



Climate change adaptation of major infrastructure projects

Country report for Luxembourg

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Note for the readers of the printed version: the present country report links to a large number of resources via hyperlinks, which by nature are only active in the electronic version. In order to find the identified resources, an online search will usually deliver the right result; but otherwise it is also possible to make use of Annex II of the main report where all the identified resources and their hyperlinks are presented.

Disclaimer: The identified resources are non-exhaustive and present a snapshot of the readily available and accessible material during 2017. This information was collected through finite web-based desk research, and through questionnaires and interviews aimed at the relevant national competent authorities (ESIF managing authorities, research institutes, ministry officials, etc.). Further resources might be available but not accessible due to privacy restrictions, or a lack of mandate to share related material. Following the publication of the present report, more resources will continue to reach the public domain, including through Climate-ADAPT and the identified national websites.

1. INTRODUCTION

The [EU Strategy on Adaptation to Climate Change](#) of 2013 includes actions to enhance the resilience of infrastructure and mainstream climate adaptation into the European regional and cohesion policy. The [Common Provisions Regulation](#) (CPR) of 2013 states under article 8 that climate change mitigation and adaptation, and risk prevention shall be taken into consideration for investments made with the support of the European Structural and Investment Funds (ESI Funds). The regulation integrates climate change adaptation considerations into the preparation and approval of major projects¹ or other projects funded by the ESI Funds through the requirement to conduct climate change vulnerability and risk assessments. In coordination with the ESI Funds, and complimentary to them, the LIFE fund in addition assists in the realisation of the climate change adaptation objectives. Climate change analyses (such as vulnerability and risk assessments) are also sporadically found to be undertaken for infrastructure projects that are financed outside the framework of EU funds.

This report for Luxembourg focuses on the adaptation to climate change of infrastructure projects supporting the requirement to undertake climate change vulnerability and risk assessments by presenting:

- **Legal, policy and institutional framework:** A schematic outline of national and regional policy and legal framework, and organisational structure to deal with adaptation;
- **Resources:** Offering the most important resources supporting the realisation of climate change vulnerability and risk assessments for infrastructure projects. The available resources for data, methodologies, tools, guidance, design standards, system framework and institutional capacity are contextualised and listed in this section;
- **Sector overview:** Identifying the approach, main strengths and weaknesses for each of these sectors: Transport, Broadband, Urban Development, Energy, Water and Waste; and
- **Case studies:** Current practice in adaptation and resilience of infrastructure projects.

Country Overview

The National Adaptation Strategy was adopted by the Council of Ministers of Luxembourg in June 2011 and provides a framework for adaptation to the impacts of climate change. Luxembourg's present (2018) government stresses that the 2011 strategy will be revised and updated. The primary responsible institutional body with regard to climate change adaptation is the [Ministry of Sustainable Development and Infrastructure](#) (MSDI), which is divided in four departments (Environment, Spatial Planning and Development, Public Works, and Transport). The [Department of the Environment](#) is responsible for formulating environmental policy and drafting legislation. There is cooperation between the ministries and regular staff meetings and coordination groups, where all stakeholders are involved. Luxembourg has also been actively involved with its neighbour countries France and Germany to develop transnational cooperation to harmonise flood management in the Moselle and Saar basins.

The [Luxembourg Institute of Science and Technology](#) (LIST) stores measured data from different institutions and has a network of five measuring stations that continuously

¹ major project: an operation comprising a series of works, activities or services intended in itself to accomplish an indivisible task of a precise economic or technical nature which has clearly identified goals and for which the total eligible cost exceeds EUR 50 000 000 and in the case of operations contributing to the thematic objective under point (7) of the first paragraph of Article 9 of Regulation 1303/2013 where the total eligible cost exceeds EUR 75 000 000

collects and monitors data along Luxembourg's water courses, and updates the [Hydrological Monitoring Network](#) of areas prone to flooding. LIST has also developed a methodology to analyse and evaluate recorded environment data regarding climate change, and the [Hydrological Monitoring Network](#) provides a methodology for refurbishment of natural areas specifically as part of flood defence. LIST uses the [Weather Research and Forecasting Model](#) as well as the [COSMO-CLM model](#) to develop predictions and scenarios. In addition, there is a tool with regard to climate change indicators ([ETCCDI: Expert Team on Climate Change Detection and Indices](#)) that allows the collection of indicators to derive the impacts in various sectors. The urban development and transport sectors have the most comprehensive guidance, namely, the National [Master Programme for Spatial Planning \(PDAT\)](#), which, with focus on spatial planning and urban building, it indirectly address the issue of adapting to climate change. It also presents the different steps to perform vulnerability assessment importance of understanding regional climate impacts. EU resources are in use, such as the [Guide to Cost-Benefit Analysis of Investment Projects](#), the publication on [Climate Change and Major Projects](#) and the non-paper [Guidelines for Project Managers](#).

