Climate change adaptation of major infrastructure projects

Country report for Belgium

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Contents

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 projects[1] 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 Belgium 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 and the National Adaptation Plan (2017-2020) were approved by the National Climate Commission (NCC) in December 2010 and in April 2017 respectively. Since Belgium is a federal state, the regional and the federal governments have adopted, each in their own area of competence, adaptation plans (the Brussels Capital Region Adaptation Plan, the Flanders Adaptation Plan, the Walloon Adaptation Action Plan, and the Federal Contribution to the National Adaptation Plan). The responsible institutions for climate adaptation are the National Climate Commission, the Permanent Secretariat and working group on adaptation (CABAO); the Coordination Committee for International Environmental Policy, the Climate Change Adaptation Team, the Flemish Task Force Adaptation (VTFA), the Wallonia Air and Climate Agency, Climate Change Unit (AWAC); and the Brussels Environmental Agency (Bruxelles Environnement).

The main website for climate adaptation National Climate Platform www.climate.be / www.klimaat.be. All regions (Brussels, Flanders, and Wallonia) have web pages where

[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

climate information is gathered and there are links to research projects. Data for Climate Change Adaptation are available from the Invent and Fedra databases, and StatBel, the Belgian national statistics agency. Additionally, information is found through the The MIRA portal and report (2015), the Royal Meteorological Institute, the research project CORDEX.BE, the Flanders Hydraulics Research, KU Leuven (KUL) and VITO. Impact Assessments are available, namely for the Brussels Capital Region, for the Flemish region, for the Wallonia region, and for the Federal level.

Methodologies that support climate adaptation are available. Examples include the Standard method for socio-economic cost-benefit analysis of transport infrastructure projects, including specifications for freight transport and sea port infrastructure), and the multi-layer water safety framework. Tools that support climate adaptation include the water assessment (*watertoets in Dutch*), the GIS-based tool LATIS, the climate perturbation tool for statistical downscaling, the UrbClim model for heat island effects, the SIRIO tool (2017) for sewer and rainwater systems modeling, the Cities and municipalities adapt tool, the green tool Antwerp, and the tool 'Adapte ta Commune' (2017). Tools developed following EU requirements include Flood Maps which are mapping areas of potential significant flood risk and include a set of interactive maps available with the Walloon waterways, Walloon Floods portal and several portals in Flanders such as the VMM mapviewer (geoloketten in Dutch), www.waterinfo.be, DOV. Guidance for the climate adaptation of projects is accessible, in the Scheldt River Basin Management Plan and the Program of Measures, the Flanders coastal Protection Master Plan (2011), the Sigma Plan (2005 update) and the The Guidelines for integrating climate change adaptation in EIA (2016) in Flanders. All regions (Flanders, Wallonia and Brussels Capital Region) have extensive information, including guidance documents and templates available for project applications (ERDF / INTERREG). EU-level resources in use are primarily 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. The Bureau for Standardisation (NBN) is collaborating with the European standardization bodies at the Adaptation to Climate Change Coordination Group (ACC-CG) and there are design standards for all sectors accessible at BEN-website. Financial resources are found to be available from the ESI Funds, while more specifically, some guidance is available on financing adaptation projects and integrating adaptation in spatial planning.

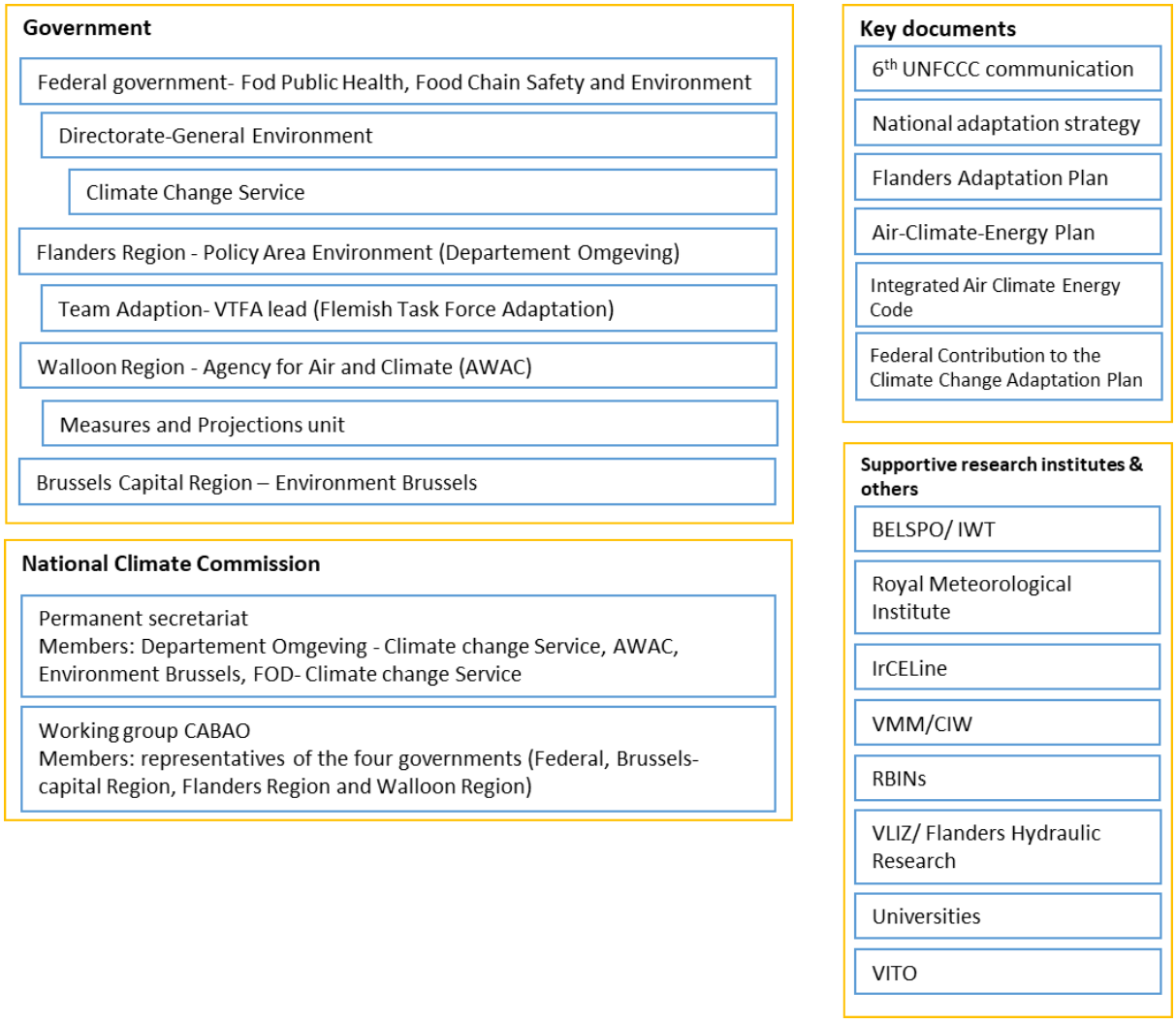
The transport sector is highly exposed to climate change. The 'Evaluation of vulnerabilities for the Walloon Region regarding climate change' (2011) is a vulnerability analysis for the territory in Wallonia, and there is a brief discussion note on climate change in the transport sector (2016). The Federal Contribution to the NAP (2016) includes adaptation targets and actions for the transport sector. The broadband sector is not involved in the federal or regional climate change adaptation plans or initiatives organized by the administrations and other governmental bodies. The urban development sector is taking steps towards climate adaptation. The regional planning policy plans (Flanders draft spatial policy plan- Witboek ruimte Vlaanderen (2016), Wallonia Spatial development Plan SDER (2013) and Brussels regional development plan GPDO (2013) take adaptation into account on a strategic level. The province of Antwerp has its own regional adaptation plan (2016) with seven key actions, one of which is specifically to support the uptake of adaptation by municipalities. The energy sector is represented by the FEBEG (the federation of Belgian electricity and gas companies), and a general report and conclusions of an energy workshop provide insight into potential impacts and the sector's overall sensitivity to climate change. The energy sector is represented in both the Flanders Adaptation Plan (VAP) and Brussels Integrated Air-Climate-Energy Plan. The water sector is presenting a number of initiatives to adapt to climate change. There are efforts to define water quantity targets (2016), a guidance exists on how to increase rain water infiltration, and a report on the Climate change adaptation for maritime and inland port and navigation structure. Notable are the Water management Waterways, preview 2020 masterplan, the methodologies for Flood Risk Management Plans and for developing rainwater plans, the Water assessment (watertoets), and the GIS-webplatform that shows flood-risk. The waste sector is currently adapting via EU level

initiatives, such as the Directive 1999/31/EC on the landfill of waste and the Directive 2010/75/EU on industrial emissions (IED).

