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Study on the Climate-resilient Infrastructure in the Republic of North Macedonia

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Abbreviations

AFOLU	Agriculture, Forestry and Other Land Use
BREEAM	Building Research Establishment Environmental Assessment Method
BUR	Biennial Update Report
CEN-CENELEC	European Committee for Standardization
CGECA	Global Centre of Excellence on Climate Adaptation
COP	Conference of Parties
DIN	Deutsche Industrial Norms (German standards agency)
DNSH	Do No Significant Harm
DRR	Disaster Risk Reduction
EBRD	European Bank for Reconstruction and Development
EC	European Commission
EIA	Environmental Impact Assessment
EIB	European Investment Bank
EN	European Standard
ENDC	Enhanced National Determined Contributions
ETSI	European Telecommunications Standards Institute
EU	European Union
FAO	Food and Agriculture Organisation of the United Nations
GCA	Global Center for Adaptation
GCAP	Green City Climate Action Plan
GCF	Green Climate Fund
GHG	Greenhouse gasses
HMS	The Hydro-Meteorological Service
IFI	International financial institution
IPCC	Intergovernmental Panel on Climate Change
ISO	International Standardisation Organisation
ISRSM	Standardisation Institute of the Republic of North Macedonia
JSC	Joint stock company
kV	kilo Volt
LCA	Law on Climate Action
LEED	Leadership in Energy and Environmental Design
LNG	Liquefied natural gas
MAFWE	Ministry of Agriculture Forestry and Water Economy
MKS	Macedonian standard
MoE	Ministry of Economy
MoEPP	Ministry of Environment and Physical Planning
MoTC	Ministry of Transport and Communication
MW	Mega Watt
NAP	National Adaptation Plan
NC	National Communication
NCC	National Council on Climate Change
NDP	Nationally determined parameters
NEN	Nederlands Normalisatie-Instituut (Netherlands Standards Institute)
NSDI	National Spatial Data Infrastructure
OECD	Organisation for Economic Co-operation and Development

PV	Photovoltaic
RES	Renewable Energy Sources
RIMSYS	The River Monitoring System project in Macedonia
RM	Regulatory Measures
RNM	The Republic of North Macedonia
SEA	Strategic Environmental Assessment
TCFD	Task Force on Climate-Related Financial Disclosures
TEN-E	Trans-European Networks for Energy
TEN-T	Trans-European Transport Network
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
USAID	United States Agency for International Development
WB	World Bank
WBIF	Western Balkans Investment Framework
WEI	Water use index

Introduction and Summary

This document was produced under the UNDP 00111750 "Macedonia's Fourth National Communication and Third Biennial Update Report on Climate Change under the UNFCCC" project - REFERENCE: RFP 97-2021 for Development of a climate-resilient infrastructure study.

This study assesses the potential and benefits of climate-resistant infrastructure in the Republic of Northern Macedonia. UNDP and the Ministry of Environment and Physical Planning (MoEPP) are implementing the project "Macedonia's Fourth National Communication and Third Biennial Update Report on Climate Change under the UNFCCC" (4th NC/3rd BUR)". The immediate objective of the project is to assist the country in the preparation and submission of its Fourth National Communication and Third Biennial Update Report on Climate Change to the Conference of the Parties to the United Nations Framework Convention on Climate Change (UNFCCC). The climate change vulnerability and adaptation analyses shall build upon the previous NCs and will focus on areas other than those covered by the National Adaptation Planning process and will be new for the NCs, such as vulnerability of the transport sector and the vulnerability of the urban areas, including the built-in environment.

As part of this process this study was produced. The analysis and recommendations are conducted thoroughly on the sectoral basis and include transport infrastructure, energy infrastructure, water infrastructure, and built environment.

The study is constituted of the following main aspects:

- General overview of interconnection between climate change and infrastructure;
- Analysis of relevant legal and strategic framework covering main primary and secondary laws and sectoral strategic documents. The analysis includes the overview of these frameworks against climate resilient considerations against relevant sectoral infrastructure;
- Overview of current practices in designated sectors in all phases of infrastructural development and implementation;
- Climate vulnerability assessment of infrastructure in designated sectors;
- Overview of best international practices, standards, and codes against North Macedonian context and identification of entry points within current legislation and standards, recommendations on the implementation of efficient standards and procedures in strategic and technical regulation on a per sector basis, and identification of main co-benefits resulting from applying climate resilience considerations.

The overview and analysis was carried out using the following resources:

- **A comprehensive and detailed desk research/literature review** of all the relevant documentation provided by the UNDP, available online, and provided by other stakeholders.
- **Comprehensive stakeholder consultations.** A number of key stakeholders were contacted during the process of development of this study. Detailed explanation is given under sub-chapter 3.1.
- **Institutional knowledge.** Institutional knowledge of all involved experts.

Summary of key findings

The following presents the list of key findings resulting from the analysis under this study. Detailed elaboration is given under respective sub-chapters throughout the study.

Analysis of relevant national legal and strategic framework in the context of climate resilience:

- Key finding 1. There are no specific regulations, obligations, and references regarding climate proofing of infrastructure in North Macedonia;
- Key finding 2. Various strategies and especially the new Long-Term Strategy on Climate Action provides strong basis for inclusion of climate proofing process into infrastructural projects.
- Key finding 3. There are potentially already climate proofing related activities of infrastructure that are not systematically recognised as building resilience.
- Key finding 4. Climate adaptation strategies are being developed at the local level, including supporting analyses

Current practices related to designing and permitting process for infrastructural projects/investments:

- Key finding 1. Work is underway to mainstream climate considerations into spatial planning
- Key finding 2. When IFIs finance the preparation of technical documentation for infrastructure projects, the EIA study includes climate adaptation considerations
- Key finding 3. SEA legislation is fully in line with the EU directive, while EIA legislation is not
- Key finding 4. Design practice shows that adaptation to climate change considerations are scarce

Current practices and technical standards

- Key finding 1. The Institute for Standardisation of the Republic of North Macedonia is a member of the European standardisation bodies and has the same obligations as all other European members.
- Key finding 2. All Eurocodes have been transposed.
- Key finding 3. There are several examples of good practice in including infrastructure resilience in capital projects in North Macedonia.
- Key finding 4. Engineers have knowledge and experience of standards, but not in a systematic way. Trainings and education are needed to make design and implementation similar.

Transport sector

- Key finding 1. There is a strong national strategic objective for climate proofing of transport sector.
- Key finding 2. The road network is relatively well developed. However, roads are in average condition, and most of the roads do not meet modern standards.
- Key finding 3. Very relevant initiatives are ongoing such as regional “ClimaProof” project financed by the Austrian Development Cooperation (ADC) and implemented by the UN Environment Programme.

- Key finding 4. Guidelines for designing climate resilience for the Public Enterprise for State Roads have been developed
- Key finding 5. Climate resilience requirements for transport infrastructure are not sufficiently included in the legislation system.

Energy sector

- Key finding 1. The sector is heavily oriented around climate mitigation related activities.
- Key finding 2. It is likely that any newly built infrastructure co-financed by international donors will require climate proofing.

Water sector

- Key finding 1. There is a relatively well developed strategic and legislative framework that still needs improvements. The framework is oriented around floods and irrigation.
- Key finding 2. There is a need for improved data sets related for flood risk mapping and climate models.
- Key finding 3. Several relevant initiatives are ongoing which may be scaled up in the future.

Built environment

- Key finding 1. Cities and municipalities are preparing (and started implementing to some extent) their climate strategies, although not required by regulation
- Key finding 2. Several municipal Disaster Risk Reduction (DRR) strategies contain climate risk assessment and propose adaptation measures
- Key finding 3. Maintenance and energy renovation of buildings do not consider climate adaptation and related measures
- Key finding 4. Spatial and urban plans should prescribe regulations on land use and construction that reduce the impact of climate change.

Vulnerability assessment analysis

For the purposes of this climate vulnerability and impact analysis, the key elements defining the level of climate risk include: (a) climate hazards, (b) exposure of the infrastructure, (c) vulnerability factors of the infrastructure (see some examples below).

Climate hazards		
Greater frequency and intensity of extreme events **extreme rainfall events, floods, landslides**.	Rise in average temperatures and extreme temperatures → **heatwaves**	Variability of seasonal rainfall patterns → **longer dry seasons, drought.**
Exposure		
River flooding. The exposure to river flood hazard in North Macedonia is classified as **HIGH**, which means that potentially damaging and life-	**Drought.** The exposure to drought hazard is classified as **MEDIUM**, which means that there is up to a 20% chance that droughts will occur in the coming 10 years.	

threatening river floods are expected to occur at least once in the next 10 years.	
Landslides. The landslide susceptibility of North Macedonia is classified as **HIGH**, which means that this area has rainfall patterns, terrain slope, geology, soil, land cover and that make localized landslides a frequent hazard phenomenon.	**Extreme heat.** The exposure to extreme heat hazard is classified as **MEDIUM**, which means that there is more than a 25% chance that at least one period of prolonged exposure to extreme heat, resulting in heat stress, will occur in the next five years.
Vulnerability	
Sensitivity. (1) Limited capacity of water drainage systems in urban areas to accommodate high volume of rainfall in short periods. (2) Inadequate construction materials and limited integration of risk-informed design options.	**Coping capacity. (1)** Limited capacity of key agencies to translate forecasts into meaningful guidance and anticipatory actions to protect infrastructure during extreme events. (2) Insufficient legal framework to ensure risk-informed infrastructure design.

Summary of key recommendations

The following presents the list of key recommendations resulting from the analysis under this study. Detailed elaboration is given under respective sub-chapters throughout the study.

Cross-cutting / Horizontal recommendations

- Recommendation 1: Consider updating requirements under the secondary legislation related to environmental impact assessments (EIA), under the Law on Environment, to include climate vulnerability assessment and identification of possible climate adaptation measures – alignment with the EU Green New Deal activities.
- Recommendation 2: Consider non-regulatory implementation of climate resilience criteria for infrastructural projects through procurement and/or thematic initiatives.
- Recommendation 3. Continue to strengthen the legal ground for the introduction of climate adaptation in spatial (and urban) planning, including the adoption of a new spatial planning methodology.
- Recommendation 4. Strengthen the commitment to climate adaptation in the SEA procedure.
- Recommendation 5. Include “resilience to climate change” as a basic requirement for construction under the Law on Construction.
- Recommendation 6. Establishment of a coordination mechanism for climate adaptation activities is vital.
- Recommendation 7. Consider institutional capacity building, knowledge transfer and sharing, awareness raising, and other activities related to climate resilient infrastructure.
- Recommendation 8. Increase adoption of relevant technical standards. Ensure appropriate and up to date transposition.
- Recommendation 9. Consider developing report on current state of infrastructure and damages occurring from climate change impacts.

- Recommendation 10. Require climate risk reporting from public and private companies (potentially local units and all other large physical property owners) involved in critical infrastructure management.

Recommendations for transport sector

- Recommendation 1. Consider promotion and update of transport design guidelines among public and private sector (municipalities, engineers, designers, and other transport experts)
- Recommendation 2. Consider incentivising climate resilient transport projects and innovative adaptation solutions – transfer of best international applicable technical solutions.

Recommendations for energy sector

- Recommendation 1. Consider climate-proofing of energy infrastructure projects – more emphasis on climate adaptation

Recommendations for water sector

- Recommendation 1. Full transposition of Floods Directive 2007/60/EC

Recommendations for built environment

- Recommendation 1. Utilise nature-based solutions for adapting urban areas to climate change.
- Recommendation 2. Consider climate adaptation options in energy renovation projects, in synergy with climate mitigation solutions.

1. Climate change and infrastructure

1.1 Climate change impacts to infrastructure

Over the last decade, and especially last several years, climate resilience in the context of infrastructure is becoming one of the major considerations and areas of combating against climate change impacts. The Paris Agreement has the goal of holding temperature increases "well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels".

According to the Climate-Resilient Infrastructure Officer Handbook[1], climate-related shocks and stresses are increasing in frequency and magnitude, causing damages to infrastructure systems and disruptions in the provision of services. Yet there is not sufficient investment needed to infrastructure systems' climate resilience. The global urban infrastructure investment gap alone is estimated to be over USD 4.5 trillion per year.

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Infrastructure networks will be affected by the physical impacts of climate variability and change, but will also play an essential role in building resilience to those impacts. Extreme events illustrate the extent of this potential exposure. The OECD policy paper[2] states that new infrastructure assets should be prioritised, planned, designed, built and operated to account for the climate changes that may occur over their lifetimes. Existing infrastructure may need to be retrofitted, or managed differently, given climate change.

Worldwide, all types of infrastructure will be affected by negative climate impacts and therefore will be exposed to variety of risks. Increasing its resilience to these impacts will have a crucial role in avoiding substantial direct and indirect economic and financial damages. Therefore, this aspect has got a lot of attention and has been taken into consideration by decision-makers and other key stakeholders, such as engineers, planners, designers, and other relevant experts. There is a series of projects, standards, certificates that are established as the result. Series of methodologies and other technical guidelines for climate resilient infrastructure considerations are now available. However, the lack of designated regulation and legal framework still pose a significant barrier for the implementation of those guidelines.

General overview of climate change impacts to infrastructure sectors

There is a vast variety of acute and chronic climate change impacts that affects infrastructure both directly and indirectly. Hence, climate change risks fall into two categories:

[1] https://gca.org/wp-content/uploads/2021/08/GCA-Handbook-V2.0-13-September-2021-2.pdf

[2] https://www.oecd.org/environment/cc/policy-perspectives-climate-resilient-infrastructure.pdf

- **Chronic stresses** – Hazards due to long-term changes in average climatic conditions, which are typified by their slow onset occurrence. For example, the effects of long-term changes in average temperature, sea-level rise, glacier melting or long-term erosion of coasts or landscapes. These are also sometimes referred to as slow onset events.
- **Acute shocks** – Hazards due to extreme weather events. For example, hurricanes and other extreme storms, droughts or floods. These are also sometimes referred to as rapid onset events.

These risks are produced by the increase in frequency or magnitude of different natural hazards due to the effects of climate change. Additionally, chronic stresses and acute shocks can, and often do, compound one another. The impacts of climatic hazards produce disruptions in the service provided by infrastructure and have negative consequences for the communities they serve. Some of these disruptions can also affect the capacity of a community to recover quickly from the impacts of climatic hazards. For example, a damaged road prevents emergency services to arrive promptly to affected locations.

The major issue related to climate impacts to infrastructure are severe physical and functional losses of infrastructure. There are three main dimensions, interlinked together, that are relevant for the extent of damages and losses that climate impacts might have on infrastructure.

- **Exposure to climate impacts** – types and severity of climate change impacts onto given infrastructure at some location.
- **Sensitivity/vulnerability** – the degree to which infrastructure is exposed to climate impacts.
- **Adaptive capacity** - The ability to use all the available strengths, attributes and resources to reduce hazard-related risks, cope with adverse conditions and recover from impacts.

The lower exposure and sensitivity and the higher adaptive capacity is damage and losses will be lower, or not occurring at all.

Typical exposures of different types of infrastructure are given in the table below:

Table 1 Climate change impacts to infrastructure, disaggregated by relevant sectors[3]

Sector	Temperature changes	Changing patterns of precipitation	Changing patterns of storms
Water sector	• Increased need for treatment • Increased evaporation from reservoirs Increased water demand	• More risk of overtopping river embankments and flooding • Overwhelming drainage systems • Disruptions to the supply due to water scarcity	• Physical damages to assets like water and wastewater treatment plants • Decreased standard of protection offered by flood defences

[3] Based on https://gca.org/wp-content/uploads/2021/08/GCA-Handbook-V2.0-13-September-2021-2.pdf

Sector	Temperature changes	Changing patterns of precipitation	Changing patterns of storms
Transport sector	• Melting road surfaces and buckling railway lines • Damage to roads due to melting of seasonal ground frost	• Damage to roadbed for non-paved roads • Disruptions due to floods or higher water levels in water ways	• Physical damages to assets like bridges networks • Disruption of and airport services
Energy sector	• Power outages or reduced output from power plants • Impact on transmission lines • Lack of cooling water for thermal plants • Excess pressure and demand on networks from overheating • Reduced efficiency of solar panels	• Physical damages to assets like wind farms and distribution networks	• Disruptions in the supply of energy • Downed power lines and transmission • Damage to assets • Economic losses due to power outages
Built environment	• Heat islands • Disruptions and damages to air conditioning systems due to change in average air moisture content	• Disruptions in distribution of basic services due to reduced water availability	• Physical damages to buildings • Death and injuries

1.2 Definition of climate resilient infrastructure

According to the OECD[4], The defining characteristic of climate-resilient infrastructure is that it is planned, designed, built and operated in a way that anticipates, prepares for, and adapts to changing climate conditions. It can also withstand, respond to, and recover rapidly from disruptions caused by these climate conditions. Ensuring climate resilience is a continual process throughout the life of the asset. Efforts to achieve climate resilience can be mutually reinforcing with efforts to increase resilience to natural hazards.

Climate-resilient infrastructure reduces, but may not fully eliminate, the risk of climate-related disruptions. The extent to which climate change translates into risks for infrastructure depends upon the interaction of changing climate hazards with exposure (the location of assets) and vulnerability. Climate risks to infrastructure can be reduced by locating assets in areas that are less exposed to climate hazards (e.g. avoiding new construction in flood plains), and by making the assets better able to cope with climate impacts when they materialise. The development of

[4] https://www.oecd.org/environment/cc/policy-perspectives-climate-resilient-infrastructure.pdf

infrastructure should also consider the impacts on risk elsewhere: for example, the potential contribution to flood risk resulting from increases in paved surfaces. This definition of climate resilience focuses on the process used and outcomes achieved to assess whether climate change impacts have been considered and, if necessary, managed. Given the context-specific nature of climate adaptation, the measures used to achieve this will vary widely. In general, there are two broad categories of adaptation measures in this context:

- **Structural adaptation measures**: e.g., changing the composition of road surfaces so that they do not deform in high temperatures or using permeable paving surfaces to reduce run-off during heavy rainfalls. Ecosystem-based approaches using natural infrastructure to design adaptation measures are also key alternatives to be considered alongside structural adaptation measures.
- **Management (or non-structural) adaptation measures**: e.g., changing the timing of maintenance to account for changing patterns of energy demand and supply, investment in early warning systems or purchasing insurance to address financial consequences of climate variability. These measures can also include enhanced monitoring of existing assets to reduce the risk of failure as climate conditions change. Adaptive management approaches also include provisions to include flexibility from the outset to monitor and adjust to changing circumstances over the assets lifetime.

In general, climate resilient infrastructure is infrastructure that has appropriate scale and scope of adaptive capacity against the exposure at a given location. This ensures longer lifetime and less/no damage to the infrastructure and environment.

This scope of this study covers four sectors in North Macedonia:

- **Transport sector** – Includes all infrastructure related to transport sector – road, freight, train, aviation, and water transport.
- **Energy sector** – Includes all infrastructure related to energy sector – power producing facilities, transmission grid network, other energy transport infrastructure such as pipelines.
- **Water sector** – Includes all infrastructure related to water sector – Irrigation systems, dams and hydro power plants, dikes, waterway management, pumping stations, wastewater treatment facilities.
- **Built environment -** It includes all buildings, social and business infrastructure, public and green areas intended for human activity. In the built environment, different types of infrastructure can provide different services and benefits. These different types of infrastructure can be positioned in a continuum that goes from grey infrastructure to green and blue infrastructure based on their characteristics.

    - **Grey infrastructure** – Grey infrastructure are built up, engineered and physical structures, often made of concrete or other long-lasting materials. These include roads, railways, canals, energy, dikes, embankments, centres and breakwaters for riverine flood protection, piped drainage systems for storm water management (such as storm sewers or concrete detention basins), and air conditioning or cooling centres to cope with extreme heat.
    - **Green infrastructures** – Green infrastructure is principally characterized by well-functioning biophysical systems, primarily related to green spaces, that support biodiversity, natural ecological processes and to which some management and

restoration may apply. They are represented mainly by forests, parks, street trees, and grasslands inland.

- **Blue infrastructure** – Blue infrastructure can be also characterized by well-functioning biophysical systems, but primarily related to water. This includes water bodies, including ponds, wetlands, rivers, lakes, and streams.

1.3 Role of enabling framework in building of climate resilience of infrastructure

As already mentioned, even though there is a number of standards and methodologies for the implementation of climate resilient measures related to infrastructure the enabling environment remains weak and undeveloped, worldwide.

Enabling environment is essential for effective and sustainable considerations for improving climate resilience of infrastructure. According to the OECD[5] , the following are key aspects of enabling environment in this context:

- **National policies/strategies** - National adaptation planning can help identify entry points for mainstreaming, and promote cross-sectoral coordination. Most OECD and G20 countries have, or are developing, national adaptation strategies and plans that address one or more core infrastructure sectors, such as transportation, energy, and water. Infrastructure adaptation to climate change can be facilitated by incorporating climate risk into broader infrastructure planning frameworks. Spatial planning can help reduce infrastructure exposure to climate hazards by determining the possible locations for different types of infrastructure. Spatial planning frameworks tend to be established nationally, but local authorities are involved in their implementation and may issue their own regulatory requirements. Additionally, technical standards can be embedded into secondary legislation for the respective sectors.
- **Strategic Environmental Assessment (SEA) and Environmental Impact Assessment (EIA)** - A key element of mainstreaming adaptation into infrastructure is the integration of climate risks into the decision-support tools used in standard policy and project appraisals. A Strategic Environmental Assessment (SEA) designed to account for climate risk can serve as a tool for mainstreaming adaptation into infrastructure-related policies, plans and programmes.
- **Technical codes and standards** - Regulatory standards, such as technical codes. Technical codes provide concrete quantitative and qualitative criteria and thresholds to be met, depending on the type of investment, sector, and location.

It is noteworthy that climate scenarios play a vital role in informing the strategic and legislative framework. More specifically, correct and detailed climate forecasting data is needed in order to set up effective and tailored path, from the policy perspective, towards climate proofing of infrastructure. More details on this context is given in chapter 4.

[5] https://www.oecd.org/environment/cc/policy-perspectives-climate-resilient-infrastructure.pdf

Status in the European Union (EU)

As a candidate for European Union (EU) membership, the Republic of North Macedonia has committed to transposing the EU legal framework into its national legal system. At the EU level, the umbrella document related to adaptation to climate change is the new **EU Strategy on Adaptation to Climate Change**[6], amending the **EU Strategy on Adaptation to Climate Change** enacted in 2013. The new Strategy was adopted in 2021. It sets out how the European Union can adapt to the unavoidable impacts of climate change and become climate resilient by 2050. There are four principle objectives:

- Make adaptation smarter;
- Make adaptation faster;
- More systematic adaptation;
- Stepping up international action for climate resilience.

The new EU strategy is largely focused on investing in resilient, climate-proof infrastructure. It states that in order to minimise the risk of disasters and be cost-effective over its lifetime, infrastructure investments should be climate resilient. As a first major step, the EC developed extensive climate proofing guidance for new major infrastructure projects called **Technical guidance on the climate proofing of infrastructure in the period 2021-2027.**[7] These guidelines have been updated and will be expanded to other EU funds with special attention to critical infrastructure. More specifically, these guidelines provide comprehensive recommendations on how to integrate the climate vulnerability and risk assessment from the beginning of the project development process, including EIA, because this would generally provide the broadest range of possibilities for selecting the optimal adaptation options. The instructions are covering the following:

- Vulnerability to climate risks in the screening phase;
- Detailed analysis of impacts, likelihood, and climate risks identification;
- Risk assessment;
- Adaptation measures tailored and required against nature and magnitude of identified climate risks
- Specific guidelines on how to embed climate proofing of infrastructure into the national EIA, aligning it with Directive 2011/92/EU on The Environmental Impact Assessment (EIA).

The Commission will continue to update this guidance and extend to existing infrastructure and promote its use beyond EU funding. It will also use external policy instruments to promote their international uptake.

The new EU Strategy also puts an emphasis on the need to update relevant standards and codes. More specifically, the Commission has worked with European Standardisation Organisations to update standards governing the safety and performance of infrastructure in a changing climate. They produced guidance for standard writers and initiated an update of 12 infrastructure standards

[6] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM:2021:82:FIN

[7] https://op.europa.eu/en/publication-detail/-/publication/23a24b21-16d0-11ec-b4fe-01aa75ed71a1/language-en

as a pilot. This action will cover a wider range of standards and help speed up the standardisation of adaptation solutions. The Commission will encourage Member States to involve national standardisation in the implementation of their National Adaptation Strategies, in complementarity with the EU-level standardisation workClimate change adaptation considerations have been included in the preparation and approval process of **European Structural and Investment Funds**.[8] The European Structural and Investment Funds promote eleven Thematic Objectives, of which Thematic Objective 5 is 'Promoting climate change adaptation, risk prevention and management.

In the context of the republic of North Macedonia as being the EU pre-accession country, in 2020 the EC has issued **Guidelines for the Implementation of the Green Agenda for the Western Balkans**.[9] This Staff Working Document (SWD) outlines in more detail the actions related to the Green Agenda for the Western Balkans included in the Communication on an Economic and Investment Plan for the Western Balkans adopted by the European Commission. It further details the five pillars of the Green Agenda: (1) climate action, including decarbonisation, energy and mobility, (2) circular economy, addressing in particular waste, recycling, sustainable production and efficient use of resources, (3) biodiversity, aiming to protect and restore the natural wealth of the region, (4) fighting pollution of air, water and soil and (5) sustainable food systems and rural areas. Main initiatives proposed with this guideline are as follows:

- Facilitate swift alignment with the EU Climate Law
- Assist the partners in the preparation and implementation of long-term climate adaptation strategies to increase resilience, notably through climate-proofing of investments
- Provide technical assistance on Emissions Trading Scheme and alternatives to fossil fuels
- Explore options for early inclusion of the Western Balkans in the EU Emissions Trading Scheme if fully aligned
- Include the region in the European Climate Pact and its activities

The Instrument for Pre-Accession (IPA) III proposal foresees a dedicated window of the programming framework for the implementation of the Green Agenda and sustainable connectivity. According to the draft proposal, IPA beneficiaries will be encouraged to develop energy efficiency and renewable energy sources and to shift to resource-efficient, safe, and sustainable low-carbon economies in line with the wider EU targets for climate action and environmental protection. While IPA funding may be sufficient to kick-start action in key areas, substantial funding form other stakeholders, in particular international financial institutions (IFIs), will be essential. In line with this, it is still not clear how these modalities will be established in the context of supporting climate proofing in EU pre-accession funds.

EU taxonomy - The EU taxonomy represents a new comprehensive classification system for standardising "green" economic activities and is primarily designed for use in the financial sector. The EU taxonomy is defined by Regulation (EU) 2020/852 establishing a framework for facilitating

[8] The European Structural and Investment Funds comprise a family of five funds: the European Regional Development Fund (ERDF) and European Territorial Cooperation goal (ETC, which falls under ERDF); the Cohesion Fund (CF); the European Social Fund (ESF); the European Agricultural Fund for Rural Development (EAFRD); and the European Maritime and Fisheries Fund (EMFF).

[9] https://ec.europa.eu/neighbourhood-enlargement/system/files/2020-10/green_agenda_for_the_western_balkans_en.pdf

sustainable investments and amending Regulation (EU) 2019/2088 (*Sustainable finance taxonomy - Regulation (EU) 2020/852*[10]). Namely, as the main tool for achieving the EU's 2030 climate and energy goals as well as the objectives of the European Green Deal. The EU taxonomy consists of six main environmental objectives. All environmental objectives are simultaneously tested for an investment/measure. Testing shall be carried out using clearly set technical criteria for each of the environmental objectives – one of the environmental objectives is adaptation to climate change. Economic activity is considered to **contribute significantly to adaptation to climate change if this activity**:

- includes adaptation solutions that significantly reduce the risk of adverse effects of the current climate and the expected future climate on that economic activity or significantly reduce this detrimental impact, without increasing the risk of adverse effects on people, nature or property; or[11]
- provides adaptation solutions that contribute significantly to preventing or reducing the risk of adverse effects of the current climate and the expected future climate on humans, nature or property, without increasing the risk of adverse effects on other people, nature or property.
- Adaptation solutions shall be assessed and classified in order of priority using the best climate projections available and shall at least prevent or reduce:
    - the detrimental impact of climate change on an economic activity specific to a specific location and context; or
    - the potential adverse impact of climate change on the environment in which economic activity takes place.

The adverse effects of climate change taken into account include impacts arising from (I) chronic or slow-occurring climate hazards (such as average temperature rise and sea level rise) and (II) rapid or acute climate hazards (such as extreme precipitation, storm surges, floods and heat waves).

1.4 Embedding of climate resilient infrastructure in international climate agreements

UNFCCC foundations for climate resilience

The UNFCCC contains, in Art. 4, a long list of commitments dealing with adaptation imposed on all parties of the convention. More specifically, it foresees that all the parties shall:

- formulate, implement, publish and regularly update national and regional programs containing measures to facilitate adequate adaptations to climate change;
- cooperate in preparing for adaptations to the impacts of climate change; develop and elaborate appropriate and integrated plans for coastal zone management, water resources

[10] https://eur-lex.europa.eu/legal-content/HR/TXT/PDF/?uri=CELEX:32020R0852&from=HR

[11] https://eur-lex.europa.eu/legal-content/HR/TXT/?uri=celex:32020R0852, Article 17 Essential harm to environmental goals

and agriculture, and for the protection and rehabilitation of areas, particularly in Africa, affected by drought and desertification, as well as floods;
- take climate change considerations into account in the relevant social, economic and environmental policies and actions, and employ appropriate methods—for example, impact assessments formulated and determined nationally to minimize adverse effects on the economy, public health and the quality of the environment—or measures to mitigate or adapt to climate change;
- promote, cooperate and exchange the relevant information in scientific, technological, technical, socio-economic and other research, intended to further the understanding and to reduce or eliminate the remaining uncertainties regarding the economic and social consequences of various response strategies;
- promote and cooperate in the education, training and public awareness related to climate change.

Glasgow Climate Pact CP.26

Glasgow Conference of Parties (COP 26) – held in late 2021 resulted in Glasgow Climate Pact. This pact, among other, recognises the importance of climate mainstreaming into national decision making and planning processes. Relevant decisions from the Pact include:

- Urges Parties to further integrate adaptation into local, national and regional planning;
- Emphasizes the urgency of scaling up action and support, including finance, capacity building and technology transfer, to enhance adaptive capacity, strengthen resilience and reduce vulnerability to climate change in line with the best available science, taking into account the priorities and needs of developing country Parties;
- Welcomes the national adaptation plans submitted to date, which enhance the understanding and implementation of adaptation actions and priorities;
- Notes with concern that the current provision of climate finance for adaptation remains insufficient to respond to worsening climate change impacts in developing country Parties;
- Calls upon multilateral development banks, other financial institutions and the private sector to enhance finance mobilization in order to deliver the scale of resources needed to achieve climate plans, particularly for adaptation, and encourages Parties to continue to explore innovative approaches and instruments for mobilizing finance for adaptation from private sources.

2. Analysis of relevant national legal and strategic framework in the context of climate resilience

2.1 Overview of institutional framework and responsible key stakeholders

The following table presents an overview of key stakeholders relevant for climate resilient infrastructure.

Table 2 Key stakeholders relevant for climate resilient infrastructure

Organization	Responsibility
Public institutions	
Ministry of Environment and Physical Planning	The Ministry of Environment and Physical Planning (MoEPP) has been designated as the National Focal Point to the UNFCCC and is the key governmental body responsible for policy making regarding the provisions of the UNFCCC. It is the main coordinating body at national level to coordinate inter-institutional cooperation with regard to the preparation of the National Plans on Climate Change and Action Plans. In accordance with the Law on Environment, additional governmental bodies responsible for the preparation of the National Plans on Climate Change (in addition to the body of state administration responsible for the environment, which is currently the Ministry of Environment and Physical Planning) are the bodies of the state administration responsible for the: affairs of agriculture, forestry and water management; nature protection (currently under the Ministry of Environment); economy; hydrometeorology; transport and communications and health.
Office of the Deputy Prime Minister of the Government of North Macedonia responsible for economic affairs / National Designated Authority (NDA)	The Deputy Prime Minister responsible for Economic Affairs serves as the National Designed Authority (Focal Point) for the Green Climate Fund and is chairing the National Council on Sustainable Development. The Cabinet of the Deputy Prime Minister of the Government of Republic of North Macedonia is responsible for coordination of the economic departments within the Government and development and monitoring of the process of alignment of the national legislation with the EU acquis, strategic guidelines, policies, reforms, structures to be realized by the country to fulfil the requirements for EU membership. In regard to climate action, tasks also comprise the coordination of the National Adaptation Plan and overall implementation of the Agenda 2030, including goal 13 on climate action.
Ministry of Agriculture, Forestry and Water Economy	The Ministry of Agriculture, Forestry and Water Economy is responsible for emissions from agricultural activities and an improvement of Hydro-meliorative systems.

Organization	Responsibility
Ministry of Economy	The Ministry of Economy (MoE) is responsible for the energy sector, among other matters, and as such is closely involved with climate-relevant issues. All energy-related matters concerning climate action require coordination and communication with the MoE, be it policies, strategies and legislation. The MoE competences also cover road transport vehicles and thus the CO2 emissions from vehicles, especially through the Bureau of Metrology. Furthermore, the MoE is also the competent authority for climate related aspects of tourism, including adaptation.
Ministry of Transport and Communications	Competences of the Ministry of Transport and Communication (MoTC) in climate action cover certain fields of effort-sharing (building sector). The Ministry is also responsible for aviation issues. Additional climate-related activities which are under the responsibility of the MoTC are: road traffic, railways, urban planning, construction, land management, housing and communal services and infrastructure and the Captains Port Office in Ohrid (Captaincy, Ohrid).
Energy Agency	The Energy Agency of the Republic of North Macedonia is to support the implementation of the energy policy of the Government of the Republic of North Macedonia by participating in the preparation of energy strategies, development plans and programs, data collection and processing and preparation of reports, encouraging the introduction of measures for energy efficiency and creating conditions for increased use of renewable energy sources for electricity production.
National Hydro Meteorological Service	The Hydro-Meteorological Service (HMS) is a legal entity within the Ministry of Agriculture, Forestry and Water Economy. It is responsible for performing measurements, monitoring and research related to climate-meteorological and hydrological parameters in the country in accordance with the Law on hydrometeorological matters. It also provides early warnings of meteorological and hydrological hazards. The HMS also monitors surface and ground water quantities and qualities. The River Monitoring System project in Macedonia (RIMSYS) supports the authorities of Macedonia in strengthening their capacity to screen long-term changes in the water pollution and the hydrological regimes of the most important rivers of the country.
Chamber of authorized architects and authorized engineers	The Chamber of authorized architects and authorized engineers performs public authorizations determined by the Law on Construction, the Law on Urban Planning and keeps records for them. In order to protect the public interest and the interest of third parties, the Chamber promotes the architectural and engineering activity in accordance with the Constitution, the Law on Construction, the Law on Urban Planning, its statute, the code of professional ethics and other general acts of the chamber.
Crisis Management Center	CMC is a governmental institution and a centre of expertise in civilian crisis management.
Standardisation Institute of the Republic of North Macedonia – ISRSM	The Institute for Standardization of the Republic of North Macedonia (ISRSM) is a national standardization body that represents national interests in international, European, and regional standardization organizations, promotes standardization activities, and through the association of public and private stakeholders, ISRSM prepares and adopts voluntary national standards.