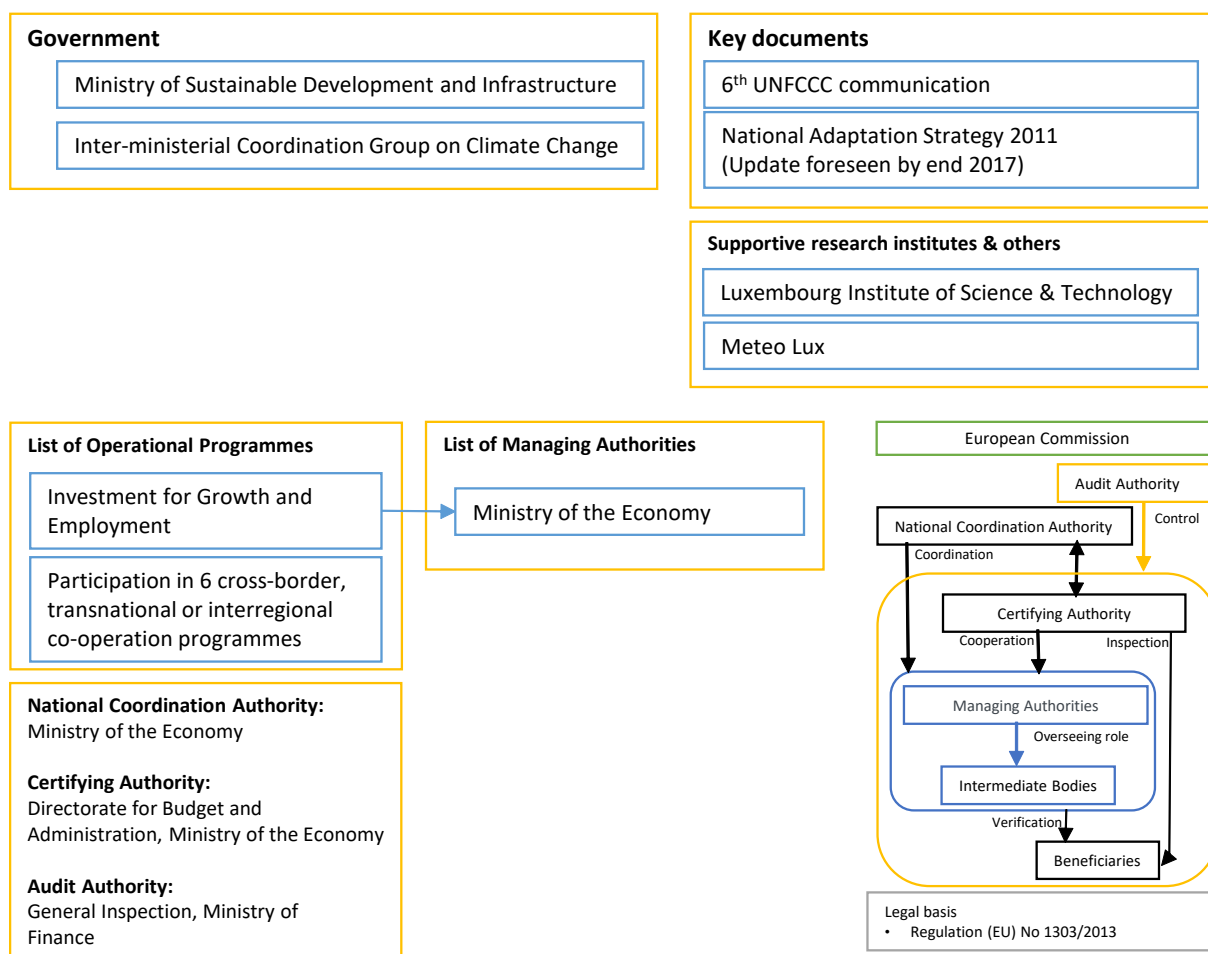
Evidence of climate adaptation in the main infrastructure sectors was partially observed. The [Integrated Transport and Spatial Planning Concept \(IVL\)](#) was developed to guide the implementation of the main targets set out in the PDAT. For the water sector, the Hydro-Climatological Observatory has established [hydro-climatological database for long-term studies](#), while the [national geoportal of Luxembourg](#) contains flood hazard maps and flood risk maps with information on necessary protective measures in urban areas. Luxembourg has adopted [River Basin management Plans](#) that contain a summary of economic analysis of water use and a programme of measures, and a [Flood Risk Management Plan \(FRMP\)](#), which contains measures to reduce the impacts of flooding hazards. The broadband, energy and waste sectors are not involved in the national or regional authority climate change adaptation plans or initiatives organised by governmental bodies.