Case studies of climate adaptation have been conducted in the present study and offer brief insights into the Redevelopment Groenplaats in Antwerp, the KerkeBEEK Flood risk management and implementation plan and the KEttingplein project. Two examples within the framework of Flanders' masterplan coastal safety (2011) are the storm surge barrier in Nieuwpoort or the adapted sea dike in Wenduine (2015).

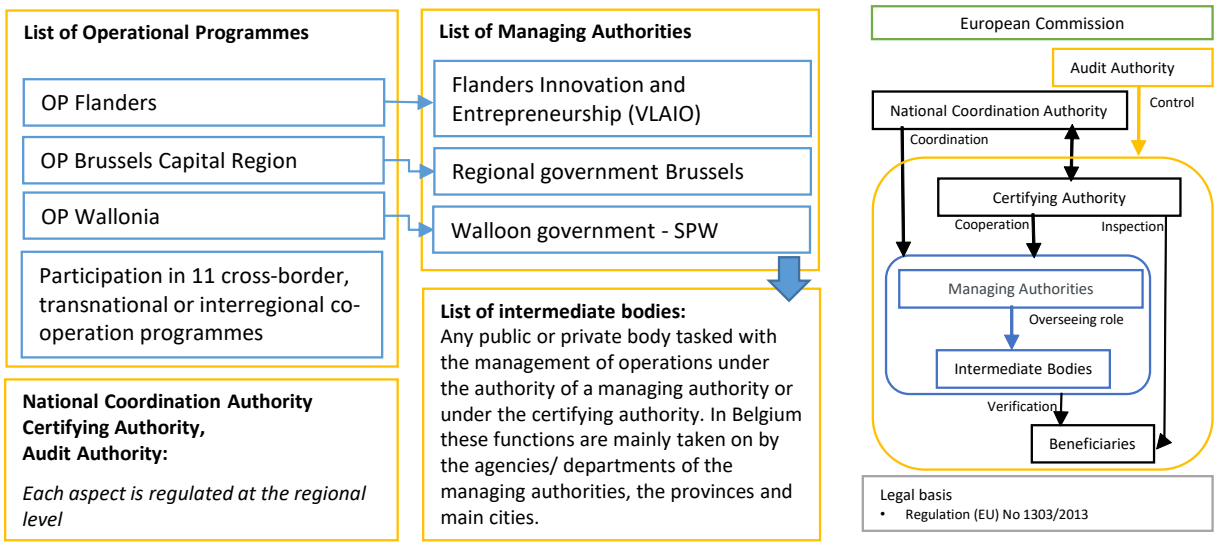
2. LEGAL, POLICY AND INSTITUTIONAL FRAMEWORK

Belgium's federal structure is composed of the Federal State, three Regions and three Communities. They each have powers and responsibilities for different fields. Environmental policy and infrastructure works are the competence of the Regions (Flanders, Wallonia and Brussels-Capital Region). The exceptions are the large energy infrastructure projects (incl. nuclear energy) marine, air and rail transport infrastructure projects, which are the responsibility of the federal government.



The National Climate Commission is responsible for the implementation of the national climate change policy (e.g. enabling and monitoring the National Climate Plan, implementing or following up on actions and measures defined in the plan, gathering information and reporting as required). Belgium has an approved national adaptation strategy: the National Adaptation Strategy (NAS) of Belgium was approved in 2010 and set up a roadmap for the adoption of a national action plan. The National Climate Change Adaptation Plan (NCCAP or NAP, 2017) was adopted in April 2017 and forms the

framework for contribution from the federal level (2016), Flanders (VAP, 2015), Wallonia (PACE, 2016) and Brussels Capital Region (Integrated Air-Climate-Energy Plan, 2016). With regard to climate change and adaptation, policy and action plans are prepared by the Federal State and by the Regions. Overall, action on adaptation is led by the environmental departments (see organogram above) in close cooperation with the sectoral administrations (e.g. mobility and transport departments). Universities, research institutes and governmental bodies at federal or regional level support with data collection, monitoring, elaboration of guides, tools, etc. At local level, climate policy and action plans are prepared by provinces and municipalities. The Climate ADAPT website and the national Climate Change Adaptation Plan (2017) both offer a detailed description of the different stakeholders and the general organization of adaptation policy in Belgium.



The regions are responsible for the management of European Structural Funds (EDRF, INTERREG, etc.). These responsibilities generally rest with the departments of economy in the different administrations. A central platform (Europe in Belgium) gives a short overview of available funds and where to find more information. Aside from a central contact point (VLAIO), in Flanders there are also contact persons for the five provinces and the two largest cities in Belgium (Ghent and Antwerp). In Wallonia, the Coordination Unit for Structural Funds provides information and serves as point of contact (SPW, secretariat general). Similarly, the Brussels administration economy department has a Coordination and EFRO Management Unit which provides support and evaluates project applications. In Wallonia, there is a detailed web platform to find EU-funded projects (EnMieux). In Flanders, the Department of Economy is a member of the VTFA (Flemish Taskforce Adaptation), however, there is no comprehensive cooperation on the integration of climate change adaptation in the project proposals or evaluation. For the 2014-2020 period no major projects have been submitted so far.

3. RESOURCES

This country report has reviewed the currently available resources in Belgium for adapting to the impacts of climate change across six key infrastructure sectors. Adaptation to climate change is integrated in the legal basis[2] for ESIF-funded projects, through the processes of vulnerability and risk assessments which are, broadly:

[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

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 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. At national level, the web portal www.climat.be (in French) and www.klimaat.be (in Dutch) presents general information on climate change and adaptation, national and regional research reports and the National Climate Adaptation Plan (NCCAP or NAP, 2017). The NAP states the ambition to further develop this platform and includes links to available information in Belgium on climate change adaptation, including impacts and vulnerability analysis. The

information will be intended for both professionals in the field of adaptation and people with little to no experience in adaptation. This action is forecasted for 2017-2018.

The Federal Contribution to the NAP (2016), the Flanders Adaptation Plan (VAP, 2015), the Plan Air-Climate-Energy (PACE, 2016) and the Integrated Air Climate Energy Plan (Brussels, 2016) all provide insight in the current observed and future climate change and list adaptation options (measures) for different policy fields, such as transport, energy and urban development.

Climate related research is made accessible through the Invent and Fedra databases. StatBel is the Belgian national statistics agency and maintains a database of statistics relating to Belgium's economy, society and environment. The exact content of these databases was not examined in the context of the present study.

Given that environmental policy is a competence of the regions, most information is available at regional level. All regions (Brussels, Flanders, and Wallonia) have web pages where climate information is gathered and there are links to research projects.

The Evaluation of vulnerabilities for the Walloon Region regarding climate change (2011) is a vulnerability analysis for the territory in Wallonia and just one example of the material available at these websites. Currently, the majority of material is aimed at providing an overview of potential impacts and supporting local authorities.

In Flanders, a new web platform is to be launched in 2018. The platform will collect all available information on adaptation in Flanders and integrate the current webpages. Two important objectives of the future website are:

- Enable a user friendly approach for interested parties to conduct a vulnerability analysis (aimed at different sectors); and
- Provide easy access to both raw climate data and processed data (climate projections) etc. including background information to help with correct interpretation and use of data.

