integration of nature-based solutions to attain these objectives. Furthermore, by identifying specific SDG targets, the potential for synergy between policies and NBS measures becomes evident, paving the way for a more sustainable and resilient future.

In the second chapter of the thesis, a positive and theoretical perspective is presented on nature-based solutions as promising and environmentally friendly innovations for the future. The latter explores various examples of solutions and assesses their feasibility. The alignment of the NRRP Mission 2 with the Sustainable Development Goals (SDGs) is emphasised, as these goals encompass different aspects of development and place sustainable development at the core, encompassing economic, social, and environmental dimensions. The ecological transition requires technological innovation and societal change while upholding environmental sustainability criteria.

By connecting the four components of Mission 2 outlined together with the SDGs goals, significant benefits emerge, supported by the findings of the methodology. Urgent action is required to implement ecological measures to combat climate change, safeguard oceans and marine resources, and manage forests to prevent desertification. Increasing investment in renewable energy sources is imperative to achieve Europe's goals, including promoting electric mobility in urban and regional transportation to mitigate air pollution. Advanced digital technologies must be seamlessly integrated throughout the energy supply chain to optimise energy utilisation. In contrast, efficient energy storage systems are critical for enhancing overall energy efficiency. Implementing intelligent and automated energy efficiency systems in smart buildings is equally essential.

Furthermore, embracing a circular economy model that values waste as a resource is highlighted as a way to promote regeneration and sustainability. Reducing pesticide usage and expanding organic farming areas within the agroecological model are potential solutions to minimise emissions and mitigate intensive farming practices' adverse health and environmental impacts. These proposals are consistent with the findings of the social methodology, as many responses expressed support for initiatives in this direction. Overall, these strategic points and approaches must be carefully considered to ensure a successful ecological transition, addressing the challenges of climate change and promoting sustainable development.

The interviewees and literature strongly support using nature-based solutions (NBS) to address climate change impacts. NBS is considered effective in achieving various Sustainable Development Goals (SDGs), as shown in Table 2. The financing of NBS aligns with the "Do No Significant Harm" (DNSH) criterion imposed by the European Union, as these solutions promote sustainable utilisation of nature and contribute to climate change mitigation and resilience. This perspective is reinforced by the literature, specifically in sections 2.1 and 2.3, as well as the responses from the interviewed experts. Therefore, the adopted methodology supports the hypothesis of funding and implementing NBS in Italian infrastructure.

The thesis also highlights various initiatives related to NBS financing, which extend beyond public and private funding to include approaches like crowdfunding. However, the challenge lies in identifying suitable financing methods for NBS, despite their numerous advantages highlighted in the available literature. In this context, examining the initiatives proposed by the Italian NRRP, built upon six interconnected pillars, is relevant. To effectively implement and finance NBS to achieve environmental and climate goals in Italy, Mission 2 of the NRRP becomes particularly relevant. As emphasised in the literature review, NBS represent a new frontier of green innovations that need help with precise definition. Consequently, this lack of clarity in purpose often translates into insufficient funding for NBS. This thesis aims to explore how a financial instrument like the Italian NRRP can be utilised to finance and implement NBS in Italy while adhering to the objectives and requirements established by the European Union.

Despite the European Union's targets and regulations aimed at directing funding towards environmentally friendly solutions, Italy still needs more certainty. The country's 108 measures to improve environmental and climate sustainability only marginally exceed the minimum requirement set by EU Regulation 241/2021, with the National Recovery and Resilience Plan (NRRP) committing funds just 0.5% above the threshold. This indicates a lag in sustainable innovation and raises questions about Italy's commitment to sustainability. The survey data confirms this perception, showing an unsatisfactory perception of the government's interest in sustainability issues.

The methodology employed in this thesis aligns with the specific focus of NRRP funds for implementing nature-based solutions (NBS) in Italy. It supports the predominance of Component 4 (M2C4), which pertains to territory protection and water resource management, particularly from a social perspective. However, experts in sustainable finance and the NRRP task force emphasise that M2C4 cannot be separated from M2C1. The Ministry of Agriculture, Food Sovereignty and Forestry task force for NRRP states that the

main measures related to NBS can be found in Component 1 and Component 4. This view is also shared by the professor of Green and Sustainable Finance, who highlights the interconnectedness of these two sectors, which serve as a bridge between supportive infrastructure measures and the country's economic transformation. The methodology results, particularly at the technical level, underscore the crucial role of sustainable agriculture and the circular economy, which mutually benefit NBS implementation.

In light of the National Recovery and Resilience Plan (NRRP), this analysis has delved into the underlying reasons, outcomes, and potential implications of investing in Nature-Based Solutions (NBS) projects. The involvement of a sustainable finance expert has been instrumental in advancing the implementation of NBS in Italy, as it has showcased the economic perspective and the utilisation of regenerative economy principles to foster sustainable development. The significance of regenerative agriculture and the regenerative economy cannot be overstated in achieving sustainability, with a particular emphasis on ensuring the continued viability of human resources in the agricultural industry.

To attain environmentally friendly financial systems and encourage sustainability and regeneration in our economic and social structures, shifting the perception of sustainable finance is imperative. This necessitates novel and innovative concepts and a new financial framework that adheres to regenerative economics principles. By emphasising diversity, connectivity, and a harmonious equilibrium between resilience and efficiency, we can reorganise ecosystems for sustainable progress and lay the foundation for a brighter future.

In times of significant disruption, such as the current COVID-19 pandemic, a unique opportunity exists to make noteworthy progress towards sustainability. It is crucial to analyse financial ecosystems and consider how finance can facilitate the transition to a more sustainable future. Through collective efforts and knowledge sharing, a new economic system can be developed that effectively addresses the environmental and social challenges of the present day.

A society committed to sustainability understands that initiatives like the National Recovery and Resilience Plan are essential to promoting progress. Taking advantage of the recovery phase is imperative to implementing appropriate measures for the future. At the NBS level, these measures will secure an ecological transition and a sustainable future. Following the guiding principles in the United Nations Agenda 2030 and the Sustainable Development Goals (SDGs) is paramount to achieving this goal. It should serve as the framework for our COVID-19 recovery efforts. In the future, a synergistic approach must be taken, grounded in the principles championed by the European Union, including environmental and climate tagging and a solid commitment to environmental protection through the Do No Significant Harm principle, which must serve as the foundation of sustainable development in the country.

Hence, incorporating NRRP is a reliable and effective method of implementing and financing NBS. The utilisation of NRRP can enhance the sustainability and resilience of our natural resources, thereby facilitating efficient restoration and preservation. This approach ensures the proper functioning of the Earth's ecosystems. It provides a cost-effective and sustainable solution to long-term environmental challenges.

Overall, by incorporating the value of nature into the economic system and implementing necessary safeguards, NBS can significantly contribute to addressing climate change and environmental degradation while promoting sustainable economic growth and development.

Annex

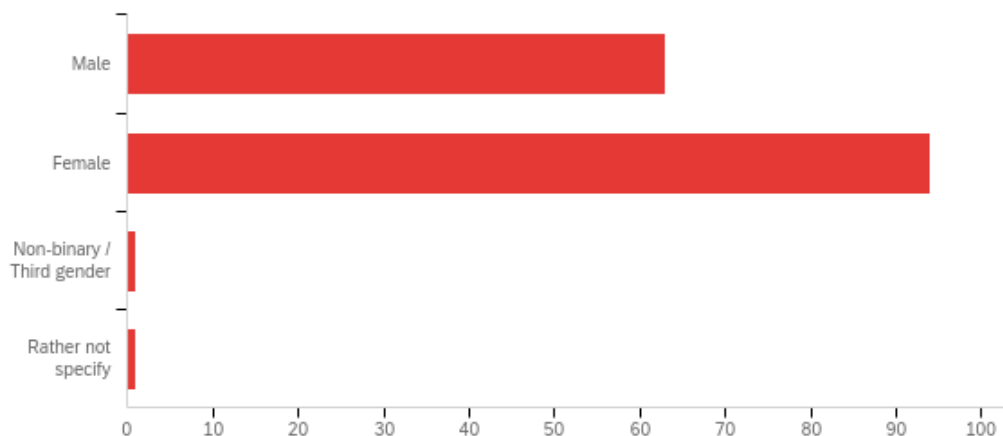
Annex 1

Annex 1 is dedicated to outlining the template of questions with corresponding answers to the Qualtrics survey on Implementing and Financing Nature-Based Solutions in Earth Science carried out by the author of the thesis. The following section shows a default report provided by the platform and retrieved on April 30th, 2023, 1:29 pm CEST. The answers have been elaborated and reported in Chapter 5 of the present thesis.

Q0 - Purpose

Hi! I am Maria Vittoria Mori, and I am currently studying Law, Digital Innovation & Sustainability at Luiss University. I am conducting qualitative research for my master's degree thesis. My research question reads as follow: "How can Nature-Based Solutions (NBS) be effectively implemented and financed using NRRP to promote sustainable investments in Earth Science and achieve climate and environmental objectives in Italy?". This thesis aims to explore the crucial role of Nature-Based Solutions (NBS) in the field of Earth Sciences by understanding how these solutions can be funded in Italy through the National Recovery and Resilience Plan (PNRR). The research conducted in this thesis will provide insights into the most effective strategies to promote sustainable NBS investments in Italy, which can contribute to biodiversity conservation, climate change mitigation and environmental sustainability goals. The results will support ongoing efforts to create a more sustainable and resilient future for Italy and the planet, highlighting the importance of working towards sustainable development through innovative and eco-friendly solutions. It will only take a few minutes of your time! Thank you for your participation!