Two case studies have been identified in Luxembourg, the first one being a study on the [consequences of climate change for the Rhine catchment Area](#), and the second being the [Future Cities Adaptation Compass](#), a practical tool to check the vulnerability and adaptation options across sectors.

2. LEGAL, POLICY AND INSTITUTIONAL FRAMEWORK

The Ministry of Sustainable Development and Infrastructure, is the primary governmental authority with responsibility over adaptation to climate change. Following the National Adaptation Strategy adopted in 2011, a revised version covering more sectors is under preparation. The document was prepared in consultation with other ministries gathered in the ad hoc Inter-ministerial Coordination Group in Climate Change and with input from the Luxembourg Institute of Science and Technology.

ESI Funds are absorbed in the country mainly through the national Operational Programme for Investment for Growth and Employment. Managed by the Ministry of the Economy, the Operational Programme does not foresee the implementation of major projects for the programming period 2014-2020.



3. RESOURCES

This country report has reviewed the currently available resources in Luxembourg for adapting to the impacts of climate change across six key infrastructure sectors. Adaptation to climate change is integrated in the legal basis² for ESIF-funded projects, through the processes of vulnerability and risk assessments which are, broadly:

1. Vulnerability – evaluating the sensitivity and exposure of infrastructure to climate change
2. Risk – estimating the likelihood and impact of relevant climate hazards
3. Adaptation - consideration of adaptation options and integration into the project planning

The legal requirements for major projects also foresee climate change mitigation. This study however is focused on climate change adaptation and does not cover mitigation aspects.

Information on the requirements for climate change adaptation is available in the 2016 publication [Climate Change and Major Projects](#), and details on the methodology of climate resilience analysis is provided in the 2017 JASPERS publication [The Basics of Climate Change Adaptation, Vulnerability and Risk Assessment](#). Further resources are

² Regulation (EU) No 1303/2013, Commission Delegated Regulation (EU) No 480/2014, Commission Implementing Regulation (EU) No 1011/2014, No 215/2014, 2015/207; and the Directives 2001/42/EC, 2011/92/EU and 2014/52/EU

being identified in the present publication and its references. Effective vulnerability and risk assessments for the adaptation of major projects to climate change require the resources explained in the following table:

Resources	Explanation
Data Availability	The availability, accessibility and applicability of data on climate projections and impacts, on past and historic events, on geophysical parameters, on long-term scenarios, on economic, environmental and social impacts, etc.
Methodologies	The existence of quantitative or qualitative methodologies (a system of processes, a set of principles and rules) for integrating climate change adaptation in the development of infrastructure projects.
Tools	The availability of tools for planning, evaluation, impact estimation (i.e. software, maps, computer simulations, long term climate forecasts etc.) to assist with the adaptation of infrastructure to climate impacts
Guidance	The provision of guidance on how to use methodologies (i.e. for conducting climate change vulnerability and risk assessments) or develop the required infrastructure project documentation relating to climate adaptation.
Design Standards	The availability of published engineering design standards (i.e. by BSI, DIN, ISO) for infrastructure projects that include sections or appropriate provisions to ensure resilience to climate change impacts
System	The institutional and legal framework that the formal authorities work with to deliver their primary responsibilities for climate adaptation, infrastructure, and management of European Structural and Investment Funds
Institutional capacity	The human and technical capacity of institutions to carry out their functions. It depends on being adequately resourced, on having the appropriate expertise, and on collaborating effectively and enforcing laws and regulations

3.1. Data Availability

Quantitative data are essential to understand the relevant risks and the requirements for any corresponding climate change adaptation in key sectors. The website of the Ministry of Sustainable Development and Infrastructures (MSDI) does not have a specific webpage dedicated to adaptation. Only a brief introduction to the [country's climate policy](#) is provided.

[STATEC](#) is the state authority coordinating official statistics in the country and provides a database relating to society, the economy and the environment. The exact content of this database was not examined in the context of the present study.

The [Luxembourg Institute of Science and Technology](#) (LIST) is a research institute whose activities include data collection relating to climate adaptation. LIST stores measured data from different institutions and has a network of five measuring stations that continuously collects and monitors data along Luxembourg's water courses, and updates the [Hydrological Monitoring Network](#) of areas prone to flooding.

Regarding flood occurrences, preliminary risk assessment has been undertaken including the preparation of [flood hazard maps and flood risk maps](#) in compliance with EU Floods Directive 2007/60/EC. Luxembourg has been actively involved with its neighbour countries France and Germany to develop transnational cooperation to harmonise flood management in the Moselle and Saar basins. The project FLOW MS led to the [assessment of the impact of climate change on the Moselle Saar basins](#). Through the INTERREG North West Europe, the project [RheinBlick2050](#) analysed the impact of climate change on the Rhine river basin up to 2050 and 2100.