Organization	Responsibility
Public Enterprise on State Roads	The Public Enterprise for State Roads was founded by Government of the Republic of Macedonia for the purpose of performing the planning, construction, reconstruction, rehabilitation, maintenance, protection of the public roads, and managing the state roads. The Public Enterprise is established as a legal entity, acts independently in the legal operations, and is accountable for the undertaken liabilities with its total assets.
Spatial Planning Agency	The Agency for Spatial Planning is in charge of implementing the general planning policies and the overall spatial policy of the Republic of North Macedonia. The Agency, among others, develops a Spatial Plan of the Republic of North Macedonia (hereinafter: Spatial Plan), implements and elaborates in detail the Spatial Plan by preparing Spatial Plans for specific regions, Spatial Plans for areas of special interest and Spatial Plans for the municipalities, for the municipalities of the City of Skopje and the General Plan of the City of Skopje
Other	
International organisations	International organisations such as IFIs, UN agencies, and other often initiates projects, programmes, and investments that support and promote climate resilience within various infrastructure and sectors.
Private sector	Various experts and investors. Critical for the implementation of climate resilience aspects within infrastructure.
Educational institutions	Vital for the implementation and mainstreaming of climate resilience context into curriculums
Experts, engineers, architects	Essential for the implementation of technical solutions, designs, and innovations related to climate resilience.

2.2 Overview of national relevant legal and strategic framework with an analysis of climate resilient infrastructure context

2.2.1 Climate change and environment - horizontal and cross-cutting legal and strategic framework

In accordance with the Law on ratification of the UNFCCC[12] and the Law on Environment[13], the Ministry of Environment and Physical Planning (MoEPP) it is the National Focal Point to the UNFCCC and is the key governmental body responsible for policy making regarding the provisions of the UNFCCC. It is the main coordinating body at national level to coordinate inter-institutional

[12] Law on ratification of the UNFCCC, OG of the RM no. 61/97.

[13] Law on Environment, OG of the RM no. 53/05, 81/05, 24/07, 159/08, 83/09, 48/10, 124/10, 51/11, 123/12, 93/13, 187/13, 42/14, 44/15, 129/15, 192/15, 39/16, 28/18, 65/18 and 99/18.

cooperation with regard to the preparation of the National Plans on Climate Change and Action Plans.

In April 2021, Macedonian Government has submitted its enhanced NDC (ENDC) significantly increasing the ambition to reduce GHG emissions. In line with the increased ambition, the ENDC includes social aspects such as the impact of the proposed mitigation measures for creation of green jobs, adopting a gender-responsive approach, and enhanced engagement of the youth. Additionally, the ENDC highlights the vital role of the private sector in the mitigation actions and the contribution to the regional development of the Republic of North Macedonia.

The enhanced NDC is focused on mitigation area, with a vision to include adaptation component in the subsequent submissions, once the relevant national strategic and planning documents are prepared and adopted. Therefore, the ENDC does not specifically defines area of implementing adaptation, including infrastructure. However, it clearly specifies an objective of the development of the National Adaptation Plan (NAP). The NAP will incorporate cross-sectorial and sector-specific adaptation actions and measures, along with identified adaptation investment priorities based on the review of national and sectorial development policies and plans, and the outcomes of an extensive consultation process, including stakeholders from all sectors and levels of governance, climate-related institutions and agencies, along with private sector, civil society, academia and women associations and youth NGOs representatives. The NAP development is planned to be done through the Green Climate Fund (GCF) Readiness Programme.[14] During the preparation of this study, a number of key stakeholders were contacted to obtain inputs and comments on the context of this study, including the GCF's National Designated Authority Cabinet of the Deputy President of the Government in Charge for Economic Affairs and Coordination of Economic Sectors who clearly specified the willingness and plan to include climate resilient infrastructure as one of focus areas of the NAP.

Climate Action

Recently, the Republic of North Macedonia conducted a number of key activities related to strengthening of national legal and strategic framework for climate change. Currently there is no separate **Law on Climate Action**. Climate Change issues are treated under the Chapter on global issues within the Law on Environment (Articles 187-190). The preparation of the new Law on Climate Action (or LCA) started in February 2019, supported by the EU. Draft Law on Climate Action and first Long-term Strategy on Climate Action are in the final phase of Assembly adoption. The new Law on Climate Action will, once adopted, act as an overarching climate change related legislation tool.

The Draft Law will regulate the framework for climate action in the RNM (Republic of North Macedonia). When enacted, the Law will serve as an umbrella law for all climate mitigation and adaption considerations in the country. More specifically, the Draft Law covers both climate mitigation and adaptation aspects. The Law's objective, among others, specify: "*to contribute to climate change mitigation and adaptation to their adverse effects; prescribe rules to ensure that climate change mitigation and adaptation to their adverse effects are taken into account and aligned with sectoral policies, plans and administrative practices; establishing monitoring and reporting mechanisms, necessary for timely, transparent, accurate, consistent, comparable and complete reporting and verification of information on specified anthropogenic greenhouse gas*

[14] https://www.greenclimate.fund/readiness

emissions by source and sinkhole removal, and on climate change adaptation actions. In line with the monitoring the Law states that every fourth year an Adaptation Action Report will be developed by the body responsible for the implementation of this Draft Law.

As un umbrella law, The Draft Law does not specifically refer to types of climate adaptation measures to be specifically supported. However, it poses a strong legal foundation for the implementation of all types of adaptation measures required to meet national climate adaptation needs.

While the adoption of the Draft Climate Action Law is still pending, **the Long-term Strategy on Climate Action and Action Plan** were adopted in 2021. The Long-term Strategy defines specific objectives disaggregated towards climate mitigation and adaptation. Climate adaptation specific objectives are as follows:

- Specific objective 5: To build solid systems for the regular and periodic collection data for the production and dissemination of scientific and technical knowledge.
- Specific objective 6: To increase the resilience of climate change impacts of key socio-economic sectors and ecosystems.

The adaptation measures contained in this Strategy are limited and mainly aimed at addressing the key barriers and gaps identified in the Third National Communication to the UNFCCC. As already stated above, the preparation and adoption of the National Adaptation Plan is an important step for Republic of North Macedonia to identify adaptation needs and to develop and implement policies and measures and actions to address those needs; and enable actions to protect vulnerable communities. Additionally, the Long-term strategy emphasizes the need for climate mainstreaming in EIA and SEA by following latest updates and recommendations from the EU level and based upon EU EIA and SEA directives. The Long-term strategy specifically includes infrastructure as one of the key areas covered by the EIA and SEA recommendations provided within the Long-term strategy.

The country has also prepared an **Action Plan for the 1st Stage of Implementation of the Strategy and Law (Action Plan)**. The Action Plan covers the period 2021-2030, contains all the measures envisaged in this Long-term Strategy on Climate Action (Strategy), plus measures for administrative and legal strengthening. Each measure envisages a period of implementation, indicators, budget, implementation powers and stakeholders. Under this Action Plan, NAP development under the GCF Readiness Programme is listed as an adaptation measure related to Objective 6 of the Long-term strategy.

Law on Environment

Currently the Law on Environment covers climate change aspects in North Macedonia. Accordance with the Law on Environment, additional governmental bodies responsible for the preparation of the National Plans on Climate Change are the bodies of the state administration responsible for the:

- Affairs of agriculture, forestry and water management and hydrometeorology (Ministry of Agriculture Forestry and Water Economy-MAFWE);
- Nature protection (currently under the Ministry of Environment);
- Economy (Ministry of Economy-MoE);
- Transport and communications (Ministry of Transport and Water Management) and health (Ministry of Health-MoH).

The Law on Environment prescribes the adoption of a National Plan on Climate Change, an Action Plan for prevention of the causes and mitigation of the negative effects of climate change as well as a National Inventory of anthropogenic greenhouse gas emissions by sources and sinks (hereinafter: National Inventory). A separate inventory report will be adopted with the adoption of a new Law on Climate Action.

A complete analysis and overview of the climate/environmental legislative and strategic framework is presented in the following sub-chapter 2.1.2.

The following sub-chapters presents the summarisation of relevant legislation and strategic pieces in accordance to relevance for the implementation/enabling potential of including climate resilient infrastructure aspects. The tables are consistent of the following:

- **Item -** name of legislation/strategic document;
- **Description (including standards as relevant)** - short description of the document emphasising this study's context;
- **Relevance to increasing climate resilience of national infrastructure** - what is the relevance and linkage of a given document to the climate resilient infrastructure context. In other words, what is nature and extent to which mainstreaming of climate resilience infrastructure aspects can be included
- **The level of climate resilience consideration inclusion/enabling potential - infrastructure wise -** describes the level to which adaptation aspects are currently included in the given legislation piece. Also, describes the level to which climate adaptation is covered in general. For example, inclusion of climate mitigation and adaptation objectives in the Draft Climate Action Law enables regulation of climate resilient infrastructure in other laws and bi-laws. The level is marked as follows:
    - LOW – Not considered at all.
    - MEDIUM – Some inclusion, vaguely considered, not defined.
    - HIGH – High level of inclusion, a law or strategy is regulating climate proofing of infrastructure. High level of enabling potential.

2.2.2 Complete overview - climate change and environment – horizontal and cross-cutting legal and strategic framework

Table 3 Climate change and environment – horizontal and cross-cutting legal and strategic framework

Item	Description (including standards as relevant)	Relevance to increasing climate resilience of national infrastructure	The level of climate resilience consideration inclusion/enabling potential - infrastructure wise	
Primary legislation			Level	Description
Draft Law on Climate Action (or LCA) - (not enacted – in drafting process)	The Draft Law will regulate the framework for climate action in the RNM (Republic of North Macedonia). When enacted, the Law will serve as an umbrella law for all climate mitigation and adaption considerations in the country. The climate adaptation and cross cutting objectives of the Law are (according to Article 4 of the current draft): • To contribute to the mitigation of climate change and to the adaptation to its adverse effects; • To establish the policy, planning and administrative framework necessary to mitigate and adapt to climate change in a cost-effective manner; • To provide for the rules to ensure that mitigation of	One of the purposes of this Law is to strengthen the administrative capacity in line with EU accession in achieving low carbon competitive economy and climate resilient economy. This Law shall apply to the preparation and adoption of the basic planning documents for climate action in the Republic of North Macedonia. Those will include: 1) The Long-term Strategy on Climate Action of the Republic of North Macedonia (hereinafter: Strategy); and 2) The Action plan for the implementation of the Strategy. The LCA is expected to set a profound change in the climate capacities of the country, as well as to enhance cross-sectoral policy coordination and climate mainstreaming in the country.	MEDIUM	In the process of drafting, the LCA will need implementation through secondary legislation and through sectoral legislation and related by-laws. There are no clear references on infrastructure in the resilience context. However, this is expected as climate action is cross-sectoral and, thus, builds upon climate-specific and sectoral legislation at the same time. (Establishment of functional National Council on Climate Change (NCCC) • Adoption of the Long-term Strategy on Climate Action - adopted • Adoption of Action Plan to implement the Strategy - adopted • Adoption of secondary legislation – in progress.

Item	Description (including standards as relevant)	Relevance to increasing climate resilience of national infrastructure	The level of climate resilience consideration inclusion/enabling potential - infrastructure wise	
	climate change and adaptation to its adverse effects are taken into account and are complied with in sectoral policies, plans and administrative practices; • To establish the monitoring and reporting mechanisms necessary for timely, transparent, accurate, consistent, comparable, and complete reporting and verification of information on specified anthropogenic greenhouse gas emissions by sources and removals by sinks, and on climate change adaptation actions.			
Law on Environment (2005) (Official Gazette of the RM no. 53/05, 81/05, 24/07, 159/08, 83/09, 48/10, 124/10, 51/11, 123/12, 93/13, 187/13, 42/14, 44/15, 129/15, 192/15, 39/16)	The Law on Environment is the basis for environmental policy and management, thus providing guiding principles and policy instruments also. This Law contains the fundamental environmental protection principles, which are basis for determination of the procedures for environment management and which are common for all laws regulating particular environmental media.	The Law on Environment is the basis for environmental policy and management. It is a foundation upon which secondary legislation, critical for inclusion of climate proofing infrastructural aspects, is based.	HIGH	Climate adaptation aspects will be taken over and covered by the Law on Climate Action, once it gets approved. However, there are number of secondary legislation, most notably those related to EIA, that would be key tool in mainstreaming climate adaptation considerations in national infrastructural development. This Law, therefore, has a vital role in this process.

Item	Description (including standards as relevant)	Relevance to increasing climate resilience of national infrastructure	The level of climate resilience consideration inclusion/enabling potential - infrastructure wise	
Law on Ratification of the United Nations Framework Convention on Climate Change (Official Gazette of the Republic of Macedonia No. 61/97)	Laws by which the Republic of North Macedonia ratified the Kyoto Protocol and the UNFCCC, Doha Amendment to the Kyoto Protocol, Kigali Amendment to the Montreal Protocol on Substances that Deplete the Ozone Layer, and the Paris Agreement	N/A	N/A	N/A
Law on Ratification of the Kyoto Protocol to the United Nations Framework Convention on Climate Change (Official Gazette of the Republic of Macedonia No. 49/2004)				
Law on Ratification of the Paris Agreement (Official Gazette of the Republic of Macedonia No. 161/2017)				
Law on Ratification of the Doha Amendment to the Kyoto Protocol to the United Nations Framework Convention on Climate Change (Official Gazette of the Republic of Macedonia No. 152/2019 dated 25.07.2019)				
Law on Ratification of the Kigali Amendment to the Montreal Protocol on Substances that Deplete the Ozone Layer (Official Gazette of RSM No. 34/2020)				
Secondary legislation				
Rulebook on the information of: announcement for informing the public about the intention to implement a project; the	This by-law, amending the Law on Environment (2005) defines the guidelines and consideration for conducting	In case this is prescribed within the rulebook, Environmental Impact Assessments are usually one of main tools for conducting climate	LOW	Currently these by-laws do not regulate and provide guidance on inclusion of climate vulnerability assessment,

Item	Description (including standards as relevant)	Relevance to increasing climate resilience of national infrastructure	The level of climate resilience consideration inclusion/enabling potential - infrastructure wise	
decision on the need for EIA for the project ("Official Gazette of the Republic of Macedonia" no. 33/06) (Article 90 paragraph 4 of the Law on Environment)	Environmental Impact Assessment. This Bylaw prescribe the content of: announcement for informing the public about the intention to implement a project; the decision on the need for EIA for the project, the EIA Study for the project, the Report for EIA adequacy.	vulnerability and risk assessments of a given investment on a given location.		associated risk assessment, and need for identification of climate adaptation measures.
Rulebook on the contents of the requirements that the EIA Study for the project should fulfil ("Official Gazette of the Republic of Macedonia" no. 33/06) (Article 84 of the Law on Environment).	Bylaw that refers to the contents of the requirements that the EIA Study should fulfil.			
Rulebook on the content of the requirements to be met by the study for assessment of the impact of the project on the environment ("Official Gazette of RM" no. 33/06 from 20.03.2006) (Article 80 paragraph 5 of the Law on Environment)	Bylaw determines that any legal and natural person that intends to implement a project -an investor is obligate to submit to MoEPP a notice of intention for project implementation, as well as an opinion on the need for EIA of the project (notification). Notification must contain the following data: Information for the investor, Project characteristics, Project location, Characteristic of possible impact on the environment, Additional information.			

Item	Description (including standards as relevant)	Relevance to increasing climate resilience of national infrastructure	The level of climate resilience consideration inclusion/enabling potential - infrastructure wise	
Rulebook on the form, content of the procedure and the manner of preparation of the report on the adequacy of EIA study of the project, as well as procedure for authorization of the persons from the list of experts for EIA who will prepare the report ("Official Gazette of RM" no. 33/06 from 20.03.2006) (Article 86 paragraphs 11 and 12 of the Law on Environment)	This Bylaw prescribe the form, content, procedure and manner of preparation the report on the adequacy of EIA study of the project and prescribes the procedure for authorization of the persons from the List of experts for EIA who will prepare the report.			
Decree on determining the projects and the criteria on the basis of which the need for conducting an environmental impact assessment is required ("Official Gazette of the Republic of Macedonia" no. 74/05, 109/09, 164/12 and 202/16) (Article 77 of the Law on Environment)	Bylaw that specify projects which are subject to a mandatory requirement for an environmental impact assessment procedure and define the criteria on the basis of which a need is identified for an environmental impact assessment of other projects specified in general terms which may have a significant impact on the environment, as well as define the criteria on the basis of which a need is identified for an environmental impact assessment in case of changes appearing on existing projects.			
Decree on the criteria on the basis of which decisions are made whether certain planning documents could have a	Bylaw that set out the criteria based on which it shall be determined whether a given planning document is likely to	SEA is a key element of mainstreaming adaptation into infrastructure is the integration of climate risks into the decision-	LOW	

Item	Description (including standards as relevant)	Relevance to increasing climate resilience of national infrastructure	The level of climate resilience consideration inclusion/enabling potential - infrastructure wise	
significant impact on the environment and human health ("Official Gazette of RM" no. 144/07 of 30.11.2007) (Article 65 paragraph 4 of the Law on Environment)	have a significant impact on the environment and on human health.	support tools used in standard policy and project appraisals. A Strategic Environmental Assessment (SEA) designed to account for climate risk can serve as a tool for mainstreaming adaptation into infrastructure-related policies, plans and programmes.		
Decree on the content of the report on the strategic environmental assessment ("Official Gazette of RM" no. 153/07 of 20.12.2007)	Bylaw that set out the criteria based on which it shall be determined whether a given planning document is likely to have a significant impact on the environment and on human health.			
Strategic documents				
Long-Term Strategy on Climate Action	The general objective of the Strategy related to climate adaptation is: Reduction of national net GHG emissions (including Forestry and Other Land Use and excluding MEMO items) of 72% by 2050 compared to 1990 levels (or GHG emission reduction of 42% by 2050 compared to 1990, excluding FOLU and MEMO items) and increased resilience of North Macedonia's society, economy	The Strategy is a Roadmap for achieving long-term objectives concerning climate action where three main objectives of climate action have been set: full transposition and implementation of the EU climate acquis; achieving low-carbon economy; achieving climate "resilient" society. The Strategy covers both mitigation, adaptation, and cross-cutting national approach towards climate change. In terms of adaptation/increasing resilience to climate change, the Strategy is aiming at introducing measures	HIGH	The Strategy, among others, have an objective of mainstreaming the climate resilience aspects into relevant sectors covered by this study. It does refer to green infrastructure and needs for the implementation and consideration of climate risks in EIA and SEA, and other planning and designing processes.

Item	Description (including standards as relevant)	Relevance to increasing climate resilience of national infrastructure	The level of climate resilience consideration inclusion/enabling potential - infrastructure wise	
	and ecosystems to the impacts of climate change. To support compliance with the general objective and with the implementation of sectoral measures, the general objective of the Strategy is disaggregated into 10 specific mitigation, adaptation and crosscutting objectives. Specific climate adaptation related objectives are: 6: To build solid systems for the regular and periodic collection data for the production and dissemination of scientific and technical knowledge. 7: To increase the resilience of climate change impacts of key socio-economic sectors and ecosystems. 8: To establish comprehensive policy planning, coordination and policy implementation instruments for climate action. 9: Mainstream climate change related aspects into the future national strategic planning	related to increasing capacity and knowledge pool. However, it puts an emphasis on mainstreaming climate consideration in EIA and SEA and importance of calculating climate risks.		

Item	Description (including standards as relevant)	Relevance to increasing climate resilience of national infrastructure	The level of climate resilience consideration inclusion/enabling potential - infrastructure wise	
	documents related to education, research, and development, innovation, social inclusion and equal opportunities on women and men. 10: To promote the green transition through capacity building, training for new skills and awareness rising.			
Action Plan for the 1st Phase of Implementation of the Long term Strategy and the Law.	Draft Action Plan on implementation of the initial phase of Strategy and Law (the "first stage" or phase of implementation of the Strategy and Law have been defined as the period 2021-2030) focuses on: (1) the identification of actions to be carried in a first phase of implementation of the Strategy, (2) Drafting the Action Plan and (3) The elaboration of concept notes for proposals to attract international climate finance for the implementation of specific actions identified in the Action Plan.	This Action Plan contains specific climate actions identified in the Strategy and Law on Climate Action, prescribes responsible institutions, relevant legal framework (international and domestic), time frames and an estimation of the resources necessary for their implementation. The Action Plan in a systematic approach, divide each action in sub-activities that contribute to the achievement of the main action. The Action Plan also provides a framework to monitor and evaluate its implementation.	MEDIUM	In terms of climate resilience, and especially related to infrastructure, the most relevant measure could be the preparation of the NAP under the GCF readiness programme.

Item	Description (including standards as relevant)	Relevance to increasing climate resilience of national infrastructure	The level of climate resilience consideration inclusion/enabling potential - infrastructure wise	
	The actions contained in the Action Plan are segregated as follows: a) 63 actions that support the implementation of the mitigation objectives of the Strategy, b) Actions that support the implementation of the adaptation objectives of the Strategy such as: actions that support the cross-sectoral coordination objectives of the Strategy (to build solid systems for the regular and periodic collection data for the production and dissemination of scientific and technical knowledge; to increase the resilience of climate change impacts of key socio-economic sectors and ecosystems); and c) Actions that support the implementation of the legal framework for climate action and the strengthening of institutional capacity (to promote the green transition through capacity building, training for new skills and awareness rising, enabling climate mitigation through			

Item	Description (including standards as relevant)	Relevance to increasing climate resilience of national infrastructure	The level of climate resilience consideration inclusion/enabling potential - infrastructure wise	
	circular economy policies and legislation in the waste sector, strengthening capacity for monitoring socio-economic vulnerability to climate change)			
Enhanced Nationally Determined Contribution (Enhanced NDC submitted in 2021)	The North Macedonian government with Enhanced NDC has increased its ambition to 'reduce GHG emissions in 2030 by 51% compared to 1990 levels, resulting in an 82% reduction of net emissions in 2030 compared to 1990 levels'. The main components of NDC enhancement are realized in the areas: Mitigation ambition, Implementation and Communication.	The enhanced NDC is focused on mitigation area, with a vision to include adaptation component in the subsequent submissions, once the relevant national strategic and planning documents are prepared and adopted.	MEDIUM	No referral to a specific adaptation objectives
NDC Implementation Roadmap for North Macedonia 2020-2030	The Roadmap provides a snapshot of the ambitious targets of the ENDC, an overview of the mitigation measures in the key sectors – energy, AFOLU and waste – highlighting the targets and the financial strategy for their implementation. The Roadmap also outlines the governance structure needed for the implementation of the ENDC, the implementation strategy and the Financial strategy.	No adaptation measures	LOW	No adaptation measures

2.2.3 Spatial planning - legal and strategic framework

The spatial planning process in Macedonia is governed by the Ministry of Environmental Protection and Physical Planning (Department of Spatial Planning) and the Agency for Physical Planning. Spatial planning in the Republic Macedonia is centralized and the umbrella plan is the Spatial Plan of the Republic of Macedonia, adopted by the Assembly of the Republic of Macedonia in accordance with hierarchically lower documents for spatial planning (ie regional spatial plans and spatial plans of areas of special interest to the Republic). Municipalities can set their own priorities in local plans, but must ensure vertical alignment with the objectives of the Spatial Plan of the Republic of Macedonia.

Currently there are three main legal instruments in North Macedonia related to Spatial Planning:

- **Law on Spatial and Urban Planning Official Gazette No. 51/2005, 55/13, 163/13, 42/14 -** This law regulates the conditions and the manner of the system of spatial and urban planning, the types and content of the plans, the preparation and the procedure for adoption of the plans, the implementation of the plans and the monitoring of the realization of the plans, the supervision and other issues in the field of spatial and urban planning. planning. The current, active, version of this Law does not take into account climate risks.
- **Law on Implementation of the Spatial Plan of the Republic of Macedonia Official Gazette of RM no. 39/04** -This law regulates the conditions, manners and dynamics of the implementation of the Spatial Plan of the Republic of North Macedonia the rights and responsibilities of entities in the implementation of the Spatial Plan, financing and overseeing the implementation of the Spatial Plan.
- **Law on Urban Planning Official Gazette of the RNM no. 32/2020** - This law deals with hierarchy, preparation, adoption and implementation of urban plans, i.e. primarily processes and procedures, and does not address climate change.

The Law on Spatial and Urban Planning, as well as the planning practice, does not currently address the issue of climate change, at least not directly. For example, climate adaptation is not explicitly mentioned as one of the principles of spatial planning, although protection against natural disasters could be considered in part as a substitute for climate adaptation.

Furthermore, in the North Macedonia there is no obligation to develop climate change adaptation or resilience (as well as mitigation) plans at the local level. However, there are cases of local level climate change strategies or plans that were developed voluntarily. For example, the City of Skopje has developed studies that could serve as a basis for mitigating the risks of floods or industrial accidents, the cadastre of green infrastructure, and most importantly the Resilient Skopje – Climate Change Strategy. In spite of that, it still remains open how will identified measures from these documents be embedded into spatial and urban plans (Spatial Plan, General Urban Plan, Detailed Urban Plans) of the city.

At the same time, a methodology for integrating climate change into spatial planning and GIS tools was developed. Climate change adaptation measures are expected to be integrated into the new national spatial plan with the help of this methodology and tools.

The analysis of these legislation pieces is covered under sub-chapter 2.2.7.

2.2.4 Transport sector

Table 4 Transport sector legal and strategic framework analysis

Item	Description (including standards as relevant)	Relevance to the assignment	The level of climate resilience consideration inclusion – infrastructure wise	
Primary legislation			Level	Description
Law on Vehicles (2016) (Official Gazette of the RM no. 140/08, 53/11, 123/12, 70/13, 164/13, 138/14, 154/15, 192/15, 39/16)	The purpose of this law is to ensure a high degree of safety of road traffic and in the performance of agricultural and forestry works, protection of life and health, protection of the environment and nature and energy efficiency.	The Law that regulates aspects of sustainable transport and potentially smart mobility.	LOW	There are no climate resilience related aspects covered by this law.
Law on Motor Vehicle Tax (2019) (Official Gazette of the RNM no. 261/2019)	The aim of this law is to regulate the system of taxation on motor vehicles in North Macedonia and the competencies of the customs authority in relation to this tax.	The aim of this law is to regulate the system of taxation on motor vehicles in North Macedonia and the competencies of the customs authority in relation to this tax.	LOW	The impact of this law on mitigation is very significant, while the resilience potential is negligible.
Strategic documents				
National Transport Strategy 2018-2030	The Government of the Republic of Macedonia is committed to transpose EU Guidelines and Directives/Regulations (the EU acquis) with the aim of integrating within the European Union and becoming a full member of the European Union. The National Transport Strategy (NTS) demonstrates this ambition through the	The National Transport Strategy covers climate change considerations within the sector.	HIGH	• Regulatory measure (RM) 5, 1.3. Modify national transport infrastructure standards regarding the environmental sustainability and climate change included. • Strategic action OSM 19 3.1. Preparing a comprehensive study for quantifying impacts of climate change, climate variability and extreme weather events on

Item	Description (including standards as relevant)	Relevance to the assignment	The level of climate resilience consideration inclusion – infrastructure wise	
	development of a sustainable transport sector that is harmonized with other strategic developments of the country; that disposes of an intermodal infrastructure fully integrated into the European TEN-T network; that is governed according to the principles of good governance respecting the universal right of "mobility" for all; and that is properly regulated in accordance with EU rules and regulations while incorporating international best practices for its further development.			infrastructure and services (network resilience)

2.2.5 Energy infrastructure

Table 5 Energy infrastructure related legal and strategic framework analysis

Item	Description (including standards as relevant)	Relevance to the assignment	The level of climate resilience consideration inclusion – infrastructure wise	
Primary legislation			Level	Description
Energy Law (2018) (Official Gazette of the RM no. 96, 28.5.2018, 96/2019)	This Law regulate: the objectives and the manner of implementing the energy policy; the construction of energy facilities; the status and competence of the Energy and Water Supply	The Energy Law regulates the construction of energy infrastructure.	LOW	Objective 8. - protection of the environment and mitigation of climate change from the

Item	Description (including standards as relevant)	Relevance to the assignment	The level of climate resilience consideration inclusion – infrastructure wise	
	Regulatory Commission of the RNM; electricity, natural gas, heat energy markets, as well as the crude oil, oil derivatives and transport fuels market; the manner and procedure for determining and fulfilling the obligations for providing a public service on the electricity, natural gas and heat energy markets, as well as the rights and obligations of the energy consumers and the users of the energy systems; the manner and conditions for encouraging the use of renewable energy sources.			negative impacts in the performance of energy activities. There are no explicit considerations of building climate resilience of energy infrastructure noted.
Law on energy efficiency (RES Directive 2009/28/EC Energy efficiency directive 2010/31/EC, Regulation 714/2009)	This Law regulates: the efficient use of the energy; the energy efficiency policy; the competences of the competent Ministry for energy matters and the Energy Agency for the implementation of this Law; the obligations of the public sector regarding the energy efficiency and the energy consumption; the energy efficiency obligation scheme and the alternative measures; the energy audits of the large enterprises; the energy efficiency in generation, transmission, distribution and supply; the provision of energy services and the manners for financing the supporting measures for energy efficiency; the energy efficiency of buildings; and the energy labelling and eco-design for energy-related products.	Relevant in terms of climate adaptation considerations within the Law	LOW	The Law states the following - Construction of large and small hydro power plants by taking into account environmental and social impacts.
Secondary legislation				
Rulebook on Renewable Energy Sources (2019) (Official Gazette of	This Rulebook prescribes in more detail: 1) types of power plants for production of electricity from renewable energy sources, 2) the conditions and the manner in which the surplus of the produced energy from renewable	The decree covers definitions of the renewable energy generation facilities	LOW	The decree only mentions climate change consideration in a very general way.

Item	Description (including standards as relevant)	Relevance to the assignment	The level of climate resilience consideration inclusion – infrastructure wise	
the RNM no. 112, 3.6.2019)	sources of energy intended for own consumption is transferred to the electricity distribution network, 3) the manner of issuing an approval for measuring the wind potential for electricity generation, 4) the method of measuring the wind potential for electricity production energy, 5) the manner of issuing, transferring and revoking the guarantees of origin and their content, 6) the manner, procedure and conditions for recognition of guarantees of origin issued in other countries, 7) the content, the form and the manner of keeping the register of power plants which produce electricity from renewable energy sources, and 8) the content, the form and the manner of keeping the register of guarantees of origin.			
Strategic documents				
The Strategy for Energy Development of the Republic of North Macedonia until 2040	The Strategy for Energy Development of the Republic of North Macedonia until 2040 (the Strategy) is prepared according to the requirements of the new Energy Law, which was adopted end of May 2018. Overarching goal of the Strategy is to provide an evidence-based policy in the energy sector through a robust analytical work and broad participatory consultation, which supports sustainable	Relevant in terms of climate adaptation considerations within the Strategy.	LOW	No climate resilience considerations are part of the Strategy.

Item	Description (including standards as relevant)	Relevance to the assignment	The level of climate resilience consideration inclusion – infrastructure wise	
	growth and is understood by all stakeholders and implemented by the Government of the Republic of North Macedonia.			
Strategy for utilization of renewable energy sources in the Republic of Macedonia by 2020	The national renewable energy strategy.	Though the period of the Strategy expired it is still relevant in terms of potentially undertaken climate resilient	MEDIUM	The Strategy states Monitor and assess the climate change vulnerability (particularly health impacts) and undertake appropriate adaptation measures.
Other				
Development plan of ESM AD (JSC Macedonian Power Plants) (2018-2022) (Article 94 of the Energy Law (Official Gazette no. 96/18, 96/2019)	ESM AD Development and Investment Plan is for the period 2018 – 2022. Defines the medium-term development and projects of the company, so that it can respond appropriately on market conditions, taking into consideration the upcoming liberalization of the electricity market (liberalization finished at 1 January 2019). The goals of AD ESM in the period 2018 - 2022 were the following: • self-sustainability in market conditions, • increased profitability, • participation in the regional electricity markets and • increase the installed capacity from renewable sources. In order to achieve the goals, AD ESM was planning to take following activities: • Increased production from renewable energy sources;	Planned Projects are relevant in terms of potentially undertaken climate resilient. The greatest risks for a successful realization of the listed principles and planned activities of all electricity distribution system operators (EVN, ESM, BEG) and Transmission System Operator (MEPSO) are the uncertain flows in the economy, constraints upon physical and regional planning and ecological demands, insecurities regarding the construction of new generation facilities, and uncertainties in the stable financing of all necessary activities. All these entities ought to prepare a study or environmental impact assessment with detailed analysis for all	LOW	The Plans mention positive climate impact that some projects will have in a very general way.

Item	Description (including standards as relevant)	Relevance to the assignment	The level of climate resilience consideration inclusion – infrastructure wise	
	• Maintenance, revitalization and modernization of existing facilities as well as construction new for the production of electricity and heat; • Use of domestic resources (lignite reserves) for production of electric energy; • Energy efficiency that is achieved by taking a series of optimization measures costs in order to increase production, • Increase the use of natural gas.	infrastructural projects as per the Law on Construction.		
Development plan of EVN Macedonia, AD (2021-2025) (Article 94 of the Energy Law (Official Gazette no. 96/18, 96/2019)	According Article 94 of the Energy Law, EVN Macedonia, as others electricity distribution system operators (such as BEG and ESM) is responsible for the long-term development planning of the electricity distribution system in the area where it performs its activity.			
Development plan of Balkan Energy Group (BEG)	Balkan Energy Group is planning to develop the heat distribution system in the next 5 years.			