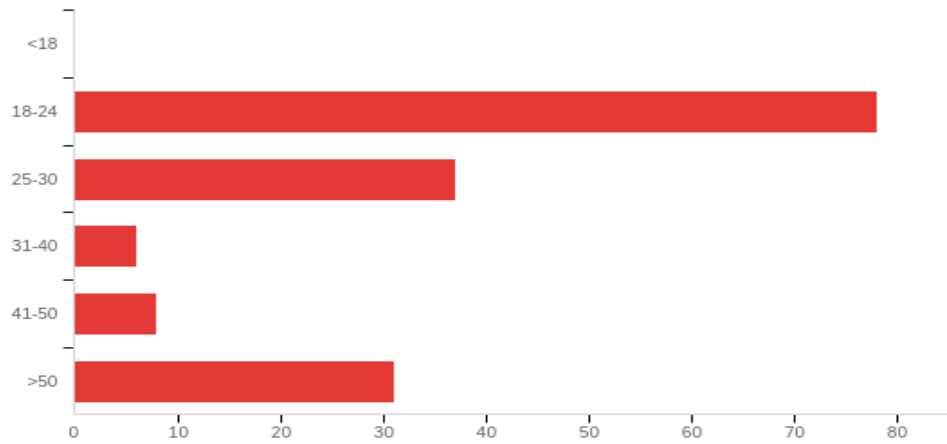
Q1 - Gender



#	Field	Min	Max	Mean	Standard Deviation	Variance	Count
1	Gender	1.00	4.00	1.62	0.53	0.29	160

#	Answer	%	Count
1	Male	39.62%	63
2	Female	59.12%	95
3	Non-binary / Third gender	0.63%	1
4	Rather not specify	0.63%	1

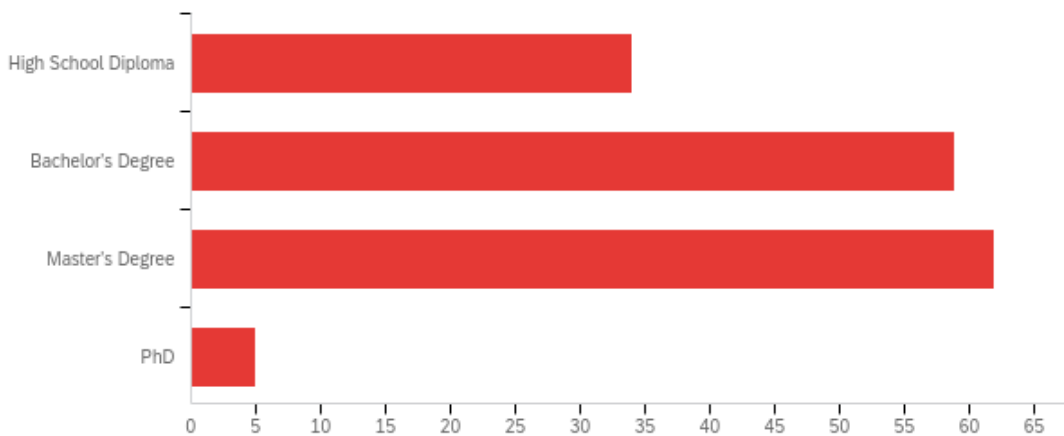
Q2 - Age



#	Field	Min	Max	Mean	Standard Deviation	Variance	Count
1	Age	2.00	6.00	3.23	1.55	2.42	160

#	Answer	%	Count
1	<18	0.00%	0
2	18-24	48.75%	78
3	25-30	23.13%	37
4	31-40	3.75%	6
5	41-50	5.00%	8
6	>50	19.38%	31
	Total	100%	160

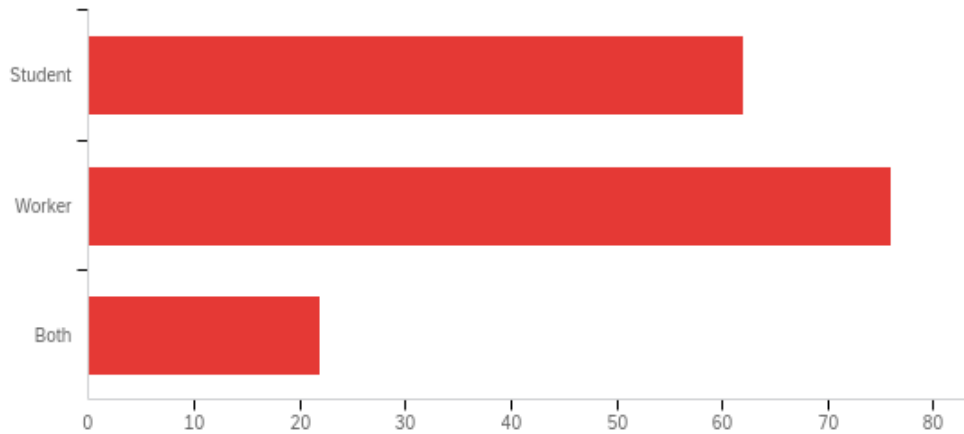
Q3 - Education Level



#	Field	Min	Max	Mean	Standard Deviation	Variance	Count
1	Education Level	1.00	4.00	2.24	0.82	0.67	160

#	Answer	%	Count
1	High School Diploma	21.25%	34
2	Bachelor's Degree	36.88%	59
3	Master's Degree	38.75%	62
4	PhD	3.13%	5
	Total	100%	160

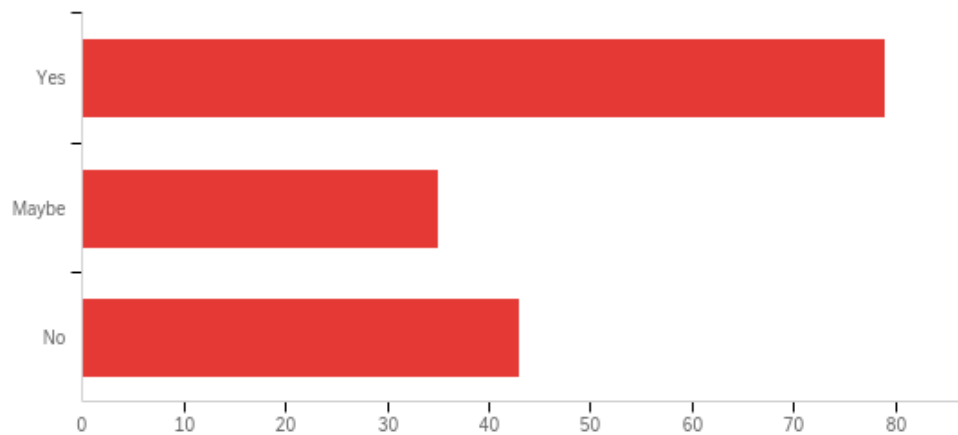
Q4 - Employment



#	Field	Min	Max	Mean	Standard Deviation	Variance	Count
1	Employment	1.00	3.00	1.75	0.68	0.46	160

#	Answer	%	Count
1	Student	38.75%	62
2	Worker	47.50%	76
3	Both	13.75%	22
	Total	100%	160

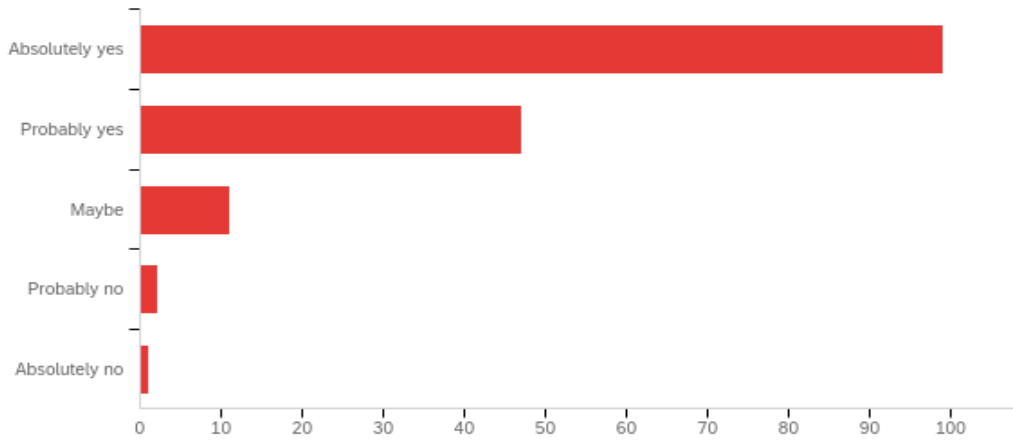
Q5 - Have you ever heard of Nature Based Solutions?



#	Field	Min	Max	Mean	Standard Deviation	Variance	Count
1	Have you ever heard of Nature Based Solutions?	1.00	3.00	1.77	0.85	0.72	160

#	Answer	%	Count
1	Yes	50.32%	81
2	Maybe	22.29%	36
3	No	27.39%	43
	Total	100%	160

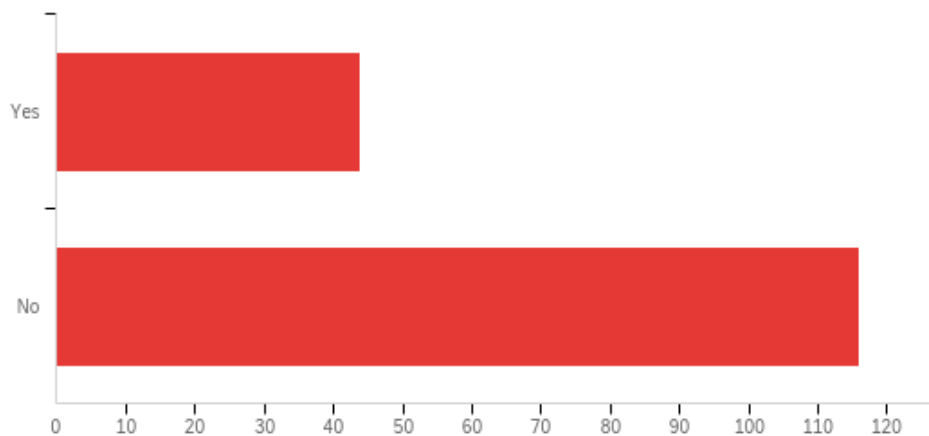
Q7 - Do you agree that nature can provide effective solutions to mitigate climate change?



#	Field	Min	Max	Mean	Standard Deviation	Variance	Count
1	Do you agree that nature can provide effective solutions to mitigate climate change?	1.00	5.00	1.49	0.73	0.54	160

#	Answer	%	Count
1	Absolutely yes	61.88%	99
2	Probably yes	29.38%	47
3	Maybe	6.88%	11
4	Probably no	1.25%	2
5	Absolutely no	0.63%	1
	Total	100%	160

Q8 - Have you ever invested, donated or participated in sustainable projects or initiatives that aim to protect the environment?



#	Field	Min	Max	Mean	Standard Deviation	Variance	Count
1	Have you ever invested, donated or participated in sustainable projects or initiatives that aim to protect the environment?	1.00	2.00	1.73	0.45	0.20	160

#	Answer	%	Count
1	Yes	27.50%	44

2	No	72.50%	116
	Total	100%	160

Q9 - If yes, could you explain what kind of project/initiative it is? (Both Italian and English answers are accepted)

Con la mia famiglia abbiamo creato BioFavole, un'azienda agricola biologica che pratica agricoltura biologica e sostenibile. Certo, non è un progetto urbano ma rurale, tuttavia con le esperienze in azienda molti turisti possono assaporare la bellezza di una immersione nella natura, tra frutteti pieni di api e coccinelle.

I have participated in university projects, and I have donated for initiatives in my hometown to protect the local biodiversity

Crowdfunding, incentivi fiscali per interventi privati

I am participating in the development of the innovative idea and foundation of a start-up whose wide objective is the protection of river water.

“No net Loss deforestation” target achievement for a multinational energy utility

Donated to WWF and participated to Treedom, Forestami, Beach Clean Up.

Actually, my Uni in UK is organizing green weeks to take care of parks or natural reserves

For my son disable, and for other children disable's

Hope this can be considered as a healthy and protecting the environment, I am eating just what the nature is supplying like fish eggs and meet and vegetables, no industrial food or transformed products.

