1 Relevance of green infrastructure in Italy

The climate crisis has increased the average global temperature and is leading to more frequent high-temperature extremes across the globe. In Italy, the infrastructure network has already suffered serious damages and losses, and the impact of climate change on infrastructure assets is projected to increase. Mainstreaming climate change considerations in the decision-making process for public investments is more urgent than ever. In particular, green infrastructure and nature-based solutions can be used as instruments to steer the infrastructure sector into a more sustainable and resilient path.

Today, **Italy must take urgent action to mitigate climate change and adapt to its impacts**. Climate change will affect infrastructure assets, disrupting the services they offer and threatening the stability of social and economic networks. Even though the year 2021 was not as hot as the previous ones, heat waves hit the Italian peninsula over the summer period, with the most intense one reaching 48.8 ºC in Syracuse, Sicily. Heavy rainfalls also occurred, especially in the Liguria region, causing floodings, landslides, and mudslides. In October, a tropical cyclone in the Mediterranean Sea brought heavy rains in the southern regions of the country, resulting in the flooding of rivers and canals (Istituto Superiore per la Protezione e la Ricerca Ambientale (ISPRA), 2021[1]). In between 1st January and 1st November, Italy faced 133 extreme-weather and climate-related events, which caused major impacts in several regions and cities. Climate-induced extreme events have severe impacts on infrastructure networks, such as metros, train lines and electricity grids. For example, between 2010 and 2021, subways and urban trains in major Italian cities have been closed for a total of 83 days (29 days in Rome, 19 in Milan, 15 in Naples, 12 in Genoa, etc.), while electricity networks have been subject to widespread disruptions for a total of 89 days due to extreme weather conditions (Legambiente, 2021[2]). A recent report coordinated by the Ministry of Infrastructure and Transport (MIT)[1] investigates current and future climate change impacts on transport infrastructure, both at the national and local level (see Box 1.1). According to the report's estimates, the direct economic impact of climate change on infrastructure assets in Italy is projected to increase up to EUR 5.17 billion per year by 2050, which represents an increase of about 12 times compared to the value of current damages (Ministero delle infrastrutture e dei trasporti (MIT), 2022[3]).

In order to make infrastructure resilient to climate change and implement effective adaptation strategies, MIT has committed to the "*transformative resilience*" approach. The latter aims to go beyond the traditional way of responding to the climate crisis with ad-hoc measures and adopts a more systemic and integrated approach. This approach leverages "*green*" measures, i.e. solutions that build on nature and the multiple benefits provided by ecosystems to enhance the resilience and adaptive capacity of infrastructure assets (Ministero delle infrastrutture e dei trasporti (MIT), 2022[3]).

In its National Recovery and Resilience Plan (Piano Nazionale di Ripresa e Resilienza, PNRR), Italy allocates 37.5% of the EU funds made available through the Next Generation EU Plan to actions that can help the country achieve its climate goals. It also outlines substantial measures and investments that will contribute to environmental goals, biodiversity protection, the restoration of ecosystem services[2], and improvements in natural resource management. These cut across different sectors, including infrastructure for transport, energy, public buildings, water, etc. (European Commission, 2021[4]). In other words, through the PNRR, the country aims to steer the infrastructure sector onto a greener trend.

In this context, developing an **infrastructure governance system that is prepared to manage the environmental challenges of our time** is key to enhance and protect the country's natural capital, while at the same time also strengthening resilience to climate change. Doing so also provides an opportunity to rethink public infrastructure investments and strengthen risk management, not least by strengthening preventative measures, risk awareness, and emergency preparedness against climate risks such as heatwaves, windstorms, wildfires, floods, landslides, drought, extreme precipitation, soil erosion, and so on.

Box 1.1. Climate change, infrastructure, and mobility in Italy

The "Climate change, infrastructure and mobility" report published in 2021 by the Carraro Commission investigates current and projected climate change impacts on Italian transport infrastructure at both the national and local level. Building on this information, it sets out a number of recommendations to best manage changing climate conditions, both in terms of adaptation (i.e. to increase resilience and adapt to the impacts of climate change) and mitigation (i.e. to reduce greenhouse gas emissions), with a thorough territorial approach. Below follows a collection of the main facts and data from the report.