2.2.6 Water sector

Table 6 Water sector legal and strategic framework analysis

Item	Description (including standards as relevant)	Relevance to the assignment	The level of climate resilience consideration inclusion - infrastructure wise	
Primary legislation			**Level**	**Description**
Law on waters ("Official Gazette of the Republic of Macedonia" No. 87/08, 6/09, 161/09, 83/10, 51/11, 44/12, 23/13, 163/13, 180/14, 146/15, 52/16, 151/21)	This law regulates issues related to: surface waters, permanent or temporary watercourses, lakes, reservoirs, springs, groundwater, coastal land, water habitats and their management, including water distribution, protection and conservation of water, as well as protection against the harmful effects of water; water management facilities and services; organizational structure and financing of water management; conditions, manner and procedures under which water can be used or discharged.	Climate change is contributing to the increased likelihood and negative impacts of floods on infrastructure, as well as droughts on hydropower capacity. The law treats water and energy facilities.	MEDIUM	This law defines measures for protection against floods, erosion and regulation of torrents, water monitoring, river basin management, sets the basis for technical standards for construction, management and maintenance of water management facilities and plants, including water supply, electricity, dams, accumulations, etc. There is no explicit mention of infrastructure in terms of climate change.
Law on crisis management ("Official Gazette of the Republic of Macedonia" No. 29/05, 36/11, 41/14, 104/15, 39/16, 83/18)	This law regulates the crisis management system: organization and functioning, decision-making and use of resources, communication, coordination and cooperation, assessment of threats to the security, planning and financing.	This law is applicable, but does not link activities directly to climate change.	LOW	The crisis management system deals with the prevention, early warning and management of crises that pose a risk to the well-being, health and life of humans and animals, and are caused by natural disasters and epidemics or other risks. There is no explicit mention of climate change or infrastructure.
Law on hydro-meteorological activities ("Official	This law regulates the bases of the functioning of	This law establishes a unified system of meteorological and hydrological observation and	MEDIUM	Although the terms “climate change” or “infrastructure” are not mentioned, the law defines the

Item	Description (including standards as relevant)	Relevance to the assignment	The level of climate resilience consideration inclusion - infrastructure wise	
Gazette of the Republic of Macedonia" No. 103/08)	hydrometeorological activity in North Macedonia	establishes obligations for warning and notification of extreme weather conditions.		competencies of the Directorate for Hydrometeorological Affairs in case of emergency, dangerous and catastrophic unfavourable weather and hydrological situations.
Law on local self-government ("Official Gazette of the Republic of Macedonia" No. 05/02)	This law regulates the competencies of the municipality; direct participation of citizens in decision-making; organization and affairs of municipal bodies, acts of municipal bodies; property - subsistence in the municipality; supervision over the affairs of municipal bodies; mechanisms of cooperation between the municipality and government, protection of local self-government, establishment of official languages, etc.	The Law on Local Self-Government, which, among other things, regulates the competencies of municipalities responsible for implementing, preparing and undertaking protection and rescue of citizens and goods from war destruction, natural and other disasters, as well as from the consequences they caused.	MEDIUM	Part related to the activities of local self-government in case of natural disasters is very much related to infrastructure, district heating (where it exists), transport, water supply and the built environment. This law does not explicitly mention climate change or infrastructure, so it could be updated.
Law on water economy ("Official Gazette of the Republic of Macedonia" No. 51/15)	This law regulates the operation, use, operation and maintenance of hydro systems, irrigation systems and drainage systems. The purposes of this law are: ensuring economical management; use, operation and maintenance of hydro systems, irrigation systems and drainage systems; defining the scope of services provided to water users by the water operator; establishment of conditions for normal and successful operation of the performer of the water economy activity and use of its services by the water users, and establishment of a state-owned joint stock company Water Economy of the Republic of Macedonia.	The law defines that the subject of work of a water management company is to maintain and manage irrigation and drainage systems in general, for the purpose of water supply for irrigation, water supply of utility companies for water use for human use, water supply for industrial and technological needs, including electricity production, drainage, drainage land and drainage of drained water.	MEDIUM	It is defined that the water management company builds and maintains facilities for protection and defence against floods, for prevention and protection against erosion, for arranging rivers and torrents, etc. The company adopts acts on the manner of work in case of drought and similar situations that prevent regular work. Although climate change is not directly mentioned, some action is planned in case of extreme weather events.

Item	Description (including standards as relevant)	Relevance to the assignment	The level of climate resilience consideration inclusion - infrastructure wise	
Law on urban planning ("Official Gazette of the Republic of Macedonia" No. 32/20)	This law regulates the system, goals and principles of spatial and urban planning, the content of urban plans, conditions for performing urban activities, procedures for preparation, adoption and implementation of urban plans, supervision of law enforcement, etc.	Urban planning in general should be very much related to climate change.	LOW	This law deals with hierarchy, preparation, adoption and implementation of urban plans, i.e. primarily processes and procedures, and does not address climate change.
Law on Protection and Rescue ("Official Gazette of the Republic of Macedonia" No. 36/04, 49/04, 86/08, 124/10, 18/11, 41/14, 129/15, 71/16, 106/16, 83/18)	This law regulates the system for protection and rescue of people, environment, material goods, natural resources, animal and plant world and cultural heritage from natural disasters and other accidents in peace, state of emergency and state of war.	This law regulates responsibilities and organization of the protection and response to disasters in the country, including floods. In addition to the national strategy, protection and rescue programs and plans are adopted at the level of the state and local self-governments. Activities, principles and participation of institutions, organizations and companies in protection and rescue are defined.	MEDIUM	This law covers natural disasters and mentions measures in the construction and operation of infrastructure. There are no details.
Strategic documents				
The Water Strategy of the Republic of North Macedonia	National water strategy	The strategy for one of the key sectors screened by this study	LOW	Need for adapting to climate change just briefly mentioned without specific data.

2.2.7 Built environment

Table 7 Built environment legal and strategic framework analysis

Item	Description (including standards as relevant)	Relevance to the assignment	The level of climate resilience consideration inclusion – infrastructure wise	
Primary legislation			Level	Description
Law on Construction (Official Gazette of the RNM No. 32/20)	This Law shall regulate the construction process, the basic requirements for the construction, the necessary project documentation for obtaining construction approval, the rights and obligations of the participants in the construction process, the manner of use and maintenance of the construction, as well as other issues of significance for the construction process.	This law is of high relevance for this assignment as it defines mandatory requirements for new and existing constructions, such as mechanical endurance and safety. Moreover, it prescribes the compliance with technical standards and norms.	LOW	The basic requirements for construction ensure the resilience, durability and safety of the structure, but it is not clear against which external threats. Resilience to climate change should be ensured through this law.
Law on Spatial and Urban Planning (Official Gazette of RNM No. 51/2005, 55/13, 163/13, 42/14) – to be replaced by the new Law on Spatial Planning	This law regulates the system of spatial and urban planning, the goals and principles of spatial and urban planning, the types and content of the plans, the development and procedure for the adoption of plans, the implementation of plans and the monitoring of the realisation of plans, supervision and other issues in the field of spatial and urban planning.	Spatial and urban planning should be playing a key role in addressing climate change and promote climate adaptation as they coordinate spatial and temporal distribution of various activities in a, given territory that is vulnerable to certain impacts of climate change.	MEDIUM	This law deals with the hierarchy, preparation, adoption and implementation of urban plans, but also with plans of different levels. However, it does not explicitly mention climate change, but only notes that planning ensures sustainable development, protection of the natural and human environment, disaster prevention and the like).
Law on Urban Planning, (Official Gazette of the RNM No. 32/20)	The Law regulates the conditions and the system of spatial and urban planning, types of planning documentation and procedures for drafting and adopting the same, and other matters in the field of special and urban planning.	This law regulates the issues on planning of the space, defining the types and contents of various plans.	HIGH	• Objective 7 – Coping with climate change. • Additionally, according to the Law, the general urban plan must also contains measures for protection of nature, the natural heritage and the environment, including measures to

Item	Description (including standards as relevant)	Relevance to the assignment	The level of climate resilience consideration inclusion – infrastructure wise	
				adapt to climate change, waste management measures and others. • The documentation basis should contain all prepared and available maps of risks and areas under threat of natural, climatic and artificial disasters, disasters and catastrophes, such as risk maps and flood risk zones.
Law on Communal Activities (Official Gazette of the RNM No. 95/12)	The Law regulates the basic conditions and the manner on performing communal activities, the financing of communal activities, the financing of facilities construction and maintenance of the communal infrastructure, and other issues of importance for the communal activities.		LOW	The Law emphasises the need for regular maintenance and reconstructions. Also, for local self-government units it requires having a plan for continuation of performance of communal services in case of a natural disaster or an accident.

3. Analysis of current practices in regard to consideration of climate change impacts in planning and designing of infrastructure as well as in relevant sectors in North Macedonia

This chapter presents an analysis and overview of current practices related to consideration of climate change impacts and risks related to infrastructure in North Macedonia. The chapter covers the following:

- **Current practices related to legislation/regulation and strategic framework.** Though chapter 2 provides a comprehensive overview of legislation/strategic framework in this context it does not provide results of the discussion with key stakeholders. Therefore, this chapter provides an overview of key findings taking into account results from stakeholder consultations
- **Current practices related to designing and permitting process for infrastructural projects/investments.** An overview of a national process from planning to constructing infrastructural projects. An analysis of current practices of climate mainstreaming into this process is provided.
- **Current practices related to standards.** As already noted, standards play vital role in climate proofing of infrastructural projects therefore a dedicated analysis of national context and current practices is given.
- **Current practices on a sectoral level.** A brief overview of each sector alongside an analysis of status of climate mainstreaming is given, on a per sector level.

The overview and analysis was done by the following:

- **A comprehensive and detailed desk research/literature review** of all the relevant documentation provided by the UNDP, available online, and provided by other stakeholders.
- **A comprehensive stakeholder consultations.** A number of key stakeholders were contacted during the process of development of this study. Detailed explanation is given under sub-chapter 3.1.
- **Institutional knowledge.** Institutional knowledge of all involved experts.

3.1 Stakeholder consultations

The consulting team held bi-lateral meetings with identified stakeholders in North Macedonia, to learn about relevant practices and standards, as well as initiatives, programs and projects related to infrastructure resilience.

These stakeholders were the key for getting information on past, ongoing, and planned activities potentially related to climate resilience of infrastructure. This is specifically related to policies and programmes implemented by these organisations. Furthermore, other governmental

stakeholders relevant for this matter were included into outreach. For more information of list of contacted stakeholders please see Annex B.

The stakeholder consultations had the following objectives:

- Gather first-hand information from decision makers and other relevant institutions on gaps identified in policy overview;
- Understand what are planned activities in regard to mainstreaming climate resilience narrative, emphasis on relevant infrastructure and sectors, into relevant primary and secondary legislation and strategic framework of North Macedonia;
- Understand the position of relevant decision-making institutions in regard to implement above mentioned narrative into relevant legal and strategic framework;
- Understand activities related to other linked initiatives/programmes/projects related to climate resilient infrastructure that designated institutions might be part of/lead;
- Understand current practices in regard to the implementation of climate adaptation standards and codes regardless of the regulation.
- Understand current state of relevant infrastructure and type and rate of damages caused by climate impacts, if any.
- Understand capacity and current practices within relevant governance institutions, experts and engineering communities, and other relevant institutions in regard to climate resilience and its link to relevant infrastructure.

3.2 Current practices related to legislation and strategic framework related and relevant to climate change and infrastructure

3.2.1 Key findings

The following presents the key findings related to legislation and strategic framework related to climate proofing of infrastructure. The findings are based on the analysis under chapter 2 and stakeholder consultations.

Key finding 1. There are no specific regulation, obligations, and references regarding climate proofing of infrastructure in North Macedonia

The result of analysis of climate adaptation aspects and climate risk assessment is not part and obligation under regulation. This is specifically related to EIA and SEA requirements. The new draft Climate Action Law, if enacted, provides strong basis for future inclusion of these requirements. Main governance related stakeholders confirmed willingness to take into account aspects of climate resilient infrastructure once a secondary legislation under Climate Action Law initiates.

Key finding 2. Various strategies and especially new Long-Term Strategy on Climate Action provides strong basis for inclusion of climate proofing process into infrastructural projects.

Though there are no concrete obligations under national legislation, the strategic framework related to new Long-Term Strategy on Climate Action provides concrete signals and elaboration on importance of inclusion of climate risks into the EIA and SEA processes. Also, there are concrete

references to building resilience of infrastructure under the Strategy's objectives. Also, National Transport Strategy 2018-2030 is substantially oriented around importance of climate proofing of national transport sector. This is backed up with concrete planned activities as described in chapter 2.

Key finding 3. There are potentially already climate proofing related activities of infrastructure that are not systematically recognised as building resilience.

This finding relates to actions and activities that have climate proofing characteristics but are not recognised/labelled as such. For example legislation related to water sector prescribes specific requirements related to flood, erosions, etc. protection when related projects are planned.

Key Finding 4. Climate adaptation strategies are being developed at the local level, including supporting analyses

There is no obligation to develop plans for adaptation to climate change or resilience (as well as mitigation) at the local level. However, there are cases of voluntarily developed climate change strategies or plans at the local level. For example, the City of Skopje has developed studies that could serve as a basis for mitigating the risk of floods or industrial accidents, also the cadastre of green infrastructure, and most importantly, Resilient Skopje - Climate Change Strategy. Nevertheless, it remains open how the measures identified in these documents will be translated into the city's spatial and urban plans (Spatial Plan, General Urban Plan, Detailed Urban Plans). In general, the implementation of all identified measures of the Strategy is uncertain.

3.3 Current practices related to designing and permitting process for infrastructural projects/investments

3.3.1 The role of planning, designing, and permitting process in climate proofing of infrastructure

Mainstreaming of climate proofing into planning and designing of infrastructure presents a crucial step towards building climate resilience of infrastructure. It is often a prerequisite and the most cost-efficient option for building climate resilience. This approach is also called 'No-Regrets' Risk-Based Approach to climate proofing of infrastructure.

Climate change will affect infrastructure provision and operation, with the severity of these effects depending on decisions that could result in increased exposure of assets. Chapter 4 provides an overview of exposure to climate impacts of North Macedonian infrastructure.

In order to conduct proper planning of climate resilient infrastructure it is crucial to have timely, accurate, and usable information on future climate hazards and changing climate in general. Therefore, National Hydrometeorological Service of North Macedonia plays a vital role in providing this type of information. It is relatively straightforward to conclude that better and more detailed climate models are associated with a better response, i.e. the possibility of introducing more appropriate risk reduction measures.

In order to carry out proper planning of climate change-resilient infrastructure, it is crucial to have timely, accurate and usable information on future climate threats and climate change in general. Therefore, the National Hydrometeorological Service of Northern Macedonia plays a vital role in providing this type of information. It is relatively simple to conclude that better and more detailed climate models are associated with a better response, i.e. the possibility of introducing more appropriate risk reduction measures for each type of infrastructure project, either during the preparatory or operational stage of the project.

Furthermore, MoEPPs appropriate departments should adopt methodologies to consistently assess climate risks and vulnerabilities Also, technical experts, architects, civil engineers and other experts should identify sets of appropriate planning and design measures, i.e. technical standards that would ensure the resilience of the infrastructure, as well as to monitor their efficiency over time. Climate considerations are repeated in different phases of the project development cycle, and like other elements of the project, in the mature phase of project development they become more detailed. Considering climate risks and assuming appropriate measures at an early stage can eliminate later changes of the project. When it comes to existing projects (retrofitting), climate considerations and measures need to be integrated into management or maintenance.

The diagram below shows the usual stages of project preparation and how climate adaptation is relevant to all project phases:

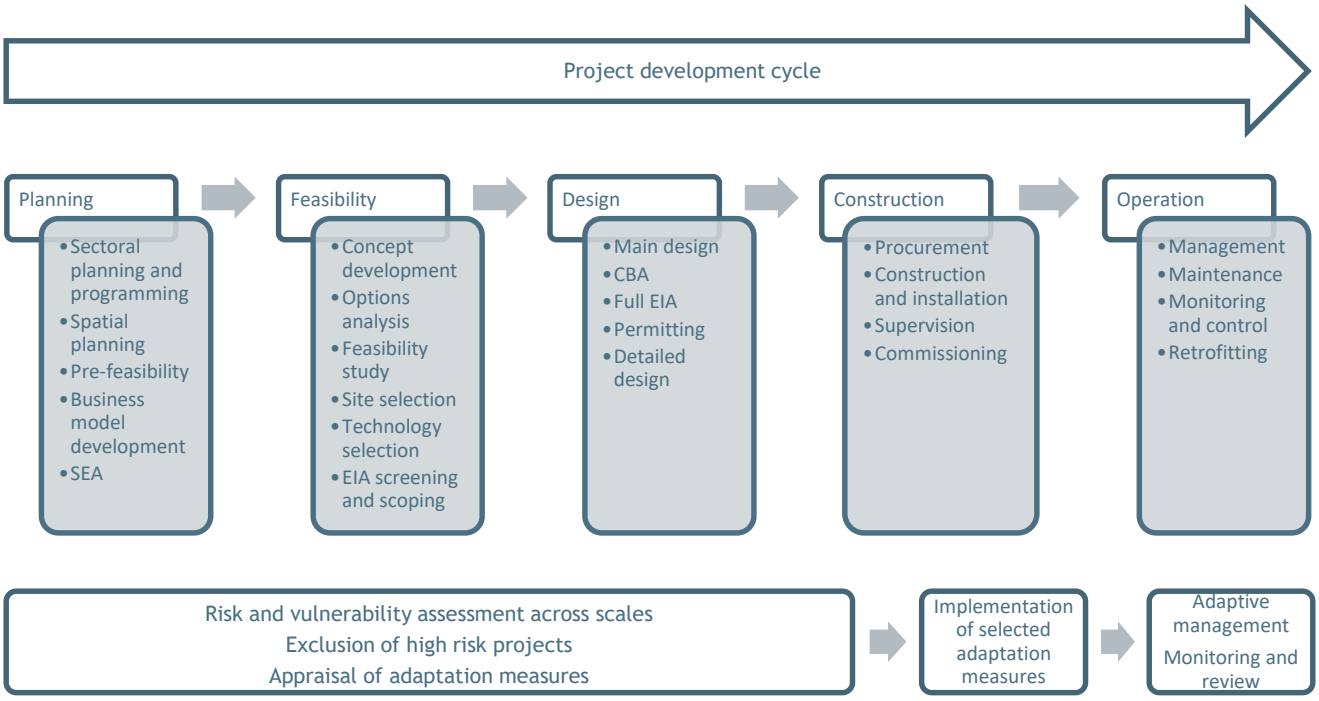


Figure 1: Integrating Climate Change Adaptation into the Project Development Process[15]

In general, decision-makers, investors, engineers and other professionals must have access to high-quality data and a knowledge base in order to adapt the entire process of planning, designing and managing projects to climate change. This can be achieved by developing platforms and online tools that provide accessible, credible and transparent information on past and future climate

[15] https://poseur.portugal2020.pt/media/40461/jaspers-guidance-note.pdf

behaviour, training of technical professionals involved in all segments of the project preparation cycle. In parallel, institutional capacity to manage climate risks needs to be enhanced.

There are several mechanisms to introduce climate proofing of infrastructure in planning, designing, and permitting process:

- **Enabling climate resilience through policy and regulation -** This is by far the most effective way for the introduction of climate proofing into infrastructural projects, especially if climate risk assessment and consideration of appropriate measures through the various stages of infrastructure planning and development is introduced as a legal obligation. Such a way of implementing climate considerations into national policies would require slight amendments of existing laws and decrees. National policies vital for this are:
    - Legal framework related to Strategic Environmental Assessment (SEA) – mainly oriented around spatial planning.
    - Legal framework related to Environmental Impact Assessment (EIA) – project level considerations.
    - Legal framework related to construction – basic requirements for any building / construction.
    - Technical codes - regulated introduction of technical codes can ensure proper technical response towards vulnerabilities identified by SEA and EIA.
- **Voluntary standards relevant for climate proofing.** This aspect is explained in detail in sub-section 3.4.
- **Voluntary guides, toolkits and standards for disclosing climate risks -** There are number of guidance documents/methodologies on how to climate proof infrastructure, for all phases of infrastructural projects. Tools for disclosure should encompass both the physical vulnerability of specific assets, and examine whether management responses are sufficient to ensure continual management of climate-related risks. Relevant initiatives are being developed to support this ambition. For example, EBRD and the Global Centre of Excellence on Climate Adaptation (CGECA) are currently developing metrics for climate risks and opportunities, and identifying how climate risk information can be incorporated within financial reporting systems.[16]
- **Infrastructure developers and engineers/investor initiatives.** In many developed countries climate resilience is now being integrated into frameworks of voluntary sustainability rating programmes. Potential benefits of these ratings include increased performance, reduced costs and marketing advantages. They provide a consistent form for tenderers to require, and bidders to demonstrate, compliance with sustainability objectives. Furthermore, there is also an option for investors to take initiatives and request climate proofing of infrastructure in order to protect their investments.

3.3.2 Brief overview of planning, designing, and permitting process in North Macedonia

As already noted, robust stakeholder consultations were conducted in the preparation of this study. The general conclusion is that there are no regulated requirements that would involve mandatory climate proofing of infrastructural projects in North Macedonia, in any part of the process.

[16] https://www.oecd.org/environment/cc/policy-perspectives-climate-resilient-infrastructure.pdf

However, when international financial institutions or organisations are involved in financing infrastructural projects it is almost always required to follow international procedures and safeguards. Most investments financed by the key donors and IFIs (EU, EBRD, EIB, WB) are prepared through technical assistance grants which are managed by the IFI in charge (Lead IFI) and require full compliance with environmental standards of these institutions, e.g. alignment with EU regulations concerning EIA, SEA and biodiversity protection, contribution to climate finance (mitigation or adaptation) and encouragement of improved design ensuring long-term resilience to changing climate risks.

Box 1: WBIF Grants for Technical Assistance Guidelines

Based on Western Balkans Investment Framework (WBIF) Grants for Technical Assistance Guidelines[1] issued in January 2021, which defines eligibility criteria for the projects to be financed, tracking climate finance commitments is a responsibility of donors or financiers, not of the Beneficiaries. In this context, the assessment of contributions to climate finance (mitigation and adaptation) is done by the Lead IFI during the assessment stage and is developed using the Rio Markers methodology which examines whether climate change is the principal objective of a project, one of the (significant) objectives or it is not an objective at all.

The Lead IFI may propose a specific percentage of the project budget that contributes to climate change by following its own policies or methodologies. To enhance project design and implementation and reduce the impact of climate change risks on the project, the grant application should provide information on potential contribution of the project to GHG emissions reduction and assessment of climate risks, including the measures that would improve the climate resilience of the project. The information provided will depend on sector and maturity of the project (e.g. pre-feasibility, feasibility study, detailed design, etc.).

Checklist to determine if the project location is likely to be exposed to climate change risks contains the following parameters that needs to be elaborated:

Parameter	Elaboration
Average temperature rises and increased risk of heat waves	• Regions where average temperature is already high; • Urban centres, where the 'urban heat island effect' will exacerbate high temperatures; • Regions with limited freshwater supplies.
Decreased seasonal precipitation, increased risks of drought, wildfire	• Regions where rainfall is already scarce; • Locations where current demand for water almost matches supply or outstrips; • Locations where water quality is poor; • Regions prone to wildfire; • Trans-boundary river basins where tensions over water use already exist
Increased seasonal precipitation and more rapid snow melt – increased risk of river flooding, flash floods, or soil erosion	• Regions with high rainfall; • Estuaries, deltas, river floodplains; • Mountainous regions; • Locations prone to landslips; • Urban centres with storm water systems not designed to manage intense rainstorms; • Contaminated environments (land, water).
Possible increase in storm intensity and frequency	• Areas at risk of storms; • Urban centres at risk from storms.

Relevant planning, designing, and permitting process includes the following:

- **Planning** – Spatial and urban planning system and associated processes, as stipulated by the Law on Spatial and Urban Planning
- **Designing** – Utilisation of various technical codes and standards to fulfil basic requirements for construction, as defined by the Law on Construction
- **Permitting** – Construction approval and audit to ensure alignment with the Law on Construction

3.3.3 Current practices related to mainstreaming climate change into the process

Planning/feasibility phase

Spatial and urban planning system

The spatial planning system in North Macedonia is governed by the Ministry of Environmental Protection and Physical Planning (MoEPP) and the Agency for Spatial Planning. The MoEPP's Department of Spatial Planning is mandated to manage and implement the policies and monitor the processes of spatial planning in the Republic of Macedonia, as currently regulated by the Law on Spatial and Urban Planning (under the process of amendments) and, Law implementing the Spatial Plan of the Republic of Macedonia and the Law on Urban Planning. The Agency for Spatial Planning is in charge of developing and monitoring the implementation of the Spatial Plan of the Republic of North Macedonia, as well as preparing Spatial Plans for specific regions, Spatial Plans for areas of special interest and Spatial Plans for the municipalities, for the municipalities of the City of Skopje and the General Urban Plans.

Spatial planning in Northern Macedonia is centralized, meaning that the Spatial Plan of the Republic of Macedonia acts as an umbrella plan which is then harmonized with hierarchically lower documents, more precisely, regional spatial plans and spatial plans of areas of special interest to the Republic. Spatial plans at the local level are under responsibility of local governments and municipal councils and must be vertically aligned with the objectives of the Spatial Plan of the Republic of Macedonia. The state territory is not fully covered by local plans, which means that not all municipalities have developed their own plans, but refer to the Spatial Plan of the Republic of Macedonia for construction or management purposes.

Some of the key principles for spatial planning in the North Macedonia are:

- balanced spatial development,
- rational land use,
- overcoming urban barriers to persons with disabilities,
- sustainable development,
- protection and improvement of the environment and nature,
- protection of immovable cultural heritage,
- protection against military destruction,
- natural and technological disasters and accidents, realization of public interest and protection of the private interest,
- enhancement of regional peculiarities and participation of public in proceedings for the adoption and implementation of the planning documents.

All spatial and urban planning processes are overseen by the MoEPP as well as the Agency for Spatial Planning which creates documentation related to the current spatial aspects required for the pre-planning process and operates the single geo-referenced spatial information system for spatial and urban planning in the country. They are also subject to strategic environmental assessment, which is decided depending on the scope of the plan's intervention and is usually carried out as a parallel process.

The following table presents the overview of the most important strategic and legal pieces relevant for spatial planning in North Macedonia.

Table 8 Spatial planning legal and regulatory framework

Document	Description
National level	
Spatial plan of the Republic of Macedonia	The plan is a strategic and legal document that provides a general foundation of the spatial development of Northern Macedonia. It prescribes the development goals of the country and spatial measures for the overall economic, social, ecological and cultural development. It contains basic guidelines for land use, use of natural resources and protection measures, including all major infrastructure projects. The plan was adopted in 2004 for a period of 15 years. It was harmonized with various sectoral laws and strategies, and is implemented through lower level spatial plans which provide more detailed planning guidelines.
Spatial plan of the region	The spatial plan of the region is developed for the area covering physical and economic functional whole. So far, three regional plans are set as priorities, while spatial regional plans for the Skopje and Polog regions are prepared as drafts.
Spatial plan for area of special interest for the Republic	The spatial plan for area of special interest for the country is developed for the areas that require the specific regime of use or protection, such as national park or other protected area, reservoirs or water sources, areas for exploitation of mineral resources, transport and other infrastructural corridors and facilities (e.g. power plants), melioration systems and other projects of the importance to the country, as established by the Spatial plan of the Republic of Macedonia.
Local level	
Spatial plan of the municipality / or City of Skopje and municipality of Skopje	The local level spatial plans set objectives for spatial and urban planning of municipalities in line with the economic, social, ecological and cultural development objectives planned in the Spatial Plan of the Republic of Macedonia. A number of municipal plans were adopted at the end of 20th century, and only some of them were amended according to the current laws and country's spatial plan.
General Urban Plan	a limit of the planning scope is the border of the city or border of the fourth and blocks subject to modification and addition, zone limits according to land purpose and general regime construction and use, primary traffic

Document	Description
	network with Levelman solution, primary infrastructure, urban area boundaries for detailed space planning, borders of the monument allocations and other protected goods as well as other data needed for the planning solutions.
Detailed urban plan / Urban plans for villages / Urban plans for out of the settlement	The detailed urban plan is adopted for undefined areas within the settlement, and determines the arrangement and use of plots and the rules of construction, connection and layout of traffic and other infrastructure. The development of a detailed urban plan may be mandatory for all settlements and parts of settlements if its construction is determined by the spatial and urban plan of city or municipality. The urban development plan is adopted for the village within the municipality of rural character. The plan defines the arrangement and use of plots and building rules, including the connection and arrangement of infrastructure. The urban plan outside the settlement defines the purpose of uninhabited space, as well as the rules for the construction of buildings in the area. It is adopted for areas that were not covered by previous urban plans.

Historically, the practice of spatial planning and construction has always been adapted to the observed (past and present) local climatic conditions. Later, through formalized planning systems, environmental awareness was built in, and it was strengthened with regard to the consequences of planned activities on the environment through the obligation of strategic environmental assessment for spatial and urban plans, which is also the case in the Northern Macedonia. However, based on stakeholder consultations, climate change is still a relatively new topic for the Northern Macedonia, established spatial and **urban planning systems still do not take into account the vulnerability to increased risks of climate change, i.e. future climate conditions and effects, and climate change factors are still not integrated as determinants in spatial or urban planning.**

In order to make progress on this issue, UNDP North Macedonia, together with its partners, has carried out several actions:

- **Methodologies for mainstreaming climate change considerations into spatial planning** - A dialogue has been launched with the MoEPP on how to include climate change considerations in the national spatial plan and spatial plans for certain northern Macedonian regions, resulting in a recently developed methodology for integrating climate change into the new national spatial plan[17].
- **Recommendations for integrating climate change into spatial planning legal framework** - A recommendation was made that the new Law on Spatial Planning could prescribe the methodology of climate change as part of the general methodology i.e.. principle of spatial

17 https://api.klimatskipromeni.mk/data/rest/file/download/40db321ed2ac26536dda473b3556686a416522bf669183d764ad723fd1070665.pdf

planning. Based on this recommendation, guidelines in higher-level plans should not be transferred to lower-level plans only in the form of recommendations, but as legal obligations, i.e. mandates and prohibitions. The new Law on Urbanism, adopted in the first half of 2020, justifies the need for climate action and climate change mitigation. The law, however, is not very specific. Therefore, the forthcoming Law on Spatial Planning and the Law on Climate Action will be used as a supplement to the Law on Urbanism. In particular, the new Law on Climate Actions, which is currently being drafted, will be considered an opportunity to require the inclusion of consideration of change and integration in all spatial and urban plans.

- **GIS tool with mapped climate risks** - To inform project developers, engineers, planners, but also wider public on climate risks, UNDP North Macedonia has facilitated the development of GIS tool which overlays various data[18], such as cadastre and spatial plans, with maps containing various climate risks, such as urban heat islands or flood-prone areas. The use of this tool is still voluntary, but it is strongly encouraged that it becomes an integral part the National Spatial Data Infrastructure (NSDI) and, more importantly, of the future planning and design processes.

Strategic Environmental Assessment (SEA)

SEA, was introduced in Macedonian Law on Environment in 2005, based on the European Union Directive 2001/42/EC on the assessment of the effects of certain plans and programmes on the environment (SEA Directive). Strategic assessment of the effects to the environment and human health is a procedure implemented by the national administrative bodies and local self-government units. More specifically, applied when adopting strategies, plans and programmes, for the purpose of securing environmental protection and sustainable development at an earlier stage during planning and developing programs that identify and justify individual projects.

Strategies, plans and programs, including their changes, which are subject to SEA are determined by a Decree on the strategies, plans and programmes, including amendments to such strategies, plans and programmes, that are subject to a mandatory procedure for assessment of their impact on the environment and human health ("Official Gazette of the Republic of Macedonia" No. 153/07 and 45/11). In short, planning documents which are prepared for agriculture, forestry, fisheries, energy, industry, mining, transport, regional development, telecommunications, waste management, water management, tourism, spatial and urban planning and land use shall be subject to SEA when they set a framework for future development of projects that are subject to environmental impact assessment. Also, SEA is implemented for all planning documents governing management of protected areas, declared as protected areas by law, or that are likely to have effects on those areas.

Whether planning document is likely to have a significant effect on the environment and human health is determined by the body preparing the planning document in accordance with the Decree on the criteria for SEA and the Rulebook on the format, contents and form of the decision for implementation or non-implementation of strategic assessment, that prescribes the forms based on which the need for implementation or non-implementation of strategic assessment is determined.

[18] https://gisportal.gdi.mk/visios/PPKP

Once it is determined that the document shall undergo SEA procedure, the state body or local government unit preparing the document shall request opinions from the authorities to determine the scope of SEA report. The content of SEA report is prescribed by the Decree on the content of the strategic environmental impact assessment report ("Official Journal of RM" no 153/07) and must contain the following:

a) résumé/an outline of the contents, main objectives of the plan or programme and relationship with other relevant plans and programmes;
b) the relevant aspects of the current state of the environment and the likely evolution thereof without implementation of the plan or programme;
c) the environmental characteristics of areas likely to be significantly affected;
d) any existing environmental problems which are relevant to the plan or programme including, in particular, those relating to any areas of a particular environmental importance, especially from the aspects of protection of wild birds and habitats;
e) the environmental protection objectives, established at international, Community or Member State level, which are relevant to the plan or programme and the way those objectives and any environmental considerations have been taken into account during its preparation;
f) the likely significant effects on the environment in general, including on issues such as biodiversity, population, human health, fauna, flora, soil, water, air, climatic factors, material assets, cultural heritage including architectural and archaeological heritage, landscape and the interrelationship between the above factors. These effects include secondary, cumulative, synergetic, short- term, medium and long- term, permanent and temporary positive and negative effects;
g) the measures envisaged to prevent, reduce and as fully as possible offset any significant adverse effects on the environment of implementing the plan or programme
h) résumé/an outline of the reasons for selecting the alternatives dealt with, and a description of how the assessment was undertaken including any difficulties (such as technical deficiencies or lack of know-how) encountered in compiling the required information;
i) a description of the measures envisaged concerning monitoring in accordance to the law provisions;
j) a non-technical summary of the information provided points (a) to (i) of paragraph (1) of this article

Based on stakeholder consultations, the context of climate change adaptation in SEA procedures, it seems consideration of climate risks is very limited. As SEA is still a process conducted in accordance with national policies and requirements that do not include climate mainstreaming, there are not many cases of diligent assessment of climate risks and selection of appropriate measures.

Environmental Impact Assessment (EIA)

In 2005, the Law on Environment consolidating the environmental impact assessment process was introduced, based on the provisions of Directive 85/337/EEC for assessment of the effects of certain public and private projects on the environment. In addition, in 2005 and 2006, decrees related to related to screening and determination of scope were passed. In the meantime the EU's EIA directive was amended and is currently codified by Directive 2014/52/EU, but it is not yet transposed to the Macedonian Law on Environment.

The aim of EIA is to determine the potential environmental effects of a proposed development, so that those who take the decisions in developing the project and in authorising the project are informed about the likely consequences of their decisions before they take those decisions. Besides having the preventive principle, EIA procedure includes the principle of integration, precaution and public participation.

The Department for Environment of the MoEPP is responsible for implementation of the EIA procedure. The decision on the consent of the EIA process is required before obtaining other permits for the project, such as construction permits or permits for exploitation or abstraction of resources, which are granted by the Ministry of Transport and Communications. The State Environmental Inspectorate monitors the implementation of the EIA, including verifying that the EIA has been undertaken for all projects that require it, and monitors whether the mitigation measures proposed in the EIA are being implemented. The Decree on determining projects for which and criteria on the basis of which the screening for EIA should be carry out (Official Gazette of Republic of Macedonia No. 74/05) sets out the types of projects for which full EIA procedure is mandatory and for which there should be a screening process conducted. These include all types of infrastructural projects, depending on a size of an investment.

In accordance with the EIA procedure, the investor or project promotor has to prepare an EIA study. The procedure begins with the submission of notification regarding the intent to implement project to the MoEPP, which also has an obligation to inform citizens and civil society organizations, immediately after receiving a notification of intent to implement a project.

The contents of the EIA study is determined by the Ordinance on content and requirements to be fulfilled by the study on environmental impact assessment (Official Gazette of Republic of Macedonia No.33/2006). The study should include the following information:

- Description of the project along with information on the location, nature and size of project and required land area;
- Description of the environment of the project location;
- Description of the natural, cultural and historical heritage and landscape;
- Description of the type and quantity of expected emissions, especially air emissions and wastewater, solid waste, and other information necessary to evaluate major environmental impacts of the project;
- Description of the measures to prevent, reduce and eliminate the impact environment, as well as substitution measures;
- Description of the environmental impacts of the project taking into account the level of development of science and the accepted methods of evaluation;
- Description of the technology that will be used;
- Description of the alternative solutions for the realization of the project (zero alternative should also be included);
- Analysis of the difficulties (technical deficiencies or lack of knowledge) that developer or expert was faced during the preparation of the study; and
- Non-technical summary.

For projects that do not require an EIA, an "elaborate for environmental protection" must be prepared. The elaborate can be considered a less comprehensive and formalised form of

environmental impact assessment and is mainly required for the realization of smaller-scale projects within different industries.