Molte iniziative relative ai progetti plastic Free, pulizia delle spiagge, riciclo, Eco day, ecc.

Zero carbon emissions, zero plastic initiatives adopted in my company

Progetto LIFE sull'impronta di carbonio Progetto agricoltura bio dinamica

Beach cleaning

Worked with LCA

Molteplici Iniziative consistito in raccolta plastica con associazione plasticfree

Manifestazioni, creazioni di tavole rotonde, laboratori

Nel mio lavoro compro prodotti eco friendly non testati su animali e con packaging riciclabile

Less plastic therefore using re-usable sports bottles. Promoting this theory and practice in my previous workplace, doing this worldwide at customer premises and exhibitions

Sto investendo in un progetto di coltivazione fuori suolo che mira a creare ortaggi con il 90% di acqua in meno rispetto ad una coltivazione da terreno.

The last initiative developed with my company is called "Forestiamo l'Italia" it consists of a fundraiser and subsequent donation to plant 1000 trees for each Italian region

Iniziativa di raccolta rifiuti in siti ambienti naturali come spiagge o parchi.

Ho investito in fondi che supportano aziende green.

Donations

Green future project

Progettazione di soluzioni sostenibili per la città

Investimenti in fondi basati su fattori ambientali e sociali Partecipazione a progetti di sostenibilità ambientale (3Bee, Treedom)

Ho usato spesso piattaforme (ad esempio Treedom) per piantare alberi nel mondo. Si tratta di piccole offerte che sono volte a piantare una determinata tipologia di albero e favorire il rimboschimento degli alberi nelle zone del mondo che necessitano/li stanno perdendo.

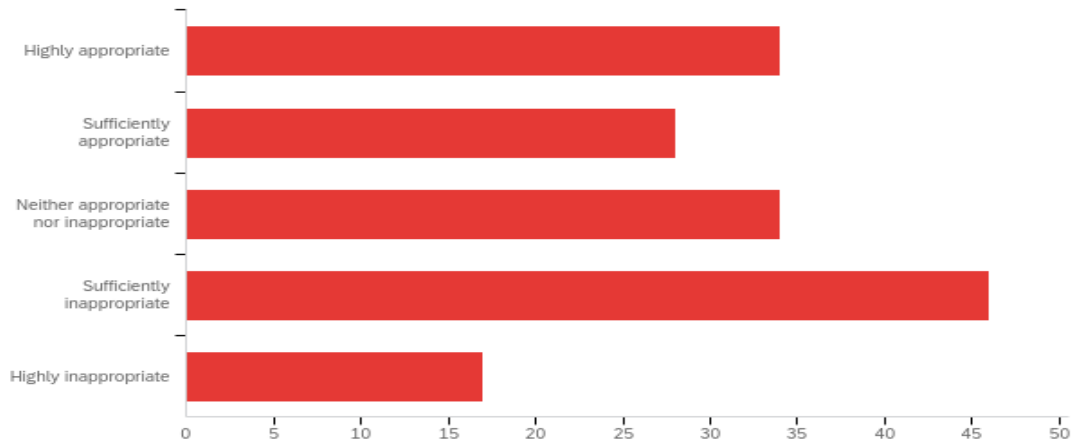
Tree plantation

Stock

I work for an energy company, so we are often involved in green initiatives

WWF

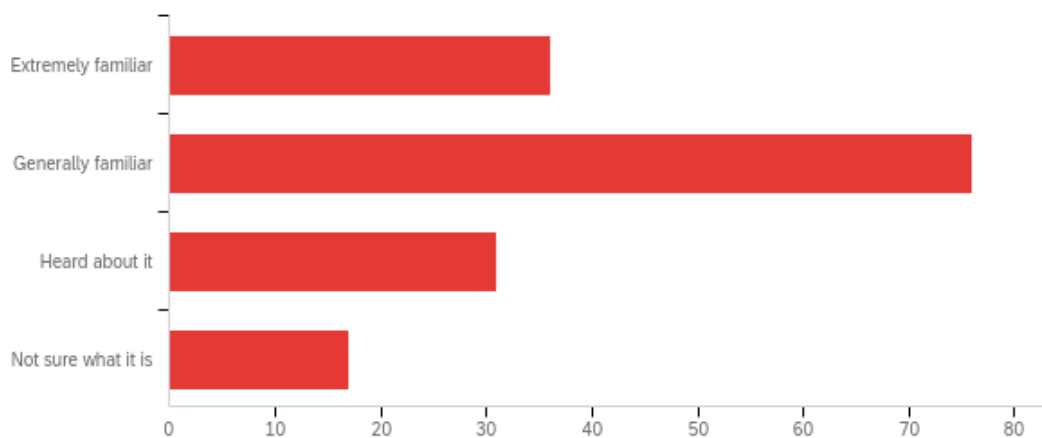
Q10 - What is your opinion on the role of government institutions in promoting and supporting the implementation of this type of initiative?



#	Field	Min	Max	Mean	Standard Deviation	Variance	Count
1	What is your opinion on the role of government institutions in promoting and supporting the implementation of this type of initiative?	1.00	5.00	2.90	1.32	1.74	160

#	Answer	%	Count
1	Highly appropriate	21.38%	34
2	Sufficiently appropriate	17.61%	28
3	Neither appropriate nor inappropriate	21.38%	35
4	Sufficiently inappropriate	28.93%	46
5	Highly inappropriate	10.69%	17
	Total	100%	160

Q11 - Are you familiar with the National Recovery and Resilience Plan (PNRR)?

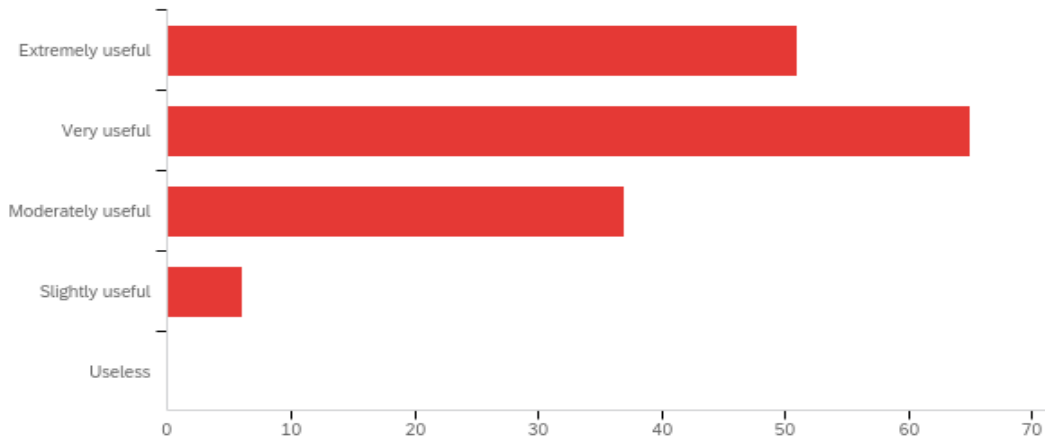


#	Field	Min	Max	Mean	Standard Deviation	Variance	Count
1	Are you familiar with the National Recovery and Resilience Plan (PNRR)?	1.00	4.00	2.18	0.90	0.81	160

#	Answer	%	Count
1	Extremely familiar	22.50%	36
2	Generally familiar	47.50%	76

3	Heard about it	19.38%	31
4	Not sure what it is	10.63%	17
	Total	100%	160

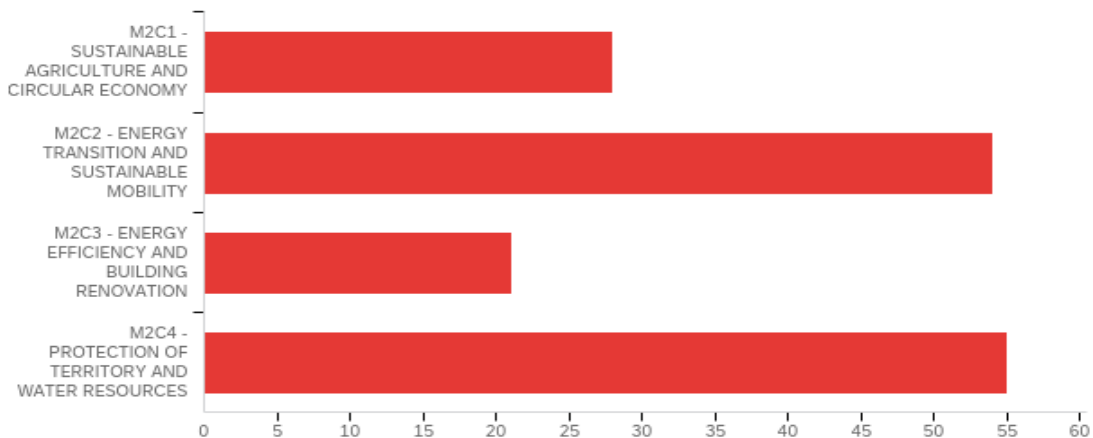
Q12 - Would you find it useful to know how the PNRR supports nature-based solutions?



#	Field	Min	Max	Mean	Standard Deviation	Variance	Count
1	Would you find it useful to know how the PNRR supports nature-based solutions?	1.00	4.00	1.99	0.84	0.70	160

#	Answer	%	Count
1	Extremely useful	32.08%	52
2	Very useful	40.88%	65
3	Moderately useful	23.27%	37
4	Slightly useful	3.77%	6
5	Useless	0.00%	0
	Total	100%	160

Q13 - If you had to choose one of the projects under Mission 2 - Green Revolution and Ecological Transition of the PNRR, which one would you find most useful?



#	Field	Min	Max	Mean	Standard Deviation	Variance	Count
1	If you had to choose one of the projects under Mission 2 - Green Revolution and	1.00	4.00	2.65	1.13	1.28	160

Ecological Transition of the PNRR, which one would you find most useful?

#	Answer	%	Count
1	M2C1 - SUSTAINABLE AGRICULTURE AND CIRCULAR ECONOMY	17.72%	28
2	M2C2 - ENERGY TRANSITION AND SUSTAINABLE MOBILITY	34.18%	55
3	M2C3 - ENERGY EFFICIENCY AND BUILDING RENOVATION	13.29%	21
4	M2C4 - PROTECTION OF TERRITORY AND WATER RESOURCES	34.81%	56
	Total	100%	160

Q14 - Can you please explain why you think it is the most useful? (Both Italian and English answers are accepted)

Can you please explain why you think it is the most useful? (Both Italian and English answers are accepted)

Per garantire l'utilizzo e il reimpiego dei prodotti esistenti il più a lungo possibile e ridurre, quindi, la produzione di rifiuti

La maggior parte delle emissioni viene dagli edifici

70% of emissions come from fossils fuels so it mitigates that better

Good production is something basic that the whole world will benefit from. The English term I think of is 'grass roots'

Perché l'agricoltura è il settore primario e se non torna ad essere la priorità per tutti finiremo per non sapere più cosa mangiamo e dove viviamo. Gli altri sono conseguenze.