The MIRA portal and report (2015) are the main data sources on climate change in Flanders. Some data are provided for the whole Belgian territory (e.g. extremes in rainfall). MIRA (Flanders Environment Report, 2015) is published by the Flemish Environment Agency (VMM), and describes, analyses and evaluates the state of the environment. Furthermore, MIRA evaluates the environmental policy and forecasts possible environmental developments, based on raw climate data provided, for example, by the Royal Meteorological Institute (RMI). With regard to climate change adaptation, the MIRA Climate report (2015) holds the majority of contemporary data, makes data more accessible and provides background information on how to use the data. The MIRA report analyses to what extent climate change is already apparent in Flanders and Belgium, including new indicators for drought and the urban heat island effect. Climate scenarios for Flanders were calculated for 2030, 2050 and 2100, taking into account the 5th IPCC report. The climate report comes with five scientific research reports and a diverse sets of indicators (greenhouse gas emissions, temperature, precipitation and evapotranspiration, and sea level), which are also accessible online. Depending on the indicator and monitoring programmes, data are frequently updated. In 2018, the MIRA climate portal for Flanders will be launched to provide easy access to maps, graphs and raw data on climate change effects and impacts. It is foreseen that this portal will be mentioned as a prime data source in other websites, such as the above mentioned new web platform on climate change adaptation in Flanders.

In the two-year research project CORDEX.BE (2015-2017), new scenarios based on the latest info according IPCC (AR5) and Cordex have been developed for the whole territory of Belgium. The exercise provides coherent scenarios with high resolution (3-5km²) and local models concerning the impact from climate change on tides and the urban

environment, etc. For this reason, the previous climate models and scenario analysis for Belgium are not listed in the available resources (ALADIN, CCI-HYDR, MACCBET). A potential method in the future would be to translate the scenarios to answer the needs of different sectors. Infrabel (the Belgian rail infrastructure manager) and the RMI are investigating potential funding opportunities to set up such a project.

A general report provides some insight into potential impacts and the overall sensitivity to climate change within BENELUX. Given the federal structure of Belgium, some physical parameters are available at national level (e.g. weather-related parameters through the Royal Meteorological Institute of Belgium, air quality parameters such as fine particulate matter or ozone by IrCELine) and others at regional level (e.g. data on water quantity and quality: The Flemish water managers, Walloon waterways and Walloon Floods portal). Flanders Hydraulics Research (Watlab in Dutch) and the Flanders Marine Institute (VLIZ) provide data on water levels, sea water temperature, waves, etc. A heat-stress study for the whole territory of Flanders is underway and is expected to be completed by the end of 2018. For the Brussels Capital- region and some large cities (Antwerp, Ghent), data are already available.

The study Identification and evaluation of the cost of inaction to climate change in Wallonia (2014) provides an estimation of the costs of inaction or not adapting to climate change in the Walloon region.

The Flood Risk Management Plans (FRMP/ ORBP in Dutch) and a few climate change adaptation pilot projects provide some data on economic value of assets at risk and/ or social vulnerabilities to climate change. Some examples are:

- Flood resilient cities: (2011) in addition to modelling the impact of climate change on flood risk, both economic and societal losses were calculated in this Interreg project led by the VMM (the Flanders Environmental Agency) for the Flanders study. The cost of adaptation measures was also taken into account in the adaptation measure appraisal. The project is published at Climate-ADAPT but full reports are no longer available online;

- The presentation cost of adaptation (2013) informs on research in Flanders regarding the cost of climate change adaptation measures for four case studies in an urban setting. The analysis was made for three climate projections (high, medium, low);

- The heat stress vulnerability analysis of the city of Ghent (2012) provides some information on economic and social vulnerability; and

- The discussion paper climate adaptation region Ghent (2015) gives an insight in the impact of heat stress and green greening scenarios on the living and working conditions in Ghent city and harbor (outdoor conditions).

The NAP (2017) acknowledged limitations in knowledge on social and economic vulnerabilities regarding climate change were and said a research project to address this will be undertaken in 2018-2019.

Specific data can be accessed via the following organizations:

- Data on soil erosion
- Data on soil salinity
- Data on sea/ water temperature, ocean pH, waves, etc.:
  - Flanders Sea Institute
  - Agency for Maritime Services and Coast
- Data on air quality parameters
- Wave modelling, water balance models from the Flanders Hydraulics Research Lab
- Data on water quantity and quality:

- The Flemish water managers (including Interactive flood risk map)
- Walloon waterways
- Walloon Floods portal

There are a number of research institutes whose activities cover issues relating to climate adaptation, including the Flanders Hydraulics Research, KU Leuven (KUL) and VITO.

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. Some methodologies will be relevant to only part of the risk and vulnerability analysis process, e.g. a cost-benefit analysis methodology.

In Belgium, the Flood Risk Management Plans (FRMP- ORBP in Dutch) and River basin management plans are one document, thus ensuring that both plans are fully integrated. The methodology for the new generation of these plans, takes the climate projections into account. These documents are used in project preparation (e.g. through the Environmental Impact Assessment (EIA) and other preparatory / feasibility documents and assessments). This means that regarding water quantity and its potential impacts, climate change will be increasingly integrated in large infrastructure projects as the ORBP's are systematically updated. Within the river basin management plans that have taken the climate scenarios into account, climate data are used in cost benefit analysis with regard to adaptation option appraisal. This approach is in line with the multi-layer water safety framework (guidelines to increase resilience against floods, such as providing space for water buffering etc.).

The water assessment is an assessment to check potential negative impacts to the water system from construction of building or infrastructure projects and to prevent a (significant) increase in flood risk. Plans that can have an impact on the water system also require a 'water assessment' (e.g. spatial planning, urban planning…). In large construction projects, the VMM takes the climate projections into account when deciding on the required safety levels for the water assessment and formulating their advice. For so-called signal areas, a more in-depth investigation is required.

Flanders Policy Area Mobility and Public Works (MOW) uses a standard method for socio-economic cost-benefit analysis of transport infrastructure projects. Specific methodologies are available for freight transport and sea port infrastructure, including a list of key (cost) figures.

For many projects, consultancies and research institutions develop specific methodologies, often based on previous projects, which are then checked by adaptation experts within the different administrations in order to ensure quality and take new scientific insights into account (e.g. by using new climate models). The method in which climate data/scenarios are included in projects depends upon the project. Some relevant projects are:

- Flood Resilient Cities (2011) (INTERREG Flood Resilient Cities- see also Climate ADAPT): the results of the projects are no longer available online. The general brochure provides an overview of the methodologies used for both translating climate projections into flood risk maps and calculating the potential socio-economic impacts and inform on adaptation measure appraisal;

- Ypres, De Vloei (2010), (INTERREG Future Cities): sustainable urban development project at the border of a small town (Ypres, 35000 inhabitants). A specific study was made to enable a sustainable water management, taking future climate change impacts into account and installing a natural water drainage/ buffer system;

- The EIA for the spatial development plan for a fruit market in the municipality Vrasene has integrated climate change adaptation in the description of the water system (File number: PL0168). As the auction site is located in a 'signal area', an area where the water system has been identified as not compatible with the allocated spatial functions, additional attention was demanded by the EIA Unit on flood risks and adaptation measures;

- The design for the Kieldrecht lock in Antwerp is based on the updated Sigma Plan, rather than the integration of new climate models. The Sigmaplan is designed to cope with a flood with return period of 10000 years and 60cm sea level rise;

- Integrated River Basin Management Ny, (2012, AMICE, Inttereg- see also Climate Adapt), project on the adaptation of the Meuse and its catchment to the impact of flooding and low waters from climate change, including a report on climate proofing of present and planned projects with a clear description of the methodology, allowing for replication;

- Vulnerability analysis for urban area's (industrial sites …) in cities such as Antwerp (2015) and Ghent (2016) (both online and offline sources);

- Kettingplein, Ghent (2017): modelling based on climate projections for storms with a return period of 50 years- data from Royal Meteorological Institute and University of Leuven (RMI/KUL);

- (Climate) robust Plan for Water and Energy (2016): redevelopment of the industrial area Albert canal;

- Heat stress vulnerability study (2013) for the city of Ghent on heat stress and the urban heat island effect; and

- Coastal defense projects have been developed in the framework Flanders Masterplan Coastal Safety, which defines some methodological elements (e.g. defined safety levels) for Coastal protection projects.

Additional pilot projects, such as the Albert Canal locks, can be found through the Interreg project websites in which Belgian municipalities participate (e.g. Frames, Sponge 2020, Scape, Triple C, Begin, Urbact- Resilient Cities, …).