The EIA procedure is long existing in the North Macedonia, but it still faces challenges towards its full implementation. In particular, the EIA procedure, as arguably the strongest tool for increasing climate adaptation of any type of investment, does not regulate or require climate vulnerability assessment and appropriate identification of adaptation measures. At the moment, the main issue remains the transposition of the amended EIA Directive 2014/52/EU, amending Directive 2011/92/EU on the assessment of the effects of certain public and private projects on the environment. New elements to be introduced by the transposition of the amending directive into the EIA procedure include a wider scope of EIA covering climate change and risk prevention, which would address the current loophole in law and practice.

Nevertheless, as already mentioned and confirmed by key stakeholders, there are numerous examples of EIAs in the Northern Macedonia that conduct climate risk assessments, especially when international financial institutions are involved. This implies that the country definitely has the capacity and knowledge for this type of assessment, but it needs to be further enhanced.

Design/construction phase

The Law on Construction[19] regulates the process of building approvals and construction, and it is governed by the Ministry of Transport and Communications. During the development of the project design, it should be ensured that each construction, depending on the purpose, meets the basic requirements for the construction anticipated by the parameters of the urban plan or the state, i.e. local urban planning documentation or the infrastructure project other conditions prescribed by the Construction Law and any other laws.

Project documentation shall be a set of mutually harmonized studies, projects, surveys, analyses, expert reports and other documentation that establishes the concept and defines the technical solution for the construction, reviews the conditions and ways of building and ensures its technological function, anticipated duration and conditions for use. Through the process of preliminary design concept, choice of options, location of the project, choice of technology are examined. The main project is a set of all mutually harmonized technical subprojects that serve as evidence to meet all legal and technical requirements of construction. The construction project or detailed design specify in construction costs and timeline plan, and instructions to contractors in detail. Not all projects need to be elaborated to the level of detailed projects, but they are recommended depending on the complexity of construction.

Depending on the purpose, the project may be:

1) preconstruction activities project;
2) basic project;
3) draft project;
4) as-built project, and
5) project for use and maintenance of the construction.

[19] Official Gazette of the Republic of Macedonia", no.130/2009

Moreover, technical subprojects included in the overall project may be:

1) architectural;
2) engineering (statics with seismic);
3) electrotechnical;
4) traffic related;
5) thermotechnical, and
6) other projects and studies, depending on the purpose of the construction.

As for the project design process, it begins with extensive data collection and analyses. The Law on Construction defines **preparatory activities which comprise of research and development of analyses and other professional documentation, obtaining data for analysis of** geological, geotechnical, geodetic, hydrological, **meteorological**, urban, technical, technological, economic, energy, seismic, water and traffic conditions, fire protection and environmental protection conditions , which indicates that meteorological conditions need to be taken, but it is not specified whether only current or future conditions are considered and their possible impact on other conditions (e.g. the impact of prolonged heat waves on hydrological or traffic conditions).

Basic requirements for the building are:

- Mechanical endurance, stability and seismic protection
- Fire protection
- Hygiene, health and protection of the working and living environment
- Safety in use
- Protection against noise
- Energy efficiency and thermal savings
- Unobstructed access and movement to and in the construction
- Connection to gas infrastructure
- Bicycle area
- Physical infrastructure for electronic communication
- Exceptions to the basic requirements of the construction

The above requirements can be fulfilled through the use of commonly agreed and accepted technical standards, which define various of design and execution principles that help to attain the above-mentioned basic requirements for the building. In addition, all construction products, their technical features and other technical requirements have to conform to the Construction Law and the other regulations on the quality of construction products.

The design process is an entry point for applying technical codes, standards, and any other technical design approach. These all may include the aspects of climate resilience. Based on stakeholder consultations it is unlikely that there are voluntary climate resilience approaches currently applied in designing processes, even with those projects co-financed by international donors and other international organisations.

Operational phase

In the context of climate resilience, operational phase may be important. It includes carrying out **activities in order to maintain the basic requirements for the facility in the course of it's lifetime**. This requires **defining the optimal technical. technological and functional conditions**

that ensure the longevity of the whole construction and shall particularly contain the type, manner, purpose and deadlines for periodical control in defined time periods of the condition of the construction system, equipment, devices and installations, periodical monitoring in defined intervals including an analysis of the effect on the technological process, of climate effects, as well as other effects over the loading capacity and stability of particular elements, i.e. of the construction as a whole, the deadlines for regular, i.e. general repairing of plants, devices, equipment and installations, as well as deadlines for mandatory replacement of certain elements, devices, equipment, installations and other parts of the construction.

Above mentioned requirements are solid basis for conducting appropriate maintenance and monitoring of infrastructure and thereby potentially mainstream climate considerations. That would potentially mean monitoring of resilient performance of infrastructure against climate impacts as well as introducing specific climate resilient technical solutions in retrofitting infrastructure.

Permitting and licensing

The issuance of construction approval allows the commencement of building of the construction. In the North Macedonia, as regulated by the Law on Construction, construction approvals are split into two categories.

First category constructions are mainly larger scale projects of national importance such as: nuclear power stations, thermal power stations and hydro power stations with capacity of and exceeding 1 MV, long-distance transmission lines with voltage level of 35 kV and above, transformers with voltage level of 35 kV and above, oil pipelines, state roads, railway lines, airports, dumps for hazardous waste, dams with accumulations, constructions for mineral and chemical industry, constructions for the ferrous and nonferrous metallurgy, constructions for manufacturing wood pulp and paper, technological industrial development zones established by the Government of the Republic of North Macedonia and by legal entities and the constructions in these zones, constructions for higher education purposes, observatories, national cultural institutions, constructions considered protected immovable cultural heritage in accordance with the law (separate goods, monumental wholes without the contact zones and archaeological sites), memorial monuments, telecommunication centres for receipt of satellite signals.

Second category constructions are: constructions intended for primary and secondary school education, constructions in the field of culture, constructions for the needs of the bodies of the municipalities, the municipalities in the city of Skopje and the City of Skopje, industrial and green zones established by the municipalities, constructions for the needs of the religious communities, industrial constructions, residential and business constructions, constructions for constructions for the needs of the agroexchange markets, trade centres, hotels, recreational centres, constructions for scientific and research activity, multifloor parking lots, markets, municipal roads, accompanying service facilities on the municipal roads and streets defined by law, electronic communication networks and devices, thermal and hydro power stations with capacity of up to 1 MV, windmills, constructions for generation of electrical energy from renewable sources with capacity of up to 1 MW, PV panels for generation of electricity installed on ground, long-distance transmission lines with voltage level of up to 35 kV.

The construction approval for the first category constructions shall be issued by the state administrative body responsible for carrying out the activities related to land development, which

is the Ministry of Transport and Communications. The construction approval for the second category constructions shall be issued by the mayor of the municipality, i.e. the mayors of the municipalities in the city of Skopje.

The competent bodies for construction approvals are obliged, within a period of five working days as of the day of receipt of the application, to review the submitted documentation and to establish whether the application is complete, whether the submitted documentation has faults, whether the basic project is prepared in accordance with the designing regulations, the urban plan or the urban planning documentation or the infrastructure project, and whether the applicant is the sole holder of the construction right, whether the basic project disturbs the standards and the norms for the constructions intended for individual housing (A1) with regard to the allowed height (floors and meters) and the number of housing units, which are determined in the Rulebook for the Standards and Norms for Urban Planning.

In order to obtain a construction approval, the investor shall submit an application in an electronic form to the competent body, with the following documentation:

- architectural urban project, verified by a competent body, if the urban plan or the urban planning documentation anticipates preparation of this project, that is, an infrastructure project in the case of linear infrastructure constructions;
- basic project, including a report for audit of the basic project or a written report with consent to the validation of the basic project, if it is prepared abroad, as well as a positive opinion on the designed level of mechanical endurance, stability and seismic protection of the construction,
- draft project if it has not been previously submitted and approved
- proof of the construction right, and
- land survey report for numeric data on the construction land.

During the review of documentation, competent bodies in charge for construction approval shall be paying special attention to integration of climate adaptation measures.

In the Macedonian legislation the EIA procedure has to be finalised before applying for construction approval, meaning that EIA is usually prepared in parallel with the design of the basic project which after the feasibility study, draft project and infrastructural project (e.g. for linear buildings) is finished.

As for design authorizations for legal entities and licenses for persons, they are issued by the Chamber of Authorized Architects and Engineers. In Northern Macedonia, there are A licenses for the design of first category buildings and B licenses for the design of B buildings of the second category. The conditions for obtaining a design license are: university degree, at least 5 (2) years of experience and at least 3 references, all from the field for which the license is applied for.

Box 2: Climate change risk assessment as a part of environmental permit application in the UK

Operators in the UK shall carry out climate change risk assessment for each new environmental permit application (for certain installations and projects), if they expect to operate for more than 5 years. When completing the permit application form, they must calculate their climate change risk test result. The screening tool is made up of three questions to which there are different answers with different weights. A combined score of five or more requires the operator to complete and submit a climate change risk assessment as part of the application form. If the screening result is lower than five, the operator does not

need to submit his risk assessment with the application form, but must still keep it as part of his environmental management system.

The completed climate change risk assessment will take into account:

• Future summer and winter maximum daily temperatures

• Increase in rainfall intensity

• Increased winter rainfall

• Sea level rise

• Dryer summers

• Fluctuations in watercourse flow [20]

The next step for the operator is to find measures to manage the significant risks identified. These measures could:

• manage risk by introducing control measures to address climate change hazard, its impact on business or environmental impact

• risk transfer, such as insurance

• eliminate the risk, for example by changing the hazard elimination procedure

The UK Environment Agency provides examples in the sectoral guides for climate change risk assessment, which can guide operators in developing their climate adaptation plans.

3.3.4 Key findings

Key Finding 1. Work is underway to mainstream climate considerations into spatial planning

Significant efforts have been made in actions to incorporate climate change (including adaptation) into the forthcoming national spatial plan. Also, a methodology has been developed that will enable the consistent inclusion of climate change adaptation in spatial and urban plans at all levels. Additional incentives are needed to ensure that climate change is embedded into all relevant laws and put into practice.

Key Finding 2. When IFIs finance the preparation of technical documentation for infrastructure projects, the EIA study includes climate adaptation considerations

Stakeholder consultations confirmed that when EIA studies are funded by international financial institutions, they include a wider range of environmental and climate factors, including assessing the project's vulnerability to climate change and selecting appropriate adaptation measures. Usually, international and local EIA experts are involved in the development of IFI-financed EIA studies. Local capacities need to be further developed, i.e. data and guidance should be provided

[20] https://www.gov.uk/guidance/adapting-to-climate-change-risk-assessment-for-your-environmental-permit

to EIA experts (this can be developed by the MoEPP in cooperation with the Chamber of Architects and Engineers).

Key Finding 3. SEA legislation is fully in line with the EU directive, while EIA legislation is not

The Norther Macedonia is late with transposition of the (EIA) Directive 2014/52/EU amending Directive 2011/92/EU on the assessment of the effects of certain public and private projects on the environment. The introduced changes will provide a complete legal ground for climate change assessment within the EIA.

Key Finding 4. Design practice shows that adaptation to climate change considerations are scarce

Consideration and adaptation to local conditions is an integral part of design practice. However, there is no sufficient level of awareness and knowledge about future climate change impacts, as well as of established engineering solutions to combat them.

3.4 Current practices and technical standards

Standards and codes are one of the pillars of ensuring climate resilience of infrastructural projects. Standards are crucial to ensuring infrastructure is prepared to withstand present and future climate scenarios. They can assist stakeholders to incorporate climate risks, resilience and adaptation measures in the planning, delivery and management of infrastructure. The security and durability of infrastructure requires the existence and respect of standards, as tools for designers, builders, operators and users.

This sub-chapter provides an overview of the role of standards and codes in improving climate resilience of infrastructure, provides a snapshot towards international practices, and most importantly provides an overview in the context of North Macedonia.

3.4.1 The role of standards in climate resilient infrastructure

According to the (GCA) Global Center for Adaptation[21], there are several tools, typology, of standards that are considered in this context:

- **Standards -** which are technical and/or managerial definitions, procedures, and frameworks to promote consistent use of certain topic in one or more stages of the infrastructure lifecycle.
- **Codes -** which are standards that were consolidated by a legislation or regulation at any jurisdictional level and are usually related to minimum technical requirements to ensure the safety of the delivery of infrastructure.
- **Guidance documents -** which are usually recommendations or research to inform the development of standards and can include good practices on the implementation of infrastructure.
- **Rating systems -** which are frameworks that can encompass metrics from standards, codes and guidance documents for the evaluation of an infrastructure project according to a level of performance from planning to management.

The report takes the same approach as GCA and for clarity purpose labels the entire above-mentioned typology as standards.

By definition, a standard is a document that provides conditions, specifications, guidelines, or characteristics that are used to make materials, products, processes, and services fit for purpose. Technical standards are important instruments for regulating the construction sector and guaranteeing the security of investment in it. Therefore, building standards, as a vital instrument for regulating the construction sector, need to adapt to the new frequency and intensity of climate impacts in order to protect existing and new infrastructure and buildings, strengthening resilience to the changing climate.

In general, standardisation is based on the following principles:

- voluntary participation of all stakeholders in the standard-setting process;
- voluntary application of standards;

[21] https://gca.org/wp-content/uploads/2021/01/Stocktake-of-Climate-resilient-Infrastructure-Standards.pdf

- harmonisation of stakeholders' views on the technical content of the standard is achieved by consensus;
- transparency of the standard-setting process;
- mutual harmonisation of different standards.

Standards are developed and defined through the process of knowledge sharing and good practice, and are built on the consensus reached between experts representing stakeholders in standards commissions. Professional work in the narrower areas of standardisation takes place in standards commissions, which are represented by groups of experts from different sectors. In order to carry out specific activities and tasks, each standards commission may establish sub-commissions and / or working groups.

According to EBRD's report **Climate change: Standards, and their role in improving the climate resilience of infrastructure investments,** there are three relevant types of standards and their use in climate resilient projects:

- **Test methods and analysis standards** - these measure characteristics such as temperature and chemical composition. Typically, these are used by verification and assurance organizations and can be used throughout and infrastructure project's construction phase to assure that the materials used meet the required performance specification – concrete composition and strength is an example.
- **Organization standards** – these describe the functions and relationships of a company, as well as elements such as quality management and assurance, maintenance, value analysis, logistics, project or system management, production management, etc. Typically these are used by larger organizations and corporations, an example being ISO 9001 on quality management.
- **Specification standards** – these define characteristics of a product (product standards), or a service (service activities standards) and their performance thresholds such as fitness for use, interface and interoperability, health and safety, environmental protection, etc. Typically these are used in infrastructure projects at the design stage to perform the structural design calculations (e.g. safety, loadings, resistance to loadings), and to select and specify the desired materials' performance (e.g. concrete strength, paint coatings, fixings).

There are at least two ways that standards can be developed – those required within a sector, industry or company, and those produced by a standards body such as national (e.g. NEN, DIN, MKS), regional (e.g. CEN and CENELEC) or international standard bodies (e.g. ISO, IEC, ITU). The three European Standardization Organizations, CEN, CENELEC and ETSI are officially recognized as competent in the area of voluntary technical standardization by EU Regulation (1025/2012) that settles the legal framework for standardization.

Benefits of using standards are many. Specifically, impacts from climate change will affect long life infrastructure (>30 years), its design, operation, maintenance and emergency responses. Standards provide tools for designers, builders, operators and users to ensure infrastructure safety, operability and longevity. Adopted at the early stages of a project lifecycle, standards can help to build in resilience, avoiding costly 'retrofit' solutions. Organisational standards can be covenanted into loan agreements, giving investors assurance that good practice is being followed.

Asl already noted in chapter 1, the role, importance and need for the existence and updating of standards related to infrastructure resilience have been recognised by the institutions of the European Union. Based on the updated **EU Climate Change Adaptation Strategy**, the European Commission has updated its climate resilience guidelines for new major infrastructure projects. So far, the European Commission and European standardisation organisations have launched an update of 12 standards governing the safety and performance of infrastructure in a changing climate.

Updates will be extended to existing infrastructure. The developed guidelines for standards will enable the acceleration of solving a wider range of standards related to the resilience of infrastructure. **The Adaptation Strategy recognises and encourages Member States to include national standardisation in their national adaptation strategies**.

3.4.2 International practices and standards relevant to increasing infrastructure resilience

Updating and adjustments of standards and codes so that reflect climate risks and support increase of resilience of infrastructural projects has just recently become of great interest for various key stakeholders. Regulatory standards, such as technical codes, are being reviewed and strengthened to promote climate resilience worldwide. National governments are revising national technical standards to account for climate resilience.

As already noted, there are three levels of standard organisations and usually they feed into each other. For example, national standards are based on international standards. These levels include:

- National standards such as DIN, MKS, and any other national standards.
- Regional standard bodies such as The European Committee for Standardization - CEN, European Committee for Electrotechnical Standardization – CENELEC, and others.
- International standard bodies – Most notably ISO.

International standards

An international standard is a standard adopted by the International Organisation for Standardisation[22]. Standards produced by standards bodies - such as ISO or European standards - may be the subject of choice. These "voluntary standards" may become mandatory if adopted by a regulatory body, or when invoking laws, contracts, etc. Clients, investors and other organisations may choose to require compliance with the standard as part of a contractual agreement.

Standards produced by a standards body respond to a market need. The ISO process is summarised below, other bodies such as CEN/CENELEC use similar processes[23]:

- ISO standards respond to a need in the market, from e.g. a request from industry or other stakeholders. Typically, an interested group communicates the need for a standard to ISO via its national standards body;

[22] https://www.iso.org/home.html

[23] https://www.ebrd.com/documents/climate-finance/climate-change-standards-and-their-role-in-improving-the-climate-resilience-of-infrastructure-investments.pdf?blobnocache=true

- These standards are developed by groups of experts from all over the world, that are part of larger groups called technical committees. These experts negotiate all aspects of the standard, including its scope, key definitions and content;
- Technical committees are made up of experts from the relevant industry, but also from consumer associations, academia, NGOs and government;
- Developing ISO standards is a consensus-based approach and comments from all stakeholders are taken into account.

ISO standards are organisational standards. In general, this group of standards includes risk, asset and environmental management, climate change adaptation, adaptation planning for organisations including local governments and communities, reporting, service activities, sustainable development in cities and communities, security and resilience.

ISO standards in relevance to climate adaptation are organisational standards.

In terms of ISO standards vital for increasing of climate resilience of infrastructure, the following standards are most relevant:

- **ISO 14090:2019 Adaptation to climate change** – These standards specify principles, requirements and guidelines for adaptation to climate change. This includes the integration of adaptation within or across organizations, understanding impacts and uncertainties and how these can be used to inform decisions.
- **ISO 14091:2021 Adaptation to climate change — Guidelines on vulnerability, impacts and risk assessment.** Gives guidelines for assessing the risks related to the potential impacts of climate change. It describes how to understand vulnerability and how to develop and implement a sound risk assessment in the context of climate change. It can be used for assessing both present and future climate change risks. Risk assessment according to this document provides a basis for climate change adaptation planning, implementation, and monitoring and evaluation for any organization, regardless of size, type and nature.

Regional standards - Eurocodes

Eurocodes[24] are construction standards that can play an important role in strengthening resilience to the effects of climate change. The Eurocodes fall into the Specification Standard category and include 10 sets of standards (EN 1990 - 1999) covering subjects related to construction. More specifically the structural design, covering the basics of design, effects on structures, major building materials and a wide range of types of structures and products. They provide common rules for the design of construction works and the verification of the strength and stability of structures under extreme loads. They refer to buildings, infrastructure and other construction facilities. Their implementation in European countries began in 2010. Unlike European standards, Eurocodes used for construction projects are mandatory for public works in the EU.

in many cases Eurocodes are called up in national legislation, either by incorporation or by reference. In these cases, the use of Eurocodes is mandatory. They are therefore powerful tools that ensure the structural safety of infrastructure works and are widely used as requirements in

[24] https://www.en-standard.eu/eurocodes/

contracts for design and engineering of public works; investors in Europe should not need to mandate their use as they are already required.

The following table presents the list of Eurocodes sets of standards:

Table 9 List of 10 Eurocode sets[25]

Standard set	Name
EN 1990	Eurocode: Basis of structural design
EN 1991	Eurocode 1: Actions on structures
EN 1992	Eurocode 2: Design of concrete structures
EN 1993	Eurocode 3: Design of steel structures
EN 1994	Eurocode 4: Design of composite steel and concrete structures
EN 1995	Eurocode 5: Design of timber structures
EN 1996	Eurocode 6: Design of masonry structures
EN 1997	Eurocode 7: Geotechnical design
EN 1998	Eurocode 8: Design of structures for earthquake resistance
EN 1999	Eurocode 9: Design of aluminium structures

Currently, the most relevant Eurocodes in this context are EN 1990: Eurocode: Basis of structural design which sets out how subsequent Eurocodes (EN 1991 – EN 1999) and EN 1991: Eurocode 1: Actions on structures. EN 1991 covers 'mechanical actions' including climate-relevant Snow Loads Part 1-3), Wind actions (part 1-4), and Thermal actions (Part 1-5).

The national application of Eurocodes in the EU Member States and those other using Eurocodes is based on nationally determined parameters (NDP)[26], relevant for defining thermal performance (maximum and minimum cold air temperature) shows a good level of compliance. Basically, Eurocodes prescribe methodology while each member define its parameters for an efficient application of this standards. Although Eurocodes are intended to harmonize the levels of safety in construction in Europe, Member States are free to take into account differences in national circumstances. Eurocodes take into account differences in countries related to construction practices, geographical, climatic conditions, procedures, etc. Due to their flexibility, they are used in various regulatory systems.

Based on already mentioned new EU Adaptation Strategy, the European Commission (EC) is working with European standardisation organisations to look at how far standards, codes and other rules need to be strengthened so that transport, energy, buildings and other infrastructure can cope with climate impacts and extreme events. This is indeed intended for the second generation of the Eurocodes, and all other standards relevant to transport infrastructure, energy infrastructure, and

[25] https://eurocodes.jrc.ec.europa.eu/showpage.php?id=13

[26] When the EN Eurocodes are used for the design of construction works, or parts thereof, the NDPs of the Member State on whose territory the works are located shall be applied. Each country using Eurocodes should have its own NDP determined.

buildings/construction. The EC requested the assessment of the climate change implications for the Eurocodes, the European standards for structural design. The work commenced in 2016 and updated second generation of Eurocodes is expected to be published in 2023.[27]

This should include revising and updating snow, wind and thermal-related measures, converting ISO standards on actions from waves and currents and on atmospheric icing; and preparing a document with the probabilistic basis for calculating partial safety factors and load combination factors, taking into account the variability and interdependence of climatic actions.

The EC requested the assessment of the climate change implications for the Eurocodes, the European standards for structural design.

Box 3: JRC Report *Thermal design of structures and the changing climate*[28]

In view of the central role European technical standards can play in addressing climate resilience of infrastructures and buildings, assessment of the impact of climate change on new and existing structures is a key aspect in the future evolution of standards. The Commission is working with European standardization organisations to look at how far standards, codes and other rules need to be strengthened so that transport, energy, buildings and other infrastructure can cope with climate impacts and extreme events. This is indeed intended for the second generation of the Eurocodes.

The impacts of climate change are particularly pertinent to infrastructure and buildings given their essential role in the functioning of our societies and economies. They are characterised by a long lifespan and high economic value and thus need to adapt to, and be resilient to future impacts of a changing climate. Buildings and infrastructure can be vulnerable to climate change because of their design.

Standardisation plays an important part in strengthening Europe's resilience to the impact of a changing climate, since it is an important instrument to regulate the construction sector. In this context, the publication of the Eurocodes by the European Committee for Standardisation (CEN) in May 2007, marked a major milestone in the European standardisation for construction. One of the main concepts of the Eurocodes is the Design Working Life (DWL), which is defined as the period for which the structure shall be used with anticipated maintenance but without major repair.

To proceed with the adaptation of structural design to the implications of climate change, the expected changes in the climatic actions shall be assessed in terms of the Eurocodes concept for the characteristic values of the variable climatic actions. Thus, updated European maps for the definition of thermal loading taking into account the climate change are necessary. Such maps can be published in informative annexes in the respective Eurocodes Parts of the second generation of the Eurocodes, as is currently the case of the European scale snow load map, which is incorporated in Annex C to EN 1991- 1-3. The production of updated thermal design maps taking into account the climate

European standards

The European standard is a standard adopted by the European Organisation for Standardisation (CEN / CENELEC / ETSI). **EU Regulation 1025/2012** regulates the legal framework for standardisation. If it is adopted on the basis of the request of the European Commission for

[27] https://publications.jrc.ec.europa.eu/repository/handle/JRC121351

[28] https://publications.jrc.ec.europa.eu/repository/bitstream/JRC121351/jrc_report_thermal_maps_final_online.pdf

application in the harmonised legislation of the European Union, it is called a harmonised standard. In addition to them, this group also includes European technical standards for the design of facilities, construction works, railway and air transport.

Manufacturers, other economic operators or conformity assessment bodies may use harmonised standards to demonstrate that their products, services or processes comply with relevant EU legislation. European standards defining the design and operation of infrastructure would usually be adopted as "good practice" in contracts. They can be applied in the phases of design, construction and operation of relevant infrastructure and have a moderate impact on adaptation investments. European standards are relevant mainly after the design of the facility is completed, for more detailed aspects of infrastructure design, maintenance and operation of construction.

There are several European Standards relevant for increasing of climate resilience of infrastructure. However, these are Specification Standards or Test/ Analysis Standards and have yet to be modified to account for future climate changes. These standards include the following:

Table 10 List of relevant European Standards

Standard set	Name
Building sector	
EN ISO 15927-4	Hygrothermal performance of buildings – Calculation and presentation of climatic data. Part 4: hourly data for assessing the annual energy use for heating and cooling;
FprEN 16798-1 and -3; -2 and -4	Energy performance of buildings Part 1: Indoor environmental input parameters for design and assessment of energy performance of buildings addressing indoor air quality, thermal environment, lighting and acoustics - Module M1-6; and Part 3: Ventilation for non-residential buildings - Performance requirements for ventilation and room-conditioning;
EN 16309	Sustainability of construction works. Assessment of social performance of buildings - calculation methodology
EN ISO 52000-1	Energy performance of buildings - Overall energy use and definition of energy ratings
Energy sector	
EN 16348	Gas infrastructure. Safety Management System for gas transmission infrastructure and Pipeline Integrity Management System for gas transmission pipelines. Functional requirements
EN 15399	Gas infrastructure. Safety Management Systems for gas networks with maximum operating pressure up to and including 16 bar
EN 1473	Installation and Equipment for LNG – Design of Onshore Installations
Transport Sector	
EN 206	Concrete Specification, performance, production and conformity
EN 15723	Closing and locking devices for payload protecting devices against environmental influences - Requirements for durability, operation, indication, maintenance, recycling
EN 50125-1, -2 and -3	Railway applications - Environmental conditions for equipment, Part 1: Equipment on board rolling stock, Part 2: Fixed electrical installations, Part 3: Equipment for signalling and telecommunications;
EN 1915-1 and -2	Aircraft ground support equipment - General requirements, Part 1: Basic safety requirements, and Part 2: Stability and strength requirements, calculations and test methods.

Individual specific standards related to climate resilience of infrastructure

There are specific, voluntary basis standards or labels, not part of any specific national guidelines nor regulated. Some of these examples are Leadership in Energy and Environmental Design (LEED) and Building Research Establishment Environmental Assessment Method (BREEAM).

- **LEED**[29] is a certification system for buildings, houses and communities, which provides a framework for healthy, highly efficient, cost-saving buildings. The LEED certificate is awarded for the design and construction of all types of buildings, including interior design, operation and maintenance. The LEED Climate Resilience Screening Tool, part of this certificate, provides a practical framework to identify climate sensitivities and to prioritize opportunities to promote enhanced resilience through the green building outcomes rewarded in LEED credits.
- **BREEAM**[30] is a global sustainability assessment method for master planning, infrastructure and building projects that reflects the value of assets with better performance over the life cycle of the built environment, from new construction to use and renovation. BREEAM does this through third-party certification to assess the performance of the environmental, social and economic sustainability of assets. It aims to encourage and support efforts to mitigate the future impacts of climate change on the building by considering a number of relevant factors during the design stages.

3.4.3 Status of standards in the context of climate resilient infrastructure in North Macedonia

The Law on Standardisation [31] regulates the goals and principles of Macedonian national standardisation, the status of the Institute for Standardisation of the Republic of Macedonia, as well as its tasks, membership and financing, preparation, adoption and publication of Macedonian national standards and their application.

The ISRSM is the national body responsible for standards and a full member of European standardisation bodies with the same obligations as all other EU member states. Accordingly, all European standards are also valid in North Macedonia. The ISRSM works closely with stakeholders from the sectors of industry, education and with ministries, primarily MoEPP. Stakeholders have their representatives on technical committees.

The ISRSM is a member of the following international and European standardisation organisations:

- International Organisation for Standardisation - ISO (full member);
- International Electrotechnical Commission - IEC (associate member);
- European Committee for Standardisation - CEN (full member);
- European Committee for Electrotechnical Standardisation - CENELEC (full legal member);

[29] https://www.usgbc.org/help/what-leed

[30] https://www.breeam.com/

[31] https://dejure.mk/zakon/zakon-za-standardizacija

- European Telecommunications Standards Institute - ETSI (national standardisation organisation).

The "Macedonian standard" is considered to be a standard adopted by the Institute for Standardisation of the Republic of North Macedonia (ISRSM). The Macedonian standard can be identical to the European (EN), international (ISO/IEC) standard, or some other national standard. In that case, it can be recognized by the marks MKS EN, MKS ISO, MKS DIN, etc.

Also, a North Macedonian standard can be solely developed in country (not all standards have to be transposed from abroad). In that case, it is developed by experts from ISRSM and technical working groups, finally adopted by ISRSM. Although such standard has not been adopted at European and international level, its existence must be reported to European standardisation bodies.

Approximately 30,000 various standards have been adopted in North Macedonia. As soon as new European standard is adopted, the old one must be withdrawn. Within 2-3 months from the adoption of the European standard, it will be adopted in North Macedonia as well. Standards are reviewed every 5 years.

The standards are developed by respecting the principle of consensus by the technical committees composed of stakeholders - manufacturers, companies, consumer associations, citizens' associations and chambers of commerce, educational and scientific institutions, certification bodies, laboratories, inspection bodies, and other legal entities. The task of the technical committees in the preparation and implementation of the program for adoption of standards in certain areas, monitoring and participation in the work of the relevant technical working bodies of international and European standardisation organisations. The work of these technical committees is organised and coordinated by the national standardisation body, i.e. the ISRSM.

The basic procedure for drafting the standards is in accordance with the Internal Rules of ISRSM[32] which are based on European and international principles are:

- Identification of the need for new standards (submitted initiative);
- Studying the need for a new standard;
- Establishment of a technical committee (existing or new),
- Preparation of a draft standard and reaching a consensus within the technical committee;
- Public debate on the draft standard;
- Approval and publication of the standard.
- An initiative for preparation and adoption of the Macedonian standard can be submitted by all interested parties, government bodies, or other legal entities, by the technical bodies of the Institute, and others.

North Macedonia is in process of EU integration and as such required to transpose Directive 2004/18/EC on Public Procurement. According to this directive it is mandatory that Member States accept designs to the EN Eurocodes. The EN Eurocodes will become the standard technical specification for all public works contracts. If proposing an alternative design one must demonstrate that is technically equivalent to an EN Eurocode solution.

[32] https://isrsm.gov.mk/en/development-of-macedonian-standards_p7.html

Up until now many Eurocodes have already been transposed and translated in North Macedonia. Specificity of Eurocodes lays with the fact that each country has to determine its own parameters in order to use these standards properly and efficiently, the National Determined Parameters (NDPs). In North Macedonia they are determined by the technical committee responsible for Eurocodes and national annexes. North **Macedonia has its NDPs determined**. For example, maps for seismology, wind, snow, and temperature (maximum and minimum) for North Macedonia have been made.

As already mentioned, all currently available Eurocodes have been transposed and translated. Also, those require NDPs which are also developed. The plan is that only Eurocodes will be valid from 2023 onwards. However, the EU is currently updating Eurocodes in order to account for climate resilience. The Eurocodes are under review for ease of use and new thinking, and this includes for modification to account for future climate change. Eurocodes do not presently account for all weather and climate impacts including flooding and drainage. It is unclear how would this be reflected in North Macedonia.

Furthermore, in 2020 National Hydrometeorological Service – Skopje recognized importance of Eurocodes and the need for implementing updated and appropriate climate related information. They've published **"Climate Maps Needed for Implementation of European Standards (Eurocodes) in the Republic of North Macedonia"**. Basically, it is analysis that describes the methodology used by the National HMS to prepare the climate maps through which the Eurocodes should be adopted and implemented in the Republic of North Macedonia. The analysis covers snow loads, wind actions, and thermal actions. The following was recommended for taking into account when Eurocodes are applied:

- cooperation with neighbouring countries for better harmonization and inclusion of data from border areas should certainly be one of the priorities, which would provide a more credible picture of the border regions;
- longer timeframe for processing additional stations so that more accurate snow load data could be obtained, including measurements of actual snow density values (where available), will certainly provide a more reliable load analysis. This more detailed analysis will make it possible to define and determine the exceptional snow load, also.

3.4.4 Key findings

Key finding 1. The Institute for Standardisation of the Republic of North Macedonia is a member of the European standardisation bodies and has the same obligations as all other European members.

This Law on Standardisation regulates the status of the Institute for Standardisation of the Republic of Macedonia, as well as its tasks, membership and financing, preparation, adoption and publication of Macedonian national standards and their application.

The ISRSM is a member of the following international and European standardisation organisations:

- International Organisation for Standardisation - ISO (full member);
- International Electrotechnical Commission - IEC (associate member);
- European Committee for Standardisation - CEN (full member);
- European Committee for Electrotechnical Standardisation - CENELEC (full legal member);

- European Telecommunications Standards Institute - ETSI (national standardisation organisation).

The international and European standards apply in North Macedonia.

Key finding 2. All Eurocodes have been transposed.

The text of the standards / Eurocodes have been adopted in English. The translations have been mostly done, but have not been verified yet. Nationally determined parameters are written in Macedonian. By the middle of 2023, it will be possible to choose whether the design parameters from the Eurocodes or the existing Macedonian construction standards will be applied. After that period, only the Eurocodes will be valid.

Key findings 3. There are several examples of good practice in including infrastructure resilience in capital projects in North Macedonia.

These examples relate to modern highways financed by international financial institutions. These institutions require that climate resilience be taken into account when designing. In general, the involvement and quality of climate change measures are higher in projects financed by international financial institutions than by local sources.

Key findings 4. Engineers have knowledge and experience of standards, but not in a systematic way. Trainings and education are needed to make design and implementation similar.

The engineering and research community will adapt quickly to new standards and practices. There are enough engineers in North Macedonia who would be willing to follow and apply the guidelines. Engineers have knowledge and experience of standards, but not in a systematic way. Trainings and education are needed to develop a unified approach to design and implementation. This training could potentially be organised by the Ministry of Transport and Communications and / or the Ministry of Economy / Ministry of Environment and Physical Planning in cooperation with Chamber of Architects and Engineers, technical faculties, the Institute for Standardization of North Macedonia and public companies responsible for relevant sectors.

3.5 Transport sector

3.5.1 Brief overview of the sector

Roads

According to the National transport strategy[33], the existing transport infrastructure in North Macedonia consists of 14,410 km of public roads, 699 km of railways and 2 international airports. Air traffic is organised through two international airports, in Skopje and Ohrid. The only water transport is on Lake Ohrid. Apart from a few lines between places in Northern Macedonia, an international lake line has been established between North Macedonia and Albania, but it is seasonal.