L'acqua è basilare per il territorio e la sua salvaguardia. Permette di coltivare, allevare, produrre ricchezza in maniera circolare facendo sì che nel territorio si incrementi la vita stessa.

Dal consumo energetico provengono molti problemi concernenti il riscaldamento globale

Non saprei è stato molto difficile scegliere, penso perché lo vedo come un principio più alto, gli altri non tengono necessariamente conto del territorio e delle risorse d'acqua

Because it truly deals with the protection of the environment and therefore the quality of citizen's life

The water and the use are strategic

Intervenire nel recupero e nel rendere più performante a livello energetico il patrimonio edilizio esistente

Because all 3 remaining pillars highly depend on the efficiency and existence of water resources.

È il punto che richiede l'investimento più sostanziale in termini di infrastrutture e R&D e il PNRR offre una quantità di liquidità difficilmente reperibile in futuro

Penso che l'urgenza più grande sia rendere sostenibile lo stile di vita urbano

Building industry is one of the sectors most responsible for CO2 emissions and many industrial processes are still very obsolete and not energy efficient

I believe M2C2 would be the most useful project as both energy production and mobility are currently two of the major sources of pollution in the environment.

Per evitare ulteriori deforestazioni e combattere la limitata disponibilità di risorse idriche

Farming activities and livestock consume huge amounts of resources and their sensitive with respect to climate conditions may lead to even higher consumption of energy, water, and other complementary products in the future

Le altre opzioni possono essere perseguite attraverso normali processi.

Il cambiamento climatico mette a rischio il ns ecosistema

Transition energy is the biggest challenge for our century, and with globalisation and the movement of billions of people everywhere they're the most important challenges for us

People need to have the possibility to use energy and not be affected so much in terms of expenses and it is necessary that governments create the possibility to travel easily less charges and less environment impact. People need to meet other people to socialize to find new interests, to open their minds sharing

their experience. In a global world massified, we need to go back to social real life not the social means by social tools but with affordable costs.

Credo che sia utile non solo all'ambiente ma in primis alla salute

Cause energy field right now is probably the most important for the sustainable future of society

Important resources for humans and all species

Because agriculture is the base of human life

Stiamo. Andando verso la siccità

I believe a sustainable agriculture is a valid method to maintain a regular ecosystem in nature

É l'unico settore dove gli interventi sono più efficaci

In Italia il trasporto è ancora troppo inefficiente e inquinante, ci sono ampi margini di miglioramento che renderebbero anche l'aria meno inquinata, oltre a risparmiare energia

Simply because the "confusion" within this topic lately has escalated, leading the country to a pause in energy transition

La difesa del territorio e delle acque è la base per poter cercare di salvare il pianeta

Miglioramento psicofisico delle vite delle persone. Risparmio energetico e soprattutto riduzione non solo dell'uso e dipendenza anche geopolitica delle sostanze fossili,

Penso sia sicuramente il punto più veloce da attuare e che possa portare grandi miglioramenti immediati per le persone

Water is life

Sono tutte importanti ma la c1 fa riferimento a ciò che noi portiamo sulle tavole di casa, tutti noi mangiamo e tutti noi consumiamo giornalmente alimenti provenienti dall'agricoltura, sarebbe un'ottima base di partenza

The current energy resources of the planet are limited, expensive and polluting, we must change our approach and push towards alternative sources.

Penso che questo sia l'ambito più appropriato rispetto a cui destinare le risorse messe a disposizione dalla UE. Se per quanto riguarda la transizione energetica, l'economia circolare ed il rinnovo del parco edilizio si possono immaginare altri tipi di interventi atti a favorire soluzioni di mercato, reputo invece che per la protezione del territorio e delle risorse idriche occorra l'impegno in prima persona del governo e delle amministrazioni locali

Il clima sta cambiando soprattutto per le emissioni nei decenni precedenti e dei paesi in via di sviluppo, assolutamente estranei alla tutela dell'ambiente. In questa situazione ormai compromessa occorre mettere in sicurezza il territorio, laddove possibile, ed evitare lo spreco di acqua a causa di condutture obsolete.

Penso sia la più utile poiché l'acqua è indispensabile per la vita dell'uomo ed è importante preservarla, insieme alle sue risorse.

Perché credo che la maggior parte dell'inquinamento derivi dalle case ed in particolare da case e edifici non adatti a trattenere il calore e non efficienti a livello energetico.

Each one is highly important. However, water waste in Italy is too high. Government must intervene as soon as possible.

It would help to face the actual crisis in terms of energy

Penso che la m2c4 sia la più utile perché può essere un buon punto di partenza per tutti gli altri progetti.

Because of the hydro-water emergency that is hitting our country

Senza agricoltura, e del conseguente indotto, non c'è vita

Credo che siano tutti importanti, ma ho messo m2c4 poiché lo avverto come il progetto più urgente da realizzare.

Because agriculture is one of the most impactful factors

Durante un progetto di ricerca su tecnologia e sostenibilità, la climate smart agriculture è stata la tecnologia più nominata dai papers analizzati. Ne deduco dunque che sia anche una delle opzioni con più casi di successo.

Although globally electricity generation and distribution accounts for only about 27 percent of total greenhouse gas emissions, clean energy will be critical to the electrification of many other emissions-

generating activities and to achieving net zero emissions (or at least near net zero, which I believe is more realistic)

Because at the moment is the most urgent issue

Sector requiring urgent intervention

Reducing the scale of trades into circular economies would entail on some levels, all the other following projects because they would require less resources

In my opinion water is our most precious resource that might run out

Because of climate change, water is the most important in the short term

L'acqua è il bene più importante della terra

Penso che tutte le alternative siano in realtà utili, ma nel particolare trovo che bisogna sempre mettere al primo posto protezione del territorio e acqua fondamentali per la sussistenza di ogni forma di vita

L'acqua è un elemento fondamentale per preservare la vita

Perché le tecnologie sono già presenti e implementabili nel breve termine (es nucleare e rinnovabili), inoltre gli effetti si possono vedere subito e questo fa più presa sulle politiche e sulla gente

Sustainable mobility is the key to solve problems like traffic and pollution in big cities

I think that m2c4 is the most useful project because it could be considered the starting point to realize a concrete green revolution and ecological transition.

Solo per una scelta di priorità e urgenza. Per il resto considero utili tutte le alternative sopra proposte.

È la tematica più vicina e alla portata del cittadino

It might have a bigger impact also because it affects everyday behaviours that could easily change

Transizione energetica e mobilità sostenibile ridurrebbero di molto emissioni dannose per il pianeta

Penso che sia sicuramente la questione più urgente da affrontare dal momento in cui il settore dei trasporti contribuisce in maniera abbastanza pesante sull'inquinamento.

They are all very relevant but among the topics water management is the one that I feel more

L'acqua è un bene prezioso, se non partiamo con la sua salvaguardia non possiamo pensare di aggiustare tutto il resto.

Because the buildings in the cities should be renovated under a sustainable view, increasing the energy efficiency for every one of us. But also, other measures should be implemented to make the city greener.

Because production processes and mobility are the things that most produce pollution

Because it is where we probably are farthest from acceptable value

Energy efficiency is key

Il consumo di energia è enormemente aumentato e la tendenza è di forte aumento

È importante tutelare la biodiversità e le risorse naturali come la risorsa idrica. Si tratta di elementi fondamentali per ecosistemi che siano bilanciati bene tra presenza dell'uomo e della natura che vada oltre lo sfruttamento delle risorse e verso un sostentamento che vada di pari passo con la protezione ambientale.

I personally think energy is the key driver of all the other elements mentioned above. Finding a sustainable way to manage and exploit energy will help gain benefit under many other sustainability aspects

Because

È di certo al pari delle altre per importanza, ma secondo me l'efficienza prodotta da una 'building renovation' consentirà di risparmiare un cospicuo ammontare di energia

Agriculture is one of the most impacting sectors

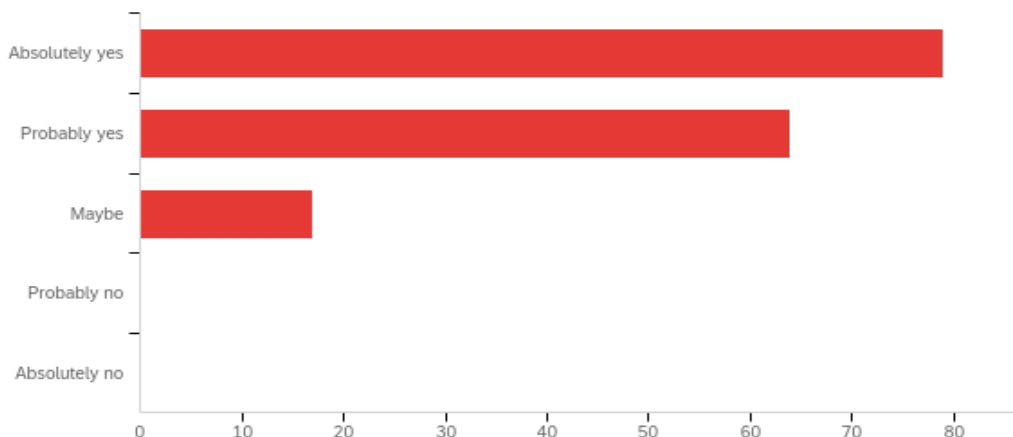
Because the benefits from the energy transition would be tangible on a large scale and could help the development of the other projects

For the co2 emissions

Since we need to face out fossil fuels by 2050, renewable energy sources are necessary to achieve the goal

To reduce GHG emissions

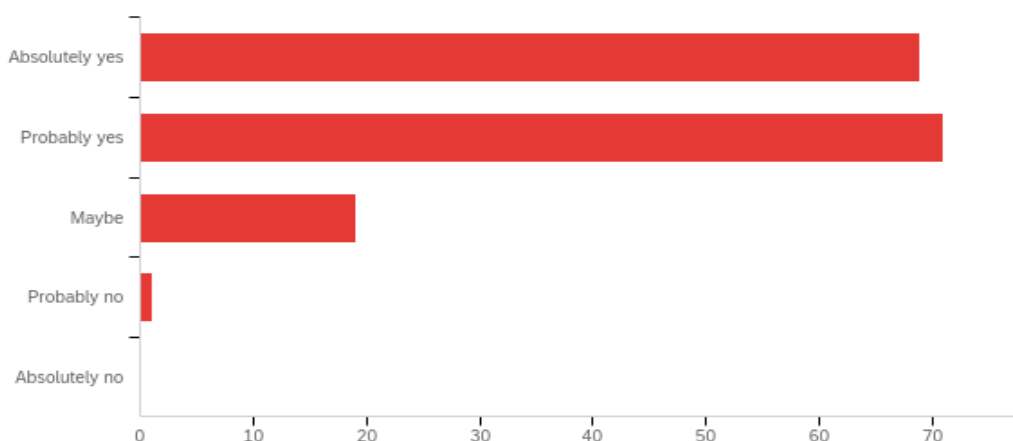
Q15 - Do you think that the projects in Mission 2 can contribute to improving the quality of life of local communities?