The [Sixth National Communication of Luxembourg on Climate Change](#) provides detailed information on Luxembourg's national circumstances, national CCA policies, sector measures, and projections for emissions and efforts toward increasing knowledge and awareness towards climate change.

Updates for a wide range of national adaptation actions, can be found in the [National adaptation actions deliveries database on EIONET](#), and on the [Climate-ADAPT](#) website.

3.2. Methodologies

Methodologies for integrating climate change adaptation into the development of infrastructure projects rely on the basic rules of risk assessment. The [Luxembourg Institute of Science and Technology](#) (LIST) developed a methodology to analyse and evaluate recorded environment data regarding climate change. The [Hydro-Climatic Observatory Network](#) provides a methodology for refurbishment of natural areas specifically as part of flood defence.

3.3. Tools

Tools are highly valuable for facilitating climate adaptation studies and planning for infrastructure. They can be public or private, numerical or descriptive, and be provided in many mediums, such as software, text documents, maps, and so on. Some tools are generic (such in risk assessments) whilst others are specific to a certain set of circumstances.

The Luxembourg Institute of Science and Technology uses the [Weather Research and Forecasting Model](#) as well as the [COSMO-CLM model](#) to develop predictions and scenarios. In addition to this there is also a tool with regard to climate change indicators ([ETCCDI: Expert Team on Climate Change Detection and Indices](#)). It allows a collection of indicators primarily for changes in prediction and air temperature to derive the impacts in various sectors.

The Water Management Agency and the Water Navigation Agency have developed a [Flood Warning Service](#) providing competent authorities and the public information and warning about floods +/- 48 hours before the flood event.

Within the project Future Cities there is a specific tool, the [Adaptation Compass](#) to support the development of climate-proof city regions. The tool is used to check vulnerability and adaptation potentials: through data acquisition and coordination.

Luxembourg has been actively involved with its neighbour countries France and Germany to develop transnational cooperation to harmonise flood management in the Moselle and Saar basins. Through the INTERREG Greater Region, the project FLOW MS has led to the development of the software [FLOOD MS Cockpit](#) to access and analyse spatial and technical data related to flood prevention and management in the region. The water balance model [LARSIM](#) is also of significant potential use.

EIONET provides [Flood Maps](#) which are publically available, mapping areas of potential significant flood risk. EIONET also contains Flood Risk Management Plans.

For a continual update of available tools, the reader is referred to the European Climate Adaptation Platform [Climate-ADAPT](#), which has a dedicated tools section.

3.4. Guidance

Guidance is an essential requirement to ensure consistency in applying methodologies and tools. The urban development and transport sectors have the most comprehensive guidance, the National Spatial Plan [Master Programme for Spatial Planning \(PDAT\)](#). With focus on spatial planning and urban building, it indirectly address the issue of adapting to climate change but emphasises on. It also presents the different steps to perform vulnerability assessment importance of understanding regional climate impacts.

The [Integrated Transport and Spatial Planning Concept \(IVL\)](#) guides the implementation of the main targets set out in the PDAT and defines more precisely the polycentric urban spatial model of Luxembourg.

Luxembourg has been actively involved with its neighbour countries France and Germany to develop transnational cooperation to harmonise flood management in the Moselle and Saar basins. Through the INTERREG Greater Region, several projects have been conducted in the past and current programming period, including the development of a common [guidance](#) on flood management.

Luxembourg is also involved in cooperation project as part of the INTERREG for North-West Europe. The project C-Change (2012) ([Adaptation to Climate Change: Strategy for Spatial Planning](#)) led to the development of a strategy to adapt spatial planning in Luxembourg to several climate impacts (heatwaves, drought, floods and extreme rainfalls, extreme winds and storms). Finally the [Flow MS](#) project provides guidance to foster trans-border cooperation in flood management.

Specific procedures or guidelines assess the potential impact of climate change on the resilience of infrastructure have not been found.

3.5. Design Standards

Design standards are critically important for all infrastructure projects to ensure stability and optimal functioning under the strain of natural phenomena. For civil works (including bridges, buildings, masts and towers for the mobile access networks), EN standards are available to address natural forces such as wind and snowfall, e.g. EN1991-1-4 (Eurocode 1) and EN1993 (Eurocode 3) for structures in steel. However, these standards might be outdated and not account for the impacts of climate change.

The Lithuanian Standards Board ([LST](#)), is collaborating with the [European Standardization Organizations](#) in the context of the EU Regulation No 1025/2012 on European standardisation. The European Committee for Standardisation (CEN) and Electrotechnical Standardisation (CENELEC) established the [Adaptation to Climate Change Coordination Group \(ACC-CG\)](#) to coordinate standardisation work in the field of adaptation to climate change in support of the implementation of the EU Strategy on Adaptation to Climate Change. More information is available in the section on *Available resources at the EU level* in the Final Report of the present study (European Commission, 2018).