[33] http://www.mtc.gov.mk/media/files/2019/NTS-final%20MK.pdf

The road network consists of 899 km of state highways, 3,778 km of regional and 9,733 km of local roads. Most of these roads have two lanes. The open railways were built as single-track, and only sections of Corridor X are electrified to about 34% of the total length. There is no railway connection with Albania and Bulgaria. It is planned to build new railway connections in the length of 89 km from Kumanovo to the Bulgarian border and 66 km from Kičevo to the Albanian border.

The road infrastructure along Corridor X is 195 km long and is located in the direction from Serbia to Greece, and 83% of this road has already been built according to the standards for modern highways. Corridor VIII connects the Adriatic Sea with the Black Sea and has a length of 298 km. Only 37% of the road infrastructure along Corridor VIII is at the highway level in line with standards. Corridor X-d is a section of Corridor X, which starts in Veles and ends at the border crossing with Greece. The length of this road is 117 km and this section has 2 lanes. The entire length of Corridor X was completed in the first half of 2018. The connection with the Corridor VIII highway has not been realised and projects are underway.

Railways

The railways network length in North Macedonia is slightly below 700 km. Partial rehabilitation of about 54 kilometres of the railway on Corridor X is still underway. However, other railways also need to rehabilitate tracks and modernize signalling and telecommunications systems, as well as improve conditions at railway stations. Most railway stations were built according to standards different from those prescribed in the European Agreement concerning international railways for combined transport.

Estimates of the Public Enterprise for State Roads say that slightly less than 80% of Macedonia's national road network is in good or satisfactory condition. However, World Bank data show that only 40% of highways are in good or satisfactory condition. About 70% of locomotives and motor vehicles were produced between 1965 and 1974. The railway on Corridor X is single-track, electrified, mostly in medium condition, with two recently renovated sections Tabanovce-Kumanovo 11.6 km and Miravci-Smokvica 12.5 km, which can be described as good condition. The railway on Corridor VIII is not yet fully built.

Airports

The concession period for the airports began in 2010, and the planned works under the concession agreement included the construction of a new airport terminal building in Skopje, expansion of space, a new administrative building and a new parking lot on the access road. Ohrid Airport has completed the modernisation of the terminal building. The concession agreement also envisages the construction of a third airport named for freight traffic near Štip. The country's two main airports are being modernised and reconstructed.

3.5.2 Current practices related to climate proofing of transport sector infrastructure

National Transport Strategy 2018-2030 sets up strong foundation for climate proofing of infrastructure. It contains concrete set of envisaged activities:

- Regulatory measure (RM) 5, 1.3. Modify national transport infrastructure standards regarding the environmental sustainability and climate change included.

- Strategic action OSM 19 3.1. Preparing a comprehensive study for quantifying impacts of climate change, climate variability and extreme weather events on infrastructure and services (network resilience)

These activities presents clear pathway towards climate proofing of transport infrastructure and it is yet to be defined how will this be achieved.

Currently, national technical standards and regulations relating to railway infrastructure and traffic are almost the same as those applied by the former Yugoslav railway company. It is necessary to harmonize standards and rules with EU directives and technical standards.

The vehicle fleet is old in both road and railway traffic. As there has been some improvement with the procurement of new public transport buses in Skopje, the bus fleet, like the size of rail passenger cars, is more than 10 years old. It is necessary to further implement the necessary regulations and accessibility standards for persons with disabilities in road and rail transport.

Although addressing the effects of climate change in the Western Balkans in general takes precedence over a preventive action, there are examples of good practice in including infrastructure resilience in capital projects in North Macedonia. For the construction of some sections of the motorway between Skopje and Kosovo[34], the Environmental and Social Impact Assessment (ESIA) Study has made proposals on how the road should be resilient to climate change. The proposed measures should be incorporated into the main project, so the contractor will have to apply them during construction. This is another example of such a practice, next to the ESIA Study for the highway between Bukojčani and Kočani[35].

There are also several relevant initiatives present in North Macedonia. Please see the table below:

Table 11 Overview of the most relevant initiatives/projects/programmes – transport sector

Initiatives/projects/programmes	Relevance to climate resilient infrastructure
Transport sector	
The project **"Enhancing Environmental Performance and Climate Proofing of Infrastructure Investments in the Western Balkan Region from an EU integration perspective" (CLIMAPROOF)** is financed by the Austrian Development Cooperation (ADC) and implemented by UNEP. (2017-2021)[36]	ClimaProof project will result in increased technical capacities of the relevant national authorities in the field of climate proofing of road infrastructure and green infrastructure. For large infrastructural projects detailed and specific climate projections during the planning phase will be prepared which will allow integration of adaptation measures in both the planning and realisation phase, thus

[34] http://www.roads.org.mk/470/5414/public-disclosure-of-documents-for-environmental-protection-and-social-aspects-according-to-the-ebrd-prs-for-the-project-construction-of-motorway-a4-skopje-blace-section-2-km-2000-to-km-12250

[35] http://www.roads.org.mk/470/5409/addendum-of-esia-study-for-construction-of-highway-a2-section-bukojcani---kicevo

[36] https://climaproof.net/

Initiatives/projects/programmes	Relevance to climate resilient infrastructure
	maximizing resilience to climate variability and extreme weather events.
The World Bank - **Technical assistance preparation of climate resilience design guidelines for the public enterprise for state roads in North Macedonia - Climate resilience design guidelines**[37] **(2019).**	Guidelines provide detailed and practical instructions on how to conduct a climate change and natural hazard road network vulnerability and risk assessment. The methodology distinguishes between two main groups of actions: i) risk impact assessment, and ii) identification and prioritisation of engineering/ non-engineering solutions for risk reduction/ mitigation. The identification of road sections under the most critical need for intervention is performed through four steps incorporating 9 tasks spanning across three layers: hazard, risk, engineering screening and the planning layer. The Guidelines defines engineering and non-engineering measures, as well as institutional and legal recommendations.
Detailed Design and Environmental and Social Impact Assessment for Motorway A4, Skopje - Blace. Section: Interchange Stenkovec-Blace Border Crossing Point (12.5 km) – **Climate Resilient Report** (Funded by EBRD and EIB)[38]	Report envisages measures to adapt to climate change during road construction phase and during the operational phase as well.

Box 4: Moravian Corridor ("Moravski koridor"), Serbia

The construction of a new highway in Serbia can be mentioned as an example of a good practice in the Western Balkans region. As this highway passes through an area that often has serious problems with floods, this climate impact is seriously taken into account during design and construction processes. The construction of this highway is also important for the road infrastructure of North Macedonia, because it will improve its connection with other countries in the region.

Construction of the highway "Moravian Corridor" E761 from Pojate to Preljina is underway. That corridor will connect the central parts of Serbia with the two most important highways in Serbia, which are part of the European road network: the E75 highway, through which it connects in the north with Belgrade and Central and Western Europe and in the south with North Macedonia and Bulgaria, and with the E763 Belgrade - South Adriatic highway.

Realisation of the Moravian Corridor Project includes:

- construction of a highway with a total length of 112.37 km and 40 bridges;
- hydro-technical regulation of the river Zapadna Morava;

37 http://www.roads.org.mk/470/5151/climate-resilience-design-guidelines-for-the-public-enterprise-for-state-roads

38 https://wbif.eu/project/PRJ-MKD-TRA-002

- "digital corridor".

The contractor Bechtel ENKA will build a large flood protection system to protect the area around the highway from flooding, erosion and subsequent water pollution. This will be the first flood mitigation system of this magnitude to be built along the highway in the Balkans.

The works on the hydro-technical arrangement of the river Zapadna Morava will include a total of 18 hydro-technical facilities, as follows:

- average curvature (construction of a new riverbed) of 22,655 km;
- regulation of the riverbed (protection of the left and right banks of the West Morava) of 11,725 km;
- coastal fortifications (protection of the left and right banks of the West Morava) of 4,465 km;
- reconstruction of existing and construction of new defensive embankments in the total length of 21.2 km.

The total length of hydro-technical works is 60.42 km.

This highway will be the first 5G road in Serbia. Along the route of the highway, the construction of underground telecommunication cable lines is planned, through which optical cables will be laid and all devices on the highway will be connected. The goal of the digital corridor is to enable fast and reliable exchange of information, in order to enable safe traffic and comfortable use of the highway.

Construction is expected to be completed in mid-2024.

3.5.3 Key findings

Key finding 1. There is a strong national strategic objective for climate proofing of transport sector.

National Transport Strategy 2018-2030 contains clear objectives for inclusion of standards and practices for climate proofing its infrastructure by 2030.

Key finding 2. The road network is relatively well developed. However, roads are in average condition, but most of the roads do not meet modern standards.

The existing transport infrastructure in North Macedonia consists of almost 15,000 km of public roads. According to the World Bank data show that less than 50% of roads are in good or satisfactory condition.

Key finding 3. Very relevant initiatives ongoing such as regional "ClimaProof" project financed by the Austrian Development Cooperation (ADC) and implemented by The UN Environment Programme.

For example, ClimaProof project is dealing closely with comprehensive climate vulnerability assessment of road sector in North Macedonia. This type and level of information can be extremely valuable for planning within the sector. Especially, in terms of choosing proper climate proofing technologies.

Key finding 4. Guidelines for designing climate resilience for the Public Enterprise for State Roads have been developed

These guidelines include climate adaptation measures that relate primarily to drainage and structure specifications, retaining walls, and slope stabilisation. The guidelines can also be useful for increasing the resilience of other types of infrastructure. [39] It is recommended that Public Enterprise for State Roads continue with the implementation of these guidelines, by providing trainings and capacity building of construction companies and experts/engineers.

Key finding 5. Climate resilience requirements for transport infrastructure are not sufficiently included in the legislation system.

Mandatory use of standards that contribute to increasing resilience can be ensured by introducing obligations to apply those standards. This can be achieved by including standards in relevant sectoral laws and bylaws.

3.6 Energy sector

3.6.1 Brief overview of the sector

As a candidate for EU membership, the Republic of Northern Macedonia is obliged to transpose the EU legal framework into its national legal system, at the national level, but also at the level of local self-government. North Macedonia's intended enhanced nationally determined contribution (EINDC) includes reducing GHG emissions in 2030 by 51% compared to 1990 levels (expressed in net emissions, a decrease of 82% in 2030 compared to 1990 levels.). CO2 emissions from fossil fuel combustion by 30% (or 36% at a higher level of ambition) by 2030 compared to the BAU scenario. The country will have to adopt a Long-term climate action strategy and a Law on climate action. The Long-term climate action strategy has been adopted by the Government in September 2021. One of the goals they need to ensure is to achieve a climate-resilient economy / society. The following presents some main characteristics of the sector relevant in the context of the study, according to the Strategy for Energy Development [40]:

- The installed capacity of electricity in North Macedonia is 2.06 GWh and it is produced from thermal power plants (48%), hydro power plants (34%), combined gas power plants (15%) and RES (3%). In recent years, the production of electricity from coal is constantly declining, and from RES is increasing. The country has a relatively high import dependence in the region. Despite the reduction in consumption, the average share of imports is about 30% of total electricity consumption.
- The district heating system operates only in Skopje. About 8.3% of households in North Macedonia use district heating (25% in Skopje), 61.6% firewood, 28.6% electricity, and the remaining 1.5% other fuels.

[39] http://www.roads.org.mk/UserFiles/files/ZivotnaSredina/2019/Joze/PartB-CLIMATE%20RESILIENCE%20DESIGN%20Guidelines.pdf

[40] https://klimatskipromeni.mk/data/rest/file/download/4a5343d50dc1080836144142d925d9f80d71a5545a86b6a9a68218f5cb3cc179.pdf

- North Macedonia has a well-developed transmission network with five interconnection points. The total transmission network consists of 577 km 440 kV and 1,601 km 110 kV power lines. Northern Macedonia has interconnections with Serbia, Kosovo, Bulgaria and Greece.
- In addition to the development of new transmission lines and interconnectors, the existing obsolete transmission network needs revitalisation in order to increase the reliability of the transmission infrastructure. The long-term investment plan until 2040 envisages investments in a system of 163 mil. EUR, of which 87 mil. EUR for new network and 76 mil. EUR for network revitalisation.
- The duration and frequency of power outages in the distribution network in Northern Macedonia are relatively high compared to the region. With regard to the distribution network, North Macedonia has the potential to improve power reliability. Investing in the distribution network is one of the most important activities to improve security of supply.
- North Macedonia imports natural gas entirely, via Bulgaria. Natural gas accounts for 7% of primary energy consumption, but with the potential to increase this share, which requires the development of other supply routes, such as the planned interconnection with Greece in 2022. There is also the potential for interconnections with other neighbouring countries.
- North Macedonia has launched an ambitious plan to bring gas to the entire territory of Northern Macedonia. The total planned investments in all three phases amount to EUR 323.1 million.

3.6.2 Current practices related to climate proofing of energy sector infrastructure

The Ministry of Economy and its Energy Department is the country's key energy policy creator. In this capacity the Ministry of Economy is responsible for:

- Developing and/or adopting energy legislation including energy efficiency and renewables
- Developing and proposing adoption of strategic/planning documents relevant for energy planning and development including but not limited to Strategy for Energy Development, Plan for realization of the Strategy, energy balances, energy market and rules, National Energy Efficiency Action Plan, Building Renovation Strategy, Renovation Plan for reconstruction of public buildings owned and occupied by the central government, Plan for increasing the number of nearly zero-energy buildings, etc.
- Monitoring implementation of the energy legislation and strategic/planning documents that are energy-related
- Supervising the work of the Energy Agency and local self-government units with respect to their responsibilities related to energy efficiency
- Establishing the system for energy audits both for buildings and for large enterprises (including issuance of licenses and authorizations for energy audits; establishing and maintaining the registries of licensed and authorized energy auditors, etc.

During stakeholder consultations, Ministry of Economy – Energy Department and Energy Agency were contacted. Current activities within the sector are heavily oriented around climate mitigation and there are not known activities related to increasing resilience of current and future energy infrastructure. However, since future investments are almost always done in cooperation with international donors and other such institution, it appears that at least EIAs that cover climate risks are done. It is not known to what extent and how are these conducted. For example, The European

Investment Bank (EIB) is continuing to invest in the energy security of the Western Balkans by providing a €28.9 million investment loan for the construction of the North Macedonia section of the gas interconnector between North Macedonia and Greece.[41] The EIB uses **Technical guidance on sustainability proofing for the InvestEU Fund**[42] for investments over 10 million EUR. This is a specific set of guidelines that requires robust environmental and social management due diligence which include climate vulnerability assessment of infrastructure alongside identification of required climate adaptation measures.

Box 5: Future-proofing Europe's energy infrastructure - Revision of the TEN-E Regulation

In the past ten years, the EU has improved cross-border energy infrastructure thanks to the TransEuropean Networks for Energy (TEN-E). 95 energy infrastructure projects – known as Projects of Common Interest – have received €4.7 billion of funding under the EU budget through the Connecting Europe Facility (CEF).

The Commission's new proposal brings TEN-E rules in line with the European Green Deal objective of becoming climate-neutral by 2050 and achieving a higher 2030 climate target. The new rules will ensure that all future energy infrastructure projects align with our climate-neutral ambition.

An example concerns the Trans-European Networks for Energy (TEN-E, Regulation (EU) No. 347/2013), which determines the selection criteria for the energy Projects of Common Interest (PCIs) and aims at expediting the interlink between national energy systems. It is mainly based on identifying priority corridors and thematic areas whose implementation would establish a true European infrastructure.[43]

Updated regulation, expected over the course of 2022, will include new climate parameters.

3.6.3 Key findings

Key finding 1. The sector is heavily oriented around climate mitigation related activities.

Current activities within the sector are heavily oriented around climate mitigation and there are not known activities related to increasing resilience of current and future energy infrastructure.

Key finding 2. It is likely that any newly built infrastructure co-financed by international donors will require climate proofing.

Usually, investments into energy related infrastructure are cots intensive, co-financed by international organisations that use their own climate proofing tools – for example EIB.

[41] https://www.eib.org/en/press/all/2021-485-team-europe-eib-continues-to-invest-in-the-security-of-energy-supply-in-the-western-balkans

[42] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52021XC0713(02)

[43] https://www.mdpi.com/1996-1073/15/6/1999/html

3.7 Water sector

3.7.1 Brief overview of the sector

Water supply

North Macedonia has about 8 billion m^3 of freshwater sources. In the years of intensive water use, the WEI (water use index) was about 20%, and at peak times, as in 2012, up to 35%. Water is used for human consumption (drinking water), irrigation, industrial, economic and other purposes. In the last few years, it has been observed that the demand for water is becoming quite variable, both in terms of the total demand for water from all sectors, but also in terms of demand from individual sectors.

In 2015, about 80% of the country's 2.07 million inhabitants were supplied with water from centralized drinking water systems operated by public utility companies. About 10% of the population is supplied to local rural water supply systems, and 10% have their own, individual water supply. Water losses in water supply companies remain high, ranging from 40 to 65%. North Macedonia has faced a seasonal shortage of drinking water in urban and rural areas. In addition, a high incidence of water-borne diseases may indicate that water resources are contaminated with untreated municipal wastewater[44].

Sewerage

The current state of sewage systems differs in urban and rural areas. Overall, existing systems are quite old, the collection network is composed of different materials, the pipes are cracked and there are leakages of wastewater. Urban wastewater and stormwater systems are not separated, and during floods the pipes are overloaded and subject to increased pressure, causing flooding of streets during heavy rainfall. By now, 12 cities and towns have built separate sewerage systems. Skopje has separate systems for wastewater (56% of the entire network) and for rainwater (18% of the network)[45].

Irrigation

Most irrigation systems in North Macedonia were built before the 1990s. For this purpose, more than 27 large dams, more than 120 small dams, about 1,400 km of main canals / pipelines and about 6800 km of detailed irrigation networks were built. Namely, the existing network is old, destroyed or not functioning and needs to be repaired. Therefore, it was up to the farmers to find solutions on their own, by digging wells, securing pipes and installing pumps.

With irrigation of less than 10% of agricultural land and climate change causing more frequent and intense heat waves and droughts, losses in agricultural production can be expected.

[44] https://unece.org/fileadmin/DAM/env/epr/epr_studies/ECE.CEP.186.Eng.pdf

[45] https://www.eea.europa.eu/soer/2010/countries/mk/country-introduction-macedonia-the-former-3/country-introduction-macedonia-the-former-2

3.7.2 Current practices related to climate proofing of water sector infrastructure

As already described in Chapter 2, North Macedonian water sector is regulated by set of laws which do, to some extent, take into consideration climate change related impacts and risks. This is most notably present in the Law on Waters that does refer to floods protection. According to the MOEPP[46], the Law on waters contains chapter on floods protection, but this subject needs to be further developed in relevant sub laws in accordance with the Floods Directive 2007/60/EC. This Directive is approximately 20% transposed into the Law on Waters. Final date of full implementation of this Directive is not determined yet. Furthermore, the same source states the need for a number of flood related activities on national level. Most notably, those include:

- Preparation of the Preliminary Flood Risk Assessments in accordance with the requirements of the EU Floods Directive 2007/60/EC, Article 4 and Article 5;
- Preparation of the Flood Hazard maps and Flood Risk maps for all river basins in line with the requirements of the EU Floods Directive 2007/60/EC, Article 6;
- Preparation of the Flood Risk Management Plans for all river basins in accordance with the requirements of the EU Floods Directive 2007/60/EC, Article 7.

The MAFWE prepared Draft "Irrigation and drainage strategy 2021-2031". If approved, **the "National Irrigation and Drainage Strategy 2021-2031"**(NIDS) will be a long-term strategic document, which sets the roadmap for irrigation and drainage development in the Republic of North Macedonia. It is based on and is consistent with the overarching national policies for rural and agricultural development set out in the **National Agricultural and Rural Development Strategy 2021 – 2027** (NARDS).

This Strategy is pending its approval and contains several specific activities relevant for the context of this study. Some of which include:

- Preparation of the study of the effects of climate change on irrigation and drainage including the changes in crop and irrigation water requirement and water availability
- Preparation of an action plan that would among other focus on promotion and application of modern irrigation systems and practices, de-risking by better water management (flood control, drainage management and insurance), preparation of management plans for each of the irrigation and drainage systems
- Investment in the rehabilitation and modernisation of existing irrigation infrastructure for reduction of water losses and increase of the water use efficiency (reduction of the water conveyance/distribution losses, reduction of on-farm losses, participatory approach)
- Investment in Rehabilitation and modernisation of the drainage systems.

Even though investment in modernisation of irrigation infrastructure is envisaged it is not clear how would, and if, that infrastructure be climate proofed.

In 2021, the MAFW, in cooperation with Food and Agriculture Organisation (FAO) prepared and submitted the project proposal to Adaptation Fund called **Building climate resilience of the**

[46] https://climaproof.net/s/North-Macedonia-recommendations-and-guidelines.pptx

agricultural system in Radovish region through improved irrigation, land and water management. [47] The project aims to establish a climate-resilient agricultural system in Radovish valley by removing structural land barriers to adaptation and minimising threats to agricultural production due to climate-change-induced water demand increased and technological, information, and knowledge gaps. The project targets eleven adjacent villages in Radovish municipality in North Macedonia, with a specific focus on young farmers and women farmers. Component 2 of the proposal aims at building resilience to climate change shocks and risks to agricultural production in Radovish valley through climate-proofing the irrigation system for resilient agricultural production and efficient and sustainable irrigation water management. More specifically adaptation measures envisaged are:

- Replacement of the open right channel that is highly deteriorated to closed pressurized system to eliminate technical and losses from evapotranspiration;
- Construction of energy-efficient (with frequency converter) pumping station accompanied with pumping pool immediately after the diversion structure to facilitate the introduction of water-saving on-farm technology (sprinkler and irrigation) and regulate water supply to the irrigation network;
- Full replacement of old-type to new type hydrants to enable multiple user irrigation;
- Protective structure built, including river crossing and closure of the section of existing canal that passes through the village Injevo.

The above-mentioned project is subject due to approval from the Adaptation Fund.

Table 12 Overview of the most relevant initiatives/projects/programmes – water sector

Initiatives/projects/programmes	Relevance to climate resilient infrastructure
Water sector	
Report **''Water resources and climate change - Vulnerability assessment and adaptation measures''** developed as a part of the country's Third National Communication on Climate Change to the United Nations Framework Convention on Climate Change by the Ministry of Environment and Physical Planning with support from the United Nations Development Programme (UNDP) and the Global Environment Facility (GEF)[48]	This publication summarizes the key findings of an assessment of the vulnerability of the Republic of Macedonia's water resources to climate change and possible adaptation strategies and measures.
The project **''Integrated climate-resilient transboundary flood risk management in the Drin River basin in the Western Balkans (Albania, the Former Yugoslav**	The objective of the project is to assist the countries with integrated climate-resilient, basin-wide transboundary flood risk management (FRM) by improving climate risk knowledge and information; improving transboundary cooperation arrangements

[47] https://www.adaptation-fund.org/wp-content/uploads/2021/10/AFB.PPRC_.28.18-Proposal-for-North-Macedonia.pdf

[48] http://www.unfccc.org.mk/content/Documents/ADAPTATION/new_Water%20Resources_final_EN%20so%20CIP.pdf

Republic of Macedonia, Montenegro)'' financed by the Adaptation Fund[49]	and policy framework for FRM and applying concrete FRM interventions.
Improving Resilience to Floods in the Polog Region.	The project's ambitious goal is to instigate transformational change in managing flood risk in the region, accelerating the shift from purely reactive responses to floods to integrated systems to manage hazards, vulnerabilities and exposure of communities and assets to prevent/mitigate losses and alleviate the impact of future floods.

3.7.3 Key findings

Key finding 1. Relatively well developed strategic and legislative framework that still needs improvements. The framework oriented mostly on floods.

The water sector takes into account climate related risks such as floods, though it is not known to what extent. There are improvements needs in regards harmonisation with EU Floods Directive 2007/60/EC. Security of water systems, either planned or existent, seems not to take into account other climate impacts such as possible droughts.

Key finding 2. Need for improved data sets related for flood risk mapping and climate models.

There is a need for information that is aligned with EU Floods Directive. More specifically, according to the directive above there is a need to produce floods hazard maps and flood risk maps. These are requirements under Article 6 and 7 of the EU Floods Directive 2007/60/EC. This part of the Directive is not transposed yet and is vital aspect for effective and precise implementation of climate risk and vulnerability assessment within this sector.

Key finding 3. Several relevant initiatives are ongoing which may be scaled up in the future.

There are activities, within this sector, that are very relevant for climate proofing of infrastructure. For example, if MAFW's/FAO project gets approved by the Adaptation Fund, it could potentially be scaled up and substantially increase national "know how" on climate proofing in general and especially irrigation sector.

3.8 Built environment

3.8.1 Brief overview of the sector

Around 60% of Macedonian citizens live in the urban areas. North Macedonia has 1 mid-size and 4 small-size cities. Skopje, serving as the political, economic, academic and cultural centre, has over 506,000 people, about 18.7% of the country's total population. The other four cities with

[49] https://www.adaptation-fund.org/project/integrated-climate-resilient-transboundary-flood-risk-management-drin-river-basin-western-balkans-albania-former-yugoslav-republic-macedonia-montenegro/

populations over 50,000 are Bitola with 74,550, Kumanovo with 70,842, Prilep with 66,246, and Tetovo with 52,915. Seventeen towns have populations between 10,000 and 50,000.

Most social, commercial and residential buildings require some level of renovation. Looking at the residential sector, there are 391,684 individual houses and 19,260 multi-apartment buildings (MABs) in the Northern Macedonia. The average number of dwellings in the MABs is 15.2, and the housing units located in the MABs make up about 42% of the total housing units[50]. The average age of residential buildings in North Macedonia is over 30 years, and consists mostly of multi-apartment blocks, and due to poor maintenance, about 100,000 units in collective residential buildings need urgent EE intervention.

Within the urban settlements, the growing incidence of heat waves and flash floods is noticeable, and these are just some of the climate impacts that have been further exacerbated by dilapidated infrastructure and poor land use policies.

3.8.2 Current practices related to climate proofing of built environment sector

Built environment sector projects are mostly located within the urban areas, and for the time being, in the North Macedonia there is no comprehensive urban development strategy at the national level. Nevertheless, several cities have been preparing their own local development strategic plans, in accordance with the Law on Local Self-Government. On the other hand, with the support of international initiatives, some cities are preparing ambitious climate strategies or disaster risk reduction plans, as follows:

- As many as 6 Macedonian cities are signatories to the Covenant of Mayors, an initiative that commits cities to local energy and climate action, which since recently includes climate adaptation, along with mitigation.
- The City of Skopje has developed a Green City Action Plan (GCAP) under the EBRD's Green Cities Program and a Resilient Skopje Climate Change Strategy with UNDP's support. According to Skopje's GCAP, these are some of the identified actions and measures for adapting to climate change:
    - Promote safe and resilient infrastructure, housing and urban development
    - Develop a wildfire risk assessment to assess vulnerable areas and plan for integrated forest fire prevention
    - Ongoing rehabilitation and strengthening of existing natural and built flood protection infrastructure
    - Encourage development of green infrastructure across the city
    - As an example, the measure for upgrading the Skopje Green Cadastre through setting up of an inventory of additional trees and shrubs from Resilient Skopje Strategy has already been completed.
- Several cities and municipalities in the North Macedonia are preparing their local disaster risk reduction plans, within the project **"Improved Capacity For Crisis Response In Municipalities In North Macedonia"** supported by the British Embassy in North Macedonia.

[50] http://www.rec.org/publication.php?id=523

These plans develop municipalities' risk profiles (including climate risks elaboration) and identify measures to strengthen the strategic response to crises, most of which are climate adaptation measures.

When it comes to climate change mitigation, the built environment sector is making visible progress. Requirements for energy efficient renovation of buildings have become legally binding, as have requirements for new construction to be energy efficient. Also, a number of low-carbon infrastructure projects have been implemented, such as electric buses or solar photovoltaic panels that are installed on public buildings. The EBRD-funded shopping centre in Skopje was built according to the BREAAM standard, which requires, among other things, that adaptation measures be taken into account when designing and using the building.

The legal framework for the built environment sector consists of the Law on Spatial and Urban Planning, the Law on Urbanism and the Law on Construction. Spatial plans determine the conditions and parameters for the arrangement and construction of buildings, roads, public areas, parks and other infrastructure that ensures the functionality of cities. Given recent efforts to integrate climate change conditions into spatial planning, future urban plans are expected to have project parameters aligned with climate adaptation. Regarding design of buildings, secondary legislation for construction provides more detailed guidelines for designing different type of facilities, such as schools, hospitals or hotels.

Table 13 Overview of the most relevant initiatives/projects/programmes – built environment sector

Initiatives/projects/programmes	Relevance to climate resilient infrastructure
Built environment sector	
Mainstreaming Climate Change considerations into Spatial Planning Recommendations for Urban and Neighborhoods Plans (lower-level plans) - Developed within the project "Macedonian Forth National Communication and Third Biennial Update Report on Climate Change", implemented with technical and financial support from UNDP and GEF[51]	Recommendations for Country level plans (National Spatial Plan) and Region level plans (Regional Plans) Recommendations for Urban and Neighbourhoods Plans (lower level plans)
Project **Municipal Climate Change Strategies**, including climate adaptation and/or resilience financed by USAID, 2012-2015[52]	Project was implemented by the CSO Milieukontakt Macedonia. 8 municipalities (Bogdanci, Bogovinje, Krivogashtani, Mavrovo/Rostushe, Pehcevo, Studenicani, Tearce and Vinica) have developed and adopted climate change strategies in 2015.

[51] https://klimatskipromeni.mk/data/rest/file/download/802f1a43e84dff9a911d3a874b7bb01852b11caef00533fc37057257af3be7f0.pdf and https://klimatskipromeni.mk/data/rest/file/download/aad45f0f25323f27d9ac911991e41df2b3e1420cf0581d01bbf580eb02b86a33.pdf

[52] https://www.usaid.gov/macedonia/fact-sheets/municipal-climate-change-strategies-mccs-project

Initiatives/projects/programmes	Relevance to climate resilient infrastructure
	These strategies have been developed through a participatory process aimed at empowering the local civil society and population. Several small-scale priority actions have been identified and implemented (energy efficiency in public buildings, riverbed rehabilitation, installation of water meters).
Resilient Skopje – Climate Change Strategy financed by the UNDP, 2017[53]	The Strategy, adopted in 2017 by the City of Skopje, assesses the potential of a reduction of GHGs at the city level as well as the vulnerability of a number of sectors to climate change, It also contains an action plan, with a list of concrete measures, both geared towards emissions reductions and aimed at strengthening the resilience of the City.
Skopje Lab supported by the UNDP[54]	Thermal Map of Skopje was developed and 14 measures have been selected that are adapted for Skopje and can be applied by the municipalities or the City of Skopje.
EBRD Green Cities Programme - Green City Action Plans for Skopje and Kumanovo are under development [55]	Green City Action Plans assess a variety of environmental and climate indicators and select strategic actions in 5-10 sectors, including policy actions and infrastructure investments. It is assumed that part of the actions will contribute to adaptation and resilience.
Improved Capacity for Crisis Response in Municipalities In North Macedonia[56]	The local DRR strategic plans are being developed for the municipalities of Kichevo, Ostivar, Konche, Karabinci, Kadavarci and Veles as well as the City of Skopje. These plans provide a strategic framework and measures that contribute to the long-term resilience of the municipalities against contemporary risks.
Think Hazard project supported by GFDDR[57]	ThinkHazard! provides a general view of the hazards, for a given location, that should be considered in project design and implementation to promote disaster and climate resilience. The tool highlights the likelihood of different natural hazards

[53] https://skopje.gov.mk/media/4051/resilient-skopje-strategy-eng.pdf

[54] https://skopjelab.medium.com/skopje-thermal-map-the-warmest-hotspots-in-the-city-and-measures-to-tackle-the-problem-a4fa5c0b31e2

[55] https://www.ebrdgreencities.com/

[56] https://idscs.org.mk/en/2022/02/01/strategic-plans-for-disaster-risk-reduction-2021-2025-adopted-by-the-municipal-councils-in-north-macedonia/

[57] https://thinkhazard.org/en/report/241-fyr-of-macedonia

Initiatives/projects/programmes	Relevance to climate resilient infrastructure
	affecting project areas (very low, low, medium and high), provides guidance on how to reduce the impact of these hazards, and where to find more information.

Box 6: Making Dutch cities rainproof with innovative grey and green solutions

The Netherlands has a problem with excess water, as it is fighting against both rising sea levels and heavy rains, as well as frequent floods. Due to climate change, precipitation in the country increased by 25% over the past century.[58] So what to do with all this water in a densely populated country, which can hardly keep its feet dry without great technical effort? The Dutch have learned that building more flood defences against intense rainfalls is not enough and they are now trying to "rainproof" urban areas. Various projects and schemes are now being tested in urban areas to catch, hold and slowly release rainwater from heavy downpours to reduce floods.

1) Rotterdam Watersquare
Instead of making bigger sewer pipes, the City of Rotterdam made a choice to invest in redesigning public space in a way that it can retain the water during excess rains. Public space such as Benthemplein in Rotterdam has been turned into water plaza with basins that turn into small lakes during heavy rains, and thus collect runoff ie. store excess water and prevent floods. The square is also nicely designed, planted with vegetation and during dry weather is used as skate park and basketball playground.[59]

Source: https://www.springwise.com/multi-use-city-square-built-collect-floodwater/

2) Raingardens in Amsterdam

[58] https://www.uncubemagazine.com/blog/13323459

[59] https://land8.com/waterplein-benthemplein-reveals-the-secret-of-versatile-water-squares/

Nature-based solutions are addressing various environmental challenged by mimicking the nature and are an alternative to traditional, engineered solutions. In 'Blok 54', a new building on the city island IJburg in Amsterdam, green roof and rain garden were created to buffer stormwater and create habitat for diverse vegetation and birds. There is also sustainable food production as planted fruit trees produce fruits such as apples and strawberries. The vegetation along the creek acts as a sensory garden for poly handicapped children from the health care centre inside the building.[60]

3.8.3 Key findings

Key finding 1. . Cities and municipalities are preparing (and started implementing to some extent) their climate strategies, although not required by regulation

Several cities have been involved in initiatives and programs of international institutions that have managed to develop their own strategies for climate mitigation or adaptation. However, full implementation of identified measures is still lagging behind.

Key finding 2. Several municipal DDR strategies contain climate risk assessment and propose adaptation measures

Five municipalities in North Macedonia adopted Local strategic plans for Disaster Risk Reduction (DRR) 2021 – 2025. Currently, same plans are being developed with the municipalities of Kichevo and Gostivar and the City of Skopje. The aim of local DDR strategies is to reduce the risk of accidents regarding prevention, preparedness, response, and recovery from natural disasters. The plans provide a strategic framework and a set of short and mid-term measures and activities that contribute to the long-term resilience of the municipalities and their citizens against contemporary risks, including climate risks. These plans contribute to implementing the Target E of the Sendai Framework on Disaster Risk Reduction 2015 – 2030.

Key finding 3. Maintenance and energy renovation of buildings do not consider climate adaptation and related measures

Extensive renovation programs for residential and public buildings could be an opportunity to consider incorporation of climate adaptation measures for buildings, where possible.