#	Field	Min	Max	Mean	Standard Deviation	Variance	Count
1	Do you think that the projects in Mission 2 can contribute to improving the quality of life of local communities?	1.00	3.00	1.61	0.67	0.45	160

#	Answers	%	Count
1	Absolutely yes	49.38%	79
2	Probably yes	40.00%	64
3	Maybe	10.63%	17
4	Probably no	0.00%	0
5	Absolutely no	0.00%	0
	Total	100%	160

Q16 - Do you think that the projects in Mission 2 can help create new job opportunities?



#	Field	Min	Max	Mean	Standard Deviation	Variance	Count
1	Do you think that the projects in Mission 2 can help create new job opportunities?	1.00	4.00	1.70	0.70	0.49	160

#	Answers	%	Count
1	Absolutely yes	43.13%	69
2	Probably yes	44.38%	71

3	Maybe	11.88%	19
4	Probably no	0.63%	1
5	Absolutely no	0.00%	0
	Total	100%	160

Q17 - What initiatives or policies do you think can be put in place to promote Nature Based Solutions?

Erogazioni di fondi perduti alle imprese che investono in NBS.

Piantare alberi, incrementare il verde, curare i boschi inselvaticiti, evitare gli sprechi alimentari e produrre meno rifiuti tossici, gestire bene lo smaltimento senza inquinare, produrre energie pulite, ridurre gli scarichi

Programmi di studio nelle scuole primarie

Non saprei davvero, la mia conoscenza in merito è misera

More local actions and policies, NBS have a huge potential if considered within a bottom-up approach

Comunicazione mirata ma non assillante

Sistemi di Open Innovation tra aziende private che mettono fondi e comunità locali che offrono spazi per co-creare iniziative a grande risonanza mediatica

Aumentare il grado di consapevolezza delle persone riguardo il proprio stile di vita e sensibilizzarle verso modelli più sostenibili. Rendere le opportunità di NBS più familiari e quindi farle avvertire come necessarie

PPP - polluter pays principle

- Provide a system of measurement of returns from the implementation of nature-based solutions; - Improving EU policy frameworks for nature-based solutions; - Develop a community of nature-based solution initiatives that can be replicated elsewhere; - International research and innovation to mainstream nature-based solutions.

A 3 R programme reduce recycle and reduce, focus the attention on the waste

to have nature and clean air, fewer planes, fewer chimneys and more nature made up of trees and flowers. Bucolic

Initiatives of rewarding for whoever promote NBS not only referred to money but also recognitions less to pay if.....discount on taxes if...

Energia rinnovabile, più pannelli solari in città, incoraggiare l'uso di mezzi pubblici o noleggiandolo o condivisibili ecologici

Green roof, urban agriculture, urban wetlands

Efficientamento energetico immobili pubblici - centri per il riuso - miglioramento/aumento verde urbano - incentivi energie rinnovabili/comunità energetiche - efficientamento reti idriche - utilizzo di beni prodotti da materiali riciclati (tipo asfalto utilizzato da enti locali) ...

Un'ottimizzazione dei consumi e una riduzione degli sprechi

I haven't many ideas, but I believe an opportune people training campaign can be a good start.

Migliorare l'utilizzo negli allevamenti

É sufficiente applicare bene la politica agricola comunitaria

Usarle come bonifica di siti inquinati

No ai fossili

Clean our oceans, less intensive meat production and re-use utilities

Fondi e agevolazioni per investire nei settori, in questi periodi di difficoltà economica occorre un supporto per poter investire altrimenti tutti avranno paura.

I think we need to invest on several fronts, hydrogen energy, synthetic fuels, not just electric motors or solutions

Formazione nelle scuole

Regarding water waste, maintaining or substituting water pipes where needed.

promote them on all levels of education

Investment in research and development showing the benefits of adopting alternative and more efficient solutions that can improve everyday life.

Sostegno economico per gli agricoltori per sostenere i costi degli investimenti

I wouldn't know

Tutte le iniziative volte ad istruire la "popolazione" (Corsi universitari, approfondimenti alle scuole primarie e secondaria, aggiungere oltre al corso sulla sicurezza uno sulla salvaguardia di ambiente nelle aziende)

Ridurre gli sprechi. Riciclaggio e riutilizzo

Educazione (dalle scuole a gruppi di ascolto per cittadini)

Don't know, I'm not expert in this field

Gli orti e frutteti urbani accessibili a tutti.

Evitare sprechi, riutilizzare i beni anche destinandoli a scopi diversi da quelli per cui sono stati prodotti, rispettare l'ambiente, utilizzare prodotti naturali, incentivare lo sfruttamento di energia solare o eolica, produrre beni con un solo materiale in modo da poter essere facilmente riciclabile, vietare l'abbattimento degli alberi per la produzione della carta soprattutto per un volantinaggio inutile, superato e dannoso, utilizzare meno possibile l'automobile per gli spostamenti brevi e incentivare l'uso di biciclette, riqualificare le abitazioni per un efficientamento energetico.

raising awareness and financing NBS implementation

Nelle scuole, uscite sul campo e spiegare ai ragazzi di cosa ci si occupa. Organizzare giornate aperte a tutto il pubblico per illustrare le intenzioni e le iniziative.

implementing awards for those who behave sustainably (like lower bills)

Explain where we could end up if we do nothing and that many things would improve

Forti incentivi uniti a penalità per non-NBS Promuovere nelle scuole, a partire dalla Primaria, il concetto di NBS e portare casi di successo

Sicuramente tutti gli incentivi che sono stati individuati dal PNRR svolgono un ruolo fondamentale nel mettere in atto le politiche di decarbonizzazione, di riduzione dei consumi e della produzione, del raggiungimento dell'obiettivo 0 emissioni entro il 2050

Awareness raising campaigns

Reduce the air damage

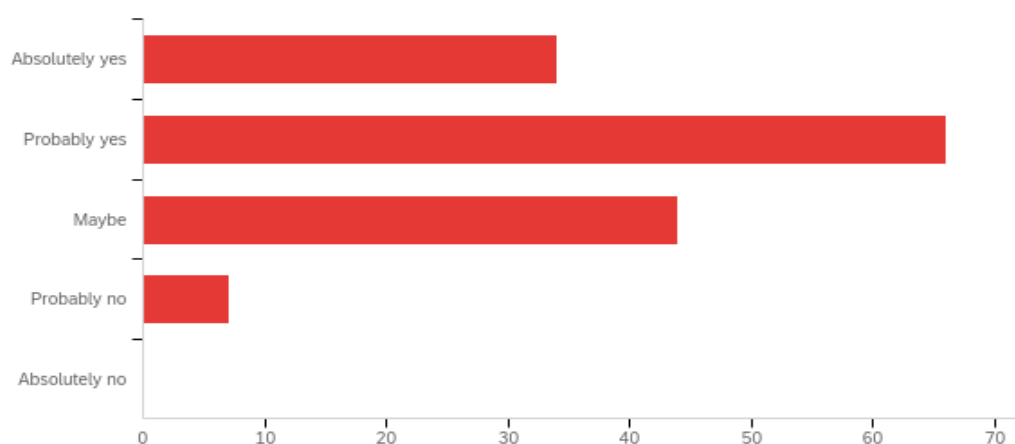
Solutions that promote the development of ecosystems

A policy that prioritizes sustainable development, targets the circular economy, and makes maximum use of available funds

Each company should respect the UN Agenda 2030's criteria

See forthcoming energy efficiency in buildings directive which could be implemented to create momentum for NBS

Q18 - Do you think that Mission 2 of the PNRR is able to stimulate the adoption of nature-based solutions in Italy?

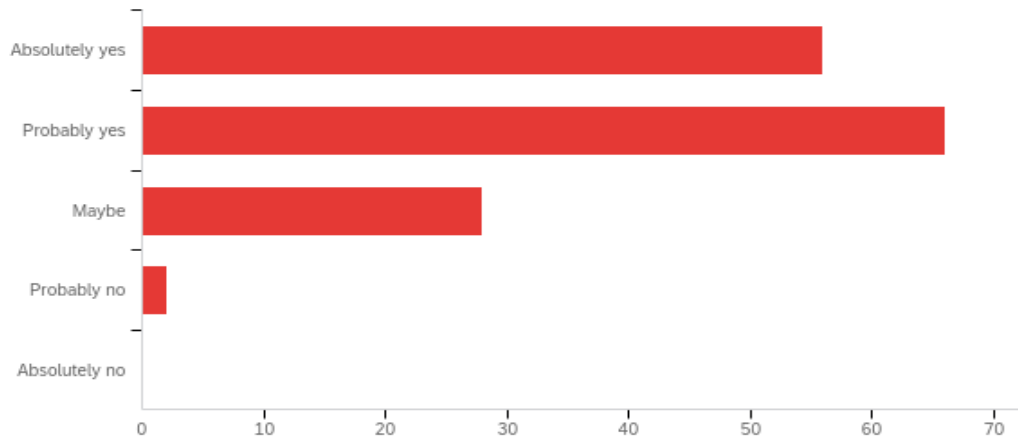


#	Field	Min	Max	Mean	Standard Deviation	Variance	Count
1	Do you think that Mission 2 of the PNRR is able to stimulate the	1.00	4.00	2.16	0.82	0.68	151

adoption of nature-based solutions in Italy?

#	Answer	%	Count
1	Absolutely yes	22.52%	34
2	Probably yes	43.71%	66
3	Maybe	29.14%	44
4	Probably no	4.64%	7
5	Absolutely no	0.00%	0
	Total	100%	151

Q19 - Are you willing to explore the topic of Nature Based Solutions further?



#	Field	Min	Max	Mean	Standard Deviation	Variance	Count
1	Are you willing to explore the topic of Nature Based Solutions further?	1.00	4.00	1.84	0.76	0.58	160

#	Answer	%	Count
1	Absolutely yes	36.84%	59
2	Probably yes	43.42%	69
3	Maybe	18.42%	29
4	Probably no	1.32%	3
5	Absolutely no	0.00%	0
	Total	100%	160

Annex 2

Annex 2 is dedicated to outlining the pattern of questions posed by the author of the thesis to the two experts who were interviewed for the methodology, the answers to which have been elaborated and reported in Chapter 5 of the present thesis. The interviews were conducted on May 10th and May 16th, 2023, respectively.

Questions from the Interview with the Green and Sustainable Finance Professor

1. What is 'sustainable finance' and how can it contribute to the achievement of sustainable development goals?
2. How can the financial sector support and encourage the transition to a green economy?