3.6. System

The institutional system for adapting to climate change requires a legal framework (laws and implementing regulations) and strategies and policies (with implementing action plans). The system is usually conflated with disaster management (and its various components, preparedness, reduction etc.) and more generally with resilience.

Institutional and legal framework

In June 2011, Luxembourg's Council of Ministers adopted a [National Adaptation Strategy on Climate Change](#) (hereby found as an annex to Luxembourg's reporting requirements), which prioritizes (i) biodiversity, (ii) water, (iii) agriculture and (iv) forestry and provides a framework for adaptation to the impacts of climate change in Luxembourg. A revision was planned for 2017 but no update was available by the end of the year. The revision foresees measures in the areas affected by variations in rainfall and river regimes (drinking water, agriculture, viticulture, energy, navigation, health and others).

The Environmental Impact Assessment (EIA) Directive has been transposed into national legislation with the [Grand-Ducal Regulation of 15 May 2018 establishing the list of projects subject to an environmental impact assessment](#), and with [Law of 15 May 2018 on the environmental impact assessment](#).

The National Risk Assessment is undertaken in line with thematic ex-ante conditionality 5.1, according to which, national or regional risk assessments for disaster management need to be taking into account climate change adaptation.

Responsible authorities

The [Ministry of Sustainable Development and Infrastructure](#) (MSDI) is the primary responsible institutional body with regard to climate change adaptation. It is divided in four departments: Department for the Environment, Department for Spatial Planning and Development (DATER), Department for Public Works and the Department for Transport. The Division for European Affairs within the ministry has responsibility over ESI Funding shared with the Direction for Regional Policy, Ministry of the Economy and International Trade).

The [Department of the Environment](#) is responsible for formulating environmental policy and drafting legislation. In 2010, the "Partenariat pour l'Environnement et le Climat" was launched, bringing together a number of stakeholders with the aim of building a "Climate Change and Sustainable Development" package of policies and measures around the following five thematic areas: urban planning, housing and construction; mobility; energy and eco-technologies; biodiversity, forest, water and agriculture; and international aspects of impacts of climate change.

Management of the ESI Funds

Luxembourg has one national Operational programme (Investment for Growth and Employment), which is managed by the Ministry of the Economy. It is also participating in 6 cross-border, transnational or interregional co-operation programmes. To ensure the management of the ESI Funds, the National Coordination Authority is the Ministry of the Economy, the Certifying Authority is the Directorate for Budget and Administration, again at the Ministry of the Economy, and the Audit Authority is the General Inspection of the Ministry of Finance

3.7. Institutional Capacity

The institutional challenge for climate change adaptation is that climate policy is a cross-cutting issue, and requires co-operation across a large number of institutions. To be effective in delivering climate change adaptation a minimum level of capacity is needed on leadership, technical and human resources, effective collaboration, and financial support.

Technical and human resources

The Luxembourg Government supports research institutions to carry out climate change research related to vulnerability projections. [LIST](#) provides the climate data for the ministries. Luxembourg is also collaborating with the International Commission for the Protection of the Rhine (ICPR), the Meuse (ICPM) and the Mosel/Saar (ICPMS) in the area of sustainable water use and flood risk. The institutional capacity (human, technical, equipment) relevant to climate change adaptation is currently developing further, based on the revision of the National Adaptation.

Effective collaboration

An ad-hoc Inter-ministerial Coordination Group in Climate Change had been set up for the preparation of the NAS, but no formal inter-sectoral or inter-ministerial committee is currently operational for coordination of climate adaptation. There is however intensive cooperation between the ministries and regular crisis staff meetings and coordination groups, where all stakeholders are involved.

Financial resources

The [ESI Funds are enabling the development of major projects](#) in the 2014 – 2020 but, by early 2018, there have been no funds allocated for major projects in Luxembourg. However, the [dataset will be updated regularly](#) to reflect changes in the programme lists and major project notifications.

According to the [ESIF-viewer](#), Luxembourg is planning investments of 48 Million EUR. Projects under the Thematic Objective 6 on preserving and protecting the environment and promoting resource efficiency are receiving 2 Million EUR, while projects under Thematic Objective 1 on strengthening research, technological development and innovation, are receiving 10 Million EUR. The shares within these thematic Objectives that may relate to climate adaptation are unknown.