Key finding 4. Spatial and urban plans should prescribe regulations on land use and construction that reduce the impact of climate change

Recent amendments to the Law on Urbanism, as well as the possibility of applying climate-resistant methodology for spatial planning at the national and regional level open the way for the development of new local spatial and urban plans that would propose new rules for use and protection of space. as well as construction parameters, which would ensure the resilience of the built environment to climate change.

[60] https://una.city/nbs/amsterdam/rain-garden-city-island

4. Climate vulnerability assessment of relevant infrastructure sectors in North Macedonia

4.1 Assessment on the current and projected climate hazards/extremes impact

4.1.1 Country climate profile

North Macedonia's climate is highly influenced by the great variance in elevation across the country. It is already experiencing changes in mean temperature and precipitation and increase in the frequency and the intensity of climate extremes such as floods and droughts in the past decade. The climate ranges from alpine in the west and north-west of the country, to Mediterranean in the southern districts of the Vardar river valley, and is characterized by cold winters, hot summers and a highly variable precipitation regime. A common feature of the climate is alternating periods of long drought and high intensity rainfall. Annual mean temperatures range from approximately 8°C in the north-west regions of the country to 15°C in central areas. Annual precipitation ranges from about 400 mm in the south-eastern and central districts to over 1000 mm in the mountain areas.[61]

4.1.2 Historical climate trends

North Macedonia is already experiencing climate change. The *Analysis and interpretation of climate variability and climate change in the Republic of North Macedonia*[62], shows that although there is considerable inter-annual variability, general historical trends indicate that overall average temperature across the country has moderately increased in the period 1991-2020, in the range of 0.7°C to 1.4°C compared to reference period 1961 – 1990. While mean annual precipitation levels demonstrated decreasing trend in the period 1981 – 2010, it showed a general trend of increasing for the period 2010 – 2020 compared to reference period.

The last fourteen consecutive years (2007-2020), with the exception of 2011, are years in which the seven highest values of annual air temperature (period 1951-2020) have been recorded.

- **Temperature:** During the period 1991-2020, the average annual temperature is higher on the whole territory in the range of 0.7°C to 1.4°C compared to reference period 1961 – 1990. The decadal averages of the annual air temperature shows that the last decade

[61] Government of North Macedonia, 2014. *Third National Communication on Climate Change for UNFCCC.*
[62] National hydrometeorological service, 2021. Analysis and interpretation of climate variability and climate change in the Republic of North Macedonia.

(2011-2020) is the warmest decade since the beginning of meteorological measurements on the territory of the Republic of North Macedonia.

- **Precipitation:** Seasonal and regional variability in precipitation is high, but records indicate a general trend of increasing in the annual amount of precipitation at most meteorological stations for the period 1991-2020 (up to 6%).

4.1.3 Climate extreme events

North Macedonia is highly exposed to climate extreme events and in particular floods and landslides. Studies show that the annual average population affected by flooding in the country is about 70,000 and the annual average affected GDP about $500 million.

Table 14. Record on the number of people affected and total damage in USD from extreme climate events in the period 1990 – 2022. .(Source: EM-DAT, CRED / UCLouvain, Brussels, Belgium – www.emdat.be. Last accessed: 10 March 2022)

Year	Disaster Type	Total Deaths/ #	No Injured	Total Affected	Total Damages ('000 US$)	Total Damages, Adjusted ('000 US$)
1993	Drought			10,000		
1995	Flood			1,500	245,000	435,662
2001	Extreme temperature	15				
2002	Flood			1,650		
2003	Flood	2		4,000		
2003	Flood			750		
2004	Flood			100,000	3,600	5,165
2004	Extreme temperature	15				
2005	Flood			2,000		
2006	Flood			1,500		
2007	Extreme temperature			202		
2012	Extreme temperature	1		5,100		
2013	Flood	1		4,911		
2014	Extreme temperature			8,800		
2015	Flood	7	30	5,030	87,000	99,463
2015	Flood			100,000		
2016	Flood	22	60	33,582	50,000	56,450
2017	Extreme temperature	3		2,220		

4.1.4 Climate change projections

Climate change projections for the Republic of North Macedonia were conducted as part of the Report on climate change projections and changes in climate extremes (2020), using regional climate models from the EURO-CORDEX database, which is the reference database of climate projections for Europe. The climate modelling considered the RCP4.5 and RCP8.5 scenarios[63] for the periods 2016 – 2035, 2046 – 2065 and 2081 – 2100 with reference period 1986 – 2005. A summary of the projections include:

Temperature. In case of RCP4.5 scenario (Figure 1) mean daily temperature will continuously increase, from about 1 °C in the near future to about 2,5 °C by the end of the century. In terms of warming there are no substantial differences between different seasons. The highest warming is expected for summer season for all future periods. For the middle of century, for other three seasons (winter, spring and autumn) the warming is almost of the same order, but is more pronounced for winter for the last analysed period.

Box 7: Key limitations with availability of climate information

While basic early warning system is in place in North Macedonia, its capacities, comprehensiveness, and ability to share information should be strengthened. For example, the Hydrometeorological Services (HMS) and the Ministry of Environment and Physical Planning regularly monitor weather events and river systems, yet they remains underused. Data management and analysis is a key problem, and there is little capacity to translate forecasts into meaningful public guidance and protection of key infrastructure.

The CMC has a department of analytical planning, but data management and analysis remain a key issue. Analysis within CMC follows international standards; nevertheless, predictive event modeling based on the data could be improved, crowdsourced data do not appear to be integrated in the analysis, and surveillance centers are not properly equipped. During the 2016 flash floods, the hydrometeorological system had little capacity to translate forecasts into meaningful public guidance for anticipatory action.

Source: The World Bank, 2021. Emergency Preparedness and Response Assessment

[63] A **Representative Concentration Pathway** (**RCP**) is a greenhouse gas concentration trajectory adopted by the IPCC. Four pathways were used for climate modeling and research for the IPCC fifth Assessment Report (AR5) in 2014. The pathways describe different climate futures, all of which are considered possible depending on the volume of greenhouse gases (GHG) emitted in the years to come. The RCPs – originally RCP2.6, RCP4.5, RCP6, and RCP8.5 – are labelled after a possible range of radiative forcing values in the year 2100 (2.6, 4.5, 6, and 8.5 W/m^2, respectively)

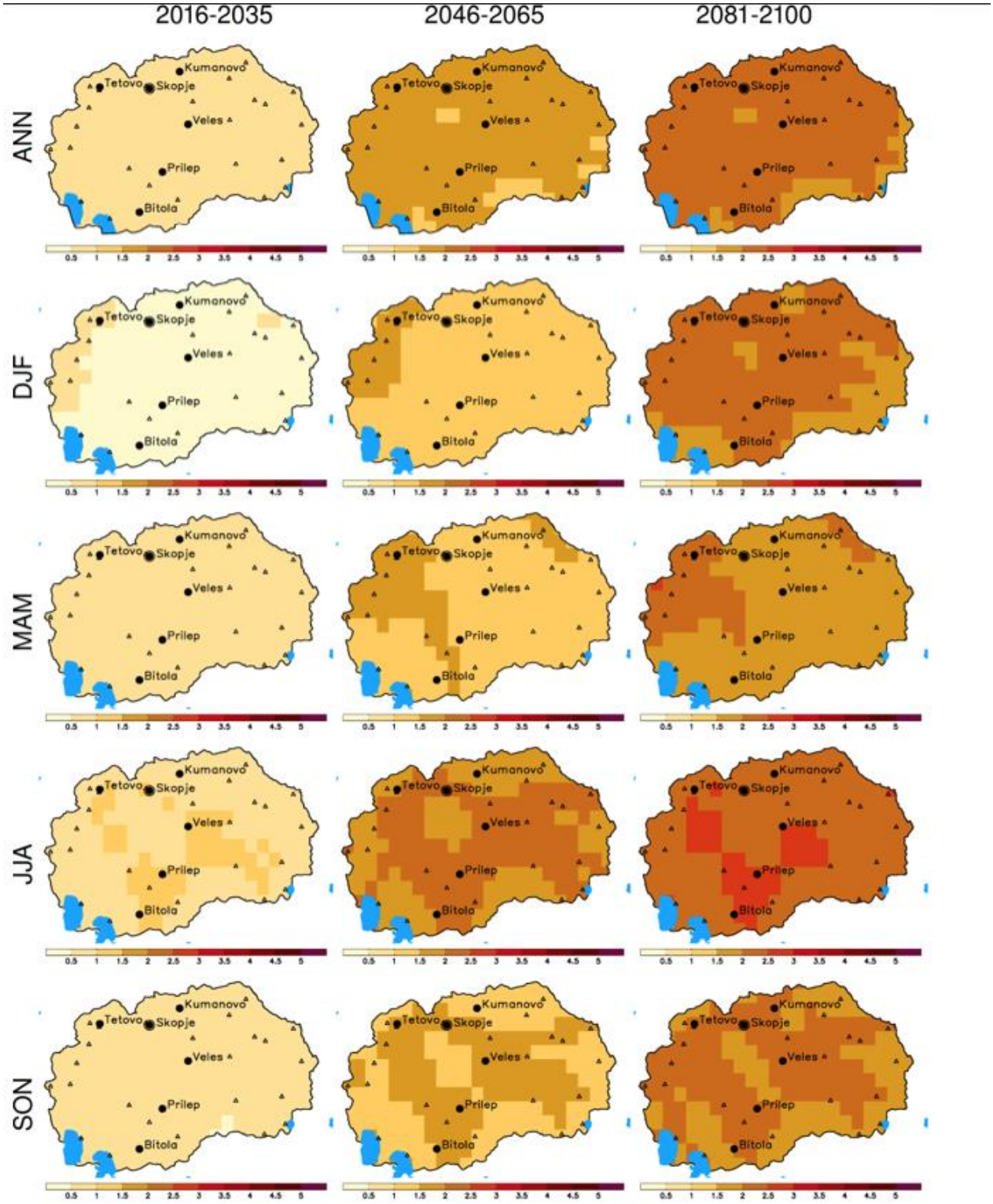


Figure 2 Future daily mean temperature change, for three future periods, 2016-2035, 2046-2065 and 2081-2100 with respect to the period 1986-2005

Precipitation. In case of RCP4.5 scenario (Figure 2) for all three future periods decrease in annual, spring and summer precipitation is expected, clearly pronounced for the summer season, with decrease higher then 20%. For autumn, for first two periods increase is expected over the majority

of territory, but for the last period decrease is projected. For winter there is no clear signal in change since that for all three period +/-5% of change is dominant over majority of territory.

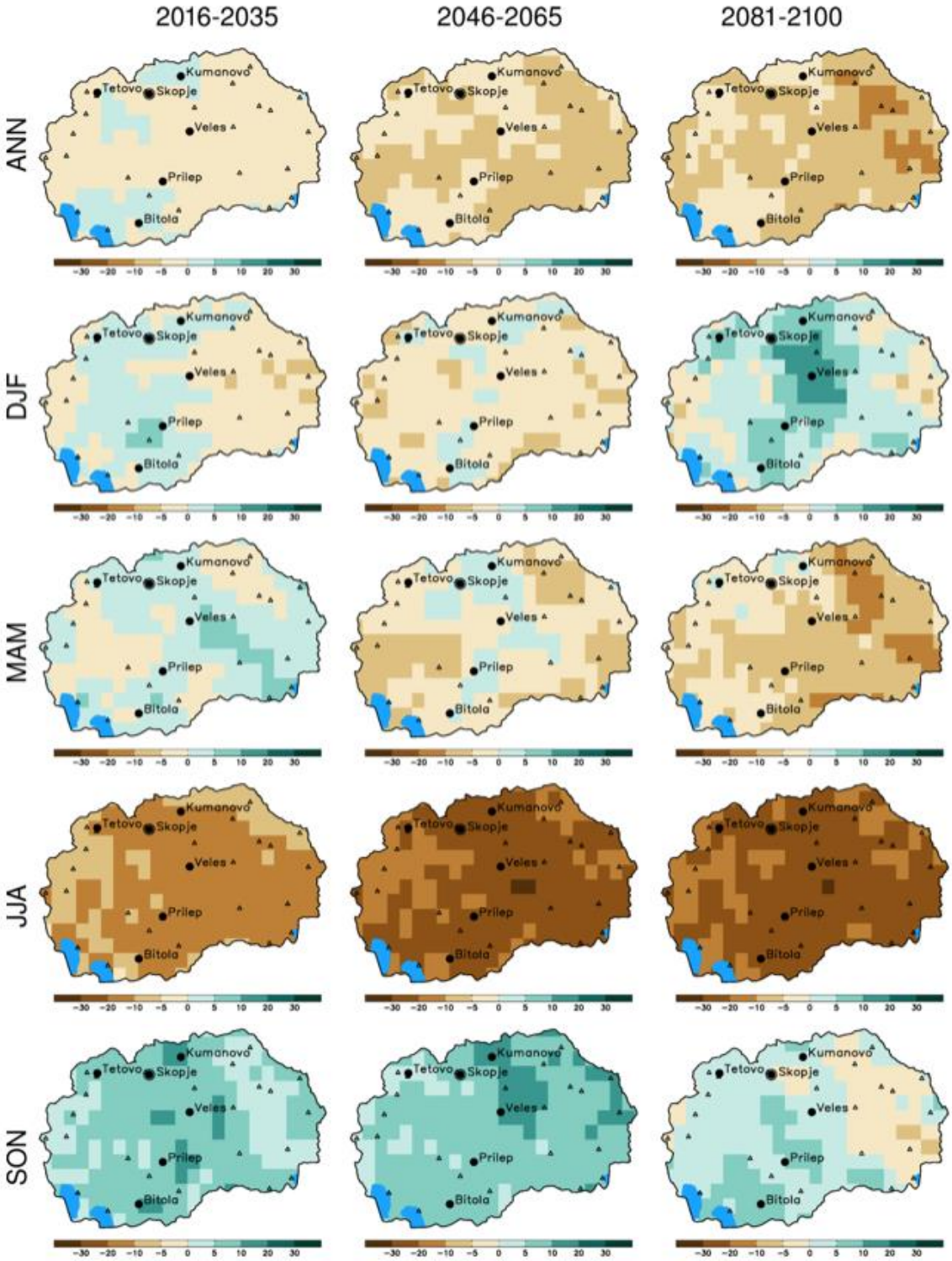


Figure 3 Future precipitation change, for three future periods, 2016-2035, 2046-2065 and 2081-2100 with respect to the period 1986-2005, on annual level and for winter (DJF), spring (MAM), summer (JJA) and autumn (SON), for RCP4.5 scenario

4.1.5 Changes in climate extreme events

Cold extremes. For the near future expected decrease in frost days is between -20 and -30 days per annum regardless scenario. By the end of the century decrease in the *low* scenario will remain the same, and for *high* scenario decrease is between -50 and -60 days. For the middle of the century change is between these upper and lower bounds of *low* and *high* scenarios. The change in ice days is very similar to the change of frost days, except that amplitude of change is smaller, for near future change is from -2 to -5 days, and for the end of the century it is up to -20 days for *high* scenario. Cold waves will be shorter in the future, and for the *high* scenario disappearance of cold waves is possible.

Hot extremes. Hot extremes include heat waves, maximum temperatures and tropical nights. Hot extremes are expected to increase in the future. The simulated increase in summer days for the near future between 20 and 30 days. For the end of the century for *low* scenario change will remain the same but for *high* scenario increase will be between 50 and 60 days per annum, over the majority of the country. Increase in tropical night are mainly projected to the low altitude areas. For the near future increase are between 5 to 20 days. For the end of the century significant increase is expected in the case of *high* scenarios, and in low altitude areas increase of more than 60 days can be expected. Finally, increase in duration and frequency of heat waves over the whole territory can be expected. For the near future the increase in frequency has values from 1 to 3 more events in 20-year period for all scenarios. By the end of the century, in case of *high* scenario this change can increase up to 40 more events in 20-year period in western and eastern part of the country. The duration of heat waves for is projected to increase up to 25 more days by end of the century, in case of *high* scenario.

Precipitation extremes. Upper limits of change is 60% increase in number of days with precipitation above 40 mm/day, and 20% increase in daily maximum precipitation accumulation. The physical background of this change is fact that warmer atmosphere that can holds more water vapor (7% more water vapor in 1 °C warmer air) indicating higher chances for more extreme precipitation, and consequently higher chances for induced flash foods.

Analysis of consecutive dry days index reveals that in the future the **risk of drought** will increase. In the near future increase in the number of consecutive dry days is between 5 and 20 days, depending on location and scenario. For the end of the century in case of high scenario expected increase is above 30 days. This increase is consistent with the projected decrease in summer precipitation, especially in case of mid and high scenario.

4.2 Methodological approach for vulnerability assessment of the infrastructure in North Macedonia

4.2.1 Methodology and scope

According to the methodology proposed by the IPCC (IPCC, 2014), the impacts (risks) of climate change on infrastructures originate from the dynamic interactions between the hazards generated by climate phenomena, the exposure of infrastructures and their vulnerability to the climate hazard they are exposed to (see Figure 4). The climatic hazard represents the potential occurrence of a

climatic event that may cause damage and losses to property, infrastructure and the provision of services in general. Exposure, on the other hand, refers to the spatial distribution of infrastructures potentially subject to the hazard. Vulnerability expresses the degree to which an infrastructure is damaged when exposed to a hazard.

The quantification of hazards, exposure and vulnerability is subject to uncertainty both in terms of magnitude and probability of occurrence, and each element is variable in time and space depending on future climatic and socio-economic changes. Obviously different types of infra- structures are characterised by different levels of vulnerability to climate change.[64] Moreover, as the impacts of climate change occur locally, individual infrastructures also have different exposures to climate hazards depending on their geographical location. As mentioned above, climatic and socio-economic processes influence hazard, exposure and vulnerability and, consequently, the resulting impacts.

The impact of an extreme climatic event on an infrastructure is manifested in terms of physical damage to the components constituting the infrastructure itself and, consequently, in terms of costs necessary for securing and/or for restoration/replacement/reconstruction interventions (direct impacts). In addition, the partial or complete destruction of the infrastructure may cause economic losses associated with possible reductions in service provision due to reduced functionality of the infrastructure or others interconnected to it (indirect impacts).

Figure 4 shows the different underlying elements of vulnerability and risk analysis: drivers, hazard, exposure, effective exposure, stressors, sensitivity, coping capacity, vulnerability, and impacts. The arrows depict the relationship between these concepts. Risk will finally be identified as the combination of probability of the hazard and its impacts and consequences.

The question of which objects in a city are potentially hit by a hazard is captured by the concept of **exposure**. This describes the presence of people, livelihoods, species or ecosystems, environmental services and resources, infrastructure, or economic, social, or cultural assets in specific places that could be adversely affected. Exposure is a determining factor of the **potential damages or losses**, e.g. if there are 40,000 buildings in a city potentially all of them could be hit by a flood.

Figure 2 also introduces the concept of **effective exposure**, i.e. the portion of the exposed assets that is actually affected by a specific hazard occurrence, e.g. residential buildings in flood prone areas for a 100-year flood.

[64] Forzieri et al., 2018. Escalating impacts of climate extremes on critical infrastructures in Europe. Global Environment Change.

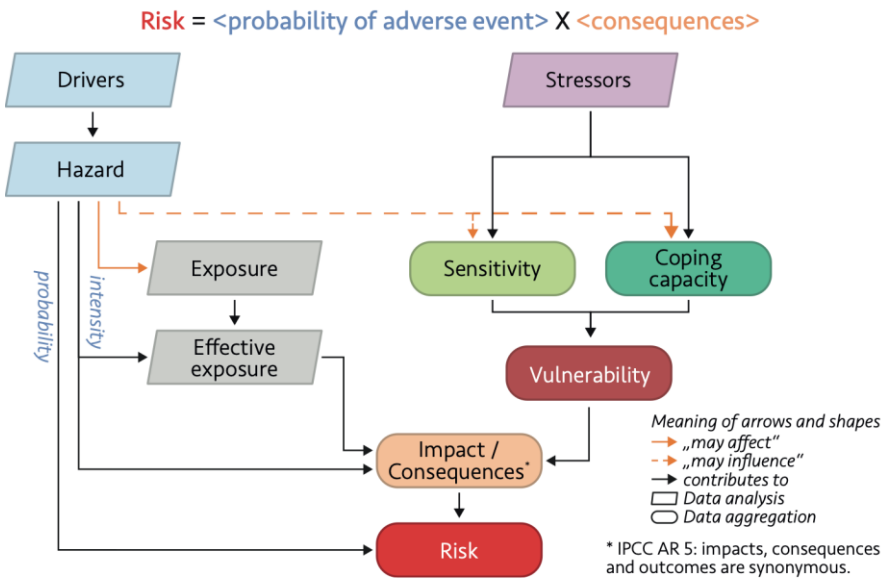


Figure 4. Approach to vulnerability and risk analysis (Source: Frauenhofer, 2019)

Non-climatic trends and events—called **stressors**—can have an important effect on the system exposed. Examples are population growth or change of land-use; a growing percent- age of sealed surface will in general increase the probability of flooding events and thus the risk to all exposed objects. Information on the development of stressors can be used to create urban development projections, i.e. possible future changes of sensitivity and coping capacity indicators.

Different objects are more or less sensitive to a hazard. For example, a well-built stone house is less sensitive to a storm than a wooden shack. This is captured by the concept of **sensitivity**. It is defined as the degree to which an exposed object, species, or system could be affected by the considered hazard. As such, one may perceive sensitivity towards a hazard as a property of an exposed object in regard to a specific hazard. A city as a whole will have some means of coping with a hazard, e.g. with flood barriers and/or ready and trained emergency personnel. These kinds of capacities are captured by the concept of **coping capacity**. It is the ability of people, institutions, organizations, and systems, using available skills, values, beliefs, resources, and opportunities, to address, manage, and overcome ad- verse conditions in the short to medium term. **Vulnerability** is then derived from the interplay of the elements stressors, sensitivity, and coping capacity. It contributes directly to the impact or consequences that a hazard causes to the exposed objects.

4.2.2 Key elements for the vulnerability and risk analysis for the infrastructure sector in North Macedonia

For the purposes of this climate vulnerability and impact analysis, the key elements defining the level of climate risk include: (a) climate hazards, (b) exposure of the infrastructure, (c) vulnerability factors of the infrastructure. Figure 5 provides an overview of these critical elements.

Climate hazards

Greater frequency and intensity of extreme events → **extreme rainfall events, floods, landslides.**

Rise in average temperatures and extreme temperatures → **heatwaves**

Variability of seasonal rainfall patterns → **longer dry seasons, drought.**

Exposure

River flooding. The exposure to river flood hazard in North Macedonia is classified as **HIGH**, which means that potentially damaging and life-threatening river floods are expected to occur at least once in the next 10 years.

Drought. The exposure to drought hazard is classified as **MEDIUM**, which means that there is up to a 20% chance that droughts will occur in the coming 10 years.

Landslides. The landslide susceptibility of North Macedonia is classified as **HIGH**, which means that this area has rainfall patterns, terrain slope, geology, soil, land cover and that make localized landslides a frequent hazard phenomenon.

Extreme heat. The exposure to extreme heat hazard is classified as **MEDIUM**, which means that there is more than a 25% chance that at least one period of prolonged exposure to extreme heat, resulting in heat stress, will occur in the next five years.

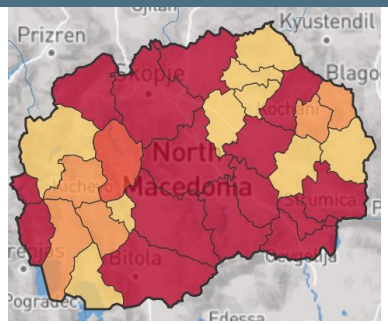
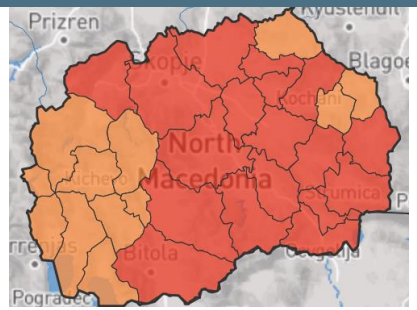
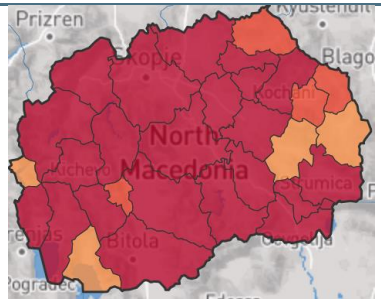
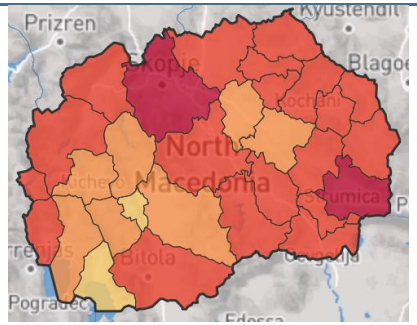
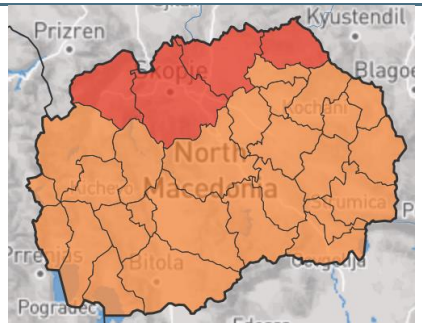
Vulnerability

Sensitivity. (1) Limited capacity of water drainage systems in urban areas to accommodate high volume of rainfall in short periods. (2) Inadequate construction materials and limited integration of risk-informed design options.

Coping capacity. (1) Limited capacity of key agencies to translate forecasts into meaningful guidance and anticipatory actions to protect infrastructure during extreme events. (2) Insufficient legal framework to ensure risk-informed infrastructure design.

Figure 5. Key elements determining the climate risks for the infrastructure in North Macedonia. (Source: authors)

Table 15. Climate hazard exposure for North Macedonia [65]

Hazard	Risk level	Region(s)	Hazard	Risk level	Region(s)
River flood	High		Extreme heat	Medium	
Urban flood	High		Landslides	High	
Drought	Medium				

[65] ThinkHazard (http://thinkhazard.org/en/report/241-the-former-yugoslav-republic-of-macedonia), accessed 10 February 2022.

4.3 Vulnerability and impact assessment of the infrastructure in relevant sectors

4.3.1 Sectoral interdependence of climate impacts

The critical infrastructures are strongly interconnected through physical and logical-functional links such as to constitute a complex system of systems. Therefore, damage and loss of functionality originated by climatic hazards on single infrastructures (sections 4.3.2- 4.3.5) can be cascaded on other infrastructures through the interdependencies that cost transmission channels of the effects of failures and malfunctions. A failure of any one of these infrastructures can lead directly to damage to another. Interdependence between infrastructures can be: physical, when the state of one infrastructure depends on the supply of the product or service of another; cyber, when the state of operation of an infrastructure is controlled by the flow of information transmitted through the telecommunication system; geographical, when two or more infrastructures are exposed to the same causes of failure and/or stress because they share the same physical location; logical, when the state of one infrastructure depends on the state of the other, e.g. through the exchange of services, socio-economic factors, regulatory and legislative constraints.

Taking energy infrastructures as an example, these are dependent on: a) water infrastructure, which provides the necessary cooling mechanisms for power generation and oil and gas refining, protects energy plants from flooding and ensures that the working environment for staff is healthy and hygienic; b) telecommunications infrastructure, for the operation of control and management systems, in particular for the development of smart grids and smart meters, and for communications; and c) transport infrastructure, to support the fuel supply chain for power generation and the distribution of oil and gas products, as well as to provide access for staff.

In contrast, energy is used for (a) water networks, to operate water treatment plants and pumping stations; (b) telecommunications, to operate equipment; and (c) transport, to operate transport systems. In addition, in urban environments, energy, water, telecommunications and transport infrastructures are often co-located: for example, power cables may be placed under roads next to communication cables, adjacent to water and gas pipes, and above sewers.

4.3.2 Climate impacts in the transport sector

Land transport infrastructure includes road and rail works. As far as railway infrastructure is concerned, the following have been taken into account: the roadway, which includes the body of the road (civil works such as embankments, trenches, minor civil works and works of art such as bridges, viaducts and tunnels) and the railway superstructure (the set of elements designed to create the rolling and driving surface of the railway vehicle); railway installations (electrical traction, safety and signalling installations, telecommunications systems); railway stations and buildings. As far as road infrastructure is concerned, the following were considered: the road surface (which also includes all road structures such as bridges, viaducts and tunnels); road surfaces; and signalling systems. The climate impacts on land transport infrastructure are described below.

Extreme temperatures. Heat waves tend to exacerbate the phenomena of pavement failure and degradation with a consequent increase in the number of maintenance and rehabilitation

interventions and associated costs.[66] As far as railway infrastructure is concerned, one of the main impacts of heat waves is the deformation of tracks caused by thermal expansion (i.e. buckling). These deformations compromise the level of rail services: in such circumstances, there are often increases in line running times due to reductions in operating speeds and/or interruptions to services. In more extreme cases, the safety of train operation could be compromised. Other impacts attributable to rising temperatures are the excessive overheating of signalling and telecommunications components, which could reduce their reliability and generate malfunctions.[67] Particularly significant could be the increase in displacements required for the mobile restraint devices and expansion joints of road and rail bridges; this could result in unacceptable reductions in running comfort or the percolation of aggressive water, such as that rich in antifreeze salts, from the deck, with exacerbation of degradation phenomena. These physical impacts translate into consequent costs of restoration/replacement/reconstruction of damaged infrastructure components and a possible reduction in operations.

Cold waves. Cold waves tend to damage road pavements (cracking and degradation of the road surface) and these impacts require maintenance and possible blockages or disruption to traffic. These effects are particularly accentuated by the amplification of freeze-thaw cycles.[68] Snow and ice events also require snow and ice removal with similar impacts on traffic and increased maintenance/restoration costs. Excessive temperature reductions can affect the functioning of train signalling, communication and routing systems, e.g. due to freezing, as well as the functionality of the contact line which does not allow pantograph-rope coupling. Drought Prolonged periods of drought can exacerbate the phenomena of land subsidence causing degradation and deformation of the road surface with consequent need for maintenance.

River floods. All floods generate important impacts on land transport infrastructure. In particular, we can distinguish two main impact phenomenologies: a) fluvial erosion that can lead to structural damage due, for example, to increased thrusts on geotechnical structures and bridge abutments, b) undermining of foundations of geotechnical structures and bridge piers. Floods and heavy rainfall can also cause temporary flooding of roads and railways and/or damage to them due to water run-off and the malfunction/collapse of drainage. In addition, localised heavy rainfall in small catchments can generate major impacts on transport infrastructure due to the high solid transport that can obstruct roads and railways. All these physical impacts translate into consequent costs of restoration/replacement/reconstruction of damaged/destroyed infrastructure components.

Landslides. Slope instability, which is often caused by heavy rainfall, is another major climatic hazard for land transport infrastructure. Mud, debris and boulders can encroach on roads and railways and interrupt traffic.[69] In the presence of particularly severe events, landslides can generate damage to various infrastructure components or even destroy them, as in the case of the

[66] Nemry, F. e Demirel, H.(2012). Impacts of climate change on transport: a focus on road and rail transport infrastructures. (Publications Office of the European Union, 2012).
[67] Ferranti, E. et al. (2016). Heat-Related Failures on Southeast England's Railway Network: Insights and Implications for Heat Risk Management. Weather Clim. Soc. 8, 177-191.
[68] OECD, 2016. Adapting Transport to Climate Change and Extreme Weather: Implications for Infrastructure Owners and Network Managers
[69] Klose, M., Damm, B. e Terhorst, B. (2015). Landslide cost modeling for transportation infrastructures: a methodological approach. Landslides 12, 321-334.

collapse of bridges and viaducts.[70] All these physical impacts translate into consequent costs of restoration/replacement/reconstruction of damaged/destroyed infrastructure components. The Italian peninsula, due to its geological, morphological and climatic peculiarities, consists of a territory that is particularly prone to phenomena of hydrogeological instability.

Box 8: Snapshot of landslide impacts in Pelagonia region

Landslides in the Palegonia region are a common event and often result in impacts of the road infrastructure. Due to extreme rainfall, melting snow and road infrastructure characteristics, in February 2010, on M-5 Resen to Bitola roadway a landslide occurred which caused significant difficulties in traffic. The landslide resulted in an open crack of more than 20 cm with length estimated at 60-70 meters. The repairing of the road took 6 months and caused significant challenges for the road traffic and the economic activities in the region.[71]

Landslide on the road M5 Resen-Bitola

Wind storms. Following strong wind gusts, both road and railway surfaces can be temporarily unusable due to fallen branches and trees or windblown debris. In addition, windblown trees could hit overhead contact lines and thus interrupt rail services for a long period of time. In the presence of particularly strong winds, structural damage can be caused to infrastructure components, both rail and road, as a result of direct impact with wind-blown debris or wind pressure (e.g. damage to cable-stayed bridges and viaducts, to factories). Such phenomena may require extraordinary maintenance operations with possible increased costs for the restoration/replacement/ reconstruction of the affected infrastructure components. Table 16 shows a list of the major climate hazards and related impacts for the transport sector.

Table 16. Climate impacts on the transport infrastructure.

Climate hazard	Impacts for the transport infrastructure
Heat waves Increase in average temperature	• Deterioration of the road surface • Damage to bridges and viaducts related to thermal expansion
Drought	• Deterioration of the road surface, structural damage to the roadway due to subsidence phenomena
River flooding	• Structural damage due to direct impact with waves, in particular bridges and viaducts; roadway subsidence; erosion at the base of bridge piers and abutments

[70] OECD (2016). Adapting Transport to Climate Change and Extreme Weather: Implications for Infrastructure Owners and Network Managers

[71] GAUSS Institute, 2019. Study on landslides mapping as a result of floods in the Pelagonia region

Climate hazard	Impacts for the transport infrastructure
	• Deterioration of the road surface • Flooding of the roadway with consequent reduction of operations • Malfunctioning of drainage systems
Landslides	• Possible obstruction of the roadway • Structural damage caused by direct impact of mass movements
Wind storms	• Possible obstruction of the roadway as a result of falling trees • Structural damage as a result of wind pressure or impact with debris, in particular bridges and viaducts

Source: Klose, M., Damm, B. e Terhorst, B. 2015, OECD, 2016.

4.3.3 Climate impacts in the energy sector

The energy infrastructures considered include both the plants for the production of electrical power from conventional and renewable sources and the networks for its transmission and distribution.[72] The climate impacts on energy production, transmission and distribution infrastructure are described below.