3. What challenges and opportunities does the financial sector face in supporting the transition to a sustainable economy?
4. What role do taxonomy, DNSH and tagging play in this respect?
5. How can financial institutions collaborate with public and private stakeholders to ensure the sustainability of projects financed through the NRRP?
6. How does the NRRP promote sustainable financing, in particular through nature-based solutions?
7. How can projects funded through the NRRP promote sustainable economic development?
8. How could the economic sustainability of nature-based solutions be ensured, and how could the NRRP support the development of sustainable economic models based on them?
9. What are the long-term prospects for investments in nature-based solutions in Italy, and how could the NRRP support the development of a sustainable and resilient financial sector in this area?

Questions from the Interview with the MASAF's Task Force for the Implementation of the NRRP

1. What are your views on nature-based solutions as a tool to address Italy's environmental and climate challenges, and how could the NRRP support their implementation?
2. How could collaboration between the public and private sectors be encouraged to support the implementation of nature-based solutions in Italy, and how could the NRRP support such collaboration?
3. In the light of your studies and professional experience, what are the main strategies that could be adopted to ensure that nature-based solutions are successfully implemented in the Italian context through the NRRP?
4. What are the main synergies between nature-based solutions and other actions in the NRRP, such as energy efficiency, green infrastructure, sustainable mobility and environmental protection?
5. What are the geographical areas and types of ecosystems that could benefit most from nature-based solutions in Italy, and how could the NRRP support specific interventions in these areas?
6. What are the main political and social challenges that might prevent the effective implementation of nature-based solutions in Italy, and how could the NRRP support the adoption of effective strategies to address them?
7. What role do taxonomy, DNSH and tagging play in this respect?
8. What are the long-term prospects for nature-based solutions in Italy?
9. How is the NRRP preparing to support further investment in this area?

References

- Alves, F. M., Santos, R., & Penha-Lopes, G. (2022). Revisiting the missing link: An ecological theory of money for a regenerative economy. *Sustainability*, *14*(7), 4309–4327. <https://doi.org/10.3390/su14074309>
- Ascani, A., Faggian, A., & Montresor, S. (2021). The geography of Covid-19 and the structure of local economies: The case of Italy. *Journal of Regional Science*, *61*(2), 407–441. <https://doi.org/10.1111/jors.12510>
- Babí Almenar, J., Elliot, T., Rugani, B., Philippe, B., Navarrete Gutierrez, T., Sonnemann, G., & Geneletti, D. (2021). Nexus between nature-based solutions, Ecosystem Services and urban challenges. *Land Use Policy*, *100*, 1–22. <https://doi.org/10.1016/j.landusepol.2020.104898>
- Brugnara, L., & Orlando, C. (2022). (rep.). *108 misure verdi: cosa fa il PNRR per la transizione ecologica* (1–13). Milano, Italia: Osservatorio sui Conti Pubblici Italiani, Università Cattolica del Sacro Cuore. Retrieved May 22, 2023, from <https://osservatoriocpi.unicatt.it/ocpi-pubblicazioni-108-misure-verdi-cosa-fa-il-pnrr-per-la-transizione-ecologica>
- Chausson, A., Turner, B., Seddon, D., Chabaneix, N., Girardin, C. A., Kapos, V., Key, I., Roe, D., Smith, A., Woroniecki, S., & Seddon, N. (2020). Mapping the effectiveness of nature-based solutions for climate change adaptation. *Global Change Biology*, *26*(11), 6134–6155. <https://doi.org/10.1111/gcb.15310>
- Chausson, A., Welden, E. A., Melanidis, M. S., Gray, E., Hiron, M., & Seddon, N. (2023). Going beyond market-based mechanisms to finance nature-based solutions and Foster Sustainable Futures. *PLOS Climate*, *2*(4), 1–17. <https://doi.org/10.1371/journal.pclm.0000169>
- Cohen-Shacham, E., Maginnis, S., Janzen, C., & Walters, G. (2016). Nature-based solutions to address global societal challenges. *International Union for Conservation of Nature (IUCN)*, *XIII*, 1–114. <https://doi.org/10.2305/IUCN.CH.2016.13.en>
- Communication from the Commission of 22 November 2016 to the European Parliament, the Council, the Economic and Social Committee and the Committee of the Regions, COM (2016)739 final, on *Next steps for a sustainable European future: European action for sustainability*. Retrieved April 14, 2023, <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52016DC0739>
- Costituzione della Repubblica Italiana. (1948). Articolo 9.

- Di Pirro, E., Roebeling, P., Sallustio, L., Marchetti, M., & Lasserre, B. (2023). Cost-effectiveness of nature-based solutions under different implementation scenarios: A national perspective for Italian urban areas. *Land*, 12(3), 603. <https://doi.org/10.3390/land12030603>
- European Commission, Directorate-General for Environment, (2014). Mapping and assessment of ecosystems and their services: an analytical framework for ecosystem assessments under action 5 of the EU biodiversity strategy to 2020: discussion paper – final, April 2013, *Publications Office of the European Union*. <https://doi.org/10.2779/12398>
- European Commission, Directorate-General for Research and Innovation, (2015). Towards an EU research and innovation policy agenda for nature-based solutions & re-naturing cities: final report of the Horizon 2020 expert group on ‘Nature-based solutions and re-naturing cities’: (full version), *Publications Office of the European Union*. <https://data.europa.eu/doi/10.2777/479582>
- European Commission. (2016). Nature-based solutions. Research and innovation. Retrieved March 17, 2023, from https://research-and-innovation.ec.europa.eu/research-area/environment/nature-based-solutions_en
- European Commission. (2019). *The Common Agricultural Policy: Separating fact from fiction*. Agriculture and Rural Development. Retrieved May 22, 2023, from https://agriculture.ec.europa.eu/document/download/2bbc14c1-75e8-4fdd-842e-94c015dbfcaa_en
- European Commission. (2021). Commission Delegated Regulation (EU) 2021/2139 of 4 June 2021 supplementing Regulation (EU) 2020/852 of the European Parliament and of the Council by establishing the technical screening criteria for determining the conditions under which an economic activity qualifies as contributing substantially to climate change mitigation or climate change adaptation and for determining whether that economic activity causes no significant harm to any of the other environmental objectives. *Official Journal of the European Union*, 1(L-442). Retrieved April 14, 2023, from <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32021R2139>.
- European Commission, Commission Staff Working Document. (2021). Impact Assessment Report. Accompanying the document: Proposal for a regulation of the European Parliament and of the Council establishing a carbon border adjustment mechanism, SWD(2021)643 final. Retrieved May 21, 2023, from <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A52021SC0643>.
- European Commission. (2021). NextGenerationEU: European Commission raises €20 billion in first transaction to support Europe’s recovery. *NextGenerationEU*. Retrieved April 14, 2023, from https://ec.europa.eu/commission/presscorner/detail/en/IP_21_2982.

- European Commission. (2022). *Integration of environmental dimensions in public finances – Implementing the ‘Do No Significant Harm’ (DNSH) principle in public funding programmes*. Reform Support. Retrieved April 6, 2023, from https://reform-support.ec.europa.eu/integration-environmental-dimensions-public-finances_en.
- European Environment Agency (EEA). (2021). Nature-based solutions in Europe: Policy, knowledge and practice for climate change adaptation and Disaster Risk Reduction. *Publications Office of the European Union, 1*, 1–164. Retrieved April 18, 2023, from <https://www.eea.europa.eu/publications/nature-based-solutions-in-europe>.
- European Parliament and Council. (2020). Regulation (EU) 2020/852 of the European Parliament and of the Council of 18 June 2020 on the establishment of a framework to facilitate sustainable investment and amending Regulation (EU) 2019/2088. *Official Journal of the European Union, 13*(L-198). Retrieved May 22, 2023, from <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32020R0852>.
- European Parliament and Council. (2021a). Regulation (EU) 2021/1119 of the European Parliament and of the Council of 30 June 2021 establishing the framework for achieving climate neutrality and amending Regulations (EC) No 401/2009 and (EU) 2018/1999 (‘European Climate Law’). *Official Journal of the European Union, 1*(L-234). Retrieved March 20, 2023, from <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32021R1119>.
- European Parliament and Council. (2021b). Regulation (EU) 2021/241 of the European Parliament and of the Council of 12 February 2021 establishing the Recovery and Resilience Facility. *Official Journal of the European Union, 17*(L-57). Retrieved May 22, 2023, <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32021R0241>
- European Union. (2012). Consolidated versions of the Treaty on European Union and the Treaty on the Functioning of the European Union. *Official Journal of the European Union, 55*(C-326). Retrieved March 20, 2023, from <https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:12012E/TXT:en:PDF>.
- Faivre, N., Fritz, M., Freitas, T., de Boissezon, B., & Vandewoestijne, S. (2017). Nature-based solutions in the EU: Innovating with nature to address social, economic and environmental challenges. *Environmental Research, 159*, 509–518. <https://doi.org/10.1016/j.envres.2017.08.032>.
- Goodwin, S., Olazabal, M., Castro, A. J., & Pascual, U. (2023). Global mapping of urban nature-based solutions for climate change adaptation. *Nature Sustainability, 1-12*. <https://doi.org/10.1038/s41893-022-01036-x>

- Governo italiano. (2021a). Rivoluzione verde e transizione ecologica. Retrieved March 20, 2023, from <https://www.governo.it/it/approfondimento/rivoluzione-verde-e-transizione-ecologica/16703>
- Governo italiano, Presidenza del Consiglio dei ministri. (2021b). Bandi e Avvisi delle Amministrazioni Titolari. Italia Domani - Portale PNRR. Retrieved April 18, 2023, from <https://www.italiadomani.gov.it/it/opportunita/bandi-amministrazioni-titolari.html?orderby=%40jcr%3Acontent%2Fstatus&sort=asc>
- Governo italiano, Presidenza del Consiglio dei ministri. (2022a). Piano Nazionale di Ripresa e Resilienza (PNRR). Italia Domani - Portale PNRR. Retrieved March 15, 2023, from <https://www.italiadomani.gov.it/content/sogei-ng/it/it/home.html>
- Governo italiano, Presidenza del Consiglio dei ministri. (2022b). *Il principio DNSH (do no significant harm) nel PNRR*. Italia Domani - Portale PNRR. Retrieved April 6, 2023, from <https://www.italiadomani.gov.it/content/sogei-ng/it/it/Interventi/dnsh.html>
- Lhotka, O., & Kysely, J. (2022). The 2021 european heat wave in the context of past major heat waves. *Earth and Space Science*, 9(11). <https://doi.org/10.1029/2022EA002567>.
- MEA. (2005). Ecosystems and human well-being: Synthesis. Millennium ecosystem assessment. *World Health*, 1134, 25-60. <https://wedocs.unep.org/20.500.11822/8701>.
- Pauleit, S., Zölch, T., Hansen, R., Randrup, T. B., & Konijnendijk van den Bosch, C. (2017). Nature-based solutions and climate change – four shades of Green. *Theory and Practice of Urban Sustainability Transitions*, 29–49. https://doi.org/10.1007/978-3-319-56091-5_3.
- Rotondo, F., Perchinunno, P., L'Abbate, S., & Mongelli, L. (2022). Ecological transition and sustainable development: Integrated Statistical Indicators to support public policies. *Scientific Reports*, 12(1), 1–12. <https://doi.org/10.1038/s41598-022-23085-0>.
- Seddon, N., Chausson, A., Berry, P., Girardin, C. A., Smith, A., & Turner, B. (2020). Understanding the value and limits of nature-based solutions to climate change and other global challenges. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 375(1794), 1–12. <https://doi.org/10.1098/rstb.2019.0120>.
- United Nations. (2015). *The 17 goals | Sustainable Development*. United Nations - Department of Economic and Social Affairs. Retrieved April 3, 2023, from <https://sdgs.un.org/goals>
- United Nations. (2021). *Principles for Ecosystem Restoration to guide the United Nations decade 2021–2030*. UN Decade on Restoration. Retrieved April 3, 2023, from