4. SECTOR OVERVIEW

4.1. Introduction

Since 2014, the requirements for major projects to obtain ESIF funding³ demand that project applications integrate climate change considerations⁴, such as a vulnerability and risk analysis and adaptation option appraisal. At EU-level, material is available to assist in fulfilling these requirements. Key web sites and documents are:

- The [Climate-ADAPT](#) website containing many links to data and a [map viewer](#)

³ http://ec.europa.eu/regional_policy/archive/projects/major_projects/index_en.cfm

⁴ For a compilation of the climate change requirements for major projects in 2014-2020, see: <http://www.jaspersnetwork.org/plugins/servlet/documentRepository/displayDocumentDetails?documentId=401>

- EUROPEAN COMMISSION Directorate-General for Regional and Urban policy: The [Guide to Cost-benefit analysis of Investment projects](#) (also referred to as the 'CBA guide')
- EUROPEAN COMMISSION DIRECTORATE-GENERAL CLIMATE ACTION: [Non-paper of Guidelines for Project Managers: Making vulnerable investments climate resilient](#)
- JASPERS Guidance note: [The Basics of Climate Change Adaptation, Vulnerability and Risk Assessment](#)
- JASPERS Guidance note: [An overview of the most important sources for integrating climate change in \(major\) projects](#)

Additional relevant material can be found in the Final Report of the present study (European Commission, 2018) in the section *Available resources at the EU level* and in *Annex I*.⁵

4.2. Transport

Investments in the transport sector are very diverse, covering roads (including bridges and tunnels), inland waterways, rail, ports / airports, and public transport infrastructure. Any disruption caused in this sector can affect many other sectors (economic and societal) directly. Potential threats are extreme weather events, such as extended heat waves, flooding, heavy rainfall or storm amongst other. Extreme weather events are a potential threat to both infrastructure and operation of the transport system.

Road infrastructure

The National Spatial Plan [Master Programme for Spatial Planning \(PDAT\)](#) is the existing framework document for transport infrastructure project developers. The [Integrated Transport and Spatial Planning Concept \(IVL\)](#) was developed to guide the implementation of the main targets set out in the PDAT. A specific [Sectorial Plan for Transport](#) is also available, but does not address the issues of climate change. However, adaptation to climate change is included in the preliminary remarks of the [SEA guidance](#) for transport projects published by the Ministry of Sustainable Development and Infrastructure.

Railway infrastructure

See section above on Road infrastructure. No railway specific guides or documents on climate adaptation have been retrieved from desk study or interviews.

Airport infrastructure

Luxembourg-Findel International Airport is the only international airport in the country. One meteorological synoptic station and one aeronautical meteorological station are operated from this airport. Both stations monitor key climate and aviation weather parameters. No specific strategy on making the airport climate resilient was retrieved from desk study or interviews. But more general materials are available which apply to all types of projects, including airport infrastructure. See section 4.1 for more information.

⁵ European Commission (2018) Climate change adaptation of major infrastructure projects. A stock-taking of available resources to assist the development of climate resilient infrastructure. Final report.

4.3. Broadband

The International Telecommunication Union has issued the recommendation L.1502 [“Adapting information and communication technology infrastructure to the effects of climate change”](#) for the purpose of identifying climate threats and their impact. L.1502 supports Resilience by design in identified risky areas, and proposes changes to equipment installation standards to ensure protection from more frequent extreme weather phenomena and their impacts. The European broadband sector standardisation bodies have not prepared vulnerability assessment and risk management framework for dealing with climate change in broadband projects.

The Communications and Media service of the Ministry of State is in charge of broadband strategy, its coordination as well as implementation in the country. For the programming period 2014-2020, Luxembourg is not expected to receive funds on broadband infrastructure investments. There are currently four ongoing projects in the context of the [Digital Single Market](#), none of which are undertaking specific investments or measures on climate adaptation.

It is a general best practice for operators to use flood mapping information from environmental agencies to safeguard new planned data centres from flooding. For civil works (e.g. masts and towers for the mobile access networks), EN standards are available to address wind and snowfall, e.g. EN1991-1-4 (Eurocode 1) and EN1993 (Eurocode 3) for structures in steel. But these standards don't take climate change into account. CEN-CENELEC is currently working on adapting a number of EN standards to climate change. See Final Report of the present study (European Commission, 2018) for more information in the section on *Available resources at the EU level*.⁶

See section 4.1 for more information on other documents that can help in taking climate considerations into account.

4.4. Urban Development

Investments in the urban development sector include site developments (industrial and other), urban planning, local infrastructure, building projects (such as hospitals, schools), and much more diverse projects. Cities have a unique position to analyse and respond to local impacts and vulnerabilities, such as heat island effects, which depend on the specific layout of a city, its green spaces, and numerous other factors. Cities can actively support the uptake of climate change adaptation in infrastructure projects through, for instance pilot projects, and can initiate dedicated infrastructure projects to improve their resilience to climate change.