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 as in risk assessments) whilst others are specific to a certain set of circumstances.

In Flanders, the water assessment (*watertoets in Dutch*) is obligatory for all building and infrastructure projects. The requirements for this include that flood risk maps be consulted, together with maps showing capacity for infiltration of rainwater. Based on the results, a construction permit can be rejected, but more likely specific measures or conditions can be imposed, such as a request for extra water infiltration or buffering infrastructure.

Web portal waterinfo.be provides flood risk maps and data related to actual water levels, flows and precipitation are available on. Additionally, there is also a web-application that provides a roadmap for writing the required 'water assessment'. In large infrastructure projects, the water assessment is often integrated in the EIA.

Research institutes and universities have developed several modelling tools:

- Flanders Hydraulics Research conducts data collection (water levels) and modelling of climate impacts to better understand e.g. coast protection infrastructure (e.g. wave modelling by, for instance, using numerical models such as SWASH, DualSPHysics and Xbeach). They also provide models on water balance (e.g. MIKE Basin) to carry out scenario analysis in a changing climate, for example in case of drought. The GIS-based tool LATIS, also developed by Flanders Hydraulics Research and University of Ghent, calculates economic risk as well as human losses caused by floods. This tool was used for several studies, including the impact of different climate change scenarios on flood risks within the framework of the Masterplan for Flanders' Coastal Safety.

- The KUL developed a climate perturbation tool for statistical downscaling and generating perturbed time series and the SIRIO tool (2017), which allows to model sewer and rainwater systems, including climate change impacts. SIRIO is not freely available.

- Regarding the urban heat island effect, VITO has developed the UrbClim model and has used their insights on heat studies for the cities of Ghent, Antwerp and to provide insights on heat stress and the urban heat island in the MIRA report. While most studies are freely accessible, the tool is not freely available.

There are also some tools that are guiding projects to integrate adaptation, though do not go into detail on how to do this. Examples are:

- Sustainability assessment (2015, duurzaamheidsmeter) for industrial site (similar to BREEAM assessments) by Vlaio (Policy Area Economy, Flanders). The instrument can be downloaded after completing a contact request. The assessment asks for a heat stress vulnerability study and flood risk assessment (including mention of climate scenarios and changing precipitation patterns, a demand for increased water infiltration/ buffering and green infrastructure). The tool/ assessment is very much a voluntary instrument;

- Sustainability assessment (2014, assessment for urban areas) for the city of Ghent. While the instrument for industrial sites is available online, the instrument for urban areas (mixed functions / neighborhoods) has to be requested from the Environment and Climate Department of the city;

- The Cities and municipalities adapt tool, is an online decision tree (2015), developed by the Climate Change Unit of the Flanders 'environment' policy area. It is a guidance tool for local authorities on which 'climate instrument' they should use. The original study has been translated into an interactive format. The value of this tool is in the overview of available international tools/ methods and guidance;

- The "green tool" Antwerp (groentool in Dutch) provides insight in the impact of green infrastructure on the (urban) environment (air quality, heat stress. Water management, biodiversity and carbon capture). It can be used to check adaptation measures or to find inspiration for new adaptation measures; and

- The tool 'Adapte ta Commune' (2017), provided by the Walloon Air and Climate department (AWAC), helps municipalities to develop their climate change adaptation plan and carry out a vulnerability analysis. The tool exists of an excel

file and a guidance document. This tool seems to replace the older 'vulnerability analysis tool' (2011).

Finally, there is a set of interactive maps available with the Walloon waterways, Walloon Floods portal and several portals in Flanders such as the VMM mapviewer (geoloketten in Dutch), www.waterinfo.be, DOV, etc. The VMM map viewers have layers available for water assessment maps (watertoetskaart), the insurance maps, flood risk maps, flood danger maps and risk maps for rainfall/ flash floods. A document is currently being drafted to explain how the maps in Flanders relate to each other and what information is exactly accessible in which maps. In time, the objective is to make the data even more user friendly for different target groups such as project developers, the broader public, etc.

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.

In long term policy plans (e.g. Flanders Spatial Policy Plan, the Water Policy Plan (2013)) Climate Change adaptation (and the climate projections) is increasingly integrated into principles and actions. In Flanders Spatial Policy Plan (ongoing), adaptation is included on a strategical level- relevant for spatial planners and project preparation on a high level scale (first stages of large project preparation/ development). Some overarching general principles are certainly relevant with regards to adaptation options/ measures in infrastructure projects, such as blue-green networks, limiting/ preventing additional soil sealing and green infrastructure.

Flood risk management plans and river basin management plans are collated in one document. These plans are the basis for, among other assessments, EIA assessments of large infrastructure projects. In this manner, climate change scenarios (mainly the potential impacts on water quantity) are integrated in the planning and design processes of infrastructure projects. In the Scheldt River Basin Management Plan and the Program of Measures, some guidance on how to integrate climate change adaptation is provided. Some guidance on dealing with water quantity problems, climate change induced or not, is provided through the multi-layer water safety framework, as developed by VMM.

Flanders coastal Protection Master Plan (2011) provides an overview of areas where water protection is low and where measures need to be taken. This has led to the implementation of measures including dykes, providing protection for 1000-year storms and taking into account estimated sea level rise (30cm by 2050). Sand supplement projects are also part of the protection activities.

Similarly the Sigma Plan (2005 update) defines flood protection management in one of the major river basins in Belgium, the Scheldt river basin. This plan is the basis for specific flood protection infrastructure works, such as the design and implementation of natural flood areas (see also Climate ADAPT).

Several initiatives for guidance on integrating climate change in EIA have been set-up:

- Guidance for integrating climate change adaptation in SEA and impact studies is being drafted by the FOD. At federal level, there is also a guidance document for

environmental screening and scoping of projects, which will be revised, based on the new SEA guidance; and

- The Guidelines for integrating climate change adaptation in EIA (2016) in Flanders have been drafted by the Flemish government and are freely available. Currently, EIAs include reference to relevant (local) adaptation policy plans, but do not integrate a tailored vulnerability or risk analysis. In signal areas (signaalgebieden in Dutch), areas where flood risk and future development conflict are predicted, more in-depth information is asked for in the water assessment of EIA.

Guidance for municipalities to integrate adaptation in their infrastructure projects is provided:

- In Flanders, the Burgemeestercovenant website offers a set of adaptation measures and information to aid in adaptation option appraisal (financial, adaptation capacity, etc.) and links to several studies that provide additional guidance. One example is the Cities and municipalities adapt tool and study (2015), see also the chapter on 'tools'. The website includes some guidance on how to finance adaptation projects; and
- In Wallonia, guidance is offered for municipalities to take the first steps in their adaptation plans with a newly-launched campaign 'Adapte ta commune' (2017) (adapt your community) and to carry out a sensitivity analysis (linked to the vulnerability tool) or a set of fiches on potential adaptation measures.

Regarding project applications for structural funds, some material is provided by the managing authorities. All regions (Flanders, Wallonia and Brussels Capital Region) have extensive information, including guidance documents and templates available for project applications (ERDF / INTERREG). In the Flanders templates, there is a description required of how the project improves (the protection of) the environment/ climate change) guidance on the necessities for a project application. A description of 'climate parameters' is demanded in the Walloon guidance.

The city of Ghent is developing a manual for the development of public space to help project developers with practical guidelines (e.g. 'provide X m² of space for water buffering/ infiltration). The objective is to increase the uptake of climate robust measures and provide the solutions the city is aiming for.

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 Bureau for Standardisation (NBN) is collaborating with the European Standardisation Organisations 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).

Currently, in Belgium climate adaptation has first and foremost been included in policy plans and frameworks, rather than hard standards and (legal) requirements.

There are design standards for all sectors (accessible at BEN-website) and there are several standards that address risks from extreme weather events in construction/ infrastructure projects. For instance, addressing flood risk through the regional rainwater regulation or preventing excess heat in buildings through the Energy Performance Standards. At national level, the efforts to integrate climate change adaptation in standards by the European standardization organization CEN are supported. The European standards or modifications to existing standards will be adopted when they become available.