<https://www.decadeonrestoration.org/publications/principles-ecosystem-restoration-guide-united-nations-decade-2021-2030>

United Nations Environment Programme and International Union for Conservation of Nature. (2021). Nature-based solutions for climate change mitigation. Retrieved March 20, 2023, from <https://www.unep.org/resources/report/nature-based-solutions-climate-change-mitigation>

World Meteorological Organization. (2023). 2022 State of the Global Climate. *WMO Annual Report Highlights Continuous Advance of Climate Change*. Retrieved April 26, 2023, from <https://public.wmo.int/en/media/press-release/wmo-annual-report-highlights-continuous-advance-of-climate-change>.

Summary

The release of the 2022 State of the Global Climate report by the World Meteorological Organization emphasises the unprecedented impact of greenhouse gases on the Earth's systems and the devastating consequences experienced by communities worldwide. This thesis focuses on the urgent need to address nature loss and climate change, emphasising the Italian context. It highlights the far-reaching implications of climate change, including rising temperatures, sea-level rise, ocean acidification, extreme weather events, and their detrimental effects on ecosystems, wildlife, and natural resources. Italy, a State that is particularly vulnerable to climate events, has witnessed increasing heatwaves and droughts in recent years, with coastal areas and floodplains being the most threatened locations. These phenomena severely affect human health, livelihoods, and overall well-being. Thus, the thesis acknowledges the damaging consequences of prioritising short-term economic growth over environmental protection, which has led to significant ecological damage. Global initiatives such as the UN Decade on Ecosystem Restoration and international agreements like the Paris Agreement and the UN 2030 Agenda for Sustainable Development have been established to tackle these obstacles and move towards a sustainable future. Within this context, the European Union has been instrumental in promoting sustainability and combating climate change through various policies and programs, including the European Green Deal.

Therefore, this thesis explores the crucial role of nature-based solutions (NBS) in Earth Sciences. It examines their financing potential in Italy through the National Recovery and Resilience Plan (NRRP or PNRR). It thoroughly examines multiple aspects, including challenges related to NBS implementation and financing, the central research question, the employed methodology, the obtained findings, the significance of sustainable investments in NBS, the alignment with the United Nations Agenda 2030 and SDGs, the crucial role of the NRRP, the interrelatedness of various components within the NRRP, the pressing need for ecological measures and the adoption of a circular economy, and the necessity for future research exploration.

The literature review in Chapter 2 of the thesis is divided into three sections. It focuses on implementing and financing nature-based solutions within the Italian NRRP. While acknowledging the potential benefits of NBS, it highlights the need for increased funding and support for their implementation. The chapter aims to identify critical factors for effective implementation of NBS and achieving climate and environmental goals. As a matter of fact, nature-based solutions have gained recognition as a promising approach to addressing global environmental challenges by imitating or working with nature to achieve sustainable outcomes. Hence, the thesis emphasises the importance of NBS in attaining the objectives set out by the Paris Agreement and the Sustainable Development Goals (SDGs).

The first section introduces NBS, their benefits, and their alignment with EU policies and SDGs. Indeed, the concept of NBS has recently emerged as a response to climate change and associated challenges. NBS refers to solutions inspired and supported by nature, providing environmental, social, and economic benefits while building resilience. The International Union for Conservation of Nature (IUCN) defines NBS as actions that conserve, manage, and restore ecosystems while ensuring human well-being and biodiversity

benefits. Consequently, the given dual definition consent to classify NBS into two main categories: Natural or Seminal Ecosystems and Artificial Surfaces or Systems. Within the first category, NBS can be labelled into three types. Type 1 focuses on better management of existing ecosystems through non-physical changes. Type 2 involves restoring and partially recreating existing ecosystems, therefore, it may be requiring physical changes. Type 3 is shared among the first category, Natural or Seminal Ecosystems, and the second category, Artificial Surfaces or Systems. Type 3 is the creation of artificial ecosystems. It entails the complete reclamation or creation of novel ecosystems involving significant alterations on a broad scale.

Accordingly, NBS have wide-ranging applicability and can be implemented in various landscapes, including coastal areas, water management, forests, forestry, and agriculture. However, as the methodology confirms, more research has been conducted on rural ecosystems. Indeed, NBS has been recognised as a cost-effective and long-term solution to environmental challenges like global warming, water scarcity, and biodiversity loss.

The advantages of NBS include minimising climate-harmful consequences, preserving biodiversity, establishing sustainable livelihoods, and restoring ecosystem services. However, there is a need for empirical evidence to support the effectiveness of NBS in practice. NBS align with the United Nations' SDGs, such as Zero Hunger, Good Health and Well-being, Clean Water and Sanitation, Decent Work and Economic Growth, Reduced Inequalities, Sustainable Cities and Communities, Responsible Consumption and Production, and Climate Action. NBS offer a unique opportunity to address climate change and biodiversity loss while supporting socio-economic development and community resilience. Ecosystem services, which are the benefits ecosystems provide to humans, are essential for the success and sustainability of NBS. These services can be categorised into regulation, culture, and provision of services. NBS contribute to ecosystem services by restoring or enhancing natural systems. In contrast, healthy ecosystems are crucial for the benefits provided by NBS. To ensure the long-term contribution of NBS to global objectives, guidelines and policies are needed to guide their implementation.

The Next Generation EU (NGEU) initiative is the European Union's response to the Covid-19 pandemic crisis, aiming to accelerate the ecological and digital transition, improve worker training, and achieve equity in various aspects. The initiative established the Recovery and Resilience Facility (RRF) to support EU Member States financially. The RRF offers grants and loans totalling 723.8 billion euros, with the entire NGEU breakdown amounting to 806.9 billion euros. The funds are distributed across six funding pillars, including green transition, digital transformation, social cohesion, health, and policies for new generations. Member States must submit National Recovery and Resilience Plans (NRRPs) outlining their investments and reforms to receive funding. As an EU member state, Italy is subject to European norms and agreements promoting sustainable development. Hence, the second section of Chapter 2 explores the NRRP's investments in the green transition and the possible financing of NBS through the fund.

Supported by the European RRF funds, the Italian NRRP aims to address the economic and social repercussions of the COVID-19 pandemic and foster the country's ecological transition. Italy, the largest

recipient of NGEU funding, will receive 191.5 billion euros, with 68.9 billion euros in grants and 122.6 billion euros in loans. Italy's NRRP focuses on missions aligned with the RRF pillars, including Mission 2 of the NRRP, Green Revolution and Ecological Transition. It focuses explicitly on the green revolution, addressing four significant components: sustainable agriculture, energy transition, energy efficiency, and protection of territory and water resources. The NRRP allocates significant funding, as per almost 60 billion euros, to these components to make Italy more resilient to climate change, protect nature and biodiversity, and ensure a just transition to a net-zero economy. The plan emphasises NBS to address environmental challenges and promote sustainable development.

Aligning with the EU's ecological norms, Italy's NRRP allocates 37.5% of funds to green measures. Indeed, the categorisation of actions classified as green by the European Commission resulted in 71.7 billion euros, counting 108 measures of the NRRP as a green investment. Hence, NRRP's green investments cover sustainable infrastructure, energy efficiency, renewable energy, and environmental protection, from which actions and funds could be drawn to finance NBS. However, the sum represents the bare minimum to respect the European tagging principle of 37% to receive the funding.

The third section discusses the challenges and opportunities of implementing NBS through the NRRP, including funding and stakeholder participation. NBS offers a practical approach to mitigating climate change impacts by working harmoniously with the natural environment. Despite recognising their potential, challenges must be addressed in implementing and financing NBS.

The damage caused by human activity to Earth's ecosystems is significant due to an economic model that prioritises short-term economic growth over environmental protection. A shift in our mindset and relationship with nature is necessary to prevent further damage and stay within planetary boundaries. Incorporating the value of nature into the economic system is crucial, as the financial market currently undervalues the essential benefits of nature. Opportunely, there is growing recognition in the business community of the importance of nature, as more than half of the world's GDP is moderately or highly dependent on nature.

The EU taxonomy for sustainable finance is an excellent initiative that raises awareness in the business community. Indeed, the EU developed a classification system to identify economic activities contributing to a green and low-carbon economy. The taxonomy sets criteria for economic activity sustainability based on six environmental objectives: climate change mitigation, adaptation, sustainable use and protection of water and marine resources, transition to a circular economy, pollution prevention and control, and conservation and restoration of biodiversity and ecosystems. The DNSH principle, a fundamental pillar of the Italian NRRP, ensures that public investments align with the EU's sustainable development goals and do not cause significant harm to the environment, human health, and society. DNSH assessments evaluate the long-term effects of each financed intervention based on the six environmental objectives. Four scenarios are identified: no or minimal impact, substantial and direct contribution, significant contribution but not 100%, and negative impact. Different approaches are taken for assessments based on the scenario, with a more thorough analysis

for higher-risk investments. While governmental climate mitigation funding allocated to nature-based initiatives is modest, opportunities exist for integrating NBS into various industries.

Increasing funding and support for NBS is crucial for their comprehensive implementation and contribution to mitigating climate change. Public bodies, private organisations, and communities can fund biodiversity initiatives. However, challenges like cash flow limitations and unfavourable regulations hinder investments. The DNSH principle can help overcome barriers and promote sustainable NBS practices by directing public investments toward projects with positive environmental and social impacts. Undeniably, successful implementation of NBS requires adequate financing, which can be facilitated by governments, donors, and multilateral development banks through grants and concessional finance. The private sector is vital in NBS implementation as investors, developers, customers, and beneficiaries. Private organisations are interested in NBS to increase customer value, reduce costs, and contribute to corporate sustainability goals. Also, communities and citizens can donate through crowdfunding and donations, which provides financial benefits, raise awareness, and promote environmental stewardship. Overall, by incorporating the value of nature into the economic system and implementing necessary safeguards, NBS can significantly contribute to addressing climate change and environmental degradation while promoting sustainable economic growth and development.