Heat waves/Average temperature increase. Temperature increases have multiple impacts on the security of energy availability, influencing processes and the operation of plants and systems. Basically, this results from the fact that the air may not be cool enough and the water may not be sufficient and sufficiently cool for cooling systems. In particular, under conditions of prolonged high temperatures, such as those experienced when heat waves occur, fossil fuel plants typically experience a loss of efficiency and thus economic revenue.[73] Rising air temperatures can also reduce the efficiency of electricity generation and transmission infrastructures: power plants become less efficient as ambient temperatures rise and cooling becomes less effective.[74] Rising temperatures also have an impact on transmission and distribution systems by reducing their thermal capacity. The current flowing through overhead transmission cables generates heat, and the standard for transmission cables refers to a certain temperature threshold: if the air temperature rises, current transmission is generally reduced to prevent the cable from reaching this threshold.[75]

In addition, high night-time temperatures reduce the system's ability to release heat and thus reduce temperatures. It should also be considered that heat waves are typically accompanied by stationary areas of high pressure that lead to light winds on the earth's surface resulting in reduced

[72] Cox, S., Hotchkiss, E., Bilello, D., Watson, A. e Holm, A. (2017). Bridging Climate Change Resilience and Mitigation in the Electricity Sector Through Renewable Energy and Energy Efficiency.
[73] Cruz, A. M. e Krausmann, E. (2013). Vulnerability of the oil and gas sector to climate change and extreme weather events. Clim. Change 121, 41-5
[74] Sieber, J. (2013). Impacts of, and adaptation options to, extreme weather events and climate change concerning thermal power plants. Clim. Change 121, 55-66.
[75] Schaeffer, R. et al. (2012). Energy sector vulnerability to climate change: A review. Energy 38, 1-12

wind power generation.[76] In addition to contributing to the above impacts, the average increase in temperature tends to alter the temporal distribution of energy demand, and thus the load on the grid. Such effects can already be observed in the migration of peak demand from the winter period to the summer period, during which the increased cooling needs of spaces have led to an increase in the power generation capacity required to meet energy demand.[77] The occurrence of milder temperatures during the winter period and higher temperatures in the summer implies a higher energy demand for cooling buildings and a reduction for heating.

River flooding. Generating and processing plants, fuel storage systems and fuel transport systems are particularly vulnerable to possible structural damage and interruption of service caused by flooding as they are often located close to rivers due to the ease of fuel transport and the availability of water for cooling. These effects translate into increased costs for restoration/replacement/reconstruction of affected infrastructure components and loss of economic revenues due to reduced operations. Similarly, wave and tidal power generation plants may be subject to malfunction due to extreme weather that limit their operation.[78]

Table 17. Climate impacts for the energy infrastructure

Climate hazard	Impacts for the energy infrastructure
Heat waves Increase in average temperature	• Loss of efficiency of fossil fuel plants • Reduction in electricity transmission capacity • Reduction in power generation capacity due to reduced discharge capacities in reservoirs • Reduction in wind power generation capacity due to weakening of high pressure winds • Increased energy demand in the summer period and consequent increased vulnerability of the system when exposed to extreme events
Drought	• Structural damage to oil and gas pipelines due to subsidence • Decreased water availability for cooling of production facilities
Cold waves Snowfall	• Formation of snow/ice sleeves on transmission and distribution lines Yield loss in solar installations
Wildfires	• Structural damage caused by exposure to fire and high temperatures
River flooding	• Structural damage to process plants, storage systems and fuel transport systems due to direct impact with the waves
Wind storms	• Structural damage as a result of wind pressure or debris impact • Reduction in operation of wind turbines due to decoupling of turbines from generators to avoid damage to them

[76] Ke, X., Wu, D., Rice, J., Kintner-Meyer, M. e Lu, N. (2016). Quantifying impacts of heat waves on power grid operation. Appl. Energy 183, 504-512.
[77] Zachariadis, T. e Hadjinicolaou, P. (2014). The effect of climate change on electricity needs - A case study from Medi- terranean Europe. Energy 76, 899-910.
[78] Bompard et al., 2013

Climate hazard	Impacts for the energy infrastructure
	• Disruption caused by the action of wind on foreign bodies on the infrastructure: falling trees and their impact on transmission and distribution lines

Source: Cruz & Krausmann, 2013, Sieber, 2013 & Rübbelke & Vögele, 2011, Ke et al., 2016, Zachariadis & Hadjinicolaou, 2014.

4.3.4 Climate impacts in the water sector

Water management infrastructures can be used for agricultural purposes or for urban and industrial use. Water infrastructures for agricultural use include storage reservoirs and derivation works, adduction and distribution networks (pressurised, free-flowing and mixed) and, finally, irrigation systems, understood as the final part of the water network that connects the distribution network to the irrigated crops. The water infrastructures for urban and industrial use considered include the collection, purification and depuration works, adduction and distribution to the final users (mainly industrial users and, in urban areas, residential, commercial and service users) and, finally, the drainage and collection systems of rainwater and waste water. The climate impacts on water management infrastructures are described below.

Extreme temperature. Heat waves have a generally limited impact on storage, diversion, supply and distribution works. Some impacts may occur on drinking water and sewage infrastructure, resulting in increased operating costs, due to potential changes in concentrations of toxic algae and organic material in water at source.[79]

Cold waves. As with heat waves, extreme minimum temperatures associated with cold waves do not generally induce significant damage to open water storage and distribution infrastructure, while frost damage to pressurised systems and irrigation systems is possible. Similarly, also for urban and industrial water infrastructures, impacts can occur on water collection works, where frost can limit accessibility and withdrawal (e.g. from mountain springs), or on supply and distribution networks, where frost can cause breakage of pipes and meters (Rajani & Kleiner, 2001). Such events can therefore generate necessary costs for restoration/replacement/reconstruction of affected infrastructure components.

Drought. Droughts have an indirect impact on irrigation infrastructures, producing a significant increase in irrigation demand in the served territories. Droughts generate high impacts on catchment works directly dependent on water availability. An increase in temperature accompanied by a slower recharge of the aquifers can cause both a reduction in water availability and alterations in its quality, thus requiring changes in the operations of the water collection and, subsequently, purification and transport infrastructures, with possible increased management costs. Increased water demand in different sectors may be a source of increasing conflict and

[79] Li, Z., Clark, R. M., Buchberger, S. G. e Jeffrey Yang, Y. (2014). Evaluation of Climate Change Impact on Drinking Water Treatment Plant Operation. J. Environ. Eng. 140, A4014005.

competition between different water uses.[80] Finally, prolonged drought situations may have direct impacts on water supply and distribution works (e.g. increased failure of water mains in hot and dry periods due also to changes in the soil stress state with reduced moisture content) and on wastewater drainage systems (with reduced dilution capacity and increased solids concentration, which may cause blockages, clogging and blockage/breakage of pumping systems).[81] These issues may cause an increase in costs related to ordinary and extraordinary maintenance of the physical components, as well as operating costs related to interruptions and anomalies in the regular operation of the mentioned infrastructure components. Impacts may occur on supply and distribution works if continuous supply is jeopardised, especially in regions exposed to prolonged drought conditions, with consequent costs related to the use of alternative sources of drinking water supply (e.g. tankers).

Table 18. Climate impacts in the water sector infrastructure.

Climate hazard	Irrigation infrastructure	Urban water infrastructure
Heat waves Increase in average temperature	• Loss of efficiency of fossil fuel plants • Reduction in electricity transmission capacity • Reduction in power generation capacity due to reduced discharge capacities in reservoirs • Reduction in wind power generation capacity due to weakening of high pressure winds • Increased energy demand in the summer period and consequent increased vulnerability of the system when exposed to extreme events	• Increased concentrations of toxic algae and organic material in water at source, resulting in increased operating costs for drinking water and purification
Drought	• Increase in irrigation demand Reduction in water availability	• Failure and breakage of aqueduct components in adduction and distribution works • Obstruction, clogging and blockage/breakage of pumping systems in wastewater drainage systems due to reduced dilution capacity and increased solids concentration • Water supply at risk

[80] de Oliveira, R. P., Matos, J. S. e Monteiro, A. J. (2015). Managing the urban water cycle in a changing environment. Water Util. J. 9, 3-12.

[81] Hughes, J., Cowper-Heays, K., Olesson, E., Bell, R. e Stroombergen, A. Impacts and implications of climate change on wastewater systems: A New Zealand perspective. Clim. Risk Manag. 31, 100262 (2021).

Climate hazard	Irrigation infrastructure	Urban water infrastructure
Cold waves Snowfall	• Frost failures in pressure systems and irrigation systems	• Limited accessibility and possibility of withdrawal from mountain sources • Potential breaks in pipes and meters in supply and distribution networks
Wildfires	• Structural damage caused by exposure to fire and high temperatures	
Extreme rainfall River flood	• Reduction in the useful capacity of reservoirs • Increased likelihood of collapse or structural failure • Damage to pipelines and pumping stations Risk of silting, instability and collapse of embankments and regulation structures • Limited distributed lamination capacity of artificial drainage networks placed in defence of the territory • Compromise of ecosystem, recreational and tourism services provided by the networks	• Blockage and malfunction of pumping systems (wastewater) • Inflow peaks with high solids concentration at treatment plants • Risk of overflow and spillage of wastewater into natural water bodies
Landslides	• Silting up of storage and distribution infrastructure, reducing operating efficiency • Damage to adduction and distribution infrastructure and irrigation systems • Risk of dam collapse in storage and diversion systems	• Rupture of buried pipelines and underground infrastructure, resulting in the leakage of drinking water or release of wastewater and potential risk of contaminant infiltration

Source: Li et al., 2014, de Oliveira et al., 2015, Hughes et al., 2021

4.3.5 Climate impacts in the built environment

Infrastructure in the build environment is particularly vulnerable to climate change impacts as it provides basic services to the urban population. Apart from the water supply and sanitation services, discussed in section 4.3.3. Other key infrastructure include in the build environment include municipal and special waste management infrastructure.

The infrastructures considered in relation to the integrated waste management system include treatment plant sections, collection and transport services to dedicated treatment plants and landfills. Among the various types of plants, waste-to-energy, mechanical and biological plants

(such as composting and anaerobic digestion) and recycling stations for separately collected waste were considered. The climate impacts on waste management infrastructure are described below.

Heat waves/Maximum temperature rise. Heat waves have a direct effect on the degradation rate of waste, leading to an increase in odour emissions and a decrease in the moisture content of the waste. In general, in treatment plants, the increase in average temperature leads to an alteration of the process conditions (especially in biological plants such as composting and anaerobic digestion) and to a reduction in the efficiency of the treatment process. Particularly in composting plants, as temperatures rise, the waste may dry out quickly and make it more difficult to replenish moisture by wetting, increasing the risk of treatment process inhibition. In addition, a reduction in operations, particularly in collection services, may occur as a result of the severe climatic stresses to which ecological operators may be exposed during heat waves. These effects are typically accompanied by an increase in infrastructure maintenance costs.

Cold waves. Such extreme weather events can lead to a slowdown in biological processes, resulting in increased energy consumption to restore ideal conditions in treatment plants.[82] Depending on the severity of the event, the collection service may be interrupted or slowed down. A possible increase in the moisture content of the waste, often associated with low temperatures, may cause greater difficulty in combustion or treatment in general (increased soiling, making recycling operations difficult). In addition, in anticyclonic conditions, the risk of reducing the dispersion of pollutants conveyed to the chimney (or biofilter) may increase, with a consequent increase in the fallout of pollutants in the areas surrounding the plants. These phenomena contribute to generating an increase in maintenance and operating costs.

River flooding. River and coastal flooding, and flooding in general, are particularly problematic at landfill sites due to the potential for leachate spills and the uncontrolled release of waste into the environment.[83] The occurrence of these extreme climatic phenomena can contribute to the formation of debris and flood waste, which contributes to the increased need for waste management. With regard to collection facilities and systems, there may be disruption of access roads and interruption of service, or even damage to the technology leading to plant downtime for maintenance, with the subsequent need to transfer the waste to be treated to another plant, causing increased investment and maintenance costs.

Wind storms. Windstorms can generate structural damage as a result of wind pressure or debris impact on waste management infrastructures and induce a reduction in collection service operations.[84] Strong gusts of wind may also generate unhealthy air due to increased wind-driven dispersion of dust and gases from the landfill cover, while plants may experience increased wind-driven dispersion of convoked emissions. In the case of treatment plants, damage could occur to the sheds, resulting in plant downtime. With regard to the collection of waste, it could be difficult for vehicles to pass through in periods of strong wind and stormy weather, with the possibility of dispersion of waste into the environment.

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[82] Bebb, J. e Kersey, J. (2003) *Potential impacts of climate change on waste management.* https://www.gov.uk/govern- ment/publications/potential-impacts-of-climate-change-on-waste-management.

[83] Idem.

[84] Idem.

Table 19. Climate impacts in the treatment plants.

Climate hazards	Treatment plants
Heat waves Increase in maximum temperature	• Increased decomposition of waste, resulting in increased odours • Drying of waste and increase in the water resource needed for the process (biological plants)
Cold waves	• Possible reduction in the dispersion of pollutants down the chimney • Increased humidity of the waste with consequent difficulties in combustion/treatment
River flooding	• Interruption of access roads Interruption of service and damage to technology resulting in plant downtime
Wind storms	• Increased wind dispersion of ducted emissions • Damage to infrastructure and consequent interruption of service

Source: Bebb, J. e Kersey, J. 2003.

5. Overview and recommendations on climate resilient measures

This chapter presents the recommendations on climate proofing/mainstreaming, in order to increase resilience to climate change impacts, based on a comprehensive overview presented throughout this study and associated key findings. It is disaggregated as follows:

- Cross-cutting/horizontal recommendations;
- Recommendations for the transport sector related infrastructure;
- Recommendation for the energy sector related infrastructure;
- Recommendations for the water sector related infrastructure;
- Built environment related recommendations.

5.1 Cross-cutting / Horizontal recommendations

Recommendation 1: Consider updating requirements under the EIA secondary legislation, under the Law on Environment, to include climate vulnerability assessment and identification of possible climate adaptation measures – alignment with the EU Green New Deal activities.

Elaboration

As already noted, EIA with embedded climate adaption related requirements is probably the most powerful tool for climate-proofing of infrastructural projects. This fact has been stated by many sources presented throughout the study. As already concluded, the legal framework of Northern Macedonia related to environmental impact assessment does not require a climate vulnerability assessment and thus appropriate adaptation solutions. The amended EU EIA Directive 2014/52/EU, which has yet to be transposed in the North Macedonia, recognizes the need to introduce climate impacts as important elements in assessment and decision-making processes. It also explicitly seeks a description of the vulnerability of the project to climate change.

It noteworthy, that regulation of climate adaptation aspects is not, or very limited, present in EU member states as well. For example, Croatia, even as a member state, does not have climate adaption regulated and the whole concept is relatively new. This is not only case in the region but also world-wide. This has been recognized by the EU and therefore the new Adaptation Strategy was enacted that is specifically aiming and strengthening European legal and regulatory framework in this regard, especially noticeable under EU Green New Deal approach.

Potential approach

The European EIA Directive 2014/52/EU stipulates climate change assessment, but only generically describes the approach which is the reason why robust climate adaptation assessment was not yet been properly coordinated or implemented on the EU level in this context. As a solution, in 2021, EC developed and enacted **Technical guidance on the climate proofing of infrastructure in the**

period 2021-2027[85]. The guidance is a product of harmonized combination under several already ongoing EU initiatives and requirements that were enforced within. It covers both climate mitigation and adaptation aspects in climate proofing of infrastructural projects.

Implementation and timeline

It is recommended that MoEPP, while leading the process of creating the secondary legislation related to Climate Action Law, takes into consideration amending EIA requirements to include mandatory climate risk assessment aspects. This inclusion should consider multi stakeholder approach and form a working group that would be consistent of representatives from other relevant ministries, various expert representatives from all relevant sectors including engineers, architects, EIA experts as well as public agencies.

In terms of timeline, consultations on Climate Action Law secondary legislation have already started. EIA climate considerations are the amin prerequisite for achieving climate resilient infrastructure. Therefore, proposed timeline for completion of this process would be by the end of 2023.

The full methodology description is presented in the guidance document. **It is recommended that EIA secondary legislation requirements are amended and that include this above-mentioned guidance document.**

Co-benefits

There are numerous co-benefits that might result from this approach. They are defined and listed as follows:

- Amending EIA with requirements described above would result in increased demand for appropriate and precise climate related information.
- The guidance presented above is also considering mitigation aspects of climate proofing infrastructure. This means that every infrastructural project can marginally contribute to reduction of GHG emissions and thus contributing towards ENDC objectives.
- This approach would raise awareness on climate adaptation among key stakeholders and other relevant community. It would require, and thus result, in substantially increased national capacity for mainstreaming climate resilience aspects in array of projects within many sectors.

Recommendation 2: Consider non-regulatory implementation of climate resilience criteria for infrastructural projects through procurement and/or thematic initiatives.

Elaboration

Updating secondary legislation can potentially be time consuming and uncertain process, there is also a possibility for implementation of climate resilient/climate proofing criteria in public procurement or by initiating thematic call for applications in case there is a room for such initiatives. For example, line ministries can ask for an EIA that includes conducted climate vulnerability assessment and possible adaptation options regardless of regulation. Of course, this

[85] https://op.europa.eu/en/publication-detail/-/publication/23a24b21-16d0-11ec-b4fe-01aa75ed71a1/language-en

context does not have to be done only through EIA but theoretically for any type of project of any size. This would require readjusted and simplified criteria.

Potential approach

There are several potential approaches under this recommendation. Procurement calls could be asking for the following:

- For every large infrastructural project technical guidance elaborated under previous recommendation can be used. It means that there would be specific EIA requirement to include this aspect under a given call for applications.
- Line ministries and other public institutions can create simplified/ criteria related to ensuring climate resilience of projects. There are many different approaches and methodologies available worldwide that can be used for this matter.
- **The implementation of EU Taxonomy and Do Not Significant Harm (DNSH) approach** for large infrastructural projects. The latter is another EUs very efficient tool for ensuring climate proofing of infrastructural projects. The EU taxonomy is a new regulation under EUs Green New Deal initiatives that will soon be in full implementation in the EU members states.

As already described in chapter 1, the EU taxonomy represents a new comprehensive classification system for standardising "green" economic activities and is primarily designed for use in the financial sector. The EU taxonomy is defined by Regulation (EU) 2020/852 establishing a framework for facilitating sustainable investments and amending Regulation (EU) 2019/2088 (*Sustainable finance taxonomy - Regulation (EU) 2020/852*[86]). Namely, as the main tool for achieving the EU's 2030 climate and energy goals as well as the objectives of the European Green Deal.

It is recommended that this approach is used for infrastructural projects in general. Looking at all these 6 objectives simultaneously, in other words testing prescribed criteria against some investment in parallel for all of them, can result in very sustainable investments. That means that not only climate proofing of some infrastructural project is ensured, but also its sustainability as it will have to present that it does not significantly harm to any of other environmental objectives, DNSH approach. An example of DNSH analysis is presented in Annex C.

Implementation and timeline

It is recommended that the MoEPP initiates and implement this approach into relevant procurement calls under its management. Lessons learned and experience from this process could be analysed afterwards in order to appraise its efficiency and customise approach tailored to North Macedonian context.

As this is a non-regulatory approach, with guidelines already available, this process can be initiated immediately.

Co-benefits

Key co-benefits for this approach are as follows:

[86] https://eur-lex.europa.eu/legal-content/HR/TXT/PDF/?uri=CELEX:32020R0852&from=HR

- This approach does not require regulation changes and updates, though it is encouraged for those to happen.
- Using EU taxonomy can have tremendous benefits on a national level. Every infrastructural projects, as well as others, can be tested by the DNSH approach and thus ensure full sustainability in every single climate and environmental dimensions.
- The EU taxonomy is still yet to be fully developed. However, the rising number of international and domestic institutional investors are working to align their investment portfolios with the EU Taxonomy criteria, given that soon many of them will be obliged submit non-financial reports on the share of their ”green activities”. Moreover, some donor funds use EU Taxonomy as a tool for selecting only sustainable projects. If North Macedonia opt for choosing this option, it can build its readiness substantially prior to possible enforcement towards Northern Macedonia in the coming years.

Recommendation 3: Continue to strengthen the legal ground for the introduction of climate adaptation in spatial (and urban) planning, including the adoption of a new spatial planning methodology.

Elaboration

The Republic of North Macedonia is cooperating with UNDP on several climate change tasks. Regarding spatial planning and climate change, a discourse was established with the MOEPP, but also with other stakeholders, and a Methodology for Mainstreaming Climate Change Considerations into Spatial Planning in North Macedonia was developed with a focus on the new National Spatial Plan which is developed. Moreover, GIS tool mapping areas subject to various climate impacts was developed and recommendations were given for the integration of climate change into the overall spatial and urban planning system. It remains to be agreed and see how this will all be implemented i.e.. translated to future plans. Northern Macedonia still lacks a strong legal ground for considering climate adaptation in spatial and urban planning, but forthcoming changes to the law as well as the national spatial plan provide an opportunity to address this issue.

Potential approach

Climate adaptation should be explicitly incorporated into the legal framework for spatial planning, making climate change considerations legally binding for spatial and urban plans at all levels. As a proposal, climate adaptation can be added as a key principle for spatial planning.

However, it is crucial to continue developing a spatial planning methodology with regard to climate risks, at all planning levels, taking into account their purpose, scale and level of detail. This includes usage of GIS tool containing maps with spatial data on climate change implications i.e. a map of areas prone to various climate impacts (including extreme and slow-onset events) and adjusting land use plans, protection and construction regulations accordingly. Initiating the development of pilot plans at different levels could be a great approach to test the applicability of the proposed methodology. The introduction of tools such as GIS during plan development process is highly recommended, as it supports a deeper analysis of the impact of various climate risks on geographical space.

Implementation and timeline

MoEPP has to ensure that climate adaptation is firmly embedded into the new Law on Spatial Planning, including a legally-binding provision of making spatial and urban plans at all levels climate proof.

At the same time, methodology for mainstreaming climate change considerations into spatial and urban plans has to be fully developed (for different types of plans) and applied to every new plan or amendments of an existing plan.

Recommendation 4: Strengthen the commitment to climate adaptation in the SEA procedure

Elaboration

The SEA process has great potential for moving towards climate resilience as it eliminates harmful and supports resilient projects at an early stage, during the programming or planning phases.

In North Macedonia, as in many other countries, there is a starting point for integrating climate adaptation into the SEA procedure, but there is still a need for a clear commitment to implement it. Namely, as defined in the Regulation on the content of the Strategic Environmental Assessment report which directly transposes the provisions of Annex I (f) and (g) of the SEA of the EU Directive, all SEA reports must contain “likely significant effects on the environment in general, including issues such as biodiversity, population, human health, fauna, flora, soil, water, air, climatic factors, material goods, cultural heritage including architectural and archaeological heritage, landscape and the interrelationship between the above factors. These effects include "secondary, cumulative, synergistic, short-term, medium-term and long-term, permanent and temporary positive and negative effects" and "measures designed to prevent, reduce and completely neutralize all significant adverse effects on the plan or program environment".

However, there are several examples of SEA studies for plans and programs that comprehensively take into account the effects of climatic conditions on other factors. Namely, there is a gap in the strategic framework, as well as data and tools for conducting accurate climate risk assessment and selection of measures for specific sectors.

Potential approach

As with the EIA, climate adaptation is not mandated or regulated in the North Macedonia, so there is no law that explicitly imposes an obligation to adapt all new, but also existing, activities to future climate conditions, which in the context of the SEA procedure leaves room for circumventing proper climate considerations. The forthcoming Law on Climate Action, as well as some existing laws (i.e. the Law on Environment or the Law on Local-self Government Units), as well as accompanying decrees that further define the SEA procedure, could serve to impose or reiterate the need for by integrating climate adaptation considerations. Also, an upcoming NAP could serve to embed this requirement.

Regardless of the legal and strategic framework, the development of statutory (or non-statutory) practical guidelines for SEA experts on how to integrate climate adaptation within SEA (assess climate risks and vulnerabilities, assess impacts and select measures for each of the sectors), as well as for MOEPP staff deciding on SEA, but also authorities acting as a plan-makers, would encourage quality implementation of climate adaptation through the SEA procedure.

Additionally, consideration could be given to expanding the content of the professional exam conducted by the MOEPP when giving future authorizations for SEA experts, or organising training for all existing SEA practitioners.

Box 9: Guidelines for Integrating Climatic Factors into the Strategic Environmental Assessment Process in Ireland

In view of supporting SEA practitioners, including authorities preparing plans, the Environmental Protection Agency (EPA) SEA Section in collaboration with the EPA Climate Services Unit prepared the Guidance for Integrating Climatic Factors into the Strategic Environmental Assessment Process in Ireland. It was informed by a literature review of existing good international practices, external review and modification of existing guidance on climate change in a format that should be usable by SEA practitioners. The document does not constitute statutory guidance and it is intended to serve as a good practice guidance note on how to practically incorporate climate change into plans and programmes in Ireland that fall under the scope of the SEA Directive.

The guidance presents information on the causes and consequences of climate change; how these causes and consequences can be described, evaluated and incorporated into the SEA; and where appropriate information can be found. It is structured around the following steps, covering both climate mitigation and adaptation:

- SEA process and climate change

- climate change baseline

- sectoral impacts of climate change

- climate change objectives and indicators

- climate change responses

- integration of SEA Findings into the plan/programme

- monitoring, evaluation and follow-up

The full document can be found here.

Implementation and timeline

The forthcoming enforcement of the Law on Climate Action could mandate that any future plan or programme must take climate considerations into account or that the SEA process must take climate adaptation as an additional factor.

Technical guidelines for SEA experts on integration of climate adaptation within the SEA process shall be developed by the MoEPP in collaboration with the Chamber of Architects and Engineers / universities, with a strong involvement of practitioners. The drafting of the guidelines can begin in 2022, as the legal basis for climate considerations in SEA procedure already exist (EU Directive transposed into Macedonian law as mentioned in the previous paragraphs).

Recommendation 5: Include ''resilience to climate change'' as a basic requirement for construction under the Law on Construction

Elaboration

The existing Law on Construction, which is soon to be amended, prescribes basic requirements for constructions and their parts, such as mechanical endurance, stability and seismic protection, fire protection, sanitary and health protection, protection of the working and living environment, protection against noise, safety in the use, efficient use of energy and thermal protection or bicycle parking space, which all must be fulfilled through planning, design and construction. But also, these features shall be sustained during the usage period of construction. Public bodies in charge of issuing permits at the national or local level verify compliance of basic project with these requirements when granting construction approval.

Potential approach

The adverse effects of climate change, and in particular climate disasters, can cause disruptions in the provision of services, but also enormous material damage to infrastructure. Current basic requirements for construction consider a wide range of conditions, which might suggest that e.g. in the event of extremely strong winds, heavy rainfalls or floods, the structure is protected from collapse, destruction and deformation as one of the requirements is mechanical stability or safety. In spite of that, due to seismic forces that have a different effect and are much higher than the normally dimensioned load, seismic protection as been added separately.

Following the same approach, protection against changing climatic conditions should be added, i.e. climate resilience should be ensured as a new basic requirement for construction. To be specific, climate change can be devastating and affect not only the building but also its environment. Therefore, climate resilience as a basic requirement for construction should be viewed as twofold:

- climate resilience of construction (e.g. design measures that can prevent damage from floods, severe winds, prolonged heat waves)
- influence of construction on climate resilience of its environment (e.g. design measures that reduce potential negative impacts of construction to its environment, such as avoiding use of materials with high heat storage capacity in the areas suffering from urban heat island or reducing drainage and water absorption capacity of an area that is prone to heavy rainfalls)

This approach would result in adoption of new or amended technical standards or revised design practices, which incorporate climate adaptation measures.

Implementation and timeline

As a part of the following amendments of the Law on Construction, climate resilience shall be added as a new basic requirement for construction.

Recommendation 6: Establishment of a coordination mechanism for climate adaptation activities is vital.

Elaboration

Coordination mechanism is vital as it ensures interaction from various key stakeholders necessary for analysis and resilience actions to be identified and standardised, More specifically, that would include coordination between all policy makers to ensure proper mainstreaming of climate proofing tools within relevant policies and procedures. Climate change adaptation is argued to require coordinated policy responses because it is a complex, long-term, knowledge intensive, cross-

sectoral, and multi-level governance challenge that involves many interdependencies and actors with different perceptions, goals, and approaches.

Potential approach

As already noted, the new Climate Action Strategy alongside several other several other strategies provide strong basis for inclusion of climate proofing aspects into national legal and regulatory framework. Several activities for coordination on this matter could be considered:

- Establishment of coordination body within the MoEPP or any other relevant institutions. This body would coordinate activities on a governance level with an objective to mainstream climate adaptation aspects into relevant legislation. Furthermore, it would serve as a link between other relevant public institutions such as National Hydrometeorological Service, engineering and architect community, private sector, international relevant institutions, and other relevant stakeholders.
- Coordination could be defined by the upcoming NAP, part of the GCF readiness proposal.
- Coordination mechanism would ensure the development of proper climate models and other national technical information required for the implementation of various climate assessment methodologies, standards and codes, and other guidelines and approached. A demand driven approach.

Implementation and timeline

It is suggested that coordination mechanism be established be the MoEPP. Coordination mechanism modalities could be designed immediately in order to embed them into the NAP GCF readiness proposal.

Co-benefits

- Approach would ensure a substantial capacity building within key stakeholders.
- Effective cooperation on many levels can ensure market driven cooperation and project pipeline identification.

Recommendation 7: Consider institutional capacity building, knowledge transfer and sharing, awareness raising, and other activities related to climate resilient infrastructure.

Elaboration

Concrete climate adaptation activities are very knowledge demanding. Preparation and evaluation of adaptation project require a high extent of multidisciplinary expertise. This is mostly due to very explanatory based nature of climate adaption projects. This requires substantial capacity building within various key institutions. When comes to public institutions, evaluation efforts are significant, and appropriate capacity is crucial and enabling factor. Furthermore, private sector needs to be ready to respond to any legal or procurement requirements.

Potential approach

There are several potential activities to consider in this context:

- Participation in training and programmes related to increasing capacity of public institutions. It is likely that this is most efficiently done through initiatives with international organisations.
- Inclusion of climate change curriculum in educational institutions at all levels, including financial support for research projects related to climate resilient infrastructure.
- Establishment of initiatives and trainings for engineers and architects. It is noteworthy that during stakeholders consultations, it was uniformly communicated that there is already a high level of capacity within national technical experts for conducting implementation of climate adaptation measures of any kind, related to infrastructure. It may therefore be of interest to appraise this level for proper understanding.
- Cooperation with international organisations on project/programmes/initiatives related to improving climate resilient infrastructure. Design and establishment of scalable demo models.
- Awareness campaigns /webinars/workshops to emphasise on this topic, its importance, and finally increase adoption of adaptation considerations (raise interest and demand from the private sector).

Implementation and timeline

It is suggested that line ministries, in cooperation with international organisations, promote and initiates programmes and projects that would secure knowledge transfer and institutional capacity building in this aspect. For example, climate resilient infrastructure projects may be considered as a priority in GCF country programming.

It would be beneficial to secure at least one programme by the end of 2023.

Co-benefits

- Better coordination and cooperation among institutions.
- Ability of various institutions to deal not only with infrastructural related project but any other adaptation related initiatives/projects/investments.

Recommendation 8: Increase adoption of relevant technical standards. Ensure appropriate and up to date transposition.

Elaboration

As described under sub-chapter 3.4., technical codes and standards are key for the implementation of appropriate adaptation measures. Standards are crucial to ensuring infrastructure is prepared to withstand present and future climate scenarios. They can assist stakeholders to incorporate climate risks, resilience and adaptation measures in the planning, delivery and management of infrastructure. The security and durability of infrastructure requires the existence and respect of standards, as tools for designers, builders, operators and users.

Proposed approach

There are several things to consider in regard to technical standards:

- Consider using ISO 14090:2019 and ISO 14091:2021 in planning phases of infrastructural projects.

- As already noted, North Macedonia is transposing all Eurocodes and is expected that this would be completed in 2025. However, EC is also working on updating Eurocodes to account for climate resilience and risks, so-called second-generation Eurocodes. It is strongly advised that second generation of updated Eurocodes is transposed as well. The ISRSM would have a key role to ensure this is fulfilled.
- Consider using other voluntary standards in potential infrastructural projects to raise awareness and showcase benefits.

Implementation and timeline

ISRSM, as the main responsible body in this context, should ensure that the process of EU's updating of Eurocodes is monitored. Once these standards are ready, a process for transposing of those updated Eurocodes should be initiated.

Furthermore, MoEPP and other line ministries, in their procurement processes, might favor applicants that use ISO standards described above.

Timeline is dependent on finalization of EU's updating of Eurocodes.

Recommendation 9: Consider developing report on current state of infrastructure and damages occurring from climate change impacts

Elaboration

During stakeholder consultation, the Crisis Management Center was contacted. It appears, that much information in regard to damage to infrastructure is regularly collected, including those related to climate hazards. However, these are not systematically processed and publicly available. It would be important to understand what are current climate impacts on various infrastructure in North Macedonia in order to pin point where specifically planning and standards need to be strengthened.

Potential approach

Initiate a study development, followed up by maintained data platform, that would look at the following aspects:

- Portfolio of infrastructure and planned projects disaggregated by various sectors;
- Historical and current damage resulted from climate hazards;
- Identify key entry points for improving future infrastructural projects;
- Assessment of funding needs for retrofitting of critically damaged infrastructure by also taking into account costs associated with improving its resilience.

Implementation and timeline

It is suggested that Crisis Management Center process available data and create an online free access database and/or report on observed damage of infrastructure due to climate and natural impacts.

Ideally, this process would be done by the end of 2023.

Co-benefits

- Potential for development of correct and precise feasibility studies, risk assessments, and scientific work in the context of link between climate change and infrastructure.

Recommendation 10: Require climate risk reporting from public and private companies (potentially local units and all other large physical property owners) involved in critical infrastructure management

Elaboration

Most of the infrastructure in northern Macedonia is obsolete and requires significant investment, with climate change perhaps not being singled out as a leading reason for repair or modernization. However, given the availability of climate finance, but also the growing consensus among the financial industry on including climate risks before providing financing (e.g. the bank sets interest rates according to the company's climate exposure), it is necessary to consider the current state of infrastructure in terms of upgrading it to become climate-proof.

Potential approach

Designated body (e.g. the Ministry of Transport and Communications, the Ministry of Environment and Physical Planning, or some other body which may be suitable for climate (risk) evaluation or monitoring function) should be empowered to instruct public and private enterprises managing critical infrastructure to assess climate change effects on their assets and business operations and suggest an adaptation response, in a form of report.

According to the Law on Communal Activities, public enterprises licensed to perform communal activities, both national and local, are obliged to work on development plans and programs for communal activities every three years, which should include climate-resilient investments or, at least, ensure that anticipated investments incorporate elements that make them climate-proof.

Moreover, the same law requires local self-government units to prescribe the manner of acting in case of the communal service supply discontinuance due to an accident or natural disaster. Given that, potentially the same obligation could be applied to local self-government units as they manage a part of infrastructure and communal activities (e.g. landscaping, collection and management of waste, maintenance of public areas and open drainage systems, and others).

Box 10: Prompting utilities to prepare their climate adaptation plans through the "Adaptation Reporting Power" in the UK

Organizations responsible for the delivery of critical services and infrastructure should be assessing the risks and impacts of climate change and preparing the necessary response plans, as part of their risk management processes. To encourage them to do so, the 2008 UK Climate Change Act introduced the "Adaptation Reporting Power" which grants the Secretary of State to invite reporting bodies (which are bodies with "public functions" and "legal entities") to report on what they are doing to adapt to climate change.

It is the primary legislative lever available to the Government to ensure that the impacts of climate change are considered in key sectors and organizations such as local, regional and national water and energy companies, carriers, digital companies and others. As adaptation to climate change is not a one-time exercise, but a cyclical, iterative process, it is important that adaptation becomes built into the core of every body's business, not a one-off. independent activity (e.g. just making this report). If the adjustment is embedded in the organization's existing business structures and / or regulatory frameworks, the organization may not be required to re-report or will only be required to provide updated information on its activities.

Each submitted report should detail:

•the current and future projected impacts of climate change on their organisation;

•proposals for adapting to climate change;

•an assessment of progress towards implementing the policies and proposals set out in previous reports.