The Regional Rainwater Regulation is a mandatory check to see whether an infrastructure or construction project buffers and infiltrates rainwater in a sufficient manner. This regulation fits the principles of climate change adaptation, but the current regulation does not take the climate projections into account. The regulation includes the calculation of needed water infiltration and buffering volumes.

The design standard for sewer systems, the so-called Code of Good Practice (2012), has explicitly been adapted to address climate change adaptation. In the calculation of capacity for sewer systems, a return period of 20 years instead of two years needs to be used as minimum capacity in order to handle increased / changing rainfall patterns in the future. To receive funding, a sewer project is required to apply the design standard. This ensures the uptake of the design principles of the 'Code of Good Practice'.

Sector organizations, such as Infrabel, the Belgian rail infrastructure manager, have specific in-house design principles. For rail projects, there is a handbook on drainage systems explaining how to calculate the needed water volumes to be infiltrated/ buffered (bundle 30.6.2- available offline). As with the rainwater regulation, the calculations have not yet been adapted to take an increase in (more) extreme weather events into account.

Provinces and local authorities have the authority to install more strict measures in, for instance, their construction codes. This is the case in the cities of Ghent and Antwerp, which have included adaptation measures in their construction codes. Examples of these are the requirement to use light colored surface materials to improve the urban climate in periods of heat waves or the requirement to infiltrate or buffer larger water volumes compared to the norms defined in the regional rainwater regulation. For most of these measures, there is not yet a full understanding of their potential impact.

The above-mentioned cities reference design principles for both public domain and private developments in their adaptation plans. In the case of Ghent, these principles are discussed when relevant in the two weekly meetings for infrastructure projects, where the adaptation team participates. At present, some of the principles are being tested in pilot projects (e.g. for the 'Kettingplein' (2017)). Depending on the results they might become more widely integrated.

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

The National Adaptation Strategy was approved by the National Climate Commission (NCC) in December 2010. The strategy describes the main climate change impacts, the existing adaptation responses, a roadmap to a National Adaptation Plan (NAP) and some policy guidelines for an adapted future. The Strategy pursues the improvement of the communication and consistency between the adaptation activities.

The adaptation working group (CABAO) has prepared the National Adaptation Plan (2017-2020); it was adopted by the National Climate Commission (NCC) in April 2017. This plan identifies specific adaptation measures that need to be taken at national level in order to strengthen cooperation and synergies between the different entities on adaptation. It has been submitted to regional and federal advice Councils to take into account the stakeholders opinions.

Belgium is a federal state, composed of three geographic regions and three language-based communities, each with its own executive and legislative bodies. The regional and the federal governments have adopted, each in their own area of competence, adaptation plans:

- The Brussels Capital Region Adaptation Plan, part of the its Integrated Air-Climate-Energy Plan adopted on 2 June 2016
- The Flanders Adaptation Plan, part of the Flemish Climate Policy Plan 2013-2020
- The Walloon Adaptation Action Plan
- The Federal Contribution to the National Adaptation Plan

Additionally, to back up the above mentioned strategies and plans, there are Impact Assessments for the Brussels Capital Region, for the Flemish region, for the Wallonia region, and for the Federal level.

Belgium has transposed the EIA Directive, which includes provisions on climate adaptation, with the Decree transposing Directive 2014/52/EU of 24 May 2018 in Wallonia), the order of 30 November 2017 reforming the Brussels Code of Spatial Planning (for the Brussels Capital Region), and the Decision of the Flemish Government on the rules for EIAs on 17 February 2017.

Responsible authorities

The following Belgian government organizations can be considered to play a key role with regards to climate change adaptation and its integration in infrastructure projects:

- The National Climate Commission (NCC/ NKC/ CNC), which is responsible for the development, adoption and implementation of the NAS and the NAP.
- the Permanent Secretariat and working group on adaptation (CABAO);
- The Coordination Committee for International Environmental Policy (CCIM/ CCIEP/ CCPIE);
- FOD Health, Food Chain Safety and Environment, Climate Change Unit;
- Policy Area Environment (Omgeving in Dutch), climate Change Adaptation Team (former LNE) & VMM/ CIW;
- The Flemish Task Force Adaptation (VTFA);
- Wallonia Air and Climate Agency, Climate Change Unit (AWAC); and
- Brussels Environmental Agency (Environment Brussels).

International cooperation is organized through the International Scheldt Commission (ISC) and the International Meuse Commission (IMC) for the respective river basins. At a national level, the CCIM Steering Group on Water Policy organizes cooperation between the different regions and the federal government. MOW (Policy Area Mobility and Public works) is one of the representatives in these commissions.

The different contributions to the national adaptation plan (VAP, PACE, integrated air-climate-energy plan and the Federal contribution to the NAP) have involved different sectors. In the table below an overview is provided:

	Federal authority:	Flanders: VAP	Wallonia: PACE	Brussels Capital	National authority:

	Federal contribution to the NAP			Region: Integrated Air-Climate-Energy Plan	NAP
Energy		x		X	x
Infrastructure	x	x		X	
Transport	x	x			
Water Management		x	x	X	
Buildings		x		X	

In Flanders, for instance, the sector administrations are represented in the Flemish Task Force Adaptation (VTFA). The sectors have provided input (e.g. adaptation measures) for the Flemish Adaptation Plan (VAP) and are responsible to follow up on those actions. The working group on adaptation within MOW (Policy Area of Mobility and Public Works), for instance, coordinates efforts to incorporate climate change adaptation in their organization and projects. For instance, AWV (the Road Transport Agency and part of MOW) reported in 2015 on the status of adaptation actions, such as defragmentation of green spaces in order to build climate robust blue green networks and integration of the code of good practice for rain water drainage in its projects (Progress Report Flanders Climate Plan, (2015)). These updates will contribute to a revision of the Flanders Climate Policy Plan, including the Flanders Adaptation Plan (VAP).

Aside from the climate change teams, the water policy units are also important stakeholders, who drive the integration of climate adaptation in both policy and projects and have been driving flood resiliency in Belgium for several decades. The legal framework for the development of water quantity targets and flood risk management targets (2016) has been put in place. The CIW (coordination committee on integrated water policy) has been appointed as 'drought coordinator' for Flanders.

The Policy Area of Economy, science and innovation, responsible for the (re)development of industrial sites and the managing authority in Flanders (Vlaio) is also part of the VTFA.

The overarching approach is to systematically integrate climate change adaptation into different policy plans, sector documents such as:

- Flood Risk Management Plans and River Basin Management Plans (OBRP);
- The Spatial Policy Plan for Flanders (includes climate change adaptation at a strategic level) – pending;
- The greening norm (Flanders Spatial Policy Plan) is not yet in place; and
- Flanders Mobility Plan (This plan will be aligned with the climate change policy plan and spatial policy plan. The approach concerning adaptation is probably not yet complete) - pending.

This approach of mainstreaming is called the "climate reflex" and was one of the objectives of Flanders climate policy.

The accountable regional authorities for adaptation (Policy area Environment – Omgeving, AWAC, Environment Brussels (Bruxelles Environnement), FOD Health, Food Chain Safety and Environment) are involved in the Sendai Platform for the uptake of disaster risk management.

The different legal and organizational structures in the country are explained in detail at the National Climate Platform www.climate.be / www.klimaat.be, in the national Climate

Change Adaptation Plan (2017), in the progress Reports for the IPCC (2013), and at the country webpages for Belgium at Climate ADAPT.

Management of the ESI Funds

Belgium has three Operational Programmes one for each region: Flanders, Brussels Capital Region, and Wallonia. It is also participating in 11 cross-border, transnational or interregional co-operation programmes. The three national Programmes are correspondingly managed by the Flanders Innovation and Entrepreneurship (VLAIO), the Regional government of Brussels, and the Walloon government – SPW. Intermediate bodies in Belgium are any public or private body tasked with the management of operations under the authority of a managing authority or under the certifying authority. In Belgium these functions are mainly taken on by the agencies/ departments of the managing authorities, the provinces and main cities.