Consequently, this thesis provides an opportunity to discuss the following research question: *How can NBS be effectively implemented and financed using the NRRP to promote sustainable investments in Earth Science and achieve climate and environmental objectives in Italy?*

The research provides insights into strategies for promoting sustainable investments in NBS, contributing to biodiversity conservation, climate change mitigation, and environmental sustainability. By conducting a literature review on NBS and qualitative research involving interviews with green finance and Earth science experts, the thesis aims to provide insights into strategies for promoting sustainable investments that support biodiversity conservation, climate change mitigation, and environmental sustainability in Italy.

This thesis explores the effective implementation and financing of nature-based solutions in Italy to promote sustainable investments in Earth Science and achieve climate and environmental objectives. The research is based on the NRRP and NBS alignment with the UN 2030 Agenda and SDGs. It investigates the effective implementation and financing of NBS using the NRRP to promote sustainable investments in Earth Science and achieve climate and environmental objectives in Italy.

Nature-based solutions are an effective instrument for achieving various SDGs. They leverage natural ecosystems and processes to address environmental and social challenges, aligned with the UN 2030 Agenda and SDGs. The research aims to contribute to Italy's sustainable and resilient development by addressing environmental challenges and identifying strategies for financing and implementing NBS. The NRRP Mission 2, Green Revolution and Ecological Transition, aligns with the SDGs as well, so the ecological transition necessitates technological innovation and societal change while upholding environmental sustainability criteria.

The literature supports this viewpoint, highlighting NBS as an effective instrument for pursuing European objectives. The financing of NBS aligns with the DNSH criterion imposed by the European Union. The Italian NRRP is based on six interconnected pillars. It is proposed as a solution to combat climate change, protect oceans and marine resources, and manage forests to mitigate desertification. The main challenge of these solutions is to identify ways of financing them. Strategic points and approaches must be carefully considered to ensure a successful ecological transition.

The Italian NRRP can seek to finance and implement nature-based solutions to achieve environmental and climate goals. However, there is still a lack of definitional clarity and adequate funding for NBS. Italy's 108 measures to improve environmental and climate sustainability barely exceed the 37% limit imposed by EU Regulation 241/2021, indicating a lag in sustainable innovation and the country's commitment to sustainability. Survey data confirms this, implying an average unsatisfactory or inappropriate perception of the government's interest in sustainability issues.

The MASAF measures fall under mission two of the NRRP, with sub-components M2C1 concerning sustainable agriculture and the circular economy and M2C4 on land and water resource protection. The methodology used to support this thesis, from the social perspective, confirms the predominance of M2C4. However, experts in sustainable finance and the task force for NRRP implementation emphasise the importance of M2C4 and its inseparability from M2C1. The Green and Sustainable Finance professor highlights the central importance of components related to sustainable agriculture and the circular economy, which have a mutually beneficial relationship for NBS implementation. Currently, in Italy, no specific funds are exclusively dedicated to these solutions; instead, they are sub-understood in specific public tenders resulting from funding allocated through the PNRR.

MASAF is responsible for measures worth approximately 4 billion euros, distributed over four measures related to the ecological transition of M2C1 and M2C4. To implement NBS successfully, public funding is needed from governments, donors, and multilateral development banks. Private organisations and citizens can contribute to NBS through investments, donations, and crowdfunding. Public bodies, private organisations, and communities can fund biodiversity initiatives through national public tenders.

As remembered in the literature review, NBS have broad applicability in various landscapes, including coastal areas, water management, forests, forestry, and agriculture. However, more research is needed on rural ecosystems, and addressing sustainable agriculture is crucial. The NRRP task force leader outlines the MASAF's plans for sustainable development. At the same time, the professor draws a historical-economic framework for NBS implementation in the context of sustainable agriculture in Italy. Three measures are proposed: logistics development in the agri-food sector, agrisolar park, and mechanisation innovation for agriculture.

The professor also emphasises that traditional agriculture has deep historical and social roots, and more must be done to protect the environment and preserve traditional agriculture. Intensive agriculture and large-scale distribution have significantly increased CO₂ emissions and sustainable finance can contribute to

changing this system. However, a profound transformation of the approach to agriculture is necessary to ensure equity and sustainability. Targeted public interventions and a broader strategic vision are essential to ensure this. NBS could reduce herbicides and fertilisers, create animal corridors, and significantly impact the environment and biodiversity.

It is essential to thoroughly assess public measures to support agriculture and understand their specific function and alignment with sustainable finance principles. The EU's CAP plays a fundamental role in leveraging available funds and promoting the development of sustainable agriculture. To ensure comprehensive support for the farming community, adequate evaluation of agricultural policies and transparent accounting for sustainable farming activities are essential. Increasing investments in the agricultural sector is fundamental to ensure sustainable growth and improve the resilience of the farm system.

Protecting land and water resources is essential for achieving sustainability and ensuring inhabitants' quality of life. The MASAF expert has identified M2C4 Investment 4.3, which focuses on the irrigation agri-system to improve water management and system resilience. This measure is closely linked to the theme of NBS and M2C1. It includes ongoing projects and 42 new initiatives to address drought and its consequences. It requires structural intervention policies to promote resilient territories, efficient water utilisation, and intelligent afforestation strategies to counter the decline of fertile land. Ensuring the transfer of resources, including adequate income, is imperative and can be facilitated through supportive measures such as NBS. It requires a personal commitment from the government and local administrations, and individual entrepreneurs to whom the funds can be allocated.

The respondents of the survey also suggested addressing environmental problems and promoting sustainability through NBS, such as afforestation, increasing green areas, forest conservation, reducing food and toxic waste, managing waste disposal responsibly, and promoting clean energy and reduced discharges. They highlighted the need for school educational programs to raise awareness about sustainability, providing training on sustainable investments through NRRP, adopting renewable energy, installing solar panels in cities, encouraging eco-friendly transportation, implementing green roofs, urban agriculture, and wetlands, and reducing reliance on fossil fuels, cleaning oceans, promoting sustainable meat production, and encouraging utility reuse. The respondents believed raising awareness and providing financial support for NBS implementation are critical in addressing environmental challenges.

Therefore, the European strategy to improve sustainable development includes the implementation of conditionalities, such as DNSH and environmental and climate tagging, to ensure environmental protection and promote sustainable initiatives. DNSH requires compliance with the principles of the Next Generation EU and national calls, ensuring compliance with the criteria of the European climate change mitigation taxonomy, climate change adaptation, sustainable use and protection of water and marine resources, transition to a circular economy, including waste reduction and recycling, pollution prevention and control, and protection of biodiversity and ecosystem health. Environmental and climate tagging requires each project to have a significant percentage of ecological components, at least 37%, to ensure sustainable agriculture. Despite

challenges related to the bureaucratic structure and the current energy emergency, the NRRP is reviewing and reshaping projects to address practical difficulties and ensure effective and consistent implementation of the ecological mission. This process aims to overcome bureaucratic limitations and ensure the success of the NRRP in promoting sustainable development and addressing energy challenges.

The public sector can be crucial in facilitating private investment in NBS, but several obstacles hinder its efficiency. One major challenge is the need for more cash flow in current NBS projects, which can be attributed to the high initial costs and extended time frames required for investors to recoup their investments. Regulatory barriers also limit funding mechanisms, making them unsuitable for large-scale investments. To address these obstacles, the MASAF expert has proposed a strategy of synergy and cohesion, which involves creating synergies between national and European funds to promote territorial cohesion and sustainable development. The RepowerEU supports investments in the energy sector and requires solid and constant relations between Italian ministries for measures to implement the plan. This strategy addresses current and future challenges in the NBS sector, promoting balanced and inclusive growth at the national level.

This discussion analysed the motivations, results and possibilities of financing NBS initiatives via NRRP. The professor of sustainable finance underlined a fundamental aspect of the diatribe concerning the financing of nature-based solutions from a more economic perspective, further explaining how applying the regenerative economy concept could support sustainable development in the country. Pursuing sustainability requires a concerted effort towards implementing regenerative agriculture and economy, prioritising the well-being and professional development of individuals involved in the agricultural sector. Implementing NBS under a regenerative economy model is a critical and progressive strategy, emphasising restoring and enhancing natural ecosystems to achieve a sustainable and resilient economy. It integrates biodiversity-based practices and technologies to address environmental challenges while promoting economic growth.

The involvement of a sustainable finance expert has been instrumental in advancing the implementation of NBS in Italy, as it has showcased the economic perspective and the utilisation of regenerative economy principles to foster sustainable development. In times of significant disruption, such as the current COVID-19 pandemic, a unique opportunity exists to make noteworthy progress towards sustainability.

The concept of a regenerative economy is a highly effective approach towards attaining climate and environmental targets while fostering sustainable development across the public and private sectors. Drawing from the principles and mechanisms outlined in the regenerative economics literature, it can be redesigned sustainable development ecosystems to promote social, economic, and ecological regeneration. To effectively address the ecological and social challenges of the modern era, it is necessary to establish a new financial paradigm. This paradigm must prioritise regenerative processes such as cross-scale circulation, participatory governance, symbiotic mutualism, collaboration, collective learning, and creative adaptation. It is also essential to explore how unexpected events such as the COVID-19 pandemic can be leveraged to drive transformative changes towards sustainability.

Adopting these measures on a broader scale within the NBS would undoubtedly play a pivotal role in facilitating the ecological transition and advancing towards a sustainable tomorrow. Emphasising the fundamental principles outlined in the UN 2030 Agenda and the SDGs as the guiding framework for COVID-19 recovery can be translated into practical implementation. A future endeavour seeking to lead present funding towards a long-term outlook entails promoting a synergistic approach grounded in the principles championed by the European Union, such as environmental and climate tagging and the commitment to environmental protection through the Do No Significant Harm principle.

A society committed to sustainability understands that initiatives like the NRRP are essential to promoting progress. Taking advantage of the recovery phase is imperative to implementing appropriate measures for the future. At the NBS level, these measures will secure an ecological transition and a sustainable future. Following the guiding principles in the UN 2030 Agenda and the SDGs is paramount to achieving this goal. It should serve as the framework for our COVID-19 recovery efforts. In the future, a synergistic approach must be taken, grounded in the principles championed by the European Union, including environmental and climate tagging and a solid commitment to environmental protection through the DNSH principle, which must serve as the foundation of sustainable development in the country.

Therefore, incorporating NRRP is a reliable and effective method of implementing and financing NBS. The utilisation of NRRP can enhance the sustainability and resilience of our natural resources, thereby facilitating efficient restoration and preservation. This approach ensures the proper functioning of the Earth's ecosystems. It provides a cost-effective and sustainable solution to long-term environmental challenges. Overall, by incorporating the value of nature into the economic system and implementing necessary safeguards, NBS can significantly contribute to addressing climate change and environmental degradation while promoting sustainable economic growth and development.