The National Spatial Plan [Master Programme for Spatial Planning \(PDAT\)](#) is the existing framework document for urban development. The [Integrated Transport and Spatial Planning Concept \(IVL\)](#) was developed to guide the implementation of the main targets set out in the PDAT. The [Sectoral Plan for Housing](#) and the [Sectoral Plan for Economic Activity Zones](#) are relevant reference documents for urban development projects; however, they do not address the issue of climate change adaptation. Adaptation to climate change is included in the preliminary remarks of the [SEA guidance](#) for Housing projects as well as in the [SEA guidance for Economic activity zones](#) published by the Ministry of Sustainable Development and Infrastructure. The project Future Cities developed an [Adaptation Compass](#), which provides guidance for a better spatial structure and serves to check vulnerability and adaptation potentials.

⁶ European Commission (2018) Climate change adaptation of major infrastructure projects. A stock-taking of available resources to assist the development of climate resilient infrastructure. Final report.

Luxembourg is also involved in several cooperation projects on climate change adaptation. As part of the INTERREG for North-West Europe, the project C-Change led to the development of a [Strategy](#) to adapt spatial planning in Luxembourg to several climate impacts (heatwave, drought, floods and extreme rainfalls, extreme winds and storms). As part of the INTERREG Greater Region, the project [SICadapt](#) analysed the impacts of climate change, offering good-practice solutions for urban areas amongst other sectors.

The Hydro-Climatological Observatory has established [hydro-climatological database for long-term studies](#), while the [national geoportal of Luxembourg](#) contains flood hazard maps and flood risk maps with information on necessary protective measures in urban areas.

See section 4.1 for more information on other documents that can help in taking climate considerations into account.

4.5. Energy

Project investments in the energy sector are related to power generation infrastructure, energy distribution networks and energy storage (e.g. through hydropower). Potential impacts of climate change on energy infrastructure may include increased damage to power generation plants or problems with energy provision, leading to black-outs or other disruptions. Disruptions in the energy sector can have large impacts on different sectors due to the increasing dependency on (electric) power provision for all kind of operational systems such as water supply (pumping installations, ...) , the food system (transport, cooling, ...), transport, (electrified vehicles, dynamic traffic information, ...).

Luxembourgish stakeholders involved in the Benelux Energy Expertise Network have the opportunity to take part in workshops and knowledge exchange, organized by the BENELUX. A [general report](#) and [conclusions of the energy workshop](#) are available and provide some insight into potential impacts and the sectors overall sensitivity to climate change within the BENELUX.

Luxembourg is mostly undertaking efforts on mitigating climate change within its territorial borders. Its energy infrastructure has not been found to specifically address climate adaptation. The energy transmission and distribution grid will need to be adapted to variable energy production, offering an opportunity to integrate adaptation measures to the grid.

See section 4.1 for more information on other documents that can help in taking climate considerations into account.

4.6. Water

Investments in the water sector are linked to efficient water supply (including reduction of leakage), wastewater treatment and water reuse as well as the implementation of [River Basin Management Plans \(RBMP\)](#) to ensure integrated water management at the river basin scale. Important threats are linked to water quantity (droughts and floods) as well as quality (water pollution). Climate change can have an impact on both water quantity and quality. Following the EU Floods Directive 2007/60/EC, Member States are obligated to perform flood risk assessment and to elaborate flood hazard and risk maps and flood risk management plans. Flood risk maps include the history of floods and climate scenarios. Member States also need to take climate change into consideration when developing RBMP. A [Guidance document on adaptation to climate change in water management](#) is available to ensure that the RBMP are climate-proofed. [Evaluations of the RBMP and FRMP](#) are also available on the EC website.

The [6th National Communication to the UNFCCC](#) refers to preliminary sectoral vulnerability analyses that were done for agriculture, forestry, biodiversity, drought, human health, infrastructure and economy on the basis of expert judgement.

Luxembourg has adopted [River Basin management Plans](#) that contain a summary of economic analysis of water use and a programme of measures, and a [Flood Risk Management Plan \(FRMP\)](#), which contains measures to reduce the impacts of flooding hazards. A Flood at-risk development is promoted in the directive [Art. 39 Loi sur 19 Decembre 2008 relative à l'eau](#) as water-adapted construction. The official [national geoportal of Luxembourg](#) contains the results of the preliminary flood risk assessment and has prepared flood hazard maps and flood risk maps; however these do not take account of the effects of climate change. On their basis, a [Flood Risk Management Plan](#) was established. Luxembourg also has a [Flood Reporting and Prevention Service](#) and a [flood warning service](#) operated in co-operation with the Water Management Administration and the Water Navigation Service.