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 involved administrations and government organizations have designated accountable persons to integrate climate change adaptation in their line of work or project. Except in leading adaptation administrations (FOD, Departement Omgeving, AWAC, Environment Brussels), people in charge of the uptake of climate change adaptation combine this task with other responsibilities. In most cases, the responsibility is taken on within the Environmental Support Unit. This is for instance the case in Infrabel. Additionally, within the leading adaptation organizations (FOD, Omgeving, AWAC, Environment Brussels), adaptation receives much less attention than mitigation with approximately 5-20% of personnel resources appointed to climate change adaptation and 95-80% to climate change mitigation.

The VTFA, Flemish Task Force Adaptation, consists of administrators from the different policy units and services (spatial planning, urban green, water…). The different sector administrations (MOW, CIW, Environment, Agriculture and Fisheries, waterways) and different agencies within MOW work together on climate change adaptation policy and adaptation measures. Sector administrations have the responsibility to carry out actions with their own budget- no specific budget is provided. There are several sector based working groups (with representatives from the regions/ federal government) who come together and the adaptation team provides information on climate change. Furthermore, the working groups assist in identifying if/ how adaptation can be included in the sectorial work. The approach is not systematic, but ad hoc where the most added value is expected.

The Flemish administration (Environment, team climate change adaptation) organizes meetings to bring together the different municipalities that have signed mayor adapt or the covenant of mayors for climate and energy in order to exchange information. The platform Vlaamse Kimaat Top provides some additional information on e.g. climate studies, climate deals and climate commitments (objectives) from both public, research institutions and government.

Municipalities obtain support on climate change adaptation actions through workshops by e.g. VMM on multilayer water safety (building flood resiliency and dealing with remaining

risks), the VVSG (Flanders association for municipalities, climate and energy day-support with for instance participation to the Covenant of Mayors for Climate and Energy), the provinces and their respective sustainable building support units in Flanders. The Pollec Campaign in Wallonia raises awareness and drives municipalities to start their own energy and climate policy, based on the Covenant of Mayors for Climate and Energy.

Depending on local awareness concerning climate change and institutional capacity, city administrations take action to integrate adaptation in their infrastructure projects not financed through the ESI Funds. For example, at the city of Ghent, a member of the climate change unit joins two weekly meetings with the infrastructure department to ensure that climate adaptation is included in (small and medium sized) urban development projects[3] where possible. These meetings allow city administrators to integrate adaptation measures in the various pilot projects.

The University of Gent (UGent) has a Think tank on Climate Change Adaptation. This four-year project brings together leading experts from both research institutions, the private sector and administrations. Whilst not an official body, the project provides a platform for cooperation and knowledge exchange.

Effective collaboration

Inter-sectoral and intra-sectoral focus groups have also been set up at regional and federal levels. The role of these focus groups is to exchange data, gather information on the adaptation measures currently undertaken by the various departments (bottom-up approach), to identify the objectives and priority measures to be taken and/or reporting on measures undertaken.

Belgium is a federal state, composed of three geographic regions and three language-based communities, each with its own executive and legislative bodies. They intervene on an equal footing but in different areas of competence (further details are available on portal belgium.be).To take national decisions there are commissions/coordination committees where governments and ministries are represented. The National Climate Commission (NCC) deals with domestic climate issues and the Coordination Committee for International Environmental Policy (CCIEP) treats the international environmental affairs.

Within the National Climate Commission, the Adaptation Working Group 'CABAO' is an active platform for knowledge transfer between the regions and federal level. It has organized several sector-based working groups to assist the sectors with including climate change adaptation objectives into their projects and policies. The approach is not systematic, but ad hoc, where added value is expected. The NAP has included the organization of annual workshops to improve the integration of CCA in the different sectors.

International cooperation is organized through the International Scheldt Commission (ISC) and the International Meuse Commission (IMC) for the respective river basins. At a national level, the CCIM Steering Group on Water Policy organizes cooperation between the different regions and the federal government. MOW (Policy Area Mobility and Public works) is one of the representatives in these commissions.

Financial resources

The ESI Funds are enabling the development of major projects in the 2014 – 2020. Concerning major projects, by early 2018, there have been no funds allocated for major

[3] The projects in question are not major projects and not funded by ESIF. One of the pilot projects is for instance the redevelopment of a square 'Kettingplein'. Some of lessons learned from the pilot projects will be used to then change 'standards' for design solutions. As most projects are still in a pilot phase and not integrated as a standardized design solution, they are not yet included in the section of 'design standards' of this country report.

projects in Belgium for the 2014 -2020 programming period according to the datasets of the European Commission. However, the dataset will be updated regularly to reflect changes in the programme lists and major project notifications.

According to the ESIF-viewer, Belgium is planning investments of 2.3 Billion EUR. Projects under the Thematic Objective 5 on promoting climate change adaptation, risk prevention and management will be receiving 6 Million EUR, with an additional 2 Million EUR approved for Network Infrastructures in Transport and Energy (Thematic Objective 7); and 165 Million EUR in Environment Protection & Resource Efficiency (Thematic Objective 6); 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 funding[4] demand that project applications integrate climate change considerations[5], such as a vulnerability and risk analysis and adaptation option appraisal. At EU-level, material is available to assist in fulfilling these requirements. Key websites and documents are:

- The Climate-ADAPT website containing many links to data and a map viewer
- 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*.[6]

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 sea-level rise and extreme weather events, such as extended heatwaves, flooding, heavy rainfall or storm, and landslides amongst others.

[4] http://ec.europa.eu/regional_policy/archive/projects/major_projects/index_en.cfm

[5] 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

[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.

Extreme weather events are a potential threat to both infrastructure and operation of the transport system.

At national level, the web portal www.climat.be (in French) and www.klimaat.be (in Dutch) presents general information on climate change and adaptation, national and regional research reports and the national climate adaptation plan (2017), including sector related information and a description of impacts on a strategic level. The MIRA portal and report (2015) provide extensive data on climate change some for the territory of Belgium, others only for Flanders. The 'Evaluation of vulnerabilities for the Walloon Region regarding climate change' (2011) is a vulnerability analysis for the territory in Wallonia. This information is relevant to projects in all sectors.

Key-documents such as the 'Vision 2050, a long term-strategy for Flanders' (2016) provide a policy framework on future integration of climate change adaptation in projects.

The think tank adaptation, a group of leading experts on climate change from different administrations and research institutions, has released a brief discussion note on climate change in the transport sector (2016), including some policy recommendations and practical examples of adaptation measures.

Road infrastructure

The Flanders Policy Area Mobility and public works (MOW) has both road transport infrastructure (agency of road transport- AWV) and waterway projects (de Vlaamse Waterweg- Flanders Waterways) in its portfolio. AWV follows the requirements set in the EIA guidelines and water assessment ('Watertoets' in Dutch) when constructing new infrastructure. For large road infrastructure projects were the VMM (Flanders Environment Agency) provides advice, the VMM states that they take climate projections into account to define the safety levels for the water assessment.

The code of good practice for sewer systems and water drainage (2012) takes climate change into account and is systematically used in AWV projects. Within AWV, some changes to standards, in materials used and project processes have been integrated, but these changes have not been documented in reports or other accessible sources. The measures are e.g. to minimize soil sealing by using permeable surface materials for car parking, maximizing green areas, etc. With regards to disaster risk prevention and management, dynamic traffic management is used to manage and control traffic in the case of e.g. extreme weather events.

The progress report of the VAP (2015, Flemish Adaptation Plan) has a limited list of the progress made and implemented adaptation measures by the agency (e.g. defragmentation of nature areas and sustainable road verges in order to increase climate robust blue green networks).

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

Railway infrastructure

The Federal Contribution to the NAP (2016) includes adaptation targets and actions for the railway transport sector.

Rail infrastructure manager Infrabel has carried out a risk analysis (offline document), which has resulted in additional awareness on the topic of climate change adaptation at an organizational level. The risk analysis has resulted in the following approach:

- Attention will be paid to the integration of climate change adaptation in the design of large engineering works with a long lifetime (100 year) such as bridges and tunnels. Specific design guidelines exist in a handbook for these types of infrastructure projects and a table with parameters and data on changes in

climate patterns are included. The first focus of Infrabels adaptation efforts will be on these projects.

- A design standard (bundle 30.6.2) on drainage systems and water management will be updated in a next phase. Steps are taken to collect data and translate climate projections into the design standard.