In the UK, to date, there have been three rounds of reporting. The reports of various organisations that were invited to report under the third round of the climate change Adaptation Reporting Power can be found here.

Overall, an analysis of previous rounds of reporting on the strength of adaptation shows that certain sectors, such as water and infrastructure, have well-adjusted adaptation plans that summarize the risks they face. However, almost no sector has shown sufficient progress in reducing the identified risks . The UK did not extend this type of reporting to local governments after recognising that many LGUs were already taking adaptation measures and do not want to burden them with additional reporting activities.

Implementation and timeline

Designated body (e.g. the Ministry of Transport and Communications, the Ministry of Environment and Physical Planning, or some other body which may be suitable for climate (risk) evaluation or monitoring function) should be empowered for implementation.

Would be beneficial to align with the development of updated EIA requirements.

5.2 Recommendations for transport sector

Recommendation 1: Consider promotion and update of transport design guidelines among public and private sector (municipalities, engineers, designers, and other transport experts)

Elaboration

As already noted, transport sector in North Macedonia already have several ongoing relevant initiatives as well as strong foundation, in the latest national transport strategy, for increasing resilience of its infrastructure. Initiatives include ClimaProof project and the World Bank's Technical assistance preparation of climate resilience design guidelines for the public enterprise for state roads in North Macedonia. These initiatives clearly presents the recognition of importance of climate resilience of infrastructure within the sector. For example, ClimaProof project's objective is to conduct a comprehensive and specifically tailored vulnerability assessment of North Macedonian transport sector.

Potential approach

Potential approach is quite straightforward as above-mentioned initiatives and strategic framework support the implementation of climate resilience aspects within the sector. The resulting capacity should be scaled up and taken into consideration in any future infrastructural projects in transport sector. However, stronger legal framework, adoption of the most up to date standards, and overall coordination would be vital for that to happen.

It would also be very useful to develop guidelines for the rail transport in a similar way to the guidelines developed by the World Bank for the road transport.

It is very important to ensure that such guidelines are actually implemented in the processes of design, construction and maintenance of infrastructure.

Implementation and timeline

It is suggested that the Ministry of Transport and Communications organise training for engineers designers, and transport experts to promote implementation and usage of World Bank's guidelines for road transport. In parallel, these guidelines could be amended based on results from ClimaProof project and additional guidelines for other types of transport could be considered for development. It is suggested that training are conducted by the end of 2023.

Recommendation 2: Consider incentivising climate resilient transport projects and innovative adaptation solutions – transfer of best international applicable technical solutions

Elaboration

There are many international examples of best practices. Significant experience has been developed in the transport sector, as many projects are adapting to the forecasted impacts of climate change. It may be worthwhile to consider technology and knowledge transfer in this regard.

Potential approach

Key stakeholders might consider opting for applying different applicable and available international methodologies and technical solutions related to climate adaptation. This can be done through pilot projects in cooperation with international organisation and academia.

The railway transport is characterized by a fairly old infrastructure and train compositions. The railways to Albania and Bulgaria are not yet complete. Having this in mind, it may be advisable to launch initiatives that specifically address the support of improving railway infrastructure in all segments, with mandatory consideration of climate resilience in design, construction and public procurement processes.

Implementation and timeline

The Ministry of Transport and Communications, in cooperation with international organisation/s might consider promotion of climate resilient innovative design solutions in transport sector, based on best international practices. This might be done through various awareness raising events. Furthermore, if there are going to be initiatives for railway modernisation, the line ministry might consider implementation of international best practices, in line with the climate resilient narrative. *Co-benefits*

- Inclusion of innovation and academia sectors and support towards tailored technological solutions, most appropriate for North Macedonian context.
- Quality transport infrastructure also provides socio-economic benefits through greater safety, higher traffic, additional income from tourism and new jobs.

5.3 Recommendations for energy sector

Recommendation 1: Consider climate-proofing of energy infrastructure projects – more emphasis on climate adaptation

Elaboration

The power sector is generally viewed in the context of climate mitigation. However, it is also the case that the sector is itself significantly vulnerable to projected changes in climate. Energy sector is extremely prone to climate risks. There is a need to consider how would those imply to availability of energy generation, transmission, and even consumption. The energy sector is vulnerable to projected changes in mean climate conditions (such as mean temperature and rainfall), in climate variability, and in the frequency and intensity of extreme weather events. For example:

- Increases in air temperature may have numerous impacts, including (i) reduced generation efficiency and output as well as an increase in customer cooling demands, stressing the capacity of generation and grid networks; (ii) hydrological changes, especially in river basins fed by melting snow and glaciers; and (iii) increase line losses in the transmission and distribution systems.
- Changes in precipitation patterns and surface water discharges, as well as an increasing frequency and/or intensity of droughts, may adversely impact hydropower generation and reduce water availability for cooling purposes.
- Changes and variations in wind speeds can damage wind farms.
- Extreme weather events, such as stronger and/ or more frequent storms, can reduce the supply and potentially the quality of fuel (coal, oil, gas), reduce the input of energy (water, wind, sun, biomass).

Potential approach

Cross-cutting and horizontal recommendations under sub-chapter 5.1. are very valid for the energy sector as well. There is a need for quality and tailored climate models, appropriate legislation, and technical codes and standards that would ensure that climate risks are taken into consideration in energy sector.

Box 11: Endesa (Spain) integrating climate adaptation into business strategy of energy company

Endesa is a Spanish, private energy supply company providing electricity and gas. In 2011, the company started working towards a Strategy for Climate Change Adaption, by conducting risk and opportunity analysis in relation to the adaptation policy approaches in each of the countries in which they operate. Within the project's framework, a specific climate change vulnerability analysis was carried out for each one of Endesa facilities around the world.

In the first phase of the initiative, the pilot cases included a detailed analysis of the vulnerability to climate change for the company activity at the hydroelectric plants in the water reservoirs of Cala (Sevilla) and El Tranco (Jaén), as well as the run-of-the-river station of Mengíbar (Jaén). In a second phase, adaptation measures for the three reservoirs in Andalusia were identified[87].

Climate Change Vulnerability and Risks

The main risks were associated with an increase in temperature, which would lead to greater evapotranspiration of vegetation in basins and increased need for water supply for irrigation. Also, lower

[87] https://climate.copernicus.eu/sites/default/files/2018-11/06_C3S_Symposium_Rodriguez_Feb2017.pdf

rainfall levels in basins would result in lower hydropower production and increased water costs. Risks related to extreme weather conditions were considered as minor risks.

Climate Change Adaptation Measures

• Water demand management - optimisation of the management of the hydroelectric installations shall be achieved by influencing the demand;

• Meteorological and climatological predictions and water reservoir management;

• Handling of suspended solids to minimise the accumulation of sediments in the water reservoirs to resolve technical problems of the installations (clogging); and

• Adaptation of emergency plans for new climate conditions.

Good Practice

- All steps of climate change adaptation assessment were carried out and described, except for implementation.

- Implemented pilot project serves as a guide for other energy utilities and projects.

- Endesa gained an extensive experience in adaptation to climate change including collaborations with the Spanish government.[88]

Implementation and timeline

It is strongly suggested that line ministries and relevant agencies put more emphasis on climate resilience on energy infrastructure. As energy investments are capital intensive and basically almost all part of critical infrastructure, it is strongly advised that Technical guidance on the climate proofing of infrastructure in the period 2021-2027 methodology is used immediately. If EIA requirements get updated then it is needed to ensure its proper implementation.

This recommendation would benefit from potential establishment of a coordination mechanism suggested as recommendation 6 under sub-chapter 5.1. Coordination mechanism would ensure that all capital projects are climate proofed.

5.4 Recommendations for water sector

Recommendation 1: Full transposition of Floods Directive 2007/60/EC

Elaboration

The purpose of the Floods Directive, as set out in Art. 1, is the establishment of a framework for the assessment and management of flood risks that aims at the reduction in the adverse effects of flooding. This target has to be achieved through the development of flood risk management plans by the member states (Recital 13 of the directive) that should focus on the prevention, protection and preparedness (Recital 14 of the directive). As already described, North Macedonia has partially transposed Flood Directive into the Law on Waters. However, there are still some aspects pending

88 https://ec.europa.eu/regional_policy/sources/docgener/studies/pdf/climate_change_major_projects/climate_change_adaptation_of_major_infrastructure_projects.pdf

transpositions, some of which include: Preliminary Flood Risk Assessments, Flood hazard and risk maps, and others.

Potential approach

Full transposition of the above-named directive would enable many key stakeholders to understand risks of floods in a given area. I would present and invaluable tool for planning and designing of infrastructural projects in all sectors as well as for the preparation of secondary legislation related to EIA and SEA.

Implementation and timeline

Transposition of Floods Directive is conducted by the Ministry of Agriculture, Forestry and Water Economy.

Co-benefits

- Every potential infrastructure related project can benefit from proper information delivered through full transposition of Floods Directive

5.5 Recommendations for built environment

Recommendation 1: Utilise nature-based solutions for adapting urban areas to climate change

Elaboration

Nature-based solutions or green infrastructure can address urban challenges exacerbated by the impacts of climate change. They are multi-functional, cost-effective and provide a wide range of environmental, economic and social benefits, such as improving air quality, social cohesion or public health. Stakeholder consultations reveal, that so far, only the City of Skopje has been active in this field. Recently, Skopje has been creating a Green Cadastre with maps of public greenery with all its attributes, and is working on a study for green corridors along the rivers Lepenec and Serava.

Potential approach

The suggestion is to further expand the concept of green infrastructure for climate adaptation, as an alternative to grey infrastructure, preferably at the national level. Also, to make a shift from project ideas to investment-ready projects raising awareness and provision of technical and financial support to cities and developers might be required.

Recommendation 2: Consider climate adaptation options in energy renovation projects, in synergy with climate mitigation solutions

Elaboration

Buildings can also be vulnerable to climate change and future events can result in the collapse, degradation or deformation of buildings, their parts or materials. The EU's climate change strategy emphasizes the need to improve the preparedness of buildings for climate change. As energy reconstruction of buildings is gaining momentum in Northern Macedonia, the introduction of

adaptation measures in energy renovation programmes should be considered, especially when it comes to renovating large-scale public buildings. As an example, the problem of high temperatures in the summer months could be solved in other ways than by installing air conditioning devices (e.g. green roofs, shading, materials that provide heat insulation).

Potential approach

Recommendations for the inclusion of climatic resistance as basic requirements for construction are provided within the cross-cutting recommendations under 5.1.

Box 12: Using innovative materials to adapt to climate change

1)**Permeable concrete that drains thousands of litters of water in just minutes**

The impervious materials, covering most of urban areas, seal the soil surface which eliminates rainwater infiltration and can cause flooding during heavy rainfall.

Permeable concrete (also called porous concrete, pervious concrete) is a type of concrete with a high porosity. It is mainly used for flatwork concrete application (parking areas, streets, squares) and allows water from precipitation to pass directly to the ground, thus reducing the runoff from a site and recharging the groundwater. In addition, the filtration process also helps to purify the water. As the water percolates through the open cells of the pavement, aerobic bacteria in the voids help to break down harmful pollutants and chemicals.

Like conventional concrete, its made from a mixture of cement, little to no fine aggregates, and water. However, it contains little or no sand, which results in a porous open-cell structure that water passes through readily[89].

2)**Ultra-white paint reducing the need for air conditioning**

Some colors are known to absorb and others reflect sunlight. The choice of materials and coatings for buildings in urban areas, which already suffer from the heat island effect, can greatly affect the reduction or increase in ambient temperature.

Scientists from Purude University came up with the idea of the whitest white paint covering the walls, saying it absorbs only 1.9% of sunlight, unlike commercial coatings that absorb between 10 and 20% of sunlight. By keeping surfaces cool and reducing the use of air conditioners, which are typically powered by electricity, paint can help reduce fossil fuel combustion and thus contribute to reducing urban islands and global warming[90].

Implementation and timeline

Current climate strategies and plans prepared by cities should encourage the use of nature-based solutions. Also, amendments of any urban plan shall include provisions that preserve and expand natural areas (e.g. green roofs, rain gardens). Green cadastres (such as the one developed by the City of Skopje) shall be replicated by other cities.
Other environmental objectives, in addition to energy efficiency, should be taken into account

[89] https://en.wikipedia.org/wiki/Pervious_concrete

[90] https://www.smithsonianmag.com/innovation/ultra-white-paint-may-someday-replace-air-conditioning-180977560/

when developing new energy renovation programmes (but also stand-alone projects). The EU Taxonomy provides a good methodology for the environmental safeguarding of energy recovery.

Annex A. – Example Questionnaires for the initial stakeholder consultations

Potential Questionnaire – Stakeholder consultations – Decision making institutions

December 2021

RE: Key points to be discussed with Name Last name (Organization) regarding UNDP's assignment "Development of climate-resilient infrastructure study"

Introduction / context of the meeting

E Co. – a private consultant firm specialized in sustainable energy and energy efficiency projects – is carrying out a "Development of climate-resilient infrastructure study" on behalf of the UNDP. The overall objective of the study is to assess the potential and benefits of climate-resilient infrastructure in the Republic of North Macedonia, including identification of specific policy and regulatory measures to increase the resilience of Macedonian infrastructure, in order to support the adaptation of the infrastructure to the expected climate change, as well as implementation of the Macedonian enhanced Nationally Determined Contribution (NDC) targets. The scope of the study aims at water, energy, transport, and built environment sectors.

As part of this process, E Co. is conducting stakeholder consultations and is reaching out to key national partners to gather their views and inputs on activities and opportunities related to climate resilience of North Macedonian infrastructure. The purpose of this conversations is to:

- Inform key public stakeholders of the process and objective of this work/study;
- Gather information on potential past, current, and future activities/initiatives/programmes related to climate resilient infrastructure primarily, but not limited to, relevant regulation and strategic framework;
- Understand barriers and drivers for the implementation of legislation, codes, and standards related to climate resilient infrastructure;
- Explore possibilities of potential updating of relevant legal and strategic framework – climate resilient infrastructure wise;
- Discuss current practices related to increasing climate resilience of infrastructure that are potentially conducted as part of the processes

Below is a list of "key topics" for discussion, though it is possible that other discussion points may come up during the course of the meeting.

Finally, if you have more comments after our meeting, please feel free to send them to Marijan Gajšak (marijan@ecoltdgroup.com) and/or Miodrag Grujić (miodrag@ecoltdgroup.com).

Questions

1. Has climate adaptation, especially related to infrastructure, been considered to be included in relevant primary and/or secondary legislation?

2. Are there any activities already ongoing or planned in regard to considerations and inclusion of climate resilience aspects into relevant legal and strategic framework? If yes, could you please specify? If no, what would be the interest of your organisation to engage is such activities?

3. Are you familiar with the applicable resilient standards and codes for planning, design and licensing, especially in relation to your sector/relevant sectors? Example of standards include LEED, BREEAM, ISO for buildings, T-CEN for transport etc.

4. Are there any activities related to climate resilience that your organisation is conducting regardless of regulation? For example, are climate resilience aspects part of the EIA?

5. Have you been engaged, currently, or planning to be in initiatives/programmes/projects related to climate resilience with an emphasis to infrastructure?

6. Have you been provided, or planning to engage, in TA activities related to increasing the knowledge and capacity of your organisation in the context of climate resilience?

7. Are you aware of any international best practices regarding resilient infrastructure, especially in your sector?

8. Are you aware and have recorded infrastructural damage in relevant sectors caused by climate impacts? If yes, do you have information on costs of the extent of those impacts? What is the general state of infrastructure in relevant sectors?

9. What is your opinion of readiness and capacity of engineering community to implement climate resilient practices into design of infrastructure within the relevant sectors?

10. Are there any other comments you would like to make?

Potential Questionnaire – Stakeholder consultations – Public agencies

December 2021

RE: Key points to be discussed with Name Last name (Organization) regarding UNDP's assignment "Development of climate-resilient infrastructure study"

Introduction / context of the meeting

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As part of this process, E Co. is conducting stakeholder consultations and is reaching out to key national partners to gather their views and inputs on activities and opportunities related to climate resilience of North Macedonian infrastructure. The purpose of this conversations is to:

- Inform key public stakeholders of the process and objective of this work/study;
- Gather information on potential past, current, and future activities/initiatives/programmes related to climate resilient infrastructure primarily, but not limited to, relevant regulation and strategic framework;
- Understand barriers and drivers for the implementation of legislation, codes, and standards related to climate resilient infrastructure;
- Explore possibilities of potential updating of relevant legal and strategic framework – climate resilient infrastructure wise;
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Questions

1. Has climate adaptation, especially related to infrastructure, been considered to be included in relevant primary and/or secondary legislation? If yes, what is the role of your organisations and could you describe activities you were included into?

2. Are you familiar with the applicable resilient standards and regulations for planning, design and licensing, especially in relation to your sector/relevant sectors? Example of standards include LEED, BREEAM, ISO for buildings, T-CEN for transport etc.

3. Are there any activities related to climate resilience that your organisation is conducting regardless of regulation? For example, are climate resilience aspects part of the EIA?

4. Have you been engaged, currently, or planning to be in initiatives/programmes/projects related to climate resilience with an emphasis to infrastructure?

5. Have you been provided, or planning to engage, in TA activities related to increasing the knowledge and capacity of your organisation in the context of climate resilience?

6. Are you aware of any international best practices regarding resilient infrastructure, especially in your sector?

7. Are you aware and have recorded infrastructural damage in relevant sectors caused by climate impacts? If yes, do you have information on costs of the extent of those impacts? What is the general state of infrastructure in relevant sectors?

8. What is your opinion of readiness and capacity of engineering community to implement climate resilient practices into design of infrastructure within the relevant sectors?

9. Are there any other comments you would like to make?

Potential Questionnaire – Stakeholder consultations – Stakeholders related to engineering communities

December 2021

RE: Key points to be discussed with Name Last name (Organization) regarding UNDP's assignment "Development of climate-resilient infrastructure study"

Introduction / context of the meeting

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As part of this process, E Co. is conducting stakeholder consultations and is reaching out to key national partners to gather their views and inputs on activities and opportunities related to climate resilience of North Macedonian infrastructure. The purpose of this conversations is to:

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- Understand barriers and drivers for the implementation of legislation, codes, and standards related to climate resilient infrastructure;
- Explore possibilities of potential updating of relevant legal and strategic framework – climate resilient infrastructure wise;
- Discuss current practices related to increasing climate resilience of infrastructure that are potentially conducted as part of the processes

Below is a list of "key topics" for discussion, though it is possible that other discussion points may come up during the course of the meeting.

Finally, if you have more comments after our meeting, please feel free to send them to Marijan Gajšak (marijan@ecoltdgroup.com) and/or Miodrag Grujić (miodrag@ecoltdgroup.com).

Questions

1. What is your view on regulating climate resilient standards and technical guidance in terms of climate resilient infrastructure?

2. How would you describe the current status and practice, if any, regarding the impact of climate change on infrastructure planning and design in North Macedonia? Is the impact of climate change included and to what extent in existing standards and practices in your sectors? In your view, what pieces of regulation should be amended/changed?

3. Are you familiar with the applicable resilient standards and codes for planning, design and licensing, especially in relation to your sector/relevant sectors? Example of standards include LEED, BREEAM, ISO for buildings, T-CEN for transport etc.

4. Can you please describe us the planning, designing, permitting, and management processes related to infrastructural projects? Have architects and engineers been involved in applying the climate resilience standards in some past or present work?

5. Are there any activities related to climate resilience that members of your organisation are conducting regardless of regulation? For example, are climate resilience aspects part of the EIA, designing and permitting process?

6. Have you been engaged, currently, or planning to be in initiatives/programmes/projects related to climate resilience with an emphasis to infrastructure?

7. Have you been provided, or planning to engage, in TA activities related to increasing the knowledge and capacity of your organisation in the context of climate resilience?

8. Are you aware and have recorded infrastructural damage in relevant sectors caused by climate impacts? If yes, do you have information on costs of the extent of those impacts? What is the general state of infrastructure in relevant sectors?

9. What is your opinion of readiness and capacity of engineering community to implement climate resilient practices into design of infrastructure within the relevant sectors?

10. Are there any other comments you would like to make?

Annex B. List of interviewed stakeholders

Stakeholder	Contact	Role
Public institutions		
Ministry of Environment and Physical Planning	Ms. Teodora Obradovic Grncarovska	National Climate Change Focal Point
	Mr Dejan Gadzovski	Advisor in MoEPP on spatial plan implementation
Ministry of Agriculture, Forestry and Water Economy	Ms Lile Simonovska	Head of Water Economy Unit
Ministry of Economy	Ms. Valentina Stardelova	Head of energy department
Ministry of Transport and Communications	Mr. Goran Temovski	Adviser for negotiations and integration in EU
	Mr. Aleksij Popovski	Engineer for Environmental Protection in Railways Infrastructure in N. Mac.
	Mr. Marjan Kopevski	
	Ms. Jasminka Kirkova	
	Ms. Svetlana Popovska	Head of Railways in the Ministry of Transport
Energy Agency	Mr. Panche Atanasovski	Energy Efficiency Advisor
Office of the Vice President of the Government of North Macedonia responsible for economic affairs / National Designated Authority (NDA)	Ms. Sandra Andovska	Advisor
National Hydro Meteorological Service	Ms. Nina Aleksovska	Head of the Meteorological Department
	Mr. Aleksandar Prodanov	Climate Change Advisor, Department of Meteorology
Chamber of authorized architects and authorized engineers	Ms. Kristinka Radevski	President of the Chamber
	Mr. Dejan Metikos	Vice-president of the Chamber
	Ms. Blagica Andonovska	Head of Environmental Department of the Chamber
Faculty of Architecture	Ms. Ognen Marina	Professor - Architecture and Urbanism
Faculty of Civili Engineering	Ms. Katerina Donevska	Professor
Crisis Management Center	Mr. Stevko Stefanovski	Head Of Department for Risk analysis, risk assessment and Strategic planning
ISRSM - Standardization Institute of the Republic of North Macedonia	Mr. Goran Pletvarski	
	Ms. Violeta Shareska Gjakovska	
UNOPS	Mr. Igor Markovski	

Annex C. – Example of DNSH analysis (EU taxonomy)

The EU taxonomy consists of six main environmental objectives:

- Climate change mitigation;
- **Adaptation to climate change;**
- Sustainable use and protection of water and marine resources;
- Transition to a circular economy;
- Pollution prevention and control;
- Protecting and restoring biodiversity and ecosystems.

The approach for climate adaptation justification sets the following criteria:[91]

- screening of the activity to identify which physical climate risks may affect the performance of the economic activity during its expected lifetime;
- where the activity is assessed to be at risk from one or more of the physical climate risks a climate risk and vulnerability assessment to assess the materiality of the physical climate risks on the economic activity needs to be conducted;
- an assessment of adaptation solutions that can reduce the identified physical climate risk;
    - for activities with an expected lifespan of less than 10 years, the assessment is performed, at least by using climate projections at the smallest appropriate scale;
    - for all other activities, the assessment is performed using the highest available resolution, state-of-the-art climate projections across the existing range of future scenarios consistent with the expected lifetime of the activity, including, at least, 10 to 30 year climate projections scenarios for major investments.
- The climate projections and assessment of impacts are based on best practice and available guidance and take into account the state-of-the-art science for vulnerability and risk analysis and related methodologies in line with the most recent Intergovernmental Panel on Climate Change reports, scientific peer-reviewed publications, and open source or paying models.
- For existing activities and new activities using existing physical assets, the economic operator implements physical and non-physical solutions (‘adaptation solutions’), over a period of time of up to five years, that reduce the most important identified physical climate risks that are material to that activity. An adaptation plan for the implementation of those solutions is drawn up accordingly.
- For new activities and existing activities using newly-built physical assets, the economic operator integrates the adaptation solutions that reduce the most important identified physical climate risks that are material to that activity at the time of design and construction and has implemented them before the start of operations.

[91] https://eur-lex.europa.eu/resource.html?uri=cellar:d84ec73c-c773-11eb-a925-01aa75ed71a1.0021.02/DOC_2&format=PDF

- The adaptation solutions implemented do not adversely affect the adaptation efforts or the level of resilience to physical climate risks of other people, of nature, of cultural heritage, of assets and of other economic activities; are consistent with local, sectoral, regional or national adaptation strategies and plans; and consider the use of nature-based solutions or rely on blue or green infrastructure to the extent possible.

All environmental objectives are simultaneously tested for an investment/measure. Testing shall be carried out using clearly set technical criteria for each of the environmental objectives.

Example 1: Building a new office building

Measure Description

Construction of a highly energy efficient office building in an office zone in the center of the capital. The building is 7,500 m² in size and is built of steel construction that allows high flexibility at the usage stage, but also disassembly upon completion of use.

Table A: First Checklist - Construction of a New Office Building1

Please indicate which of the environmental objectives listed below require a significant DNSH assessment of the measure	Yes	No	Justification if "No" is selected
Climate change mitigation		X	The project directly supports the climate change mitigation target.
Adaptation to climate change	X		
Sustainable use and protection of water and marine resources	X		
Transition to a circular economy	X		
Pollution prevention and control	X		
Protecting and restoring biodiversity and ecosystems		X	The project has a slight impact on this environmental objective, taking into account direct and primary indirect impacts throughout the lifecycle. The building is not located in or near biodiversity-sensitive areas (including the Natura 2000 network of protected areas, the UNESCO World Heritage Site and key biodiversity areas, as well as other protected areas).

Table B: Second Checklist - Construction of a New Office Building2

Environmental objective	No	Explanation
Adapting to climate change. Is the measure expected to lead to an increased negative impact of the current climate and the expected future climate, on the measure itself or on humans, nature or property?	X	The physical climate risks that could be significant for this project were assessed as part of an exposure analysis covering the current and future climate, which showed that buildings and settlements in the targeted climate zone would be exposed to heatwaves. For this reason, the building is designed in a way that does not contribute to warming the environment and has an outer envelope made of materials with high solar reflection. Also, the building provides natural ventilation and has a built-in cooling system, to provide users with thermal comfort even at extreme temperatures. Therefore, there is no

		evidence of significant negative direct and primary indirect effects of the measure throughout its lifecycle on this environmental objective.
Sustainable use and protection of waters and marine resources: Is the measure expected to be harmful: (i) to good status or good environmental potential of water bodies, including surface and groundwater; or (ii) good ecological status of sea waters?	X	The established water consumption for the water appliances listed below shall be confirmed by the technical specifications of the product, the certification of the building or the existing product declaration in the Union in accordance with the technical specifications, as follows: (a) the flow of water through the taps of the sink and kitchen faucet is no more than 6 litres/minute; (b) the maximum flow of water through the showers is 8 litres/minute; (c) for toilets, including toilet kits, shells and cisterns, the full amount of flushing water shall be a maximum of 6 litres and the maximum average flushing water is 3,5 litres; (d) the maximum water consumption in urinals is 2 litres/per shell/per hour. In flushing urinals, the maximum full amount of rinsing water is 1 liter.
Transition to a circular economy, including waste prevention and recycling: Is the measure expected to: (i) lead to a significant increase in the generation, incineration or disposal of waste, other than the incineration of hazardous, non-recyclable waste; or (ii) lead to significant inefficiencies in the direct or indirect use of any natural resource at any stage of its lifecycle that are not minimised by appropriate measures; or (iii) cause significant and long-term damage to the environment with regard to the circular economy?	X	At least 70% (mass) of non-hazardous construction and demolition waste (excluding natural material of category 17 05 04 of the European Waste List established by Commission Decision 2000/532/EC) produced on the site is prepared for reuse, recycling and recovery of other materials, including waste embankment procedures for the replacement of other materials in accordance with the waste hierarchy and the EU Protocol on the Management of Construction Waste and Demolition Waste. Operators engaged in the activity restrict the generation of waste in construction and demolition in accordance with the EU Protocol for the Management of Construction And Demolition Waste, taking into account the best available techniques and applying selective demolition to enable the removal and safe handling of hazardous substances and to facilitate reuse and high-quality recycling by selectively removing materials and applying available sorting systems for construction waste and waste from Crash. The building is designed in a way that supports circularity, in view of ISO 20887 or other standards for assessing the possibility of dismantling or adaptability of buildings, and is more resource-efficient, adaptive and flexible and that some parts thereof can be disassembled to allow reuse and recycling.
Preventing and combating pollution: Is the measure expected to lead to a significant increase in pollutant emissions into the air, water or land?	X	Operators carrying out construction shall ensure that the building parts and materials used in the construction of the building do not contain asbestos or substances of great concern, as identified on the basis of a list of substances requiring authorisation under Annex XIV. Regulation (EC) No. 10. 1907/2006.

		After testing in accordance with the conditions referred to in Annex XVII. Regulation (EC) No. Building components and materials used for construction with which users can come into contact emit less than 0.06 mg of formaldehyde per m^3 materials or components, and after testing in accordance with CEN/TS 16516 and ISO 16000-3 or other comparable standardised test conditions and determination methods, less than 0,001 mg of carcinogenic volatile organic compounds of category 1A and 1.B per m^3 material or component. Measures are taken to reduce noise, dust and pollutants during construction or maintenance work.

Annex D – Technical guidance on the climate proofing of infrastructure in the period 2021-2027Methodology

According to the guidance, under the supervision and control of the concerned public authorities, the climate vulnerability and risk assessment helps identify the significant climate risks. It is the basis for identifying, appraising and implementing targeted adaptation measures. This will help reduce the residual risk to an acceptable level. The following figure presents the general scheme for an initial climate related screening of infrastructural projects.

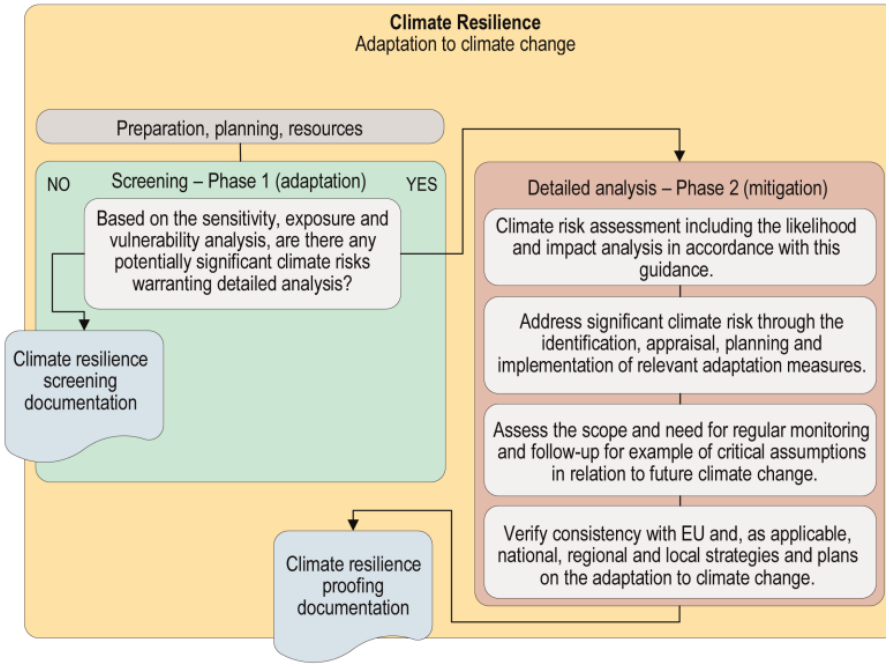

Figure 6 Overview of the climate adaptation-related process for climate proofing

In more detail, this tool requires an analysis of climate risks, vulnerability, and possible solutions in two steps process. First one is related to screening where several analyses are conducted; sensitivity, exposure, vulnerability. Based on analysis, the second phase is conducted where analysis for likelihood, impact, risk assessment is conducted. Finally, based on the result of all these analyses, adaptations options, its appraisal, and adaptation plan is developed. The process methodology scheme is presented by next figure.

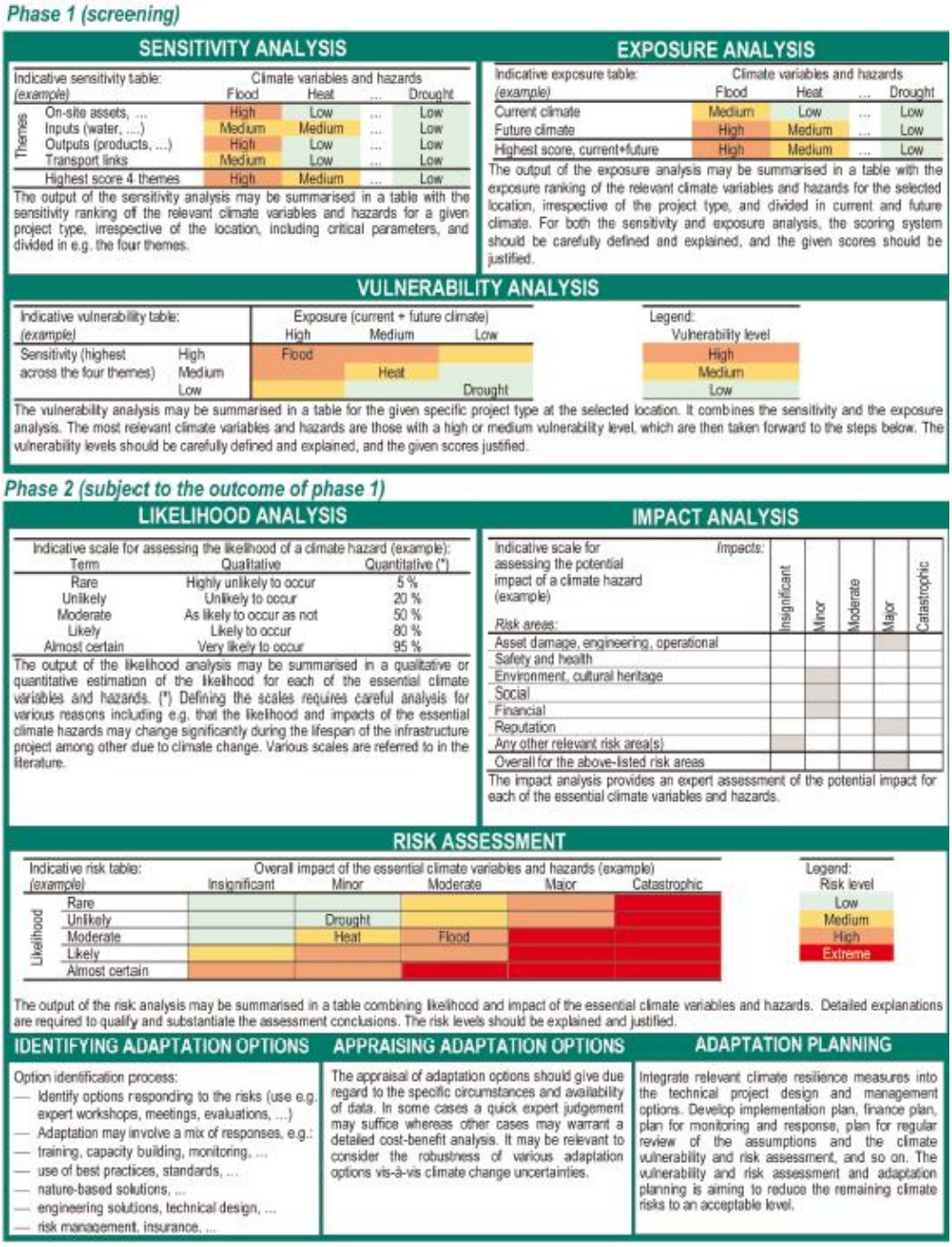

Figure 7 Indicative overview of the climate vulnerability and risk assessment, and the identification, appraisal and planning/integration of relevant adaptation measures