The [Hydro-Climatic Observatory Network](#) is continuously monitoring Luxembourg's river network, and all data are freely available. The monitoring network also serves for the design of flood protection measures. Scenarios and analysis using this data are performed by the Water Management Administration using the hydrological balance models LARSIM.

Luxembourg has been cooperating with France and Germany through the INTERREG Greater Region programmes in the past and current programming period to harmonise the countries' efforts in dealing with floods in the Moselle basin. The project [Timis Flood](#) developed an internet-based transnational flood information system and was followed by the project [Flow MS](#) which built on it to assess the consequences of climate change and low water flow in the Moselle and Saar basins and to develop relevant adjustment strategies through the realisation of different actions. The project [SICadapt](#) analyse the to the impacts of climate change, offering good-practice solutions for waterways amongst other sectors. Through the INTERREG North West Europe, the project RheinBlick2050 analysed the [impact of climate change](#) on the Rhine river basin up to 2050 and 2100.

See section 4.1 for more information on other documents that can help in taking climate considerations into account.

4.7. Waste

Project investments in the waste sector are related to separate collection infrastructure, re-use and recycling infrastructure, energy recovery facilities and closure of landfills. Potential impacts of climate change on waste infrastructure may include increased rates of waste decomposition, odour and dust due to increased temperatures, flooding of landfills and waste treatment facilities, and reduced water availability for wet processes in waste treatment facilities. Also the impact on transport infrastructure should be considered, as transport is a critical component of waste management (collection, transport to and from waste treatment facilities). The impact on transportation is discussed in the section on transport above.

Luxembourg has a [National Waste Management Plan](#) and several parts of the plan cover waste prevention measures, selective collection and high-quality recycling, but it does not yet include climate adaptation measures. A new revised waste management plan will be available in 2018.

[Directive 1999/31/EC on the landfill of waste](#) requires that landfills are situated and designed in such a way that safeguard against pollution of the soil, groundwater or surface water. This requirement is translated into [national design standards](#) for the

construction of landfills, that include the consideration of temperature, precipitation extremes and flooding where relevant.

Large waste treatment plant are subject to [Directive 2010/75/EU on industrial emissions](#) (IED), which requires as a general principle that necessary measures should be taken to prevent accidents which may have environmental consequences, and to limit those consequences. This requires that a structured management plan should be available that includes and mitigates hazards such as extreme weather conditions (e.g. flooding, very high winds). In the [BAT reference document \(BREF\) on Waste Treatments Industries](#), some information is provided on the impact of certain climatic conditions (e.g. the impact of higher temperature on biofilter performance, aerobic decomposition, etc.). Although climate change is not specifically addressed.

See section 4.1 for more information on other documents that can help in taking climate considerations into account.

5. CASE STUDIES

5.1. Case studies of climate adaptation projects

Study on the consequences of climate change for the Rhine catchment Area	
Project description	In the context of the Rheinblick2050 project, the 2010 Study of Scenarios for the Discharge Pattern of the Rhine presents discharge projections at representative gauging stations on the Rhine and the Moselle up to 2050 and 2100. Luxembourg will develop adjustment measures for all sectors relevant for water issues.
Photograph	N/A
Budget	N/A
Climate Change Vulnerability and Risks	By the middle of the century, in the Rhine catchment up to 20 % higher discharges are to be expected during winters and up to 10 % lower discharges are expected during summers, and there will be more average annual floods. Climate data of 38 catchment areas were determined from several weather stations and collected in a database.
Climate change adaptation measures	<ul style="list-style-type: none"> • Preliminary flood risk assessment • Preparation of flood hazard maps and flood risk maps • Establishment of a flood risk management plan • Flood warning service • Flood partnerships • Flood risk awareness
Good practice	The study entailed a detailed analysis of a wide set of climate relevant data in order to make hydrological projections for the future climate, and the impact on discharge of the Rhine River. The result was a common research framework.
Further information	http://www.chr-khr.org/en/publication/assessment-climate-change-impacts-discharge-river-rhine-basin-results-rheinblick2050

5.2. Case studies of infrastructure projects which have addressed climate change adaptation

Adaptation Compass – Future Cities	
Project description	The Future Cities project partners developed a practical tool to check the vulnerability and adaptation options across sectors
Photograph	
Budget	12 million
Climate Change Vulnerability and Risks	The tool helps to determine the current vulnerability of a city region or parts of a city with the Vulnerability check . The Assessment of risks and opportunities is a proposed method that uses the results of the vulnerability check and the projected climate change trends.
Climate change adaptation measures	The tool offers a module to explore adaptation that offers various adaptation options: especially the combination of different measures based on the practical experiences of the Future Cities partnership.
Good practice	This guide aims to interlink different stakes and to check the vulnerability and adaptation options across sectors.
Further information	http://www.future-cities.eu/project/adaptation-compass/

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