Climate risks and impacts

- **Climate change poses serious constraints to Italy's economic growth** and is projected to cause a GDP loss of up to 2% by 2050 under a +2ºC warming scenario. Under a +2.7ºC warming scenario, GDP losses are projected to reach 2.5%, while under a +4.4ºC warming scenario, GDP losses could reach 3.7%.
- **Climate change is also projected to have a growing impact on society and human well-being**. Changing climate conditions are projected to increase the mortality rate by 86-137% (under RCP 4.5[3]), mainly due to a rise in the number of premature deaths from extreme weather events, such as for example heatwaves, floods and wildfires. Climate change is also likely to reduce work productivity and exacerbate existing regional and socio-economic differences.
- **The physical impacts of climate change are likely to become more frequent and more extreme.** In the coming decades, the frequency and intensity of extreme weather events is projected to grow, with more frequent windstorms, more intense and frequent extreme precipitation events (especially in Italy's central and northern regions), more extreme coastal storms (especially in the upper Adriatic and upper Tyrrhenian seas), longer and more intense heatwaves, wildfires, and droughts, as well as more intense river floods. Southern regions are projected to experience particularly extreme drought events, with Sardinia and Calabria projected to experience the most pronounced worsening of drought conditions of the country.

Climate change and infrastructure

- **By 2050, the direct economic impact of climate change on infrastructure is expected to increase up to EUR 5.17 billion per year**, which corresponds to an increase of about 12 times compared to current damage estimates. Overall, in the absence of adaptation measures, the total damage to infrastructure – including both the direct and indirect impacts of climate change - is projected to reach 0.33% to 0.55% of Italy's GDP in 2050.
- Today, the majority of the climate-related damages to infrastructure in Italy are due to riverine flooding. Yet the relative amount of damages caused by droughts and heatwaves is projected to increase, accounting for about 92% of the projected climate damages by 2041-2070[4], compared to an observed 31% over the period 1981-2010
- In economic terms, climate impacts on infrastructure are likely to be more pronounced in the northern and Tyrrhenian regions of the country, as these host a higher concentration of infrastructure assets.

Source: (Ministero delle infrastrutture e dei trasporti (MIT), 2022[3])

1.1. The urgency of climate change and the need for climate-proofing infrastructure

According to the latest IPCC Assessment Report (AR6), greenhouse gas emissions (GHG) have increased across all major economic sectors globally in the period between 2010 and 2019 (IPCC, 2022[5]). Most notably, CO_2 emission reductions from fossil fuels and industrial processes – linked to improvements in the energy intensity and in the carbon intensity of energy – have not been sufficient to compensate for the emission increases resulting from rising global activity levels in industry, energy supply, transport, agriculture and buildings. Based on the Nationally Determined Contributions (NDCs) submitted by countries to date, global GHG emissions will keep increasing, making it likely for global warming to exceed 1.5°C by 2030. The need to limit global warming to 1.5°C and well below 2°C thus calls for a rapid acceleration of global GHG mitigation efforts (IPCC, 2022[5]).

At the same time, larger adaptation efforts are needed. In its analysis on climate change adaptation, risks, and vulnerability, the latest IPCC report shows that the extent and magnitude of climate risks and impacts will likely be larger than estimated in previous assessments. Changing climate conditions and extreme weather events are already causing physical damages, economic losses, as well as social and environmental disruption across all regions of the world. Observed and projected impacts include among others biodiversity loss, substantial damage and disruption to ecosystems and their services, the retreat of glaciers (with the ensuing challenges, e.g. to freshwater security), increase in heat-related human mortality, challenges to food security, damages to settlements and infrastructure, adverse impacts on the physical and mental health of people, increased occurrence of climate-related food-borne and water-borne diseases, and disruption of key societal services. Some of these impacts are already locked in and irreversible. Climate risks and their impacts are also becoming increasingly complex and difficult to manage. Indeed, multiple climate hazards are expected to occur simultaneously and exacerbate other non-climatic hazards (e.g. land subsidence in coastal areas, decreasing biodiversity, etc.), compounding existing pressures and generating cascading impacts across sectors and regions (IPCC, 2022[6]).

In this context, climate change will add to and amplify existing chronic infrastructure challenges, such as limited funding, poor maintenance and mismanagement. If not adequately managed, climate change will affect the physical integrity of infrastructure assets and reduce the quality, continuity, and reliability of infrastructure services, resulting in poorer water quality and sanitation, faulty transport networks, unreliable electricity grids, etc. (OECD, 2021[7]).

According to the 2020 OECD Survey on Infrastructure Governance, countries are leveraging **enhanced infrastructure investments as a stimulus measure** in their recovery from the Covid-19 pandemic. Although the latest data were collected in January 2021, with the pandemic still unfolding, 21 OECD countries (70% of the 30 surveyed) had already adopted an economic stimulus or recovery package. Of these, over three-quarters see infrastructure playing a key role in the recovery. For instance, in Chile, Costa Rica, Hungary, Ireland, New Zealand and Slovenia, 30% or more of the economic stimulus package has been allocated to investments in infrastructure (OECD, 2020[8]). This represents a one-off opportunity to steer the infrastructure sector onto a more resilient and sustainable path. For this reason, governments are called upon to take advantage of the recovery from the pandemic to **climate-proof their infrastructure**, which requires integrating climate change adaptation and mitigation considerations into the design, development, and management of spatial planning and infrastructure projects, including both new and existing assets (European Commission, 2021[4]).