- Overhead lines and rail tracks are appliances that can be gradually adapted to changes in climate patterns and as such not the subject of climate change adaptation efforts within Infrabel.

All documents by Infrabel are offline. Infrabel has participated in research project Ariscc and follows the actions of sector organization UIC. While the Ariscc project is used as an internal framework for decision making, the full methodology will not be carried out.

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

Airport infrastructure

The Federal Contribution to the NAP (2016) includes adaptation targets and actions for the air transport sector. The general consensus is that because of the very high safety factors that are currently used for risk assessments, climate change impacts will not require different decisions or approaches.

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

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.

At national level, the web portal www.climat.be (in French) and www.klimaat.be (in Dutch) presents general information on climate change and adaptation, national and regional research reports and the national climate adaptation plan (2017), including sector related information and a description of impacts on a strategic level. The MIRA portal and report (2015) provide extensive data on climate change some for the territory of Belgium, others only for Flanders. The 'Evaluation of vulnerabilities for the Walloon Region regarding climate change' (2011) is a vulnerability analysis for the territory in Wallonia. This information is relevant to projects in all sectors.

The broadband sector is not involved in the federal or regional climate change adaptation plans or initiatives organized by the administrations and other governmental bodies. There are no ESIF-projects for the broadband sector in Belgium. Nevertheless, it is a general best practice for operators to use flood mapping information from environmental agencies to safeguard new planned data centres from flooding. As Belgium supports the integration of climate change adaptation in European standards, developments for e.g. design standards on datacenters will be adopted when in place at EU level.

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.*[7]

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.

At national level, the web portal www.climat.be (in French) and www.klimaat.be (in Dutch) presents general information on climate change and adaptation, national and regional research reports and the national climate adaptation plan (2017), including sector related information and a description of impacts on a strategic level. The MIRA portal and report (2015) provide extensive data on climate change some for the territory of Belgium, others only for Flanders. The 'Evaluation of vulnerabilities for the Walloon Region regarding climate change' (2011) is a vulnerability analysis for the territory in Wallonia. This information is relevant to projects in all sectors.

The regional planning policy plans (Flanders draft spatial policy plan- Witboek ruimte Vlaanderen (2016), Wallonia Spatial development Plan SDER (2013) and Brussels regional development plan GPDO (2013) form the basis of urban development projects. The plans take adaptation into account on a strategic level.

All three regional authorities provide information, tools and guidance to support local communities in the uptake of climate change into their projects.

- In Flanders, the burgemeestercovenant website offers a set of adaptation measures and information to aid in adaptation option appraisal (financial, adaptation capacity, etc.) and links to several studies that provide additional guidance. One example is the Cities and municipalities adapt tool and study (2015), see also the chapter on 'tools'. The website includes some guidance on how to finance adaptation projects and integrate adaptation in spatial planning.
- In Wallonia, guidance is offered for municipalities to take the first steps in their adaptation plans with a newly launched campaign 'Adapte ta commune' (2017) (adapt your community) including a tool to support setting up a local adaptation plan and carrying out the vulnerability study. A separate webpages provides information on a set of fiches on potential adaptation measures.
- In Brussels, subsidies for the sustainable development of neighborhoods are used to increase sustainable practices and the cities resilience.

[7] 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.

The covenant of Mayors for Energy and Climate, which has tools and guidance material for municipalities to carry out risk and vulnerability assessments, is promoted in the different regions:

- In Wallonia, through the Pollec Campaign;
- In Flanders, the Policy Area Environment (Omgeving in Dutch) supports cities by organizing workshops for cities that have signed up. Provinces (e.g. East of Flanders: Healthy Climate campaign of Antwerp) or inter-municipal partnerships (e.g. Leiedal) provide group sessions or information campaigns.

The province of Antwerp has its own regional adaptation plan (2016) with seven key actions, one of which is specifically to support the uptake of adaptation by municipalities.

Vlaio (Flanders, Policy area Economy), provides funding for the development of industrial sites. To an extent, the brownfield covenant also supports the uptake of climate adaptation in project development, as it supports the sustainable redevelopment of sites and climate objectives are part of those. However, how this is done is not made specific in the covenant, nor are there particular objectives/ requirements regarding climate adaptation and focus has mainly been on climate change mitigation measures until now. Vlaio provides a voluntary sustainability assessment (2015) to help developers and this can be downloaded after completing a contact request. Regarding climate change adaptation, the tool asks for a heat stress vulnerability study and flood risk assessment (mentioning the climate scenarios and changing precipitation patterns, a demand for increased water infiltration and buffering and green infrastructure).

The cities of Ghent (2012) and Antwerp (2013) both have several vulnerability studies for their territory (online and offline sources), allowing, among others, to define priorities and execute adaptation measures in e.g. heat stress prone areas of the city. Antwerp and Ghent developed Climate Adaptation Plan and climate platforms (Antwerp, Ghent). For a selection of pilot projects: see the case studies and chapter on methodologies. As mentioned in the section on available tools, sustainability assessments (e.g. city of Ghent (2014)) and urban sustainability projects (e.g. sustainable area contracts in Brussels) add a qualitative approach to integrating climate change (measures) in urban development projects.

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, …), etc.

At national level, the web portal www.climat.be (in French) and www.klimaat.be (in Dutch) presents general information on climate change and adaptation, national and regional research reports and the national climate adaptation plan (2017), including A brief overview of the (potential) main impacts of climate change on the energy sector. The MIRA portal and report (2015) provide extensive data on climate change some for the territory of Belgium, others only for Flanders. The 'Evaluation of vulnerabilities for the

Walloon Region regarding climate change' (2011) is a vulnerability analysis for the territory in Wallonia. This information is relevant to projects in all sectors.

Sector organization FEBEG (the federation of Belgian electricity and gas companies) is involved 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 sector's overall sensitivity to climate change within the BENELUX.

The energy sector is represented in both the Flanders Adaptation Plan (VAP) and Brussels Integrated Air-Climate-Energy Plan. The measures included in the VAP are however not focused on analyzing potential impacts from climate change to the sector or the integration of adaptation in energy infrastructure projects. There is no information provided on adaptation of energy production, distribution networks or storage.

The Flanders Energy Agency (VEA) provides regular updates on calculation methods as foreseen in its design standards for constructions regarding ventilation, cooling and energy management (Energy Performance). The Flanders Adaptation Progress Report (2015) shows that climate change scenarios have not (yet) been considered.

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.

At national level, the web portal www.climat.be (in French) and www.klimaat.be (in Dutch) presents general information on climate change and adaptation, national and regional research reports and the national climate adaptation plan (2017), including sector related information and a description of impacts on a strategic level. The MIRA portal and report (2015) provide extensive data on climate change some for the territory of Belgium, others only for Flanders. The 'Evaluation of vulnerabilities for the Walloon Region regarding climate change' (2011) is a vulnerability analysis for the territory in Wallonia. This information is relevant to projects in all sectors.

International cooperation is organized through the International Scheldt Commission (ISC) and the International Meuse Commission (IMC). On a national level, the CCIM (coordination committee on international policy) steering group on water policy organizes cooperation between the different regions and the federal government. The water quantity targets are, for instance, discussed in this group.

Because of the historic importance of water safety in Flanders and Belgium, impacts on the water system are well researched. The Sigma plan (1977) was for instance developed as an answer to the 1976 flood of the River Scheldt. The plan was updated in 2005 to integrate new insights on other aspects climate change and to form the basis for flood protection actions and integrated water management along the river Scheldt.

With the awareness of potential climate change impacts increasing, drought is being taken into account more often in the last few years. This has for instance led to the efforts to define water quantity targets (2016) and set priorities regarding water use in

times of shortage (in development). The CIW (coordination committee on integrated water policy in Flanders) has been appointed as 'drought coordinator'. VMM (Flanders Environment Agency) provides guidance on how to increase rain water infiltration into the soil and offers an overview of potential technical solutions.

For waterway projects, data on climate change are integrated, either by taking the climate scenarios into account or a higher return period for certain rainfall, combined with sea level rise. Two examples within the framework of Flanders' masterplan coastal safety (2011) are the storm surge barrier in Nieuwpoort or the adapted sea dike in Wenduine (2015). For projects in the proximity of the coast, the highest safety levels regarding wind climate are used. Waterway managers are responsible for flood protection and therefore often focus on flood related climate risks aspects which they take into account in projects (based on climate projections). Research institutes such as Flanders hydraulic institute, and Flanders Marine institute provide specific practical knowledge (see also chapter on data and tools).