In this context, **green infrastructure (GI)** has gained increased attention as an instrument to support biodiversity conservation, strengthen the ecological connectivity across green areas, enable the protection and restoration of terrestrial and marine ecosystems and their services, and enhance societal resilience to changing climate conditions and extreme weather events.

1.2. The project's objectives

Given the urgency of the climate crisis and the climate risks faced by Italy, the Ministry of Infrastructure and Transport (MIT)[5] is committed to improve the management of infrastructure by strengthening environmental and climate considerations. MIT aims to ensure that all infrastructure that falls under its competency – including urban assets, buildings, roads, railways, water infrastructure, ports and airports, etc. - all contribute to the reduction of GHG emissions and to build a more resilient society – not least, by developing infrastructures that are themselves resilient to the impacts of climate change, as well as to other environmental challenges.

Mainstreaming environmental sustainability and climate change considerations in the management of existing assets and in the development of new infrastructure projects requires a good understanding of climate risks and improved governance mechanisms throughout the entire infrastructure asset lifecycle.

With the support of the European Commission under the **Technical Support Instrument** (TSI) **Regulation** (Regulation 2021/240), the OECD aims at providing technical support to MIT in the area of infrastructure governance. In the context of this TSI project, this report defines an integrated approach to strengthen the planning and financing of green infrastructure (GI) and promote the use of nature-based solutions (NbS) in project design and implementation in Italy.

It is important to note that at the international level the terms GI and NbS refer to concepts centred on supporting ecosystem services and biodiversity. For the purpose of this report and in order to be consistent with the use of the terms of GI and NbS in the Italian context, the term GI will be used as a planning instrument to ensure that the protection of biodiversity and ecosystem services as well as ecological networks are considered, right from the outset, in territorial and infrastructure development. On the other hand, the term "NbS" will be used to refer to specific project-level solutions.

The report builds on desk research conducted by the OECD, on the responses to the OECD questionnaire provided by the three Italian Ministries involved[6], and on the information gathered during the OECD's fact-finding mission in Rome[7]. The report also includes four case studies to showcase how GI and NbS are currently implemented in Italy: (i) the railway line from Bicocca to Catenanuova (Sicily), (ii) the Green Node (i.e. *Nodo Verde*) in Bari (Puglia), (iii) the Metro 4 line in Milan (Lombardy), and (iv) the Ridracoli Dam in Emilia-Romagna (see chapter 4)[8].

The report is organised as follows: chapter 2 provides a conceptual framework and an overview of the state-of-the-art of GI and NbS at the international level. Chapter 3 highlights international good practices in the implementation of GI and NbS and provides an integrated approach to strengthen GI consideration in infrastructure planning and decision-making processes. Chapter 4 identifies the main challenges and opportunities to foster GI and NbS implementation in Italy. Finally, chapter 5 summarizes the main conclusions of the report and outlines key recommendations to support the effective implementation of the proposed integrated approach in Italy. Throughout the report, due attention is paid to the existing regional differences that characterise the Italian landscape, and two main sectors are investigated: urban regeneration and transport.

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Notes

[1] The report was drafted by the European Commission on "Climate change, infrastructure and mobility", which was established by the previous minister Enrico Giovannini in April 2021 and supervised by professor Carlo Carraro. Under the previous minister Enrico Giovannini, the ministry's name was changed to "*Ministry of sustainable infrastructure and mobility*".

[2] Ecosystem services are the goods and services that nature provides and upon which humans, as well as any other species, are dependent. They can be grouped into four categories: (i) provisioning services, (ii) regulatory and maintenance services, (iii) cultural services, and (iv) supporting services (Henriette, Neubert and Marrs, 2019[9]).

[3] RCP4.5 is an IPCC climate scenario based on greenhouse gas concentrations in the atmosphere. It is considered an intermediate scenario, likely to lead to temperature increases of 2 to 3ºC.

[4] This estimate refers to a +3ºC warming scenario.

[5] Under the previous minister Enrico Giovannini, the Ministry's name was changed to "Ministry of sustainable infrastructure and mobility". Since November 2022, under the new minister Matteo Salvini, the name of the Ministry is "Ministry of infrastructure and transport".

[6] The Ministry of Infrastructure and Transport (MIT), the Ministry of Environment and Energy Security (MASE), and the Ministry of Culture (MoC).

[7] The fact-finding mission took place in Rome on 20th and 21st July 2022.

[8] The case studies were selected with the purpose to cover different regions of the country.