The Flanders Policy Area Mobility and public works (MOW) has both road transport infrastructure (agency of road transport- AWV) and waterway projects (de Vlaamse Waterweg- Flanders Waterways) in its portfolio. The policy department provides support on integrated water management and climate change adaptation. The Policy Area has a specific adaptation working group, to coordinate the adaptation efforts within the policy area and where the different agencies, such as AWV, are represented. Climate change adaptation efforts within MOW have primarily been focused on flood risk and water related issues.

MOW is one of the partners for the 'Climate change adaptation for maritime and inland port and navigation structure' report by sector organization PIANC (World Association for Waterborne Transport). The report will provide good practice guidance on climate change adaptation for ports and inland waterways and consist of a four step approach, including vulnerability and risk assessment and defining and implementing adaptation measures. The report is not yet finalized, but the framework is published online.

The "Water management Waterways, preview 2020" masterplan, developed by Flanders Waterways, describes how climate change adaptation is integrated in the projects for water transport infrastructure. A few examples are the construction of pumping installations and waterpower plants, renewal of lock and weir complexes, river restoration projects, etc. In new engineering works (locks etc.) water saving measures are integrated in the design and hydraulic modelling takes climate scenarios into account. This has been carried out in several projects such as the new lock in Harelbeke or the update for the canal to Charleroi.

The funding for sewer system projects depends on the use of the code of good practice for sewer systems (2012), which takes climate change impacts into account.

Several instruments in the water sector allow to integrate climate change adaptation in infrastructure projects and urban development:

- The methodology for Flood Risk Management Plans (FRMP), which is integrated in the River Basin Management Plans in Flanders (including uptake of climate change scenarios).

- A methodology for developing rainwater plans, to be carried out by the municipalities. The objective of a rainwater plan is to define where and how rain water can be infiltrated, buffered and carried of (in that order). The methodology specifically mentions that climate change scenarios should be taken into account, but does not give a detailed description of how this should be done.

- Water assessment (watertoets). The climate scenarios are taken into account in the case of large construction projects by VMM (Flanders environmental Agency)

to define the safety levels. In Signal areas a more in-depth analysis is required. These assessments are used as water assessments within EIA's.

- The CIW is developing a code of good practice for local authorities with regards to flood resiliency, within the framework of the multi-layer water safety approach (a qualitative approach to increasing climate resilience). This is however in development and not yet available.

- Interactive map viewers with data for the water sector and on water related climate impacts: The Flemish water managers, Walloon waterways and Walloon Floods portal

- GIS-webplatform that shows flood-risk (includes a layer that shows the impacts according to a high climate scenario 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.

At national level, the web portal www.climat.be (in French) and www.klimaat.be (in Dutch) presents general information on climate change and adaptation, national and regional research reports and the national climate adaptation plan (2017), including sector related information and a description of impacts on a strategic level. The MIRA portal and report (2015) provide extensive data on climate change some for the territory of Belgium, others only for Flanders. The 'Evaluation of vulnerabilities for the Walloon Region regarding climate change' (2011) is a vulnerability analysis for the territory in Wallonia. This information is relevant to projects in all sectors.

For landfills, 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 regional design standards (VLAREM II Part 5 in Flanders and AGWs in Walloon Region; currently there are no open landfills in Brussels Region) for the construction of landfills that include the consideration of temperature, precipitation extremes and flooding where relevant. The Flemish Waste Agency (OVAM) and the Flemish Ministry of Environment (Departement Omgeving) are assessing (closed) landfills located alongside the river Scheldt in Flanders. Possible scenarios (relocation and protection of the landfills against) flooding are being studied. The study is not available online.

No other climate adaptation measures related to waste have been revealed by the desk study or interviews. There is no sensitivity analysis available for the waste sector or for waste infrastructure projects, as known by the Flemish waste organization OVAM. Underground waste collection systems have not taken more extreme weather events into account. 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 infrastructure projects which have addressed climate change adaptation

Redevelopment Groenplaats, Antwerp	
Project description	(Re)design and redevelopment of the square 'Groenplaats' on the basis of a heat stress and wind climate analysis. In a participatory design process, the project must provide a solution for a place that is vulnerable to heat stress.
Photograph	
Budget	The budget for including the climate modelling in this project was 20.000 euro (extra budget)
Climate Change Vulnerability and Risks	The Groenplaats scored very badly in Antwerp's heat stress study. There is little shadow to be found in summer and a lack of green or blue feature. Due to its central location, this situation is expected to grow even worse in the future.
Climate change adaptation measures	- Vulnerability analysis and climate check of design - Green infrastructure to provide shade - Water and plant feature to provide a cooler climate
Good practice	The project process is set up in such a way that the adaptation potential is maximised during the whole process: the project starts

	from a vulnerability analysis (heat and wind climate) by a research team. They do not leave the project, but stay involved and check the effectivity of the design with regards to the improvement of the urban climate. Climate change adaptation objectives are a part of the terms of reference for this assignment.
Further information	https://burgemeestersconvenant.login.kanooh.be/groenplaats-antwerpen-participatief-ontwerp-voor-heraanleg-van-een-koeler-plein-met-een-warme-sfeer https://www.antwerpen.be/nl/overzicht/stadsvernieuwing/groenplaats

KerkeBEEK-Flood risk management plan and implementation	
Project description	In this flood risk management plan (FRMP), climate scenarios have been integrated. Eight governmental organizations (local municipality to regional administrations) signed a 'river contract' committing themselves to look for solutions to flood risk in the area of the Kerkebeek, together with citizens, companies in the area and other stakeholders and this in a one-year process. A specific project website has been set up. One of its functionalities informs stakeholders on how climate change could change the flood risk they are facing. Over 200 people participated in the workshops to define adaptation measures, including both infrastructure works and 'soft' adaptation measures.
Photograph	
Budget	N/A
Climate Change Vulnerability and Risks	The main risk addressed was flood risk.
Climate change adaptation measures	More than 120 potential measures were defined by the different stakeholders. In a follow up meeting on October 21, 2017, additional steps will be taken to further define measures and win-wins. One example is to define the different functions a potential water buffer should take on, based on the needs of the local community.
Good practice	The participatory approach provides an answer to dealing with uncertainty and remaining risk, whilst, creating both awareness and creative solutions. Thinking about adaptation together with the different stakeholders has led to an inspiring process that will be replicated in other flood risk management projects.
Further information	https://www.vmm.be/nieuws/archief/ondertekening-charter-eerste-stap-naar-riviercontract-voor-kerkebeek https://www.vmm.be/publicaties/orbp-analyse-west-vlaanderen

KEttingplein	
Project description	The projects objective is to design a robust square. The project is one of a series of pilots for infra projects in the city of Ghent and was set up in the framework of the climate change adaptation plan (2016-2019) for a climate robust city. For the square, the modelling of climate impacts was based on climate projections for storms with a return period of 50 years, based on data from the Royal meteorological institute and university of Leuven (RMI/KUL). With regards to the design process, a participatory approach was set up. A climate check of the different design options has been incorporated in the process.
Photograph	N/A
Budget	N/A
Climate Change Vulnerability and Risks	The main issues are heat stress and flood risk
Climate change adaptation measures	Currently, three designs are being weighed against each other. They provide a combination of the following measures: - Providing shade and a cooler environment through the planting of trees - Water buffering above ground (water square) - Decrease soil sealing by creating natural areas - Choice of specific plants
Good practice	1. Integration of climate projections and impacts in the criteria for urban development projects. The process of building a knowledge basis and experience through pilot projects provides the city with a solid basis for future decisions on climate change adaptation options. The results from the pilot projects are evaluated in order to acknowledge which measures could become 'requirements' in future projects.
Further information	https://stad.gent/mobiliteit-openbare-werken/openbare-wegenwerken-uw-buurt/openbare-werken-gent-centrum/openbare-werken-ontwerpfase/kettingplein-en-omgeving

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